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VIGOUR TESTS AS INDICATORS OF SEED VIABILITY

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Seed marks the beginning of each plant production and therefore ensuring its quality is the priority of modern seed science and a prerequisite for obtaining high yields of all plant species. Determination of seed quality and its viability indicates what seed lots can be placed onto the market, and for that reason it is very important to have reliable methods and tests to be used for seed quality and seed vigour testing.

The term vigour of viability is used to describe the physiological characteristics of seeds that control its ability to germinate rapidly in the soil and to tolerate various, mostly negative environmental factors**.** MCDONALD grouped vigour tests into three groups: *Physical tests* –

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determine seed characteristics such as size and mass. These tests are inexpensive, quick, can be applied to large number of samples, and are positively correlated with seed vigour. The main feature of seed development is accumulation of nutritive materials, which is also in direct correlation with vigour, i.e. with size and mass of seed; *Physiological tests* – using germination and growth parameters. There are two types of these tests. First type, when germination is done under favourable conditions (*standard laboratory germination, and test of growth intensity*). Second type, when seed is exposed to unfavourable environmental conditions (*cold test, accelerated aging test, and Hiltner test*); *Biochemical tests* – are considered as indirect methods for estimation of seed value. These are Tetrazolijum test, conductometric measurements, enzyme activity and respiration.

Key words: seed quality, seed vigour, vigour tests

INTRODUCTION

The main task of seed science is production of high quality seed with good physiological, biochemical and phytopathological properties. There are favourable agroecological conditions in our country for obtaining seeds with the above mentioned properties of both field and vegetable crops (MILOŠEVIĆ *et al*., 1996). At present the seed production is an important factor in the process of meeting the growing demand for sufficient quantities of healthy and safe food, while providing a high quality seed material at all stages of its production and systematic control.
Seed marks the beginning of each plant production and therefore ensuring its quality is the priority of modern seed science and a prerequisite for obtaining high yields of all plant species.

Studies relating to mechanisms of seed functioning, regular physiological, biochemical, and more recently molecular analyses of seed material should provide an insight into the quality, and give a firm basis for improvement of breeding programs, and strengthening the control systems in the process of seed production (MILOŠEVIĆ *at al*., 2007).

Economic importance of the seed production

In order to fully understand the importance of seed quality and its environmental capacity it is necessary to express funds that are realized, and their significance for the economy of a country. International seed trade represents one of the basic indicators of an economic power of a country. Seed production is among the most profitable activities in the field of agriculture. The areas it occupies are small in relation to commercial production, but financial effects are significantly higher. The data outlined in table 1 indicate the value of seed production in countries selected by the International Seed Federation - ISF. State selection criterion was the economic contribution of seed production to the domestic markets.

Table 1 - The value of seed production realized on domestic market in selected countries (millions of USD, ratio USD = EUR 1,4 (ISF, 2008)

Value on domestic market (mil. of dollars)			
USA	8,500	Morocco	140
China	4,000	Egypt	140
France	2,150	Bulgaria	120
Brazil	2,000	Chile	120
India	1,500	*Serbia*	*120*
Nippon	1,500	Niger	120
Germany	1,500	Slovakia	110
Italy	1,000	New Zealand	100
Argentina	950	Switzerland	90
Canada	550	Paraguay	80
Russian Federation	500	Portugal	80
Spain	450	Ireland	80
Australia	400	Algeria	70
Korea	400	Uruguay	70
UK	400	Kenya	60
Mexico	350	Iran	55
Poland	350	Israel	50
Turkey	350	Tunisia	45
Taiwan	300	Columbia	40
South Africa	300	Bolivia	40
Hungary	300	Slovenia	40
The Netherland	300	Zimbabwe	30
Czech Republic	300	Peru	30
Denmark	250	Libya	25
Bangladesh	250	Saudi Arabia	20
Greece	240	Zambia	20
Swedish	240	Ecuador	15
Romania	220	Tanzania	15
Belgium	190	Malawi	10
Finland	160	Uganda	10
Austria	150	Dominican Republic	7
Total = 32,002			

The total value of seed production in the world is approx. 36,5 billion dollars. Serbia occupies a highly enviable position in the achievement of financial resources from the seed trade, which accounts for $ 120 million annually.

Importance of the seed quality

Climatic, environmental conditions and traditions, determine whether a country will have successfully developed seed production, i.e. production of field and/or vegetable crops (MILOŠEVIĆ and MALEŠEVIĆ, 2004).

Determination of seed quality and its viability indicates what seed lots can be placed onto the market, and for that reason it is very important to have reliable methods and tests to be used for seed quality and seed vigour testing.

According to DORNBOS (1995) there are four important factors that affect the yield and vigour:

1. proper use of agro technical measures in the production of seed which can reduce the effects of stress,
2. seed production should be located in regions that have favourable conditions for development of certain plant species,
3. plots that can be irrigated should be selected for seed production,
4. when used for production some varieties have to be stable, uniform, and give stable yields in different climatic conditions**.** The main prerequisite for achieving economic effects, and organizing successful seed production is seed quality, i.e. its most important physiological indicator of germination. For this reason, it is necessary to put a great effort to improve seed production technology, and at the same time to determine the best methods for successful seed quality testing. Improvement of the plant properties, and therefore the seeds could be done if we better understand their biology, physiology, biochemistry and molecular biology, which help us to understand the processes that occur in seeds, as a complex living organism. Characterization of important agronomic traits is also related to new knowledge in the field of biotechnology. Numerous methods of molecular biotechnology are used today in examining the quality of seed (MILOŠEVIĆ *et al*, 2009). No modern technique that could be used in routine analysis of seed germination was established until now. Standard tests with numerous shortcomings, which often do not show realistic behaviour of the seed under field conditions are still used. Tests are standardized for a great number of plant species found in the production. Terms for seed germination (temperature, duration of test, and pre-treatments for breaking dormancy) and criteria seedling estimation (ISTA, 2009) are defined by International rules for seed testing, prescribed by International organization for seed quality testing (*International Seed testing Association-ISTA*).

Vigour tests

Standard germination test is an indicator of seed quality, which can be used to predict the field emergence, if soil conditions are nearly ideal (DUURANT and GUMMERSON, 1990). However, conditions in which the seed is found during examination are often in conflict with the conditions in the field. Field germination depends on seed viability. Seed viability or seed vigour are the set of characteristics that determine the activity and behaviour of the seed lots of commercially acceptable seed germination in different environmental conditions. In addition to the above mentioned, longevity of the seed is determined by the seed vigour without adverse consequence (ISTA, 2009). To obtain more precise information about the quality of the seed lot different vigour tests are used (MILOŠEVIĆ and ĆIROVIĆ, 1994).

Testing of seed viability using different seed vigour tests is very significant, since vigour tests give results, which are often better correlated with the results of field germination under unfavourable environmental conditions, than the results obtained by application of standard laboratory germination test (JOHANSEN and WAX, 1978).

The term vigour of viability is used to describe the physiological characteristics of seeds that control its ability to germinate rapidly in the soil and to tolerate various, mostly negative environmental factors**.** Results of vigour tests can be used in deciding whether the seed lots can be sown earlier in the season, when the occurrence of stressful conditions is possible, or it should be sown later, when the soil is warmer and the conditions become more favourable for germination and seedling growth (MILOŠEVIĆ and ZLOKOLICA, 1996). Due to the complexity of the term vigour itself ISTA (1976) has defined it as follows: "Vigour is the sum of those seed properties that determine the level of activity of seeds or seed lots during germination process“. Vigour seed is for now only a concept, rather than a set of specific characteristics of seeds or seed lots. The value obtained by determination of vigour is affected by genetic constitution of seed, the external conditions in which the mother plant is grown, and nutrition applied during that period, maturity of seed at harvest, seed weight and its size, mechanical injuries, aging, pathogens etc. ISTA has determined in its rules that vigour tests must meet two criteria, which among other things depend on plant species being tested. The first criterion is repeatability of the applied method, i.e. sufficient uniformity of the terms under which the test is run, in order to obtain results, which are approximately equal under these terms. The second criterion is that the relation between the results of vigour test, and the results of seedling growth in the field are approximately the same (http://seednet.gov.in/Material/Handbook_of_seed_testing/Chapter%2015.pdf.)

According to MCDONALD (1980), the terms for application of certain vigour test are recommended by ISTA (1976). Vigour tests should be:

- Unique in order to be performed by already employed laboratory staff
- Quick in order to require little time to be performed during season
- Objective in order to be easily standardized, and to avoid subjectivity of the person who does the estimation
- Repeatable, to give the same results if the test is repeated, or if the assessment is done by the second analyst. This is the most important requirement that vigour test must fulfilled.
- Relatively inexpensive, in order to be performed with minimal additional investment and training of the personnel, equipment and consumable material.

Types of vigour tests

There are no universally accepted vigour tests for all plant species. When choosing a vigour test one should take into account the biology, physiology and other specific features of plant species. For this reason vigou tests are grouped in several ways (tab.2).

Table 2 - Different division of vigour tests

Association of American organisations for seed testing (2002) (*Association of Official Seed Analysts - AOSA*)	HAMPTON and TEKRONY (1995) divided vigour tests into two groups:
Tests causing stress (accelerating aging test, cold test, and germination at low temperature)	*Tests recommended in order to gain insight into viability, and closer orientation relating to percentage of field germination* (conductivity test, and accelerated aging test)
Tests causing stress (accelerating aging test, cold test, and germination at low temperature)	*Recommended tests, which are still in development stage* (cold test, germination at low temperature, test of controlled decline in seed germination, complex-stress test, Hiltner test, test of seedling growth, and Tetrazolium test)
Tests of estimation and seedling growth (seedling classification according to vigour, and test of seedling growth)	
Biochemical tests (Tetrazolium test, and Conductivity test)	

MCDONALD (1975) grouped vigour tests into three groups:

- *Physical tests* – determine seed characteristics such as size and mass. These tests are inexpensive, quick, can be applied to large number of samples, and are positively correlated with seed vigour. The main feature of seed development is accumulation of nutritive materials, which is also in direct correlation with vigour, i.e. with size and mass of seed.
- *Physiological tests* – using germination and growth parameters. There are two types of these tests. First type, when germination is done under favourable conditions (*standard laboratory germination, and test of growth intensity*). Second type, when seed is exposed to unfavourable environmental conditions (*cold test, accelerated aging test, and Hiltner test*).

- *Biochemical tests* – are considered as indirect methods for estimation of seed value. These are Tetrazolijum test, conductometric measurements, enzyme activity and respiration.

Test of growth intensity or seedling growth test

Test of growth intensity or seedling growth test is used for seedling growth assessment and is suitable for species having an individual upstraight plumule, such as cereals and grasses**.** GERM (1949) was the first one to suggest measurement of seedling growth as vigour test for cereals and sugar beet. WOODSTOCK (1969) used this test for maize, EDJE and BURRIS (1970) for soybean, and PERRY (1977) for barley and wheat.

Simple equipment is needed for this test, and it occupies a small space. When this test is applied comparisons need to be done within one variety, not between varieties, for varieties can inherit different rates of seedling growth, which is not the trait of seed vigour. When seed lots of the same variety are compared, those lots that have greater mean length seemed to have greater vigour (HAMPTON and TEKRONY, 1995). This test can be used for estimation of fungicide effects on seed (HAMPTON, 1979., OECD, 2003). According to PERRY (1987) treatments with insecticides and fungicides can have adverse effects on germination and growth on filter paper in comparison to field germination.

The importance of determining seedling development is clearly emphasized by many researchers, but nevertheless due to the expressed difficulties in practice application of this test in everyday laboratory testing was doomed to failure (MILIVOJEVIĆ, 2005). The development of computer technology provides the possibility to measure the length of seedlings very effectively using the scanner and specifically designed programs. Several papers on measurement of computer-scanned seedling, which can be successfully applied to estimate salad vigour were published up to now (SAKO *et al*., 2001), and soybean (HOFFMASTER *et al*., 2003).

Cold test

In many countries maize is sown in early spring when soil and air temperatures are low, and when seed germination obtained by standard laboratory test is not in positive correlation with field emergence. According to WOTZA and TEKRONY (2001) germination results obtained with applied cold test represent the most precise indicators of maize germination in the field. Cold test is most often used for maize, sorghum and soybean in North America and Europe (FERGUSON, 1990; HAMPTON, 1992.). Besides estimation of seed germination under the most favourable conditions, AOSA (2002) also mentioned other possibilities of usage of this test for estimation of fungicide efficacy, determination of seed lots for early spring sowing, estimation of physiological damages caused by prolonged storage under unfavourable conditions, frost or drought damages, and measurement of the effects of mechanical damages on germination in cold and wet soil. The advantage of the cold test is the fact that the seed is under the influence by two stress factors: low temperature and the presence of pathogens. Soil from the plot on which the plant species in question was grown the previous year is used as substrate, for it contains certain pathogens. Usage of different soil types presents a major problem in standardization of the cold test. There are some modified cold test methods where a mixture of soil and sand, or sand alone is used as substrates. In such cases the seed is exposed only to low temperatures, while the effect of pathogens is completely ignored.

NIJESTEIN and KRUSE (2000) claimed that the least variation of results was obtained when sand alone was used as substrate. Duration of seed exposure to low temperatures should be adjusted to climatic conditions in regions where the tests are run. Shorter exposure to low temperatures (7 days) is recommended in the region with warm and dry climatic conditions (South Europe and Africa), and longer (10 days) for region with cold and wet climatic conditions (West Europe and North America). Effects of low temperatures (-6^{o}C) on germination and seed vigour depended on genotype and applied test (WOLTZ *et al*., 2006). LOVATO *et al* (2005) tested the influence of three different temperatures (5, 7,5 and 10^{0}C) in cold test on maize germination, and obtained data showed that the cold test can be successfully applied at 10^{0}C for separation of lots according to vigour, but lower temperatures (5 and 7,5^{0}C) were better for separation of lots highly tolerant to cold conditions. Preparations for seed treatment used in the testing exerted no negative influence on wheat seed germination with applied cold test (VUJAKOVIĆ *et al*, 2003a). MILOŠEVIĆ *et al* (1994) applied different methods of maize vigour testing and obtained high correlation between cold test and field emergence.

Studies conveyed by BALEŠEVIĆ *et al* (2007) revealed that in five sunflower genotypes stored in a warehouse under controlled conditions, and aging checked by the cold test the content of linolenic acid was reduced when the cold test was applied. This is yet another confirmation that vigour tests can determine changes in chemical composition of seeds.

Accelerated aging test

Seed producers encounter many problems linked to production, processing, storage, and trade each year. A very important issue that must be solved each year is the question as to which seed lots should be placed on the market, and which could be safely stored for the next season. This decision is particularly important in cases of the low prices on the market, or in cases when they formed the seed stock for the next year. This decision can not be made solely on the basis of information on the percentage of germination, as parties with similar, usually high, germination are generally stored. Longevity of seed in storage depends on plant species and conditions under which the seed lots are stored. The first orientation that can be obtained when vegetable seeds are in question are the data which confirm that individual types of seed differ in seed longevity.

The loss of seed germination under favourable storage conditions depends on seed biology, and it may take several years for that to happen. Many vegetable seeds retain germination greater than 50% even after more than 10 years of storage. For commercial vegetable production the list given below may serve as a guide:

- 1 year – sweet corn, onion, parsley, parsnip
- 2 years – beet, pepper, leek
- 3 years – asparagus, beans, carrots, celery, lettuce, peas, spinach, tomato
- 4 years – cabbage, cauliflower, kale, zucchini, squash, Brussels sprouts, chard, radish, turnip
- 5 years - cucumber, endive, melon, watermelon (VICTORY SEED, 2009)

Additional information on germination results can be obtained by accelerated aging test (TUS), which can be used to check the seed viability. TUS makes it possible to determine if certain seed lot has a lesser or greater germination capacity, and to relatively precisely determine the period of safe seed storage.

When TUS is used the seed is exposed for a short period to double stress condition, high temperature, and high relative humidity, which are the two main seed aging factors. High vigour seed will withstand these extreme conditions, and will deteriorate slower than the low vigour seed.

Tested seed is placed in a water bath, and the time period and temperature depend on plant species (Table 3). TEKRONY (2003) emphasized that precision is the key factor in vigour testing. Temperature variation can not exceed ±0,3^{o}C MCDONALD (2004). According to MILIVOJEVIĆ (2005) the lower temperatures should be applied in TUS, and the period of temperature action should be prolonged, for at 45^{o}C the proteins are more rapidly denaturised, and the aging conditions become less appropriate to natural aging conditions.

Table 3. Standards for running accelerated aging test in some plant species (HAMPTON and TEKRONY, 1995)

Plant species	Temperature (°C)	Duration (h)
Allium cepa L.	42	72
Glycine max L	41	72
Lolium perene L.	41	48
Nicotiana tabacum L.	43	72
Quercus nigra L.	41	108
Trifolium pratense L.	41	72
Triticum aestivum L.	41	72
Zea mays L.	42	96

Accelerated aging test is one of the most often used tests for vigour testing today, first of all because it is well correlated with field emergence (LOVATO *et al* 2001). Accelerated aging test is the most often used test for soybean vigour testing in North America (FERGUSON, 1990). ISTA standardized this method for soybean seed testing in 2007. Studies of LEEKS (2006) relating to seeds of *Brassica* (*B. rapa* x *campestris*, *B.* campestris, *B. napus*, *B. oleraceae* var. *alboglabra* L and *B. rapa* var. *pekinensis*) revealed that a high correlation between germination obtained by using accelerated aging and field emergence existed.

Hiltner test

Hiltner test was originally used to determine the seeds infected with pathogens, mainly fungi of the *Fusarium* genus. After it was noticed that coleoptile of the infected germinated seed was short, and was not able to penetrate the layer of tiny brick fragments without visible damages, this test started to evolve in two directions. Firstly, as a test for seed health testing, when it was discovered that temperatures below 20°C improved pathogens development. Secondly, as vigour test, since it was determined that test revealed other types of damages that indicated other negative impacts on seed, which prevented normal seedling growth.

Hiltner test is based on the fact that damaged seeds is often weak (physiological injuries, frost injuries, fungicide treatments etc.) and unable to withstand adverse conditions during germination.

Namely, a layer of stones or small brick particles used in this test cause physical stress and prevent germination. Under such unfavourable conditions only high vigour seed can form typical seedling (HAMPTON and TEKRONY, 1995).

This test is applied only in certain laboratories in Europe, and basic reason for this is that the correlation between the obtained results and field emergence varies. Also, this test sometimes fails to give additional information on seed quality in relation to standard germination test (HAMPTON and TEKRONY, 1995). Hiltner test is used mainly for wheat seed vigour testing (VUJAKOVIĆ *et al* 2003b).

In addition to the above mentioned physiological tests some biochemical tests were also developed, but they are used for indirect estimation of the seed value. Biochemical tests include tetrazolium test, conductometric measurements, enzyme activity and respiration.

Tetrazolium test

Tetrazolium test was developed in 1950 as a test for obtaining rapid general estimation of seed viability, particularly in species in which dormancy was expressed, and germination test would last too long. This test

This test is widely applied (HAMPTON and TEKRONY, 1995):

- When sowing must be performed immediately after harvest in very dormant seed;
- In slowly germinated seed;
- When information on potential seed germiability is needed urgently;
- In order to determine different types of damage caused by harvest or processing (heat, mechanical or damage caused by insects);
- In order to solve problems that could be encountered during germination testing, for example when reasons for abnormality appearance are unclear, when there is a suspected adverse effect of pesticide treatment, etc**.**

Tetrazolium test is based on reduction of colourless solution 2,3,5 – tripheniltetrazolim chloride or bromide into insoluble 2,3,5 – triphenilformazan red in colour. This solution acts as an indicator for detection of reduction processes that take place in living parts of the seed. Inside the seed, tetrazolim intakes hydrogen from dehydrogenase. By hidrogenization of tetrazolium a red, stable substance called formazan, which dyes living parts of the seed, is formed in the living cells (ISTA, 2009).

Seed is submerged in water because swollen seed is hard to crack and easy to cut in relation to dry seed, and dying is more uniform. Tissue of many plant species must be removed to introduce the dye into the tissue. Tissue removal can be done by pilling the seed coat off, punching, and longitudinal or cross-cutting of unessential seed parts.

Prepared seed is submerged into 0,5 – 1% tetrazolium solution. Seed must be completely covered with solution, and not exposed to direct light. After the time needed for dyeing expires (it depends on plant species) the estimation of dyeing is approached.

During testing the viable seed should express its potential for normal seedling formation through biochemical activity. Non viable seed expresses malformations which prevent normal seedling formation (ISTA, 2009).

All tissue (necessary for normal seedling development) of a viable seed should be dyed. Except completely dyed, viable seeds, and completely undyed, unviable seeds, a partly dyed seeds may also be found. Depending on the species, small undyed spots of some parts of these tissues may be accepted. Location, size of undyed areas, and sometimes intensity of dyeing, determine whether some seed is considered as viable or not.

Tetrazolium test has several limitations because it:

- provides too high values of vitality, i.e. within the vigour seeds it cannot be separated seed which will give typical and abnormal seedlings,
- causes difficulties in the visual identification of abnormal seedling (i.e. split coleoptiles, negative geotropism etc.),
- requires specially trained personnel and
- does not detect the presence of pathogen or phytotoxic effect.

Conductivity test

Test of electrical conductivity (conductivity test) was used for first time in 1928th year to explain high germination of pea in laboratory conditions and low germination in field conditions. The phenomenon is explained by facts that in field conditions germinating seed releases substances such as saccharides and other electrolytes into soil, enhancing activity of soil fungi. The enhanced activity can negatively affect germination and seedling growth, especially in cold and wet conditions when germination is impeded already (MATTHEWS and BRANDOCK, 1968).

It was later established that integrity of cell membranes, determined by deteriorative biochemical changes ads/or physical disruption, can be considered the fundamental cause of differences in seed vigour which are indirectly determined as electrolyte leakage during the conductivity test. The greater the speed with which the seed is able to re-establish its membrane integrity the lower the electrolyte leakage. Thus, electrolyte leakage measured from high vigour seeds is less than that measured from low vigour seeds.

Electrical conductivity is determined by various factors. Soil conductivity increases simultaneously with the increase of temperature, approximately 2% for each degree. Therefore, the strict control is required during the experiment. Conductivity depends on initial seed moisture. Higher conductivity with lower moisture could be result of cell wall damage caused by seed immersion.

Analysed seed (seed moisture 10-14%) is immersed into deionised water for 24h, at 20°C. After that period the conductivity of the solution should be immediately measured with conductometre and obtained results put in the formula:

$$\frac{Conductivity\ (\mu Scm^{-1})}{Sample\ weight\ \ (g)} = \mu S / cmg$$

If the calculated value is:

< 25 $\mu S / cmg$ - seed has a high vigour, i.e. the seed is suitable for early sowing in unfavourable conditions;

25 – 29 $\mu S / cmg$ - seed can be used for early sowing with risk in unfavourable conditions;

30 – 43 $\mu S / cmg$ - seed is not suitable for early sowing especially in unfavourable conditions;

> 43 $\mu S / cmg$ - seed has a low vigour i.e.it is not suitable for sowing.

Conductivity test allows a quick, objective vigour test that can be conducted easily in most seed testing laboratories with minimum expenditure for equipment and training of personnel. Conductivity tests have high correlations with field emergence (METTHEWS, POWELL, 1981), hence its wide use in seed vigour tests.

Enzyme activity

Oxygen radicals are intensively formed in stressful conditions such as increased humidity, drought and presence of pesticides, low temperatures and pathogen infections. Plants have developed defence mechanisms to protect themselves from damages caused by oxygen radicals. The defence mechanism can be enzymatic by its nature, and consists of antioxidant enzymes, for instance superoksid dismutase, catalase, peroxidase, glutation peroxidase, etc. The activity of antioxidant enzymes indicates to which extent seed was exposed to unfavourable conditions i.e. stress.

Adverse effects of superoksid radicals ($O_2^{\cdot -}$) and hydroxyl radikals ($OH^{\cdot}$) are manifested mainly through cell membrane damages and thiolic group oxidation, and are resulted in enzyme inactivation (HALLIWELL and GUTTERIDGE, 1989).

Efficacy of oxygen radicals removal is an important element in maintenance of functional metabolic activity, in optimal conditions as well as in stress conditions (FOYER *et al*., 1994).

Plant species differ greatly in their antioxidant activities. ŠTAJNER *et al*. (2000) concluded that maize, wheat and sugar beet seeds have high resistance to antioxidative stress due to low lipid peroxidation and high antioxidative enzyme activity.

Vigour tests are not a replacement for germination tests, however they provide additional information. MILOŠEVIĆ and RAJNPREHT (1993) pointed out that more tests need to be used, regarding the fact that no single test meets all requirements. The high vigour seed increases chances to achieve wanted plant density and high yield (TOMER and MAGUIRE, 1990).

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VIGOR TESTOVI KAO POKAZATELJI ŽIVOTNE SPOSOBNOSTI SEMENA

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I z v o d

Seme obeležava početak svake biljne proizvodnje i zato je obezbeđivanje njegovog kvaliteta prioritet savremenog semenarstva i preduslov za visoke prinose svih biljnih vrsta. Utvrđivanje kvaliteta semena i njegove životne sposobnosti ukazuje na to koje partije semena mogu da se nađu na tržištu, te je iz tog razloga potrebno dobro razmotiriti metode i testove koji se upotrebljavaju pirlikom ispitivanja kvaliteta odnosno vigora semena.

Izraz vigor ili životna sposobnost se koristi za opisivanje fizioloških karakteristika semena koji kontrolišu njegovu sposobnost da brzo klija u zemljištu i da toleriše razne, uglavnom negativne činioce spoljne sredine. MCDONALD je svrstao vigor testove u tri grupe: *Fizički testovi* – određuju karakteristike semena kao što su veličina i masa. Ovi testovi nisu skupi, brzi su, mogu se izvoditi na velikom broju uzoraka i pokazuju pozitivnu korelaciju sa vigorom semena. Glavno svojstvo razvoja semena je akumulacija hranljivih materija, što je takođe u direktnoj korelaciji sa vigorom, odnosno sa veličinom i masom semena; *Fiziološki testovi* – koriste parametre klijanja i porasta. Postoje dva tipa ovih testova. Prvi tip, kada do klijanja dolazi u povoljnim uslovima (*standardna laboratorijska klijavost i test intenziteta porasta*). Drugi tip testa je kada se seme izlaže nepovoljnim uslovima sredine (*hladni test, test ubrzanog starenja i Hiltner test*); *Biohemijski testovi* – smatraju se indirektnim metodama za procenjivanje vrednosti semena. Ovi testovi obuhvataju tetrazolijum test, konduktometrijska merenja, enzimsku aktivnost i disanje.

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