UDC575
DOI: 10.2298/GENSR1101041P
*Original scientific paper*

# EFFECT OF GENOTYPE AND PRE-SOWING FERTILIZATION ON YIELD OF GARDEN PEA

Gordana DOZET[1], Jelena BOŠKOVIĆ[1], Tamara GALONJA COGHILL[1], Veselinka ZEČEVIĆ[1], Gorica CVIJANOVIĆ[1], Dragan JOVIĆEVIĆ[2] and Vojin ĐUKIĆ[2]

[1]Megatrend University Belgrade, Faculty of Biofarming, Bačka Topola, Serbia,
[2]Institut for field and vegetable crops, Novi Sad, Serbia

Dozet G., J. Bošković, T. Galonja Coghill, V. Zečević, G. Cvijanović, D. Jovićević and V. Đukić (2010): *Effect of genotype and presowing fertilization on yield of garden pea*.- Genetika, Vol 43, No. 2, 229 -238.

During the two-year study on the influence of presowing fertilization on growth and development of garden pea (Pisum sativum L.) in three different experimental setups, five genotypes of peas were used, two of Dutch origin and three that were created at the Institute of Field and Vegetable Crops.The aim of the study was to determine the extent to which different genotypes and complex NPK fertilizer influence the yield per

*Corresponding author*: Gordana Dozet, Megatrend University Belgrade, Faculty of Biofarming, Maršala Tita 39, Bačka Topola, Serbia, phone + 381 24 718515, e-mail: gdozet@biofarming.edu.rs

plant. The average yield per plant for both years was 16.86 g. The influence of genotype on grain yield per plant was statistically significant ($p<0.01$). Tamish cultivar showed significantly lower yields during both study years, in comparison with other genotypes tested, except when compared with the Danube cultivar in year 2007. There was no regularity in the influence of pre-sowing fertilization on grain yield per plant. Regression analysis of the pea genotypes, revealed a slight reduction in yield per plant as a function of increased use of complex fertilizer. Grain yield per plant was in high positive correlation ($p<0.01$) with yield components, and with the length of the stem. The number of pods was in strong correlation with grain numbers and weight of pods. Number of grains and the absolute weight were in highly statistically significant correlation with the mass of pods.

*Key words*: garden pea, genotype fertilization, vegetable, yield

## INTRODUCTION

The major tendency in crop production is to manufacture as much food as possible, with the maximum rationalization of mineral fertilizers. Garden pea (*Pisum sativum* L.) growing has a long tradition in Serbia. Short growing season and high nutritional value stimulate both its production and consumption (GVOZDENOVIĆ *et al*., 2002, JOVIĆEVIĆ *et al*., 2002).

The most common limiting factor for obtaining high dry matter yield of agricultural plants is the accessibility of nutrients, especially nitrogen (GALONJA-COGHILL *et al*., 2009). Having grains rich in proteins, the leguminous plants show high requirements for nitrogen, an element necessary for their creation (JOVIĆEVIĆ *et al*., 2002). However, they acquire a considerable part of nitrogen by biological fixation from the atmosphere (GRAHAM *et al.,* 2004, CVIJANOVIĆ *et al*. 2008). Phosphorus is important in crop production, since its deficiency in soil often limits plant growth and development, while potassium plays an important role in the plants' water regime (KASTORI, 2008). Also, potassium is essential for generative plant development, flowering, pollination and seed filling. Since spring pea varieties have short growing season and shortened period of plant assimilates adoption, only the mineral NPK fertilizers are being used as the additional plant food (GVOZDENOVIĆ *et al*., 2007). Pea as a legume crop, has genetic predetermation for living in symbiosis with *Rhizobium leguminosarum bv. Viceae* bacteria. This communion benefits both symbionts. The microsymbiont (*Rhizobium leguminosarum bv. Viceae*) gets available photosynthetic carbonic substances while providing the macrosymbiont (pea) with the nitrogen compounds in forms that are most convenient for production of organic matter. Root nodule bacteria (*Rhizobium leguminosarum bv. Viceae*) carry out nitrogen fixation in highly organized structural formations on plant roots, supported by constant circulation of amino acids between the plant and the bacteroid, necessary for its proper functioning (PRELL and POOL, 2006). The largest numbers of nodules range from 15 to 25 per pea plant, during flowering season. The total amount of nitrogen being fixed by this symbiotic formation, according to various authors, range from 50 to 120 kg $ha^{-1}$. The numbers

of *Rhizobium leguminosarum* range from 103-106 $g^{-1}$ in Serbian agricultural soils, showing great diversity in effectiveness between different strains. Therefore, during the sowing process, highly effective selected strains of bacteria need to be introduced, using new biotechnological methods. This way, a natural phenomenon (instead of genetically modified organisms) supports the concept of sustainable agriculture: yield stability and quality while maintaining the ecological balance, resulting in food safety as well as in favourable economic outcome (MANISH *et al.,* 2005). The grain yield is the most important economic feature and is strongly influenced by environmental factors. It is necessary to understand genotypic and phenotypic correlations of yield as well as other plant features that affect grain yield.

The aim of this study was to determine the influence of genotype and different doses of pre-sowing NPK fertilization on yield per pea plant.

## MATERIAL AND METHODS

The experimental work was carried out on experimental plot of the Faculty for biofarming in Backa Topola, on calcareous chernozem soil type, during the years 2007 and 2008.

Primary soil treatment, tillage to the depth of 30 cm, was performed during the autumn and pre-seeding preparation at the end of winter. Onions and peppers were used as pre-seeding cultures, in years 2007 and 2008, respectively.

Five varieties of peas with different growing season durations were used in this study. Three pea varieties were Dutch (Orcado and Joff) and three were created at the Institute of Field and Vegetable Crops (Tamish, Dunube and Frushkogorac).

- **Tamish**, very early variety
- **Danube**, early variety
- **Frushkogorac**, medium-early variety
- **Orcado,** medium-late variety and
- **Joff,** late variety

The experiment was bi-factorial, designed in randomized block manner, as split-plot system with five repetitions. The basic plots were varieties, within which there were sub-plots with three different NPK fertilizer pre-sowing treatments: 300 kg $ha^{-1}$, 500 kg $ha^{-1}$ and control plots where no NPK was used (0 kg $ha^{-1}$).

A complex NPK fertilizer 15:15:15 was used in the trials, making up to 45 kg of N, $P_2O_5$ i $K_2O$ entered into the soil in the first seedbed version and 75 kg of N, $P_2O_5$ and $K_2O$ in the second seedbed version. The basic plot size was 5 $m^2$ (5 lines, 5 m long each with 20 cm row spacing). Sowing was performed manually, mimicking sowing machine by drawing rifles at 4-5 cm depth, with the optimum timing, on 9th March 2007 and 12th March 2008.

During the phenophase of technological maturity of plants the following parameters were determined: grain yield per plant (GY), yield components: number of pods (NP), number of grains (NG), pod weights (PoW), the absolute weight (AW) as well as morphological characteristics: plant height in the field (PH), stem length (SL), plant height up to the first fertile node (PH1FN) and plant weight (PW) while

the extent of flattening (EF) of pea plants was determined in percentages, using mathematical calculations.

Data were statistically analyzed by analysis of variance, using the method of two factorial split - plot experiment in MSTAT-C. The significance of differences between applied treatments was tested by LSD test. For the genotypes tested, the regression analysis wa performed for two parameters: yield per plant and different levels of NPK fertilizer 15:15:15. Also the correlation of yield with other studied plant features was analyzed, and the coefficient of significancy determined by t-test (IRELAND, 2010).

Meteorological data, including temperatures and amount of precipitation were obtained from valid meteorological station in Backa Topola.

## RESULTS AND DISCUSSION

Pea plant is characteristic for moderately moist and cool climates (GVOZDENOVIĆ *et al.,* 2007). The average monthly temperatures, during the growing period of pea plants (March to June) were for 9.9º higher in 2007, compared with the multi-year average (Table 1).

*Table 1. The average mongly and decade air temperatures for pea vegetation period - Bačka Topola ($^0C$)*

| Year | Months | Decades | | | Average | Perennial mean (1975-2006) |
|---|---|---|---|---|---|---|
| | | I | II | III | | |
| 2007 | March | 9.0 | 11.0 | 8.3 | 9.4 | 6.5 |
| | April | 12.2 | 15.0 | 16.3 | 13.7 | 11.5 |
| | May | 16.6 | 19.2 | 20.8 | 18.9 | 17.3 |
| | Jun | 22.1 | 24.8 | 24.4 | 23.8 | 20.6 |
| 2008 | March | 7.3 | 7.5 | 7.4 | 7.4 | 6.5 |
| | April | 10.9 | 13.8 | 14.4 | 13.1 | 11.5 |
| | May | 14.9 | 19.2 | 21.7 | 18.7 | 17.3 |
| | Jun | 22.0 | 20.4 | 25.6 | 22.7 | 20.6 |

The average amount of precipitation during the pea growing season in 2007, also showed an increase of 63.1 liters, e.g. 30.56%, compared with the several-year average amount. Precipitation was unfavourably distributed throughout the growing period, with only 1.2 l $m^{-2}$ of rain in April, which slowed the early growth of peas, whereas in May the amount was 171.3 l $m^{-2}$ (Table 2).

In the year 2008, air temperatures during the growing season were also above the average by 6.0 º C (Table 1). During the same year, the amount of precipitation was 53.6 l (or 25.96%) higher than the multi-year average (Table 2). During this year, precipitation was also unfavourably distributed, with April mean value half the multi-year average. Both research years were marked by very high temperatures. Although the amount of precipitation was higher than the multi-year

mean value, factors that expressed particularly unfavourable influence on pea plants were uneven rainfall schedule and distribution, and especially so in 2007.

*Table 2. The average monthly and decade quantities of precipitations for pea vegetation period Bačka Topola (1 m$^{-2}$)*

| Year | Months | Decades | | | Average | Perennial mean (1977-2006) |
|---|---|---|---|---|---|---|
| | | I | II | III | | |
| 2007 | March | 36.1 | 0.3 | 21.4 | 57.8 | 34.7 |
| | April | 0 | 1.2 | 0 | 1.2 | 46.1 |
| | May | 87.2 | 14.6 | 69.5 | 171.3 | 53.9 |
| | Jun | 16.6 | 5.0 | 17.7 | 39.3 | 71.8 |
| 2008 | March | 26.8 | 24.5 | 20.6 | 71.9 | 34.7 |
| | April | 4.2 | 17.5 | 1.3 | 23.0 | 46.1 |
| | May | 14.6 | 5.1 | 21.9 | 41.6 | 53.9 |
| | Jun | 30.2 | 85.8 | 7.6 | 123.6 | 71.8 |

However, very important factor in production technology, especially when no irrigation is included, is distribution of precipitation, which significantly affects both the dynamics of growth and development of plants and stability of yield (DOZET, 2006, DOZET, 2009).

The average yield per plant for both years was 16.86 g. In terms of yearly values, it was 14.37 g in 2007 and 19.35 g in the year 2008 (Table 3).

*Table 3. Yield per plant, as a function of genotype and NPK presowing fertilization (g)*

| YEAR | FERTILIZING (kg ha$^{-1}$) (F) | GENOTYPE (G) | | | | | $\bar{x}$ F |
|---|---|---|---|---|---|---|---|
| | | **Tamish** | **Danube** | **Frushkogorac** | **Orcado** | **Joff** | |
| **2007** | 0 | 9.80 | 10.20 | 16.50 | 19.20 | 15.90 | 14.32 |
| | 300 | 7.40 | 10.40 | 14.60 | 19.20 | 19.00 | 14.12 |
| | 500 | 6.00 | 11.80 | 17.90 | 20.00 | 17.70 | 14.68 |
| | **$\bar{x}$ G** | 7.73 | 10.80 | 16.33 | 19.47 | 17.53 | 14.37 |
| **2008** | 0 | 8.64 | 17.60 | 24.56 | 19.00 | 26.60 | 19.28 |
| | 300 | 8.08 | 19.68 | 23.72 | 27.81 | 23.88 | 20.63 |
| | 500 | 10.00 | 17.68 | 20.68 | 21.72 | 20.56 | 18.13 |
| | **$\bar{x}$ G** | 8.91 | 18.32 | 22.99 | 22.84 | 23.68 | 19.35 |
| ***Average 2007 - 2008*** | | | | | | | **16.86** |

| LSD | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2007 | | | | 2008 | | | |
| | Factors and interactions between of factors | | | | | | | |
| | G | F | GxF | FxG | G | F | GxF | FxG |
| 1 % | 4.54 | 2.16 | 4.82 | 5.14 | 4.29 | 2.57 | 5.74 | 6.08 |
| 5 % | 3.30 | 1.61 | 3.60 | 4.42 | 3.11 | 1.92 | 4.29 | 4.56 |

The effect of pea genotype on grain yield per plant was statistically significant. Tamish cultivar showed significantly lower yields in both research years, compared with the other tested genotypes, except with Danube cultivar in year 2007. No significant regularity of the effect of presowing fertilization on grain yield per plant was recorded. Presowing fertilization treatment showed no effect in year 2007, while significantly higher grain yield per plant (20.63 g) was achieved in 2008, with the application of 300 kg ha-1 NPK 15:15:15 fertilizer, compared with the treatment with the highest amount of fertilizer applied in this study (18:13 g).

The interaction between genotype and fertilization was not at significant level. The exceptions were Tamish cultivar (year 2007), where higher grain weight per plant (9.80 g) in control plants were observed, compared with plants fertilized with 500 kg ha-1 NPK 15:15:15 (6.00 g) and Orcado cultivar (year 2008) where significantly higher grain weight per plant (27.81 g) was found in plants fertilized with 300 kg ha-1 NPK 15:15:15, compared with the control plants (19.00 g).

The Tamish cultivar, being a very early variety, had the lowest yield per plant in both research years. The interaction between the genotype and fertilization was highly statistically significant. The Orcado cultivar showed higher yield per plant in all experimantal setups in 2007, being very significant compared with Tamish and Danube varieties ($p<0.01$), and significant ($p<0.05$), in comparison with Frushkogorac variety fertilized with 300 kg ha-1. In the year 2008, for all experimental setups, Tamish variety showed a significantly lower yield compared with other genotypes studied. The regression analysis revealed a slight reduction in yield per plant as a function of increased amount of compex fertilizer applied, with the exception of Tamish cultivar, which responded to increased amounts of fertilizer by increasing its grain yield. However, that increase was below the level of statistical significance (Figure 1).

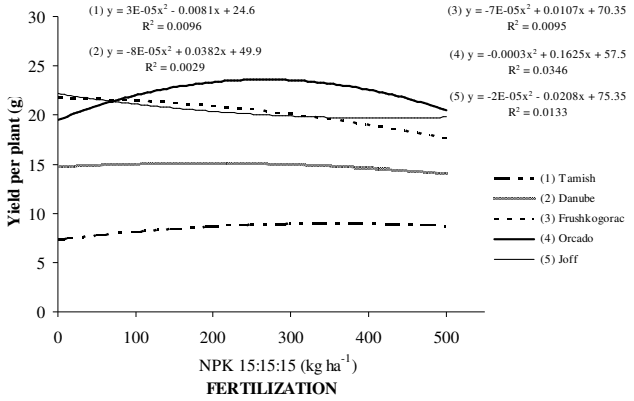


Figure 1. Regression analysis of yield per plant and the amount of NPK fertilizer, in various genotypes studied

Table 4 shows the correlation coefficients between the studied properties of garden peas. Grain yield per plant was highly positively correlated ($p<0.01$) with yield components, as well as with the stem length.

*Table 4. The correlation coefficients between some studied properties of garden pea*

| Properties | GY (g) | PH (cm) | SL (cm) | PH1FN (cm) | NP | NG | PW (g) | W1000 (g) | PoW (kg) | EF (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| GY (g) | 1.00 | | | | | | | | | |
| PH (cm) | -0.11 | 1.00 | | | | | | | | |
| SL (cm) | 0.74** | 0.17 | 1.00 | | | | | | | |
| PH1FN (cm) | 0.43 | 0.13 | 0.83** | 1.00 | | | | | | |
| NP | 0.70** | -0.15 | 0.40 | -0.11 | 1.00 | | | | | |
| NG | 0.84** | -0.19 | 0.67** | 0.26 | 0.91** | 1.00 | | | | |
| PW (g) | 0.38 | 0.14 | 0.52 | 0.14 | 0.58 | 0.54 | 1.00 | | | |
| W1000 (g) | 0.68** | 0.27 | 0.68** | 0.49 | 0.30 | 0.47 | 0.09 | 1.00 | | |
| PoW (kg) | 0.85** | 0.22 | 0.82** | 0.50 | 0.53* | 0.68** | 0.47 | 0.80** | 1.00 | |
| EF (%) | 0.75** | -0.38 | 0.83** | 0.66** | 0.52* | 0.77** | 0.51 | 0.47 | 0.65** | 1.00 |

$p<0.05$*;
$p<0.01$**

Plant height to the first fertile nodes as well as number of seeds, 1000 grain weight and weight of pods per plant significantly increased, by increasing the stem length. Number of pods has strong correlation with number of grains and weight of pods. Also, the number of grains and absolute weight showed high statistically significant correlation with weight of pods. Such strong genetic and phenotypic ratios were also found in maize (BOĆANSKI *et al.,* 2009). The ratio of crop flattening was determined by genotype, as high and semi-high varieties are always more prone to flattening than low varieties (DOZET *et al.,* 2010). The greater the length of the stem, the more prone it becomes to flattening, so a strong positive correlation between these features was recorded ($r = 0.83$).

## CONCLUSION

The influence of pea genotype on grain yield per plant was statistically significant ($p<0.01$). Tamish cultivar showed singificantly lower yield in both research years, in comparison with other tested genotypes. The grain yield per plant was strongly positively correlated with yield components and with the length of plant stem. The number of pods was significantly correlated with number of grains and the weight of pods. The number of grains and absolute weight were in high statistically significant correlation with pod weights.

## ACKNOWLEDGEMENTS

The authors want to express their gratitude to »Poljoprivredna stručna služba d.o.o. Bačka Topola« (Agricultural Expert Services Ltd., Backa Topola) from Backa Topola, for the laboratory analyses and the data on temperatures and precipitation.

Received, October 12th, 2010
Accepted, June 03rd, 2011

## REFERENCES

BOĆANSKI, J., Z. SREĆKOV, and A. NASTASIĆ (2009): Genetic and phenotypic relationship between grain yield and components of grain yield of maize (*Zea mays* L.). Genetics *41* (2): 145-154.

CVIJANOVIĆ, G., J. SUBIĆ and G. DOZET (2008): The significance of nitrogen –fixer as a biofertilizer in organic production, International Symposium on New Researches in Biotechnology, Ministry of Education and Research, University of Agronomical Sciences and Veterinary Medicine Bucharest, Special Volume, Series F, Bucharest, November 20-21, 2008, ISSN 1224-7774, pp 574-582

DOZET, G. (2006): Effects of row spacing and different maturity groups on yield and quality of soybean by irrigation. M.Sci. thesis, University of Novi Sad, Faculty of agriculture, Novi Sad.

DOZET, G. (2009): Nitrogen previous crop fertilization and Co and Mo application effect on soybean yield and grain characteristics. PhD thesis, Megatrend university, Belgrade, Faculty of biofarming, Backa Topola.

DOZET, G., J. BOŠKOVIĆ, D. JOVIĆEVIĆ, V. ZEČEVIĆ, LJ. KOSTADINOVIĆ, V. ĐUKIĆ (2010): Influence of pre-sowing fertilization to the level of pea lodging. Scientific Journal of University of Szeged, Faculty of Agriculture *5* (1): 566-571.

GALONJA-COGHILL, T., LJ. KOSTADINOVIC, N. BOJAT, Z. HOJKA (2009): Agro-ecosystems under high voltage powerlines. Global NEST Journal, CEST 2009 Special issue, p.293-298, Publisher: Global NEST Journal, ISSN 1790-7632

GRAHAM, P.H., M. HUNGRIA, B. TLUSTY (2004): Breeding for better nitrogen fixation in grain legumes: Where do the Rhizobia fit in Online. Crop Management DOI: 10.1094/CM-2004-0301-02-RV

GVOZDENOVIĆ, Đ., D. BUGARSKI, J. GVOZDANOVIĆ-VARGA, J. ČERVENSKI, A. TAKAČ (2007): Especially Vegetable Crops. Megatrend university, Belgrade.

GVOZDENOVIĆ, Đ., M. VASIĆ, D. BUGARSKI, J. GVAOZDANOVIĆ-VARGA, A. TAKAČ and J. ČERVENSKI (2002): Vegetable breeding at the Novi Sad Institute, Scientifical papers, Faculty of Agriculture XXXIV, Proceedings. University of Timisoara, Romania, 359-369.

IRELAND, C. (2010): Experimental statistics for agriculture and horticulture. Publisher:CABI; First edition. ISBN-10:1845935373; ISBN-13:978-1845935375. P. 352.

JOVIĆEVIĆ, D., Đ. GVOZDENOVIĆ, D. BUGARSKI, J. GVOZDENOVIĆ-VARGA and M. TATIĆ (2002): New varieties of garden peas *(Pisum sativum)* in Yugoslavia. Proceedings of the Second Balkan Symposium on Vegetables and Potatoes, Acta Horticulturale 579; 181-183.

KASTORI R., I. MAKSIMOVIĆ (2008): Plant nutrition. Vojvodina Academy of Sciences and Arts. Novi Sad.

MANISH K., S. RANA NEERJA , U.K. KOHLI (2005): Genotypic variability for nitrogen fixation and its influence on the yield of garden peas (*Pisum sativum* cv. Hortense L.). Legume Research - An International Journal, *28* (4), http://www.indianjournals.com

PRELL, J. and P. POOL (2006): Metabolic changes of rhizobia in legume nodules. Trends in Microbiology, *14* (4): 161-168.

# UTICAJ GENOTIPA I PREDSETVENOG ĐUBRENJA NA PRINOS BAŠTENSKOG GRAŠKA

Gordana DOZET[1], Jelena BOŠKOVIĆ[1], Tamara GALONJACOGHILL [1], Veselinka ZEČEVIĆ[1],Gorica CVIJANOVIĆ[1], Dragan JOVIĆEVIĆ i Vojin ĐUKIĆ

[1] Megatrend univerzitet, Fakultet za biofarming, Bačka Topola, Srbija
[2] Institut za ratarstvo i povrtarstvo, Novi Sad, Srbija

I z v o d

U dvogodišnjem istraživanju ispitivan je uticaj predsetvenog đubrenja u tri različite varijante na rast i razviće kod baštenskog graška (*Pisum sativum* L.). U radu je korišćeno 5 genotipova graška, od kojih su 3 stvorena na Institutu za ratarstvo i povrtarstvo u Novom Sadu, a 2 su holandskog porekla. Cilj je bio da se ustanovi u kojoj meri različiti genotipovi i kompleksno đubrivo NPK utiče na prinos po biljci kod konzumnog graška. Prosečan prinos po biljci za obe istraživane godine iznosio je 16.86 g. Uticaj genotipa graška na prinos zrna po biljci bio je na nivou statističke značajnosti ($p<0.01$). Sorta Tamish imala je vrlo značajno manji prinos u obe istraživačke godine u poređenju sa ostalim ispitivanim genotipovima, izuzev u odnosu na sortu Danube u 2007. godini. Nije zabeležena pravilnost kod uticaja predsetvenog đubrenja graška na prinos zrna po biljci. Regresiona analiza kod ispitivanih genotipova graška pokazala je da sa povećanjem primenjenog komplesnog đubriva dolazi do neznatnog smanjenja prinosa po biljci. Prinos zrna po biljci bio je u visoko pozitivnoj korelaciji ($p<0.01$) sa komponentama prinosa, kao i sa dužinom stabljike. Broj mahuna je u jakoj korelaciji sa brojem zrna i masom mahuna. Broj zrna i apsolutna masa su u visoko statistički značajnoj korelaciji sa masom mahuna.

Primljeno, 12.X. 2010.
Odobreno. 03. VI . 2011.