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Društva Genetičara Srbije i IX Simpozijum Društva selekcionera i
semenara Republike Srbije

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PLENARNA PREDAVANJA

PL-1

KONKURENTNA STRATEGIJA POSLOVANJA JAVNOG INSTITUTA ZA OPLEMENJIVANJE

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Postoji dugotrajna debata i pogrešno shvatanje uloge javnih oplemenjivačkih instituta u semenskoj industriji u jugoistočnoj Evropi. Neke dileme se odnose na sledeća pitanja: Da li javni istraživački instituti treba da obavljaju komercijalne aktivnosti zajedno sa naučnim? Kakvu vrstu vrednosti i konkurentsku strategiju oni mogu nastaviti? Šta je sa društvenom odgovornosti Instituta u slučaju njihove privatizacije? Uglavnom zbog ograničenih javnih budžeta kako u zemljama u razvoju tako i u razvijenim zemljama, politika Vlade često uključuje privatizaciju javnih oplemenjivačkih instituta kao rešenje problema. S obzirom da su mnoge komercijalne sorte još uvek razvijene konvencionalnim tehnikama oplemenjivanja, zainteresovanost za preuzimanje takvih institucija je u porastu tokom poslednjih nekoliko decenija. Međutim, nije posvećena velika pažnja razvoju konkurentne poslovne strategije u javnim institutima za oplemenjivanje, tako da krajnji korisnici i društvo mogu i dalje imati koristi i javne dobrobiti. Ovaj rad se bavi ovom posebnom agendom koja je već godinama bila na stolu u okviru Vlada i akademske zajednice u regionu. Uključuje menadžerski pristup zasnovan na temama Majkla E. Portera i iskustvu na terenu u postizanju konkurentne poslovne strategije u Poljoprivrednom institutu Osijek, Hrvatska. Analizira važnost održive poslovne strategije koja uključuje posebnu vrednost, zajedno s osnovnim elementima druge strategije koji su potrebni za zadovoljavanje potreba klijenata i društava, kako bi se zadržao i položaj Instituta na tržištu.

Ključne reči: biznis, strategija, predlog ponude, privatizacija.

COMPETITIVE BUSINESS STRATEGY OF A PUBLIC BREEDING INSTITUTE

There is a long-term debate and misconception about the role of the public breeding institutes in the seed industry in southeastern Europe. Some of dilemmas refer to the following questions: Should a public research institutes practice commercial activities along with scientific ones? What kind of value proposition and competitive strategy can they pursue? What about social responsibilities of the Institutes in case of their privatization? Mainly due to squeezed public budgets in both developing and developed countries, the governments' policy often includes privatization of public breeding institutes as a proposed solution to the problem. Since vast of commercial cultivars have been developed still by conventional breeding techniques, the interest for acquiring such institutions raised over the last several decades. However, not much attention has been paid to developing competitive business strategy within the public breeding institutes so the customers and society may still benefit from the both its value proposition and public good. This paper deals with this particular agenda that has been on the table for years within the governments and academic community in the region. It includes managerial approach based on Michael E. Porter's foundations and on-the-ground experience in pursuing competitive business strategy at the Agricultural Institute Osijek, Croatia. It analyses the importance of having sustainable business strategy that includes a distinctive value proposition along with other strategy's essential elements required for meeting both customers' and societal needs, as for keeping the Institute's position on the market as well.

Key words: business, strategy, value proposition, privatization

PL-2

PROIZVODNJA SEMENA U REPUBLICI SRBIJI KROZ NUMERIČKE POKAZATELJE O BROJU SORTI, POVRŠINI I PRINOSU

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Oplemenjivanje i selekcija su početni koraci u stvaranju novih sorti. Stvaranje nove sorte zahteva vreme i troškove, ali stvaranje nove sorte ne znači da će ona opravdati svoja ulaganja i dostići komercijalnu vrednost. U Republici Srbiji u Registru sorti poljoprivrednog bilja upisano je mnogo više sorti nego što se koristi u komercijalnoj proizvodnji. U ovom radu predstavljena je proizvodnja semena u Republici Srbiji, kroz numeričke pokazatelje broja registrovanih sorti, broja sorti koji se komercijalno koriste, kroz podatke o površinama, prinosu i atestiranim količinama semena, a takođe je analitičkim pristupom prikazana zastupljenost domaćih i stranih sorti najvažnijih poljoprivrednih kultura.
Cilj ovog rada je da se na osnovu podataka predstavi stanje i trendovi u oblasti semenarstva prema merljivim parametrima.

Ključne reči: sorta, seme, broj, količina

PRODUCTION OF SEEDS IN THE REPUBLIC OF SERBIA THROUGH NUMERICAL INDICATORS ON THE NUMBER OF VARIETIES, AREA AND YIELD

Breeding and selection are the initial steps in creating new varieties. Creating a new variety requires time and cost, but the creation of a new variety does not mean that it will justify its investments and achieve commercial value. In the Republic of Serbia, much more varieties have been entered in the Register of Agricultural Varieties than they are used in commercial production.
In this paper production of seeds in the Republic of Serbia has been presented, through numerical indicators of the number of registered varieties, the number of varieties that are commercially used, through data on areas, yield and certified quantities of seeds, and also the analytical approach shows the representation of domestic and foreign varieties of the most important agricultural crops.
The aim of this paper is to present the state and trends in the field of seed production based on the data according to the measurable parameters.

Key word: variety, seed, number, quantity

PL-3

GENETIČKI RESURSI KUKURUZA U CRNOJ GORI KAO VRIJEDAN IZVOR NOVE GENETIČKE VARIJABILNOSTI

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Kukuruz (*Zea mays* L.) predstavlja jednu od najvažnijih gajenih biljaka na svijetu. Smatra se da je njegova domestifikacija počela u Centralnoj Americi prije oko 9000 godina. Odabiranjem genotipova prema vlastitim potrebama i po sopstvenim selekcionim kriterijumima čovjek počinje da se direktno miješa u prirodne tokove selekcije stvarajući na taj način nove populacije sa novom genetičkom varijabilnošću. Nestankom tradicionalnih sistema proizvodnje, kao i uvođenjem hibridne, mnogo prinosnije germplazme, najveći broj lokalnih populacija kukuruza je iščezao ili se nalazi u fazi nestajanja. U drugoj polovini XX vijeka, kada je već postalo jasno da poboljšane sorte i hibridi počinju da naglo potiskuju lokalne sorte i varijetete kukukuruza, započinje organizovano sakupljanje i kolekcionisanje ovih resursa, kao i formiranje banki gena za njihovu konzervaciju. U kolekcionim misijama izvedenim početkom ovog vijeka na velikom broju lokaliteta u Crnoj Gori sakupljeno je 68 lokalnih populacija kukuruza. Pored toga, u radnoj kolekciji Banke gena Instituta za kukuruz „Zemun Polje" konzervisano je još 320 uzoraka kukuruza koji su šezdesetih i sedamdesetih godina prošlog vijeka sakupljeni u Crnoj Gori. Najveći broj kolekcionisanih populacija pripada tipu genetski relativno čistih crnogorskih tvrdunaca, dok manji broj posjeduje i neka druga obilježja karakteristična za zubane i poluzubane. Crna Gora nema vlastiti program selekcije kukuruza i na proučavanju ovog materijala do sada vrlo malo rađeno. Kako bi ovaj dragocjeni resurs bio dostupan svima onima koji za njega iskažu interesovanje neophodno je što prije započeti njegovo sistematsko izučavanje, koje će pored morfoloških i bioloških osobina ponuditi i dovojno informacija o njegovoj upotrebnoj vrijednosti.

Ključne riječi: kukuruz, genetički resursi, lokalne populacije, genetička varijabilnost

GENETIC RESOURCES OF MAIZE IN MONTENEGRO AS A VALUABLE SOURCE OF NEW GENETIC VARIABILITY

Maize (*Zea mays* L.) is one of the most important cultivated plants in the world. It is believed that its domestication began in Central America about 9000 years ago. Man begun to interfere directly with natural selection patterns by selecting genotypes according to their own needs and own selection criteria, thereby creating new populations with a new genetic variability. With the disappearance of traditional production systems, as well as the introduction of hybrid, much more yielding germplasm, the largest number of local maize populations has disappeared or is in the phase of disappearance. In the late twentieth century, when it became clear that improved varieties and hybrids are beginning to suppress local maize populations and varieties, the organized collection and collecting of these resources begins, as well as the establishing of gene banks for their conservation. In collecting missions carried out at the beginning of this century on a large number of sites in Montenegro 68 local populations of maize were collected. Besides that, in the working collection of the gene bank of Maize research institute "Zemun Polje" more than 320 maize samples are preserved, which were collected in Montenegro in the sixties and seventies of the last century. The largest number of collected populations belongs to the type of genetically relatively pure Montenegrin flint corn, while a fewer are dent and half-dent type. Since Montenegro does not have its own selection programs for maize, these accessions have been poorly studied so far. In order to make this valuable resource available to all those who express their interest in it, it will be necessary to begin activities on its morphological and molecular identification as soon as possible, and provide as much information about its use-value.

Key words: maize, genetic resources, local population, genetic variability

PL-4

ANALIZA GENETSKE STRUKTURE INBRED LINIJA POLJOPRIVREDNOG INSTITUTA OSIJEK

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Različite heterotične grupe prisutne u danjašnjoj germplazmi kukuruza potječu od nekolicine američkih oplemenjivačkih programa s početka 20. stoljeća i manjeg broja kasnijih introdukcija autohtone germplazme. Informacije o genetskoj strukturi oplemenjivačkog materijala omogućuju smanjenje opsega selekcijskih pokusa uz zadržavanje efikasnosti detekcije najboljih potomstava. Cilj ovog istraživanja bio je analizirati genetsku strukturu inbred linija kukuruza razvijenih na Poljoprivrednom institutu Osijek u proteklih 10 godina u kontekstu pripadnosti pojedinim heterotičnim skupinama. Inbred linije genotipizirane su Illumina MaizeSNP50 čipom s 56000 polimorfnih SNP markera. Genotipizirane su ukupno 343 linije, uključujući tipične predstavnike svake heterotične skupine. Filtriranjem neostvarenih markera i markera koji nisu pridruženi ni jednom kromosomu dobiveno je 47000 markera koji su korišteni za analize. Analiza genetske strukture provedena je u programu STRUCTURE 2.3.4. iz 2012. godine s 5000 ciklusa zagrijavanja i 10000 replikacija. Pretpostavljeno je 10 izvornih populacija (K=7). Ostvareni rezultati obrađeni su u CLUMPAK (*Clustering Markov Package Across K*) sučelju s ciljem utvrđivanja omjera izglednosti za optimalni broj K. Procijenjeni K bio je 7 i svi rezultati bili su u skladu s evidencijom oplemenjivača. Između roditeljskih linija komercijalno najznačajnijih hibrida postojala je očigledna razlika u genetskoj strukturi. Kako bi se procijenila kvantitativna veza između genetske strukture i agronomskih svojstava hibrida, regresijska analiza treba biti provedena.

Ključne riječi: inbred linije, kukuruz, genetska struktura, SNP

GENETIC STRUCTURE ANALYSIS OF AGRICULTURAL INSTITUTE OSIJEK PROPRIETARY MAIZE INBRED LINES

Distinctive heterotic groups present in today maize germplasm originate from several US breeding programs from early 20th century, and a few later introductions of indigenous late tropical and early flint material. Information on genetic structure of breeding material provides breeders the means to minimize the number of crosses and size of trials, while maintaining the power of detection of the best progenies. The main objective of this work was to analyze the genetic structure of maize inbred lines, developed through past 10 years in Agricultural Institute Osijek in context of belonging to some of the main heterotic groups. All inbred lines were analyzed using Ilumina MaizeSNP50 genotyping chip with 56000 polymorphic SNP markers. Total of 343 inbred lines were genotyped including typical representatives of each heterotic group. Filtering of poorly typed markers and markers that failed to assign to any chromosome resulted in 47000 SNPs used for analyses. Genetic structure analysis was performed in software STRUCTURE version 2.3.4. from 2012 with 5000 burn-in cycles and 10000 replicates. Ten populations were assumed (K=10). Generated results were further processed using CLUMPAK (*Clustering Markov Package Across K*) interface in order to obtain likelihood estimates for optimal number of K. Estimated K was 7, and all the results were in concordance with the breeders notes. There was the evident distinction in terms of genetic structure between parental inbreds of the most commercially successful hybrids. In order to estimate quantitative relationships between the genetic structure and hybrid performance, regression analysis needs to be conducted.

Key words: maize inbreds, germplasm, genetic structure, SNP

PL-5

OPLEMENJIVANJE DRVENASTIH VRSTA U BOSNI I HERCEGOVINI – STANJE I MOGUĆI PRAVCI RAZVOJA

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Oplemenjivanje šumskog drveća je u čvrstoj vezi sa uzgojem pa se može reći da je rad na oplemenjivanju počeo u isto vrijeme sa uzgojnim radovima u šuma BiH. Međutim intenzivnije oplemenjivanje počinje poslije Drugog svjetskog rata ili tačnije u periodu 1955-1960. godina. Više od 60 godina aktivnosti na oplemenenjivanju šumskog drveća u Bosni i Hercegovini je vremenski period kada se možemo „okrenuti iza sebe“, napraviti analizu ostvarenog i kritički predstaviti stanje danas. U radu se prikazuje trenutno stanje šuma u BiH sa aspekta oplemenjivanja i u smislu diverziteta (genetičke raznovrsnosti), kvaliteta šuma, te bioloških u uzgojnih karekteristika. Daje se pregled šta je urađeno u oblasti oplemenjivanja do sada kroz prikaz stanja zaštićenih područja, sjemenskih objekata, provenijeničnih testova, testova potomstva, sjemenskih plantaža i dr. Oslanjajući se na realizovano, sagledavajući svjetske trendove, uvažavajući prilike u kojima se nalazimo, autori daju prijedloge i smijernice daljih aktivnosti, kao i prognoze realno ostvarivih aktivnosti i mogućih rezultata oplemenjivanja na ovim prostorima.

Ključne riječi: oplemenjivanje, trenutno stanje, dalje aktivnosti, BiH

BREEDING OF WOODY PLANT SPECIES IN BOSNIA AND HERZEGOVINA – THE CURRENT CONDITION AND ALTERNATIVE DIRECTIONS

Bearing in mind the fact that breeding of woody plant species is closely related to silviculture, it can be said that the initial breeding activities in the B&H forest occured at the same time when silviculture activities did. Whereas, the breeding activities were instensified after World War II or more precisely during the period between 1955 and 1960. The period of over 60 years of implementing breeding activities in forestry in Bosnia and Herzegovina allows us to take a look back on what we have accomplished, run an analysis of the achieved goals and critically present the current situation. The paper presents the current condition of B&H forests derived from the aspect of breeding, and in terms of diversity (genetic diversity), quality of forests and biological and silvicultural characteristics. There is an overview of what has been done in the field of breeding through the presentation of the condition of protected areas, seed stands, provenances and progeny tests, seed orchards, etc. Relying on the achieved goals, considering the world trends, taking into account circumstances and conditions, the authors provide suggestions and guidelines for further operations, as well as prospects of achievable activities and possible results of breeding throughout this region.

Key words: breeding, current state, further activities, B&H

PL-6

PRIMJENA SAVREMENIH METODA OPLEMENJIVANJA U MLIJEČNOM GOVEDARSTVU

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Govedarska proizvodnja u poljoprivredno razvijenim zemljama je nosilac stočarske proizvodnje, a stočarstvo je nosilac ukupne poljoprivrede proizvodnje. Mlijeko je, pored mesa, najznačajniji proizvod u govedarstvu. U svijetu se smatra da je proizvodnja mlijeka od strateškog značaja jedne zemlje. Intenzivnije oplemenjivanje u mliječnom govedarstvu počinje u dvadesetom vijeku kada je i napravljen veliki iskorak u selekciji goveda i usavršavanju visoko proizvodnih mliječnih i kombinovanih rasa kao što su: holštajn, braunsvis, simentalac itd. Osnovu oplemenjivanja čini procjena priplodne vrijednosti bikova i krava, koji će biti roditelji budućih generacija. Uzgajivači su koristili, a i danas koriste, različite metode procjene priplodne vrijednosti pa u tu svrhu se primjenjuju metode poređenja majka – kćerka, poređenje vršnjakinja, modifikovana metoda poređenja vršnjakinja, a kasnije selekciji indeks, metoda najmanjih kvadrata, metoda najboljih objektivnih pokazatelja, metoda modela individue. U drugoj polovini dvadesetog vijeka, kad se spoznala struktura dezoksiribonukleinske kiseline i kad su mapirani pojedini geni, makro i mikrosateliti krenulo se na procijenu genomske priplodne vrijednosti pomoću markera i samog genoma iz čega je proizašla selekcija uz pomoć markera i genomska selekcija. Sve navedene metode imaju cilj da se što tačnije procjeni priplodna vrijednost životinja i na osnovu nje provede selekcija. Primjena savremenih metoda oplemenjivanja u mliječnom govedarstvu je dovela do toga da današnja rekorderka, krava holštajn rase Bur-Wall Buckeye Gigi EX-94 3E, koja je nacionalni lider, proizvede 74 650 funti (33860 kg) mlijeka za 365 dana laktacije. Rekordna proizvodnja je zabilježena 2016. godine u Sjedinjenim Američkim Državama.

Ključne riječi: proizvodnja mlijeka, procjena priplodne vrijednosti, selekcija, mliječne rase.

MODERN BREEDING METHODS IN THE DAIRY CATTLE PRODUCTION

Cattle production of developed countries is the basis of livestock production, and livestock production is the basis of total agriculture production. Milk is, besides meat, the most important product in cattle breeding. Milk production is one of the most important strategic goals of a country in the world. Intensive breeding of dairy cattle started in the twentieth century when a major step forward was made in the selection of cattle and the improvement of high production dairy and combined breeds such as Holstein, Braunsvis, Simmental etc.The basis of animal breeding is the assessment of the breeding value of bulls and cows, which will be the parents of future generations. Breeders have used, and still use, different methods of estimating breeding values, so for this purpose are used the methods of comparison of mother - daughter, peer comparison, modified method of peer comparison, and later, selection index, least squares method, best objective method, individual model method. In the second half of the 20-th century, when the structure of DNA was recognized and when certain genes, macro and microsatellites were mapped, began to estimate the genomic breeding value using the marker and the genome itself. As a result, it was created MAS and genomic selection. All these methods have the goal to estimate the breeding value of animals, as precisely as possible, and the selection is based on them. The application of modern breeding methods in dairy cattle production led to the fact that today's record Holstein Cattle breed Bur-Wall Buckeye Gigi EX-94 3E, the national leader, produced 33860 kg of milk for 365 days of lactation. The highest milk production was recorded in the USA in 2016.

Key words: milk production, estimation of breeding values, selection, dairy breed.

1. OPLEMENJIVANJE RATARSKIH, POVRTARSKIH I LEKOVITIH BILJAKA

UV-1

SAVREMENI PRAVCI U OPLEMENJIVANJU KUKURUZA U INSTITUTU ZA KUKURUZ „ZEMUN POLJE"

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U Institutu za kukuruz „Zemun Polje" program oplemenjivanja kukuruza razvija se više od 70 godina. Stvaranje novih hibrida, koji po najbitnijim agronomskim karakteristikama nadmašuju hibride prethodne generacije predstavlja primarni zadatak svakog oplemenjivača kukuruza. Istorijski gledano, aktivnosti usmerene na stvaranje novih hibrida odvijale su se kroz različite cikluse selekcije, gde se svaki naredni ciklus odlikovao hibridima sa značajno poboljšanim agronomskim svojstvima u odnosu na prethodni. Kao rezultat ovakvog pristupa selekciji, povećanje genetičkog potencijala za prinos zrna kao najbitnijeg svojstva hibrida kukuruza dobijenih klasičnim oplemenjivanjem u poslednjih 50 godina iznosilo je 100 kg/ha.

Spajanje različitih naučnih disciplina je doprinelo ubrzanju procesa oplemenjivanja kukuruza. Primenjujući takav pristup Institut je korišćenjem tehnologije duplih haploida od 2014. godine stvorio više od 7000 novih inbred linija. Korišćenjem selekcije pomoću molekularnih markera ubrzava se proces dobijanja hibrida sa specifičnim svojstvima. U saradnji sa BASF-om razvijaju se hibridi kukuruza otporni na herbicid Focus ultra (aktivna materija *cycloxydim*). Pokrenut je program razvoja hibrida sa poboljšanim kvalitetom zrna: hibridi crvene i plave boje zrna, kao i kukuruz visokog kvaliteta zrna (*QPM*).

Ključne reči: kukuruz, oplemenjivanje, savremene metode, specifična svojstva

CONTEMPORARY TRENDS IN MAIZE BREEDING AT THE MAIZE RESEARCH INSTITUTE, ZEMUN POLJE

The maize breeding programme has been developing at the Maize Research Institute, Zemun Polje for over 70 years. The primary task of every maize breeder is to develop new hybrids that according to the most important agronomic traits outperform hybrids of the previous generation. Activities aimed at the development of new hybrids have been performed through various cycles of selection, where each subsequent cycle was distinguished by hybrids with significantly improved agronomic traits compared to the previous one. Because of such an approach to selection, the increase in the genetic potential for grain yield, as the most important property of maize hybrids developed by conventional breeding in the previous 50 years was 100 kg/ha.

The integration of multiple scientific disciplines has contributed to the acceleration of the process of maize breeding. Due to the application of such an approach, the Institute's breeders using the double haploid technology since 2014 have developed over 7000 new inbred lines. The development of hybrids with specific properties is accelerated by the marker-assisted selection. Maize hybrids resistant to the herbicide Focus ultra (active ingredient *cycloxydim*) have been developed in the cooperation with BASF. The development programme has been established for hybrids with improved grain quality: red- and blue-seeded maize hybrids, as well as maize hybrids with high grain quality (*QPM*).

Key words: maize, breeding, contemporary methods, specific traits

UV-2

FENOTIPSKA VARIJABILNOST CRVENE DETELINE (*Trifolium pratense* L.) KORIŠĆENJEM MORFOLOŠKIH MARKERA

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Crvena detelina (*Trifolium pratense* L.), izrazito stranooplodna biljna vrsta, koja se odlikuje gametofitskim sistemom inkompatibilnosti, a populacije su heterogene i sastoje se od heterozigotnih genotipova. Da bi biljni genetički resursi mogli biti korišćeni u programima oplemenjivanja, neophodno je izvršiti prethodnu karakterizaciju i evaluaciju uzoraka, koji se nalaze u kolekcijama germplazme. Precizan i sveobuhvatan opis germplazme crvene deteline je jedan od osnovnih preduslova u ostvarivanju uspešnog oplemenjivanja. Cilj ovog istraživanja je bio da se posredstvom analize homogenosti (HOMALS) oceni fenotipska varijabilnosti 46 genotipova crvene deteline koji su deo kolekcije Instituta za ratarstvo i povrtarstvo u Novom Sadu. Analiza homogenosti ("Homogeneity analysis-HOMALS"), poznata i kao višestruka korespodentna analiza ("Multiple correspondence analysis-MCA"), omogućava proučavanje povezanosti većeg broja kvalitativnih varijabli, tj. kategoričkih, nominalnih podataka. Na osnovu HOMALS analize četiri morfološke osobine (forma rasta, maljavost stabljike, boja lista i intenzitet obojenosti pege na listu) i jedne fenološke osobine (vreme cvetanja), prisutne kod 46 genotipova crvene deteline konstruisan je HOMALS grafikon, pri čemu je prvom osom objašnjeno 38,4%, a drugom osom 32,8% ukupne varijabilnosti podataka morfoloških deskriptora (i jednog fenološkog). Distanca između dva genotipa na grafikonu je odraz sličnosti njihovih profila. Analizirani genotipovi crvene deteline su na osnovu sličnosti njihovih morfološko-fenoloških profila grupisani u 7 homogenih grupa. HOMALS analiza je omogućila da se jasno izdvoje oni genotipovi crvene deteline koji su bili sa jedinstvenim profilima u odnosu na homogene grupe, a takvi genotipovi nisu bili jasno uočljivi pri primeni UPGMA klaster metode. HOMALS metoda se pokazala kao informativnija, jer je jasnije prikazala morfološku varijabilnost ispitivanog materijala.

Ključne reči: fenotipska varijabilnost, morfološki markeri, *Trifolium pratense* L.

Rezultat projekta TR 31024 Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije.

PHENOTYPIC VARIABILITY OF RED CLOVER (*Trifolium pratense* L.) USING MORPHOLOGICAL MARKERS

Red clover (*Trifolium pratense* L.) is a cross-pollinated species characterized by gametophytic incompatibility system; its populations are heterogeneous and consist of heterozygous genotypes. Use of plant genetic resources in breeding programs implies pre-characterization and evaluation of germplasm collection samples. A precise and comprehensive description of red clover germplasm is one of the basic prerequisites for achieving successful breeding. The aim of the study was to evaluate phenotypic variability of 46 red clover genotypes using Homogeneity Analysis (HOMALS), which belong to Institute of Field and Vegetable Crops, Novi Sad collection. Homogeneity analysis, also known as Multiple Correspondence Analysis (MCA), allows studying the connection of a number of qualitative variables, i.e. categorical, nominal data. Based on HOMALS analysis of four morphological traits (growth habit, stem hairiness, leaf color and leaf spots coloration intensity) and one phenological trait (flowering time) present in 46 red clover genotypes, HOMALS figure was designed, with the first axis explaining 38.4%, and the second axis 32.8% of the total variability of morphological descriptors data (and one phenological). Distance between two genotypes in the figure is a reflection of their profiles similarity. Analyzed red clover genotypes were grouped in 7 homogeneous groups based on similarity of their morphological and phenological profiles. HOMALS analysis allowed clear distinction of red clover genotypes with unique profiles compared to homogeneous groups, and such genotypes were not clearly detectable in the application of UPGMA cluster method. HOMALS method was more informative because it showed morphological variability of the tested material more clearly.

Key words: phenotypic variability, morphological markers, *Trifolium pratense* L.

This is the result of TR 31024 project funded by Ministry of Education, Science and Technological Development of the Republic of Serbia.

UV-3

KARAKTERIZACIJA I EVALUACIJA LOKALNIH POPULACIJA KUKURUZA KROZ STRATIFIKACIJSKI PROCES ODABIRA

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Sačuvane lokalne populacije kukuruza predstavljaju značajne izvore poželjnih svojstava za unapređenje radnih kolekcija oplemenjivača. U okviru predoplemenjivačkih aktivnosti na germplazmi kukuruza iz banke gena Instituta za kukuruz „Zemun Polje", primenjen je stratifikacijski proces odabira najboljih populacija za dalji rad. Ovakva procedura omogućava odabir manjeg broja uzoraka uz istovremeno zadržavanje što je moguće veće varijabilnosti unutar odabranog pula. U prvoj fazi stratifikacijskog odabira izdvojeno je 310 lokalnih populacija, kao mogući izvori tolerantnosti na sušu. U drugoj fazi, odabir je vršen na osnovu osobina populacija *per se* značajnih za oplemenjivače. Odabrano je 40 populacija za narednu fazu predopemenjivačkih aktivnosti na definisanju njihovog heterotičnog potencijala. Nakon ukrštanja sa tri divergentna testera (*BSSS, Lancaster* i nezavisne osnove) urađeni su višelokacijski ogledi dobijenih 96 *topcross* hibrida. Istovremeno uradjena je i analiza osnovnog hemijskog sastava zrna *topcross* hibrida, odabranih lokalnih populacija i testera, *NIR metodom* (Near-infrared spectroscopy). Uradjena je i genetička karakterizacija lokalnih populacija i odabranih testera primenom SSR markera. Rezultati svih preduzetih istraživanja će omogućiti dobijanje informacija neophodnih za formiranje nekoliko sintetičkih populacija, u skladu sa kratkoročnim, srednjeročnim i dugoročnim oplemenjivačkim ciljevima komercijalnog oplemenjivačkog programa Instituta za kukuruz Zemun Polje. Cilj preduzetih aktivnosti bio je da se formiranjem početnog materijala od germplazme tvrdunaca, kraće vegetacije, čvrstog stabla, nisko pozicioniranog klipa popune tzv. nedostajuća mesta u radnim kolekcijama oplemenjivača. Očekuje se da će se na taj način, makar delimično, premostiti jaz izmedju kolekcije banke gena i programa oplemenjivanja.

***Ključne reči**:* banka gena, heterotični potencijal, predoplemenjivanje, sintetičke populacije, *Zea Mays* L.

Rad je nastao kao rezultat projekta TR 31028, finansiranog od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije

CHARACTERIZATION AND EVALUATION OF MAIZE LANDRACES THROUGH STRATIFICATION PROCESS OF SELECTION

The preserved maize landraces are important sources of agronomic important traits for the improvement of breeders' working collections. The stratification process of selection of the best landraces was applied for further work within pre-breeding activities on maize germplasm from the Maize Research Institute, Zemun Polje genebank. Such procedure provides the selection of a smaller number of samples while maintaining as much variation as possible within the selected pool. Three hundred and ten landraces, as potential sources of tolerance to drought, were selected in the first step of the stratification selection. In the second step, the selection was done based on landrace traits *per se* that are significant for breeders. Forty landraces were selected for the succeeding pre-breeding activities in order to define their heterotic potential. Crosses to three divergent testers (*BSSS, Lancaster* and unrelated basis) were followed by multilocation trials for 96 derived *topcross* hybrids. At the same time, the analysis of the basic chemical composition of grain for *topcross* hybrids, selected landraces and testers, was performed by applying the *NIR method* (Near-infrared spectroscopy). The SSR markers were used to perform genetic characterisation of landraces and selected testers. Overall results will provide the information necessary for the development of few synthetic populations in accordance with short-, medium- and long-term goals of the Maize Research Institute commercial breeding programme. It could be expected that undertaken activities will contribute to fulfilling so-called missing places in the breeders' working collections through development of the initial germplasm material of early-maturing flints, with stiff stalks and low positioned ears. It is expected that in this way, even if partially, the gap between the genebank collection and the breeding programme will be overcome.

***Key words**:* gene bank, heterotic potential, pre-breeding, synthetic populations, *Zea mays* L.

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UV-4

PLOD TIKVE (*Cucurbita moschata* Duchesne) I BUNDEVE (*Cucurbita maxima* Duchesne) – PARAMETRI PRINOSA I KVALITETA

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Istraživanje je sprovedeno radi procene mogućnosti oplemenjivanja tikava (*C. moschata*) i bundeva (*C. maxima*) u pravcu poboljšanja prinosa i kvaliteta ploda. Izvršene su analize svojstava od agronomskog značaja (prinos po biljci-P, masa ploda-MP, broj plodova po biljci-BPB, datum cvetanja-DC, dužina glavne stabljike-DGS, veličina lista-VL) i svojstava od značaja za kvalitet mesa ploda (sadržaj suve materije-SSM, šećera-SŠ, karotenoida-SK, proteina-SP, rastvorljivih čestica-SRČ, refrakcioni indeks-RI, pH); kod po 20 perspektivnih linija obe biljne vrste. Ogled je postavljen na eksperimentalnoj parceli Instituta za ratarstvo i povrtarstvo, Novi Sad, Odeljenje za alternativne kulture i organsku proizvodnju u Bačkom Petrovcu, po slučajnom blok sistemu, dve sezone (2016, 2017). Kod obe vrste su zabeležene značajne razlike između linija u pogledu svih ispitivanih svojstava. Najviše su varirali SK (75,8%), MP (65,2%) i P (59,9%); a najmanje RI (0,2%), pH (3,0%) i DC (4,1%). Linije bundeva su se odlikovale značajno ranijim cvetanjem, većom MP, SŠ i SK; a manjim BPB i SP u odnosu na linije tikava (188 i 194 dana, 7,65 i 3,50 kg, 28,77 i 22,54 mg/g, 49,22 i 42,70 mg/kg, 1,9 i 5,3, 3,96 i 6,37 mg/g za bundeve i tikve, po redosledu). Kod obe vrste su izračunate pozitivne korelacije MP i P, SSM i RI, SSM i SRČ, SŠ i RI, SŠ i SRČ, RI i SRČ. Među ispitivanim linijama postoji varijabilnost neophodna za selekciju i oplemenjivanje, pri čemu posebnu pažnju treba obratiti na MP, SŠ i SK. Zbog korelacije RI i SRČ od ≈ 1,00; u budućim istraživanjima nije neophodno ispitivati oba parametra.

Ključne reči: *Cucurbita maxima*, *Cucurbita moschata*, kvalitet, prinos

Rezultat projekta: "Novi koncept oplemenjivanja sorti i hibrida povrća namenjenih održivim sistemima gajenja uz primenu biotehnoloških metoda" (*TR-31059)*

SQUASH (*Cucurbita moschata* Duchesne) AND PUMPKIN (*Cucurbita maxima* Duchesne) FRUIT – YIELD AND QUALITY PARAMETERS

This study was aimed to access possibilities for breeding squash (*C. moschata*) and pumpkin (*C. maxima*) for improved fruit yield and quality. Traits of agronomic importance (yield per plant-Y, fruit weight-FW, number of fruits per plant-NFP, anthesis date-AD, length of main stem-LMS, leaf blade size-LBS) and traits related to fruit flesh quality (dry weight-DW, sugars-SC, carotenoids-CC, proteins-PC, soluble solids-SSC, refractive index-RI and pH) were analyzed in 20 perspective lines of each plant species. The two-year (2016, 2017) trial was set at the Institute of Field and Vegetable Crops Novi Sad experimental plot, Alternative Crops and Organic Production Department in Bački Petrovac, randomized in complete block system. Significant differences were found among lines of both species in terms of all investigated traits. The highest variation had CC (75.8%), FW (65.2%) and Y (59.9%), and the lowest RI (0.2%), pH (3.0%) and AD (4.1%). Pumpkins flowered earlier and had higher FW, SC and CC and lower NFP and PC when compared to squashes (188 and 194 days, 7.65 and 3.50 kg, 28.77 and 22.54 mg/g, 49.22 and 42.70 mg/kg, 1.9 and 5.3, 3.96 and 6.37 mg/g for pumpkins and squashes, respectively). The parameters FW and Y, DW and RI, DW and SSC, SC and RI, SC and SSC, RI and SSC correlated. The variability among the lines is sufficient for selection and breeding. The attention should be paid on FW, SC and CC. Since RI and SSC correlated with coefficient of ≈ 1.00, it would be sufficient to analyze one parameter only.

Key words: *Cucurbita maxima*, *Cucurbita moschata*, quality, yield

Result of the project: "New concept of breeding vegetable varieties and hybrids for sustainable growing systems using biotechnological methods" (TR-31059)

UV-5

OPLEMENJIVANJE VIŠEGODISNJIH KRMNIH VRSTA

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Višegodišnje krmne vrste su uglavnom prirodni poliploidi, najčešće tetraploidi, što im omogućava plastičnu i prilično složenu gensku osnovu. Komleksna genetička gradja ovih vrsta otežava proučavanje njihove genetičke osnove, kao i utvrdjivanje veličine i structure genetičke varijabilnosti, kao osnove za odabiranje najpogodnijeh metoda selekcije za dati selekcioni material. Stranooplodni način oprašivanja, uz jako izraženu inbreed depresiju, već u prvim samooplodnim generacijama kod pojedinih vrsta, čini teško ili skoro nemoguće dobijanje homogenog selekcionog materijala. Pored toga, svaki selekcioni ciklus traje dve do četiri godine u zavisnosti od vrste, što produžava proces kreiranja novih sorti. Zbog svega navedenog oplemenjivanje krmnih leguminoza i trava je pravi izazov za oplemenjivače. Pored povećanja prinosa, uz očuvanje kvaliteta biomase, posebna pažnja se poklanja kompetitivnosti (posebno važna za vrste koje se gaje u smešama) i poljskoj perzistenciji ovih vrsta koja je komleksna osobina i pre svega zavisi od tolerantnosti sorte na biotske i abiotske stresne uslove u polju. Zbog specifične genetske strukture ne postoji univerzalan selekcioni metod. Najčešće korišćen metod oplemenjivanja za odabiranje roditeljskih komponenti je rekurentna selekcija. Povećanje heterozigotnosti se postiže uvođenjem različitog selekcionog materijala čijim ukrštanjem se dobija varijabilnost željenih osobina. Sorte krmnih vrsta su uglavnom sintetici, jer samo sorte sa širokom genetičkom osnovom mogu postići stabilne i visoke prinose, i imati dobru poljsku perzistenciju koja je izuzetno važna kod višegodišnjih vrsta.

Ključne reči: krmno bilje, varijabilnost, selecija

BREEDING OF PERENNIAL FORAGE CROPS

Perennial forage crops are mostly natural polyploidy, usually tetraploids, which enable them to have a plastic and rather complex genetic base. Complex genetic structure of these species make it difficult to study their genetic basis, as well as determining the size and structure of genetic variability, as the basis for selecting the most appropriate selection methods for given selection material. C*ross-pollination*, with very severe inbreeding depression, already in the first selfed generations of same species, makes it difficult or almost impossible to obtain homogeneous selection material. Because of this, the breeding of forage legumes and grasses is a real challenge for breeders. In addition to increasing the yield and quality of biomass, special attention is paid to competitiveness (especially important for the species which growing in mixtures) and the field persistence of these species, which is a complex trait and depends on the tolerance of the variety to biotic and abiotic stress conditions in the field. Because of the specific genetic structure, there is no universal selection method. The most commonly used breeding method for selecting parental components is a recurrent selection. Increasing heterozygosity is achieved by introducing a different selection material with the crossing to obtain the variability of the desired properties. The varieties of fodder species are mainly synthetics, because only varieties with a broad genetic basis can achieve stable and high yields, and have good field persistence, which is extremely important in perennial species.

Key words: forage crops, variability, breeding

U-1

GENETIČKA VARIJABILNOST KOLEKCIJA PROLEĆNOG BELOG LUKA U SRBIJI

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Vegetativni način razmnožavanja belog luka (*Allium sativum* L.) je ograničavajući faktor ne samo za održavanje genetičke raznovrsnosti, već i za eksploataciju u selekciji. U našem regionu dominiraju domaći ekotipovi prolećnog belog luka, visoko adaptirani agroekološkim uslovima. U radu je ispitivana varijabilnost genotipova prolećnog belog luka koji se nalaze u kolekciji Institutu za ratarstvo i povrtarstvo u Novom Sadu (*NS*) i Poljoprivrednog fakulteta u Beogradu (*BG*). Podaci o kvantitativnim osobinama lukovice za 71 genotip prikazani su pomoću nekoliko parametara deskriptivne statistike kao i multivarijantne analize glavnih komponenti (PC). Zbog prisustva genotipova sa ekstremnim vrednostima određenih osobina korišćena je i robusna verzija analize glavnih komponenata (r-PC). Visok stepen varijabilnosti ustanovljen je za masu lukovice, broj čenova i masu čenova kod obe kolekcije. Genotipovi sa visokim vrednostima mase lukovice, čenova i broja čenova imali su značajan doprinos u vizualizaciji međuzavisnosti ovih osobina kao i njihovom grupisanju.

Ključne reči: beli luk, kolekcija, genetička varijabilnost, glavne komponente

Rezultat projekta: TR31030, „Stvaranje sorata i hibrida povrća za gajenje na otvorenom polju i u zaštićenom prostoru“

GENETIC VARIABILITY IN THE SERBIAN COLLECTION OF SPRING GARLIC

Vegetative propagation of garlic (*Allium sativum* L.) is a limiting factor not only for maintenance of genetic variability, but also for exploitation during selection. Local ecotypes of spring garlic that are highly adapted to agroecological conditions prevail in our region. Variability of spring garlic genotypes that are part of the Institute of Field and Vegetable Crops in Novi Sad (*NS*) and Faculty of Agriculture in Belgrade (*BG*) collections was studied in this paper. Data about bulb quantitative traits for 71 genotypes are shown using several parameters of descriptive statistics and multivariate analysis of principal components (PC). Presence of genotypes with extreme values of determined traits was the cause of using robust version of the principal component analysis (r-PC). High degree of variability was determined for the weight of the bulb, number of cloves and weight of cloves in both collections. Genotypes with high values of bulb weight, clove weight and number of cloves had a significant contribution to visualization of these traits interdependence, as well as their grouping.

Key words: garlic, collection, genetic variability, main components

Project: TR31030, "Development of vegetable cultivars and hybrids intended for outdoor and indoor production"

U-2

AUTOMATSKO MERENJE MORFOLOŠKIH I FIZIOLOŠKIH OSOBINA KUKURUZA U USLOVIMA SUŠE I NEDOSTATKA AZOTA TOKOM VEGETATIVNOG RAZVOJA

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Snabdevanje biljaka vodom i dostupnost azota su glavni faktori koji utiču na produktivnost kukuruza širom sveta. U ovom eksperimentu proučavan je razvoj nadzemnog dela biljake 20 inbred linija kukuruza u uslovima nedostatka vode i azota tokom vegetativnog razvoja (počev od faze šestog lista pa do početka metličenja) uz pomoć automatskog merenja biljaka. Blizu 200 digitalnih osobina je dobijeno obradom fotografija nastalih uz pomoć vidljive, fluorescentne i blisko-infracrvene svetlosti. Odabrano je 25 reprezentativnih digitalnih osobina za dalje analize. Takođe, poslednjeg dana eksperimenta na klasičan način su merene sveža i suva masa nadzemnog dela biljke, relativni sadržaj vode u listu, sadržaj hlorofila u listu i broj listova po biljci. Nedostatak vode je bio glavni faktor u smanjenom razvoju nadzemnog dela, kod svih genotipova (detektovano nakon desetog dana od početka stresa), dok je uticaj nedostatka azota bio vidljiv tek na kraju eksperimenta. Fenotipske korelacije između procenjene digitalne i ručno merene biomase bile su statistički značajne i kretale su se u rasponu od nivoa srednjih vrednosti (u uslovima nedostatka vode i azota) do relativno visokih vrednosti (oko 0.8) u uslovima bez stresa. Utvrđene su najbitnije digitalne osobine za akumulaciju biomase u svakom tretmanu. Korišćenjem indeksa stresa svaki genotip je svrstan u jednu od četiri grupe po načinu adaptacije na stresne uslove, i njihovi proseci su testirani za digitalne osobine.

Ključne reči: kukuruz, digitalno fotografisanje, korelacije, indeksi stresa

AUTOMATED PHENOTYPING OF MAIZE MORPHOLOGICAL AND PHYSIOLOGICAL RESPONSE TO VEGETATIVE WATER AND NITOGEN STRESS

Water supply and nitrogen availability are major abiotic factors affecting agricultural productivity of maize worldwide. In this experiment we have evaluated shoot developmental characteristics of twenty maize inbred lines, under water and nitrogen shortage in mid to late vegetative stage (from-leaf six up to start of tasseling) using high-throughput automated phenotyping platform. Nearly 200 digital traits have been extracted from automated imaging by visible (color), fluorescence and near-infra-red imaging systems. In addition, fresh and dry weight, relative water content, chlorophyll content and leaf number were measured manually at the end of the experiment. A set of 25 representative digital traits has been chosen for further analysis. Limited water supply was the main restrictive factor in maize shoot development for all the genotypes (detectable ten days after the beginning of the stress), while the effect of limited nitrogen supply mostly could not be observed until the very end of the experiment. Simple correlations between fresh i.e. dry biomass and digital biomass at the end of the experiment were significant and ranged from moderate (in limited water and nitrogen supply conditions) to relatively high (nearly 0.8) in stress free condition. Most important image-based traits for mid-season biomass accumulation in maize plants were identified in each treatment. By using stress indexes each genotype was classified in different response groups to particular stress and their means were tested for digital traits.

Key words: maize, digital imaging, water stress, correlations, stress indexes

U-3

STVARANJE NOVE GENETIČKE VARIJABILNOSTI U CILJU POVEĆANJA PRINOSA SEMENA I ULJA SUNCOKRETA

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Povećanje prinosa semena i ulja kod suncokreta svakako predstavlja jedan od najvažnijih imperativa u savremenom oplemenjivanju suncokreta. Cilj ovog eksperimenta je bio ukrštanje genotipova suncokreta radi stvaranja nove genetičke varijabilnosti koja će doprineti povećanju prinosa semena i ulja. Materijal za ovo istraživanje je uključio 6 genotipova suncokreta odabranih na osnovu svojih agronomskih i proizvodnih karakteristika. Ukrštanje je rađeno metodom nepotpunog dialela u ranim jutarnjim časovima ručnom emaskulacijom. Analizom varijanse je utvrđeno postojanje statistički značajne razlike između genotipova korišćenih u ukrštanju što nam potvrđuje da se odabrani roditelji razlikuju u ispitivanim osobinama. Poredeći roditelje najvišu prosečnu vrednost prinosa semena po biljci ostvario je roditelj R1 (98,29 g), dok je najniži prinos semena po biljci ostvaren kod roditelja R3 (46,52 g). Najviša prosečna vrednost prinosa semena po biljci u F2 generaciji ostvarena je kod kombinacije R5 x R6 (79,75 g), dok je najniža vrednost ostvarena kod kombinacije R1 x R6 (49,85 g). U pogledu prinosa ulja najviša prosečna vrednost izmerena je kod roditelja R1 (43,59 g), dok je u F2 generaciji najviši prinos ulja ostvarila kombinacija R5 x R6 (38,66 g). Od ukupno 15 F2 populacija, više prosečne vrednosti prinosa semena i ulja po biljci u odnosu na roditelje ostvarene su kod 4 kombinacije ukrštanja. Ovakav rezultat navodi na zaključak da dobijene F2 generacije mogu predstavljati važan izvor nove genetičke varijabilnosti koje će se koristiti u oplemenjivačkom programu u cilju dobijanja produktivnijih hibrida suncokreta.

Ključne reči: oplemenjivanje, suncokret, prinos semena i ulja

Rezultat projekta: TR 31025, „Razvoj novih sorti i poboljšanje tehnologija proizvodnje uljanih biljnih vrsta za različite namene“

CREATING NEW GENETIC VARIABILITY WITH THE AIM OF INCREASING THE YIELD OF SEED AND OIL IN SUNFLOWER

Increasing yield of seed and oil in sunflower is certainly one of the most important imperatives in modern sunflower breeding. The aim of this experiment was to cross the sunflower genotypes in order to create a new genetic variation that will contribute in order to increase seed and oil yield. The material for this research included 6 sunflower genotypes selected on the basis of their agronomic and production characteristics. The crossing was done by incomplete dialel method in early morning hours by manual emasculation. The analysis of variance revealed the existence of a statistically significant difference between the genotypes used in crossing, which confirms that the selected parents differ in the examined properties. Comparing parents the highest average value of seed yield per plant was achieved by parent R1 (98.29 g), while the lowest seed yield per plant was achieved with parent R3 (46.52 g). The highest average value of seed yield per plant in the F2 generation was achieved with the combination R5 x R6 (79.75 g), while the lowest value was achieved with the combination R1 x R6 (49.85 g). In terms of oil yield, the highest average value was measured at parent R1 (43.59 g), while in the F2 generation the highest oil yield was achieved by the combination R5 x R6 (38.66 g). Of the total of 15 F2 populations, higher average yield of seed and oil per plant compared to parents were achieved in 4 cross combinations. This result leads to the conclusion that the obtained F2 generations can represent an important source of new genetic variability to be used in the breeding program in order to obtain more productive sunflower hybrids.

Key words: breeding, sunflower, seed and oil yield

Project: TR 31025, "Development of new varieties and production technology improvement of oil crops for different purposes"

U-4

ULOGA I ZNAČAJ MIKRO OGLEDA U OPLEMENJIVANJU BILJAKA I KOMERCIJALIZACIJI REZULTATA OPLEMENJIVANJA

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Kako se u procesu oplemenjivanja inicijalno generiše ogroman broj potencijalno novih hibrida/sorata, a u krajnjoj instanci komercijalizuje veoma ograničen broj, od velikog je značaja sistem mikro ogleda koji treba da obezbedi prvilan izbor najperspektivnijih genotipova tokom procesa selekcije. Istovremeno sistem mikro ogleda treba da bude tako koncipiran da da pouzdane informacije kao osnovu važnih poslovnih odluka (koji hibridi/sorte se predlažu za registraciju, gde se predlažu za registraciju, koji hibridi/sorte imaju komercijalnu perspektivu radi što ranijeg otpočinjanja umnožavanja semena i konačno koji su to hibridi koji će biti ponuđeni tržištu radi usmerenog i efikasnog koncipiranja komercijalnih i marketinških aktivnosti). Obzirom na izuzetnu važnost koju ima, sistem multilokacijskih mikro ogleda pretstavlja jednu od materijalno, tehnički i kadrovski najzahtevnijih faza, te kao takav zaslužuje posebnu pažnju. Koliko će sam sistem mikro ogleda biti u mogućnosti da odgovori svim postavljenim zahteva sa jedne strane zavisi od načina na koji je sistem mikroogleda hijerarhijski koncipiran (eksp. dizajni, broj i izbor lokacija, broj ponavljanja ..., a sa druge strane od kvaliteta ulaznih podataka što je od posebnog značaja. Kod samog testiranja su moguće dve vrste greške:

- Zadržavanje u daljem radu genotipova koji to ne opravdavaju svojim performansama
- Eliminacija „poželjnih“ genotipova

Kako bi se minimizirala mogućnost ovakvih grešaka i obezbedila kvalitetna osnova za donošenje ispravnih odluka, sa jedne strane neophodno je koncipirati efikasan hijerarhijski sistem ispitivanja, pri čemu svaki sledeći nivo ispitivanja mora biti i kvalitativno i kvantitativno „bolji“ od prethodnog, a u analizu treba da uđu samo podaci koji realno reprezuntuju performase genotipa.

THE ROLE AND IMPORTANCE OF MICRO-EXPERIMENTS IN PLANT BREEDING AND THE COMMERCIALIZATION OF THE RESULTS OF BREEDING

Since in the process of breeding initially generates a huge number of potentially new hybrids / sorts, and ultimately commercializes a very limited number, a micro-trial system is essential to ensure the proper choice of the most promising genotypes during the selection process. At the same time, the micro-trial testing system should be designed on the way that generate reliable information as the basis of important business decisions (which hybrids / varieties are proposed for registration, where they are proposed for registration, which hybrids / varieties have a commercial perspective for the early start of seed multiplication and finally which are the hybrids that will be offered to the market for a focused and efficient conception of commercial and marketing activities. Because of the exceptional importance that it has, the system of multilocational micro-observations represents one of the material, technical and personnel most demanding phases.As such deserves special attention. How much the micro-trial testing system itself will be able to respond to all the requirements set, on one side depends on the way the system is hierarchically conceived (ehp. Designs, number and location selection, number of repetitions ...), and on the other hand the quality of inputs data is of particular importance. Two types of error are possible when testing:

- Retain in the further work of genotypes that do not justify this with their performance
- Elimination of "desirable" genotypes

In order to minimize the possibility of such mistakes and provide a good basis for making the right decisions, on the one hand it is necessary to design an efficient hierarchical system of testing, with each subsequent test level having to be qualitatively and quantitatively "better" than the previous one as well as use of input data that actually represent the performance of estimated genotype.

U-5

UTICAJ RECIPROČNIH UKRŠTANJA NA KOMPONENTE PRINOSA I KVALITET ZRNA DVOLINIJSKIH HIBRIDA KUKURUZA

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Izbor koja ce linija biti očinska, a koja majčinska komponenta u nekoj hibridnoj kombinaciji može uticati na pojedine osobine tog hibrida usled ispoljenog materinskog efekta. Cilj ovog rada je bio ispitati variranje komponeti prinosa i kvaliteta zrna originalnih i recipročnih varijanti deset priznatih ZP hibrida koji pripadaju srednjekasnoj grupi zrenja FAO 500-600. Svi hibridi imaju jednu zajedničku liniju T1, Lankaster tipa, koja je očinska komponenta u originalnim, odnosno majčinska u recipročnim verzijama hibrida. Ogled je postavljen u dva ponavljanja i na dve lokacije tokom 2016 godine. Hibrid i lokacija su bili značajni faktori u variranju većine osobina osim broja redova zrna u klipu. Hibridi ZPH2 i ZPH7 su imali značajno veće vrednosti dužine klipa i broja zrna u redu u svojim recipročnim varijantama, u odnosu na originalni za 11.2 i 13.4%. Hibridi ZPH7 i ZPH8 su imali i značajno veću masu 1000 zrna u originalnim verzijama sa linijom T1 kao očinskom komponentom, u odnosu na recipročnu varijantu hibrida. Broj redova zrna u klipu nije pokazao značajno variranje između različitih varijnati istih hibrida. ZPH9 i ZPH10 su imali značajno veći sadržaj proteina u zrnu u svojim originalnim, u odnosu na recipročne varijante (7.1, odnosno 8.2%).

Ključne reči: kukuruz, recipročni efekat, komponente prinosa, kvalitet zrna

INFLUENCE OF THE RECIPROCAL EFFECT ON GRAIN YIELD COMPONENTS AND GRAIN QUALITY IN SINGLE-CROSS MAIZE HYBRIDS

The choice of parental maize inbred lines, and maternal component in a particular hybrid combination can affect some exhibited traits of the hybrid due to the manifestation of the maternal effect. The aim of this paper was to examine the variation of yield components and quality of the grain of the original and reciprocal variants of ten ZP maize hybrids belonging to the maturity FAO 500-600 group. All hybrids have one common inbred line T1 of Lancaster type, which is a paternal line in the original and maternal in the reciprocal version of the hybrid. The trial was set in two replications and two locations during 2016. Hybrids and locations were important factors for the majority of traits except for the number of kernel rows of the ear. ZPH2 and ZPH7 hybrids had significantly higher ear lenght and kernel number per row in their reciprocal variants, compared to the original by 11.2 and 13.4%. The hybrids ZPH7 and ZPH8 also had a significantly higher weight of 1000 grains in the original versions with line T1 as the paternal line compared to their reciprocal hybrid variant. The number of kernel row per ear did not show a significant variation between the different variants of the same hybrids. ZPH9 and ZPH10 had significantly higher grain protein content in the original, compared to their reciprocal variants (7.1 and 8.2% respectively).

Key words: maize, reciprocical effect, yield components, grain quality

U-6

OCENA ADAPTABILNOSTI I STABILNOSTI PRINOSA NS JARE ULJANE REPICE PRIMENOM GGE BIPLOT ANALIZE

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Informacije koje obuhvataju uticaj faktora spoljašnje sredine na rast i razvoj useva značajne su za odabir specifičnih sorti za gajenje u ciljanim regionima i za smanjenje gubitka prinosa. S obzirom na to da su glavni efekti uticaja spoljašnje sredine (E) i genotipske interakcije (GE) najvažniji izvori variranja prinosa useva, tehnika GGE biplota je jedan od metoda koji se često koristi za analizu interakcije GE. Ciljevi istraživanja su bili da se proceni stabilnost prinosa semena, grafički prikažu efekti genotipa (G) i interakcija genotipa i spoljašnje sredine (GE), i da se identifikuju i preporuče najbolji genotipovi uljane repice za specifične regione rasta, koristeći GGE biplot. Ogled je postavljen na dva lokaliteta u Srbiji (Sombor i Novi Sad) i dva lokaliteta u Makedoniji (Skoplje i Bitola), sa 9 jarih genotipova uljane repice. Prve dve glavne komponente objasnile su 86,5% G + GE varijacije za prinos semena (PC1 64,46%, PC2 22,048%). Oba lokaliteta u Srbiji su bila jasno razdvojena od oba lokaliteta u Makedoniji. Sombor i Bitola su bili najbliži idealnom lokalitetu za gajenje jare uljane repice. Genotip JR-NS-36 je bio najstabilniji i najbliži idealnom genotipu. Najpogodniji genotipovi za gajenje u Srbiji su JR-NS-6 i JR-NS-11, dok je JR-NS-9 imao najveći i najstabilniji prinos u Makedoniji. Tehnika GGE biplota se pokazala korisnom za preporuke genotipova uljane repice za pojedine regione gajenja, uzimajući u obzir specifičnosti genotipova i uslova okoline.

Ključne reči: Uljana repica, GGE biplot, interakcija genotip x spoljašnja sredina, stabilnost

Rezultat projekta: TR 31025, „Razvoj novih sorti i poboljšanje tehnologija proizvodnje uljanih biljnih vrsta za različite namene"

EVALUATION OF ADAPTABILITY AND YIELD STABILITY OF NS SPRING RAPESEED USING GGE BIPLOT ANALYSIS

The information considering the effect of environmental factors on crop growth and development is essential for selection of specific cultivars for growing in target regions and for decreasing the possibility of significant yield loss. Since the main environmental effects (E) and genotype environment interaction (GE) are the most important sources of crop yield variation, the GGE biplot technique is one of the tools often used for GE interaction analysis. The objectives of the study were to evaluate grain yield stability, graphically summarize the effects of genotype (G) and genotype by environment (GE) interaction, and to identify and recommend the best rapeseed genotypes for the specific growing regions, using GGE biplot. The study was carried out at two locations in Serbia (Sombor and Novi Sad) and two locations in Macedonia (Skopje and Bitola), with 9 spring rapeseed genotypes. The first two principal components explained 86.5% of the G+GE variation for seed yield (PC1 64.46%, PC2 22.048%). Both locations in Serbia were clearly separated from both locations in Macedonia. Sombor and Bitola were closest to the ideal location for rapeseed growing. Genotype JR-NS-36 was the most stable and closest to the ideal genotype. However, the most suitable genotypes for growing in Serbia are JR-NS-6 and JR-NS-11, while JR-NS-9 had the highest and the most stable yield in Macedonia. GGE biplot technique proved to be useful for recommendation of rapeseed genotypes for specific growing regions, taking into account the specificities of the genotypes and environmental conditions.

Key words: Rapeseed, GGE biplot, genotype x environment interaction, stability

Project: TR 31025, "Development of new varieties and production technology improvement of oil crops for different purposes"

U-7

AKUMULACIJA ABSCISINSKE KISELINE I ALDEHID OKSIDAZNA AKTIVNOST KOD *Pisum sativum* L. U USLOVIMA NEDOSTATKA VODE

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Izlaganje stresnim uslovima životne sredine, kao što je suša, ima negativan efekat na rast biljaka. Abcisinska kiselina (ABA) se akumulira u uslovima osmotskog stresa i igra važnu ulogu u odgovoru na stres i u toleranciji biljaka. Cilj ovog istraživanja je bio da se odredi koncentracija ABA i ekspresija aldehid okidaznog enzima (AO) kod 7 sorti stočnog graška u početnim fazama klijanja semena i u stadijumu trećeg para listova. Osmotski stres je stimulisan primenom PEG 6000. Stres suše je izazvan prekidanjem zalivanja. Koncentracija ABA je merena Elisa metodom. U nadzemnom delu ponika utvrđeno je značajno povećanje sadržala ABA kod jedne grupe sorti (Javor, Partner, Junior) i smanjenje koncentracije ABA kod drugih sorti (Mraz, Dukat, Pionir, Trezor). Dukat je pokazao najveću akumulaciju ABA u listovima, a najmanja je izmerena kod sorte Javor. Promene u ekspresiji gena *PsAO1*, *PsAO2* i *PsAO3* analizirane su polukvantitativnim RT-PCR-om. Ekspresija gena PsAO2 nije pokazala značajne razlike u poređenju sa kontrolom. Ekspresija gena *PsAO1* i *PsAO3* se povećala u nadzemnom delu ponika sorte kod koje je došlo do akumulacije ABA (Javor), tj. smanjena je kod sorte kod koje je akumulacija ABA bila smanjena (Trezor). S obzirom na to da je ekspresija gena *PsAO3* bila konstantno povećana pod uticajem i osmotskog stresa i suše, može se zaključiti da je ovaj gen od primarnog značaja za biljke graška izložene delovanju stresa.

Ključne reči: osmotski stres, suša, stočni grašak, ABA, genska ekspresija

ACCUMULATION RATES OF ABSCISIC ACID AND ALDEHYDE OXIDASE ACTIVITY IN PISUM SATIVUM L. IN RESPONSE TO WATER DEFICIT

Exposure to to environmental stresses, such as drought, causes adverse effects on the growth of plants. Abscisic acid (ABA) accumulates under osmotic stress conditions and plays an important role in the stress response and tolerance of plants. The aim of this research was to determine the rates of ABA and the expression of Aldehyde oxidase enzyme (AO) among 7 cultivars of field pea at early seedling stage and at stage of third pair of leaves. Osmotic stress was stimulated using PEG 6000. The drought stress was induced by a termination of irrigation. ABA concentration was measured by the Elisa method. In the shoot of seedlings a significant increase in ABA content in one group of cultivars (Javor, Partner, Junior), and a decrease in ABA concentration in other cultivars (Mraz, Dukat, Pionir, Trezor) was confirmed. Dukat showed the highest accumulation of ABA in leaves, while the lowest was measured in cultivar Javor. The changes in gene expression of *PsAO1*, *PsAO2* and *PsAO3* were analysed by semi-quantitative RT-PCR. Expression of gene *PsAO2* did not indicate significant differences compared to control, while the expression of genes *PsAO1* and *PsAO3* increased in seedlings of the cultivar which accumulated ABA (Javor), i.e. decreased in the cultivar in which accumulation of ABA was decreased (Trezor). As the expression of gene *PsAO3* had constantly been increased under osmotic stress and drought conditions it could be concluded that the most important gene is *PsAO3*, whose expression is increased in pea plants exposed to stress.

Key words: osmotic stress, drought, field pea, ABA, gene expression

U-8

STAY- GREEN I OSOBINE KORENOVOG SISTEMA ZA POBOLJŠANJE PRINOSA JEČMA U USLOVIMA SUŠE

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Biljke koje pokazuju bolja *stay- green* svojstva su one koje zadržavaju zelenu površnu listova duže vreme nakon cvetanja, čime im je omogućena i produžena fotosintetska aktivnost tokom perioda nalivanja zrna. Sa druge strane, specifična arhitektura korenovog sistema može doprineti održavanju zelene površine listova preko boljeg pristupa vlagi uskladištenoj u zemljištu tokom kritičnih faza nalivanja zrna. Kolekcija od 132 komercijalne sorte i elitne linije ječma poreklom iz programa oplemenjivanja za gajenje u severnom regionu Australije je ocenjena na osnovu *stay- green* i osobina korenovog sistema (ugao i broj seminalnih korenova) u tri različita eksperimenta. Kako bi ispitali *stay- green* osobine, tokom 2017 godine postavljena su dva poljska ogleda (u uslovima navodnjavanja i suvo polje), u istraživačkom centru Hermitage (The Department of Agriculture and Fisheries, Queensland). Žućenje listova je ocenjeno preko všestrukih NDVI snimaka, počev od faze cvetanja do pune zrelosti ječma, na svakih pet do sedam dana. Korišćenjem odgovarajućeg modela, broj dana od cvetanja do pune zrelosti je utvrđen prilagođavanjem logističke funkcije NDVI podacima za svaku parcelicu, i dobijene su vrednosti značajnih parametara žućenja listova: maksimalni NDVI indeks, dinamika žućenja, vreme do početka, sredine i potpunog žućenja listova. Za fenotipsku ocenu korena (ugao i broj seminalnih korenova), koristili smo Clear Pot metod (providne saksije). Eksperiment potpuno randomiziranog dizajna je postavljen u *Speed breeding* stakleniku, gde je 132 genotipa ječma gajeno u uslovima produženog fotoperioda (22 h osvetljenje/ 2 h mrak) i temperaturnom režimu 22/17°C. Cilj istraživanja je bio da se ispita varijabilnost osobina korenovog sistema i stay- green svojstva različitih genotipova ječma, i utvrde korelacije između osobina korena i prinosa kao i *stay- green* osobina i prinosa.

Ključne reči: stay-green, osobina, koren, suša, ječam

STAY- GREEN AND ROOT TRAITS FOR BARLEY YIELD IMPROVEMENT IN DROUGHT CONDITIONS

Plants exibiting the stay- green phenotype are able to maintain green leaf area for longer time after anthesis, allowing maintainance of photosynthesis for longer during grain filling period. On the other hand, specific root architecture may contribute to the stay- green phenotype by improving access to stored soil moisture during the critical grain filling stage. A collection of 132 commercial barley varieties and elite breeding lines from Northern Region Barley breeding program (Australia), were evaluated for stay-green and root traits (seminal root angle and root number) in three different experiments. To invastigate stay- green traits two partial replicated row- column design field experiments were conducted at the Department of Agriculture and Fisheries (DAF) Hermitage Research Facility (Hermitage, QLD) during 2017, irrigated and dry land. Stay-green was measured by performing multiple NDVI recordings (every 5 to 7 days), from flowering through to crop maturity. Using a senescence evaluation tool, the number of days from flowering to maturity was estimated by fitting a logistic function to the NDVI data centred on the flowering date of each plot, and values for key stay-green traits are obtained: maximum NDVI index, senescence dynamics, time to beginning, middle and complete leaves senescence. To phenotype seminal root angle and root number We used Clear Pot method. The experiment with a randomised complete block design was set up in speed breeding glasshouse, under controled conditions with extended photoperiod (22 hours light/ 2 hours dark) and temperature regime 22/17°C. In this study We explored the variation in root architecture and stay- green, as well as correlations between root traits and yield, and stay-green and yield in a different barley genotypes.

Key words: stay-green, trait, root, drought, barley

U-9

PRINOS ZRNA I PARAMETRI STABILNOSTI ZA ZP HIBRIDE KUKURUZA U VOJVODINI ZA PERIOD 2014-2017

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U Srbiji se nalaze dva velika reona za ratarsku proizvodnju, Vojvodina (predstavlja severni deo Srbije) i Centralna Srbija. Glavna razlika između ovih proizvodnih reona je u klimi, tako da se klima u Centralnoj Srbiji odlikuje nešto manjim količinama padavina tokom vegetacione sezone i temperaturama koje su za nijansu niže tokom cele godine. U ovom istraživanju testirano je 10 komercijalnih ZP hibrida kukuruza na ukupno 72 lokaliteta tokom 2014-2017. Broj lokacija po godinama je iznosio: 25, 20, 19 i 8 u 2014, 2015, 2016, 2017 respektivno. Cilj istraživanja je bio ocena stabilnosti i prinosa zrna za hibride koji su najzastupljeniji na tržištu Vojvodine. Stabilnost prinosa je ocenjena uz pomoć metode *Eberhart i Rusell* (1966). Prosečan prinos u Vojvodini je varirao između 9,198 t/ha (ZP 341) do 10,225 t/ha (ZP 606). Najviša stabilnost prinosa je zabeležena kod hibrida ZP 427 (b_i=0,96) i ZP 388 (b_i=0,96). Pored pomenutih, visoka stabilnost prinosa je zabeležena kod hibrida ZP 666 (b_i=1,050) i ZP 600 (b_i=1,056). Najprinosniji hibrid ZP 606 nije pokazao tako visoku stabilnost (b_i=1,081). Hibridi ZP 434 (b_i=0,900) i ZP 560 (b_i=1,119) su se pokazali kao najmanje stabilni, s tim što je hibrid ZP 434 pokazao značajno bolju prilagodljivost u lošijim uslovima gajenja, dok se hibrid ZP 560 pokazao bolje u povoljim uslovima gajenja.

Ključne reči: kukuruz, prinos zrna, parametri stabilnosti

GRAIN YIELD AND STABILITY PARAMETERS OF ZP MAIZE HYBRIDS GROWN IN VOJVODINA IN THE 2014-2017 PERIOD

Serbia has two production areas, Vojvodina (northern province of Serbia) and Central Serbia. The main difference is that the climate is drier and harsher in Central Serbia, ie. primarily reflected in lower rainfall during the vegetation period and higher altitude compared to Vojvodina. This study encompassed tests of 10 commercial ZP maize hybrids that were carried out in total of 72 locations in the 2014-2017 period in the following mode: 25, 20, 19 and 8 locations in 2014, 2015, 2016, and 2017, respectively. The objective of the study was to estimate grain yield and stability of hybrids most distributed in the Vojvodina market. The method after *Eberhart and Rusell* (1966) was applied in the estimation of yield stability. The average yield in Vojvodina varied from 9.198 t/ha (ZP 341) to 10.225 t/ha (ZP 606). The highest yield stability was recorded in the hybrid ZP 427 (b_i=0.96) and ZP 388 (b_i=0.96). Besides mentioned hybrids, high stability was obtained by hybrids ZP 666 (b_i=1.050) and ZP 600 (b_i=1.056). The top yielding hybrid ZP 606 not expressed such a high level of stability (b_i=1.081). The hybrids ZP 434 (b_i=0.900) and ZP 560 (b_i=1.119) was the most unstable hybrids. ZP 434 showed significantly better adaptation to poorer growing conditions and ZP 560 was better adapted to favourable growing conditions.

Key words: maize, grain yield, stability performance

U-10

VARIJABILNOST VISINE STABLA I PREČNIKA GLAVE RAZLIČITIH INBRED LINIJA SUNCOKRETA

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Gajeni suncokret (*Helianthus annuus* L.) poseduje usku genetičku varijabilnost usled malog broja predaka od kojih je nastao. Povećanje genetičke varijabilnosti suncokreta postiže se ukrštanjem postojećih genotipova u cilju rekombinacije gena. Cilj ovog rada je bio da se ispita varijabilnost visine stabla i prečnika glave 93 inbred linije suncokreta stvorene na Institutu za ratarstvo i povrtarstvo u Novim Sadu, i da se formiraju grupe odabranih inbred linija na osnovu njihove sličnosti. Ogled je postavljen u blok sistemu sa tri ponavljanja, na oglednom polju Rimski Šančevi, Instituta za ratarstvo i povrtarstvo, a merenje visine stabla i prečnika glave je vršeno tokom faze fiziološke zrelosti za svaku liniju. Prikupljeni podaci o prosečnim vrednostima linija su analizirani hijerarhijskom klaster analizom u programu STATISTICA 10. Najveću prosečnu vrednost za visinu stabla pokazala je linija L-43 (184,33 cm), dok je najniži prosek pokazalalinija L-61 (73,03 cm). Najveću srednju vrednost za prečnik glave pokazale su linije L-46 i L-45 (24,7 cm), dok je linija L-93 imala najnižu prosečnu vrednost za datu osobinu (10,35 cm). Linije su raspoređene u šest klaster grupa sa jednom izdvojenom linijom. Prosečna vrednost visine stabla je opadala od klastera jedan do klastera šest dok je izdvojena linija L-61 imala najnižu vrednost. Najveću prosečnu vrednost prečnika glave pokazale su klaster grupe broj jedan i šest. U ovom radu je primećeno da najniže i najviše linije poseduju veći prečnik glave doklinije srednjeg rasta imaju manji prečnik glave. Rezultati ovog ogleda se mogu koristiti za oplemenjivanje kao pokazatelji divergentnosti između linija kao roditeljskih komponenti.

Ključne reči: suncokret, genetička varijabilnost, klaster analiza

Rezultat projekta: TR 31025: „Razvoj novih sorti i poboljšanje tehnologija proizvodnje uljanih biljnih vrsta za različite namene“

VARIABILITY OF STEM HEIGHT AND HEAD DIAMETER OF DIFFERENT LINES OF SUNFLOWER

Cultivated sunflower (*Helianthus annuus* L.) has narrow genetic variability as the result of a small number of ancestors. It is possible to increase genetic variability by crossing existing genotypes in order to achieve new gene recombination. The aim of this research was to examine variability and create groups for stem height and head diameter of 93 sunflower lines created in Institute of Field and Vegetable Crops in Novi Sad (IFVCNS). The trial was organized in block design with three replications, at experimental field Rimski Šančevi of IFVCNS. Stem height and head diameter were measured during the phase of physiological maturity for each line separately. Collected data were analyzed by cluster analysis (joining-tree clustering) in STATISTICA 10 software. The highest value for plant height had genotype L-43 (184.33 cm), while genotype L-61 (73.03 cm) had the lowest value. The range of head diameter size was from 10.35 cm (L-93), to 24.70 cm (L-45, L46). Cluster analyse divided lines into six groups and one extracted line. The average height of the stem was decreasing from cluster one to cluster six, while extracted line (L-61) was the shortest. The highest value for head diameter had clusters one and six. It is noticed that the shortest and the tallest groups of plants have the biggest head diameter, while lines with medium stem height have a smaller head diameter. The results of this trail can be used in breeding programs of IFVCNS as a morphological markers for diversity between inbred lines.

Key words: sunflower, genetic variability, cluster analysis

Project: TR 31025: "Development of new varieties and production technology improvement of oil crops for different purposes"

U-11

RECIPROČNI EFEKAT NA PRINOS ZRNA I VLAGU ZRNA U BERBI KOD DVOLINIJSKIH HIBRIDA KUKURUZA

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Cilj istraživanja bio je da se ispita uticaj recipročnih ukrštanja na prinos zrna i procenat vlage zrna u momentu berbe kao najvažnijih agronomskih osobina u proizvodnji kukuruza. Ispitivani su ZP 333, ZP 335, ZP 366, ZP 388, ZP 4007 i njihove recipročne varijante, kao i samooplodne linije komponente ovih hibrida. Hibridi pripadaju srednje ranoj grupi zrenja FAO 300-400 i imaju zajedničku komponentu ZPL 1 kao oca, odnosno majku u recipročnoj varijanti. Ogled je bio postavljen u dva ponavljanja u dve godine, ukupno na sedam lokacija. Na vlagu zrna u momentu berbe značajno su uticali faktori hibrid, lokacija i interakcija hibrid × lokacija, dok je na prinos zrna značajno uticao samo faktor lokacija. ZP 366 recipročni je imao značajno viši prinos zrna i značajno niži procenat vlage u momentu berbe (11,02 t/ha i 17,36%) u odnosu na normalni ZP 366 (10.36 t/ha i 17,99%). ZP 335 recipročni je imao značajno viši udeo vlage u zrnu u momentu berbe (16,71%) u odnosu na normalni ZP 335 (16,09%). Kod ZP 366 je takođe utvrđena i značajna razlika u heterozisu između normalne i recipročne verzije.

Ključne reči: kukuruz, recipročni efekat, prinos zrna.

RECIPROCAL EFFECT ON GRAIN YIELD AND GRAIN MOISTURE AT HARVEST IN SINGLE-CROSS MAIZE HYBRIDS

The aim of the research was to study influence of reciprocal crosses on grain yield and grain moisture percentage at harvest as the most important agronomic traits in maize production. ZP 333, ZP 335, ZP 366, ZP 388, ZP 4007 and their reciprocal crosses were examined, as well as inbred lines representing their components. The hybrids belong to medium maturity group FAO 300-400 with ZPL 1 inbred line as a common paternal parent, ie. maternal parent in their reciprocal crosses. The trial was set up in two replications during two years and seven locations in total. Hybrid, location and hybrid × location interaction influenced significantly kernel moisture at harvest, while only location significantly influenced grain yield. ZP 366 reciprocal showed significantly higher grain yield and lower grain moisture at harvest (11,02 t/ha i 17,36%) comparing to normal ZP 366 (10.36 t/ha i 17,99%). ZP 335 reciprocal had significantly higher grain moisture at harvest (16,71%) than normal ZP 335 (16,09%). Significant difference in heterosis was also determined between ZP 366 normal and reciprocal hybrid.

Key words: maize, reciprocal effect, grain yield.

U-12

KVALITET ZRNA SOJE U ZAVISNOSTI OD TIPA ZEMLJIŠTA I NIVOA ĐUBRENJA AZOTOM

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U trogodišnjem periodu (2009-2011) praćen je uticaj tipa zemljišta i nivoa đubrenja azotom na kvalitet zrna soje (sadržaj ulja i proteina u zrnu) sorti soje različitih grupa i specifičnih svojstava zrna. Poljski mikroogledi su postavljeni na dve lokacije i to: Institut za kukuruz „Zemun Polje“ (tip zemljišta černozem) i selo Kloka (tip zemljišta gajnjača). Izvedeni su metodom podeljenih parcela (split-plot) u tri ponavljanja.
Kvalitet zrna soje (sadržaj ulja i proteina u zrnu) je najviše zavisio od tipa zemljišta, manje od sorte, a najmanje od količine azota. Najveći sadržaj proteina utvrđen je đubrenjem sa najvećom kličinom azota (90 kg/ha). Veći sadržaj ulja je na zemljištu tipa gajnjača. Prosečan sadržaj proteina je iznosio 30,6 %, a ulja 21,5 %.

Ključne reči: azot, kvalitet zrna, proteini, soja, sorta, tip zemljišta, ulje.

SOYBEAN SEED QUALITY DEPENDING ON SOIL TYPE AND LEVEL OF NITROGEN FERTILIZATION

In the three-year period (2009-2011), the influence of soil type and nitrogen fertilization level on the quality of soybean grain (the content of oil and protein in grains) of soybean varieties of different groups and specific grain properties was conducted. Field microexperiments were located in Maize Research Institute of Zemun Polje (the chernozem soil type) and the village of Kloka (brown forest) and were achieved using split-plot method in three repetitions.
The quality of soybean grain (seed oil and protein content) mostly depended on the soil type, less on the variety, and at least the amount of nitrogen. The highest protein content was determined by fertilization with the highest nitrogen level (90 kg/ha). Higher seed oil content was determined on brown forest soil type. The average protein content was 30.6 % and oil 21.5 %.

Key words: nitrogen, seed quality, protein, soybean, variety, soil type, oil.

U-13

BIOFORTIFIKACIJA – VAŽAN DEO POLJOPRIVREDNE PROIZVODNJE

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Biofortifikacija predstavlja čitav kompleks mera koje obuhvataju selekcionisanje novih genotipova, manipulacije genima, različite mere gajenja kojima se omogućava bolja apsorpcija i povećana akumulacija esencijalnih elemenata, kao što su gvožđe, cink, mangan, bakar i dr. u jestivim delovima gajenih biljaka. Pored toga, nezaobilazni deo biofortifikacije predstavlja i unapređenje faktora koji povećavaju apsorpciju mikroelemenata, a eliminisanje faktora koji ometaju njihovu apsorpciju i time smanjenje antinutritiva. Rezultati su pokazali da je u semenu linija koje pripadaju Lankaster heterotičnoj grupi povećanje sadržaja Zn bilo praćeno padom fitata, dok veći sadržaj β-karotena u semenu BSSS genotipova može poboljšati apsoprpciju Mn i Zn. Neke linije kukuruza iz Banke gena imaju povećanu pristupačnost Mg, Fe, Mn i Zn, zahvaljujući nižem odnosu fitat/β-karoten i mogle bi se iskoristiti u selekciji fortifikovanih hibrida kukuruza. U semenu nekih populacija, variranje u sadržaju Fe i Zn je nezavisno od inhibitora i promotera. Održiva proizvodnja koja obuhvata kombinovane ili pokrovne useve može da poboljša apsorpciju i akumulaciju esencijalnih elemenata u zrnu kukuruza i soje. Tako, u zrnu soje gajene u kombinaciji s kukuruzom, β-karoten je osnovni faktor koji doprinosi Fe pristupačnosti. Naizmenični redovi u kombinaciji s bio-đubrivom doprinose povećanoj Fe i Mg pristupačnosti, kao i boljem iskorišćenju uslova, povećavajući plodnost zemljišta soje i kukuruza. U eksperimentima s pokrovnim usevima, kombinacija organskog malča i bio-đubriva se pokazala kao najefikasnija za poboljšanu pristupačnost Mg i Zn iz zrna kukuruza šećerca, dok su stočni grašak i ozimi ovas najefikasnija kombinacija za poboljšanu Fe pristupačnost. Određena bio- i organska đubriva mogu povećati nivo β-karotena, a smanjiti nivo fitata u zrnu kukuruza, povećavajući pristupačnost esencijalnih elemenata.

Ključne reči: ratarske vrste, povećanje sadržaja mikroelemenata, prinos, mere gajenja, poboljšani genotipovi.

BIOFORTIFICATION – IMPORTANT PART OF AGRICULTURAL PRACTICE

Biofortification represents complex of different measures that include new genotypes breeding, gene manipulations, different cropping measures which enable better absorption and accumulation of essential elements, like iron, zinc, manganese, copper, etc. in edible plant parts. Besides, increase in factors that promote microelements absorption, as well as reduction in antinutritives (factors that supress microelements absorption) represent unavoidable part of biofortification. Results showed that Zn increase is followed by reduction in phytate content, particularly in maize lines from *Lancaster* heterotic group, while increased *β*-carotene content could improve Mn and Zn availability from grain of *BSSS* genotypes. Some maize lines from Gene bank were characterised with increased Mg, Fe, Mn and Zn availability, owing to low phytate/*β*-carotene ratio. They could be used in breeding for production of fortified maize hybrids. In grain of some landraces, variations in Fe and Zn content are independent of variations in inhibitor and promoter contents.
Sustainable practices, like intercropping or application of cover crops could improve absorption and accumulation of essential elements in maize and soybean grain. For instance, in grain of intercropped soybean *β*-carotene is the main factor contributing to Fe availability. Alternating rows in combination with biofertilizer emphasised increased Fe and Mg availability and better utilization of the conditions and the soil fertility under the both, maize and soybean. In experiments with cover crops, organic mulch+biofertilizer expressed the highest efficiency for improved Mg and Zn bioavailability from sweet maize kernel, while field pea+winter oats was the most effective for improved Fe bioavailability. Some biofertilizers and organic fertilizers could increase *β*-carotene level and decrease phytate concetration in maize grain, thus increasing bioavailability of essential elements.

Key words: crops, increase in microelements concentration, yield, cropping measures, improved genotypes.

U-14

UTICAJ GENOTIPA I SPOLJAŠNJE SREDINE NA SADRŽAJ PROTEINA I ULJA KOD PŠENICE (*Triticum aestivum*, L.)

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Cilj ovog rada bio je da se ispitaju efekti genotipa, godine, doze đubrenja azotom (N) i njihovih interakcija na sadržaj proteina i ulja kod 24 sorte ozime pšenice (*Triticum aestivum*, L.). Postavljen je dvogodišnji poljski ogled na lokalitetu Rimski šančevi, sa dve doze prihrane N (45 i 110 kgha^{-1} N). Ulje je ekstrahovano iz mekinja dobijenih laboratorijskim mlinom MLU 202. Klasična metoda Rushkovski korišćena je za određivanje sadržaja ulja, dok je sadržaj proteina određen metodom ICC 105/2. Utvrđena je značajna varijabilnost među genotipovima za oba analizirana svojstva. Sadržaj proteina kretao se od 10,9% (NS 40S) do 17,1% (Banatka), sa prosekom od 13,3% i koeficijentom varijacije (CV) od 3,1%. U toku dve godine ispitivanja na nižoj dozi N, sadržaj ulja se kretao od 2,6% (Skopljanka) do 5,2% (Dragana), dok je na višoj dozi N, varirao od 2,5% (Pobeda) do 5,4% (Simonida). U celom ekperimentu ostvaren je prosečan sadržaj ulja od 3,96%, sa CV od 9,2%. Svi izvori variranja (genotip - G, godina - Y i doza đubrenja N - N) i njihove interakcije imali su značajan uticaj na sadržaj proteina i ulja, osim uticaja interakcije Y × N na sadržaj proteina. Što se tiče sadržaja ulja, uticaj godine bio je jače izražen od uticaja azota, dok je kod sadržaja proteina bilo obrnuto. Analiza glavnih komponenti (PCA) korišćena je za grupisanje genotipova u skladu sa njihovom stabilnošću i reakcijom na različite uslove gajenja. Identifikovani su genotipovi koji mogu poslužiti kao roditelji u oplemenjivanju pšenice na veći sadržaj ulja i proteina.

Ključne reči: GxE interakcija, đubrenje N, sadržaj proteina, sadržaj ulja, pšenica

Rad je nastao kao rezultat projekta TR 31066, finansiranog od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije.

GENOTYPIC AND ENVIRONMENTAL EFFECTS ON PROTEIN AND OIL CONTENT IN WHEAT (*Triticum aestivum* L.)

The aim of this study was to analyse the effects of genotype, year, nitrogen (N) fertilizer doses, and their interactions on the protein and oil content in 24 cultivars of winter wheat (*Triticum aestivum* L.). A two-year field trial was set up on the Rimski šančevi site, with two N doses (45 and 110 kgha^{-1} N). The oil was extracted from bran obtained by using the MLU 202 laboratory mill. The classic method of Rushkovsky was used to determine the oil content and ICC 105/2 method to determine the protein content. Significant variability was found among the cultivars for both analysed traits. Protein content ranged from 10.9% (NS 40S) to 17.1% (Banatka), with the average of 13.3% and coefficient of variation (CV) of 3.1%. During the two trial years, at the lower N rate oil content varied from 2.6% (Skopljanka) to 5.2% (Dragana), and at the higher N rate from 2.5% (Pobeda) to 5.4% (Simonida). The average oil content was 3.96%, with CV of 9.2%. All sources of variation (genotype - G, year - Y and N fertilizer dose - N) and their interactions significantly affected protein and oil content, except the effect of interaction Y × N on protein content. The effect of the year was more profound than N effect on oil content, and the opposite was found for protein content. Principal component analysis (PCA) was used to group the genotypes regarding their stability and reaction to different growing conditions. The study identified the genotypes that can be parents in wheat breeding for higher oil and protein content.

Key words: G×E interaction, N fertilization, protein content, oil content, wheat

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U-15

KORELACIJE IZMEĐU AGRONOMSKIH I TEHNOLOŠKIH OSOBINA KORENA ŠEĆERNE REPE U RAZLIČITIM SREDINAMA

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Šećerna repa je najvažniji usev za proizvodnju šećera u umerenim klimatskim regionima sveta. Oplemenjivanje i selekcija su veoma složeni jer je neophodno ostvariti ravnotežu između brojnih osobina korena. Cilj ovog istraživanja je da se analiziraju korelacije između osobina korena šećerne repe gajenih u različitim uslovima sredine. Tokom dve uzastopne godine (2014. i 2015.) odnosi između osobina (prinos korena, sadržaj šećera, štetni kalijum, štetni natrijum, alfa amino azot, iskorišćenje šećera i prinos kristalnog šećera) su ispitivani u različitim tretmanima mineralne ishrane. Biljni materijal se sastojao iz osam hibrida šećerne repe dok su sredine predstavljene rastućim dozama mineralnih đubriva (N, P, K). Ogled je postavljen na polju Instituta za ratarstvo i povrtarstvo u Novom Sadu. Prikupljeni podaci su standardizovani i obrađeni u programu *STATISTICA 12*. Multivarijacioni analize, genotip x osobina (G x T) i sredina x osobina (E x T) zajedno sa Pirsonovim koeficijentima korelacije su korišćene za ocenu odnosa između agronomskih i tehnoloških osobina korena. U obe sezone rezultati istraživanja su pokazali jaku vezu prinosa kristalnog šećera sa prinosom korena i sadržajem šećera. Korelacije između sadržaja šećera i iskorišćenja su bile jake, međutim tokom 2014 godine su bile pozitivne dok su u narednoj sezoni bile negativne. Prema rezultatima multivarijacione analize u obe godine hibrid sa najboljim performansama je bio G3 dok su tretmani sa manjim dozama N i srednjim količinama P i K imali najbolji prinos i kvalitet korena.

Ključne reči: šećerna repa, multivarijaciona analiza, korelacije

Rezultat projekta: TR31015 "Poboljšanje sorti, hibrida i tehnologije šećerne repe"

CORRELATIONS BETWEEN AGRONOMICAL AND TECHNOLOGICAL ROOT TRAITS IN SUGAR BEET UNDER DIFFERENT ENVIRONMENTS

Sugar beet is the most important sugar crop in the temperate regions of the world. Breeding and selection are very complex since it is necessary to achieve the balance between the numerous sugar beet root characteristics. The aim of this study was to analyse correlations between root traits of sugar beet in different environmental conditions. The relations between traits (root yield, sugar content, potassium, sodium, amino nitrogen, recoverable sugar and white sugar yield) were examined during the two consecutive years (2014 and 2015) in different mineral nutrition treatments. Plant material consisted of eight sugar beet hybrids, while environments were represented as treatments with growing levels of mineral fertilizers (N, P, K). The trial was located on the fields of the Institute of fields and vegetable crops in Novi Sad. Data were standardized and statistically analysed in program *STATISTICA 12*. Multivariate analysis, genotype x trait (G x T) and environment x trait (E x T) together with Pearson correlation coefficient were used for evaluation of relations between agronomical and technological root traits. In both growing seasons results of study have shown strong positive connections of white sugar yield with root yield and sugar content. Correlations between sugar content and recoverable sugar were also strong, however during 2014 this relation was positive while in the next season it was negative. According to multivariate analysis during both years best performing hybrid was G3 while treatments with low amount of N and medium levels of P and K had best root yield and quality.

Key words: sugar beet, multivariate analysis, correlations

Result of the project: TR31015 "Improvement of sugar beet varieties, hybrids and production technology"

U-16

UTICAJ FOLIJARNOG ĐUBRIVA NA SADRŽAJ KAROTENOIDA U ZRNU KUKURUZA ŠEĆERCA

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Velika upotreba kukuruza šećerca u ljudskoj populaciji zahteva poboljšani nutritivni kvalitet zrna. Folijarno đubrenje je agrotehnička mera koja se koristi kao dopuna osnovnom đubrenju. Folijarnom prihranom biljke se obezbeđuju esencijalnim mikroelementima, posebno u uslovima zemljišta sa nepoželjnim karakteristikama. Karotenoidi, pigmenti kukuruza, imaju blagotvorno dejstvo na zdravlje čoveka. Cilj rada je bio da se ispita uticaj primenjenog folijarnog đubriva na sadržaj karotenoida u zrnu tri hibrida kukuruza šećerca. Folijarno đubrivo je primenjeno kada je kukuruz bio u fazi 5-6 listova. Sadržaj karotenoida (lutein, zeaksantin i *β*-karoten) u zrnu nakon berbe u mlečnoj kao i u punoj zrelosti, određen je primenom HPLC-DAD metode. Studentov *t*-test pokazao je da primenjeno folijarno đubrivo statistički povećava sadržaj ukupnih karotenoida u zrnu svih analiziranih hibrida u poređenju sa kontrolom (bez primene folijarnog đubriva). Povećanje koncentracije ukupnih karotenoida u zrnu od mlečne do pune zrelosti bio je 27.44% - 38.52% i 31.78% - 57.03%, respektivno. Primenom folijarnog đubriva postignuto je očuvanje i poboljšanje sadržaja ukupnih karotenoida u zrnu kukuruza šećerca namenjenog za ljudsku ishranu (mlečna zrelost) i semensku proizvodnju (puna zrelost). Stoga se može zaključiti da folijarno đubrenje predstavlja važnu agrotehničku meru koja obezbeđuje povećani nutritivni kvalitet tj. sadržaj karotenoida u zrnu kukuruza šećerca.

Ključne reči: folijarno đubrenje, zrno kukuruza, *β*-karoten, nutritivni kvalitet.

Rezultat projekata MPNTR TR31068 Poboljšanje svojstava kukuruza i soje molekularnim i konvencionalnim oplemenjivanjem i TR31037 Integralni sistemi gajenja ratarskih useva – očuvanje biodiverziteta i plodnosti zemljišta.

IMPACT OF FOLIAR FERTILIZER ON CAROTENOIDS CONTENT IN SWEET MAIZE GRAIN

Broad usage of sweet maize in human population requires an improved nutritional quality of the grain. Foliar fertilization is a part of cropping practices used as a supplement to basic fertilization. Through foliar fertilization, plants are provided with essential nutrients, especially under the unfavorable soil characteristics conditions. Carotenoids, maize pigments, have a beneficial effect on the human health. The aim of this study was to examine the influence of the applied foliar fertilizer on the carotenoids content in kernel of three sweet maize hybrids. Foliar fertilizer was applied in the 5-6 leaf stage of maize. Carotenoids content (lutein, zeaxanthin and *β*-carotene) in kernel harvested in milky as well as in fully maturity phase, was determined by using HPLC-DAD. According to Student's *t*-test ($p < 0.05$), applied foliar fertilizer showed a statistical enhancement of total carotenoids content in all tested sweet maize hybrids, compared to the control (no foliar fertilizer application). The increment of the total carotenoids content in kernel from milky to fully maturity was 27.44% - 38.52% and 31.78% - 57.03%, respectively. The preservation and improvement of the total carotenoids content in sweet maize kernel intended for human consumption (milky phase) as well as for maize seed production (fully maturity phase) was achieved by foliar fertilizer application. Therefore, it can be concluded that foliar fertilization is an important part of cropping practices to provide higher nutritive quality i.e. carotenoids content in sweet maize grain.

Key words: foliar fertilizer, maize seed, *β*-carotene, nutritive quality.

*Results of the Projects TR31068 - Improving the quality of maize and soybean by conventional and molecular breeding and TR31037-*Integrated system *of field* crop *cultivation: conservation of biodiversity and soil fertility.*

U-17

VARIJABILNOST KOMPOZICIJE *Glu-1* ALELA KOD GENOTIPOVA PŠENICE (*Triticum aestivum* L.)

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Visokomolekularni glutenini (HMW GS) su deponovani u endospermu semena pšenice. Sinteza HMW GS je kontrolisana sa tri genska lokusa**,** *Glu-A1*, *Glu-B1*, *Glu-D1*, na dugim kracima hromozoma 1A, 1B i 1D. Cilj ovog rada je bio identifikacija kompozicije *Glu-1* alela genotipova ozime pšenice i odredjivanje polimorfnosti *Glu-1* lokusa. Izučavano je 20 genotipova ozime pšenice. Najmanje 30 semena jekorišćeno za ekstrakciju glutenina u SDS sa pH-6.8 pomoću 10% β-merkaptoetanola. HMW gluteninske podjedinice su razdvojene metodom elektroforeze pri pH-8.9, na 11.8% SDS poliakrilamidnom gelu. Dobijeni elektroforegrami su korišćeni za analizu i determinaciju gluteninskih podjedinica i identifikaciju *Glu-1* alela. Rezultati su pokazali različitu kompoziciju gluteninskih podjedinica koje su kontrolisane sa tri *Glu-1* lokusa. Identifikovano je 12 alela na tri *Glu-1* lokusa i to na *Glu-A1* (*a, b, c*), na *Glu-B1* (*a*, *b, c, d, e, h*), na *Glu-D1* (*a, b, d*). Učestalost identifikovanih alela je varirala od 5% **(***Glu-B1h*) do 50% (*Glu-D1a*). Najučestaliji aleli su bili *Glu-A1b* (35%), *Glu-B1c* (35%) i *Glu-D1a* (50%). Medju 20 genotipova pšenice je determinisano 11 tipova kompozicije glutenina. Kod šest genotipova je bila specifična kompozicija alela, dok je ista kompozicija gluteninskih alela bila kod Baranjke i G-3680/03 (*a, d, a*), kod G-3401-4/03 i G-3411/03 (*a, c, b*), kod sorti Bistra, Libelulla i Morava (*a, e, a*), kod Martonvasari 2, G-3401-2/03 i G-3902/03 (*b, b, d*), ***i*** kod Fruškogorka, G-3401-3/03, G-3414-3/03 i G-3426/03 (*b, c, d*). Na osnovu rezultata može se zaključiti da je kod izučavanih genotipova pšenice ustanovljena polimorfnost *Gl*u-1 lokusa.

Ključne reči: glutenini, aleli, pšenica, polimorfnost, učestalost.

Rad je rezultat projekta MPNTR 31092 „Izučavanje genetičke osnove poboljšanja prinosa i kvaliteta strnih žita u različitim ekološkim uslovima".

COMPOSITION VARIABILITY OF *Glu-1* ALLELES IN WHEAT GENOTYPES (*Triticum aestivum* L.)

High-molecular weight glutenins (HMWG) are deposited in endosperm of wheat seed. The synthesis of HMW GSs are encoded by three loci, *Glu-A1*, *Glu-B1*, *Glu-D1*, on long arm of 1A,1B and 1D chromosome, respectively. The aim of this study was identification of *Glu-1* allele composition of winter wheat genotypes and determination of polimorphisms of *Glu-1* loci. The twenty winter wheat genotypes were studied. At least 30 seeds chrashed and used for extraction of glutenins in sodium dodecyl sulfate (SDS) at pH-6.8 and by 10% β-mercaptoethanol. The HMW GS separated by metod of SDS polyacryl amide gel electrophoresis on the gel 11.8% at pH-8.9. Electrophoregram was used for analysis and determining glutenins subunits and identification of *Glu-1* alleles. The results showed different composition of glutenin subunits encoded by three *Glu-1* loci. The 12 alleles were identified at the three *Glu-1* loci, i.e. at the *Glu-A1* (*a, b, c*), at the *Glu-B1* (*a*, *b, c, d, e, h*), at the *Glu-D1* (*a, b, d*). The frequency of identified alleles varied from 5% (*Glu-B1h*) to 50% (*Glu-D1a*). The most frequent alleles were *Glu-A1b* (35%), *Glu-B1c* (35%) and *Glu-D1a* (50%). Among twenty wheat genotypes, the eleven different type of glutenin alleles composition were identified. The six genotypes had specific allele composition, while the same allele composition was identified in Baranjka and G-3680/03 (*a, d, a*), in G-3401-4/03 and G-3411/03 (*a, c, b*), in Bistra, Libelulla, Morava (*a, e, a*), , in Martonvasari 2, G-3401-2/03 and G-3902/03 *(b, b, d*), in Fruškogorka, G-3401-3/03, G-3414-3/03 and G-3426/03 (*b, c, d*). On the base of results we can conclude that in analyzed wheat genotypes established polymorphysms of the *Glu-1* loci.

Key words: glutenin, alleles, wheat, polymorphism, frequency.

Result of the Project TR 31092 - "Study of the genetic basis of yield improvements and the quality of small grains under different ecological conditions"

U-18

ISPITIVANJE KOMBINACIONIH SPOSOBNOSTI ZA BROJ ZRNA U REDU INBRED LINIJA KUKURUZA RAZLIČITIH CIKLUSA SELEKCIJE

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U ovom istraživanju proučavane su inbred linije kukuruza dobijene iz različitih ciklusa selekcije dve sintetičke populacije BSSS i $BSCB_1$ kao i linije roditelji elitnog hibrida.Cilj je bio da se za osobinu broj zrna u redu ispita varijabilnost inbred linija i njihovih hibrida, heterozis i opšte i posebne kombinacione sposobnosti.Najveći prosečan broj zrna u redu dobijen je kod hibrida ZPL2 x B73 (44,2) za koji je utvrđena i najviša vrednost heterozisa od (59,4%) dok je najmanji prosečan broj zrna u redu ostvario hibrid B90 x B91(15,60). Za linije iz BSSS populacije i linije roditelje elitnog hibrida konstatovano je da neaditivni geni preovlađuju u nasleđivanju što pokazuje odnos OKS/PKS koji je bio manji od jedinice dok je za linije $BSCB_1$ sintetika i linije elitnog hibrida aditivna varijansa veća od neaditivne.Linija B73(C5) iz sintetika BSSS se pokazala kao najbolji opšti kombinator u obe ispitivane godine i lokacije što upućuje da se može koristiti u programima oplemenjivanja na povećan broj zrna u redu.U $BSCB_1$ populaciji inbred linija B97(C9) takođe je ispoljila visoke vrednosti za OKS.

Ključne reči: kukuruz, heterozis, kombinaciona spsobnost, broj zrna u redu.

Rezultat projekta MPNTR TR 31068: Poboljšanje svojstava kukuruza i soje molekularnim i konvencionalnim oplemenjivanjem.

STUDYING COMBINING ABILITIES FOR THE NUMBER OF KERNELS PER ROW IN MAIZE INBRED LINES OF DIFFERENT CYCLES OF SELECTION

Maize inbred lines developed from different cycles of selection of two synthetic populations, BSSS and $BSCB_1$, as well as the parental inbreds of an elite hybrid were observed in this study. The objective of the study was to observe the following parameters for the number of kernels per row: variability of inbred lines and their hybrids, heterosis, general and specific combining abilities. The greatest number of kernels per row was recorded in the hybrid ZPL2 x B73 (44.2). Moreover, the highest value of heterosis was also determined in this hybrid (59.4%). On the other hand, the lowest average number of kernels per row was detected in the hybrid B90 x B91 (15.60). Negative genes prevailed in inheritance in the inbreds of the BSSS population and parental inbreds of the elite hybrid, which was indicated by the GSC to SCA ratio that was below unit, while the additive variance was greater than the non-additive one in the inbreds of the synthetic $BSCB_1$and the inbreds of the elite hybrid. The inbred B73(C5) of the synthetic BSSS had the highest GCA effects in both locations and both years of investigation indicating that it can be used in the breeding programmes for the increased number of kernels per row. In the $BSCB_1$ population, the inbred line B97(C9) also expressed high values of GCA.

Key words: maize, heterosis, combining ability, number of kernels per row.

Results of the Project TR 31068: Improvement of maize and soybean characteristics by molecular and conventional breeding.

U-19

IZBOR HIBRIDA SUNCOKRETA NA OSNOVU STABILNOSTI U RAZLIČITIM AGRO-EKOLOŠKIM USLOVIMA

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Imajući u vidu da je proizvodnja suncokreta u Srbiji ekstenzivna od velike je važnosti odabrati hibride koji će ostvariti stabilan i visok prinos semena i ulja u različitim uslovima spoljašnje sredine. Cilj rada bio je identifikacija najstabilnijih hibrida suncokreta za prinos semena i ulja korišćenjem AMMI modela. Ispitivano je devet novostvorenih hibrida koji pripadaju kategorijama rani, srednje rani i srednje kasni. Hibridi su gajeni na različitim lokacijama u severnom delu Srbije tokom dve vegetacione sezone (2013-2014). Odabrane lokacije jesu geografski bliske, ali različite su u pogledu agro-ekoloških uslova (zemljišta, padavina i temperature), čime su stvoreni specifični mikro-klimatski uslovi za gajenje suncokreta. Grupna analiza varijanse prinosa semena i ulja pokazala je da su glavni efekti, hibridi i spoljašnja sredina, kao i njihova interakcija bili statistički visoko značajni. Biplot analiza je utvrdila da je sredina E3 najstabilnija za proizvodnju suncokreta. Na osnovu rezultata AMMI modela, najmanju interakciju sa spoljašnjom sredinom, odnosno najstabilniji hibridi za prinos semena i ulja bili su NS8 i NS2. Dobijeni rezultati ukazuju da se oba hibrida mogu preporučiti za proizvodnju u različitim sredinama u Srbiji, i to hibrid NS2 kao ranostasan, stabilan za prinos ulja, a hibrid NS8, srednje kasni hibrid, visokog potencijala rodnosti i pogodan za sve sisteme proizvodnje.

Ključne reči: suncokret, hibrid, prinos semena, prinos ulja, stabilnost

SELECTION OF SUNFLOWER HYBRIDS BASED ON STABILITY ACROSS ENVIRONMENTS

Bearing in mind that the sunflower production in Serbia is extensive, it is very important to select a hybrid that will achieve stable and high seed and oil yields in different enviromental conditions. The objective of the study was to identify the most stable sunflower hybrids for seed and oil yield using AMMI model analysis. Nine newly developed early, medium early and medium late hybrids were tested. Hybrids were grown in different locations across Northern Serbia during two growing seasons (2013-2014). Selected locations are geographically close, but environmentally different in terms of soil, rainfalls and temperature, thus creating a specific microclimate conditions for sunflower growing. Pooled analysis of variance for seed and oil yield showed that the main effects of hybrids, environments and their interaction were highly significant. Biplot analysis determined that E3 environment was the most stable for sunflower production. According to results of AMMI model, the most stable hybrids for the seed and oil yield, i.e. the lowest interaction with the enviroment, were NS8 and NS2. The obtained results indicate that both hybrids can be recommended for production in different environments in Serbia, NS2 hybrid as early-growing, stable for oil yield, and NS8 hybrid, medium-late hybrid, high productivity potential and suitable for all production systems.

Key words: sunflower, hybrid, seed yield, oil yield, stability

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FP-1

OCENA STABILNOSTI PRINOSA SEMENA KONZUMNIH HIBRIDA SUNCOKRETA PRIMENOM AMMI ANALIZE

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Važnu ulogu u stvaranju novih visoko prinosnih hibrida konzumnog suncokreta ima proučavanje interakcija između genotipa i uslova spoljne sredine. U cilju procene stabilnosti NS konumnih hibrida u različitim uslovima spoljne sredine, postavljen ogled sa 10 konzumnih hibrida, stvorenih u IFVCNS na lokalitetu Rimski Šančevi po slučajnom blok sistemu u tri ponavljanja u 2011, 2012, 2014, 2016 i 2017 godini. Primenjena je AMMI analiza (*Additive Main Effects and Multiplicative Interaction*), jedna od najznačajnijih i najviše korišćenih multivarijacionih analiza kojom se određuje interakcija između genotipa (hibrida) i spoljašnje sredine (godine). Upoređujući sredine, najviše prosečne vrednosti prinosa semena kod hibrida za sve godine ispitivanja su ostvarene u 2012. godini koja je bila ekstremno topla. Konzumni hibrid NS H 6487 ostvario je najviši prinos semena od svih ispitivanih hibrida u 2012. godini. Najvišu prosečnu vrednost prinosa semena za sve godine ispitivanjaje postigao hibrid NS H 6485 (4129 kg), a najnižu prosečnu vrednost prinosa semena hibrid NS H 1200 (3559 kg). AMMI analiza je pokazala da su genotipovi NS H 6489 i NS H 6308 bili najstabilniji u visini prinosa za analizirani period, oni se odlikuju najnižim vrednostima interakcije i karakterišu širokom adaptabilnošću. Ovi hibridi su ostvarili prosečnu vrednost prinosa za sve godine ispitivanja višu od ukupnog proseka ogleda. Nastaviće se dalji rad na ispitivanju NS konzumnih hibrida primenom AMMI analize kako bi se ocenio uticaj genotipa, spoljašnje sredine i njihove intrekcije na visinu prinosa semena, povećala preciznost u davanju preporuke za gajenje hibrida u različitim rejonima sa prilagođenim načinom proizvodnje rejonu gajenja konzumnog suncokreta.

Ključne reči: suncokret, AMI biplot, prinos semena, stabilnost

Rezultat projekta: TR 31025, „Razvoj novih sorti i poboljšanje tehnologija proizvodnje uljanih biljnih vrsta za različite namene“

STABILITY EVALUATION OF CONFECTIONERY SUNFLOWER SEED YIELD USING AMMI ANALYSIS

Studying the interaction between genotypes and environmental conditions plays an important role in creation of new high-yielding confectionery sunflower hybrids. In order to evaluate the stability of the NS confectionery sunflower hybrids in different environmental conditions, a trial was set with 10 confectionery sunflower hybrids created at IFVCNS at the location of Rimski Šančevi in a random block system with three repetitions during 2011, 2012, 2014, 2016 and 2017. The AMMI analysis (*Additive Main Effects and Multiplicative Interaction*) was applied, it is one of the most important and widely used multivariational analysis for determining the interaction between genotypes (hybrids) and the environment (year). By comparing the environments the highest average values of seed yield for all examined years were achieved in 2012, which was extremely warm. Confectionery hybrid NS H 6487 achieved the highest seed yield out of all hybrids studied in 2012. The highest average value of seed yield for all the examined years was obtained by NS H 6485 hybrid (4129 kg), and the lowest average value of seed yield NS H 1200 hybrid (3559 kg). AMMI analysis has shown that the genotypes NS H 6489 and NS H 6308 were the most stable when it comes to the height of the yield for the analyzed period. They poses the lowest value of interaction and are characterized by wide adaptability. These hybrids have achieved the average yield value higher than the total average of the trial for all the years analyzed. The evaluation of NS confectionary hybrids using the AMMI analysis will be continued in order to assess the impact of genotypes, environment and their interaction on the seed yield height and at the same time to increase the precision of providing the recommendations for hybrids in different regions and by different means of production of sunflower hybrids.

Key words: sunflower, AMI biplot, seed yield, stability

Project: TR 31025, "Development of new varieties and production technology improvement of oil"

FP-2

BIPLOT ANALIZA UTICAJA PRAJMINGA SEMENA NA POČETNI PORAST PONIKA KUKURUZA

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Cilj ovog ispitivanja bilo je utvrđivanje uticaja prajming tretmana i genotipa na klijanje i rani porast ponika kukuruza, kao i sagledavanje povezanosti ovih osobina. Takođe, analizirana je mogućnost primene GT biplot analize u ovom tipu ispitivanja. Prajming tretman se sastojao od potapanja semena deset inbred linija kukuruza u vodu (hidroprajming) i rastvor KNO_3. Seme je zatim posejano u posude sa vlažnim sterilnim peskom i stavljeno na suboptimalnu (15°C) i optimalnu temperaturu (25°C) u trajanju od 7 dana. Nakon toga je izmerena dužina i masa ponika, utvrđena je klijavost i izračunato vreme potrebno za 50% nicanja, kao i vigor indeks. Rezultati su pokazali da početni porast ponika na obe temperature može biti poboljšan prajmingom semena. Primećena je različita reakcija linija na korišćene prajming tretmane. Ove razlike predstavljaju korisnu informaciju za izbor odgovarajuće inbred linije i pogodnog prajming tretmana za setvu u različitim temperaturnim uslovima. Ispitivanje je pokazalo da se biplot analiza može koristiti kao brz vizuelni metod za prikazivanje rezultata efekta prajminga ili nekog drugog tretmana semena na različite parametre klijanja, nicanja i početnog porasta ponika. Takođe, ova analiza se može koristiti i za sagledavanje veze između ispitivanih osobina.

Ključne reči: *Zea mays,* klijavost, multivarijaciona analiza, suboptimalna temperature.

Rezultat projekta: TR31073, "Unapredjenje proizvodnje kukuruza i sirka u uslovima stresa"

BIPLOT ANALYSIS OF SEED PRIMING EFFECT ON MAIZE SEEDLING GROWTH TRAITS

The objectives of this study were to determine the effect different priming treatments and genotype on maize germination and early seedling growth traits, as well as, to examine the association among these traits. In addition, the application of Genotype by Trait biplot methodology in this type of analysis was evaluated. Seed priming treatment was conducted on ten maize inbred lines by soaking seeds in water (hydro priming) or 0.5% KNO_3 solution. Seed was sown in sterile moistened sand and placed at suboptimal (15°C) and optimal temperature (25°C) for seven days. After that seedling length and seedling weight were measured, final germination, time to 50% emergence and vigor index were calculated. The results showed that seed priming can improve seedling growth traits at both temperatures. There are differences in genotype response to various seed priming solution. The observed differences represent useful information for the selection of adapted maize inbred line and adjustment priming treatment for sowing in different temperature conditions. This study showed that biplot could be easily used for assessing the effect of seed priming, or some other treatment, on seedling growth traits. Moreover, it can be used for perceiving the associations among the seedling growth traits.

Key words: *Zea mays*, germination, multivariate analysis, suboptimal temperatures.

Project: TR31073, "Maize and sorghum production improvement in stress conditions"

FP-3

UTICAJ ORGANSKIH ĐUBRIVA NA MASU 1000 SEMENA I UDEO JEZGRA NS KONZUMNIH HIBRIDA SUNCOKRETA U USLOVIMA ORGANSKE PROIZVODNJE

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Institut za ratarstvo i povrtarstvo ima za cilj stvaranje konzumnih hibrida suncokreta (*Helianthus annuus* L.) koji će ostvariti optimalane prinose i zadržati stabilnost u različitim uslovima sredine. Prinos semena zavisi od hibrida i njegove interakcije sa spoljnom sredinom, ali i od agrotehničkih mera. Cilj ovog istraživanja je da se uporedi efekat tretmana i odabranih genotipova na masu 1000 semena i udeo jezgra. Prikazani su rezultati ispitivanja tri različita tretmana đubrenja (Guanito, Guanito + Naturplasma, Guanito + Trainer) na NS konzumne hibride suncokreta (NS Leviathan, NS Slatki, NS Gricko, NS Argonaut i NS Vitez) u uslovima organske proizvodnje. Ogled je postavljen na parcelama Centra za razvoj organske proizvodnje u Selenči kao slučajan blok sistem sa tri ponavljanja. Podaci su analizirani metodom analize varijanse, a izražen je uticaj različitih tretmana i hibrida na udeo jezgra i masu 1000 semena. Uticaj interakcije izmedju tretmana i hibrida, na udeo jezgra i masu 1000 semena nije bio statistički značajan. Utvrđen je statistički značajan uticaj hibrida na udeo jezgra, a hibridi NS Vitez i NS Argonaut su pokazali najveći udeo jezgra. Takođe, utvrđen je i statistički značajan uticaj hibrida na masu 1000 semena, a hibrid NS Vitez je pokazao najveću masu 1000 semena. Preliminarni rezultati ukazuju da na varijabilnost ispitivanih svojstava najviše utiču hibridi, dok tretmani nisu imali statistički značajan uticaj na masu 1000 semena i udeo jezgra. Da bi se potpunije procenila efikasnost odabranih tretmana na NS konzumne hibride suncokreta u uslovima organske proizvodnje potrebna su dodatna istraživanja koja će uključiti veći broj parametara.

Ključne reči: Masa 1000 semena, udeo jezgra, konzumni suncokret, organska proizvodnja, đubrenje

Rezultat projekta: TR 31025, „Razvoj novih sorti i poboljšanje tehnologija proizvodnje uljanih biljnih vrsta za različite namene“

THE EFFECTS OF ORGANIC FERTILIZERS ON 1000 SEED MASS AND KERNEL RATIO OF NS CONFECTIONERY SUNFLOWER HYBRIDS IN THE CONDITIONS OF ORGANIC PRODUCTION

The Institute of Field and Vegetable Crops aims to create confectionery sunflower hybrids (*Helianthus annuus* L.) that will achieve optimal yields and maintain stability in different environmental conditions. Seed yield depends on hybrids and its interaction with the environment, but also from agrotechnical measures. The aim of this research is to compare the effect of treatment and selected genotypes on 1000 seed mass and kernel ratio. The study presents results of three different fertilization treatments (Guanito, Guanito + Naturplasma, Guanito + Trainer) on NS confectionery sunflower hybrids (NS Leviathan, NS Slatki, NS Gricko, NS Argonaut and NS Vitez) in organic production conditions. The trial was located at experimental field of Center for the Development of Organic Production in Selenča as a random block design with three repetitions. The data was analyzed with ANOVA, and the influence of different treatments and hybrids on the kernel ratio and 1000 seed mass was expressed. The influence of the interaction between treatments and hybrids, on the kernel ratio and 1000 seed mass was not statistically significant. There was statistically significant influence of hybrids on kernel ratio, and hybrids NS Vitez and NS Argonaut showed the largest values. Also, statistically significant influence of hybrids on the 1000 seed mass was determined, and hybrid NS Vitez showed the highest 1000 seed mass. Preliminary results indicated that the variability of the tested traits was mostly influenced by hybrids, while the treatments did not have a statistically significant effect on the 1000 seed mass and kernel ratio. To assess the efficiency of the treatments on NS confectionery hybrids under the conditions of organic production further research, that will include a number of parameters, is required.

Key words: 1000 seed mass, kernel ratio, confectionery sunflower, organic production, fertilization

Project: TR 31025, “Development of new varieties and production technology improvement of oil crops for different purposes”

P-1

GGE-BIPLOT ANALIZA PRIOZVODNIH KARAKTERISTIKA LINIJA KUKURUZA

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U dvogodišnjim ogledima, koji su izvedeni na lokalitetima Zemun Polje (1) i Pančevo (2), testirano je šest linija kukuruza (L1, L2, L3, L4, L5 i L6). Primenom GGE-biplot metoda analizirana je varijabilnost i stabilnost broja redova zrna, mase 1000 zrna i prinosa zrna. Na GGE-biplot grafikonu, za broj redova zrna, uočava se da su najbolju ekspresiju u lokalitetu 1 imali genotipovi L5 i L4. Kako se vrednost lokaliteta 2 nalazi na samoj granici dva sektora, isti genotipovi ispoljili su visoke vrednosti broja redova zrna i u ovom lokalitetu. Genotip L6 imao je dobru ekspresiju samo na lokalitetu 2. Genotipovi L1, L2 i L3 ispoljili su mali broj redova u oba lokaliteta. Linije L6, L5 i L4 su imale najveće vrednosti mase 1000 zrna i istovremeno najveću stabilnost. Date linije su posebno dobre rezultate za ovo svojstvo postigle u lokalitetu 1. Linija L3 imala je prosečne vrednosti i visoku stabilnost, za masu 1000 zrna, dok su linije L2 i L1 ispoljile najmanje vrednosti. Najveću stabilnost prinosa zrna ispoljila je linija L3, čija se prosečna vrednost za ispitivanu osobinu skoro poklapa sa opštim prosekom za sve genotipove uključene u istraživanje. Linija L5, koja je bila najprinosnija, takođe se karakteriše visokom stabilnošću. Najmanju stabilnost prinosa imale su linije L6 i L4, ali su imale dobru ekspresiju ove osobine na ispitivanim lokalitetima. Linije L2 i L1 postigle su najniže prinose. Pored dobrih kombinacionih sposobnosti, koje moraju da poseduju linije kukuruza, za semensku proizvodnju veoma su važne priozvodne karakteristike linija *per se* kao što je nivo i stabilnost prinosa zrna i masa hiljadu semena. Analiza interakcije GGE-biplot metodom omogućila je izdvajanje linija kukuruza koje su pokazale najveću stabilnost i potencijal za prinos u različitim uslovima spoljašnje sredine.

Ključne reči: linije kukuruza, broj redova zrna, masa 1000 zrna, prinos zrna.

Rezultat projekta : Razvoj novih sorti i poboljšanja novih tehnologija proizvodnje uljanih biljnih vrsta za različite namene;MPNTR TR-31025 (2011-2019)

ASSESSMENT OF MAIZE LINES PRODUCTION PARAMETERS BY GGE-BIPLOT ANALYSIS

Six maize lines (L1, L2, L3, L4, L5 and L6) where tested in two locations (Zemun Polje-1 and Pančevo-2) during two year. The variability and stability of the number of rows of grains, 1000 grain mass and grain yield of lines is analyzed using the GGE-biplot method. On the GGE-biplot for the number of grain rows across location is shown that the best expression in location 1 had genotypes L5 and L4. As the value of the location 2 was into the border of two sectors, the phenotypic expression on the mentioned genotypes was also high in this location. The genotype L6 had good expression only in location 2. The other three genotypes did not show a good result in any of the observed location. The lines L6, L5 and L4 had the best expression and are feature high stability for the 1000 grains mass. The best result lines achieved in the first location. Line L3 had average expression and high stability, while lines L2 and L1 achieved the lowest values. Highest grain yield stability exhibited line L3, whose it average grain yield was on the level of grand mean value for yield. The line L5, had the high yield and yield stability. The lowest stability and at the same time high grain yield had lines L6 and L4. Lines L2 and L1 achieved the lowest yield. Beside good combination ability the maize inbred lines should characterized by good performances *per se,* important for commercial seed production, like a grain yield, stability and 1000 grain mass. GGE-biplot analysis allowed the identification of lines which showed the highest stability and yield potential in different environments.

Key words: maize lines, number of grain rows, 100 grain mass, grain yield.

Project: TR 31025, "Development of new varieties and production technology improvement of oil crops for different purposes"

P-2

PLODONOŠENJE I INKUBACIJA BUKOVAČE U ZAVISNOSTI OD SUPSTRATA

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Povećanje proizvodnje bukovače u poslednje tri decenije, uslovilo je ispitivanja vrsta i kombinacija supstrata, kao jednog od najvažnijih faktora koji direktno utiču na visinu prinosa i trajanje inkubacionog i predfruktifikacionog perioda. Bukovača se u Srbiji najčešće proizvodi na supstratu pripremljenom od pšenične slame.
U ovom istraživanju je supstrat pšenične slame poslužio kao standard drugim ostacima biljne proizvodnje kao što su sojina slama, stabljike kukuruza i suncukretove ljuspice, kao i njihovim kombinacijma sa pšeničnom slamom. Prinos dobijen na čistim supstratima sojine slame, stabljikama kukuruza i suncukretovim ljuspicama kao i na supstratima dobijenim od kombinacije sojine slame, stabljika kukuruza i suncukretovih ljuspica sa pšeničnom slamom, bio je viši od prinosa dobijenog na standardnom supstratu od pšenične slame. Brzina inkubacije i predfruktifikacionog perioda nisu u korelaciji sa prinosom u zavisnosti od supstrata. Iz dobijenih istraživanja zaključeno je, da je radi povećanja prinosa bukovače neophodno pšeničnoj slami dodavati ostatke drugih biljnih proizvoda.

Ključne reči: prinos, pšenična slama, sojina slama, stabljike kukuruza, suncukretove ljuspice

FRUCTIFICATION AND INCUBATION OF OYSTER MUSHROOM DEPENDING ON THE SUBSTRATE

The increase of oyster mushroom production in the last three decades led to testing types and combinations of substrates, as one of the most important factors that directly affect the yield and duration of incubation and pre-fructification period. Oyster mushroom is produced in Serbia most often on a substrate prepared from wheat straw.

In this study, wheat straw substrate served as a standard for other plant product residues, such as soybean straw, maize stalks and sunflower husks, as well as their combinations with wheat straw. The yield obtained on pure soybean straw substrate, maize stalks and sunflower husks, as well as on substrates derived from a combination of soybean straw, maize stalks and sunflower husks with wheat straw, was higher than the yield obtained on the standard wheat straw substrate. The rate of incubation and pre-fructification period was not correlated with the yield depending on the substrate. It was concluded from obtained study that, in order to increase the yield of oyster mushroom, it is necessary to add the residues of other plant products to the wheat straw.

Key words: yield, wheat straw, soybean straw, maize stalks, sunflower husks

P-3

ISPITIVANJE VARIJABILNOSTI NS KOLEKCIJA ULJANIH BILJNIH VRSTA

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Varijabilnost biljnih genetičkih resursa pruža mogućnost oplemenjivačima da razviju nove i poboljšane sorte izmenjenog kvaliteta i otporne na bolesti i nepovoljne uslove sredine. Oplemenjivanje uljanih biljnih vrsta u Institutu za ratarstvo i povrtarstvo (IFVCNS) ima uspešnu pedesetogodišnju tradiciju čiji je rezultat kolekcija od 7000 linija gajenog suncokreta, kao i kolecija divljih srodnika suncokreta i značajne kolekcije genetičkih resursa uljane repice, bundeva i još 24 alternativne uljane biljne vrste. Poznavanje genetske konstitucije i odnosa između genotipova unutar kolekcije je od suštinskog značaja za efikasno korišćenje germplazme. U studijama varijabilnosti, molekularni markeri imaju prednost u odnosu na druge tehnike jer su nezavisni od uslova životne sredine i faze razvoja biljke, te se sve više se koriste za analizu genetičke varijabilnosti. U skladu sa tim, varijabilnost IFVCNS kolekcija divljeg i gajenog suncokreta, uljane repice, bundeve i šafranjike je analizirana upotrebom različitih molekularnih markera. Molekularne analize su pokazale postojanje velike inter- i intraspecies varijabilnosti u testiranim populacijama. U većini slučajeva, dobijeno grupisanje genotipova je odražavalo filogenetske odnose. Dobijeni su različiti rezultati u pogledu geografskog porekla, odnosno nije utvrđena korelacija između grupisanja i geografskog porekla testiranih genotipova bundeve, dok su se kod uljane repice genotipovi grupisali prema geografskom poreklu. Utvđena je i potvđena povezanost pojedinih markera i otpornosti na bolesti, izmenjenog kvaliteta, kao i pojedinih kvantitativnih svojstava. Pomoću do sada korišćenih molekularnih analiza nije pronađena čvrsta korelacija za morfološka i svojstva uslovljena većim brojem gena. Dalja istraživanja će se fokusirati na asocijativno mapiranje i dalje pronalaženje veza između molekularnih markera i agronomski važnih osobina.

Ključne reči: suncokret, uljana repica, tikve, alternativne uljane biljne vrste, molekularni markeri

Rezultat projekta: TR 31025, „Razvoj novih sorti i poboljšanje tehnologija proizvodnje uljanih biljnih vrsta za različite namene“

VARIABILITY STUDIES ON NS OIL CROPS COLLECTIONS

Diversity in plant genetic resources provides an opportunity for plant breeders to develop new and improved cultivars with altered quality traits, resistant to diseases and unfavourable environment. Oil crops breeding at Institute of Field and Vegetable Crops (IFVCNS) has a successful 50-year long tradition that resulted in collection of 7000 sunflower inbred lines, as well as collection of wild sunflowers and substantial collections of genetic resources of rapeseed, pumpkins and 24 minor oil crops. The knowledge of genetic constitution and relationships among genotypes within the collection is essential for effective utilization of germplasm. In variability studies, molecular markers have advantages over other techniques as they are independent of the environment and plant growth stage and they have been increasingly employed for genetic diversity analyses. Hence, variability of IFVCNS collections of wild and cultivated sunflower, rapeseed, pumpkins and safflower were accessed with the use of different molecular markers. Molecular analyses revealed great inter- and intra-species variability of tested accessions. In most cases, molecular clustering reflected phylogenetic relationships. Contrasting results were obtained regarding geographic origin, as no correlation was found between clustering and geographical origin of tested pumpkin genotypes, while in rapeseed tested genotypes clustered according to geographic origin. Relationship between certain markers and disease resistance, altered quality, as well as certain quantitative properties was established and verified. No solid correlations were found for morphological and polygenic traits by molecular studies conducted so far. Further studies will focus on associative mapping studies and finding links between molecular markers and agronomically important traits.

Key words: sunflower, rapeseed, pumpkins, minor oil crops, molecular markers

Project: TR 31025, “Development of new varieties and production technology improvement of oil crops for different purposes”

P-4

KVALITET BIOMASE JARE GRAHORICE (*Vicia sativa* L.) U RAZLIČITIM STADIJUMIMA ZRELOSTI BILJKE

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Rasprostranjenost grahorice u svetu je na površinama nešto manjim od milion hektara, a najviše se gaji u Evropi i Aziji. U povoljnim uslovima, za kratko vreme grahorica može da proizvede velike količine biomase. Zbog toga se, osim za ishranu životinja, koristi i kao zelenišno đubrivo u organskoj proizvodnji. Zahvaljujući sposobnosti azotofiksacije ostavlja velike količine mineralnog azota u zemljištu, pa se njenom proizvodnjom ostvaruju uštede smanjenjem upotrebe mineralnih đubriva. Smatra se da je krma grahorice visoko kvalitetna i sa visokim sadržajem proteina, zbog čega je cenjeno hranivo za ishranu životinja. U ishrani životinja se najčešće koristi u različitim smešama sa strnim žitima, za proizvodnju sena i za dehidrataciju. Prilagođena je za gajenje u različitim agroekološkim uslovima, a može se sejati u jesen i u proleće. U kolekciji Instituta za krmno bilje Kruševac postoji kolekcija jarih grahorica gde se, uporedo sa domaćim i materijalom iz regiona, ispituju i genotipovi poreklom iz Australije. U radu je ispitivan kvalitet biomase 12 jarih genotipova grahorice (*Vicia sativa* L.) poreklom iz različitih agroekoloških područja. Tokom 2016. godine postavljen je ogled po slučajnom blok sistemu u dva ponavljanja. Uzorci za ispitivanje kvaliteta su uzimani u tri roka, sa razmakom od 10 dana. Ispitivani su neki važniji parametri kvaliteta biomase: sadržaj sirovih proteina, ADF, NDF i BEM. Dobijeni rezultati ukazuju da postoje veoma značajne razlike između ispitivanih genotipova, ali i da stadijum zrelosti biljke značajno utiče na kvalitativne osobine biomase grahorice.

Ključne reči: grahorica, biomasa, kvalitativne osobine, faza zrelosti

THE QUALITY OF VETCH BIOMASS (*Vicia sativa* L.) AT DIFFERENT STAGES OF PLANT MATURITY

The planting of vetch in the world is less than a million hectares on the surface, and is mostly cultivated in Europe and Asia. Under favorable conditions, for a short time vetch can produce large amounts of biomass. Therefore, besides feeding animals, it is also used as green manure in organic production. Thanks to the ability of nitrogen fixation, it leaves large amounts of mineral nitrogen in the soil. Also, its production reduces cost by reducing the use of mineral fertilizers. It is believed that the vetch fodder is high quality and with high protein content, because it's on the price as a quality feed. In animal nutrition, vetch is most often used in various mixtures with cereals, for hay production and for dehydration. It is suitable for growing in different agroecological conditions, and can be sown in autumn and spring. In the collection of the Institute for forage crops Krusevac, there is a collection of spring vetch with different origin: domestic genotypes, material from the region and genotypes originating from Australia. This paper examines the quality of biomass of twelve genotypes of vetch (*Vicia sativa* L.) originating from different agroecological areas. During 2016, a random block system, with two replications was conducted. Samples for quality testing were taken at three plant stages in intervals of 10 days. Some important parameters of biomass quality were examined: crude protein content, ADF, NDF and BEM. The obtained results indicate that there are very significant differences between the tested genotypes, but also that the stage of maturity of the plant significantly affects the qualitative characteristics of the vetch biomass.

Key words: vetch, biomass, qualitative features, maturity stage

P-5

PROIZVODNJA ORGANSKE SPELTE U SRBIJI

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Površine pod organskom biljnom proizvodnjom već duži niz godina beleže kontinurano povećanje, kako u svetu, tako i u Srbiji. Ovaj vid poljoprivredne proizvodnje u Srbiji se odvija na ukupno 14357,96 ha, pri čemu vodeću ulogu zauzimaju žita. S obzirom da pšenica spelta beleži sve veće interesovanje u proizvodnji zdravstveno bezbedne hrane, tako u organskom sistemu poljoprivredne proizvodnje zauzima sve veće površine. U tom smislu, cilj ovog rada bio je da prema podacima Ministarstva poljoprivrede, šumarstva i vodoprivrede Republike Srbije, prikaže podatke površina na kojima se prozvodi ova vrsta žita u Srbiji, prema regionalnoj raspodeli za 2012, 2015 i 2016. godinu. Ukupna proizvodnja spelte je na površini od 157,9 ha. Najveće površine zastupljene su u regionu Vojvodine (120,04 ha), a zatim slede Južna i Istočna Srbija (22,3 ha), Šumadija i Zapadna Srbija (14,1 ha), dok se najmanji vid organske proizvodnje spelte odvija u Beogradu, na svega 1,5 ha. Jedina priznata sorta u Srbiji je Nirvana. S obzirom da spelta poseduje veoma dobre biološke i agronomske osobine, to je čini naročito pogodnom za uzgoj u organskom sistemu poljoprivredne proizvodnje.

Ključne reči: spelta, organska proizvodnja, površine, regioni

THE PRODUCTION OF ORGANIC SPELT WHEAT IN SERBIA

Areas used for the production of organic plants have been permanently increasing for many years, both in the world and in Serbia. This type of agricultural production in Serbia is performed on the area of 14357.96 ha, and the leading role belongs to cereals. Since great attention has been paid to spelt wheat in the production of organic food, the organic system of agricultural production has been distributed over larger areas. Therefore, the objectives of this study was to present data on the areas cultivated with this type of cereals in Serbia according to regional distribution in 2012, 2015 and 2016 provided by the Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia. Spelt wheat is cultivated on the area of 157.9 ha. The greatest areas are in Vojvodina (120.04 ha) and are followed by the areas in south and eastern Serbia (22.3 ha), Šumadija and western Serbia (14.1 ha), while the smallest production of organic spelt wheat is registered in Belgrade (only 1.5 ha). The variety Nirvana is the only spelt wheat variety released in Serbia. Since spelt wheat has very good biological and agronomic traits, it is particularly suitable for growing within the organic farming system.

Key words: spelt wheat, organic production, areas, regions

P-6

TOLERANTNOST ZP LINIJA KUKURUZA NA HERBICIDE

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Visoka selektivnost prema herbicidima je jedna od važnijih pitanja u proizvodnji. Gajenje kukuruza bez kompeticijskog udela korova daje velike mogućnosti. Eliminacijom korova iz polja stvaraju se idealni uslovi za biljke. Herbicidi su i dan danas prva solucija za suzbijanje korova. Sa druge strane, linije kukuruza su osetljivije na herbicide u odnosu na hibride. U ovim istraživanjima sedam linija kukuruza je testirano na četiri herbicida na lokalitetu Zemun Polja tokom 2015. i 2016. godine. Herbicidi (izoksaflutol, izoksaflutol + tienkarbazon-metil, nikosulfuron i foramsulfuron) su primenjeni u preporučenim i dvostrukim dozama. Reakcije linija kukuruza na herbicide je dvaputa ocenjena: u periodu od 2-3 nedelje posle primene herbicida i drugi put 2-3 nedelje posle prve ocene. Na kraju vegetacionog ciklusa izmeren je prinos zrna. Prva grupa herbicida (izoksaflutol, izoksaflutol + tienkarbazon-metil) primenjena u dvostrukoj dozi je izazvala blaga i veoma blaga oštećenja listova kod dve linije kukuruza u 2015. godini. U istoj godini, linija L3 je imala nešto jača oštećenja u tretmanu sa izoksaflutolom, za razliku od ostalih linija gde nisu zabeležena oštećenja. U 2016. godini nisu zabeležena oštećenja linija od ove grupe herbicida. Druga grupa herbicida (nikosulfuron, foramsulfuron) primenjeni u obe doze uticali su na ispoljavanje blagih simptoma kod linija L3 i L4 u 2015. godini, sa nešto jačim oštećenjima u drugoj oceni. U drugoj godini samo u tretmanu sa foramsulfuronom su zabeležena značajna oštećenja linije L3 u obe ocene. Primenjeni herbicidi nisu značajno uticali na prinos zrna u 2015., za razliku od 2016. kada je u pojedinim tretmanima prinos zrna bio značajno niži od kontrole. Dobijeni rezultati ukazuju na visoku tolerantnost ispitivanih linija na primenjene herbicide.

Ključne reči: suzbijanje korova, vizuelna ocena, prinos

Rezultat projekata MPNTR TR 31037:Integralni sistemi gajenja ratarskih useva – očuvanje biodiverziteta i plodnosti zemljišta i TR 31068: Poboljšanje svojstva kukuruza i soje molekularnim i konvencionalnim oplemenjivanjem.

ZP MAIZE INBRED LINES TOLERANCE TO HERBICIDES

High selectivity towards herbicides is one of the important point in maize growing. Enabling no weeds competition gives huge advantage in maize production. Furthermore, excluding weeds from fields creates optimal environment for plant growing. Herbicides are worldwide the first tool in weed management systems. On the other hand, maize lines are, in general, more sensitive to herbicides than hybrids. In this experiment seven maize inbred lines were tested to four herbicides at Zemun Polje in 2015 and 2016. Herbicides (isoxaflutole, isoxaflutole + thiencarbazone-methil, nicosulfuron and foramsulfuron) were applied in recommended and double dose. Plant response to herbicides were evaluated twice (visual estimation): in period 2-3 weeks after herbicide treatment and 2-3 weeks after first estimation. At the end of vegetation grain yield was measured. First herbicides group (isoxaflutole, isoxaflutole + thiencarbazone-methil) caused slight and very slight damages on leaves in only two lines in 2015 applied in double dose. In the same year, line L3 express medium damages in isoxaflutole treatment, with no damages in other lines. In 2016. there were no herbicides effects on tested herbicides. Second herbicide group (nicosulfuron and foramsulfuron) caused light damages in lines L3 and L4 (both doses) in 2015, with medium damages in same treatment in second estimation. In second year, only foramsulfuron significantly influenced L3 in first and second estimation. Applied herbicides did not effects significantly grain yield in 2015, while in 2016 only in few treatments grain yield was significantly lower compared to control. Obtained results indicated high tolerance of tested lines.

Key words: weed control, visual estimation, yield

Results of the projects : TR 31037 Integrated system of field crop cultivation: conservation of biodiversity and soil fertility and TR 31068 Improving the quality of maize and soybean by conventional and molecular breeding

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MEĐUZAVISNOT PRINOSA ZRNA I KOMPONENTI PRINOSA TRITIKALEA NA KISELOM ZELJIŠTU

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Poljski ogled sa sortama tritikalea Favorit, Tango i KG-20 izveden je tokom tri godine sa ciljem da se analizira uticaj primene različitih količina mineralnih hraniva, naročito fosfora i kalcizacije na prinos zrna, komponente prinosa, kao i njihovu međuzavisnost. Ogled je postavljen na zemljištu tipa pseudoglej, jako kisele reakcije (pH_{H2O} 4.2) po slučajnom blok rasporedu u tri ponavljanja. Primena mineralnih đubriva i kalcizacija uticali su na značajno povećanje vrednosti komponenti prinosa zrna, naročito broja klasova m^{-2}, broja i mase zrna po klasu, tako da je i prinos zrna bio značajno veći na đubrenim varijantama. Sorte tritikalea su bolje reagovale na kalcizaciju u odnosu na povećano đubrenje fosforom što se može povezati sa većom dostupnošću makro i mikroelemenata pri povećanju pH vrednosti zemljišta, odnosno imobilizacijom fosfora u jako kiseloj sredini. Sorta Favorit je najbolje reagovala na primenu mineralnih hraniva i kalcizacije, tako da je njen prinos na ovim varijantama u svim godinama bio značajno veći od sorte KG-20. Između komponenti prinosa, kao i između prinosa zrna i komponenti prinosa uglavnom su utvrđene značajne pozitivne korelacije, osim između prinosa zrna i dužine klasa. Prinos zrna je bio u najjačoj korelaciji sa brojem klasova m^{-2} (r = 0.72), visinom biljke (r = 0.63) i brojem zrna po klasu (r = 0.61). Na veoma kiselim zemljištima, pH vrednost bi kalcizacijom trebalo povećati barem do granice suboptimalne (pH 5.0), što bi doprinelo boljem iskorišćavanju potencijala za prinos zrna tritikalea.

Ključne reči: tritikale, kisela zemljišta, mineralna hraniva, prinos

Napomena: *Rad deo je projekata broj TR 31054 i TR 31092 finansiranih od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije.*

INTERDEPENDENCE OF GRAIN YIELD AND YIELD COMPONENTS OF TRITICALE IN ACID SOIL

A field trial, involving triticale cultivars Favorite, Tango and KG-20, was carried out over three-year period, in order to evoluate the effect of different rates of mineral nutrients, especially phosphorus, and liming on grain yield, yield components, as well as their interdependence. The experiment was establised on a pseudogley soil with a highly acidic reaction (pH_{H2O} 4.2), as a randomized block design with three replications. The application of mineral fertilizers and liming led to a significant increase in the value of grain yield components, particularly number of spikes m^{-2}, number and weight of grains per spike, so that grain yield was significantly higher in fertilizing variants. Triticale cultivars had better reaction to calcification in relation to increased fertilization with phosphorus, which can be attributed to higher availability of macro and micronutrients with increasing the soil pH, i.e. phosphorus immobilization in a highly acidic environment. Cultivar Favorit better responded to mineral fertilization and liming, so its yield on these variants was significantly higher, compared to other cultivars in all years. Significant positive correlations between the yield components, as well as between grain yield and yield components have been recorded, except between grain yield and spike length. The grain yield was in the strongest correlation with: number of spikes m^{-2} (r = 0.72), plant height (r = 0.63) and grain number per spike (r = 0.61).
In highly acidic soils, pH value should be increased by liming to, at least the suboptimal limit (pH 5.0), which would contribute to better realisation of grain yield potential of triticale.

Key words: triticale, acid soils, fertilisation, yield

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AMMI-BIPLOT ANALIZA GENOTIPOVA PŠENICE ZA DUŽINU KLASA I BROJ ZRNA PO KLASU U RAZLIČITIM USLOVIMA SREDINE

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U cilju analiziranja stabilnosti deset genotipova pšenice, u tri različite vegetacione sezone (2009/2010, 2010/2011 and 2011/2012), u Kragujevcu (Srbija), sprovedena je AMMI i biplot analiza. AMMI analiza za obe ispitivane osobine (dužina klasa i masa zrna po klasu) pokazala je značajan efekat genotipa, godine i njihove interakcije (G × E interakcija). Kod obe ispitivane osobine, najveće učešće u ukupnoj sumi kvadrata pripada genotipu (za dužinu klasa 75,16%, odnosno za broj zrna po klasu 25,49%), zatim okolini (9,44, odnosno 17,89%), dok najmanji udeo ima G × E interakcija (2,5%, odnosno 12,29%). Na osnovu sprovedene AMMI analize za dužinu klasa IPCA1 osa objašnjava 55,86%, a IPCA2 oca 44,14% interakcije, dok kod broja zrna po klasu IPCA1 ima 60,96%, a IPCA2 30,04% udela u intrakciji. Genotipovi Arsenal i Sterna se nalaze u okviru srednje vrednosti dužine klasa, i pokazuju najveću stabilnost, dok se genotipovi Szegedi 765 i Gružanka odlikuju najvećom nestabilnošću. Biplot analiza za broj zrna po klasu pokazuje da genotip Szegedi 765 ima najveću stabilnost i najvišu vrednost ispitivanog svojstva. Takođe, genotipovi Sterna i Rana niska pokazuju visoku stabilnost, dok se Mironovskaya 808 odlikuje najvećom nestabilnošću. Analizirani genotipovi su pokazali najviše vrednosti ispitivanih svojstava u 2009/2010. vegetacionoj sezoni, koja se odlikovala najvišom nestabilnošću, što se može dovesti u vezu sa najvišom sumom padavina u poređenju sa ostalim sezonama.

Ključne reči: pšenica, AMMI, biplot, G × E interakcija

TR 31092, projekat finansiran od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije

AMMI-BIPLOT ANALYSIS OF SPIKE LENGTH AND NUMBER OF GRAINS PER SPIKE OF WHEAT GENOTYPES AT DIFFERENT ENVIRONMENTAL CONDITIONS

In order to analyze the stability of ten wheat genotypes in three different growing seasons (2009/2010, 2010/2011 and 2011/2012), in locality of Kragujevac (Serbia), AMMI and biplot analysis were carried out. The AMMI analysis for both analyzed traits (spike length and number of grains per spike) detected significant effects for genotype, year and genotype by year (G × E) interaction. The highest participation in total sum of squares for both analyzed traits belongs to genotype (for spike length 75.16% and for number of grains per spike 25.49%), than to environment (9.44% and 17.89%, respectively), and the lowest share had G × E interaction (2.5% and 12.29%, respectively). In the AMMI analysis for spike length IPCA1 and IPCA2 explain 55.86% and 44.14% of the interaction, respectively, while for number of grains per spike, IPCA1 and IPCA2 account 60.96% and 30.04% of G × E interaction. Genotypes Arsenal and Sterna are close to the average values for spike length and expressed the highest stability, while genotypes Szegedi 765 and Gružanka showed the highest instability. Based on biplot analysis for number of grains per spike, genotype Szegedi 765 was the most stable genotype, with the highest value of this trait. Also, genotypes Sterna and Rana niska showed the high stability, while genotype Mironovskaya 808 had the highest instability. Analyzed genotypes had the highest values for both traits in 2009/2010 growing season, with highest average instability, which could be associated with higher amount of precipitation in relation to other two seasons.

Key words: Wheat, AMMI, stability, biplot, G× E interaction

Project: "The study of genetic basis improving yield and quality of cereals in different ecological conditions", TR 31092, financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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DOPRINOS SELEKCIJE U POVEĆANJU BROJA ZRNA PO KLASU KOD VIŠEREDOG JEČMA

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Informacije o promenama komponenti prinosa koje su u vezi sa doprinosom selekcije predstavljaju osnovni korak u određivanju faktora koji ograničavaju prinos i koji su značajni za prilagođavanje budućih oplemenjivačkih strategija. Broj zrna po kvadratnom metru, pre svega broj zrna po klasu, predstavlja glavnu osobinu koja je u vezi sa porastom prinosa kod različitih kultura strnih žita. Sa druge strane, analize istorijskog seta sorti nisu pokazale značajan genetički progres u povećanju mase zrna. Prema tome, glavni cilj ove studije je analiza promena u osobinama klasa kod reprezentativnog seta sorti višeredog ječma stvorenih u poslednjih 40 godina. Studija je sprovedena tokom sezone 2015/16. na oglednim poljima Instituta za ratarstvo i povrtarstvo u Novom Sadu, Srbija. Rezultati ove studije pokazali su pozitivnu asocijaciju između godine priznavanja sorte i efikasnosti oplodnje kod ozimog ječma. Broj zrna po klasu značajno je varirao u zavisnosti od uticaja genotipa i imao je pozitivnu linearnu vezu sa godinom priznavanja sorte. Pored toga, nije utvrđena značajna veza između mase klasa u cvetanju i godine priznavanja sorte. Ovi podaci pokazuju da moderne sorte verovatno imaju manju distribuciju asimilata u strukturne elemente klasa u odnosu na plodne cvetove. Prema tome, fino podešavanje raspodele suve materije u fertilne delove klasa može dovesti do povećanja efikasnosti oplodnje bez značajnih promena u masi klasa u cvetanju.

Ključne reči: komponente prinosa, napredak oplemenjivanja, šestoredi ječam

Rezultat projekta: TR-31066, Savremeno oplemenjivanje strnih žita za sadašnje i buduće potrebe

GENETIC IMPROVEMENT OF GRAIN NUMBER PER SPIKE IN SIX-ROWED BARLEY

Information about changes in the main yield components associated with genetic gain are essential for determination of yield limiting factors and adjustment of breeding strategies. Grain number per unit area, mainly grain number per spike, has been recognized as the main yield determining trait in different cereal crops worldwide. In addition, previous studies have not shown genetic progress in grain weight. Therefore, the main objective of this study was to analyse the changes in spike traits in a set of representative six-rowed barley cultivars developed in the previous 40 years. The study was conducted during 2015/16 growing season at the experimental field of the Institute of Field and Vegetable Crops, Novi Sad, Serbia. Results from our study showed significant positive relationship between the year of cultivars release and fruiting efficiency in six-rowed barley. Variation in grain number per spike was under significant influence of genotype and showed linear relationship with year of release. Moreover, there was no significant association between year of release and spike dry weight at anthesis. These data indicate that modern cultivars probably have lower resource partitioning in structural elements of spike than in devolving florets. Therefore, fine adjustment of dry matter allocation in fertile parts of spike could improve fruiting efficiency without significant changes in spike dry weight at anthesis.

Key words: breeding improvement, feed barley, yield components

Result of the project: TR- 31066 "Modern breeding of small grains for present and future needs"

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DONORI POŽELJNIH ALELA ZA POPRAVKU OSOBINE BROJ REDOVA ZRNA F_1 HIBRIDA KUKURUZA

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Za ispitivanje u ovom radu su odabrane inbred linije kukuruza dobijene iz različitih ciklusa rekurentne selekcije dve sintetičke populacije BSSS i $BSCB_1$.Cilj ovog istraživanja je bio da se za osobinu broj redova zrna oceni koja od proučavanih inbred linija ima najveće relativne vrednosti poželjnih alela za popravku elitnog hibrida.Najviše vrednosti μG^* su bile kod inbred linija B73(C5) i B84(C7) iz populacije BSSS.Ove linije su imale značajnu razliku μG^*-(μD^* ili μF^*) u korist poželjnih dominantnih alela a takođe su bile i dobri donori za osobinu prinos zrna te se može očekivati da će se paralelno dobiti biljke koje će imati i zadovoljavajući broj redova zrna. Kako su pri proceni srodnosti B73(C5) i B84(C7) pokazale srodstvo sa linijom roditelja ZPL1 potrebno je ukrstiti F_1 generacije (ZPL1 x B73 i ZPL1 x B84) povratno sa linijama donorima pa tek onda započeti samooplodnju s ciljem dobijanja linije koja će zameniti liniju ZPL1 u posmatranom hibridu.Linije B91(C8) i B97(C9) iz sintetičke populacije $BSCB_1$ pokazale su da sadrže značajne vrednosti poželjnih alela.Obe su imale značajnu pozitivnu razliku μG^*-(μD^* ili μF^*) između broja poželjnih dominantnih i nepoželjnih recesivnih alela te bi trebalo povratno ukrstiti F_1 generaciju (linija roditelj x linija donor) sa linijom donorom.

Ključne reči: inbred linije, donori, hibrid, aleli

DONORS OF FAVOURABLE ALLELES FOR THE ENHANCEMENT OF THE NUMBER OF KERNELS OF F_1 MAIZE HYBRIDS

Maize inbred lines developed from different cycles of recurrent selection of two synthetic populations, BSSS and $BSCB_1$, were selected for the observation in the present study. The aim of the study was to estimate which of the observed inbred lines had the highest relative values of favourable alleles for the enhancement of the number of kernel rows of the elite hybrid. The highest values of μG^* were recorded in the inbred lines B73(C5) and B84(C7) of the population BSSS. The difference μG^*-(μD^* or μF^*) in these inbreds was significant in favour of the favourable dominant alleles and also were good donors for the grain yield, thus it may be expected that plants with a satisfactory number of kernel rows will be simultaneously derived. In the estimation of relatedness, the inbreds B73(C5) and B84(C7) showed the consanguinity with the inbred of the parent ZPL1. Therefore, it is necessary to beck-cross their F_1 generation (ZPL1 x B73 and ZPL1 x B84) with inbred donors and then to start self-pollination with the aim to derive inbreds that will replace the inbred ZPL1 in the observed period. The values of favourable alleles in the inbreds B91(C8) and B97(C9) of the synthetic population $BSCB_1$ were significant. Both inbreds had a significant positive difference μG^*-(μD^* or μF^*) between the number of favourable dominant and unfavourable recessive alleles, and due to it, the F_1 generation (parental inbred x inbred donor) should be backcrossed to the inbred donor.

Key words: inbred lines, donors, hybrid, alleles

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PRIMENA EKOLOŠKIH ĐUBRIVA U RAZLIČITIM HIBRIDIMA KUKURUZA

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U okviru razvojnih istraživanja iz oblasti ekološke poljoprivrede poređeni su efekti primene različitih đubriva kako bi se ukazalo na prednosti mikrobioloških i organskih đubriva koja takođe mogu doprineti većem prinosu, ali za razliku od mineralnh đubriva, pozitivnije utiču na zemljište i agroekosistem. Ispitivanja su sprovedena kako bi se utvrdilo u kolikoj meri agronomska biofortifikacija doprinosi povećanju rodnog potencijala specifičnih genotipova kukuruza kao i kako utiče na pojavu i zastupljenost korova.
Hibrid kukuruza crvenog perikarpa ZP 5048 crveni, hibrid tvrdunac sa povećanim učešćem proteinskog dela ZP 737 i hibrid belog zrna ZP 552b su gajeni uz primenu mineralnog đubriva Urea, mikrobiološkog đubriva Team Micorriza Plus i organskog đubriva Fertor koja sadrže neophodne elemente za ishranu gajenih biljaka. Na kontrolnoj površini đubrenje nije primenjeno.
Rezultati su pokazali da u 2017. godini koja je bila ekstremno sušna, ima značajnih razlika u nivou zakorovljenosti i nešto manjih razlika u prinosu zrna gajenih genotipova zavisno od vrste primenjenog đubriva. Najveća masa korova utvrđena je kod hibrida ZP 737 nakon primene organskog đubriva dok je najmanja masa korova kod svih hibrida zabeležena nakon primene mikrobiološkog đubriva. Đubrenje je uglavnom doprinelo povećanju mase korova u poređenju sa neđubrenom kontrolnom varijantom.
Najveći prinos zrna je imao ZP 5048 crveni (5,83 t/ha), a najmanji ZP 737 (3,36 t/ha). Razlike u prosečnom prinosu zrna između tretmana, kao i u poređenju sa kontrolom, su bile neznatne što se može objasniti nepovoljnim meteorološkim uslovima. Primena đubriva u kukuruzu, u toku vegetacije, najčešće nije efikasna u uslovima suše zbog čega će se istraživanja nastaviti.

Ključne reči: kukuruz, hibrid, đubrenje, korovi

THE APPLICATION OF ECOLOGICAL FERTILISERS IN DIFFERENT MAIZE HYBRIDS

The effects of different fertilisers have been compared within developmental research in the field of ecological agriculture to point up the advantages of microbiological and organic fertilisers, since these fertilisers can contribute to higher yields, but unlike mineral fertilisers, they positively affect the soil and agro-ecosystem. The studies have been carried out to determine to what extent agronomic biofortification contributed to the increase of yielding potential of maize genotypes with specific traits as well as how it affected the occurrence and distribution of weeds.

The red-seeded maize hybrid ZP 5048 crveni, high-protein flint maize hybrid ZP 737 and white-seeded maize hybrid ZP 552b were grown in variants with mineral fertiliser Urea, microbiological fertiliser Team Micorriza Plus and organic fertiliser Fertor that contain essential elements necessary for the nutrition of cultivated plants. No fertiliser was applied to the control surface.

The obtained results show that there were significant differences in the weed infestation level in extremely dry 2017, while differences in grain yields of cultivated genotypes were somewhat lower, depending on the type of applied fertilisers. The highest weed mass was recorded in the hybrid ZP 737 in the variant with organic fertiliser. On the other hand, the lowest weed mass was recorded in all hybrids when microbiological fertiliser had been applied. The fertilisation mainly contributed to the increase of weed mass in comparison with the non-fertilised control variant.

The highest, i.e. lowest grain yield was recorded in the hybrid ZP 5048 crveni (5.83 t/ha), i.e. the hybrid ZP 737 (3.36 t/ha), respectively. Differences in the average grain yield among treatments, was well as compared to the control, were insignificant, which can be explained by unfavourable meteorological conditions. The application of fertilisers in the maize crop during the growing season was not particularly effective under the conditions of drought, which is why the studies will be continued.

Key words: maize, hybrid, fertilisation, weeds

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MOGUĆNOST SMANJENJA TRIPSIN INHIBITORNE AKTIVNOSTI U SIROVOM ZRNU SOJE

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Tripsin ihibitori u zrelom zrnu soje su proteini koji spadaju u kompleks antihranljivih supstanci. Njihovo prisustvo onemogućava direktnu primenu sirovog zrna soje u ishrani domaćih životinja. Kunitz tripsin inhibitor (KTI), koji se smatra glavnom inhibitornom supstancom, je dobro ispitan. Klasičnim metodama selekcije stvorene su komercijalne sorte soje bez KTI u zrelom zrnu. Bowman-Birk sojin tripsin inhibitor (BBI) i dalje je manje proučen a mehanizam genetičke kontrole njegovog prisustva nije pouzdano utvrđen, pretpostavlja se da zavisi od tri gena. U kasnijim istraživanjima je utvrđeno da prvobitno izolovan BBI predstavlja samo preovlađujuću izoformu. Prema različitim literaturnim izvorima izolovano je 7-10 izoformi, podeljenih u 2-5 podgrupa, koje se razlikuju po sastavu aminokiselinskih ostataka, molekulskoj težini, delovanju na proteolitičke fermente i mestu koje zauzimaju na gel – elektroferogramu. U okviru vrste Glycine max nisu nađeni genotipovi bez BBI. Utvrđeno je da ukupna tripsin inhibitorna aktivnost može biti značajno različita, čak da genotipovi bez KTI u zrelom zrnu mogu imati aktivnost koja nije značajno smanjena. Ovo ide u prilog podacima iz literature da broj prisutnih izoformi BBI u jednom genotipu može biti 4-10. Metodama klasične selekcije nije moguće stvoriti genotip bez prisustva BBI. Moguće je koristiti za stvaranje novih sorti materijal sa što manje prisutnih BBI izoformi, uz pretpostavku da će i tripsin inhibitorna aktivnost biti niža. Prema brojnim istraživanjima, BBI ima funkciju u odbrani biljke od insekata i patogena kao i KTI, ali i kontroliše delovanje endogenih proteolitičkih fermenata u toku klijanja i nicanja tako da njegova potpuna eliminacija nije poželjna.

Ključne reči: soja, Bowman-Birk tripsin inhibitor, tripsin inhibitorna aktivnost

Rad je rezultat projekta MPNTR: Poboljšanje svojstava kukuruza i soje konvencionalnim i molekularnim oplemenjivanjem.

THE POSSIBILITY OF REDUCING TRYPSIN INHIBITOR ACTIVITY IN OROW SOYBEAN GRAIN

Trypsin inhibitors in mature soybean grain are proteins that belong to anti-nutritive complex. Presence of trypsin inhibitors prevents the utilization of row soybean grain in domestic animals feed. Kunitz Trypsin inhibitor (KTI), as a main inhibitory matter, is well investigated. Commercial soybean varieties without KTI in mature grain were developed using conventional breeding methods. Bowman-Birk soybean trypsin inhibitor (BBI) is still insufficiently investigated as genetic control of their presence is not completely determined. There is an assumption that presence of BBI is controlled by three genes. Previously isolated BBI represent prevalent iso-inhibitor. According to different literature sources, 7-10 isoforms classified in 2-5 subgroups are differing in amino acid residues, molecular weight, influence on proteolytic enzymes, and position on gel electrophe~~o~~ro~~e~~gram. In Glycine max species BBI free genotypes are not found. It was found that trypsin inhibitory activity can be very different, even in Kunitz free grain. This is in agreement with literature data that 4-10 inhibitory isoforms could be detected in a single genotype. It is not possible to develop BBI free variety using conventional breeding methods. There is a possibility to select soybean genotypes with the smaller number of BBI forms for breeding programs, with the assumption that trypsin inhibitory activity will be lower. Numerous studies show that function of BBI is not only plant and seed protection from insects and pathogens, but it also has important role in control of proteolytic enzymes during germination and emergence. For this reason, total elimination of BBI is not recommended.

Key words: soybean, Bowman-Birk trypsin inhibitor, trypsin inhibitory activity.

Results of the Project TR 31068: Improvement of maize and soybean traits by molecular and conventional breeding.

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AKUMULACIJA PROLINA U PŠENICI KAO ODGOVOR NA TOPLOTNI STRES

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U toku ontogenetskog razvića pšenice, pojava vremena sa visokim temperaturama vazduha, utiče na promene u procesima fotosinteze i disanja, kao i na građu i funkciju ćelijskih membrana, enzimske aktivnosti. Indikator adaptivnosti na delovanje temperatura iznad 30 ^{0}C je akumulacija prolina, koji utiče na stabilizaciju proteina, zaštitu membrana i subćelijskih struktura od dejstva visokoh koncentracija neorganskih jona. Cilj ovog rada bio je da se odredi koncentracija prolina u fazi nalivanja zrna, ozime pšenice u uslovima produženog trajanja temperature vazduha iznad 30^{o}C i da se oceni varijabilnost reakcije sorti pšenice. Istraživanjima je obuhvaćeno devet sorti pšenice koje su gajene u poljskim uslovima. Klasovi za analize su prikupljani svakih sedam dana u toku faze nalivanja zrna. Uzorci prikupljeni u vreme temperatura manjih od 30^{o}C (24^{o}C) korišćeni su kao kontrola u poredjenju sa vrednostima sadržaja prolina kod uzoraka koji su bili izloženi delovanju temperatura iznad 30^{o}C (36^{o}C). Sadržaj prolina je određen spektrofotometrijski. Rezultati su pokazali da postoji statistički značajna razlika između vrednosti prolina u uslovima umerene i uslovima povišene temperature, kad dolazi do povećane akumulacije prolina. Najveći sadržaj prolina u uslovima toplotnog stresa (36^{o}C) izmeren je kod sorte Pobeda (495.8 µg g^{-1}), a najmanji sadržaj prolina kod sorte Nikol (175.3 µg g^{-1}). Variranje vrednosti sadržaja prolina je pokazalo razlike izmedju sorti pšenice u adaptivnom odgovoru na delovanje visokih temperatura što se može iskoristiti u oplemenjivanju pšenice.

Ključne reči: toplotni stres, prolin, *Triticum aestivum* L.

ACUMULATION OF PROLINE IN WHEAT AS A RESPONSE TO HEAT STRESS

During the ontogenetic development of wheat, the prolonged period of high air temperatures affects on photosynthesis and respiration processes, on the structure and function of cell membranes, enzymatic activities. The adaptability indicator on temperature above 30^{o}C is proline accumulation, which affects on protein stabilization, protection of membranes and subcellular structures from the effect of high concentrations of inorganic ions. The aim of this study was to determine the concentration of proline in the grain filling phase of winter wheat under conditions of prolonged duration of air temperature above 30°C and to assess the variability of wheat variety responses. The research involved nine varieties of wheat cultivated in field conditions. Plant ears were collected for analysis every seven days during grain filling phase. Samples collected at temperatures below 30^{o}C (24^{o}C) were used as controls compared to proline content values in samples which were exposed to temperatures above 30^{o}C (36^{o}C). The content of the proline was determined spectrophotometrically. The results showed that there is a statistically significant difference between proline values in moderate and elevated temperature conditions when proline accumulation occurs. The highest content of proline in conditions of heat stress was measured in the variety Pobeda (495.8 µg g^{-1}), while the lowest content of proline was in the variety Nikol (175.3 mg g^{-1}). The variation of proline content showed differences between wheat varieties in adaptability response under high temperature which can be useful in wheat breeding.

Key words: heat stress, proline, *Triticum aestivum* L.

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OD DIVLJIH POPULACIJA DO NOVE SORTE LIVADSKOG VIJUKA

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Livadski vijuk (*Festuca pratensis* Huds.) spada u grupu važnijih višegodišnjih travnih vrsta. Odlikuje se visokim prinosom kvalitetne biomase. Ogled je izveden u Institutu za krmno bilje u Kruševcu, a ispitivana je kolekcija od devetnaest populacija livadskog vijuka. U prvom delu istraživanja proučavana je varijabilnost najvažnijih fenomorfoloških (vreme klasanja), morfoloških (visina biljaka, dužina, širina i broj listova, dužina metlice, broj vegetativnih i generativnih izdanaka po biljci), prinosa i kvaliteta suve materije. Proučavanje nivoa i varijabilnosti najznačajnijih osobina je vršeno na pojedinačnim biljakama rasađenim na rastojanju 60 x 60 cm, po potpuno slučajnom blok sistemu, u tri ponavljanja sa 30 biljaka po populaciji, tokom dve godine. Genotipovi kod kojih je utvrđen najveći prinos suve materije po biljci su: JK Straža, JK Koprivno brdo, JK Radovanska reka, JK Radovanska reka 1 i JK Straža 1. Za sve proučavane osobine je utvrđena statistički značajna unutar populacijska varijabilnost. Analizom varijanse utvrđene su značajne razlike između ispitivanih populacija livadskog vijuka. U drugom delu istraživanja na istim populacijama je utvrđena njihova produktivnost i kvalitet suve materije u gustom sklopu. Ogled je izveden po slučajnom blok sistemu u tri ponavljanja. Veličina osnovne parcele je 5 x 2 m, a setvena norma za sve populacije je bila 25 kg ha^{-1}. Najproduktivnije populacije sa dobrim kvalitetom suve materije su odabrane i uključene u sastav sintetičke sorte livadskog vijuka, koja je poslata Komisiji za priznavanje sorti.

Ključne reči: livadski vijuk, populacije, varijabilnost, produktivnost, kvalitet

FROM WILD POPULATIONS TO NEW CULTIVAR OF MEADOW FESCUE

Meadow fescue (*Festuca pratens* Huds.) is one of the most important perennial grass species, with high yield potential and biomass quality. The collection investigated included nineteen meadow fescue accessions. The study was conducted in an experimental field of the Institute for Forage Crops, on degraded alluvium soil type. The first part of the trial was set up in a space plant nursery with plant to plant distance 60 x 60 cm as a randomized block design with 30 plants per genotype in two years. The aim was to determine values and variability for the most important phenological (heading date), morphological traits (plant height, length of leaf, width of leaf, the leaf number, panicle length and the number of generative and vegetative tillers per plant), dry matter yield per plant and dry matter yield quality. The highest dry matter yield per plant was measured in accessions: JK Straža, JK Koprivno brdo, JK Radovanska reka, JK Radovanska reka 1 and JK Straža 1. The data were analysed by ANOVA. Investigated material has demonstrated significant variability within the genotypes for all studied parameters. Also, among populations variability was high statistically significant for all investigated traits.Productivity and biomass quality was investigated in the second part of the trial. Accessions were tested in plots 5 x 2 m, as a randomised block design, in 3 replications. Each plot was sown with seeding rate to 25 kg ha^{-1}. The most productive accessions with high biomass quality used as a source to create a new cultivar of meadow fescue.

Key words: meadow fescue accessions, variability, productivity, biomass quality

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TOPLOTNO-INDUKOVAN PORAST NIVOA LIPIDNE PEROKSIDACIJE KOD GENETIČKI DIVERGENTNIH SORTI OZIME PŠENICE

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Na rast, razvoj i prinos žitarica značajno utiče temperatura. Toplotni stres kod žitarica dovodi do lipidne peroksidacije, usled čega može doći do oštećenja biljaka, a kao krajnji efekat može se javiti smanjeni prinos. Ciljevi našeg rada su bili da i) utvrdimo nivo lipidne peroksidacije kod devet genetički divergentnih sorti ozime pšenice u uslovima toplotnog stresa i pri optimalnim temperaturnim uslovima, ii) utvrdimo da li je porast lipidne peroksidacije statistički značajan, i iii) prikažemo sorte kod kojih je došlo do manjeg porasta nivoa lipidne peroksidacije. Stepen lipidne peroksidacije je određen spektrofotometrijskom metodom. Srednja vrednost nivoa lipidne peroksidacije pri optimalnim temperaturnim uslovima iznosila je 4.058 nmol g^{-1} sveže biljke, dok je srednja vrednost nivoa lipidne peroksidacije u uslovima toplotnog stresa iznosila 4.918 nmol g^{-1} sveže biljke. U uslovima toplotnog stresa, najveći porast nivoa lipidne peroksidacije uočen je kod sorte Ortegus, dok je najniži porast uočen kod sorte Simonida. Dobijeni rezultati ukazuju da temperaturni stres dovodi do statistički značajnog porasta stepena lipidne peroksidacije. Sorte koje bi smo preporučili za oplemenjivanje i hibridizaciju su Zvezdana, Simonida i Hy Star.

Ključne reči: genetička divergentnost; ozima pšenica; lipidna peroksidacija

Rezultat projekta MPNTR TR 31092: Izučavanje genetičke osnove poboljšanja prinosa I kvaliteta strnih žita u različitim ekološkim uslovima.

HEAT-INDUCED INCREASE IN LIPID PEROXIDATION LEVEL IN GENETICALY DIVERGENT VARIETIES OF WINTER WHEAT

The growth, development and yield of cereals are significantly influenced by temperature. Heat stress in cereals leads to lipid peroxidation, which can result in plant damage, and as a final effect, a reduced yield may occur. The aims of our work were to i) determine: the level of lipid peroxidation in nine genetically divergent winter wheat varieties under conditions of thermal stress and under optimal temperature conditions, ii) determine if the increase in lipid peroxidation is statistically significant, and iii) show varieties in which have occurred a minor increase levels of lipid peroxidation. The degree of lipid peroxidation was determined by the spectrophotometric method. The mean lipid peroxidation level at optimal temperature conditions was 4.058 nmol g^{-1} fresh plant, while the mean level of lipid peroxidation in conditions of heat stress was 4.918 nmol g^{-1} fresh plant. In conditions of heat stress, the highest increase in the level of lipid peroxidation was observed in variety Ortegus, while the lowest increase was observed in variety Simonida. The obtained results indicate that temperature stress leads to a statistically significant increase in the degree of lipid peroxidation. The varieties that we recommend for breeding and hybridization are Zvezdana, Simonida and Hy Star.

Key words: genetic diversity; winter wheat; lipid peroxidation

Results of the Project: TR 31092 Study of the genetic basis of improving yield and quality of small grains in different environmental conditions.

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VARIJABILNOST SADRŽAJA MAKRO I MIKRO NUTRITIENATA U LINIJAMA KUKURUZA

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Kukuruz pokazuje značajno prirodno variranje za sadržaj makro i mikronutritienata. Cilj rada je da se ispita hemijska kompozicija zrna 38 linija kukuruza različitog tipa zrna. Sadržaj karotena i tokoferola je određen HPLC metodom, a sadržaj proteina, ulja i skroba pomoću NIR-a. Sadržaj proteina je bio u opsegu od 9,08 % do 13,78 %, skroba 57,33 - 69,75 % i ulja od 2,77 % do 6,28 %. Prosečan sadržaj proteina, ulja i skroba je iznosio 11,17 %, 64,77 % i 3,95 %. Najveći sadržaj ulja imala je linija Dalas 5 (6,28 %), a proteina linija Fd96 (13,78 %). Srednje vrednosti za β-karotin, α-tokoferol, γ-tokoferol, i δ-tokoferol su 7,13; 24,85; 9,77; 47,27, i 1,61 µg/g. Sadržaj α -tokoferola je bio u opsegu od 3,10 do 38,14 µg/g i γ-tokoferola od 13,07 do 105,02.11 µg/g, β-karotena 0,24 do 37,37 µg/g i lutein+zeaksantin od 8,95 do 69,31 µg/g. Najveće vrednosti β-karotena imala je inbred linija H, L+Z inbred linija TVA912, γ-tokoferola Yum1-3 i α –tokoferola P21. Inbred linije sa narandžastim zrnom imale su najvišu vrednost L+, β-karotena i α –tokoferola dok linije sa belim zrnom imale su najveći sadržaj γ-tokoferola. Inbred linije šecerca imale su najveći sadržaj ulja, a kokičara proteina. Najveći sadržaj skroba imaju linije sa žutim zrnom. Genetička osnova nesumnjivo utiče na hemijski kvalitet i linije sa visokim sadržajem pojedinih makro i mikronutritienata mogu da se koriste u progrmima selekcije za ta svojstva.

Ključne reči: karoteini, tokoferoli, proteini, ulje, skrob, kukuruz

Rezultat projekta TR31068 Ministarstva prosvete, nauke i tehnološkog razvoja

VARIABILITY OF MACRO AND MICRO NUTRITIEN CONTENTS IN MAIZE INBRED LINES

Maize displays considerable natural variation for macronutritiens and micronutritiens. The objectives of this study were to estimate kernel chemical composition of 38 inbred lines with different kernel type. Carotenoid and tocopherol content was determined by the HPLC method, whereas oil, starch, and protein contents were detected by NIR. The results showed that the protein contents ranged from 9.08 to 13.78 %, starch contents 57.33 to 69.75 % and oil contents from 2.77 % to 6.28 %. The average protein, starch, and oil contents were 11.17, 64.77, and 3.95 %, respectively. The highest oil values were observed in inbred Dalas 5 (6.28 %) and the highest value of protein in Fd96 (13.78 %). The mean values of β-carotene, α-tocopherol, γ-tocopherol, and δ-tocopherol, were 7.13, 24.85, 9.77, 47.27, and 1.61 µg g, respectively. Content of α -tocopherol was in the range from 3.10 to 38.14 µg/g and γ-tocopherols from 13.07 to 105.02.11 µg/g, β-carotene 0.24 to 37.37 µg/g and lutein+zeaxanthin 8.95 to 69.31 µg/g. The highest value of β-carotene had inbred line H, L+Z inbred TVA912, γ-tocopherols Yum1-3 and α –tocopherol P21. Orange kernel inbred lines had the highest value of L+, β-carotene and α –tocopherol, whereas white kernel inbreds had the highest value of γ-tocopherols. Sweetcorn inbred lines had the highest value of oil and popcorn of protein. The highest starch content had yellow kernel inbreds. The genetic background undoubtedly influences chemical quality and line with high content of particularly macro and micronutritients may be used in breeding program to improve nutritional value.

Key words: carotenoids, tocopherols, protein, oil, starch, maize

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RAZNOVRSNOST ANTOCIJANINA U ZRNU ŽITARICA I LEGUMINOZA

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Antocijanini ne daju hrani samo boju, već su oni zahvaljujući svojim antioksidativnim osobinama jedinjenja sa potencijano korisnim efektom na zdravlje ljudi. Ova osobina čini ih atraktivnim alternativama sintetičkih boja u prehrambenoj industriji. Do 2016. godine, u prirodi je identifikovano skoro 1000 antocijanina. Međutim, korišćenje potencijalnih biljaka kao komercijalnih izvora prirodnih boja na bazi antocijanina ograničeno je dostupnošću samih sirovina, stabilnošću pigmenata i iz ekonomskih razloga. S obzirom da se pri preradi žitarica i leguminoza dobijaju velike količine nus-proizvoda bogatih antocijaninima i niske cene, bojeno zrno može biti značajan izvor prehrambenih funkcionalnih boja. Iz tog razloga cilj je bio da se odredi sastav antocijanina u zrnu plavog kukuruza kokičara, čileanskog purpurnog kukuruza, purpurne pšenice i crne soje, kao i da se odredi međusobni odnos acilovanih i neacilovanih formi antocijanina. U svojoj acilovanoj i neacilovanoj formi, cijanidin 3-glukozid je bio dominantni antocijanin u zrnu svih ispitanih vrsta. Sastav antocijanina u zrnu plavog kukuruza kokičara i purpurne pšenice bio je skoro identičan. Identifikovano je deset antocijanina sa acilovanim formama kao dominantnim. Sadržaj derivata cijanidina acilovanih sa malonskom kiselinom bio je veći za 13 i 3,5 puta u odnosu na sadržaj njihove glukozidne forme u kukuruzu kokičaru i pšenici, respektivno. Obrnuto je utvrđeno u zrnu purpurnog kukuruza. U njemu je sadržaj cijanidin 3-glukozida (Cy-3-Glu) iznosio 1037,2 μg/g, a cijanidin 3,6-malonilglukozida (Cy-3,6-MalGlu) je bio je 423,1 μg/g. Sedam antocijanina su identifikovani u purpurnom kukuruzu i tri u soji. Za razliku od žitarica, acilovani antocianini nisu detektovani u soji.

Ključne reči: Antocijanini, žitarice, leguminoze.

Rezultat projekta MPNTR TR 31069: Korišćenje biljnih izvora proteina, dijetalnih vlakana i antioksidanasa u proizvodnji hrane.

DIVERSITY OF ANTHOCYANINS IN GRAIN OF CEREAL AND LEGUME

Anthocyanins add not only colors to the food, but also potential health benefits to consumers because of their antioxidant properties. These qualities make them attractive alternatives to synthetic dyes. According to data from 2016, almost 1000 anthocyanins have been identified in nature. However, the use of numerous potential food plants as commercial sources of anthocyanin-based colorants is limited by availability of raw material, by pigment stability, as well as economic considerations. Colored grains hold promise as functional food colorants given that cereal processing generates a large amount of anthocyanins-rich by-products at low cost. Therefore, the aim was to determine the composition of anthocyanins in grains of blue popping maize, deep purple Chilean maize, purple wheat and black soybean, as well as the relationship of acylated and non-acylated forms of anthocyanins in them. In its acylated and non-acylated form, cyanidin 3-glucoside was the dominant antocyanins in the grain of all investigated genotypes. The composition of anthocyanins in the grain of blue popping maize and purple wheat was almost identical. Ten anthocyanins have been identified, with acylated forms as dominant. The content of cyanidin derivatives acylated with malonic acid was higher by 13 and 3.5 times in relation to the content of its glucosidic form in popping maize and wheat, respectively. Vice versa was observed in the grain of deep purple maize. The content of cyanidin 3-glucoside (Cy-3-Glu) and cyanidin 3,6-malonylglucoside (Cy-3,6-MalGlu) in deep purple maize was 1037.2 and 423.1 μg/g, respectively. Seven anthocyanins have been identified in deep purple maize and three in soybean. Acylated anthocyanins were not detected in soybean.

Key words: Anthocyanins, cereal, legume.

Result of the project TR 31069: Utilization of plant sources of protein, dietary fiber and antioxidants in food production.

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GENETIČKA VARIJABILNOST I SLIČNOST KVALITETA ZRNA KUKURUZA U KOLEKCIJAMA MAKEDONIJE I SRBIJE

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U drugoj polovini XX veka počelo je uvođenje hibridnog kukuruza u poljoprivrednu proizvodnju. Širenje hibrida dovelo je do sve manjeg gajenja lokalnih populacija, ali je zbog značaja očuvanja za eventualne buduće potrebe, počelo njihovo organizovano sakupljanje. Prve kolekcionarske misije na prostoru bivše Jugoslavije, bile su početkom 60-ih godina XX veka i oko 1000 uzoraka je sakupljeno i klasifikovano prema agro-morfološkom deskriptoru. U narednim godinama, nastavljeno je sakupljanje i ukupno je 2217 uzoraka kolekcionisano i stavljeno na čuvanje u banku gena Instituta za kukuruz. Od tog broja, 222 populacije su sakupljene na području Makedonije. Tokom 2014. godine na području istočne Makedonije sakupljeno je oko 100 uzoraka. Na osnovu mesta sakupljanja i tipa zrna, 14 uzoraka iz kolekcije Poljoprivrednog fakulteta u Skoplju je odabrano za upoređivanje i identifikaciju mogućih duplikata, „uparivanjem" sa 16 uzoraka iz kolekcije banke gena Instituta za kukuruz, sakupljenih na istom području i sa istim karakteristikama zrna. Pored upoređivanja na morfološkom i molekularnom nivou, ispitivane su i razlike u sadržajau tokoferola (*α-, β+γ-, δ-)* i karotenoida u zrnu, koje su određene HPLC metodom. Utvrđena su značajna variranja u sadržaju mikronutrienata između populacija. Najveća sličnost na morfološkom i molekularnom nivou utvrđena je između populacija broj 13 i 14, a za njih je utvrđena i sličanost u sadržaju karotenoida u zrnu. Stare populacije predstavljaju dragocen izvor gena povezanih sa kvalitetom zrna i najbolje među njima mogu se koristiti za poboljšanje kvaliteta zrna u oplemenjivačkim programima.

Ključne reči:banka gena, kvalitet zrna, kukuruz,lokalne populacije.

Rad je rezultat projekata MPNTR TR 31028: Genetički resursi kukuruza kao izvor poboljšanog kvaliteta zrna i tolerantnosti prema suši i TR 31068: Poboljšanje svojstava kukuruza i soje molekularnim i konvencionalnim oplemenjivanjem.

GENETIC VARIABILITY AND SIMILARITY IN KERNEL QUALITY IN MAIZE COLLECTIONS FROM MACEDONIA AND SERBIA

Replacement of local landraces by maize hybrid occurred during late twentieth century. Expansion of maize hybrids induced that landraces were less used, but importance for future led to their organised collection. The first organised missions happened during early sixties of the twentieth century and about 1000 samples were collected and classified according to agro-morphological descriptor. In coming decades, collection continued and the total number increased up to 2217 accessions of local landraces stored at Maize Research Institute gene bank. Out of that number, 222 maize landraces were collected in Macedonia. During 2014, in the eastern part of the Republic of Macedonia about 100 samples were collected. According to collecting area and kernel type, 14 samples from the Faculty of Agricultural Sciences and Food, R. Macedonia were chosen for the comparison and identification of possible duplicates, through coupling with the 16 MRIZP gene bank accessions from the same area and kernel characteristics. Beside morphological and molecular comparison, differences in tocopherol (*α-, β+γ-, δ-)* and carotenoid content in grains were estimated by high-performance liquid chromatography (HPLC). Significant variation was observed among the genotypes in the traits of interest. The highest similarity at morphological and molecular level was obtained for landraces 13 and 14, and for them the similar level of kernel carotenoid content was detected through HPLC analysis. Old landraces present a valuable source for grain quality traits and the best one could be included in conventional breeding programs.

Key words: gene bank, grain quality, landraces, maize.

Results of the Projects TR 31028 Exploitation of maize diversity to improve grain quality and drought tolerance and TR 31068 Improving the quality of maize and soybean by conventional and molecular breeding.

P-19

MULTIVARIJACIONI PRISTUP U UTVRĐIVANJU RAZLIKA IZMEĐU HIBRIDNIH I OP SORTI KUKURUZA PREMA SADRŽAJU NUTRITIVNIH I BIOAKTIVNIH JEDINJENJA

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Zrno kukuruza se uglavnom koristi za ishranu domaćih životinja i industrijsku preradu, ali u zemljama Afrike i Latinske Amerike ima značajnu ulogu i u ljudskoj ishrani. U mnogim razvijenim zemljama i danas se gaje slobodnooprašujuće sorte (OPV) kukuruza za pripremanje tradicionalne hrane, uprkos dostupnosti mnogo rodnijih hibrida na tržištu. Savremeno oplemenjivanje kukuruza glavni naglasak stavlja na prinos zrna, dok se kvalitetu zrna za ljudsku ishranu ne posvećuje dovoljno pažnje. Za ova istraživanja odabrane su tri hibridne i tri *OP* sorte kukuruza različite boje i tvrdoće zrna, sa ciljem da se između njih utvrde razlike u sadržaju ukupnih karotenoida, profilu fenolnih jedinjenja i antioksidativnom kapacitetu. Pored toga, analizirani su fizički parametri kvaliteta zrna, osnovni hemijski sastav zrna, kao i sadržaj proteinskih frakcija. Rezultati analize varijanse su ukazali na značajnost razlika ispitivanih genotipova kukuruza u sadržaju ispitivanih jedinjenja u zrnu. Međutim, na osnovu ove analize nisu mogli da se donesu jasni zaključci o vezama između tipa sorte (hibridna ili *OPV*), tvrdoće, pa i boje zrna sa sadržajem nekih od ispitivanih jedinjenja. Uradjena je analiza glavnih komponenata (*PCA*) za bioaktivna jedinjenja, fizičke osobine i osnovni hemijski sastav zrna, kao i za proteinske frakcije. Dobijeni rezultati su dali uvid u kompleksnost odnosa između ispitivanih parametara kvaliteta zrna kukuruza. Analiziran broj genotipova nije bio dovoljan za donošenje generalnih zaključaka, ali je očigledno da posmatranje pojedinačnih karakteristika nije pouzdan pokazatelj kvaliteta. Mutivarijacioni pristup (kroz *PCA*) omogućava identifikaciju genotipa koji poseduje kombinaciju poželjnih svojstava sa aspekta određene namene.

Ključne reči: antioksidativni kapacitet, boja zrna, tip zrna, fenolna jedinjenja, karotenoidi, *Zea mays* L.

Rad je nastao kao rezultat projekta TR 31028, finansiranog od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije

MULTIVARIATE APPROACH IN DETERMINING THE DIFFERENCES BETWEEN MAIZE HYBRIDS AND OP VARIETIES ACCORDING TO THE CONTENT OF NUTRITIVE AND BIOACTIVE COMPOUNDS

Maize grain is mainly used for animal feed and industrial processing, but in some African and Latin American countries it plays an important role in human diet. Today, in many developed countries, farmers are still growing maize Open Pollinated Varieties (OPV), despite the availability of many high yielding hybrids on the market, predominantly for its own use and for traditional food preparation. For a long period, maize breeding was focused towards increased and stabile yield, neglected grain quality, particularly for human consumption. For this study, three maize hybrids and three OP varieties differing in kernel color and type of grain were used to examine the differences in total carotenoid content, the phenolic compounds profile and the antioxidant capacity. In addition, physical parameters of grain quality, basic chemical composition of grain, as well as the content of protein fractions were analyzed. The results of ANOVA indicated the level of significant differences between evaluated genotypes based on the content of the evaluated parameters. Based on this analysis, no clear conclusions could be drawn about the relationship of type of variety (hybrid or OP), type of grain and kernel color and the content of some of the examined compounds. PC analysis was performed for bioactive compounds, physical properties, physical properties and basic chemical composition of grains, as well as for content of protein fractions. Multivariate approach contributes to better understanding of the complexity for interdependence of the tested maize grain quality parameters. Beside a small number of genotypes analyzed, it is obvious that evaluation of individual parameter is not reliable indicator of grain quality. Multivariate approach (through PCA) allows the identification of a genotype with a favorable combination of grain quality parameters from the aspect of a particular use.

Key words: antioxidant capacity, carotenoids, kernel color, phenolic compounds, type of grain, *Zea mays* L.

The research was supported by the Ministry of Education, Science and Technological Development, Republic of Serbia, through the Project TR 31028.

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OSETLJIVOST LINIJA KUKURUZA NA GAJENJE U USLOVIMA NISKE OBEZBEĐENOSTI AZOTOM

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Azot je važan makro-nutrijent, koji pored uticaja na život i funkcionisanje biljaka, u visokom stepenu utiče i na formiranje prinosa. Genotipovi kukuruza ispoljavaju različitu osetljivost na gajenje u uslovima niske obezbeđenosti azotom u zemljištu. Stoga je ispitivana varijabilnost reakcije 37 linija kukuruza na gajenje u uslovima optimalne (đubrenje ureom) i niske obezbeđenosti azotom (bez đubrenja). Sve ostale mere gajenja, kao i obezbeđenost ostalim elementima, primenjene su isto za celu parcelu. Prinos zrna linija je varirao 0,25-4,33 t ha^{-1} na delu parcele sa optimalnom obezbeđenošću azotom i u opsegu 0,24-3,88 t ha^{-1} na delu parcele sa niskom obezbeđenošću azotom. Takođe, masa 1000 semena je varirala 32,68-319,63 g na delu parcele sa optimalnom obezbeđenošću azotom i 31,36-312,47 g na delu parcele sa niskim azotom. Važno je istaći da je postojala visoka varijabilnost između linija u pogledu koeficijenta efikasnosti formiranja prinosa, koji je varirao 28,00-152,31%, što znači da su pojedine linije i u uslovima niske obezbeđenosti azotom uspele da ostvare i veće prinose u odnosu na gajenje pod optimalnom obezbeđenošću azotom. Međutim, navedene linije nisu imale visoke vrednosti prinosa, već naprotiv, njihov prinos je varirao u opsegu 0,27-2,08 t ha^{-1} na delu parcele sa niskim azotom, odnosno 0,25-1,52 ha^{-1} na delu parcele sa optimalnom obezbeđenošću azotom. Linije sa boljom efikasnošću iskorišćenja azota, kao i većim prinosom će biti uključene u dalja istraživanja, odnosno oplemenjivanje hibrida kukuruza koji bolje koriste azot iz podloge, čak i u uslovima niske obezbeđenosti.

Ključne reči: linije kukuruza, nizak azot, prinos, stepen iskorišćenja

Rezultat projekta MPNTR TR 31068: Poboljšanje svojstava kukuruza i soje konvencionalnim i molekularnim oplemenjivanjem

SUSCEPTIBILITY OF MAIZE LINES TO NITROGEN INSUFFICIENCY

Nitrogen is important macro-nutrient, which besides the responsibility for plant life and function, influences yielding in a great extent. Maize genotypes exhibit diverse susceptibility to low nitrogen level in soil. From that reason, variability in reaction of 37 maize lines to growing in conditions with optimal (fertilization with urea), and with low nitrogen (without fertilization) was examined. All other growing measures and fertilization with other elements was applied at the same manner on whole experimental plot. Maize grain yield varied 0.25-4.33 t ha^{-1} in the part with optimal nitrogen in soil and in range 0.24-3.88 t ha^{-1} in the part with insufficient nitrogen. Also, 1000 grain weight varied 32.68-319.63 g in the part with optimal nitrogen in soil and 31.36-312.47 g in the part with low nitrogen. It is important to underline that high variability between maize lines in term of efficacy of yielding was present, with values varied 28.00-152.31%, meaning that some lines under the conditions with low nitrogen achieved even higher grain yields, than in conditions with optimal nitrogen in soil. Nevertheless, these lines haven't got high yield values; it was in range 0.27-2.08 t ha^{-1} in the part with low nitrogen in soil, and accordingly 0.25-1.52 ha^{-1} in the part with optimal nitrogen. Lines with better nitrogen using efficacy, as well as higher grain yields will be introduced into further research, i.e. breeding of maize hybrids with better nitrogen usage from soil, even in the conditions with low nitrogen.

Key words: maize lines, low nitrogen, grain yield, efficacy level

Results of the Project TR 31068: Improvement of maize and soybean traits by molecular and conventional breeding

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UPOREDNO ISPITIVANJE MORFOLOŠKIH, PRODUKTIVNIH I KVALITATIVNIH OSOBINA RAZLIČITIH SORTI SLATKE ZAČINSKE PAPRIKE

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U periodu od 2014. do 2016. godine na lokalitetu Starčevo na zemljištu tipa oglejani černozem vršeno je uporedno istraživanje morfoloških, produktivnih i kvalitativnih osobina većeg broja sorti začinske paprike (Horgoška slatka HS-2, Horgoška slatka HS-5, Horgoška slatka HS-6, Szegedi 80, Aleva NK, Nada). Ogled je zasnovan po slučajnom blok sistemu u četiri ponavljanja, sa veličinom osnovnih parcela 10 m^2. Svake godine na svim lokacijama, direktna setva je izvedena ručno u poslednjoj dekadi marta na međuredni razmak od 50 cm, sa razmakom u redu 5 cm i dubinom setve od 2 cm. U toku vegetacionog perioda primenjene su mere nege koje su se sastojale u redovnom suzbijanju korova okopavanjem useva. Kao preventivne korišćene su neke od organskih metoda koje su uticale na izostanak većeg broja ekonomski značajnih štetočina i biljnih bolesti začinske paprike. U zavisnosti od agroekoloških uslova prva berba obavljana je polovinom septembra, a druga berba početkom oktobra. Najbolje produktivne osobine pokazala je sorta „Nada“, kod koje prosečni prinos svežeg ploda bio 19,8 kg/ha, odnosno suvog ploda 2,9 kg/ha. Od kvalitativnih osobina ispitivano nekoliko parametara. U proseku u istraživanom periodu, sorta „Szegedi 80“ imala je najviše odnosno 19,1 % suve materije u fiziološki zrelim plodovima. Najveći sadržaj boje od 7,8 g/kg zabeležen je kod sorte „Horgoška slatka HS-6“. Generalno, sve ispitivane sorte bile su zadovoljavajućeg prinosa i kvaliteta, što je kod pojedinih sorti potvrđeno i njihovim gajenjem u široj proizvodnoj praksi rejona Vojvodine.

Ključne reči: sorte, morfološke osobine, prinos, sadržaj suve materije i boje, začinska paprika.

Rad predstavlja deo rezultata istraživanja u okviru Projekta Integralnih i interdisciplinarnih istraživanja br. 46006 ˝Održiva poljoprivreda i ruralni razvoj u funkciji ostvarivanja strateških ciljeva Republike Srbije u okviru

Dunavskog regiona", finansiranog od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije

COMPARATIVELY RESEARCH OF MORPHOLOGICAL, PRODUCTIVE AND QUALITATIVE PROPERTIES OF DIFFERENT VARIETIES OF SWEET SPICY PEPPERS

The morphological, productive and qualitative properties of different varieties of sweet spicy peppers (Horgoška slatka HS-2, Horgoška slatka HS-5, Horgoška slatka HS-6, Szegedi 80, Aleva NK, Nada) were comparatively researched on Starčevo locality for period of 2014 to 2016. The type of soil on this locality is chernozem on loess. The experiment was arranged as a randomised complete block design with four replicates, where the plots size was 10 m^2. In each experimental year, the manual sowing were done in the rows (between 50 cm; spacing in rows 5 cm; depth 2 cm) in the spring (the last week of March). Weeds were hoeing in whole period of vegetation and some of organic alternative methods were used for suppression of economically significant plant disease and insects. Depending on agroecological conditions, the sweet spicy peppers were harvested in the first decade of September, while the second harvest was in the first week of October for every year.
The pepper variety of "Nada" showed the best productive property, where the average yield of fresh fruit was 19.8 kg/ha, while the average yield of dry fruit was 2.9 kg/ha. Several parameters were analyzed for qualitative properties, where the pepper variety of "Szegedi 80" was characterized by the highest values of dry matter (19.1 %) in physiologically mature fruits. Moreover, the morphological characteristic followed by the high color intensity was presented by the variety "Horgoška slatka HS-6" (7.8 g/kg). In general, all examined varieties of sweet spicy peppers haf satisfactory yield and quality, which was confirmed in some varieties by their cultivation in the wider production practice of Vojvodina.

Key words: varieties, morphological properties, yield, dry matter, color, sweet spicy peppers.

The paper represents a part of the research results within the Project of Integral and Interdisciplinary Research No. 46006 "Sustainable Agriculture and Rural Development in the Function of the Accomplishment of Strategic Objectives of the Republic of Serbia in the Danube Region", financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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UTICAJ AGRO-EKOLOŠKIH FAKTORA NA SINTEZU ULJA I PROTEINA U SEMENU ULJANOG LANA - *Linum usitatissimum* L.

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Predmet ove studije bio je testiranje tehnološkog kvaliteta nove sorte uljanog lana NS Primus u divergentnim godina, u ogledima koji su izvedeni na parcelama Instituta za ratarstvo i povrtarstvo, u Bačkom Petrovcu (φN 45° 20', λE 19° 40', 82 m nm) na zemljištu tipa černozem. Proizvodna 2016. godina bila je povoljnija godina za proizvodnju lana. Ukupne padavine u vegetacionom periodu 2017. godine iznosile su 165 mm i bile su manje u odnosu na 2016. godinu za oko 200 mm, dok su prosečne temperature (20,6ºC) bile veće za 1ºC.

Agro-ekološki faktori imali su značajan uticaj na sintezu ulja i proteina u zrnu uljanog lana. U 2016. godini ostvareni su statistički značajno veći prinosi zrna, prinosi proteina i prinosi ulja u odnosu na 2017. godinu. Prosečan sadržaj ulja za ispitivani period iznosio je 41,20% dok je sadržaj proteina iznosio 22,68%. Povoljnija godina za sintezu ulja bila je sušna, 2017. godina. Sadržaj ulja u 2017. godini (42,70%) bio je veći u odnosu na 2016. godinu za 3,20%, dok je sadržaj proteina bio veći u 2016. godini. Prinos zrna, u proseku za ispitivani period, iznosio je 1625 kg ha^{-1}, prinos ulja 662 kg ha^{-1}, dok je prinos proteina iznosio 369 kg ha^{-1}. Koeficijent varijacije, kao mera disperzije, za prinos ulja u zrnu i prinosa proteina kretao se u intervalu 27,37% < Cv <33,34% što ukazuje na velika variranja ispitivanih pokazatelja između godina.

Ključne reči: uljani lan, sorta, prinos zrna, komponente kvaliteta.

Rezultat projekta : Razvoj novih sorti i poboljšanja novih tehnologija proizvodnje uljanih biljnih vrsta za različite namene;MPNTR TR-31025 (2011-2019)

THE INFLUENCE OF AGRO-ECOLOGICAL FACTORS ON SYNTHESIS OIL AND PROTEIN IN LINSEED - *Linum usitatissimum* L.

The subject of this study was testing the technological quality of the new variety linseed NS Primus, in divergent years. In the experiments carried out on the plots of the Institute of Field and Vegetable Crops, in Bački Petrovac (φN 45 ° 20 ', λE 19 ° 40') on the soil of the chernozem type. Production year 2016 was more favorable year for the production of linseed. Total precipitation in the vegetation period in 2017 was 165 mm and were less than in 2016 by about 200 mm, while the average temperatures (20.6 ° C) were higher by 1ºC.

Agro-ecological factors had a significant impact on the synthesis of protein and oil in the linseed seed. In 2016 they were realized statistically significantly higher yields of seed, protein yields and oil yield compared to 2017. The average oil content for the study period was 41.20% while the protein content was 22.68%. A more favorable year for the synthesis of oil was dry year, 2017. The oil content in 2017 (42.70%) was higher by 3.20% compared to 2016, while the protein content was higher in 2016. Seed yield, on average for the investigated period, was 1625 kg ha^{-1}, oil yield 662 kg ha^{-1}, while the protein yield was 369 kg ha^{-1}. The coefficient of variation, as a dispersion measure, for seed oil yield and protein yield ranged in an interval of 27.37% <Cv <33.34%, indicating a large variation of the examined indicators between years.

Key words: oil flax, variety, grain yield, quality components.

Project: TR 31025, "Development of new varieties and production technology improvement of oil crops for different purposes"

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REZULTATI ISPITIVANJA DOMAĆIH SORTI SOJE NA DALEKOM ISTOKU RUSIJE

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Soja je stara ratarska kultura koja se gaji već 4.000 godina. Kroz vekove bila je glavni izvor hrane narodima Dalekog istoka. Takođe, danas na području Amurske oblasti koja predstavlja žitnicu Dalekog istoka Rusije, soja zauzima 60 – 70 % od ukupne površine koja se obrađuje. Prosečni prinosi su od 0,8 – 1,7 t/ha. U cilju ispitivanja proizvodnih i kvalitativnih osobina soje domaćeg sortimenta postavljen je ogled na oglednom polju Ekatarinaslavka. Na oglednom polju su posejane sorte različitih grupa zrenja „0“, „00“ i „000“. U ogledu su posejane 24 sorte soje i to 9 sorti iz grupe „0“, 10 sorti iz grupe „00“ kao i 5 sorti najkraće vegetacije iz grupe „000“. Od ukupno 24 sorte koje su ispitivane tokom 2014. godine, 11 sorti soje su poreklom iz Rusije, 3 sorte vode poreklo iz Belorusije, 2 sorte iz Austrije i 9 sorti iz Srbije. U 2015. godini postavljen je ogled sa 30 sorti soje. Ogled je izveden u maju mesecu u periodu od dve godine (2014,2015). Rezultati pokazuju da vrlo rane i rane sorte iz Srbije imaju značajan potencijal.

Ključne reči: soja, Daleki istok, proizvodnja, ogledi

RESULTS OF THE EXAMINATION OF DOMESTIC VARIETIES OF SOYABEAN ON FAR EAST OF RUSSIA

Soya is an old crop and it is grown for 4,000 years. Throughout the centuries, it was the main source of food for the peoples of the Far East. Also, today in the area of the Amur region, which represents the granary Far East of Russia, the soybean occupies 60-70 % of the total area of field crops. Average yields are from 0.8 to 1.7 t/ha. In order to examine the production and qualitative characteristics the domestic assortment, soybean was sown on experimental field in Ekatarinaslavka. Varieties of different groups of ripening "0", "00" and "000" were sown in the field. On the field where sown 24 varieties, 9 varieties from the group "0", 10 varieties from the group "00" and 5 varieties of the shortest vegetation from the group "000". During testing in 2014 out of the 24 varieties, 11 soybean varieties originate from Russia, 3 varieties originate from Belarus, 2 varieties from Austria and 9 varieties from Serbia. In 2015, 30 different varieties soybean were sown. The trial was conducted in May for a period of two years (2014, 2015). The results show that very early and early varieties from Serbia have important potential.

Keywords: soybean, Far East, production, trials

2. OPLEMENJIVANJE DRVEĆA, VOĆAKA I VINOVE LOZE

UV-1

PROVENIJENIČNI TESTOVI BUKVE KAO OSNOVA ZA OPLEMENJIVANJE VRSTE I KONZERVACIJU ŠUMSKIH GENETIČKIH RESURSA U SVETLU KLIMATSKIH PROMENA

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Čiste i mešovite šume bukve u Srbiji pokrivaju 29.3% od ukupne površine pod šumama. Klimatskim modelima predviđa se da će povećanje temperature vazduha i promena režima padavina negativno uticati na bukvu u Srbiji, s obzirom da će se većina postojećih populacija naći izvan svog ekološkog optimuma. Kako dugi životni vek drveća ne dozvoljava brzu adaptaciju na nagle promene klime, neophodno je sprovesti istraživanja kojima bi se identifikovale populacije koje pokazuju visok adaptacioni potencijal na stanišne uslove kakvi se u budućnosti očekuju u Srbiji. Provenijenični testovi predstavljaju odličnu osnovu za procenu genetičkog diverziteta unutar i između populacija, kao i procenu adaptabilnosti i produktivnosti istih. Međunarodni provenijenični testovi bukve u Srbiji su osnovani 2007. godine, od 25 provenijencija iz različitih delova Evrope, na dva lokaliteta – Debeli Lug (istočna Srbija) i Fruška gora. U radu su predstavljeni rezultati i iskustva tokom desetogodišnjih istraživanja, koja su se odnosila na procenu genetičke varijabilnosti i fenotipske plastičnosti ispitivanih provenijencija, proučavanje uticaja staništa na funkcionalne osobine, kao i proučavanje adaptabilnosti i stabilnosti ispitivanih provenijencija. Krajnji ciljevi istraživanja jesu razvijenje strategije konzervacije šumskih genetičkih resursa bukve, selekcija polaznog materijala za dalje programe oplemenjivanja i davanje preporuka za trgovinu i promet reproduktivnim materijalom bukve na nacionalnom i međunarodnom nivou, a u skladu sa direktivom Evropske Unije 1999/105/EC.

Ključne reči: klimatske promene, bukva, provenijenični test, variabilnost, adaptibilnost.

EUROPEAN BEECH PROVENANCE TRIALS AS THE BASIS FOR BREEDING AND CONSERVATION OF SPECIES FOREST GENETIC RESOURCES IN THE LIGHT OF CLIMATIC CHANGES

Poor and mixed forests of European beech in Serbia cover 29.3% of total forest coverage area. Regional climate models predicted that increase of mean air temperature and changes in precipitation patterns will negatively affect beech ecosystems in Serbia, due to majority of beech populations are expected to fall outside its bioclimatic niche. Since the long-life span of trees does not allow for rapid adaptation to sudden climate change, it is necessary to carry out researches that would help in identification of beech populations showing good adaptation potential to the future climate conditions in Serbia. Provenance trials present a great basis for assesment of inter- and intra-provenance genetic variation, as well as provenances adaptability and productivity. International beech provenance trials in Serbia were founded in 2007, from 25 provenances originating from different European countries. The trials were established at two localities – Debeli Lug (Eastern Serbia) and Fruska Gora Mountain. The paper presents the results of ten-years-research on the assessment of the genetic variability and phenotypic plasticity of the tested provenances, impact of environmental conditions on the provenances functional traits, as well as adaptability and stability of the provenances. The goals of the researches are development of a conservation strategy for beech forest genetic resources, selection of basic material for further breeding programs, and recommendations for the marketing of beech reproductive materials at the national and international level, in accordance with the European Union Council Directive 1999/105/EC.

Keywords: climate change, European beech, provenance trial, variability, adaptability.

UV-2

ŠUMSKI GENETIČKI RESURSI U SRBIJI – STANJE I PERSPEKTIVE

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Srbija predstavlja jedan od najznačajnijih regiona biološke raznovrsnosti u Evropi unutar koga značajno mesto zauzima genetički diverzitet sadržan u velikom broju vrsta šumskog drveća, poznatiji kao šumski genetički resursi. Šumski ekosistemi Srbije izgrađeni su od oko 250 autohtonih drvenastih vrsta, koje prema geografsko-flornim elementima pripadaju srednjoevropskom, pontskom i mediteranskom elementu. U okviru šumskih resursa, poseban značaj ima prisustvo 88 divljih drvenastih voćkarica iz 18 rodova. Nacionalnom inventurom šuma Srbije ustanovljeno je 49 vrsta drveća, pri čemu dominiraju lišćarske vrste (40) u odnosu na četinarske vrste (devet). Stanje šumskih genetičkih resursa u Srbiji može se okarakterisati kao nepovoljno, što je posledica narušavanja prostorne i uzrasne strukture populacija drveća selektivnom sečom, stvaranja nepovoljnih uslova za spontanu i prirodnu obnovu, neadekvatnog izbora vrsta za pošumljavanje, favorizovanja jedne vrste drveća u plantažama, čime se stvaraju monokulture malog genetičkog diverziteta. Za poboljšanje ovakvog stanja potrebno je raditi na implementaciji Nacionalnog programa konzervacije i usmerenog korišćenja šumskih genetičkih resursa Republike Srbije, unapređenju gazdovanja šumama u skladu sa konzervacionim principima, upoznavanju šire javnosti sa značajem i potrebom očuvanja šumskih genetičkih resursa, ispunjavanju međunarodnih obaveza vezanih za ovu oblast i priključivanju aktivnostima u okviru FAO organizacije u vezi sa šumskim genetičkim resursima.

Ključne reči: šumski genetički resursi, genetički diverzitet, konzervacija

Istraživanje je sprovedeno u okviru projekta „Šumski zasadi u funkciji povećanja pošumljenosti Srbije" (TR 31041) i projekta „Istraživanje klimatskih promena i njihovog uticaja na životnu sredinu - praćenje uticaja, adaptacija i ublažavanje" (III 43007) finansiranih od strane Ministarstva prosvete i nauke Republike Srbije.

FOREST GENETIC RESOURCES IN SERBIA – STATE AND PERSPECTIVES

Serbia is one of the most important biodiversity regions in Europe, within which a significant place has genetic diversity, contained in numerous forest tree species, commonly known as forest genetic resources. Serbian forest ecosystems include about 250 autochthonous woody species that, due to geographic and flora elements, belong to mid-European, Pontic and Mediterranean element. Within the available forest resources, special importance is given to the presence of 88 wild woody fruit species from 18 genera. National Forest Inventory of Serbia recorded 49 species of trees, with dominant presence of deciduous species (40) in comparison with coniferous species (nine). The state of forest genetic resources in Serbia can be characterized as unfavorable as the consequence of disturbing the spatial and age structure of the populations of trees with selective cutting, creating unfavorable conditions for spontaneous and natural restoration, inadequate selection of species for afforestation, favoring one tree species in plantations, thus creating monocultures with low genetic diversity. In order to improve this situation, it is necessary to work on the implementation of the National program of conservation and sustainable utilization of forest genetic resources of the Republic of Serbia, improvement of forest management in accordance with conservation principles, informing the general public about the importance and the need for conservation of forest genetic resources, fulfillment of international obligations related to this field and associating activities within the FAO organization related to forest genetic resources.

Keywords: forest genetic resources, genetic diversity, conservation

The performed research was conducted within the project „Establishment of forest plantations to increase the afforested areas in Serbia" (TR 31041) and project „*Studying climate change and its influence on the environment: impacts, adaptation and mitigation*" (III 43007) financed by the Ministry of Education and Science of the Republic of Serbia.

UV-3

OSNIVANJE KLONSKE SEMENSKE PLANTAŽE DIVLJE TREŠNJE (*Prunus avium* L.)

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Divlja trešnja (*Prunus avium* L.) je jedna od najvažnijih šumskih voćnih vrsta. Vrlo je vredna vrsta šumskog drveća koja raste u mešovitim šumama južne, srednje i zapadne Evrope. U šumama Srbije nalazi se u grupi ugroženih vrsta kojima se ne posvećuje dovoljno pažnje. Poslednjih godina, u Evropi se sprovode brojni programi oplemenjivanja divlje trešnje sa ciljem očuvanja i povećanja biodiverziteta i proizvodnje kvalitetnog drveta. Ovi programi započinju fenotipskom selekcijom stabala u prirodnim sastojinama i upotrebom njihovih vegetativnih delova za osnivanje klonskih semenskih plantaža, čija je osnovna namena proizvodnja genetski kvalitetnog semena. Sličan projekat realizovan je u Srbiji u periodu od 2015. do 2017. godine.

U radu su prikazane aktivnosti i proces osnivanja klonske semenske plantaže divlje trešnje (*Prunus avium* L.). Na području čitavog areala divlje trešnje u Srbiji selakcionisana su 42 stabla. Kriterijumi za izbor plus stabala bili su zdravstveno stanje, fenotipske osobine, kvantitet i kvalitet uroda. Na ranije zasađenim podlogama izvršeno je kalemljene kalem grančicama uzetim sa selektovanih plus stabala. Primenjen je metod engleskog kalemljenja. Semenska plantaža je osnovana na dva lokaliteta, u Požegi i na Jelovoj gori. U obe plantaže su ugrađena po 42 klona sa po 20 rameta i identičnim prostornim rasporedom.

Osnovane semenske plantaže obezbediće dugoročnu proizvodnju dovoljnih količina kvalitetnog semena, a istovremeno predstavljaju ex situ objekte konzervacije raspoloživog genofonda divlje trešnje u Srbiji.

Ključne reči: divlja trešnja, semenska plantaža, klon, seme.

Rezultat Projekta TR 31070: Razvoj tehnoloških postupaka u šumarstvu u cilju realizacije optimalne šumovitosti.

ESTABLISHMENT OF THE CLONAL SEED ORCHARD OF WILD CHERRY (*Prunus avium* L.)

Wild cherry (*Prunus avium* L.) is one of the most important forest fruit species. It is very valuable forest tree species which grows in mixed forests of South, Central and West Europe. In forests of Serbia it belongs to the group of endangered species to which is not paid enough attention. During the last years, many programs of wild cherry breeding have been conducted in Europe with the aim of its preserving and the increase in biodiversity and the production of quality wood. These programs begin with the phenotypic tree selection in natural stands and the use of their vegetative parts for the establishment the clonal seed orchards which main purpose is the production of the high-quality seed with genetic purity. A similar project was realized in Serbia in the period from 2015 to 2017.

This paper presents the activities and the process of the establishment of the clonal seed orchard of wild cherry (*Prunus avium* L.). In the distribution areas of wild cherry in Serbia 42 trees have been selected. The criteria for the selection were health status, phenotypic characteristics, quantity and quality of yield. The grafting was performed on the previously planted rootstocks using the scions taken from the selected plus trees. The British method of grafting was applied. The seed orchards were established on two localities, in Požega and Jelova gora. In both orchards per 42 clones with per 20 ramets and the identical spatial layout have been set up.

The established seed orchards will provide a long term production of sufficient amount of high-quality seed and, at the same time, they represent ex situ conservation facilities of the available gene-pool of wild cherry in Serbia.

Key words: wild cherry, seed orchard, clone, seed.

Results of the Project TR 31070 The developments of technological procedures in forestry in order to attain an optimal forest cover percentage.

UV-4

OPLEMENJIVANJE VOĆAKA U INSTITUTU ZA VOĆARSTVO, ČAČAK – DOSTIGNUĆA U POSLEDNJIH DESET GODINA

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U Institutu za voćarstvo, Čačak se od njegovog osnivanja intenzivno radi na stvaranju novih genotipova kontinentalnih vrsta voćaka u skladu sa zahtevima proizvodnje, tržišta i prerađivačke industrije. Programi oplemenjivanja su bazirani na primeni konvencionalnih metoda – planske hibridizacije i individualne pozitivne selekcije iz prirodnih populacija, kao i molekularnih markera za agronomski važne osobine. Oplemenjivački rad na stvaranju novih sorti jabučastih, koštičavih, jezgrastih i jagodastih vrsta voćaka sprovodi se putem odabira roditeljskih parova u skladu sa postavljenim oplemenjivačkim ciljevima, izdvajanja najboljih genotipova iz populacija planskih hibrida i prirodnih populacija na osnovu bioloških i proizvodnih osobina, i evaluacije njihove konkurentnosti u proizvodnji i na tržištu. Kao rezultat multidisciplinarnog naučnoistraživačkog rada stvorene su 43 sorte jabučastih, koštičavih i jagodastih vrsta voćaka. U periodu od 2008. godine, priznato je deset sorti – dve kruške (‘Julijana’ i ‘Anđelija’), pet šljive (‘Nada’, ‘Zlatka’, ‘Divna’, ‘Petra’ i ‘Pozna Plava’) i tri višnje (‘Sofija’, ‘Nevena’ i ‘Iskra’), a u postupku priznavanja je pet kandidat sorti – jedna kruške (hibrid IV/45), jedna šljive (hibrid XIV/21), dve breskve (genotipovi Šutaković i V/2015) i jedna trešnje (hibrid V/30). U okviru ovog rada biće predstavljene sorte priznate tokom poslednjih deset godina, kao i perspektive primene novijih znanja i metoda u oplemenjivanju kontinentalnih vrsta voćaka.

Ključne reči: kontinentalne vrste voćaka, nove sorte, oplemenjivački ciljevi, konvencionalne i savremene metode

Rezultat Projekta MPNTR TR–31064: Stvaranje i očuvanje genetičkog potencijala kontinentalnih vrsta voćaka

FRUIT BREEDING AT FRUIT RESEARCH INSITUTE, ČAČAK – ACHIEVEMENTS IN LAST TEN YEARS

Since its foundation, the Fruit Research Institute has pursued intensive breeding programmes of temperate zone fruit species in accordance with the needs of fruit growing, processing industry and the market. The breeding programmes are based on the application of conventional methods – the planned hybridization and the individual positive selection from natural populations, as well as on the use of molecular markers for agronomic important traits. A breeding work toward the development of new pome, stone, nuts and small fruit cultivars is carried out through selection of parental pairs according to defined breeding objectives, selection of the best genotypes from hybrid populations or natural populations based on biological and productive traits as well as on the evaluation of the selected genotype competitiveness in fruit growing and in the market. The multidisciplinary breeding work has resulted in 43 released cultivars of pome, stone and small fruits. Ten cultivars have been released since 2008, i.e. two pear cultivars (‘Julijana’ and ‘Anđelija’), five plum cultivars (‘Nada’, ‘Zlatka’, ‘Divna’, ‘Petra’ and ‘Pozna Plava’), and three sour cherry cultivars (‘Sofija’, ‘Nevena’ and ‘Iskra’), whereas five cultivar candidates are in the release procedure, i.e. one pear (hibrid IV/45), one plum (hybrid XIV/21), two peaches (genotypes Šutaković and V/2015) and one sweet cherry (hybrid V/30). Within this paper, cultivars released in the last ten years and a brief overview of the objectives of modern breeding programmes and perspectives of applying of the newer knowledge and methods will be presented.

Key words: temperate zone fruit species, new cultivars, breeding objectives, conventional and modern methods

Results of the Project TR–31064: Development and preservation of genetic potential of temperate zone fruits.

UV-5

PRINCIPI I TEHNIKE KONVENCIONALNOG I MOLEKULARNOG OPLEMENJIVANJA VINOVE LOZE

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Sorta je u vinogradarstvu, kao i u drugim granama biljne proizvodnje, glavni činilac povećanja prinosa i kvaliteta grožđa. Najvažniji izazov oplemenjivačkog rada je stvaranje novih sorti koje će prihvatiti tržište i koje donose profit proizvođačima. Procenjuje se da danas postoji skoro 9.500 sorti vinskog grožđa, gotovo 4.500 sorti stonog grožđa i više od 1.200 sorti kombinovanih svojstava (vinsko i stono grožđe). S obzirom da je oplemenjivanje vinove loze dugotrajan proces, prvi korak u stvaranju nove sorte je definisanje oplemenjivačkih ciljeva, tj. definisanje ideotipa sorte. Dalja realizacija sorte zavisi od raspoložive genetičke varijabilnosti, načina nasleđivanja željenih osobina i uspešnosti selekcije. U ovom radu prikazani su najvažniji ciljevi i metode u oplemenjivanju vinove loze. Među ciljevima oplemenjivanja posebno su istaknuti ciljevi oplemenjivanja vinskih sorti, sorti za proizvodnju stonog grožđa, sorti za sušenje, kao i sorti čije se grožđe koristi za preradu u sokove. Od metoda oplemenjivanja, u prvom redu obrađene su konvencionalne metode (hibridizacija, mutacije i selekcija). Određena pažnja u radu usredsređena je i na brojne molekularne metode, kao što su: genotipizacija; sekvencioniranje; QTL mapiranje; MAS selekcija; genetički inženjering; OMIC tehnologije (genomika, transkriptomika, proteomika, metabolomika, epigenomika); nove DNK tehnologije (cisgeneza, intrageneza, transgeneza) i uređivanje genoma (ZFN, TALEN, CRISPR/Cas). Dostignuća mnogih oplemenjivačkih programa pokazala su da su planskim radom na oplemenjivanju stvorene brojne privredno značajne sorte vinove loze, koje potiskuju iz proizvodnje standardne sorte i zauzimaju odgovarajuća mesta u novim vinogradima.

Ključne reči: vinova loza, hibridizacija, selekcija, molekularni markeri, genetički inženjering

PRINCIPLES AND TECHNIQUES OF CONVENTIONAL AND MOLECULAR GRAPEVINE BREEDING

The cultivar is in viticulture, as well as in other branches of plant production, the main factor of increasing the yield and quality of grapes. The most important challenge of breeding is development of new cultivars that will accept the market and bring profit to producers. It is estimated that today there are almost 9,500 cultivars of wine grapes, almost 4,500 cultivars of table grapes and more than 1,200 cultivars of combined properties (wine and table grapes). Since grapevine breeding is a long-term process, the first step in developing a new cultivar is the definition of breeding objectives, i.e. defining the ideotype of the cultivar. Further realization of the cultivar depends on the available genetic variability, the way of inheriting the desired characteristics and the success of the selection. This paper presents the most important goals and methods in the grapevine breeding. Among the breeding objectives, the breeding goals of wine cultivars, cultivars for the production of table grapes, cultivars for drying and cultivars whose grapes are used for processing into juices are especially emphasized. Conventional methods (hybridization, mutations and selection) were described as the breeding methods in the first place. Certain attention in the work is focused on numerous molecular methods such as: genotyping; sequencing; QTL mapping; MAS selection; genetic engineering; OMIC technologies (genomics, transcriptomics, proteomics, metabolomics, epigenomics); new DNA technology (cisgeneesis, intragenesis, transgenesis) and genome editing (ZFN, TALEN, CRISPR/Cas). The achievements of many breeding programmes shown that numerous of the economically important grapevine cultivars have been developed with the planned breeding work, which have been replaced standard cultivars in the production and occupied appropriate places in the new vineyards.

Key words: grapevine, hybridization, selection, molecular markers, genetic engineering

U-1

KULTURA TKIVA U PROCENI TOLERANTNOSTI NA ZASLANJENOST KOD BELIH TOPOLA

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Prikazana je procena tolerantnosti na zaslanjenost kod bele topole (*Populus alba* L.) u uslovima *in vitro*. Ispitan je efekat šest koncentracija NaCl (1 mM, 3 mM, 10 mM, 33 mM, 100 mM i 150 mM) u podlozi za ožiljavanje na devetnaest morfometrijskih i svojstava biomase, svojstava sadržaja fotosintetičkih pigmenata i biohemijskih parametara kod pet genotipova bele topole, kako bi se optimalizovala procedura procene tolerantnosti i ispitala reakcija genotipova na zaslanjenost. Podloga za ožiljavanje je bazirana na ACM (Aspen culture medium) podlozi, bez faktora rasta. Podloga sa 150 mM NaCl je snažno inhibirala ožiljavanje i uzrokovala hlorozu, nekrozu i na kraju propadanje eksplantata, dok je podloga sa 100 mM NaCl dala najjasniju diferencijaciju među ispitivanim genotipovima. Svojstva biomase su bila slabo informativna. Genotip Villafranca je dominirala po morfometrijskim parametrima i većini svojstva koja opisuju sadržaj fotosintetičkih pigmenata u izbojku, dok je najbolje rezulatate u rastu korena i procentima ožiljavanja i preživljavanja eksplantata postigao L-12. Zabeležen je opšti inhibitorni efekat na biohemijske parametere (koji se uglavnom tiču oksidativnog stresa) na podlozi sa NaCl u koncentracijama od 0 do 33 mM. Prema ovim parametrima, genotip L-80 je ostvario blagu, a LBM najjaču reakciju. Postoji značajan potencijal ua procenu tolerantnosti na zaslanjivanje u kulturi in vitro kod belih topola, ali dalja istaživanja bi trebalo takođe da se sprovedu i u poljskim uslovima.

Ključne reči: *Populus alba*, abiotički stres, NaCl

Rezultat projekta: „Istraživanje klimatskih promena na životnu sredinu: praćenje uticaja, adaptacija i ublažavanje“ (III 43007)

TISSUE CULTURE IN EVALUATION OF WHITE POPLAR SALINITY TOLERANCE

In vitro evaluation of salinity tolerance in white poplar (*Populus alba* L.) are presented in this work. The effect of six concentrations of NaCl (1 mM, 3 mM, 10 mM, 33 mM, 100 mM and 150 mM) in rooting medium on nineteen morphometric, biomass, photosynthetic pigments' content and biochemical parameters of five white poplar genotypes are tested in order to optimize salinity tolerance evaluation procedure and examine reaction of the genotypes. The rooting medium is based on ACM (Aspen culture medium), without growth factors. The medium with 150 mM NaCl severely inhibited rooting and caused chlorosis, necrosis and eventually decay of explants, while the medium with 100 mM NaCl provided the best differentiation between examined genotypes. Biomass parameters were poorly informative suggesting. Genotype Villafranca dominated in morphometric characters and most of parameters of the content of photosynthetic pigments in shoot, while the best results in root growth and percentage of explant rooting and survival were achieved by L-12. There was general inhibitory effect on examined biochemical parameters (principally related to oxidative stress) on media with NaCl ranging from 0 to 33 mM. According to these parameters, genotype L-80 achieved mild while LBM achieved the strongest reaction. There is considerable potential of tissue culture methods in evaluation of salinity tolerance in white poplar genotypes, but further research should be performed in field conditions, as well.

Keywords: *Populus alba*, abiotic stress, NaCl

Project: "Studying climate change and its influence on the environment: impacts, adaptation and mitigation" (III 43007)

U-2

SPOSOBNOST NEUTRALIZACIJE RADIKALSKIH VRSTA KAO KRITERIJUM ZA SELEKCIJU TOLERANTNIJIH KLONOVA TOPOLA PREMA OKSIDATIVNOM STRESU IZAZVANIM TEŠKIM METALIMA (Ni i Cd)

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Kao brzorastuća vrsta sa visokim stepenom transpiracije, klonovi topola predstavljaju idealne kandidate za korišćenje u svrhu fitoremedijacije teškim metalima zagađenog zemljišta. Različiti klonovi topola pokazuju različite potencijale da akumuliraju i translociraju različite teške metale, ali pokazuju i različite mehanizme tolerancije teških metala. Teški metali u biljkama stimulišu nastajanje oksidativnog stresa koji je posledica prekomerne propagacije reaktivnih kiseoničnih vrsta. Spsosobnost neutralizacije radikala predstavlja sposobnost klonova topola da se ublaži oksidativni stres smanjujući koncentraciju kiseoničnih radikala, povećavajući time toleranciju na metale. Stoga, osnovni cilj ovog istraživanja je da se procene različite sposobnosti neutralizacije različitih slobodno-radikalskih vrsta (NO, OH, ABTS i DPPH radikala) od strane listova i korena tri klona topola (M1, B229, Pe19/66) izloženih uticaju povišenih koncentracija Ni i Cd u zemljištu. Primenjene koncentracije tretmana odgovaraju maksimalnim dozvoljenim koncentracijama (MDK) u zemljištu kao i trostruko višim koncentracijama od MDK. Selekcija klonova prema njihovoj toleranciji na različite koncentracije metala procenjena je primenom analize glavnih komponenti na parametre vezane za neutralizaciju radikalskih vrsta. Klon Pe19/66 je pokazao veću toleranciju prema povišenim koncentracijama jona Ni, zahvaljujući povećanoj sposobnosti da neutralize DPPH i OH radikale tokom najvišeg tretmana niklom, dok je klon M1 pokazao veću toleranciju od ostalih prema povišenoj koncentracii Cd, zbog sposobnosti da održi visoke vrednosti neutralizacije svih ispitanih radikala (NO, OH, DPPH and ABTS radicals) tokom maksimalnog tretmana kontaminacije jonima Cd.

Ključne reči: Fitoremedijacija, klonovi topola, sposobnost neutralizacije radikala

RADICAL SCAVENGER CAPACITIES AS CRITERIA FOR SELECTION OF MORE TOLERANT POPLAR CLONES TOWARDS HEAVY METAL (Cd AND Ni) INDUCED OXIDATIVE STRESS

As a fast growing species with high transpiration rate poplars present perfect candidates for phytoremediation of soils contaminated with heavy metals as persistent and toxic inorganic pollutants. Different poplar clones express different potentials to accumulate and translocate different heavy metals, but also different clones exhibit different mechanisms of tolerance towards presence of heavy metals. Heavy metals in plants promote propagation of reactive oxygen species, thus stimulate occurrence of oxidative stress. Radical scavenger capacities (RSC) present potentials of clone's extracts to neutralize different free radical species and it present clone's ability to mitigate oxidative stress and thus better tolerate presence of heavy metals in the soil. Therefore, the main aim of this study is to estimate various radical scavenger capacities against NO, OH, ABTS and DPPH radicals in roots and leaves of different poplar clones (M1, B229, Pe19/66) exposed to elevated Ni and Cd concentration in soils. Applied concentrations of metals corresponded with maximum allowed amounts (MAA) in soil for each metal and triple MAA. Selection of more tolerant poplar clone towards different concentrations of applied heavy metals was done according to RSC against different radical species by using principal component analysis (PCA) to distinguish clones. Clone Pe19/66 showed higher tolerance towards elevated Ni concentration, due to significant increase of RSC against DPPH and OH during top nickel treatment, while clone M1 appeared to be more tolerant to elevated Cd amounts comparing to other clones, due to its ability to keep high RSC (against NO, OH, DPPH and ABTS radicals) during Cd contamination.

Key words: poplar clones, phytoremediation, radical scavenger capacity

P-1

OPLEMENJIVANJE SMRČE (*Picea abies* Karst.) U BOSNI I HERCEGOVINI

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Smrča čini više od 65% ukupne proizvodnje sadnog materijala u Republici Srpskoj i 85% u Federaciji BiH. Pošumljavanje sadnicama ove vrste se izvodi u širokoj lepezi stanišnih uslova. Oplemenjivanje smrče u BiH vršeno je uglavnom primjenom masovne i individualne selekcije, kroz izdvajanje sjemenskih sastojina i pojedinačnih stabala. Za dalji proces oplemenjivanja neoophodni su odgovarajući rezultati istraživanja iz kratkoročnih i dugoročnih testova. Prvi koraci u testiranju smrče u Bosni i Hercegovini učinjeni su osnivanjem 4 testa potomstva 2009. godine u 4 ekološko-vegetacijske oblasti. Potomstvo potiče iz 6 populacija iz prirodnog areala širom Bosne i Hercegovine. U testovima potomstva u Driniću i Srebrenici vršeno je praćenje potomstva i njegovih kvantitativnih i kvalitativnih osobina neophodnih za dalje oplemenjivanje ove vrste. Prvi rezultati ukazuju na mogućnost oplemenjivanja smrče u više pravaca:
- na kvantitativna svojstva u smislu definisanja populacija sa bržim i sporijim rastom,
- na otpornost prema pojavi kasnog proljećnog mraza gdje se izdvajaju populacije sa ranijim i kasnijim otvaranjem pupoljaka,
- na kvantitativna svojstva (broj grana u pršljenu) koja se odnose na budući kvalitet stabla u pogledu tehničkog kvaliteta drveta.
- transfer reproduktivnog materijala unutar i među ekološkim zonama uvažavajući prognoze vezane za klimatske promjene.
Navedeni rezultati su baza za dalje aktivnosti u procesu oplemenjivanja smrče u BiH koji je neophodan u cilju povećanja kvaliteta budućih šumskih zasada.

Ključne riječi: smrča, oplemenjivanje, Bosna i Hercegovina

BREEDING NORWAY SPRUCE (*Picea abies* Karst.) IN BOSNIA AND HERZEGOVINA

Norway spruce seedlings production has a share of 65% of the total production of planting stock material in the Republic of Srpska and 85% in the Federation of Bosnia and Herzegovina. Afforestation by Norway spruce seedlings is carried out in a wide range of habitats. Breeding Norway spruce in Bosnia and Herzegovina (B&H) has been carried out mainly by applying mass and individual selection, through the delineation of seed stands and individual trees. For the further process of breeding, appropriate research results from short and long term tests of the species are necessary. The first step in testing of Norway spruce in B&H was establishing 4 progeny test in 2009 in 4 ecological and vegetational areas. The progeny originates from 6 populations from natural range of Norway species in B&H. In progeny tests in Drinić and Srebrenica, the monitoring of progeny's quantitative and qualitative characteristics was carried out in purpose of further breeding of this species. The first results indicate the possibility of Norway spruce breeding in order to improve:
- quantitative properties in terms of defining populations with fast and slow growth,
- resistance to the late spring frost defining populations with different time of budburst,
- quantitative properties (number of branches in whorl) that refers to the future technical quality of wood.
- transfer of forest reproductive material within and among ecological zones taking into account forecasted climate change. These results are the basis for further Norway spruce breeding in B&H, which is necessary in order to advance quality of planted forests in the future.

Key words: Norway spruce, breeding, Bosnia and Herzegovina

P-2

MEĐU-PROVENIJENIČNA VARIJABILNOST BUKVE NA OSNOVU DVOGODIŠNJEG MERENJA POVRŠINE LISTA

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Cilj ovog istraživanja bilo je utvrđivanje među-provenijenične varijabilnosti bukve na osnovu dvogodišnjeg merenja površine lista. Selekcija stabala je izvršena u okviru evropskog provenijeničnog testa bukve na lokalitetu „Debeli Lug". Odabrano je 13 provenijencija: tri poreklom iz Nemačke, po dve iz Hrvatske, Bosne i Hercegovine, Rumunije i Srbije i po jedna iz Mađarske i Austrije. U okviru svake provenijencije selektovano je po deset stabala sa kojih je tokom avgusta 2016. i 2017. godine sakupljeno po 30 listova. Listovi su herbarizovani i skenirani. Površina svakog pojedinačnog lista je izmerena pomoću softvera ImageJ2.0.0. Dobijeni podaci su obrađeni pomoću statističkog programa „STATGRAPHICS Centurion XVI". Predstavljeni su rezultati deskriptivne statistike, jednofaktorijalne analize varijanse (ANOVA), LSD testa (Fišerov test najmanje značajnih razlika) i klaster analize. Na osnovu dobijenih rezultata, utvrđeno je da postoje statistički signifikantne razlike između srednjih vrednosti za mereno svojstvo. Najveća srednja vrednost površine lista (cm^2) za 2016. godinu zabeležena je kod provenijencije iz Rumunije (21,71), a najmanja kod provenijencije iz Nemačke (12,70). Merenja za 2017. godinu pokazuju najvišu srednju vrednost kod provenijencija iz Hrvatske (25,99; 25,04), a najmanju kod provenijencije iz Austrije (17,68). U svim provenijencijama je primećeno da su srednje vrednosti površine lista veće za listove sakupljene u 2017. godini, što je, može se pretpostaviti, rezultat delovanja faktora spoljašnje sredine. Klaster analiza pokazuje jasno grupisanje provenijencija iz Nemačke, Austrije i Rumunije, kao jedne grupe, i provenijencija iz Srbije (36), Hrvatske i Bosne i Hercegovine, kao druge grupe. Zapažena je i bliska povezanost između provenijencija 38 (Srbija) i 42 (Mađarska).

Ključne reči: među-povenijenična varijabilnost, bukva, površina lista

Istraživanje je sprovedeno u okviru projekta „Šumski zasadi u funkciji povećanja pošumljenosti Srbije" (TR 31041) i projekta „Istraživanje klimatskih promena i njihovog uticaja na životnu sredinu - praćenje uticaja, adaptacija i ublažavanje" (III 43007) finansiranih od strane Ministarstva prosvete i nauke Republike Srbije.

INTER-PROVENANCE VARIABILITY OF BEECH LEAF AREA BASED ON TWO-YEARS MEASUREMENTS

The aim of this research was to assess the inter-provenance beech variability based on two-years measurements of leaf area. Selected beech trees are locaded in provenance trial „Debeli Lug". The research included 13 provenances: three from Germany, two from Croatia, Bosnia and Herzegovina, Romania and Serbia, and one from Hungary and Austria. Ten trees were selected from each provenance and 30 leaves were collected from each tree in August 2016 and 2017 Leaves were herbalized and scanned. Every single leaf area was measured by software ImageJ2.0.0. The obtained data were processed by the „STATGRAPHICS Centurion XVI". Descriptive statistics, analysis of variance (ANOVA), LSD test (Fisher's least significant difference test) and cluster analysis were done. Based on the obtained results, it can be stated that there were statistically significant differences among mean values of measured characteristics. The highest average value (cm^2) in 2016 was recorded in Romanian provenance (21,71), while the lowest was recorded in German provenance (12,70). Based on measurements in 2017, the highest average value was recorded in Croatian (25,99; 25,04) and the lowest in Austrian provenance (17,68). In all provenances was observed that the mean values of leaf area were higher for leaves collected in 2017, that is, it can be assumed, the consequence of the external environment factors. The cluster analysis shows a clear grouping of provenances from Germany, Austria and Romania, as one group, and provenances from Serbia (36), Croatia and Bosnia and Herzegovina, as other group. The close linkage was registered between provenance number 36 (Serbian) and 42 (Hungarian).

Key words: inter-provenance variability, beech, leaf area

The performed research was conducted within the project „Establishment of forest plantations to increase the afforested areas in Serbia" (TR 31041) and project „Studying climate change and its influence on the environment: impacts, adaptation and mitigation" (III 43007) financed by the Ministry of Education and Science of the Republic of Serbia.

P-3

FENOLOŠKA VARIJABILNOST LISTANJA KALEMOVA RAZLIČITIH KULTIVARA BUKVE

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Fenološka osmatranja bukve su se u dosadašnjim istraživanjima, uglavnom odnosila na evropsku bukvu i ređe mezijsku bukvu, dok detaljnih informacija o fenološkim osmatranjima dekorativnih kultivara bukve u Srbiji, do sada, nije bilo. Cilj istraživanja bila je analiza fenološke varijabilnosti listanja, radi utvrđivanja razlika između kalemova dekorativnih kultivara evropske bukve. Kalemljenje je obavljeno 2011. godine, na podlogama proizvedenim u rasadniku i 2013. godine, upotrebom podloga bukve iz prirodnog podmlatka. Kalem grančice su sakupljene sa deset odraslih stabala: tri kultivara evropske bukve (*Fagus sylvatica* 'Purpurea', *Fagus sylvatica* 'Tricolor' i *Fagus sylvatica* 'Purpurea Tricolor') i jedne mezijske bukve sa područja Beograda. Fenološka osmatranja su obavljena u dve sukcesivne godine, u periodu april-maj, jednom u 5-10 dana. Upotrebljeno je šest fenofaza (1. faza – pupoljci u stanju mirovanja; 6. faza – listovi potpuno razvijeni) opisanih u fenološkim istraživanjima u okviru mreže evropskih provenijeničnih testova bukve, uz određene modifikacije. Na osnovu dobijenih rezultata, konstatovano je da postoji razlika u rezultatima prolećnih fenoloških osmatranja na kalemovima proizvedenim 2011. i 2013. godine. Kalemovi proizvedeni 2013. godine, kasnije su počeli da otvaraju pupoljke, a razlike su bile posebno visoke prilikom trećeg i četvrtog osmatranja 2013. godine. Srednje vrednosti evidentirane osmatranjem kalemova proizvedenih 2011. godine kretale su se do 4,80 (21. april), odnosno 6,00 (27. april), za razliku od kalemova proizvedenih 2013. god., sa vrednostima 2,93, odnosno 3,47, u istim terminima. Kalemovi klona K/CR-7 (*Fagus sylvatica* 'Purpurea') izdvojili su se prema višim srednjim vrednostima prilikom svih osmatranja, što znači da su prvi formirali listove.

Ključne reči: dekorativni kultivari bukve, kalemovi, fenologija, varijabilnost

Istraživanje je sprovedeno u okviru projekta „Šumski zasadi u funkciji povećanja pošumljenosti Srbije" (TR 31041) i projekta „Istraživanje klimatskih promena i njihovog uticaja na životnu sredinu - praćenje uticaja, adaptacija i ublažavanje" (III 43007) finansiranih od strane Ministarstva prosvete i nauke Republike Srbije.

PHENOLOGICAL VARIABILITY OF GRAFTS LEAFING OF DIFFERENT BEECH CULTIVARS

Phenological observations of beech, in previous research, were mainly related to the European beech and rarely the Moesian beech, while detailed information about the phenological observations of ornamental beech cultivars in Serbia has not been available so far. The aim of this research was to analyze the phenological variability of leafing, in order to determine the differences between the grafts of ornamental European beech cultivars. The grafting was done in 2011, using the rootstocks produced in the nursery, and 2013, using the beech rootstocks from natural offspring. The scion woods were collected from ten adult trees: three ornamental beech cultivars (*Fagus sylvatica* 'Purpurea', *Fagus sylvatica* 'Tricolor' and *Fagus sylvatica* 'Purpurea Tricolor') and one Moesian beech from Belgrade area. The phenological observations were done in two successive years, in the period April-May, once in 5-10 days. The six pheno-phases (phase 1 – dormant buds; phase 6 –fully developed leaves) defined in the phenological studies within the network of European provenenance beech trials, were used, with certain modifications. Based on the obtained results, it was found that there is a difference in the results of spring phenological observations of grafts produced in 2011 and 2013. The grafts produced in 2013, started opening buds later, and the differences were particularly high in the third and fourth observations in 2013. The mean values recorded by observing the grafts produced in 2011, ranged to 4.80 (April 21) and 6.00 (April 27), in contrast to those produced in 2013, with values of 2.93 and 3.47, in the same terms. The higher mean values were recorded in grafts of the clone K/CR-7 (*Fagus sylvatica* 'Purpurea') in all observations, which means that these grafts formed leaves first.

Keywords: ornamental beech cultivars, grafts, phenology, variability

The performed research was conducted within the project „Establishment of forest plantations to increase the afforested areas in Serbia" (TR 31041) and project „Studying climate change and its influence on the environment: impacts, adaptation and mitigation" (III 43007) financed by the Ministry of Education and Science of the Republic of Serbia.

P-4

ETR1-ALELNE KONSTITUCIJE AUTOHTONIH GENOTIPOVA JABUKE

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Etilen je najjednostavniji biljni regulator rastenja koji ima krucijalnu ulogu u dozrevanju klimakteričnog ploda jabuke (*Malus* × *domestica* Borkh.). U percepciju etilena uključena je familija receptora, locirana na membrani endoplazmatičnog retikuluma. ETR1 pripada potfamiliji I receptora za etilen kod jabuke. Cilj ovog rada je da se ispita alelni polimorfizam *ETR1* gena kod 48 autohtonih genotipova jabuke, koji se nalaze u *ex situ* kolekcionom zasadu na objektu Zdravljak Instituta za voćarstvo, Čačak. Alelni polimorfizam *ETR1* gena je utvrđen posle digestije, lančanom reakcijom polimeraze (PCR metodom) umnoženog genomskog fragmenta sa tri restrikciona enzima – *Rsa*I, *Alu*I i *Hinf*I. Poređenjem polimorfizma uočenog posle restrikcije (*Rsa*I – fragmenti veličine 800 i 890 bp; *Alu* I – polimorfni fragment veličine 850 bp; *Hinf*I – fragmenti veličine 800 i 1.130 bp), identifikovana su četiri alela *ETR1* gena – *a*, *b*, *c* i *d* u proučavanom autohtonom materijalu. Na osnovu utvrđenih alelnih konstitucija *ETR1* gena, ispitivani genotipovi se mogu svrstati u četiri grupe (*aa* – 27 genotipova; *b,a/c* – 9 genotipova; *c,a/c* – 3 genotipa; *d,a/c/d* – 9 genotipova). Alel *d ETR1* gena je do sada identifikovan isključivo kod autohtonih genotipova: 'Babovača', 'Bošnjanka', 'Funtača (Opaljenik)', 'Kamenica 1', 'Ovčiji nos', 'Strekinja', 'Šarenika', 'Tip 3' i 'Tip 6'. Molekularnom karakterizacijom i proučavanjem najvažnijih bioloških osobina autohtonih genotipova, daće se značajan doprinos očuvanju genetičke divergentnosti genofonda jabuke, odnosno obogatiće se kolekcija početnog materijala koja zauzima ključno mesto u stvaranju novih sorti.

Ključne reči: jabuka, autohtoni genotip, etilen, receptor, genotipizacija

Rezultat projekta MPNTR TR–31064 Stvaranje i očuvanje genetičkog potencijala kontinentalnih vrsta voćaka

ETR1-ALLELIC CONSTITUTIONS OF AUTOCHTHONOUS APPLE GENOTYPES

Ethylene is the simplest plant growth regulator which plays a crucial role in the ripening of climacteric apple (*Malus* × *domestica* Borkh.) fruit. The family of endoplasmic reticulum-localized receptors is involved in ethylene perception. ETR1 belongs to subfamily I of ethylene receptors in apple. This work was undertaken primarily to study the allelic polymorphism of the *ETR1* gene in 48 autochthonous genotypes from the *ex situ* apple collection at Zdravljak facility of the Fruit Research Institute, Čačak. Polymorphisms were detected by digestion of PCR product with three restriction enzymes – *Rsa*I, *Alu*I and *Hinf*I. The comparison of polymorphisms observed upon the restriction analysis (*Rsa*I – two segregating fragments of 800 and 890 bp; *Alu*I – one polymorphic fragment of 850 bp; *Hinf*I – two segregating fragments of 800 and 1,130 bp) resulted in the identification of four alleles of *ETR1* gene – *a*, *b*, *c* and *d* in the assessed autochthonous material. Based on obtained *ETR1* allelic constitutions, the autochthonous genotypes were grouped into four classes (*aa* – 27 genotypes; *b,a/c* – 9 genotypes; *c,a/c* – 3 genotypes; *d,a/c/d* – 9 genotypes). So far, allele *d* has been identified only in the following autochthonous genotypes: 'Babovača', 'Bošnjanka', 'Funtača (Opaljenik)', 'Kamenica 1', 'Ovčiji Nos', 'Strekinja', 'Šarenika', 'Tip 3' and 'Tip 6'. Molecular characterization and study of the most important biological traits of autochthonous genotypes can significantly contribute to preservation of the genetic divergence in the apple germplasm. In addition, the genotypes with useful traits can provide the increase in the number of genotypes with a potential to be used as parents in developing new apple cultivars.

Key words: apple, autochthonous genotype, ethylene, receptor, genotyping

Results of the Project TR TR–31064: Development and preservation of genetic potential of temperate zone fruits.

3. OPLEMENJIVANJE ŽIVOTINJA I MIKROORGANIZAMA

UV-1

OPASNI GENI ZA PRODUKCIJU TOKSINA KOD EFEKTIVNIH STIMULATORA BILJNOG RASTA *Bacillus* SPP.

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Biljke i mikroorganizmi (MO) stupaju u kompleksne interakcije, od kojih su neke korisne, a druge štetne. Primena korisnih MO je alternativa pojedinim tradicionalnm agronomskim tehnikama koje mogu da izazovu ozbiljne probleme po zdravlje ljudi. Međutim, neki od MO sa značajnim odlikama stimulatora biljnog rasta - PGP (Plant Growth Promoting) istovremeno mogu biti rizični po ljudsko zdravlje. Pre upotrebe MO kao inokulanta potrebna je njegova kompleksna karakterizacija polifaznim pristupom. Neophodno je dokazati i odsustvo štetnih posledica njegove primene. U ovim istraživanjima izvršena je karakterizacija stimulatora biljnog rasta *Bacillus* spp. klasičnim i molekularnim metodama. Identifikacija je bazirana na morfološkim i biohemijskim karakteristikama, kao i sekvenci 16S rRNA gena. Ispitane su PGP osobine – solubilizacija fosfata i produkcija siderofora, HCN, IAA i litičkih enzima. Molekularna karakterizacija *Bacillus* spp. izvršena je na osnovu rep-PCR i RAPD. Genei za produkciju emetičkog i enterotoksina su detektovani PCR metodom. Izolati su identifikovani kao *B. subtilis*, *B. thuringiensis*, *B. cereus*, *B. pumilus* i *Lysinibacillus fusiformis*. Najefektivniji soj sa većinom ispitanih PGP osobina i najefikasnijom stimulacijom biljnog rasta pripada *B. cereus* i nosi gene za obe vrste toksina: emetički (*cer*) i enterotoksine (*hbla*, *entFM* i *bceT*), zbog čega treba izbeći njegovu primenu kao mikrobnog inokulanta. Nekoliko *B. subtilis*, *B. thuringiensis*, *B. pumilus* i *Bacillus* sp. koji nemaju gene za produkciju toksina u svom genomu bili su efektivni PGP agensi i mogu biti dalje testirani za primenu u poljoprivrednoj proizvodnji.

Ključne reči: *Bacillus* spp., stimulatori biljnog rasta PGPB, molekularna karakterizacija, enterotoksini, emetički toksin

Zahvalnica: Istraživanja su realizovana u okviru projekata III46007 i TR37006 Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije.

TOXIN PRODUCTION GENES IN EFFECTIVE PLANT GROWTH PROMOTING *Bacillus* SPP.

Plants are involved in complex interactions with microorganisms (MO) - some of those are beneficial, others are detrimental. The application of beneficial MO is an alternative to some of the traditional agricultural techniques which can cause serious damage to human health. However, several MO with important PGP (Plant Growth Promoting) properties can cause risk to human health in the same time. The complex characterization of microorganism by polyphasic approach is needed before applying it as microbial inoculant. It is also necessary to confirm the absence of its deleterious effects. In this study, we characterized PGP *Bacillus* spp. using classical and molecular methods. Identification of the isolates was carried out by morphological and biochemical tests as well as sequencing of genes for 16S rRNA. PGP traits – phosphate solubilization and production of siderophores, HCN, IAA and lytic enzymes were observed. Molecular characterization of *Bacillus* spp. was done on the basis rep-PCR and RAPD. Genes for emetic and enterotoxin production was detected by PCR. The isolates were identified as *B. subtilis*, *B. thuringiensis*, *B. cereus*, *B. pumilus* and *Lysinibacillus fusiformis*. The most effective strain - with multiple PGP traits and the best plant growth stimulation effects belong to *B. cereus* and carry genes for both emetic (*cer*) and entero (*hbl*a, *ent*FM and *bce*T) toxins and needs to be avoided as microbial inoculant. Several *B. subtilis*, *B. thuringiensis*, *B. pumilus* and *Bacillus* sp. strains that not harbor toxic genes were effective as PGP agents and can be further tested to be applied in agriculture production.

Key words: *Bacillus* spp., Plant Growth Promoting Bacteria, molecular characterization, enterotoxins, emetic toxin

UV-2

GENETIČKI RESURSI U OVČARSTVU I KOZARSTVU CENTRALNE SRBIJE

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Na teritoriji Centralne Srbije od lokalno prilagođenih rasa ovaca prisutna je pramenka sa diferenciranim sojevima, a od koza balkanska i srpska bela koza. Ove rase se međusobno razlikuju po morfološkim, reproduktivnim i proizvodnim osobinama i na njihovo nastajanje su uticali specifični klimatski, hidrološki i ishrambeni uslovi, zahvaljujući kojima se one odlikuju dobrom adaptabilnošću, otpornošću na bolesti, izraženim materinskim instinktom, relativno dobrom plodnošću i dugim proizvodnim vekom. Produktivnost ovih genotipova je relativno niska zbog čega su u proizvodnji potencirani produktivniji genotipovi. To je dovelo do drastičnog smanjenja broja grla lokalno prilagođenih rasa, a samim tim i do gubitka genetske raznovrsnosti. Posledica ovakvog načina ovčarske i kozarske proizvodnje je da je većina lokalno adaptiranih rasa, po kriterijumu odgovarajućeg Pravilnika, ugrožena u različitom stepenu (od visoko do kritično ugrožene). Na osnovu godišnjeg izveštaja Instituta za stočarstvo za 2017. godinu, brojno stanje kvalitetnih priplodnih grla većine lokalno prilagođenih rasa je u slabom porastu i dinamika porasta nije zadovoljavajuća. Tako, broj aktivnih grla upisanih u glavnu matičnu evidenciju ovaca i koza za 2017. godinu po rasama iznosi 10386 za svrljišku pramenku, lipska pramenka 686, krivovirska pramenka 616, karakačanska pramenka 139, pirotska pramenka 124, bardoka 94 grla, balkanska koza 121 grlo i srpska bela koza 145 grla. Zaštita genetičkih resursa u Republici Srbiji još uvek nije dovoljna, iako ima pomaka u njihovom očuvanju. Ipak, hitne mere zaštite se moraju preduzeti u vidu In-Situ i Ex-Situ konzervacije kako bi se sprečio gubitak genetičkih resursa zauvek.

Ključne reči: pramenka, balkanska koza, brojno stanje, produktivnost, mere konzervacije

Istraživanje je finansirano od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije, projekat TR 31053.

SHEEP AND GOAT GENETIC RESOURCES IN CENTRAL SERBIA

From locally adapted sheep and goat breeds in Central Serbia pramenka (with its ecotypes), and Balkan and Serbian white goat are present. This breeds differ by morphological, reproductive and productive traits and their differentiation was affected by specific climatic, hydrological and nutritional conditions. Thanks to that, these breeds are characterized by the wide adaptability, disease resistance, expressed maternal instinct, relatively high fertility and a long productive lifetime. As in this paper was showed, the productivity of these genotypes is relatively low. Due to the low production, emphasizing of the more productive genotypes was done, which led to a drastic reduction in the number of locally adapted breeds, and therefore to a loss of genetic diversity. The consequence of this method in sheep and goat farming is that most of the locally adapted races are endangered in different degrees (from high to critically endangered), according to the criteria of the valid Rulebook. These breeds belong to a group of genetic resources and as such have been processed in this paper. According to the Institute for animal husbandry's annual report for Central Serbia in 2017, number of heads for most of locally adapted breeds is in slight increase, but still is not satisfactory. Thus, the number of active animals registered in flockbook for sheep and goats by races are 10386 for Svrljig pramenka, 686 Lipa pramenka, Krivovir pramenka 616, Karakachan pramenka 139, Pirot pramenka 124, Bardoka 94 animals, Balkan goat 121 and Serbian white goat 145 animals. The protection and conservation of genetic resources in the Republic of Serbia is still insufficient, although there is a shift in their conservation. However, urgent protection measures must be taken in the form of In-Situ and Ex-Situ conservation to prevent the loss of genetic resources forever.

Key words: pramenka sheep, balkan goat, number, productivity, conservation measures

Research was financed by the Ministry of Education, Science and Technological Development of Republic of Serbia, project TR 31053.

UV-3

OCENA HERITABILNOSTI I PONOVLJIVOSTI ZA VREME U TRCI KOD KASAČA

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Selekcija pastuva i kobila na osnovu rezultata iz trka sprovodi se u mnogim populacijama kasača tokom dužeg vremenskog perioda. Poboljšanja su zabeležena, i ona su rezultat genetskih i promena nastalih usled delovanja faktora spoljne sredine. Njihovo sagledavanje, kao i izbor odgovarajuće metode selekcije, omogućuju nam kvantitativno-genetske analize kroz izračunavanje genetskih parametara. Cilj ovog istraživanja je bio da se ocene koeficijenti heritabilnost i ponovljivost ostvarenog vremena u trci kod kasača. Kao materijal za rad poslužili su podaci o grlima oždrebljenim u periodu od 1998. do 2010. Baza se sastojala od 1.181 grla sa ukupno 13.316 rezultata vremena u trci. Ocena kompenenti varijansi i genetskih parametara je sprovedena pomoću univarijantnog modela životinje za ponovljena merenja upotrebom metode ograničene maksimalne verovatnoće (REML) u softverskom paketu WOMBAT (Meyer, 2006). Prvo su analizirani fenotipski parametri i uticaj različitih fiksnih faktora na ostvareno vreme u trci kod kasača. Rezultati deskriptivne statistike, tumačeni u odnosu na druga istraživanja na ovu temu, ukazuju da se prosečna vrednost posmatrane osobine, koja u ispitivanoj populaciji iznosi 84,13 s/km, nalazi na nižem nivou od mogućeg, te da prostora za unapređenje ima. Fiksni faktori su obuhvatali uticaj pola, mesec×godina rođenja, sezona trke×godina trke×hipodrom, starosti i distanca×način starta, pri čemu je primenom opšteg linearnog modela utvrđen statistički visoko značajan uticaj ($P<0,01$) svakog faktora. Izračunata je visoka vrednost heritabilnosti (0,551) i ponovljivosti (0,673), te niska greška ovih koeficijenta (0,058 i 0,013). Izračunata vrednost heritabilnosti ukazuje na to da bi u ispitivanoj populaciji direktna selekcija na osnovu vremena u trci bila efikasna.

Ključne reči: kasači, vreme u trci, heritabilnost, ponovljivost

ESTIMATION OF HERITABILITY AND REPEATABILITY FOR RACING TIME OF TROTTER HORSES

The selection of stallions and mares based on the results of the race is carried out in many trotter horse populations for a long period of time. The improvements have been recorded, and they are the result of genetic changes and changes caused by the effects of the environmental factors. Their examination, as well as the selection of the appropriate selection method, enable us to perform quantitative genetic analyzes through the calculation of genetic parameters. The aim of this research was to evaluate the coefficients of heritability and repeatability of racing time of trotter horses. As a material for research were used data on animals foaled in the period from 1998 to 2010. The database was consisted of 1,181 animals with a total of 13,316 racing time results. Estimation of variance components and genetic parameters was performed using a univariate animal model for repeated measurements using the restricted maximum likelihood (REML) method in the WOMBAT (Meyer, 2006) software package. Firstly were analyzed the phenotypic parameters and the influence of different fixed factors on the racing time of trotter horses. The results of descriptive statistics analysis, interpreted in relation to other studies on this subject, indicate that the average value of the observed trait, which is 84.13 s/km in the test population, is at a lower level than the real possibilities, and that there is room for improvement. Fixed factors included the impact of gender, month × year of birth, race season × year of race × racetrack, age and distance × start type, whereby a statistically significant impact ($P<0.01$) of each factor was determined using the general linear model. A high heritability (0.551) and repeatability value (0.673) was determined, and also a low error of these coefficients (0.058 and 0.013). The calculated heritability value indicates that in the estimated population, direct selection based on racing time would be effective.

Key words: trotter horses, racing time, heritability, repeatability

U-1

BIODIVERGENTNOST VRSTE *Aspergillus parasiticus* SPEARE – NOV PATOGEN PŠENICE U SRBIJI

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Raznolikost staništa u kojima se javljaju vrste roda *Aspergillus* sekcije Flavi i sposobnost pojedinih vrsta da sintetišu aflatoksine, čini ovu grupu najznačajnijom u okviru ovog roda. Vrste *Aspergillus flavus* i *A. parasiticus* su reprezentativni predstavnici aflatoksigenih vrsta koji se javljaju kako na zrnu mnogih biljnih vrsta, tako i u prehrambenim proizvodima širom sveta. Poslednjih godina, povećane temperature vazduha i dugotrajni sušni periodi u toku vegetacije u Srbiji, pogodovale su promenama u okviru pojave i razvoja fitopatogenih gljiva na zrnu mnogih žitarica i industrijskih biljaka. Preciznom i pouzdanom identifikacijom izolata do nivoa vrste, dobijenih iz uzoraka zrna kukuruza, primenom morfoloških i molekularnih metoda, identifikovana je vrsta *A. parasiticus* po prvi put u našim proizvodnim uslovima 2015. godine. Ovi nalazi su ukazali na mogućnost njenog prisustva i na zrnu drugih žitarica. Zbog direktnih gubitaka koji su posledica zaraze zrna pšenice, kao i moguće kontaminacije aflatoksinima, pojavila se potreba utvrđivanja prisustva i toksigenog potencijala izolata *A. parasiticus* poreklom iz Srbije. U tom cilju, prikupljeno je 50 uzoraka zrna pšenice sa 20 lokacija. Na osnovu polifaznog pristupa, analizom morfoloških, odgajivačkih i toksigenih svojstava, kao i molekularnom detekcijom i identifikacijom, primenom RFLP-PCR metode, dobijeni izolati identifikovani su kao *A. parasiticus*, po prvi put u klimatskim uslovima Srbije. Ovaj patogen predstavlja potencijalnu opasnost za proizvodnju pšenice u Srbiji. Nastavak nezaustavljivih globalnih klimatskih promena može omogućiti intenzivniji razvoj ovih patogena, čime bi ova opasnost bila još izvesnija.

Ključne reči: pšenica, *A. flavus*, *A. Parasiticus*

Rezultat projekta MPNTR TR 31023: „Redukcija toksigenih gljiva roda Fusarium i njihovih mikotoksina u proizvodnji zdravstveno bezbedne hrane na bazi žita"

BIODIVERSITY OF THE SPECIES *Aspergillus parasiticus* SPEARE – A NEW WHEAT PATHOGEN IN SERBIA

The diversity of habitats in which the species of the genus *Aspergillus* of the section Flavi occur and ability of certain species to synthesise aflatoxins, make this group the most significant within this genus. The species *Aspergillus flavus* and *A. parasiticus* are typical representatives of aflatoxigenic species that appear not only on grain of many plant species but also in food products all over the world. In recent years, increased air temperatures and long-lasting dry periods during the growing season in Serbia, have favoured changes in the incidence and the development of phytopathogenic fungi on grain of many cereals and industrial plants. In 2015, by the precise and reliable identification of the isolates to the level of species, obtained from the maize kernel samples, using morphological and molecular methods, the species *A. parasiticus* was identified for the first time under production conditions of Sebria. These findings also point out to the possibility of *A. parasiticus* presence on grain of other cereals. Direct losses as a result of wheat grain infestation, as well as possible aflatoxin contamination, have caused the need to establish the presence of toxigenic potential of the *A. parasiticus* isolates from Serbia. For that purpose, 50 wheat grain samples were collected from 20 locations. Based on the polyphasic approach, isolates of *A. parasiticus* were for the first time obtained under climate conditions of Serbia by the analysis of morphological, breeding and toxigenic properties, as well as by the molecular detection and identification, using the RFLP-PCR method. This pathogen is a potential risk for wheat production in Serbia. The continuation of unstoppable climate changes may provide a more intensive development of these pathogens, making this danger even more certain.

Key words: wheat, *A. flavus*, *A. parasiticus*

Results of the Project TR 31023: Reduction of toxigenic Fusarium species and their mycotoxins in production of safe cereal-based foods.

U-2

IDENTIFIKACIJA I KARAKTERIZACIJA *Xanthomonas campestris* PV*. campestris* IZOLOVANIH IZ ZEMLJIŠTA

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Xanthomonas campestris pv*. campestris* (Xcc) predstavlja značajnog patogena familije Brassicaceae u našim agroekološkim uslovima. Bakterija se održava u zemljištu, biljnim ostacima, na semenu, korovima, a značajnu ulogu u širenju imaju mehaničke povrede, vetar, insekti, kišne kapi i navodnjavanje. Cilj ovih istraživanja je bio karakterizacija i provera patogenisti izolata Xcc koji perzistiraju u zemljištu i predstavljaju rizik za pojavu bolesti kupusnjača. Uzorkovanje zemljišta je vršeno u periodu 2015-2017. godine na četiri lokaliteta u uslovima gajenja kupusa u monokulturi i plodoredu. Izolacija je rađena na SX agaru i YDC podlozi uz dodatak cikloheksamida. Proverom patogenosti i morfološko – biohemijskih karakteristika selektovano je 14 Xcc izolata. Identifikacija je izvršena primenom m-PCR i setova prajmera DLH 120/125 i Zup 2309/2310. Kod svih izolata i referentnog soja NCPPB 1144 amplifikovani su fragmenti veličine 370 i 619 bp, što potvrđuje pripadnost vrsti *X. c.* pv. *campestris*. Karakterizacija izolata rep-PCR metodom korišćenjem BOX A1R i $(GTG)_5$ prajmera grupisala je izolate u 2 posebna klastera, dok je RAPD metoda sa SPH1, OPA8, DJ15 i DJ16 prajmerima svrstala izolate u 4 grupe. Definisani RAPD i rep-PCR profili omogućavaju dalje poređenje zemljšnih izolata Xcc sa patogenim izolatima semena i biljnih delova kupusnjača.

Ključne reči: *Xanthomonas campestris* pv. *campestris,* zemljište, identifikacija, karakterizacija

Zahvalnica*: Ovaj rad je podržan od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije (Projekat TR31030 i III46007).*

IDENTIFICATION AND CHARACTERIZATION OF *Xanthomonas campestris* PV*. campestris* ISOLATED FROM SOIL

Xanthomonas campestris pv. *campestris* (Xcc) is a significant pathogen of the Brassicaceae family in our agroecological conditions. Bacteria survivs in a soil, plant residues, seeds, weeds, and mechanical damage, wind, insects, rain drops and irrigation methods play an important role in the spread. The aim of this study was the characterization and pathogenicity estimation of Xcc isolates that persist in soil and represent a risk to disease appearance in Brassicaceae. Collection of soil samples was carried out in the period 2015-2017 on four locations in the conditions of cultivation of cabbage in monoculture and crop rotations. The isolation was carried out on SX agar and YDC medium with the addition of cyclohexamide. Based on the pathogenicity test, morphological and biochemical characteristics, 14 Xcc isolates were selected. Identification was done using m-PCR and primer sets DLH 120/125 and Zup 2309/2310. In all isolates and reference strain NCPPB 1144 nucleic acid fragments of 370 and 619 bp were amplified, which confirms belonging to *X. c.* pv. *campestris.* Characterization of isolates by rep-PCR using BOX A1R and $(GTG)_5$ primers grouped isolates in 2 clusters, while RAPD method by SPH1, OPA8, DJ15 and DJ16 primers clustered isolates into 4 clusters. Defined RAPD and rep-PCR patterns enable comparison of soil isolates Xcc with those pathogenic isolated from seeds or leaves of Brassicaceae.

Key words: *Xanthomonas campestris* pv. *campestris,* soil, identification, characterization

U-3

PROCENA PRIPLODNE VREDNOSTI I RANG BIKOVA HOLŠTAJN-FRIZIJSKE RASE ZA OSOBINE MLEČNOSTI

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U analizu je uključeno 433 prvotelki, kćeri 10 bikova, prvi put oteljenih u periodu od 2007. do 2014. godine, na šest farmi krava Poljoprivredne korporacije Beograd AD. Kao fiksni faktori u modelu uključeni su uticaji farme, genetskih grupa i sezona teljenja, i kao slučajan faktor uticaj bika-oca. Praćene osobine mlečnosti na osnovu kojih su izračunate priplodne vrednosti su prinos mleka (kg), prinos mleka korigovan na 4% mlečne masti (kg), sadržaj mlečne masti (%), prinos mlečne masti (kg), sadržaj proteina (%) i prinos proteina (kg). Bikovi su rangirani na osnovu pomenutih osobina, a primenom Spirmanovog koeficijenta korelacije utvrđen je stepen slaganja između rangova. Prema izračunatim priplodnim vrednostima metodom *Best Linear Unbiased Prediction - BLUP* utvrđeno je da je bik-otac broj 1676 najbolje rangiran za osobine prinosa mleka (+363,88 kg), mlečne masti (+13,57 kg) i proteina (+15,55 kg) u odnosu na prosek kćeri. Uticaj sezone teljenja pokazao je visoku značajnost ($p<0,01$) za sledeće osobine: prinos mleka, prinos mleka korigovan na 4% mlečne masti i prinos mlečne masti i proteina dok za ostale osobine nije utvrđen statistički značajan uticaj ($p>0,05$). Spirmanovim koeficijentom korelacije utvrđen je statistički vrlo značajan ($p<0,01$) stepen slaganja od 0.84 između sadržaja mlečne masti (%) i sadržaja proteina (%), kao i između prinosa mlečne masti (kg) i prinosa proteina (kg) od 0.96 ($p<0,01$).

Ključne reči: priplodna vrednost, mlečnost, rang bikova, holštajn-frizijska rasa, prvotelke.

Istraživanje je finansirano od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije, projekat TR 31053.

ESTIMATION OF THE BREEDING VALUE AND RANKING OF HOLSTEIN-FRIESIAN BULLS FOR MILK PRODUCTION TRAITS

The analysis included 433 daughters of 10 bulls, calving for the first time in the period from 2007 to 2014, on 6 dairy farms of the Agricultural Corporation Belgrade AD. Fixed factors included in the model were the effects of the farm, genetic groups and calving season, and as a random factor the impact of the bull sire. The observed milk traits on the basis of which the breeding values were calculated were the milk yield (kg), the 4% fat-corrected milk yield (kg), the fat content (%), the fat yield (kg), the protein content (%) and the protein yield (kg). According to the breeding values calculated by using the Best Linear Unbiased Prediction (BLUP) method, the sire 1676 was best ranked for the traits: milk yield (+363,88 kg), fat yield (+13,57 kg) and protein yield (+15,55 kg), relative to the average of daughters. The effect of the calving season showed a high significance ($p<0.01$) for the following traits: milk yield, 4% fat-corrected milk yield, fat yield and protein yield while there was no significant effect for other traits ($p>0.05$). A statistically very significant degree of agreement between the fat content and the protein content of 0.84 ($p <0.01$) and between the fat yield and the protein yield of 0.96 ($p<0,01$) was determined by the Spearman coefficient of correlation.

Key words: breeding value, milk production traits, bull rank, Holstein-Friesian breed, primiparous heifers

Research was financed by the Ministry of Education, Science and Technological Development of Republic of Serbia, project TR 31053.

U-4

PROCENA PRIPLODNE VREDNOSTI I RANG BIKOVA HOLŠTAJN-FRIZIJSKE RASE ZA OSOBINE PLODNOSTI

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U analizu je uključeno 433 prvotelki, kćeri 10 bikova, prvi put oteljenih u periodu od 2007. do 2014. godine, na šest farmi krava Poljoprivredne korporacije Beograd AD. Kao fiksni faktori u modelu uključeni su uticaji farme, godina teljenja i sezona teljenja, i kao slučajan faktor uticaj bika - oca. Praćene osobine plodnosti na osnovu kojih su izračunate priplodne vrednosti su broj dana bremenitosti, uzrast pri prvom osemenjavanju, dužina servis perioda i međutelidbeni interval. Bikovi su rangirani na osnovu pomenutih osobina, a primenom Spirmanovog koeficijenta korelacije utvrđen je stepen slaganja između rangova. Prema izračunatim priplodnim vrednostima metodom *Best Linear Unbiased Prediction – BLUP*, utvrđeno je da je bik - otac 1517 najbolje rangiran za osobine trajanje servis perioda (-34,94 dana) i trajanje međutelidbenog intervala (-36,14 dana) u odnosu na prosek kćeri. Uticaj farme i godine teljenja nije bio statistički značajan ($p>0,05$) samo za osobinu trajanje bremenitosti. Uticaj sezone teljenja je pokazao vrlo visoku značajnost ($p<0,001$) za osobine: uzrast pri prvom osemenjavanju, dužina servis perioda i međutelidbeni interval, kao i značajnost ($p<0,05$) za osobinu trajanje bremenitosti. Spirmanovim koeficijentom korelacije utvrđen je statistički vrlo značajan stepen slaganja između trajanja servis perioda i međutelidbenog interval od 0,99 ($p<0,01$), dok između drugih osobina nije bilo statistički značajnih razlika ($p>0,05$).

Ključne reči: priplodna vrednost, rang bikova, osobine plodnosti, prvotelke, holštajn-frizijska rasa

Istraživanje je finansirano od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije, projekat TR 31053.

ESTIMATION OF THE BREEDING VALUE AND RANKING OF HOLSTEIN-FRIESIAN BULLS FOR FERTILITY TRAITS

The analysis included 433 daughters of 10 bulls, calving for the first time in the period from 2007 to 2014, on six dairy farms of the Agricultural Corporation Belgrade AD. Fixed factors included in the model were the effects of the farm, year of calving and calving season, and as a random factor the impact of the bull sire. The observed fertility traits on the basis of which the breeding values were calculated were the number of days of gestation, the age at the first insemination, the service period duration and the calving interval. Bulls were ranked on the basis of these properties, and using the Spearman correlation coefficient, the degree of agreement between the ranks was determined. According to the breeding values calculated by using the Best Linear Unbiased Prediction (BLUP) method, the sire 1517 was best ranked for the trait duration of service period (-34,94 days) and the calving interval (-36,14 days), relative to the average of daughters. The effects of the farm and year of calving showed no significance ($p>0.05$) only on the duration of the gestation. The effect of the calving season showed a very high significance ($p<0.001$) for the following traits: age at first insemination, duration of service period and calving interval, as well as significance ($p<0.05$) for the property duration of the gestation. A statistically very significant degree of agreement between the service period and the calving interval of 0.99 ($p <0.01$) was determined by the Spearman coefficient of correlation, while there was no significant difference between the other traits ($p>0.05$).

Key words: breeding value, bull rank, fertility traits, primiparous heifers, Holstein-Friesian breed

Research was financed by the Ministry of Education, Science and Technological Development of Republic of Serbia, project TR 31053.

U-5

PLODNOST KRMAČA RAZLIČITIH GENOTIPOVA NA INDIVIDUALNIM GAZDINSTVIMA U REGIONIMA POGODNIM ZA INTENZIVNU PROIZVODNJU SVINJA

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Na teritoriji Mačvanskog i Braničevskog regiona praćene su reproduktivne osobine za 1902 legla kod šest genotipova svinja: Švedski Landras-ŠL, Veliki Jorkšir-VJ i meleze- ŠLxVJ, VJxŠL, Nemački Landras-NL x VJ i Vj x NL). Praćeni su sledeći parametri: broj živorođene prasadi u leglu, broj mrtvorođene prasadi u leglu, broj odgajene prasadi po leglu, dužina trajanja laktacije (dani) i masa legla na zalučenju (kg). Sve krmače su se nalazile na srednjim i velikim gazdinstvima (od 20 do 120 krmača). Najveći broj živorođene prasadi su imale krmače genotipa VJ (12,39), kao i najveći broj odgajene prasadi po leglu (11,32), dok je najveći broj mrtvorođene prasadi utvrđen kod krmača genotipa ŠL x VJ i NL x VJ (0,50). Dužina laktacije je bila najveća kod genotipa VJ x ŠL (34 dana), dok su najveći masu legla imale krmače genotipa VJ od 93,42kg. Posmatrajući region kao faktor utvrđeno je da su svi ispitivani parametri statistički značajno ($P<0.01$) varirali, izuzev mase legla na zalučenju. Braničevski region je imao bolje rezultate za parametre: broj živorođene prasadi, broj mrtvorođene prasadi, dok je Mačvanski region imao veći broj odgajene prasadi, kraće trajanja laktacije sa većom masom legla na zalučenju. Testiranjem značajnosti utvrđeno je da je genotip značajno statistički ($P<0.01$) uticao na sve ispitivane parametre osim na broj živorođene prasadi.

Ključne reči: reproduktivne osobine, krmače, region, genotip, prasad

Istraživanje je finansirano od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije, projekat TR 31081.

FERTILITY OF SOWS OF DIFFERENT GENOTYPES ON INDIVIDUAL FARMS IN REGIONS SUITABLE FOR INTENSIVE PIG PRODUCTION

On the territory of the Mačva and Braničevo region, reproductive properties for 1902 litters were monitored in 6 pig genotypes: Swedish Landrace (SL), Large White (LW) and crosses - SL x LW, LW x SL, German Landrace (GL) x LW and LW x GL. The following parameters were observed: number of live-born piglets in the litter, number of stillborn piglets in the litter, number of piglets reared per litter, duration of lactation (days), and litter mass at weaning (kg). All sows were reared on medium size and large farms (from 20 to 120 sows). The highest number of live-born piglets was determined for LW genotype (12.39), as well as the highest number of piglets reared per litter (11.32), while the highest number of stillborn piglets was found in sows SL x LW and GL x LW (0.50). The lactation duration was the highest in genotype LW x SL (34 days), while the greatest mass of the litter was determined in sows of the LW genotype - 93.42kg. Observing the region as a factor, it was found that all investigated parameters vary statistically significant ($P<0.01$), except for the mass of the litter at weaning. The Braničevo region had better results for the following parameters: the number of live-born piglets, the number of stillborn piglets, while the Mačva region showed higher number of reared piglets, a shorter lactation duration with a higher mass of litter at weaning. By testing of the significance it has been established that the breed highly statistically significantly ($P<0.01$) affects all the parameters tested except for the number of live-born piglets.

Key words: reproductive characteristics, sows, region, genotype, piglets

Research was financed by the Ministry of Education, Science and Technological Development of Republic of Serbia, project TR 31081

FP-1

IDENTIFIKACIJA I DETEKCIJA VRSTA PATOGENIH GLJIVA MOLEKULARNIM METODAMA

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Patogene gljive kao izazivači bolesti ekonomski važnih useva uzrokuju značajno smanjenje prinosa. Pored toga što uzrokuju bolesti biljaka, veliki broj vrsta produkuje mikotoksine koji predstavljaju ozbiljnu opasnost za zdravlje ljudi i životinja. Precizna identifikacija vrsta patogenih gljiva je od velikog značaja za prevenciju, kontrolu i uklanjanje rizika koje uzrokuju ovi organizmi. Tradicionalano, utvrđivanje vrsta gljiva je zasnovano na morfološkom i biološkom konceptu. Razvoj molekularne genetike omogućio je pojavu metoda za pouzdanije proučavanje filogenije i sistematike gljiva kao i za njihovu detekciju. Metode zasnovane na PCR tehnici su u širokoj upotrebi. Među najznačajnije se ubrajaju *fingerprinting*, DNA-array, sekvenciranje i *real-time* PCR. Prednosti ovih metoda su visoka senzitivnost, specifičnost i pouzdanost. Pored toga, relativno lako se izvode, a za produkovanje rezultata potrebno je kratko vreme. Iako ove metode dobijaju sve veći značaj, u svrhu identifikacije vrsta uvek, kada je to moguće, treba koristiti i morfološke i molekularne podatke. U ovom radu prikazano je nekoliko najznačajnijih metoda i pristupa za molekularnu identifikaciju i detekciju patogenih gljiva useva.

Ključne reči: patogene gljive, identifikacija, molekularne metode

Rezultat projekta MPNTR TR 31023: Redukcija toksigenih gljiva roda Fusarium i njihovih mikotoksina u proizvodnji zdravstveno bezbedne hrane na bazi žita

IDENTIFICATION AND DETECTION OF PATHOGENIC FUNGI SPECIES BY MOLECULAR METHODS

Plant pathogenic fungi cause detrimental diseases in economically important crops thus provoking considerable yield loses. Apart from causing plant diseases, a large number of species produce mycotoxins which are a serious threat to human and animal health. Detailed and accurate pathogen fungi species identification is of crucial importance for prevention, control and elimination of risks caused by these organisms. Traditionally, determination of fungal species is based on morphological and biological concept. Molecular genetics development enabled emergence of methods for more reliable examination of phylogeny and systematics as well as detection of fungi. PCR based methods are widely used. Most significant are *fingerprinting*, DNA-*array*, sequencing and *real-time* PCR. These methods are highly sensitive, specific and accurate. Besides that, they are not laborious and time consuming. Although these methods are gaining in importance, both morphology and molecular data should be used for fungal identification whenever possible. In this paper, we review several most important tools for molecular identification and detection of plant pathogenic fungi.

Key words: pathogenic fungi, identification, molecular methods

Results of the Project TR 31023: Reduction in Toxigenic Fungi of the Genus Fusarium and Their Mycotoxins in Production of Cereal-based Organic Food.

P-1

BIOHEMIJSKA I GENETIČKA KARAKTERIZACIJA HALOTOLERANTNIH IZOLATA RODA *Bacillus* - POTENCIJALNIH PGP AGENASA

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Zaslanjenost zemljišta jedan je od najvećih problema u savremenoj poljoprivredi. U cilju prevazilaženja ovog problema, pribegava se korišćenju bioloških agenasa koji omogućavaju normalan rast biljaka, čak i u uslovima ekstremne zaslanjenosti. Tokom 2017. godine izvršena je izolacija bakerija iz zaslanjenih staništa sa tri lokacije u Vojvodini (Kovilj, Bašaid, Vajska), kao i sa 10 lokacija zapadne Srbije. Stepen tolerancije na salinitet izolata testiran je na hranljivom agaru sa dodatkom 2, 3 i 5% NaCl. Na osnovu morfologije ćelija selektovani su izolati roda *Bacillus*. U okviru biohemijske karakterizacije izolata testirana je i sposobnost produkcije enzima značajnih za stimulaciju rasta biljaka. Sposobnost produkcije proteaza ispitivana je na Skim-milk agaru, dok je produkcija amilaza ispitana na čvrstoj podlozi sa dodatkom skroba. Takođe, testirana je i sposobnost produkcije siderofora na CAS agaru i produkcija indol-sirćetne kiseline (IAA) korišćenjem tečne KB podloge sa dodatkom triptofana. Sposososobnost solubilizacije fosfata testirana je na Pikovskaya medijumu. Lipolitička aktivnost izolata testirana je na čvrstoj podlozi sa dodatkom Tween 80. Na osnovu rezultata biohemijske karakterizacije odabrani su izolati koji poseduju PGP svojstva za dalju genetičku analizu. Za utvđivanje međusobne sličnosti između odabranih izolata korišćena je BOX PCR metoda. Rezultati BOX PCR metode ukazali su na postojanje razlika između testiranih izolata. Na osnovu rezultata ovog istraživanja neki od odabranih *Bacillus* izolata se mogu dalje testirati kako bi se omogućilo njihovo korišćenje za poboljšanje rasta biljaka na zaslanjenim zemljištima.

Ključne reči: halotolerantni izolati, zaslanjena zemljišta, *Bacillus,* PGPR, BOX PCR

Rad je rezultat projekata MPNTR: TR 37006 - Proučavanje uticaja kvaliteta zemljišta i voda za navodnjavanje za efikasniju proizvodnju poljoprivrednih kultura i očuvanje životne sredine i III 46007– Novi autohtoni izolati bakterija Lysobacter i Pseudomonas kao važan izvor metabolita korisnih za biotehnologiju, stimulaciju rasta biljaka i kontrolu bolesti bilja: od izolata do preparata.

BIOCHEMICAL AND GENETIC CHARACTERIZATION OF HALOTOLERANT *Bacillus* ISOLATES AS POTENTIAL PGPR AGENTS

Soil salinization is one of the biggest problems in the modern agriculture. Biological agents which can promote plant growth in saline environment are used in order to overcome this problem. During the year of 2017, bacterial isolates were gathered from 3 saline soils in Vojvodina (Kovilj, Bašaid, Vajska), and from 10 locations in Western Serbia. Salinity tolerance was tested on nutrient agar media enriched with 2, 3 and 5% NaCl. Isolates were selected for further research based on the cell morphology and its similarity to *Bacillus* genus. Biochemical characterization of isolates was performed, and the ability to produce significant PGP enzymes was tested: protease on Skim-milk agar and amylase on the starch media. Furthermore, production of siderophores was tested on CAS agar, while the production of indol-acetic acid (IAA) was tested in liquid KB- tryptophan media. The ability of phosphate solubilization was tested on Pikovskaya media and lipolytic ability on Tween 80 media. Based on the results of biochemical tests, isolates with PGP characteristics were selected for genetic analysis. In order to determine genetic relationship between tested isolates, BOX PCR method was used. The results showed genetic diversity between tested isolates. The results of this research indicated that some of the isolates from *Bacillus* genus could be further tested in order to be used as PGP agents in saline soils.

Key words: halotolerant strains, saline soils, *Bacillus,* PGPR, BOX PCR

Results of the Projects: TR 37006 - Study of the impact of soil and water quality on irrigation for more efficient production of agricultural crops and environmental protection and III 46007 - New autochthonous isolates of bacteria Lysobacter and Pseudomonas as an important source of metabolites useful for biotechnology, plant growth stimulation and plant disease control: from isolates to preparations.

P-2

REAKCIJE RAZLIČITIH GENOTIPOVA TREŠNJE I VIŠNJE PREMA *Blumeriella jaapii* (Rehm.) v. Arx.

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Pegavost (ospičavost) lista prouzrokovana gljivom *Blumeriella jaapii* (Rehm.) v. Arx. je jedna od najvažnijih, ekonomski značajnih bolesti trešnje i višnje, kako u svetu, tako i u Republici Srbiji. Simptomi bolesti se manifestuju u vidu crvenkastih do purpurnih sitnih pega na listovima, koji žute i prevremeno opadaju. Zaražena stabla postaju osetljivija na izmrzavanje, imaju redukovan porast mladara i povećanu smrtnost rodnih pupoljaka. Uzimajući u obzir značaj bolesti, ispitivanja su bila usmerena na utvrđivanje osetljivosti genotipova trešnje i višnje u cilju pronalaženja potencijalnih izvora otpornosti prema patogenu. Proučavanjem je obuhvaćeno ukupno 17 genotipova – osam trešnje i devet višnje, koji su kalemljeni na magrivu u okviru kolekcije Departmana za voćarstvo, vinogradarstvo i pejzažnu arhitekturu, Rimski Šančevi. Ispitivanja su obavljena tokom 2016. godine u prirodnim uslovima zaražavanja, na uzorku od 100 listova po genotipu. Ocena listova sa simptomima bolesti je sprovedena poentiranjem na skali 0–5. Intenzitet bolesti – DS (%) je izračunat prema formuli Townsend i Heuberger-a, a podaci su analizirani korišćenjem programa STATISTICA 13.3. (ANOVA, Duncan test p <0,05). Utvrđena su tri nivoa osetljivosti prema *B. jaapii.* Visoku osetljivost (78–100%) su ispoljili genotipovi Ševar, Rita, Patuljasta trešnja 3/17, V1 i Erdi Botermo. U grupu osetljivih (40–68%) genotipova, svrstani su Patuljasta višnja Kać KK 1/25, Patuljasta višnja Kać 6/19, Majurka, Valeri Čkalov, Burlat, Regina, Summit, Cordia, D7 i Cigančica. Genotipovi Višnja kanal 6/28-32 i Otporna višnja su ispoljili najveći stepen otpornosti (slabu osetljivost), sa intenzitetom bolesti 16% i 20%, respektivno.

Ključne reči: trešnja, višnja, pegavost lista, osetljivost.

***Zahvalnica**: Ovaj rad je podržan od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije (Projekat TR31038).*

REACTION OF DIFFERENT SWEET AND SOUR CHERRY GENOTYPES AGAINST *Blumeriella jaapii* (Rehm.) v. Arx.

Cherry leaf spot caused by *Blumeriella jaapii* (Rehm.) v. Arx.) is one of the most important, economically significant fungal disease of cherry leaves in the world and in the Republic of Serbia. Symptoms of disease are manifested in the form of red to purple, circular spots on leaves. Leaves turn yellow and drop prematurely. Defoliated trees become more sensitive to freezing, have reduced shoot growth and increased death of spurs. Considering disease importance, the study focussed on the assessment of cherries susceptibility in order to find potential sources of resistance against pathogen. The study included 17 genotypes – eight sweet and nine sour cherries, grafted on mahaleb within collection of the Department of Fruit Science, Viticulture and Landscape Architecture, Rimski Šančevi. The assessment was made on 100 leaves per genotype, under spontaneous cherry leaf infection during 2016. Disease leaves were ranged using scale 0–5. The diseases severity – DS (%) was evaluated according to Townsend and Heuberger's formula and the data were analysed in STATISTICA 13.3. (ANOVA, Duncan test $p<0.05$). Three different levels of susceptibility agains *B. jaapii* were found. Highly susceptible (78–100%) genotypes were Ševar, Rita, Patuljasta Trešnja 3/17, V1 and Erdi Botermo. Susceptible (40–68%) genotypes were Patuljasta Višnja Kać KK 1/25, Patuljasta Višnja Kać 6/19, Majurka, Valery Chkalov, Burlat, Regina, Summit, Cordia, D7 and Cigančica. Genotypes Višnja Kanal 6/28-32 and Otporna Višnja were marked as low susceptible, with diseases severity 16% and 20%, respectively.

Key words: cherries, leaf spot, susceptibility

The results of the Project TR 31038: Selection of sweet and sour cherry dwarfing rootstocks and development of intensive cultivation technology based on the sustainable agriculture principles.

P-3

IDENTIFIKACIJA BAKTERIJA STIMULATORA BILJNOG RASTA IZ RODOVA *Bradyrhizobium* I *Bacillus*

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Uprkos variranju osobina stumilsanja rasta biljaka (PGP) kod različitih vrsta, većina bakterijskih sojeva koji ispoljavaju višestruka PGP svojstva može biti korisna u formulaciji novih inokulanata. Istraživanje efektivnih sojeva, pre PGP karakterizacije, zahteva izolaciju i identifikaciju odgovarujućih vrsta bakterija koje stimulišu biljni rast (PGPB). Cilj ovih istraživanja bio je izolacija i molekularna identifikacija PGPB. Bakterije iz roda *Bradyrhizobium* izolovane su iz korenskih kvržica različitih sorti soje. Bakterije koje pripadaju rodu *Bacillus* izolovane su iz rizosfernog, poljoprivrednog i nepoljoprivrednog zemljišta. Svi uzorci za izolaciju PGPB prikupljeni su s različitih lokaliteta u Vojvodini. Karakterizacija izolata izvršena je na osnovu morfoloških i biohemijskih svojstava. Izolati koji su pokazali sličnost sa vrstama *Bradyrhizobium* sp. and *Bacillus* sp. bili su predmet molekularne karakterizacije. Nakon ekstrakcije DNK, parcijalna 16S rDNA genska sekvenca iz izolata je umnožena PCR metodom upotrebom univerzalnih prajmera fD1 i rP3. Prečišćavanje i sekvencioniranje umnoženih fragmenata urađeno je u Macrogen, Južna Koreja. Sekvence su analizirane pomoću programa FinchTV i izvršeno je višestruko poređenje dobijenih sekvenci sa postojećim sekvencama u NCBI GenBank bazi podataka. Svi izolati *Bradyrhizobium* identifikovani su kao *B. japonicum*. U okviru *Bacillus* izolata, identifikovano je devet različitih vrsta (*B. megaterium*, *B. cereus*, *B. pumilus*, *B. subtilis, B. thuringiensis*, *B. safensis*, *B. mycoides, Lysinibacillus fusiformis*, and *L. sphaericus*). Nastavak karakterizacije ovih izolata preko PGP skrininga neophodan je za odabir potencijanlo efektivnih sojeva za inokulaciju u kontrolisanim i poljskim uslovima.

Ključne reči: *Bacillus, Bradyrhizobium,* PCR identifikacija, PGPB

Rezultat projekta: "Interdisciplinarni pristup stvaranju novih sorti soje i unapređenja gajenja i dorade semena", projekat Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije (TR-31022) i "Održiva proizvodnja biljnih proteina: soja, mikroorganizmi, odgovor na klimatske promene", projekat pokrajinskog sekretarijata za visoko obrazovanje i naučnoistraživačku delatnost (114-451-2739/2016)

IDENTIFICATION OF PLANT GROWTH-PROMOTING BACTERIA FROM GENUS *Bradyrhizobium* AND *Bacillus*

Despite the variability within the plant growth promoting properties (PGP) in different species, most of bacterial strains that exhibit multiple PGP traits might be useful in formulating new inoculants. Search for effective strains, prior to PGP characterization, require isolation and identification of desirable species of plant growth-promoting bacteria (PGPB). The aim of this study was to isolate and identify PGPB on the basis of molecular characteristics. Bacteria of *Bradyrhizobium* genus were obtained from root nodules of different soybean cultivars. Bacteria belonging to genus *Bacillus* were isolated from different soil samples which included the rhizosphere of plants, agricultural and non-agricultural soils. All samples for PGPB isolation were collected from various parts of the Vojvodina Province. Characterization of isolates was performed according to morphological and biochemical properties. Isolates showing resemblance with *Bradyrhizobium* sp. and *Bacillus* sp. were subjected to molecular characterization. Following DNA extraction, a partial 16S rDNA gene sequence from the isolates was amplified by PCR using universal primers fD1 and rP3. Purification and sequencing of the amplified fragments were done in the Macrogen, South Korea. Sequences were analyzed using the program FinchTV and compared to sequences in NCBI GenBank for identification. All isolates of *Bradyrhizobium* were identified as *B. japonicum*. Within *Bacillus* isolates, nine different species (*B. megaterium*, *B. cereus*, *B. pumilus*, *B. subtilis, B. thuringiensis*, *B. safensis*, *B. mycoides, Lysinibacillus fusiformis*, and *L. sphaericus*) were identified. Further characterization of these isolates through PGP screening will be necessary to select potentially effective strains for inoculation assays in greenhouse and field.

Key words: *Bacillus, Bradyrhizobium,* PCR identification, PGPB

Project: "Interdisciplinary approach to developing new varieties and improving growing technology and seed processing of soybean", project funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia (TR-31022) and "Sustainable production of plant proteins: soybean, microorganisms, climate changes response", project funded by the Provincial Secretariat for Science and Technological Development, Vojvodina (114-451-2739/2016)

P-4

REZULTATI PRIMENE INDUSTRIJSKOG UKRŠTANJA U UNAPREĐENJU KVALITETA JUNEĆIH TRUPOVA

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Dosadašnja istraživanja kvaliteta trupova i mesa poreklom od domaće simentalske rase (DSR) pokazala su potrebu za njegovim unapređenjem, posebno u pogledu konformacije i prekrivenosti trupova lojem. U tom smislu, industrijskim ukrštanjem sa francuskim tovnim rasama (FTR) pomenute osobine mogle bi se, putem komplementarnosti i heterozis efekta, unaprediti na brz i efikasan način. Istraživanje je sprovedeno na ukupno 96 junadi, jednako raspoređenih u tri genotipske grupe: G1- (DS); G2- F_1 melezi DSR x Limuzin i G3- F_1 melezi DSR × Šarole. Grla su držana slobodno, hranjena koncentrovanim hranivima, senom i kukuruznom silažom po volji do odgovarajućeg stepena utovljenosti i približne mase od 600 kg, sve do klanja u eksperimentalnoj klanici. Ocenu kvaliteta trupa obavio je stručni tim prema posebno utvrđenom obrascu (1-5) kako na celom trupu, tako i parcijalno, za određene delove trupa. Dobijeni rezultati pokazali su statistički značajne razlike ($p<0,01$) između meleza i DSR u pogledu konformacije.Melezi Šarolea postigli su najbolju ocenu konformacije trupova (3,94), konformacije buta (3,77) i plećki (4,06). Značajno više masnog tkiva na spoljašnjem delu trupa utvrđeno je kod domaće simentalske rase (3,44) u poređenju sa melezima Šarolea (3,27). Prisustvo masti u karličnoj šupljini bilo je izraženije kod Šarole (3,34) i Limuzin meleza (3,28), sa boljom ocenom prekrivenosti bubrega (3,50 and 3,53) u odnosu na DSR (3,17). Može se zaključiti da je ukrštanje DSR sa FTR rezultovalo boljom konformacijom najkvalitetnijih delova trupa kao i boljom distribucijom masti u unutrašnjosti trupa kod potomaka F1 generacije.

Ključne reči: domaća simentalska rasa, limuzin, šarole, konformacija, prekrivenost lojem.

Istraživanje je finansirano od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije, projekat TR 31053.

RESULTS OF INDUSTRIAL CROSSBREEDING IMPLEMENTATION IN BEEF CARCASS QUALITY IMPROVEMENT

Previous studies of the beef carcass quality originating from Domestic Simmental breed (DSB) have shown the need for its improvement, particularly in terms of conformation and fat covering. Regarding that, industrial crossing with French fattening breeds (FFB) could be the fast and efficient way to improve said properties in the progeny, based on complementarity and heterosis effect. The research was conducted on total of 96 fattening cattle equally distributed into three genotype groups: G1- (DSR); G2- F_1 crosses of DSR x Limousine and G3- F_1 crosses of DSR × Charolais. They were housed in free system, fed concentrated feed, hay and maize silage *ad libitum* to the certain degree of fattening and approximate body mass of 600 kg until slaughtering at experimental abattoir. Evaluation of carcass quality was carried out by professional board on the whole carcass and partially for certain parts of carcass according to special evaluation pattern (1-5). Results showed that regarding conformation statistically significant differences ($p<0,01$) were established between crosses and DSR. Crosses with Charolais achieved the highest score for conformation (3,94), the highest score for round conformation (3,77) and shoulder (4,06). Considerably more fat tissue on outside of the carcass was determined in DSB (3,44) compared to crosses with Charolais (3,27). Presence of fat in pelvic cavity was more expressed in Charolais (3,34) and Limousine crosses (3,28), with better score for covering of kidneys (3,50 and 3,53) compared to DSR (3,17). It can be concluded that crossing of DSR with FFB resulted in better conformation of high quality parts and more desirable internal fat distribution in F1 progeny.

Key words: domestic Simmental breed, Limousine, Charolais, conformation, fat cover.

Research was financed by the Ministry of Education, Science and Technological Development of Republic of Serbia, project TR 31053.

P-5

PROCENJENA MESNATOST KOD NAZIMICA RAZLIČITIH GENOTIPOVA

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Glavni cilj ovog rada je da se utvrdi uticaj godine, farme, i rase nazimica kao i regresijski uticaj telesne mase na kraju performans testa na sledeće osobine: uzrast na kraju testa (UKT), prosečan životni dnevni prirast (PŽDP), debljina slanine u lumbalnoj zoni (DSL1, između 3. i 4. lumbalnog pršljena, mereno 7 cm lateralno od leđne linije), debljina slanine na leđnoj regiji (DSL2, 7 cm lateralno od leđne linije između 3. i 4. rebra), dubina *Musculus longissimus dorsi* (MLD, izmereno između 3. i 4. rebra, 7 cm lateralno od leđne linije) i procenjena mesnatost (M). Istraživanjem su obuhvaćene dve farme svinja (A i B), u tri uzastopne godine (2014, 2015 i 2016). Nazimice pripadaju rasama Landras (L, 2373), Veliki jorkšir (VJ, 455) i Durok (D, 214). Na farmi A testirano je 1440 nazimica dok je na farmi B testirano 1602. Broj potomaka po očevima kretao se od 9 do 102. Posmatrajući godinu, u 2016. godini, utvrđene su najmanje vrednosti za osobine PŽDP, DSL1, DSL2, MLD i M. Nazimice testirane na farmi A su sa manjim vrednostima za ŽDP i M. Najmanju vrednost za osobinu M, a najveću za DSL1 i DSL2 su očekivano imala grla rase D. Na kraju ovog istraživanja dobijeni su sledeći rezultati: svi ispitivani faktori su pokazali veoma visoku statističku značajnost na sve ispitivane osobine ($P < 0.001$), dok genotip nazimica pokazuje visok statistički značajan uticaj na osobinu MLD ($P<0.01$).

Ključne reči: performans test, nazimica, debljina slanine, Musculus longissimus dorsi, mesnatost

Zahvalnost: Istraživanje je finansirano od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije, projekat TR 31081.

ESTIMATED MEAT LEANNESS IN GILTS OF DIFFERENT GENOTYPES

The main goal of this paper is to determine the effect of the year, farm, and the gilt breed, as well as the regression impact of the body weight at the end of the performance test on the following traits: age at the end of the test (FA), average daily gain (ADG), fat thickness in the lumbar zone (FT1, between 3 and 4 lumbar vertebrae, measured 7 cm laterally from the back line), fat thickness on the back region (FT2, 7 cm laterally from the back line between 3rd and 4th rib), depth of *Musculus longissimus dorsi* (MLD, measured between 3rd and 4th rib, 7 cm laterally from the back line) and estimated leanness (L). The study covered two pig farms (A and B), in three consecutive years (2014, 2015 and 2016). Gilts were following breeds: Landrace (L, 2373), Large White (LW, 455) and Duroc (D, 214). At farm A, 1440 gilts were tested, and farm B tested 1602. Observing the year, in 2016 recorded, the lowest values for traits ADG, FT1, FT2, MLD and M. Gilts tested on farm A are with lower values for ADG and M. The lowest value for the M trait, and the highest for FT1 and FT2, were determined in animals of breed D. At the end of this study, the following results were obtained: all investigated factors showed very high statistical significance for all investigated traits ($P < 0.001$), while the gilt genotype showed a high statistically significant effect on the MLD ($P < 0.01$) trait.

Key words: performance test, gilt, fat thickness, Musculus longissimus dorsi, leanness

Acknowledgment: *Research was financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia, project TR 31081.*

P-6

ISPITIVANJE KVALITETA MESA MUŠKE JUNADI SIMENTALSKE RASE I MELEZA SA ŠAROLEOM

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Cilj ovog ispitivanja bio je da se utvrde klanične osobine, ocena trupa, sastav polutki i kvaliteta mesa junadi domaće simentalske rase (grupa A) i njenih meleza sa šarole rasom (grupa B). Uzorkom je obuhvaćeno ukupno 30 grla, po 15 u svakoj grupi. Junad su zaklana pri telesnoj masi od oko 660 kg. Jedan sat pre klanja obavljeno je merenje junadi, a nakon klanja i primarne obrade izvršeno je merenje toplih trupova sa i bez bubrežnog loja, ocena konformacije i prekrivenosti trupa masnim tkivom. Nakon hlađenja leva polutka je rasecana u osnovne delove. Iz leđnog dela izdvojen je trorebarni isečak (9-10-11 rebro). Dobijeni rezultati istraživanja pokazuju da su junad grupe B ostvarila statistički značajno ($p<0,05$) veći randman toplog trupa sa bubrežnim masnim tkivom, kao i statistički vrlo značajno ($p< 0,01$) veći randman toplog trupa bez bubrežnog masnog tkiva u poređenju sa grupom (A). Udeli bifteka i plećke su bili statistički značajno ($p<0,05$) veći kod junadi grupe B. Dobijeni rezultati disekcije trorebarnog isečka pokazuju da su junad grupe B ostvarila statistički značajno ($p<0,05$) veći udeo *M. longissimus dorsi* u poređenju sa junadima grupe (A), dok su junad grupe (A) ostvarila statistički značajno ($p<0,05$) veći udeo masnog tkiva. Sadržaj proteina u *M. longissimus dorsi* i ukupnih pigmenata bili su statistički značajno ($p<0,05$) veći kod junadi grupe A.

Ključne reči: klanične karakteristike, kvalitet mesa, *M. longissimus dorsi*

Istraživanje je finansirano od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije, projekat TR 31053.

EXAMINATION OF THE QUALITY OF MEAT OF MALE SIMMENTAL CATTLE AND THEIR CROSSES WITH CHAROLAIS

The aim of these study was to determine the slaughtering properties, the evaluation of the carcass, composition of the carcass sides and meat quality of the domestic Simmental breed (group A) and its crosses with Charolais breed (group B). The sample included a total of 30 animals, 15 each in each group. Animals were slaughtered at body weight of about 660 kg. One hour before slaughter, animals were weighed, after slaughter and primary processing, warm carcasses were measured with and without kidney fat, and conformation and coverage of the carcass with fatty tissue assessed. After cooling period, the left carcass side was cut into the main carcass parts. A triple rib cut (9-10-11 rib) was extracted from the back. The obtained results of the study show that bovine group B achieved statistically significantly ($p<0.05$) higher yield of warm carcass with kidney fat, as well as statistically significantly ($p <0.01$) higher yield of warm carcase without kidney fat, compared to the group A. The share of beef steak and the shoulder were statistically significantly ($p <0.05$) higher in the cattle of group B. The obtained results of the dissection of the three rib cut show that the bovine group B achieved a statistically significantly ($p <0.05$) greater share of *M. longissimus dorsi* compared to the bulls in group A, while the group A achieved statistically significantly ($p<0.05$) higher share of fatty tissue. The protein content of *M. longissimus dorsi* and total pigments were statistically significantly ($p <0.05$) higher in bovine group A.

Key words: slaughter properties, meat quality, *M. longissimus dorsi*

Research was financed by the Ministry of Education, Science and Technological Development of Republic of Serbia, project TR 31053.

4. NOVE TEHNOLOGIJE U OPLEMENJIVANJU

UV-1

PRIMENA MOLEKULARNIH MARKERA ZA SELEKCIJU KUKURUZA POBOLJŠANOG KVALITETA PROTEINA ZRNA

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Molekularna genetika je danas sastavni deo različitih programa selekcije i oplemenjivanja žitarica u svetu. Najveći napredak u oplemenjivanju primenom molekularnih markera (eng. *Marker Assisted Selection* - MAS) postignut je kod kvalitativnih osobina koje su regulisane dejstvom jednog ili nekoliko gena i jasno su fenotipski definisane. Molekularni markeri se koriste kao selekcioni markeri za željeni gen (*foreground selection*), kao i radi utvrđivanja procenta genoma rekurentnog roditelja u potomstvima povratnih ukrštanja (*background selection*). Primena *foreground* i *background* selekcije smanjuje broj generacija potrebnih za stvaranje željenog genotipa klasičnim metodama selekcije koje se zasnivaju na fenotipskom odabiru biljaka. Jedan od primera uspešne primene MAS je povećanje hranljive vrednosti zrna kukuruza. Upotrebom molekularnih markera specifičnih za ciljne gene *opaque2, crtRB1* i *lpa2-2* dobijaju se linije kukuruza visokog kvaliteta proteina, visokog sadržaja beta karotena i niskog sadržaja fitina, redom. Dobijene linije koriste se za stvaranje agronomski superiornih hibrida povećane hranljive i biološke vrednosti. U Institutu za kukuruz "Zemun Polje" razvijen je program stvaranja genotipova kukuruza visokog kvaliteta proteina (eng. *Quality Protein Maize* - QPM), adaptiranih na umereno klimatsko područje, kombinovanim pristupom klasične selekcije i selekcije pomoću molekularnih markera. Jedna komercijalna linija prevedena je na QPM varijantu, korišćenjem tropske linije CML 144 kao donora poželjnih svojstava, u procesu koji se sastojao iz dva ciklusa povratnog ukrštanja i tri ciklusa samooplodnje. Ukrštanjem ove prevedene linije sa američkim QPM linijama dobijeni su hibridi poboljšanog kvaliteta proteina namenjeni ishrani tovnih pilića i prasića.

Ključne reči: kukuruz, kvalitet proteina zrna, selekcija primenom molekularnih markera

Rezultat projekta MPNTR TR 31068: Poboljšanje svojstava kukuruza i soje molekularnim i konvencionalnim oplemenjivanjem.

MARKER ASSISTED SELECTION FOR IMPROVING PROTEIN QUALITY OF MAIZE GRAIN

Molecular genetic technologies are implemented into modern grain breeding programs in the world. The greatest progress in marker assisted selection (MAS) has been achieved with the qualitative traits that are regulated by the action of a single or several genes and are clearly phenotypically defined. Markers can be used to either control the target gene (foreground selection) or to accelerate the reconstruction of the recurrent parent genotype (background selection). Both foreground and background selection decrease the number of the generations required to create desirable genotype through conventional breeding based on the fenotypic selection. One successful example of MAS application is the improvement of the maize nutritional value. Using specific molecular markers for desirable genes *opaque2, crtRB1* and *lpa2-2*, maize lines with enhanced protein quality, enhanced β-carotene content and low phytic acid content are developed, respectively. These lines are being used to obtain high-yielding hybrids with improved nutritional benefit. Breeding program for developing quality protein maize (QPM) adapted to temperate regions through marker assisted selection is being conducted at Maize Research Institute Zemun Polje. One commercial inbred line was converted to its QPM counterpart, using tropical QPM line CML 144 as a donor line, after two generations of backcrossing and three generations of selfing. By crossing this converted line with American QPM lines, the hybrids with enhanced protein quality aimed for broiler and piglets feeding are obtained.

Key words: maize, marker assisted selection, grain protein quality

Results of the Project TR 31068: Improvement of maize and soybean characteristics by molecular and conventional breeding.

UV-2

POLIMORFNOST SSR MARKERA U HIBRIDIMA KUKURUZA

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Genetička divergentnost 97 savremenih hibrida kukuruza, koji se gaje u Srbiji u poslednjih nekoliko godina, procenjena je pomoću 12 jednostavnih ponavljajućih sekvenci ili SSR (eng. *Simple Sequence Repeats*) markera. Ukupno je utvrđeno 94 alela, sa prosečno 7,8 alela po lokusu, u rasponu od 5 do 17 alela. Više od 50% su bili retki aleli sa frekvencijom manjom od 5%. PIC (eng. *Polymorphism Information Content)* vrednosti kretale su se od 0,42, za *umc1792*, do 0,81, za *dupssr10*, sa prosekom od 0,64. Ritlandove vrednosti srodnosti varirale su od 0,787 do -0,129. Minimalan broj markera dovoljan da se utvrdi razlika između hibrida sa jedinstvenim genotipom bio je osam. Analiza glavnih koordinata razdvojila je ranostasnu i kasnostanu grupu hibrida kukuruza, iako stepen diferencijacije između grupa nije bio velik (*Fst* = 0,4%). Tri markera, *bnlg1556*, *umc1075* i *dupssr10*, najviše su doprineli razdvajanju ranih i kasnih genotipova, pri čemu je razdvajanje za prva dva markera bilo statistički značajno. Vrednosti parametara genetičke divergentnost procenjene SSR markerima bile su veće kod ranostasnih nego kod kasnostasnih hibrida, ukazujući na širu genetičku osnove prve grupe. Visok nivo polimorfnosti SSR markera ukazuje na njihovu praktičnu primenu u zaštiti prava oplemenjivača ili proveri genetičke čistoće semena. Bolja diferencijacija i jasniji uvid u genetičku osnovu testiranih hibrida očekuje se daljim uključivanjem većeg broja molekularnih markera.

Ključne reči: diverzitet, mikrosateliti, fingerprinting, *Zea mays* L.

Rezultat projekta TR 31073 Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije.

POLYMORPHISM OF SSR MARKERS IN MAIZE HYBRIDS

The aim of this study was to assess genetic diversity among 97 modern maize hybrids that represent maize varieties grown in Serbia during the last several years. To this end, 12 simple sequence repeat (SSR) markers were used for fingerprinting. In total, 94 alleles were detected, with the average number of 7.8 alleles per locus, ranging from 5 to 17. More than 50% were rare alleles with frequency less than 5%. The polymorphic information content ranged from 0.42, for *umc1792*, to 0.81, for *dupssr10*, with an average of 0.64. Pairwise relatedness Ritland's values varied from 0.787 to -0.129. The minimum number of markers sufficient to differentiate hybrids with unique genotypes was eight. A principal coordinate analysis distinguished early and late maturing groups of hybrids, although the observed differentiation between groups was rather low (*Fst* = 0.4%). Three markers, namely *bnlg1556*, *umc1075* and *dupssr10*, contributed most to the discrimination between early and late genotypes, the first two significantly. The values of parameters of genetic diversity obtained with SSR markers were higher in early maturing hybrids than in those that mature later, indicating broader genetic basis of the former. A high level of polymorphism of the SSRs indicates their suitability for fingerprinting, either to protect breeders' rights or to verify seed purity. Better differentiation and more insight into genetic background of the tested hybrids could probably be achieved by increasing the number of markers.

Key words: diversity, microsatellites, fingerprinting, *Zea mays* L.

This study is a result of the project TR31073, supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

U-1

MORFOLOŠKI I MOLEKULARNI DIVERZITET KOLEKCIJE SOJE INSTITUTA ZA KUKURUZ „ZEMUN POLJE“

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Kolekcija soje Instituta za kukuruz “Zemun Polje” sadrži više od 500 genotipova koji vode poreklo iz različitih svetskih regiona. Genetička i fenotipska karakterizacija materijala kojim raspolažu kolekcije je jedan od prvih koraka u održavanju njegovog diverziteta i uspešnom korišćenju u oplemenjivanju. Cilj ovog istraživanja bio je da se utvrdi nivo genetičke i morfološke varijabilnosti u kolekciji kroz uzorak od 90 genotipova soje sakupljenih u 15 zemalja sveta, odnosno pet svetskih regiona. Morfološka deskripcija izvršena je za 16 morfoloških osobina, u skladu sa DUS protokolom. Nivo morfološke sličnosti genotipova ispitan je primenom analize homogenosti. Molekularna analiza sprovedena je pomoću 20 SSR markera. Genetičke relacije među genotipovima analizirane su primenom UPGMA klaster analize. Analizom na osnovu morfoloških deskriptora utvrđen je visok nivo diverziteta među genotipovima, i identifikovani su deskriptori najveće diskriminacione moći. Model grupisanja dobijen analizom homogenosti pokazao je visok nivo saglasnosti sa pedigre podacima, i slabu saglasnost sa podacima o geografskom poreklu. Molekularnom analizom utvrđen je visok nivo polimorfizma SSR markera. Struktura grupisanja pokazala je visok nivo podudaranja sa pedigre podacima, i u manjem obimu sa podacima o geografskom poreklu genotipova. Primenom *Mantel*-ovog testa utvrđena je značajna korelacija između matrica sličnosti dobijenih na osnovu SSR markera i matrica na osnovu morfoloških deskriptora. Dva marker sistema su dala različite ali komplementarne informacije o genetičkom diverzitetu genotipova soje, dajući doprinos određivanju budućih strategija u programu oplemenjivanja.

Ključne reči: soja, diverzitet, SSR markeri, DUS deskriptori

Zahvalnica: *Ovaj rad je rezultat projekta TR 31068 finansiranog od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije*

MORPHOLOGICAL AND MOLECULAR DIVERSITY OF MAIZE RESEARCH INSTITUT "ZEMUN POLJE" SOYBEAN COLLECTION

Maize Research Institute "Zemun Polje" soybean collection contains more than 500 accessions, originated from different parts of the world. The genetic and phenotypic characterization of accessions available in collections is one of the first steps in maintaining diversity and successful utilization in breeding. The aim of this study was to evaluate the magnitude of genetic and morphologic variation in collection, using the sample of 90 soybean genotypes, collected in 15 countries worldwide and divided into 5 geographical groups. Morphological description was carried out for 16 morphological traits according to DUS protocol. Level of morphological similarity of genotypes was investigated by the application of homogeneity analysis. Molecular analysis was performed using twenty SSR primer pairs. The genetic relations among accessions were analyzed through the UPGMA cluster analysis. Analysis based on 16 morphological descriptors determined high level of diversity among genotypes, and identified the descriptors with highest discriminatory power. Grouping model derived by homogeneity analysis showed a high level of agreement with pedigree data, and weak congruence with information on geographical origin of genotypes. Molecular analysis revealed a high polymorphism of SSR loci. Grouping structure showed a high level of agreement with pedigree data, and, to a lesser degree, with geographical origin of genotypes. By the application of *Mantel*'s test, significant correlation was determined between SSR-based distance matrices and matrices based on morphological descriptors. Two marker types provided different but complementary information on genetic diversity of soybean genotypes, which could be of importance in future breeding strategies.

Key words: soybean, diversity, SSR markers, DUS descriptors

Acknowledgments: *This research is a part of the project TR 31068 supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia.*

FP-1

GENETIČKA KARAKTERIZACIJA INBRED LINIJA KUKURUZA

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Fenotipska karakterizacija elitnog selekcionog materijala otežana je zbog prisustva recesivnih homozigotnih alela i njihove relativno niske frekvencije. Molekularni markeri pokazali su se najefikasnijim za evaluaciju i selekciju biljnog materijala, pre svega zbog mogućnosti da razlikuju genotipove na nivou DNK. Takođe, molekularni markeri su korisni za ocenu genetičke varijabilnosti i srodnosti samooplodnih linija kukuruza, pogotovo linija uske genetičke osnove. Cilj našeg rada bio je procena genetičke varijabilnosti 17 inbred linija kukuruza. Urađena je molekularna karakterizacija pomoću 25 polimorfnih SSR (*Simple Sequence Repeat*) markera iz baze podataka MaizeGDB. Ukupan broj dobijenih alela iznosio je 86, i kretao se od dva alela za marker nc133 do devet alela za marker umc1492. Na osnovu matrica genetičkih sličnosti (GS) izračunatih po *Jaccard*-u u NTSYSpc2 statističkom paketu urađena je klaster analiza. Najveća vrednost GS (0,78) dobijena je između para inbred linija ZPL4 / ZPL7, dok je najmanja vrednost GS (0,22) dobijena je za parove inbred linija ZPL6 / ZPL15 i ZPL6 / ZPL16. Na osnovu dobijenih rezultata može se zaključiti da se grupisanje inbrednih linija uglavnom slaže sa podacima o njihovom poreklu. Genetička varijabilnost dobijena pomoću SSR markera može biti korisna u odabiru najboljih roditeljskih kombinacija.

Ključne reči: inbred linije, genetička varijabilnost, SSR markeri

GENETIC CHARACTERIZATION OF MAIZE INBRED LINES

The phenotypic characterization of elite breeding material is laborious by the presence of a recessive homozygous alleles and their relatively low frequency. Molecular markers are considered to be the most effective for evaluation and selection of plant material, mostly because of the ability to distinguish genotypes at the DNA level. Also, molecular markers are useful for assessing the genetic variability and similarity of the maize inbred lines, especially the lines of narrow genetic base. The aim of our work was to assess the genetic variability of 17 inbred lines using molecular markers. Molecular characterization was done with 25 polymorfic SSR (*Simple Sequence Repeat*) markers from the MaizeGDB database. The total number of alleles was 86, and ranged from two alleles for the marker nc133 to nine alleles for the marker umc1492. Cluster analysis was performed based on the genetic similarity (GS) matrices obtained by *Jaccard* coefficient in the NTSYSpc2 program package. The highest GS value (0.78) was detected between pair of inbred lines ZPL4 / ZPL7. On the other hand, the lowest value for GS (0.22) was detected for pairs of inbred lines ZPL6 / ZPL15 and ZPL6 / ZPL16. According to the obtained results it could be concluded that grouping of inbred lines mostly agrees with their pedigrees. The variability detected using SSR markers could be useful to breeders in selecting best parental combinations.

Key words: inbred lines, genetic variability, SSR markers

P-1

GENETIČKI DIVERZITET LINIJA KUKURUZA RAZLIČITOG TIPA ZRNA

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Genetički diverzitet četrdeset samooplodnih linija kukuruza različitog tipa zrna, (šećerci, kokičari, linije sa narandžastim. belim i žutim zrnom) procenjen je SSR analizom. Dvadeset prajmera je detektovalo 104 alela, prosečno 5,2. Najveći broj alela je detektovan za narandžaste, a najmanji za linije sa belim zrnom. PIC vrednost za sve ispitane markere je bila veća od 0.6, u opsegu od 0.65 za marker umc1887 do 0.86 za marker umc1799. Najveća uočena heterozigotnost (Ho) je detektovana za linije šećerca (0.12), a najniža za grupu linija sa belim zrnom (0.09). Broj jedinstvenih alela je bio najveći za narandžaste (11) i najniži za linije sa belim zrnom (2). Najveći broj jedinstvenih alela po genotipu su imale linije sa žutim zrnom (4). Klaster analiza je grupisala linije u dve glavne grupe. Na osnovu PCA analize linije su se grupisale u tri grupe. Bolje slaganje sa pedigre podacima je pokazala PCA nego klaster analiza. Međutim, procenat varijabilnosti objašnjen sa prve dve komponente je bio samo 16.08%. analiza molekularne varijanse (AMOVA) je pokazala da je varijabilnost između individua veća (90%) nego unutar-populacijska varijabilnost (10%) što nije neočekivano uzimajući u obzir činjenicu da je veliki broj linija unutar jedne grupe veoma različitog porekla.

Ključne reči: kukuruz, tip zrna, molekularni markeri

Rezultat projekta TR31068 Ministarstva prosvete, nauke i tehnološkog razvoja

GENETIC DIVERSITY OF MAIZE INBRED LINES WITH DIFFERENT KERNEL TYPE

Genetic diversity of forty maize inbreds with different kernel type, (sweet corn, popcorn, and genotypes with orange, white and yellow kernels) was assessed with SSR analysis. Twenty primers revealed 104 alleles with an average of 5.2. The highest number of alleles was detected for orange, while the lowest for white maize. PIC value for all tested markers was greater than 0.6, in a range from 0.65 for umc1887 to 0.86 for umc1799. The greatest observed heterozygosity (Ho) was detected for sweet (0.12) while the lowest for white maize group (0.09). Number of private alleles was the highest for orange (11) and the lowest for white maize (2). The greatest number of private alleles per genotype was detected for inbreds with yellow kernel (4). Cluster analysis grouped inbreds in two main clusters. According to PCA analysis maize genotypes were grouped in three groups. Better congruence with pedigree information was revealed using PCA than cluster analysis. But, percent of variability explained with first two components was only 16.08%. AMOVA showed that variability among individuals was greater (90%) than inter-population variability (10%) which is not unexpected considering the fact those lots of inbreds inside one group are of very different origin.

Key words: maize, kernel type, molecular markers

P-2

PRIMENA MORFOLOŠKIH I MOLEKULANIH MARKERA U SELEKCIJI SUPERIRORNIH LINIJA PAPRIKE (*Capsicum annuum L.*)

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Metodom punog dialela, bez povratnih ukrštanja izvršena je hibridizacija pet roditeljskih genotipova (KP-01,KP-03, C-15, CH-1 i HM-6) radi dobijanja potomstva F_1 generacije, iz koje je samooplodnjom dobijena F_2 generacija. Osnovni cilj ovog istraživanja je bio da se primenom morfoloških (po *UPOV*-u) i molekularnih markera odrede roditelji koji su donori pozitivnih gena i koji daju ekspresivno potomstvo sa poboljšanim osobinama. Određene su genetičke vrednosti za ispitivane kvantitativne osobine (ranostasnost, broj plodova po biljci, debljina perikarpa, masa ploda i sadržaj vitamina C) roditelja, F_1 i F_2 generacije. Izračunate su fenotipske korelacije kvantitativnih osobina, kao i grupisanje genotipova na osnovu morfoloških i kvantitativnih parametara. Morfološki markeri su pokazali veliki značaj za procenu sortnih različitosti. Nijedan od 15 ispitivanih genotipova nije imao iste vrednosti za sedam ispitivanih morfoloških markera. Klaster analiza zasnovana na vrednosti kvantitativnih osobina dala je rezultate koji su znato više primenljivi u oplemenjivanju paprike u odnosu na klaster analizu zasnovanu na morfološkim markerima. Od 20 primenjenih prajmera, samo OPP-5 je obrazovao traku OPP-5-3 koja je povezana sa dugim oblikom ploda, jer je identifikovana samo kod roditelja i svih njegovih hibrida sa navedenim oblikom ploda.

Ključne reči: paprika, heterozis, genetička analiza, mrfološki i molekularni markeri, klaster analiza

USING MORPHOLOGICAL AND MOLECULAR MARKERS IN SELECTION OF SUPERIOR LINES OF PEPPER (*Capsicum annuum L.*)

By applying method of full diallel, without reciprocal crossing, the hybridization has been done for five parental genotypes (KP-01, KP-03, S-15, CH-1 and HM-6) in order to obtain progeny of F_1 generation, and F_2 generation by self-crossing. The aim of this research was to apply morphological (UPOV) and molecular RAPD markers and determine parents - donors of positive genes and produce expressive progeny with improved traits. Genetic values for researched quantitative traits (earliness, number of fruits per plant, thickness of pericarp, fruit weight and content of vitamin *C*) of parents, $F_1$and F_2 hybrids have been defined. Phenotype correlations of quantitative traits and group of genotypes according to morphological and quantitative parameters have been calculated. Morphological markers showed significance in estimating variety differences. None of 15 researched genotypes for seven researched morphological markers did not have same values. Cluster analysis based on values of quantitative traits gave more applicable result in pepper breeding comparing to cluster analysis based on morphological markers. From 20 applied primers, only OPP-5 formed tape OPP-5-3, which is connected to long shape of fruit, since it has been identified only for parents and all their hybrids with mentioned fruit shape.

Key words: pepper, heterosis, genetic analysis, morphological and molecular markers, cluster analysis

P-3

ASIMBIOTSKO KLIJANJE ZRELOG SEMENA UGROŽENE VRSTE TERESTRIČNE ORHIDEJE *Anacamptis pyramidalis* (L.) RICH. U *IN VITRO* USLOVIMA

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Cilj ovog istraživanja je iznalaženje protokola za *ex situ* konzervaciju terestične orhideje *Anacamptis pyramidalis* (L.) Rich. metodom asimbiotskog klijanja semena u *in vitro* uslovima. Ispitan je uticaj hranljivih podloga, organskih aditiva i osvetljenja na njihovo klijanje. Istraživanje je obuhvatilo 11 različitih hranljivih podloga. Kao osnovni izvor mineralnih soli i vitamina koristile su se dve različite hranljive podloge — Malmgren (MM) i Knudson C (KC) — obogaćene sa različitim organskim suplementima: kokosova voda (CW), sok od ananasa (PJ), pepton (PE), L-glutamin i folna kiselina (A) kao i kazein (CA) (za KC medijum). Sve hranljive podloge koje su obuhvaćene ovim istraživanjem sadržale su 2% saharoze, 7% agara i 1% aktivnog uglja, dok im je pH vrednost podešena na 5,8±0,02 pre autoklaviranja na temperaturi 121˚C u trajanju od 20 min. Nakon uspešne sterilizacije, semenke su posejane na prethodno pripremljene hranljive podloge i odložene u sobu za uzgajanje na temperaturu 23 ± 2˚C. Da bi se ispitao uticaj svetlosti na klijanje semena, petri kutije su postavljene na dva režima svetlosti – 16h svetlo/8h mrak ili 0h svetlo/24h mrak. Dobijeni rezultati ukazuju da svi ispitivani suplementi pozitivno utiču na klijanje semena, dok je najveći procenat klijavosti postignut na hranljivoj podlozi MM obogaćenoj sa kokosovom vodom (MMCW) i peptonom (MMPE). Hranljiva podloga KC nije podstakla klijanje semena. Takođe, semenke koje su odložene u uslove potpunog mraka imale su znatno veći procenat klijavosti za razliku od semeki koje su se nalazile u uslovima 16h svetlo/8h mrak.

Ključne reči: *in vitro*, konzervacija, orhideje, terestrične, klijanje

IN VITRO ASYMBIOTIC GERMINATION OF MATURATE SEEDS OF *Anacamptis pyramidalis* (L.) RICH., AN ENDANGERED ORCHID SPECIES

The aim of this study was to develop a protocol for the asymbiotic seed germination for the purpose of *ex situ* conservation of *Anacamptis pyramidalis* (L.) Rich., an endangered orchid species. Influence of media nutrition, organic additives and illumination was tested. The study included 11 different nutrition media combinations. Two basal media — Knudson C (KC) and Malmgren (MM) — were enriched with different supplements, added separately: coconut water (CW) pineapple juice (PJ), peptone (PE), L-glutamine with folic acid (A) and casein hydrolysate (CA) (for KC medium). All tested media consisted of 2% sucrose, 7% agar and 1% activated charcoal, while the pH for all media was adjusted to 5,8±0,02 before autoclaving at 121˚C for 20 min. The surface sterilized seeds were spread on the Petri dishes with medium and incubated at 23 ± 2˚C. To investigate the influence of illumination, seeds were cultured under two different light conditions: 16/8 light/dark and 0/24 light/dark (continuous darkness). Obtained results indicate that all investigated supplements have a positive influence on seed germination and protocorm formation. The best media combination was MM basal media supplemented with coconut water (MMCW) and peptone (MMPE), while KC basal media with all those supplements did not promote germination at all. Also, seeds cultured in continual darkness had significantly higher germination rate than those cultured in 16/8 light/dark conditions.

Key words: *in vitro*, conservation, orchids, terrestrial, germination

P-4

IDENTIFIKACIJA RAZLIČITIH SORATA LUCERKE PRIMENOM MOLEKULARNIH MARKERA

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Lucerka je, posle kukuruza, najvažnija krmna vrsta u našoj zemlji, zahvaljujući ne samo povoljnom hemijskom sastavu i visokom sadržaju proteina, već i visokim prinosima i veoma dobrim biološkim osobinama. Plava lucerka, *Medicago sativa* L. (2n = 32) je prirodni tetraploid. Cilj ovog rada je da se ispitivanjem deset različitih sorata lucerke odredi varijabilnost i grupisanje srodnih genotipova lucerke primenom *RAPD* molekularnih markera. Za ekstrakciju DNK iz biljnog materijala korišćeni su prvi zeleni listići klijanaca lucerke (kotiledoni). Za analizu podataka dobijenih molekularnom karakterizacijom korišćeni su statistički programi za populaciono-genetičke analize. Primećeno je da se u *RAPD* analizi genoma biljaka mogu pratiti repetativne sekvence koje čine značajan deo genetičkog materijala. Lančana reakcija polimeraze bazirana na repetativnim sekvencama (*RAPD-PCR*) korišćena je za utvrđivanje genetičke raznovrsnosti između različitih sorata lucerke. OPA 01, OPA 02, OPA 13 i OPB 10 prajmeri su korišćeni da bi se dobili različiti DNK profili. Na osnovu *RAPD* DNK profila može se videti razdvajanje DNK fragmenata različite veličine od 100 bp do 3 kb. Razlike između fragmenata su ocenjivane vizuelno na osnovu njihovog položaja na gelu. Na gelu na kome se nalaze različite sorte lucerke sa prajmerom OPB 10 mogu se uočiti razlike između sorata lucerke. Jasno se vidi da se sorta lucerke Zaječarska 83 razlikuje od svih ostalih sorata lucerke. Sorte Osječka 99, Osječka 88 i Osječka 66 pokazuju visok nivo međusobne sličnosti, kao i sorte Kruševačka 22 i Kruševačka 28, što je i očekivano sa obzirom da su navedene sorte koje su slične selekcionisane u istim selekcionim kućama. Ovo istraživanje je potvrdilo da proučavana kolekcija sorti lucerke poseduje varijabilnost neophodnu za uspešan selekcioni proces.

Ključne reči: lucerka, sorte, *PCR*, *RAPD*

Zahvalnica:Ovaj rad je rezultat istraživanja između projekata TR 31057 i TR 31018, podržanog od Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije.

IDENTIFICATION OF DIFFEREENT ALFALFA CULTIVARS APPLICATION OF MOLECULAR MARKERS

After maize, alfalfa is the most important forage species in our country due to favorable chemical composition and high content of protein. It is also characterized with high yields and very good biological properties. Blue alfalfa, *Medicago sativa* L. (2n = 32) is a natural tetraploid. The aim of this work was to determine variability and grouping related alfalfa genotypes using *RAPD* molecular markers, by testing ten different alfalfa cultivars. The first green leaves of alfalfa seedlings (cotyledons) were used for *DNA* extraction from the plant material. For the analysis of data obtained by the molecular characterization the statistical programs for population-genetic analysis were used. It is observed that in the *RAPD* analysis of the genome can be monitored repetitive sequences that make up a significant part of the genetic material. The polymerase chain reaction based on repetitive sequences (*RAPD-PCR*) was used to determine the genetic diversity among the different cultivars of alfalfa. OPA 01, OPA 02, OPA 13, and OPB 10 primers were used to obtain the various profiles of *DNA*. Based on *RAPD DNA* profiles, the separation of *DNA* fragments of different size from 100 bp to the 3 kb were noticed. The differences between the fragments were evaluated visually on the basis of their position on the gel. On the gel containing different varieties of alfalfa with primer OPB 10, differences between alfalfa varieties were noticed. It is clear that the cultivar Zaječarska 83 differs from all other cultivars of alfalfa. Cultivars Osječka 99, Osječka 88, and Osječka 66 showed a high level of similarity, as well as cultivars Kruševačka 22 and Kruševačka 28. This is expected, taking into account that these two groups of similar cultivars were selected in the same companies. This study confirmed that studied collection of alfalfa cultivars has variability necessary for successful selection process.

Key words: alfalfa, cultivars, *PCR*, *RAPD*

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5. SEMENARSTVO I PRIKAZ NOVIH SORTI

UV-1

MOGUĆNOSTI POVEĆANJA PRINOSA SEMENSKOG KUKURUZA

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Prinos semena po hektaru zavisi od: veličine površine koju zauzima majčinska komponenta, broja biljaka po jedinici površine, nivoa primenjenih agrotehničkih mera, načina uklanjanja metlica sa majčinske komponente (uklanjanje sa jednim ili više listova), obezbeđenosti sa vodom, vremena i načina berbe, načina dorade i dr.

Produktivnost, a samim tim i rentabilnost u semenskoj proizvodnji zavisi od genetske konstitucije hibrida kukuruza koji mogu biti prosti, trolinijski i četvorolinijski. U semenskoj proizvodnji kukuruza seju se naizmenično redovi oca i majke u određenom odnosu. Za kvalitetnu proizvodnju hibridnog semena visokorodnih hibrida kukuruza istražuju se načini setve roditeljskih komponenti (majke i oca) u semenskim usevima.

Odnos redova roditeljskih komponenti u našoj zemlji najčešće je bio 4:2 i 6:2. Iz navedenih odnosa proizilazi da majčinska komponenta zauzima od 66 do 75% površine pod semenskim kukuruzom. U SAD, kao najvećem proizvođaču semenskog kukuruza najčešće korišćeni odnos je bio 4:1 pri kom majčinska komponenta zauzima 80% površine. Prinos semena može se povećati ili povećanjem prinosa po jednoj biljci ili povećanjem broja biljaka po jedinici površine.

Cilj rada je da se ukaže na mogućnost povećanja prinosa semenskog kukuruza koristeći dva načina setve roditeljskih komponenti, klasičnu setvu pri odnosu redova 4:2 i usejavanje oca između dva reda majke. Sejana su dva novosadska hibrida kukuruza. Ispitivane su sledeće osobine: dužina klipa, ukupan broj zrna na klipu, masa 100 zrna i prinos zrna po biljci. Nisu se ispoljile značajne razlike u dužini klipa, masi 100 zrna i prinosu zrna kod ispitivanih načina setve.

Ključne reči: semenski kukuruz, razmaci između redova, prinos zrna

Rezultat projekta: TR 31073 "Unapredjenje proizvodnje kukuruza i sirka u uslovima stresa".

THE POSSIBILITIES OF INCREASING YIELD IN MAIZE SEED PRODUCTION

The yield of seeds per hectare depends on the size of the area taken by the female component, the number of plants per unit area, the level of applied agro-technical measures, the method of removing the tassels from the female component (removal with one or more leaves), water availability, time and method of harvesting and processing and other.
Productivity and therefore, profitability in seed production depends on the genetic constitution of maize hybrids, which can be single, three-way and double cross. In maize seed production, alternate rows of male and female component are in a certain relationship.
The planting ratio of parent components in our country was most often 4: 2 and 6: 2. From these relations it follows that the female component occupies 66 to 75% of the area under seed parent. Seed yield can be increased either by increasing the yield per plant or by increasing the number of plants per unit area.
The aim of the paper is to point out the possibility of increasing the yield in maize seed production using two methods of planting parental components, a classical planting ratio 4: 2, and delayed planting of mail component between the two female rows. Two maize hybrids developed in Novi Sad were planted. The following features were investigated: cob length, total number of grains per cob, 100 grain weight and yield of grain per plant. No significant differences in the length of the cob, 100 grain mass and grain yield were found between the examined planting methods.

Key words: maize seed production, distance between rows, grain yield

UV-2

UTICAJ APSOLUTNE MASE NA KLIJAVOST HIBRIDNOG SEMENA KUKURUZA

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Glavni cilj semenske proizvodnje kukuruza je da se proizvede seme što boljeg kvaliteta, da bi se omogućio genetički potencijal hibrida. Na klijavost semena kukuruza utiču mnogi abiotički biotički faktori. Sem meteoroloških uslova (prvenstveno temperatura, zatim količina i raspored padavina), veliki uticaj imaju i sledeći abiotički faktori: kvalitet zemljišta, vlaga u berbi, način berbe i transporta, sušenje i dr. Iako svi ovi faktori imaju određeni uticaj na klijavost, ona pre svega zavisi od morfoloških i fizioloških osobina hibrida. U ovom radu su analizirani rezultati iz semenske proizvodnje 8 hibrida kukuruza u periodu od 2013-2016. godine. Poređene su prosečne vrednosti apsolutne mase i klijavosti krupnih i sitnih frakcija semena ispitivanih hibrida korišćenjem Pearsonovog koeficijenta korelacije. Iako je uočen trend da u najvećem broju slučajeva krupne frakcije semena imaju veću prosečnu klijavost u odnosu na sitne, ta korilacija nije bila značajna. Pozitivna korelacija između ispitivanih osobina je zabeležena kod 7 hibrida, a statistički značajna je bila kod hibrida ZP 684, ZP 555 i ZP 606. Kod hibrida ZP 555 i ZP 606, koji imaju zajedničku majčinsku komponentu, zabeležen je najveći pozitivan direktan uticaj apsolutne mase na klijavost semena (*r=0,924*** i *r=0,971***). Negativna korelacija je zabeležena samo kod hibrida ZP 704, ali nije bila statistički značajna. Može se zaključiti da različiti genotipovi imaju različit intenzitet i smer korelacije između apsolutne mase i klijavosti semena.

Ključne reči: klijavost, apsolutna masa semena, frakcije semena, kukuruz

EFFECT OF THOUSAND KERNEL WEIGHT ON GERMINATION OF MAIZE HYBRID SEED

The main goal of maize seed production is to produce seed of the best possible quality, which would enable hybrid to reach its genetic potential. Many abiotic and biotic factors have an influence on germination of maize seed. Besides meteorological conditions (temperature, and quantity and distribution of rainfall), big impact has the following abiotic factors: soil quality, seed moisture during harvest, harvesting and transport, drying etc. Although all this factors have a certain impact on germination, it is mostly influenced by morphological and physiological properties of a hybrid. In this paper, the results were analyzed from seed production of 8 maize hybrids in four-year period (2013-2016). Average values of thousand kernel weight and germination of large and small fractions of seeds of investigated hybrids were compared using Pearson's correlation coefficient. Although a trend has been observed that, in most cases, large seed fractions have higher average germination compared to small ones, this correlation was not significant. The positive correlation between the tested properties was recorded in 7 hybrids, and significant was in hybrids ZP 684, ZP 555 and ZP 606. The highest positive correlation between germination and thousand kernel weight was recorded between hybrids ZP 555 and ZP 606 (*r=0.924*** and *r=0,971**,* respectively), who have the same maternal component. Negative correlation was recorded only in hybrid ZP 704, but was not significant. It can be concluded that the intensity and direction of correlation of thousand kernel weight and seed germination depends largely on the genotype.

Key words: germination, thousand kernel weight, seed fractions, maize

UV-3

OPLEMENJIVANJE I SEMENARSTVO ULJANIH BILJNIH VRSTA U SRBIJI

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Najzastupljenije uljane biljne vrste u Srbiji su suncokret i soja koje se gaje na preko 200000 ha, sledi uljana repica čije površine značajno rastu. Na manjim površinama gaje se crna i bela slačica, konoplja, uljana tikva, ricinus, lan, mak, sezam i šafranjika. U Srbiji je 2017. godine na sortnoj listi bilo 355 sorti uljanih biljnih vrsta, od toga suncokreta 188, soje 83 i uljane repice 71 sorta, slede uljana tikva, konoplja, bela i crna slačica i ricinus. Među domaćim i stranim semenskim kućama dominira Institut za ratarstvo i povrtarstvo iz Novog Sada sa 150 registrovanih sorata. U priznavanju su i lanik, lan, mak i šafranjika. U desetogodišnjem periodu 2008-2017, semenarstvo uljanih biljnih vrsta se u proseku odvijalo na 9955 ha godišnje, od toga najviše soje (8200 ha/god.) i suncokreta (1732 ha/god.) i na malim površinama uljana repica, uljana tikva, mak i konoplja. U sezoni 2016/2017 u Srbiji je atestirano (svih kategorija semena) 19657116 kg soje, 1666267 kg suncokreta, 137179 kg uljane repice i manje količine semena bele slačice, konoplje i uljane tikve. Preko 86% deklarisanog semena suncokreta i preko 94% semena uljane repice potiču iz uvoza. Srbija spada u veće evropske proizvođače soje i suncokreta, ima povoljne agroekološke uslove za gajenje uljanih biljnih vrsta, dugu tradiciju oplemenjivanja, jak prerađivački sektor, kvalitetne kadrove i kapacitete i razvijen sistem državne regulative u semenarstvu. Prednosti koje Srbija ima u oplemenjivanju, semenarstvu i gajenju uljarica nisu adekvatno iskorištene.

Ključne reči: uljane biljne vrste, oplemenjivanje, semenarstvo

Rezultat projekta: TR 31025, „Razvoj novih sorti i poboljšanje tehnologija proizvodnje uljanih biljnih vrsta za različite namene“

BREEDING AND SEED PRODUCTION OF OIL CROPS IN SERBIA

The most frequent oil crops in Serbia today are sunflower and soybean, planted on over 200000 ha each, followed by rapeseed, which increases significantly in surfaces. Black and white mustard, hemp, oil pumpkin, castor bean, flax, poppy, sesame and safflower are grown on smaller surfaces. In Serbia, a total of 355 varieties of oil plant species were on the variety list in 2017, out of which 188 were sunflower, 83 soybean and 71 rapeseed, followed by oil pumpkin, hemp, white and black mustard and castor bean. Among the domestic and foreign seed companies, the Institute of Field and Vegetable Crops from Novi Sad prevails with 150 registered varieties. Camelina, flax, poppy and safflower are in the registration process. In the ten-year period 2008-2017, the seed production of oil crops averaged 9,955 ha per year, of which the highest were soybean (8,200 ha / year) and sunflower (1,732 ha / year), and on small areas: rapeseed, oil pumpkin, poppy and hemp. In the 2016/2017 season in Serbia, 19,657,116 kg of soybean, 1,666,267 kg of sunflower, 137,179 kg of rapeseed and small quantity of white mustard seed, cannabis and oil pumpkin seeds were certified (all seed categories). Over 86% of declared sunflower seed and over 94% of rape seed is imported. Serbia belongs to bigger European producers of soy and sunflower, has favorable agroecological conditions for cultivation of oil crops, long tradition of breeding, strong processing sector, quality human resources and capacities and developed system of state regulation in seed production. The advantages Serbia has in breeding, seed production and growing of oil crops, have not been adequately exploited.

Key words: oil crops, breeding, seed production

Project: TR 31025, "Development of new varieties and production technology improvement of oil crops for different purposes"

U-1

PREDOSNOVNO SEME KUKURUZA U TEHNIČKOJ IZOLACIJI

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Seme dobrog kvaliteta je glavni preduslov stabilne i uspešne proizvodnje, kako semenskog tako i merkantilnog kukuruza. S obzirom da predosnovno seme iz tehničke izolacije pripada prvoj kategoriji semena (tzv. elita), očuvanje njegovog kvaliteta je osnovni preduslov za proizvodnju kvalitetnog hibridnog semena. Predosnovno seme Instituta za kukuruz “Zemun Polje“, ima ukupno 227 komercijalnih linija kukuruza, od kojih se svake godine u proseku umnožava 70. U okviru predosnovnog semena metodom „klip na red“, (tehnička izolacija), održava se genetička čistoća i umnožava potrebna količina semena samooplodnih linija kukuruza. Monitoring u polju se sprovodi od nicanja do berbe, praćenjem fenotipske uniformnosti i uklanjanjem atipičnih biljaka. U berbi se odabirom najboljih klipova stvara rezerva za setvu predosnovnog semena u tehničkoj izolaciji, a ostatak klipova spaja u masu kao rezervu predosnovnog i osnovnog semena u prostornoj izolaciji. Nakon berbe, klipovi se dosušuju do 13 % vlage u zrnu, krune i dorađuju ručno. U Laboratoriji za ispitivanje semena, određuje se klijavost i energija klijavosti (dobijene vrednosti se kreću u intervalu od 94-100 %), zdravstveno stanje (zaraženost semena ne prelazi 2 %) i apsolutna težina semena. Nakon utvrđenog kvaliteta, seme se čuva u srednjoročnim uslovima hladne komore. Za utvrđivanje genetičke čistoće linija se koristi metoda Ultra Tankoslojng Izoelektričnog Fokusiranja. Dobijeni rezultati ukazuju na visok procenat genetičke čistoće i apsolutno su u skladu sa vrednostima propisanim Pravilnikom o kontroli i proizvodnji semena 60/06.

Ključne reči: genetička čistoća, klip na red, samooplodna linija, uniformnost, *Zea mays* L.

PRE-BASIC SEED PRODUCTION UNDER CONTROLLED CONDITIONS

Seed of good quality is the main prerequisite for stable and successful seed and mercantile corn production. Considering that pre-basic seed in controlled pollination belongs to elite seed categories, preservation of its quality is a precondition for the production of quality hybrid seed. Pre-basic seed of Maize Research Institute „Zemun Polje“ main tains a total 227 maize commercial inbred lines. Approximately 70 inbreds are multiplied each year. The main goal of pre-basic seed production is maintenance of genetic purity and required amount of maize inbred lines (breeders seed) realised through application of „ear to row“ method (controlled hand-pollination). Monitoring in the field is carried out from emergence to harvest and includes the control of phenotypic uniformity and elimination of rogue maize plants. At harvest, choice of the best ears provides seed reserves of pre-basic seed, while the rest of ears provides bulk reserve of pre-basic and basic seed to be sown in spatial isolation. After harvesting and hand-processing, pre-basic seed is dried to 13 % of seed moisture content. Seed Testing Laboratory determinates seed germination and germination energy (obtained values ranging from 94-100 %), seed health testing (infestation less than 2 %), and absolute seed weight. After testing of quality, seeds are stored under medium-term controlled conditions. Ultra-thin layer polyacrylamide gel *electrophoresis method* is used for the testing of inbreed lines genetic purity*. The obtained results indicate a high percentage of genetic purity and are in absolute accordance with the values set forth in the Seed Control Regulations and Seeds Act 60/06.*

Key words: ear to row, genetic purity, inbred line, uniformity, *Zea mays* L.

U-2

KLIJAVOST SEMENA I SVOJSTVA KLIJANACA TRAVA *FESTUCA SP.* NA RAZLIČITIM TEMPERATURAMA SETVE

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Klijavost semena u velikoj meri utiče na prinos i kvalitet useva. Optimalne temperature za klijanje semena razlikuju se između vrsta i genotipova unutar vrste, a temelj su za određivanje optimalnog vremena setve. Cilj ovog istraživanja bio je utvrđivanje klijavosti semena i svojstava klijanaca (dužina korena i stabljike klijanaca) za 3 višegodišnje trave (*Festuca pratensis*, *Festuca arundinacea* i *Festuca rubra*) na različitim temperaturama (5, 10, 15 i 20º C). Ispitivanje klijavosti semena je sprovedeno u klima komori metodom navlaženog rolanog filter papira u skladu sa pravilima ISTA. Od svake vrste zasejano je po 100 semenki u 4 ponavljanja. Nakon naklijavanja utvrđena su svojstva semena i klijanaca pri čemu je utvrđen značajan uticaj temperature na sva ispitivana svojstva ($p<0,01$). Seme *F. pratensis* i *F. rubre* imalo je najveću vrednost na temperaturi 20º C, a *F. arundinacee* na 10ºC. Na 5º C seme *F. pratensis* nije proklijalo dok je na istoj temperaturi seme *F. rubra* imalo najnižu vrijednost. Za seme *F. arundinacee* utvrđena je manja klijavost na 15 i 20º C nego na 5 i 10 ºC. Najveća dužina korena i stabljike klijanaca za sve 3 vrste utvrđena je na temperaturi od 20º C. Prosečno, za sve analizirane temperature, najveća vrednost za dužinu korena klijanaca utvrđena je kod *F. arudninacea* (1,88 cm), a najmanja kod *F. rubre* (1,35 cm). Najveća prosečna dužina stabljike klijanaca utvrđena je kod *F. pratensis* (4,06 cm) a najmanja kod *F. rubra* (1,35 cm).

Ključne reči: klijavost semena, temperatura, *Festuca sp.*

SEED GERMEABILITY AND SEEDLING TRAITS OF *Festuca* SP. GRASSES AFTER VARIOUS GERMINATION TEMPERATURES

Seed germeability heavily affects crop's yield and quality. Optimum environmental temperatures during the germination vary among species and genotypes and they are crucial for setting the optimum seeding term. Aim of this research was to investigate the seed germeability and seedling traits (seedling root and shoot length) for 3 perennial forage grasses (*Festuca pratensis*, *Festuca arundinacea* and *Festuca rubra*) upon various temperatures during germination (5, 10, 15 and 20°C). Temperature treatments were conducted according to ISTA protocol for testing the seed germeability in clima-chamber in rolled filter-paper. There were put 100 seeds of each grass species at each of 4 replications. Apon the temperature treatments there were investigated seed and seedling traits, and the research has revealed significant effect of treatments to all the investigated traits ($p<0,01$). *F. pratensis* and *F. rubra* had the highest germeability at 20°C and *F. arundinacea* at 10°C. *F. pratenisis* didn't germ at 5°C. *F. arundinacea* had a lower germeability at 15 and 20°C than at 5 and 10°C. The largest root and shoot length were observed at 20°C for all of investigated grasses. When averaged over all temperature treatmens *F. arundinacea* had longest seedling roots (1.88 cm), and *F. rubra* had shortest (1.35 cm). *F. pratensis* has displayed the longest average shoot (4.06 cm) while *F. rubra* had shortest (1.35 cm).

Key words: seed germeability, environment temperature, *Festuca* sp.

U-3

OTPUŠTANJE VLAGE IZ SEMENA SUNCOKRETA U ZAVISNOSTI OD KOLIČINE PRIMENJENOG DESIKANTA

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Desikacija je agrotehnička mera koja je zbog niza prednosti postala standardna mera u semenskoj proizvodnji suncokreta. Izvodi se u periodu kada vlaga u semenu suncokreta padne na 24-50 %. Primena desikanata dovodi do ubrzanog i ujednačenog sazrevanja useva, značajnog smanjenja vlage u semenu, a samim tim omogućava raniju i sigurniju žetvu. Cilj istraživanja je bio da se utvrdi koja količina primenjenog desikanta će dovesti do bržeg sazrevanja useva poštujući pravilo ekonomske opravdanosti proizvodnje.
Ogled je bio postavljen na oglednom polju Instituta za ratarstvo i povrtarstvo na Rimskim šančevima, a ispitivanja su se vršila na hibridu Oliva. Ogled je postavljen po split-plot modelu u tri ponavljanja, gde je uticaj količine primenjene aktivne materije bio faktor glavne parcele, a uticaj roka berbe faktor podparcele. Kada je prosečna vlaga zrna iznosila 45% izvršena je desikacija herbicidom na bazi dikvata, u količini 300 g/ha a.m. i 450 g/ha a.m, dok je netretirani deo parcele služio kao kontrola. Uzimanje uzoraka za proveru vlage vršeno je dva puta nedeljno sve do tehnološke zrelosti. Dobijeni rezultati pokazuju da su oba ispitivana faktora imala visoko značajan uticaj na sadržaj vlage u semenu, dok njihova interakcija nije imala statističku značajnost. U proseku, najveći sadržaj vlage izmeren je očekivano u kontrolnoj varijanti (24,54%), dok između tretmana sa 300 g/ha a.m. (20,06%) i 450 g/ha a.m. (19,51%) nije ustanovljena statistički značajna razlika.

Ključne reči: suncokret, seme, vlaga u semenu, desikacija

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MOISTURE CONTENT OF SUNFLOWER SEED DEPENDING ON AMOUNT OF APPLIED DESICCANT

Desiccation is an agro technical measure that has become a standard measure in sunflower seed production due to a number of advantages. It is performed in the period when the moisture in sunflower seeds drops to 24-50%. The use of desiccants leads to an accelerated and uniform crop maturation, a significant reduction in seed moisture, and therefore allows an earlier and safer harvest. The aim of the research was to determine which amount of applied desiccant will lead to faster crop maturation, respecting the rule of cost-effective production.
The trial was conducted at experimental field of Institute of Field and Vegetable Crops at Rimski šančevi, and tests were carried out on the hybrid Oliva. Experimental design was a split-plot model design with three replications, where the influence of the applied amount of active ingredient was a factor in the main plot, and the effect of the harvest time was a factor of the subplot. The desiccation was carried out when the average grain moisture was 45%, with herbicide based on a.i. diquat, in the amount of 300 g / ha a.i. and 450 g / ha a.i, while the untreated part was control. Sampling for moisture testing was performed twice a week until the technological maturity. The obtained results show that both the tested factors had a significant effect on seed moisture content, while their interaction had no statistical significance. On average, the highest moisture content was measured in the control variant (24.54%), while between the treatment with 300 g / ha a.i. (20.06%) and 450 g / ha a.i. (19.51%) there was no statistically significant difference.

Key words: sunflower, seeds, seed moisture, desiccation

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U -4

REZULTATI KLIJAVOSTI SEMENA *Trifolium repens* U ISTA PROFICIENCY TESTU 17-2

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Pojava tvrdog semena kao posledica nepropustljivosti semenjače za vodu je izražena kod vrsta iz familije Fabaceae. Kod divljih biljaka ova osobina je biološki opravdana jer omogućava bolji opstanak, ali za poljoprivredu tvrda semena su nepoželjna jer klijaju sa zakašnjenjem i neravnomerno. Prilikom ispitivanja klijavosti semena ovih vrsta u laboratoriji može se primeniti predtretman (prethodno hlađenje, mehanička skarifikacija) pre naklijavanja u optimalnim uslovima. U ovom radu su prikazani rezultati ispitivanja klijavosti semena Trifolium repens sprovedena u 150 laboratorija širom sveta u okviru Proficiency testa 17-2. Ovi testovi su organizovani od strane Međunarodne organizacije za ispitivanje semena (ISTA), a obavezni su za sve akreditovane laboratorije, jer se na taj način kontroliše kompetentnost osoblja, ispravnost aparata i pouzdanost primenjenih metoda ispitivanja. U avgustu 2017. godine distribuirani su uzorci tri partije semena Trifolium repens. U Laboratoriji za ispitivanje semena u Institutu za kukuruz Zemun Polje (LIZP), ispitana je klijavost u septembru primenom mehaničke skarifikacije i prethodnog hlađenja (2 dana na 5-10°C), a zatim klijanje na 20°C. Od 90 akreditovanih laboratorija samo je još jedna primenila mehaničku skarifikaciju, 42 laboratorije nisu primenile nikakav predtretman, a 39 laboratorija je primenilo prethodno hlađenje. Dobijeni rezultati klijavosti u LIZP (Lot1-84.50%, Lot2-84%, Lot3-88.50%) su bili iznad proseka svih laboratorija (Lot1-76.95%, Lot2-79.63%, Lot3-83.27%). Kao glavni zaključak ovog Proficiency testa jeste da je skarifikacija semena značajno smanjila broj tvrdih semena u korist normalnih klijanaca. Razlog retke primene skarifikacije može biti potreba korisnika da dobije adekvatnu informaciju vezanu za broj tvrdih semena koja će se pojaviti prilikom setve semena.

Ključne reči: Trifolium repens, tvrdo seme, skarifikacija

ISTA PROFICIENCY TEST 17-2 GERMINATION RESULTS OF *Trifolium repens* SEED

The presence of hard seeds as a result of water impermeable seed coat is common in species of Fabaceae family. For wild plants, this characteristic allows better survival, but for agriculture production hard seeds are undesirable, due to delayed and uneven germination. In seed testing laboratory several pre-treatments (pre-chill, mechanical scarification) can be applied for germination testing of these species. In this paper, Proficiency test 17-2 germination results of Trifolium repens seeds conducted in 150 laboratories around the world are presented. Those tests are organized by the International Seed Testing Association (ISTA) and are mandatory for all accredited laboratories. In this way laboratory's competence (staff, apparatus, and test methods) is checked. In August 2017, samples of three Trifolium repens seed lots were distributed. In the Seed Testing Laboratory at the Maize Research Institute Zemun Polje (LIZP), germination was tested in September using mechanical scarification and pre-chilling (2 days at 5-10 °C) prior to germination at 20 °C. Among 90 accredited participants, only one more laboratory applied mechanical scarification, 42 laboratories did not use any pre-treatment, and 39 laboratories applied pre-chilling. Obtained germination results in LIZP (Lot1-84.50%, Lot2-84%, Lot3-88.50%) were higher than overall mean (Lot1-76.95%, Lot2-79.63%, and Lot3-83.27%). The main conclusion of this Proficiency test is that seed scarification significantly reduced the number of hard seeds in favour of normal seedlings. The reason for the rare application of scarification may be the requirement of the applicant to obtain adequate information regarding the number of hard seeds that will appear during seed sowing.

Key words: Trifolium repens, hard seeds, scarification

FP-1

NOVE SORTE VINOVE LOZE – VOŽD I VLADUN

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Rad na stvaranju novih sorti vinove loze na Poljoprivrednom fakultetu, Univerziteta u Beogradu je veoma intenzivan. U ranijem periodu, primenom metode planske hibridizacije stvorene su 23 sorte različitog vremena sazrevanja i namene, od kojih je poslednja priznata 2001. godine. Tokom 2017. godine, priznato je pet novih sorti vinove loze, od kojih su sorte Vožd (Začinak × Prokupac) i Vladun (Merlo × Župski Bojadiser) namenjene za proizvodnju crvenih vina. U ovom radu prikazane su najvažnije morfološke i proizvodno-tehnološke karakteristike novih sorti Vožd i Vladun, u uporednim proučavanjima sa standardnom sortom Kaberne Sovinjon tokom trogodišnjeg perioda ispitivanja (2015–2017). Novopriznate sorte se odlikuju hermafroditnim tipom cveta, zbijenim grozdom, okruglim oblikom bobice i plavo-crnom bojom pokožice. Prinos, kao i masa, dužina i širina grozda bili su kod obe sorte veći u poređenju sa standardnom sortom. Sorta Vožd imala je prinos od 1,29 kg/m^2 i masu grozda od 174,3 g, dok je kod sorte Vladun utvrđen prinos od 0,87 kg/m^2 i masa grozda od 153,7 g. Kod sorte Kaberne Sovinjon, prinos grožđa iznosio je 0,78 kg/m^2, a masa grozda 134,0 g. Sadržaj šećera i ukupnih kiselina u širi kod sorte Vožd bio je 20,5% odnosno 6,5 g/l, a kod sorte Vladun 21,8% odnosno 6,0 g/l. Vino od obe sorte bilo je pitko, harmonično, sa specifičnim sortnim mirisom i ukusom, i sadržalo je 12,1 vol. % alkohola (sorta Vožd), odnosno 12,6 vol. % alkohola (sorta Vladun). Zbog niza pozitivnih osobina grožđa i vina, očekuje se širenje sorti Vožd i Vladun u proizvodnim vinogradima Republike Srbije.

Ključne reči: *Vitis vinifera*, hibridizacija, nova sorta, morfološke osobine, prinos, kvalitet

NEW GRAPEVINE CULTIVARS – VOŽD AND VLADUN

The work on breeding grapevine cultivars at the Faculty of Agriculture, University of Belgrade is very intensive. By the method of planned hybridization, 23 cultivars of different ripening time and purposes were developed, the last of which was released in 2001. During 2017, five new grapevine cultivars were released, two of them Vožd (Začinak × Prokupac) and Vladun (Merlot × Župski Bojadiser) intended for the production of red wines. This paper presents the most important morphological and production-technological characteristics of these new cultivars that were compared with the standard cultivar Cabernet Sauvignon during the three-year period of testing (2015–2017). The newly released cultivars are characterised by a hermaphrodite type of flower, a dense bunch, a round shape of berry and a blue black color of the skin. The yield and morphometric properties of bunch (weight, length and width) were higher in both cultivars in comparison to the standard cultivar. The yield and bunch weight of the newly released cultivars were 1.29 kg/m^2 and 174.3 g for Vožd, as well as 0.87 kg/m^2 and 153.7 g for Vladun. For the Cabernet Sauvignon, the grape yield and the bunch weight were 0.78 kg/m^2 and 134.0 g, respectively. The content of sugar and total acids in the must of the Vožd was 20.5% and 6.5 g/l, while for the Vladun it was 21.8% and 6.0 g/l respectively. Wine of both cultivars was drinkable, harmonious, with a specific varietal of smell and taste and contained 12.1 vol. % of alcohol (Vožd cultivar), or 12.6% vol. % of alcohol (Vladun cultivar). Due to the numerous positive features of the grapes and wines of cultivars Vožd and Vladun, their spread to the production vineyards of the Republic of Serbia is expected.

Key words: *Vitis vinifera*, hybridization, new cultivar, morphological traits, yield, quality

FP-2

AGRONOMSKE KARAKTERISTIKE NOVE SORTE BEZOSNOG VLASENA KRUŠEVAČKI 46 (K-46)

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Bezosni vlasen (*Bromus inermis* Leyss.) je višegodišnja krmna rizomatska trava koja je rasprostranjenja u skoro celoj Srbiji, ali se nalazi uglavnom pored puteva i na rubovima semikserofilnih i mezofilnih prirodnih travnjaka. Karakteriše ga visok i stabilan prinos krme, što ga svrstava u grupu bitnih krmnih trava za komponovanje smeša naročito pri uslovima suše i na lošim zemljištima u agroekološkim uslovima Srbije. Kao krmna biljka koristi se uglavnom u smešama sa drugim travama i leguminozama za proizvodnju sena, ali se može koristiti i za spravljanje silaže.
Sorta K46 je dobijena višestrukom rekurentnom selekcijom genotipova koji su kolekcionisani širom centralne Srbije u prethodnih deset godina. Glavni oplemenjivački cilj pri oplemenjivanju ove sorte bezosnog vlasena je bilo poboljšanje prinosa i hemijskog sastava suve materije. Inače ova biljna vrsta se odlikuje visokom olistalošću sa velikim, ali u isto vreme dosta grubim listovima, pa se poboljšanje kvaliteta suve materije postiže i pravovremenim iskorišćavanjem biljne mase u fazi pred početak klasanja i oplemenjivanjem karaktristika lista. Sorta je kosidbenog tipa i podnosi sušna, slaba i erodirana zemljišta, pa stoga odlične rezultate pokazuje na travnjacima u brdsko-planinskom području, iako se može sejati i u niziji.
U sortnim ogledima na tri lokacije u dvogodišnjem periodu (2015 i 16) dostigla je prosečan prinos suve materije od oko 6400 kg/ha. Prosečna visina biljaka u trenutku kosidbe je iznosila 81,6 cm. Sadržaj sirovih proteina u prvom otkosu je iznosio 11,61 %, a u drugom otkosu 13,51 %, što predstavlja dobar kvalitet travne biomase.
Nova sorta bezosnog vlasena je veoma pogodna za komponovanje smeša za dugotrajne i otporne travnjake na lakim, marginalnim i sušnim zemljištima gde stabilizuje zemljište i produkuje dovoljnu količinu stočne hrane zadovoljavajućeg kvaliteta koji se uz upotrebu leguminoza u smešama može bitno popraviti.

Ključne reči: bezosni vlasen, nova sorta, prinos suve materije, kvalitet suve materije

TR31057 „Poboljšanje genetičkog potencijala i tehnologija proizvodnje krmnog bilja u funkciji održivog razvoja stočarstva“

AGRONOMIC CHARACTERISTICS OF NEW CULTIVAR OF SMOOTH BROMEGRASS KRUŠEVAČKI 46 (K-46)

Smooth bromegrass (*Bromus inermis* Leyss.) is perennial forage rhizomatous grass, spread throughout Serbia, mostly along the roads and at the edges of meso-xerophylous and mesophylous natural grasslands. Smooth bromegrass is important forage perennial grasses with high and stable yield and it is component of mixtures with legumes and other grasses, particularly in dry conditions on marginal soils. It has been usually used for intensive production of hay and silage.

Cultivar K46 is created by multiple phenotypic recurrent selection from genotypes collected throughout central Serbia in the past ten years. The primary aim in breeding process of smooth bromegrass was to create cultivar of good production and dry matter quality with improved adaptability to local agro ecological conditions. Smooth bromegrass is characterized by high leaf mass with slightly rough leaves. Improving of forage quality can be obtained by cutting in optimum phase at the beginning of tillering, or by improvement of leaf characteristics by breeding.

K46 is a high yield forage cultivar, with good dry matter quality for different aspects of mixtures utilization. K46 can be grown in hilly mountain areas, but also in lowlands. Average dry matter yield in two-year plot trial (2015 and 2016) at three locations was 6400 kg/ha. Plants were 81.6 cm high in average. This new cultivar of smooth bromegrass had a good forage quality. Crude protein content in the first cut was11.61 % and in the second cut 13.51 %.

New cultivar of smooth bromegrass is suitable for composing of mixtures for long lasting, resistant and productive grassland for stabilizing soils in semi-dry conditions.

Key words: smooth bromegrass, new cultivar, dry matter yield, DM quality

FP-3

NS616b – NOVI HIBRID KUKURUZA BELOG ZRNA

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U Srbiji je trenutno postoji 290 registrovanih hibrida žutog zrna Instituta za ratarstvo i povrtarstvo - Novi Sad, od kojih su samo četiri hibrida belog zrna. Hibridi belog zrna se prvenstveno koriste u ishrani ljudi za spravljanje belog kukuruznog brašna. Cilj ovog rada je prikaz agronomskih osobina novog hibrida kukuruza belog zrna NS616b. U ogledima Komisije za priznavanje hibrida na više lokaliteta u toku 2015. i 2016. godine, hibrid NS616b je ostvario značajno viši prinos zrna u odnosu na standard. Može se očekivati da će novi hibrid dati značajan doprinos unapređenju proizvodnje belog zrna kukuruza u narednom periodu, s obzirom da pored višeg prinosa poseduje i superiorne agronomske kvalitete, kao što su otpornost na poleganje, štetočine i bolesti; kao i očuvanju varijabilnosti genetskog materijala kukuruza adaptiranog na agroekološke uslove Srbije.

Ključne reči: Zea mays L. beli hibrid, prinos zrna

Rezultat projekta: TR31073, „Unapredjenje proizvodnje kukuruza i sirka u uslovima stresa“

NS616b – NEW WHITE KERNEL MAIZE HYBRID

The Institute of Field and Vegetable Crops has more than 290 maize hybrids of diverse genetic origin registered in the Republic of Serbia, of which only four are white kernel maize hybrids. Their primary use is in the human diet, which is reflected in somewhat different selection criterions in the process of breeding. Here, we present the basic agronomic characteristics of white maize hybrid NS616b. In wide scope multi-location field test trials during 2015 and 2016 vegetative season conducted by the Commission for the registration of varieties, NS616b presented significantly higher yield compared to the commercial standard. NS616b has the prospect of making a significant contribution to the maize production in the future with its high yield and other agronomic traits, as well as to contribute to variability of the maize genetic material of the Institute of Field and Vegetable Crops that has already been successfully adapted to the agroecological conditions of the region.

Key words: *Zea mays* L. white maize hybrid, grain yield

Result of the project: TR31073 "Maize and sorghum production improvement in stress conditions"

FP-4

NS 4000, NS 4040 I NS 6000 – NOVI HIBRIDI KUKURUZA

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Glavni cilj svakog komercijalno orijentisanog oplemenjivačkog programa je stvaranje hibrida koji po osnovnim agronomskim karakteristikama prevazilaze postojeće standarde. Kao standardi, koriste se hibridi dobrih agronomskih svojstava široko rasprostranjeni u praksi. Svake godine Institut za ratarstvo i povrtarstvo u cilju registracije testira veći broj hibrida kukuruza u ogledima komisije za priznavanje sorti Republike Srbije. U zadnjem ciklusu testiranja, priznato je nekoliko hibrida od kojih poseban akcenat stavljamo na NS 4000, NS 4040 i NS 6000. U pitanju su dva hibrida iz FAO grupe 400 i jedan iz FAO grupe 600. Sva tri hibrida su u dvogodišnjem ispitivanju ostvarili značajno viši prinos zrna od proseka dva standarda, uz niži sadržaj vlage u zrnu u berbi kao i zadovoljavajući nivo tolerantnosti prema poleganju, mehurastoj gari i kukuruznom plamencu. Hibridi su stvoreni konvencionalnim oplemenjivanjem i namenjeni proizvodnji zrna u uslovima suvog ratarenja i navodnjavanja. Zajednička karakteristika sva tri hibrida su visok nivo tolerantnosti prema biotičkom/abiotičkom stresu kao i brz gubitak vlage iz zrna nakon fiziološke zrelosti, što predstavlja osnovni zahtev profitabilne proizvodnje kukuruza. U cilju pune komercijalizacije, hibridi će biti dodatno testirani u postkomisijskim ogledima na većem broju lokaliteta koji reprezentuju celo proizvodno područje naše zemlje.

Ključne reči: kukuruz, hibrid, prinos zrna, tolerantnost

NS 4000, NS 4040 AND NS 6000 – NEW MAIZE HYBRIDS

The main goal of each commercially oriented breeding program is to create hybrids that, by basic agronomic characteristics, exceed the existing standards. Hybrids of good agronomic properties, widely accepted in practice are used as standards. Every year, the Institute of Field and Vegetable Crops is testing a series of maize hybrids in the Commission for the recognition of varieties of the Republic of Serbia. In the last test cycle, several hybrids have been recognized, of which special emphasis is placed on NS 4000, NS 4040 and NS 6000. Two hybrids belong to the FAO group 400 and one to the FAO group 600. In the two-year trials, all three hybrids achieved grain yield significantly higher than the average of two standards, with a lower grain moisture at harvest, as well as a satisfactory level of tolerance to lodging, corn smut and corn borer. The hybrids are created by conventional breeding methods and are intended for grain production in dry farming and irrigation. A common feature of all three hybrids is the high level of tolerance to biotic/abiotic stress, as well as the rapid dry down rate after physiological maturity. These traits are the basic prerequisite for profitable maize production. For the purpose of full commercialization, hybrids will be further tested in post-commission trials on a number of sites that represent the entire production area of our country.

Key words: maize, hybrid, grain yield, tolerance

FP-5

ZP 4567 – NOVI HIBRID KUKURUZA

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Poslednjih nekoliko godina u Srbiji je sve prisutniji trend uvođenja u proizvodnju srednje ranih hibrida kukuruza koji se odlikuju nižim sadržajem vlage u zrnu u momentu berbe i koji su pogodni za vršidbu u zrnu. Prednost hibrida kraćeg vegetacionog perioda posebno je uočljiv u godinama sa deficitom padavina i visokim temperaturama u fazi cvetanja. Druga značajna prednost srednje ranih hibrida je ranija vršidba i nakon vršidbe ovih hibrida preostaje dovoljno vremena da se zemljište pripremi za setvu narednog useva. Hibrid ZP 4567 je u ogledima sortne komisije ispitivan tokom 2016-2017. godine u okviru FAO grupe zrenja 500. Prva godina ispitivanja bila veoma povoljna sa aspekta agroekoloških gajenja kukuruza, dok se 2017. godina odlikovala izuzetno visokim temperaturama i deficitom padavina tokom vegetacione sezone. Hibrid ZP 4567 je u obe godine ispitivanja ostvario viši prosečan prinos u odnosu na oba standardna hibrida, uz niži sadržaj vlage u odnosu na standarde. U proseku, tokom dvogodišnjih ispitivanja imao je 9,9 % viši prinos, kao i 2 % niži sadržaj vlage u berbi u odnosu na prosek standardnih hibrida. Zrno ovog hibrida je u tipu zubana, hibrid ima srednje visoku stabljiku sa srednjim položaj klipa. Odlikuje se visokim potencijalom rodnosti, visokom stabilnošću prinosa, tolerantnošću na sušu, kao i brzim otpuštanjem vlage iz zrna.

Ključne reči: hibrid kukuruza, prinos, sadržaj vlage

ZP 4567 – NEW MAIZE HYBRID

During the last few years, there is an increasing trend in the introduction of medium early hybrids in Serbia, which are characterized by lower moisture content in the harvest and suitability for direct harvesting. The advantage of the hybrids with shorter vegetation period is especially noticeable in years with a deficit of precipitations and high temperatures in the flowering stage. Another significant advantage of medium-early hybrids is the early harvest and after harvesting there is enough time in order to prepare soil for the sowing of the next crop. The hybrid ZP 4567 was examined during the 2016-2017 in the Variety State Commission trials, in FAO 500 maturity group. The first year of testing was very favorable from the aspect of agroecological conditions, while 2017 was characterized by extremely high temperatures and a deficit of precipitation during the vegetation season. The hybrid ZP 4567 achieved higher average yield in both years compared to the both check hybrids, with lower moisture content compared to checks. On average, during the two-year trials, it had 9.9 % higher yield, and 2 % lower moisture content in harvest than the average of the check hybrids. This hybrid has dent type of grain, has a medium tall stalk with a middle ear position. It is characterized by high yield potential, high yield stability, good drought tolerance and rapid dry down rate.

Key words: maize hybrid, yield, moisture content

FP-6

ZP 6118k NOVI HIBRID KOKIČARA INSTITUTA ZA KUKURUZ "ZEMUN POLJE"

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Kukuruz kokičar predstavlja veoma profitabilnu kulturu sa stanovišta proizvođača i prodavaca, jer je veoma tražena i popularna vrsta povrća. S druge strane potrošači su veoma zainteresovani za njegov proizvod prijatnog ukusa. Koristi se u ljudskoj ishrani i odlikuje se visokim sadržajem vlakana, dobar je izvor kalcijuma, gvožđa, fosfora, niacina, a takođe ima i nisku kalorijsku vrednost. Pored prinosa kao najvažnije osobine koja se prati kod svih gajenih biljaka za kukuruz kokičar veoma je bitna i zapremina kokičavosti, ali i senzorne karakteristike kokica. Novi hibrid stvoren u Institutu za kukuruz „Zemnu Polje" ZP 6118k registrovan je 2018. godine. Hibrid ZP 6118k pripad FAO grupi zrenja 700. Prinos zrna u test ogledima iznosio je 6,5 – 7 t/ha, što ga čini 8-10% prinosnijim od dobro poznatog komercijalnog hibrida ZP 611k. Zrno je tamno žute boje u tipu biserca. Odlikuje se veoma visokom zapreminom kokičavosti od 39,5 cm3/g. Kokica je leptirastog oblika i zadovoljava sve senzorne karakteristike u pogledu izgled, ukus, miris, nežnost i hrskavost, lepljenje za zube, prisustva perikarpa.

Ključne reči: kukuruz kokičar, zapremina kokičavosti, senzorne karakteristike

Zahvalnica: *Ovaj rad je rezultat projekta TR 31037 finansiranog od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije*

ZP 6118k NEW POPCORN HYBRID FROM MAIZE RESEARCH INSTITUTE ZEMUN POLJE

Popcorn is very profitable crop both from the point of producers and merchants, because it is very popular vegetable. Consumers are also very interested in its product – flake which has very pleasant taste. It is consumed in human nutrition and it is a good source of fiber, calcium, iron, phosphorus, niacin, and has low caloric value. Beside the yield as the major trait in any crop, in popcorn some other parameters of popped kernel are also essential such as popping volume and sensory characteristics of popcorn flake. New popcorn hybrid ZP6118k developed at Maize Research Institute Zemun Polje, is released in 2018. This hybrid belongs to the FAO maturity group 700. Average grain yield in test trials was 6.5-7 t/ha, which is 8-10% more than well-known commercial hybrid ZP 611k. Kernel is pearl type and dark yellow. It possess high popping volume of 39.5 cm3/g. Popcorn flake is buterfly shaped and it has all good sensory characteristics concerning appearance, taste, smell, tenderness, crispness, adhesiveness to the teeth and presence of pericarp.
Key words: popcorn, popping volume, sensory characteristics

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FP-7

PROCENA STABILNOSTI PRINOSA HIBRIDA ZPSC 434 SA RAZLIČITIM PROCENTOM UČEŠĆA FERTILNIH I STERILNIH BILJAKA

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U proizvodnji hibridnog semena kukuruza najvažniji zadatak je proizvodnja kvalitetnog semenskog materijala, kao visina i stabilnost prinosa. Visina prinosa zavisi od genetičkog potencijala za prinos, dok stabilnost prinosa zavisi od sposobnosti reagovanja hibrida na uslove sredine. Stabilnost u postizanju očekivanog prinosa jedna je od najpoželjnijih osobina da bi genotip bio preporučen kao hibrid za široko gajenje. U ovim istraživanjima se polazi od pretpostavke da se proučavani hibrid kukuruza, različit procenat učešća fertilnih biljaka različito ponašaju na promene faktora spoljašnje sredine, čime ispoljavaju i različitu stabilnost prinosa. Na osnovu te pretpostavke, očekuje se izdvajanje različitih nivoa fertilnih biljaka čiji prinos najmanje varira pod uticajem promena spoljašnje sredine. Cilj rada bio je da se izvrši procena stabilnosti prinosa zrna po Eberhart-u i Russell-u (1966). Parametri stabilnosti (koeficijent - bi i standardna greška regresije - S^2di) su pokazali koji odnos sterilne i fertilne varijante hibrida je ostvario najveću stabilnost, odnosno koji su najbolje reagovali na povoljne, tj. nepovoljne uslove spoljne sredine. Kod najstabilnijeg hibrida utvrđeno je učešće od 25% fertilnih biljaka (bi - 1,000), dok je kod hibrida sa 60% učešća fertilnosti bolje reagovao na povoljne uslove gajenja (bi - 1,326), a genotip koji je bolje reagovao na lošije uslove spoljne sredine imao je 10% učešća fertilnih biljaka (bi - 0,791).

Ključne reči: citoplazmatična muška sterilnost, kukuruz, prinos, stabilnost

THE ESTIMATION OF YIELD STABILITY OF THE HYBRID ZPSC 434 WITH VARIOUS PERCENTAGE SHARES OF FERTILE AND STERILE PLANTS

In the production of hybrid maize seed, the most important task is to produce high-quality seed material and to provide high and stable yields. Yield depends on genetic potential of yielding, while stability depends on ability of hybrids to respond to environmental conditions. Stability in achieving expected yield is one of the most favourable traits for a genotype to be recommended as a hybrid for wide cultivation. The starting point in these studies was that observed maize hybrid and different percentage of share of fertile plants would differently respond to changes in the environmental factors, whereby yield stability would differ. Based on this assumption, the distinguishable levels of fettilie plants whose yields vary the least under envoronmental conditions were expected. The aim was to estimate grain yield stability after Eberhart and Russell (1966). The stability parameters (coefficient - bi and standard error of regression - S^2di) point out to which ratio of sterile to fertile variant of the hybrid had the highest stability, i.e. which variants responded best to favourable, i.e. unfavourable environmental conditions. The share of fertile plants in the most stable hybrid was 25% (bi - 1.000) while a hybrid with 60% fertility responded better to favourable growing conditions (bi - 1.326). A genotype that responded better to unfavourable environmental conditions had 10% of fertile plants (bi - 0.791).

Key words: cytoplasmic male sterility, maize, yield, stability

P-1

NS Zlatka i NS Slatka - PRVE SRPSKE SORTE LANIKA (*Camelina sativa*, L. Crantz)

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NS Zlatka i NS Slatka su registrovane u Srbiji kao prve sorte lanika (*Camelina sativa*, L. Crantz) 2018.godine, ali je seme ove vrste nađeno u arheološkim nalazištima još iz bronzanog doba na području severnog Balkana. Poslednjih godina interes za lanikom se ponovo povećava zbog njegove raznovrsne upotrebe i skromnih agroekoloških zahteva gajenja. U dvogodišnjem ogledu sorte kanditati su ispitivane u tri lokaliteta: Sombor, Pančevo i Novi Sad prema Pravilniku o metodama ispitivanja sorte lanika radi priznavanja sorte. Proizvodna i upotrebna vrednost sorte utvrđena se na osnovu rezultata ispitivanja bitnih osobina sorte za ovu vrstu. Prosečan prinos semena nešto je veći kod sorte NS Zlatka (1056 kg/ha) nego kod sorte NS Slatka (1019 kg/ha). Sadržaj ulja kod obe sorte je gotovo jednak 42,28% (NS Zlatka) i 42,12% (NS Slatka), pri čemu prinos semena uzrokuje veći prinosu ulja od 6 kg/ha kod sorte NS Zlatka. Sadržaj proteina je u negativnoj korelaciji sa sadržajem ulja i u dvogodišnjem proseku svih lokaliteta je bio 23,9 % i 24,3 %, a prinos 216 i 213 kg/ha, (NS Zlatka i NS Slatka). Ispitivane su i komponete prinosa: broj semena po ljusci i broj ljuski po biljci, kao i visina biljke i % vlage u semenu u žetvi. Od osobina kvaliteta određen je masnokiselinski sastav. Najzastupljenije su nezasićene masne kiseline: linolenska, linolna i oleinska i sorte se među sobom razlikuju u njihovom sadržaju, a uočava se i uticaj lokaliteta na sastav ulja. Sadržaj štetne eruka kiseline je nizak (oko 3 %) što omogućava upotrebu ulja ovih sorti u ishrani ljudi i domaćih životinja.

Ključne reči: Camelina, ulje, proteini, eruka kiselina

Rezultat projekta: TR 31025, „Razvoj novih sorti i poboljšanje tehnologija proizvodnje uljanih biljnih vrsta za različite namene“

NS Zlatka AND NS Slatka – THE FIRST SERBIAN CULTIVARS OF CAMELINA (*Camelina sativa*, L. Crantz)

NS Zlatka and NS Slatka cultivars were registered in Serbia in 2018. They were the first cultivars of Camelina (*Camelina sativa*, L. Crantz) even though Camelina seeds were found at the Bronze Age archeological sites in the northern Balkan Peninsula. The recent increased interest in Camelina is due to its versatility and environmental flexibility. Candidate cultivars were tested in a two-year trial at three localities - Sombor, Pančevo, and Novi Sad - according to the regulations on the methods of testing Camelina for cultivar registration purposes. The usability and value of the cultivars was determined according to the analysis of significant cultivar traits. Average seed yield of NS Zlatka cultivar was slightly higher (1056 kg/ha) compared to NS Slatka (1019 kg/ha). Oil content of the cultivars was almost the same: 42.28% (NS Zlatka) and 42.12% (NS Slatka), whereas higher seed yield resulted in higher oil yield, amounting to 6 kg/ha obtained from the cultivar NS Zlatka. Negative correlation between protein content and oil content was confirmed on the basis of the two-year averages in all three trial locations, revealing 23.9% and 24.3% protein content, as well as 216 kg/ha and 213 kg/ha oil yield in cultivars NS Zlatka and NS Slatka, respectively. The trial included analysis of the major yield components: seed/hull ratio, hull percentage, as well as plant height and moisture content in post-harvested seeds. Among the quality indicators, fatty acid content tests resulted in the highest content of unsaturated fatty acids - linolenic, linoleic and oleic acid - with different levels among the tested cultivars, and different oil content depending on locality. Content of the harmful erucic acid was low (about 3%), thus confirming the prospective use of these oils as food and feed.

Key words: Camelina, oil, proteins, erucic acid

Result of the project: TR 31025, "Development of new varieties and production technology improvement of oil crops for different purposes"

P-2

ORGANSKO SEME I STANJE NJEGOVE PROIZVODNJE U REPUBLICI SRBIJI

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Već duži niz godina organska poljoprivredna proizvodnja na globalnom nivou zauzima sve veće površine. Ovaj vid proizvodnje je u potpunosti zakonski regulisan brojnim zakonima i pratećim pravilnicima, a osnovni principi za razvoj ovog vida proizvodnje propisani su od strane IFOAM-a *(International Federation of Organic Agriculture Mvements)* i Evropske Unije. Izuzetno važno mesto u sistemu organske poljoprivrede zauzima proizvodnja semena, jer je upotreba sertifikovanog semena ključna u očuvanju njegove proizvodnje. U Republici Srbiji do 2009. godine nije postojala proizvodnja sertifikovanog organskog semena, usled čega su proizvođači koristili seme iz lokalnih populacija i konvencionalno hemijski netretirano seme. Od ukupnih površina pod organskom biljnom proizvodnjom (14357,96 ha) u Republici Srbiji, semenska proizvodnja se odvija na svega 8,4 ha, uz nejednaku raspodelu prema regionima. U regionu Vojvodine se odvija najveća proizvodnja organskog semena na površini od 5,2 ha. Međutim, u zemlji je i dalje prisutan nedostatak sertifikovanog organskog semena, te je neophodno u narednom period pokrenuti ne samo organsko semenarstvo, već i organsko oplemenjivanje.

Ključne reči: organska proizvodnja, zakonska regulativa, površine, cene

ORGANIC SEED AND THE STATUS OF ITS PRODUCTION IN THE REPUBLIC OF SERBIA

For many years, organic agricultural production has grown globally in ever-larger areas. This type of production is fully legally regulated by numerous laws and accompanying regulations, while the basic principles for the development of this type of production are prescribed by the IFOAM (International Federation of Organic Agriculture Movements) and the European Union. The seed production is extremely important within the organic agricultural system, since the use of certified seed is crucial in preserving its production. Until 2009, in the Republic of Serbia, certified organic seed was not produced, due to which producers used seeds of landraces and conventionally chemically untreated seeds. Of the total area under organic plant production in the Republic of Serbia (14357.96 ha), seed production is performed on only 8.4 ha, with unequal distribution over regions. The greatest organic seed production (5.2 ha) is carried out in the region of Vojvodina. However, there is still lack of certified organic seed in the country, and therefore it is necessary, in the following period, to start not only organic seed production, but also organic breeding.

Key words: organic production, legal regulations, areas, prices

P-3

ODREĐIVANJE RELEVANTNIH PARAMETARA PRI DORADI SEMENA CRVENE DETELINE (*Trifolium pratense* L.)

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Rad prikazuje rezultate ispitivanja pri doradi naturalnog semena crvene deteline (*Trifolium pratense* L.) različitih početnih čistoća u doradnom centru Instituta za krmno bilje u Kruševcu. Seme crvene deteline za setvu mora biti čisto, visoke klijavosti i genetske vrednosti. Najveći deo ovih zahteva je moguće ostvariti kroz doradu, odnosno odstranjivanjem nečistoća i semena lošijeg kvaliteta. Pri procesu dorade semena crvene deteline postoji veći broj tehničko-tehnoloških operacija kao što su: čišćenje, deklarisanje, pakovanje u odgovarajuću ambalažu i skladištenje. Zadatak čišćenja semena je da se iz naturalnog semena sa primesama uklone sva druga semena, korovi, primese i izdvoji čisto seme osnovne kulture. Na taj način seme se blagovremeno priprema u povoljno stanje za kvalitetnu setvu, klijanje i nicanje. Pri procesu dorade semena crvene deteline određivani su relevantni parametri na mašinama za doradu. Relevantni parametri pri doradi semena crvene deteline bili su: čisto seme (%), seme korova i seme drugih kultura (%), inertne materije (%), količina dorađenog semena (kg), gubici semena (%) i randman dorade (%). Gubici semena crvene deteline pri doradi su u direktnoj zavisnosti od vrste i količine korova i ostalih nečistoća prisutnih u naturalnom semenu. Na osnovu dobijenih rezultata moguće je izvršiti optimalno podešavanje i izbor odgovarajućih mašina za doradu semena crvene deteline, u zavisnosti od količine i vrste korova i ostalih primesa u naturalnom semenu crvene deteline.

Ključne reči: seme, dorada, crvena detelina, relevantni parametri.

Zahvalnica: Ovaj rad je rezultat istraživanja projekta TR 31057

DETERMINATION OF RELEVANT PARAMETERS IN THE RED CLOVER SEED PROCESSING (*Trifolium pratense* L.)

The paper presents the results of the seed processing of the natural red clover seed (*Trifolium pratense* L.) with different initial purity in the seed processing center of the Institute for forage crops in Kruševac. Seeds of red clover for sowing must be clean, with high germination and high genetic value. Most of these requirements can be achieved through the seed processing, by the removal of impurities and seeds with poorer quality. In this process, there are number of technical-technological operations such as: cleaning, declarations, packaging in appropriate wrapping material and storage. The task of cleansing seeds is to remove all other seeds, weeds, impurities and extracts pure seed of the basic culture. In this way, the seed is prepared in a timely manner for good germination, sprouting, and cropping. During the processing, the relevant parameters of the red clover seeds were determined: pure seed (%), weeds and seed of other cultures (%), inert matter (%), amount of processed seed (kg), seed losses (%) and processing output of the seed processing (%). The losses of red clover seeds in seed processing are in direct dependence on the type and quantity of weeds and other impurities present in the natural seed. On the basis of the obtained results, it is possible to optimally adjust and select the appropriate equipment for the red clover processing, depending on the quantity and type of weeds and other ingredients in the natural red clover seeds.

Key words: seeds, processing, red clover, relevant parameters.

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P-4

ZAVISNOST POKAZATELJA KVALITETA SEMENA RAZLIČITIH POPULACIJA PAPRIKE OD METODA ISPITIVANJA

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Cilj rada bio je utvrđivanje zavisnosti dva najvažnija pokazatelja kvaliteta semena različitih populacija paprike, energije klijanja i ukupne klijavosti od metode ispitivanja. Ocena klijavosti semena je izvedeno na dve različite podloge (filter papir i supstratu). Za istraživanje je korišteno sedam populacija semena sorti paprike različitog porekla (Slatka začinska - Negotin, Ljuta začinska - Negotin, Krivopetlja - Badovinci, Crvena duga - Belotić, Krivopetlja - Šabac, Duga zelena - Svilajnac, Šorokšari - Stara Pazova). Rezultati energije klijanja i ukupne klijavosti kod ispitivanih populacija sorti paprike značajno su veće (p=0,01) na podlozi filter papir, u odnosu na vrednosti dobijene na supstratu. Najveća prosečna energija klijanja 76 % i ukupna klijavost 93 %, utvrđena je kod populacije Slatke začinske paprike iz Negotina, dok su najmanje prosečne vrednosti 42 %, odnosno 57 % zabeležene kod populacije Krivopetlje iz Badovinaca. Statistička analiza energije klijanja i ukupne klijavosti pokazala je značajne (p=0,01) razlike pod uticajem populacije i podloge ispitivanja. Između dve ispitivane metode za energiju klijanja i ukupnu klijavost ustanovljena je značajna korelativna međuzavisnost (r=0,471, p=0,01). Veoma je važno da seme paprike ima visoku energiju klijanja i ukupnu klijavost, jer od njih zavisi ujednačeno klijanje i nicanje semena. Sprovedena ispitivanja su izvedena i sa ciljem da se ukaže na značaj očuvanje genetičkih resursa domaćih populacija paprike.

Ključne reči: populacije semena paprike, klijavost, paprika.

Rezultat projekta: TR 31018: "Razrada integrisanog upravljanja i primene savremenih principa suzbijanja štetnih organizama u zaštiti bilja"

DEPENDENCE OF QUALITY INDICATORS OF DIFFERENT POPULATIONS PEPPERS OF TESTING METHODS

The aim of this study was to determine the dependence of the two most important seed quality indicators for different populations of peppers, germination energy and total germination of the test methods. The seed germination is carried out on two different ways (filter paper and substrate). Seven populations of peppers seeds from different origin were used (Slatka začinska - Negotin, Ljuta začinska - Negotin, Krivopetlja - Badovinci, Crvena duga - Belotić, Krivopetlja - Šabac, Duga zelena - Svilajnac, Šorokšari - Stara Pazova). Results of germination energy and total germination in the investigated populations of pepper varieties significantly ($p = 0.01$) of higher values on the filter paper, compared to the values obtained on the substrate.

The highest average germination energy of 76% and total germination rate of 93% was determined in the population of Slatka začinska from Negotin, while the lowest average values were 42 % and 57 %, respectively in the population Krivopetlja from Badovinci. Statistical analysis of germination energy and total germination showed significant ($p = 0.01$) differences under the influence of the population and testing methods. Significant correlative interdependence ($r = 0.471$, $p = 0.01$) was found among the two methods for germination energy and total germination. It is very important that the pepper seeds have high germination energy and total germination, since they depend on the uniform germination and seeding of seeds. The conducted tests were carried out with the aim of indicating the importance of conserving genetic resources domestic populations of peppers.

Key words: populations of peppers seeds, germination, pepper

Project: TR 31081: "Development of an integrated management and application of modern principles of pest control in plant protection"

P-5

ISPITIVANJE DORMANTNOSTI SEMENA SUNCOKRETA

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U Laboratoriji za ispitivaje semena Instituta za kukuruz Zemun Polje, u toku redovnog ispitivanja klijavosti semena suncokreta, uočeno je kod dve partije semena veliki broj neklijalog semena. Seme je stavljeno na naklijavanje dva puta sa različitim temperaturnim režimom. U toku prvog ispitivanja seme je stavljeno na klijanje metodom između filter papira, hladjenje semena je trajalo 6 dana, energija klijanja je očitana četvrtog dana a ukupna klijavost desetog dana. Seme je naklijavano u klijalištu na 20^0C sa režimom svetlosti 8 sati dan, 16 sati noć. U toku drugog ispitivanja, seme suncokreta je postavljeno na klijanje istom metodom između filter papira, hladjeno je 6 dana, energija klijanja je očitana četvrti dan a završna klijavost deseti dan. Naklijavanje je obavljeno u sobi klijalištu na naizmeničnoj temperaturi 20<=>30^0C, sa svetlosnim režimom 8 sati dan, 16 sati noć. Urađen je i TTZ - tetrazolium test. Analizom dobijenih rezultata uočeno je da na kraju prvog ispitivanja izdvojen veliki broj neklijalog semena koje je bilo sveže bez simptoma bolesti. Na kraju drugog ispitivanja taj procenat je bio manji u odnosu na prvo ispitivanje. Naklijavanje semena na većoj, naizmeničnoj temperaturi 20<=>30^0C, u toku drugog ispitivanja, smanjilo je broj neklijalog semena. TTZ testom je potvrđena vitalnost neklijalog semena.

Ključne reči: suncokret, dormantnost semena, klijavost semena

EVALUATION OF DORMANCE SUNFLOWER SEED LOTS

A great number of nongerminated sunflower seed of two lots were observed during regular testing in the Seed Testing Laboratory of the Maize Research Institute, Zemun Polje. Seeds were germinated twice under different temperature regimes. In the course of the first test, seeds were germinated between filter paper, cooling lasted 6 days, the first count was done on the fourth day, while total germination was determined on the 10^{th} day. Seeds were germinated in the germination cabinet at 200^{o}C with 8 h (light) to16 h (night) regime. In the course of the second test, the method applied was the same: sunflower seeds were germinated between filter paper, cooling lasted 6 days, the first count was done on the fourth day, while total germination was determined on the 10^{th} day. Germination was performed in the germination cabinet at the alternating temperature of 20<=>300^{o}C, and the light regime of 8 h (light) to16 h (night). The TTZ -tetrazolium test was also performed. The analysis of obtained results showed that a great number of nongermination, but fresh and disease-free seeds were detected at the end of the first test. The corresponding percentage at the end of the second test was smaller. Seed germination at higher, alternating temperatures of 20<=>300^{o}C, in the course of the second test, reduced the number of nongerminated seeds. Seed viability was confirmed by the TTZ test.

Key words: sunflower, seed dormancy, seed germination

P-6

ZP 4118su NOVI HIBRID KUKURUZA ŠEĆERCA INSTITUTA ZA KUKURUZ "ZEMUN POLJE"

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Kukuruz šećerac se koristi u ljudskoj ishrani, a odlikuje se brojnim nutritivnim karakteristikama. Ova veoma popularna vrsta povrća koristi se podjednako u svežem stanju, odmah nakon berbe, ali takođe i za dalju industrijsku preradu, zamrzavanje i konzerviranje. S obzirom na načine upotrebe kukuruza šećerca, oplemenjivanje ove vrste usmereno je kako na postizanje visokih i stabilnih prinosa klipa i zrna, ali i na unapređenje tehnoloških i senzornih karakteristika klipa i zrna. Od 70-tih godina XX veka od kada je u Institutu za kukuruz "Zemun Polje", započet program oplemenjivanja kukuruza šećerca do danas stvoreno je više od 35 hibrida. U 2018. godini na osnovu dvogodišnjih ogleda Sortne komisije registrovan je novi hybrid ZP 4118su. Ovaj hybrid je u tipu normalnog kukuruza šećerca sa *su "sugary"* genom i odlikuje se povećanim sadržajem šećera. Ovakva struktura genotipa kukuruza šećerca obezbeđuje sladak ukus i kremastu teksturu. Hibrid ZP 4118su odlikuje se nešto dužom vegetacijom od 80-82 dana, od nicanja do tehnološke zrelosti. Visina biljke je 160-170 cm i odlikuje se veoma slabim bokorenjem. Prinos svežeg klipa bez komušine meren u test ogledima iznosio je 13,5 t/ha. Klip ima 14-16 redova, raspoređenih pravilno, vrh je ozrnjen i prekriven komušinom. Zrno je duboko i tamnije žute boje. S obzirom na pravilnost rasporeda redova i opšti izgled klipa, kao i ujednačenost klipova ovaj hibrid je pogodan i za industrijsku preradu, ali i potrošnju u svežem stanju.

Ključne reči: kukuruz šećerac, prinos svežeg klipa, ocena kvaliteta

Zahvalnica: *Ovaj rad je rezultat projekta TR 31068 finansiranog od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije*

ZP 4118su NEW SWEET CORN HYBRIDS FROM MAIZE RESEARCH INSTITUTE ZEMUN POLJE

Sweet corn is characterized by highly nutritive properties and therefore is used in human consumption. This very popular vegetable is equally used as fresh product right after the harvest, but also for further industrial processing, freezing and canning. Considering the modes of utilization of sweet corn, breeding of this species is devoted to obtaining high and stabile yields but also to the enhancement of technological and sensory properties of the ear and kernel. Since 1970's when the breeding program of sweet corn was initiated in Maize Research Institute Zemun Polje up to now, more than 35 hybrids were released. In 2018 based on the two year Variety State Commission trials, new sweet corn hybrid ZP 4118su was released. This hybrid by its allele composition belongs to the group of normal sweet corns because it contains *su* gene. Such genotype constitution provides recognizable higher sugar content, creamy kernel and soft pericarp. Hybrid ZP 4118su has a longer vegetative season with 80-82 days from emergence in the field until technological maturity, i.e. harvest. Plant is short 160-170cm and with very low tillering. Fresh ear yield measured in test trials was 13.5 t/ha. The ear has 14-16 kernel rows, with fine kernel set, properly arranged, good seed set at the top of the ear and it is covered with husk. The kernel is deep and dark yellow. Considering the fine arrangement of the kernel rows, shape, appearance and uniformity of the ears this hybrid is suitable for the industrial processing, but also for the fresh market.

Key words: sweet corn, fresh ear yield, quality parameters

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ZP399– NOVI HIBRID KUKURUZA

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Cilj oplemenjivačkih programa kukuruza je stvaranje hibrida koji se odlikuju visokim i stabilnim prinosom sa brzim otpuštanjem vlage iz zrna. Institut za kukuruz ima kontinuirani program stvaranja hibrida sa prethodno navedenim osobinama, iz koga je proistekao i hibrid ZP399. U ogledima Komisije za priznavanje hibrida Ministarstva poljoprivrede, na više lokaliteta u dvogodišnjem ispitivanju hibrid ZP399 je ostvario značajno viši prinos zrna od proseka dva standarda, uz niži sadržaj vlage u zrnu u berbi. Hibrid ZP399 je iz FAO grupe 300, žutog zrna u tipu zubana. Karakteriše ga visok potencijal rodnosti, stabilan prinos i dobra tolerantnost prema suši uz brz gubitak vlage iz zrna nakon fiziološke zrelosti. Hibrid je namenjen za proizvodnju zrna u uslovima suvog ratarenja i navodnjavanja.

Ključne reči: hibrid, kukuruz, prinos zrna

Rezultat projekta TR 31068 Ministarstva prosvete, nauke i tehnološkog razvoja

ZP399– NEW MAIZE HYBRID

The main goal of maize breeding program is to create hybrids that are charactazed by high and stable yields with a great grain dry-down rates from grain. Maize Research Institute Zemun Polje has long term breeding program to create hybrids with the aforementioned characteristics. From this program hybrid ZP399 came out. In the two-year trials of the Commission for the recognition of varieties of the Republic of Serbia, hybrid ZP399 achieved grain yield significantly higher than the average of two standards, with a lower grain moisture at harvest. Hybrid ZP399 belong to the FAO300 maturity group has yellow dent type of grain. It is characterized by high yield potential, high yield stability, good drought tolerance as well as the rapid dry down rate after physiological maturity. Hybrid is intended for grain production in dry farming and irrigation.

Key words: maize hybrids, grain yield

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UTICAJ VLAGE NA PROCENAT PRIMESA U BERBI SEMENSKOG KUKURUZA

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Berba je proces u proizvodnji semenskog kukuruza koji nastupa sa fiziološkom zrelošću, sa 35-38% vlage u semenu. Dobrom procenom početka ubiranja semenskog kukuruza smanjuju se negativni efekti koji prate berbu, a to su osipanje semena, lom semena, razvoj patogena, oštećenja klice i perikarpa, loši vremenski uslovi. Rezultati tih efekata je smanjenje kvaliteta semena. Jedan od parametara kvaliteta je i čistoća. U radu su obrađeni podaci prijema kukuruza na devet hibridnih kombinacija, merena je vlaga u toku prijema i procenat primesa. Cilj je bio utvrđivanje njihove zavisnosti. Vlaga je razvrstana u četiri kategorije na svakih 5% vlage, od 25% do 40%. Najveći procenat nečistoća dobijen je pri berbi klipa od 35-40% vlage (8,85%), a najmanje sa vlagom od 25-30%, 6,70% primesa. Na devet različitih genotipova (H1 do H9) procenat primesa kretao se od 1,12% do 21,56%, prosečna vrednost bila je 8,26%, sa odstupanjem od 4,37%. Analizom procenta primesa u odnosu na hibidnu kombinaciju dobijeni su potvrdni rezultati o zavisnosti F=2,28. Vlaga kao drugi parametar u oceni važnosti uticaja na stepen primesa, nema statističkog značaja, kao ni interakcija ova dva faktora. Mali uticaj vlage potvrđen je i njegovim parcijalnim efektom, η^2= 0,006. Značajno odstupanje između hibridnih kombinacija je imao samo jedan hibrid, H6.
Na osnovu rezultata dobijenih u ovom radu, berbu kukuruza, u cilju dobijanja kvalitetnog semena sa što manje primesa, treba prilagođavati prema hibridnim kombinacijama.

Ključne reči: kvalitet, vlaga, primese, kukuruz, berba

THE EFFECT OF MOISTURE ON THE PERCENTAGE OF ADDMIXUTRES OF MAIZE SEED AT HARVEST

Maize seed is harvested at physiological maturity when seed moisture amounts to 35-38%. A good estimation of the beginning of maize seed harvest reduces adverse effects that accompany harvest, such as seed shading, seed breakage, development of pathogens, damages of embryos and pericarp, poor weather conditions. Low quality of seed is a result of these effects. Purity is one of quality parameters. In this study, data obtained in nine hybrid combinations received were processed, moisture and admixture percentage were determined on the seed receipt. The determination of their dependence was the aim of the study. Moisture was classified into four categories of 5% from 25% to 40%. The highest (8.85%) and lowest (6.70%) percentage of impurities were obtained at ear harvest with moisture of 35-40% and 25-30%, respectively. The admixture percentage in nine different genotypes (H1 to H9) varied from 1.12% to 21.56% (on average 8.26%, with the deviation of 4.37%). The analysis of these percentages in relation to the hybrid combination shows the confirmatory results on dependence (F=2.28). Moisture, as the second parameter in the estimation of the importance of its effects on the degree of admixtures, has no statistical significance, nor does the interaction of these two factors. An insignificant effect of moisture was confirmed by its partial effect, $\eta^2 = 0.006$. Among hybrid combinations, only one hybrid, H6, showed significant deviation.
According to obtained results, in order to get high-quality seed, harvest should be adjusted to needs of hybrid combinations.

Key words: quality, moisture, admixtures, maize, harvest

P-9

PROMENA KVALITETA UZORAKA SEMENA TOKOM SREDNJEROČNOG ČUVANJA

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Sve je veći gubitak genetičke raznolikosti živog sveta, pa i gajenog bilja. Vrste i sorte koje su prestale da se gaje na većim površinama još se mogu naći u baštama. Radi njihovog očuvanja organizuju se ekspedicije, popisuju i prikupljaju uzoraci. Smatra se da je najsigurnije istovremeno čuvanje uzoraka na dva načina: na mestu nalaženja, on farm kod gajenog bilja, i *ex-situ*, čuvanje semena u gen bankama.
Tokom 2012. godine sakupljeno je više uzoraka semena gajenih vrsta u nekoliko sela na teritoriji Fruške gore. Provereni su setveni kvaliteti i zdravstveno stanje sakupljenih uzoraka. Uzorci su stavljeni na srednjeročno čuvanje na + 4^0C. Nakon petogodišnjeg perioda čuvanja ispitan je uticaj biljne vrste i početnog stanja uzorka na kvalitet semena. Za ova istraživanja odabrane su sitnosemene vrste koje kratko čuvaju klijavost, mak i salata.
Krupnoća semena nije se smanjila tokom čuvanja. Kod obe ispitivane vrste postojala je veća razlika između ispitivanih uzoraka u energiji i klijavosti semena nakon 5 godina nego na početku čuvanja. Ne uočava se sigurna veza između početnih vrednosti i pada energije i klijavosti tokom čuvanja. Kod salate je gubitak setvenih kvaliteta kao i razlika između energije i klijavosti bio drastičniji nego kod maka. Za uzorke salate se preporučuje obnavljanje semena u periodu kraćem od 5 godina. Na semenu pojedinih uzoraka i nakon čuvanja razvili su se patogeni. Zapažene su većinom saprofitne vrste. Proverom stanja na terenu ustanovljeno je da pojedini uzorci vise ne postoje na mestu nalaženja.

Ključne reči: genetski resursi, uzorci, *ex-situ*, on farm

Rezultat projekta: TR31030, „Stvaranje sorata i hibrida povrća za gajenje na otvorenom polju i u zaštićenom prostoru“

CHANGE OF SEED QUALITY IN ACCESSIONS UNDER MIDTERM STORAGE

There is a growing loss of genetic diversity of the living world, and also of cultivated plants. Species and varieties that have ceased to be cultivated on larger areas can still be found in the gardens and these accessions are collectting. It is believed that the safest is the simultaneous storage of accessions in two ways: at the site of finding, *on- farm*, and *ex-situ* conservation, keeping the seed in the gene banks. During 2012, samples of seeds were collected in several villages in Fruška Gora. Seed quality of collected samples were checked. Accessions were placed on midterm storage at + 4^{o}C. After a five-year storage period, the influence of the plant species and the initial state of the accessions, on the quality of the seed was examined. For this research were selected poppy and lettuce that shortly preserve germination.
Weight 1000 seeds have not decreased during storage. In both species there was a greater difference between the tested accessions in energy and germination of seeds after 5 years storage. No relationship is found between the initial values and the energy drop and germination during storage. In lettuce, the loss of seed quality as well as the difference between energy and germination was more drastic than poppy. For lettuce accessions it is recommended to regenerate seeds for a period of less than 5 years. On the seed of individual accessions and after storage, pathogens have been developed. Most of the saprophytic species were observed. By checking the situation in the field, it was determined that some accessions no longer exist at the site of finding.

Key words: genetic resources, accessions, ex-situ, on farm

Project: TR31030, "Development of vegetable cultivars and hybrids intended for outdoor and indoor production"

P-10

UBRZANO STARENJE I ANTIOKSIDATIVNE ODLIKE SEMENA RAZLIČITIH GENOTIPOVA KUKURUZA

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Propadanje semena ogleda se u gubitku kvaliteta, životne sposobnosti i energije. Dejstvo slobodnih radikala dovodi do peroksidacije lipida, inaktivacije enzima, degradacije proteina, razaranja ćelijskih membrana i oštećenja genetičkog materijala, i smatra se glavnim uzrokom propadanja semena. Ubrzano starenje, kao metod, omogućava proučavanje mehanizama propadanja semena u kratkom vremenskom periodu. U ovom eksperimentu su korišćene tri inbred linije (beli i žuti polutvrdunac i crveni zuban) i jedna domaća populacija kukuruza (tamno crveni kokičar), regenerisane u istoj godini i čuvane u srednjoročnim uslovima (+4°C i 45% RVV). Nezavisno od eksperimenta ubrzanog starenja, kod ovih genotipova (seme iz iste godine regeneracije) je utvrđen sadržaj ukupnih fenola, flavonoida i antocijana, kao i ukupni antioksidativni kapacitet. Za utvrđivanje stepena propadanja, seme je izloženo tretmanu ubrzanog starenja (42°C i 100% RVV), u trajanju od tri i šest dana. Eksperiment je vršen u tri ponavljanja, i za svaki set je korišćeno po 50 semena za test klijavosti. Poređenjem sa nestresiranim semenom (kontrola), starenje je rezultiralo padom energije klijavosti (48,9%), smanjenjem ukupnog broja klijanaca (40,8%), smanjenjem rasta klijanaca (70,0% za dužinu korena, 44,0% i 10,5% za svežu masu korena i izdanka, 5,0% za semeni ostatak), kao i povećanjem broja nenormalnih klijanaca (22,0%). Korelacionom analizom je utvrđeno da povećani sadržaj ukupnih fenola, a naročito poboljšana sposobnost gušenja slobodnih radikala izražena preko antioksidativnog kapaciteta korišćenjem ABTS reagensa, doprinosi manjem stepenu propadanja semena, posebno u pogledu energije klijavosti (0,947; p≤0,05), dužine korena (0,949; p≤0,05) i izdanka klijanaca (0,934; p≤0,05), kao i sveže mase izdanka (0,974; p≤0,05) i semenog ostatka (0,925; p≤0,05).

Ključne reči: energija klijavosti, fenolna jedinjenja, ukupni antioksidativni kapacitet, vigor, *Zea mays* L.

Zahvalnica: *Ovaj rad je rezultat projekta TR 31028*

ACCELERATED AGING AND ANTIOXIDANT CHARACTERISTICS IN SEED OF DIFFERENT MAIZE GENOTYPES

Seed deterioration is expressed as the loss of quality, viability and vigor during aging. The major causes of seed deterioration refer to free radical-mediated lipid peroxidation, enzyme inactivation or protein degradation, disruption of cellular membranes and damage to genetic integrity. Accelerated aging (AA) provides a simple method for studying the mechanisms of deterioration over short periods. Three inbred lines (white and yellow semi-flints and red dent), and one local maize landrace (dark red popcorn), regenerated in the same year and stored at medim-term conditions (+4°C and 45% RH), were used for this experiment. Irrespective of accelerated aging, the same genotypes were evaluated regarding total phenolic, flavonoid and anthocyanin content, as well as total antioxidant capacity. For determination of deterioration rate, seeds were exposed to 42°C and 100% RH for different time points (three and six days of AA). Three biological replicates were performed for each treatment, as well as germination assay with 50 seeds in each set of the replicate. Compared to non-stressed seeds (control), aging was evidenced by decreased germination energy (48.9%), total number of seedlings (40.8%) and seedlings growth (70.0% for root length, 44.0% and 10.5% for root and shoot fresh weight, 5.0% for seed rest, respectively), as well as increased number of abnormal seedlings (22.0%). Correlation analysis revealed that higher content of total phenolics and especially higher ABTS radical scavenging activity contributed to lower level of deterioration rate, particularly regarding energy of germination, seedlings root and shoot length, as well as shoot and seed rest fresh weight.

Key words: germination energy, phenolic compounds, total antioxidant capacity, vigor, *Zea mays* L.

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P-11

RUTAVI OVAS (*Avena strigosa* SCHREB) NOVA VRSTA U SEMENSKOJ PROIZVODNJI SRBIJE

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Na području Vojvodine od 2013. godine organizovana je proizvodnja semena rutavog ovsa (*Avena strigosa* Schreb), što ujedno predstavlja introdukciju ove biljne vrste u Srbiju. Cilj istraživanja bio je da se ustanove produktivne osobine ove biljne vrste u različitim agroekološkim uslovima. Rutavi ovas pripada diploidnoj podgrupi jednogodišnih gajenih vrsta roda *Avena*, a po morfološkim osobinama razlikuje se od ostalih gajenih vrsta ovog roda, po izrazito tankim i visokim stablima. Centrom porekla rutavog ovsa smatra se Iberijsko poluostrvo, odakle se širio ka zapadnoj i centralnoj Evropi i zauzimao niz ekoloških niša, sve do Avganistana. Od bronzanog doba tokom vremena, gajenje i upotreba u ishrani ljudi se smanjivalo, tako da je krajem dvadesetog veka u Evropi bio na rubu izumiranja. Poslednjih godina zbog svojih bioloških osobina (sposobnost vršenja remedijacije zemljišta, izraženo alelopatsko i nematocidno delovanje), rutavi ovas nalazi primenu u održivim sistemima poljoprivredne proizvodnje, kao pokrovni usev. Četvorogodišnja istraživanja (2013–2016) izvedena su u proizvodnim uslovima, na ritskoj crnici u Južnom Banatu, na karbonatnom černozemu u Sremu i smeđem stepskom zemljištu na pesku u Bačkoj. Materjal istraživanja bila je sorta Pratex. Za analizu meteoroloških uslova (količine, raspored padavina i toplotni uslovi) korišćeni su podaci Republičkog hidrometeorološkog zavoda Srbije. Rezutati ukazuju da su tip zemljišta i vremenski uslovi, kao i njihova interakcija statistički značajno uticali na prinos semena rutavog ovsa. Prosečan prinos naturalnog semena, svih godina istraživanja i svih lokaliteta bio je 2,27 t ha^{-1}, najveći je ostvaren na černozemu (2,58 t ha^{-1}), a najmanji na smeđem stepskom zemljištu (1,86 t ha^{-1}). U drugoj najpovoljnijoj godini (2014) tip zemljišta delovao je gotovo identično, u četrtoj (2016) najvlažnijoj, imao je veći efekat dejstva, dok je u trećoj (2015), sa najmanje padavina, najviše uticao.
Može se zaključiti da u pogledu prinosa u Republici Srbiji postoje povoljni uslovi za gajenje rutavog ovsa, međutim u cilju uključivanja u proizvodnji kao pokrovnog useva neophodno je izvršiti istraživanja, kao i procenu invazivnosti ove biljne vrste, za različita područja gajenja.
Ključne reči: rutavi ovas, introdukcija, agroekološki uslovi, prinos

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BLACK OAT (*Avena strigosa* Schreb) - NEW SPECIES IN SEED PRODUCTION IN SERBIA

On the territory of Vojvodina, since 2013, was organized the production of the black oat seed (*Avena strigosa* Schreb), which, at the same time, presents the introduction of this plant species into Serbia. The goal of this study was to establish the productive characteristics of this plant species in different agroecological conditions. Black oat belongs to a subset of diploid annual cultivated species of the genus *Avena* and, according to its morphological properties, differs from other cultivated species of this genus by extremely thin and high trees. Centre of the black oat origin is the Iberian Peninsula, from where it spread to Western and Central Europe and occupied series of ecological niches all the way to Afghanistan. Since the Bronze Age, over time, its cultivation and use in human consumption decreased, so that at the end of the twentieth century in Europe it was on the brink of extinction. In recent years, due to its biological characteristics (ability to perform soil remediation, pronounced alleopathic and nematicidal action), black oat found an application in sustainable farming systems as the cover crop. Four-year study (2013-2016) was performed under the production conditions on the hydromorphic black soil in South Banat, carbonate chernozem in Srem and brown steppe soil on sand in Bačka. The research material was the sort Pratex. For the analysis of meteorological conditions (quantity and distribution of rainfall and thermal conditions) were used the data from Republic Hydrometeorological Institute. Our results show that the type of soil, weather conditions and their interaction had statistically significant effect on the yield of the black oats seed. During all four years of research and at all three locations, the average yield of natural seed was 2.27 t ha^{-1}, the highest yield was recorded on chernozem soil: 2.58 t ha^{-1}, and the lowest one on brown steppe soil: 1.86 t ha^{-1}. In the second and most favorable year, the type of soil had nearly identical effect on the yield as the average value, in the fourth and most humid year it had higher effect, and in the third year, with the least rainfall, the soil type had the highest effect on the seed yield.
It can be concluded that there are favorable conditions for cultivation of black oat in the Republic of Serbia. However, in order to include black oat into production as a cover crop it is necessary to perform more research, as well as do an evaluation of this plant species invasiveness in different regions of cultivation.

Key words: black oat, introduction, agroecological conditions, yield

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