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QUALITY OF VEGETABLE SEEDS: MAIN FACTORS AND MODERN ASPECTS

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ABSTRACT: One of the most precise methods for qualification of vegetable seeds, which gives more full information, than just values of germination, is the determination of seed vigour.

In the present paper are described the history of development, definitions, principles and priorities of the seed vigor and its significance for agricultural practices and especially for complex characterization of vegetable seed quality. The main part of the presentation is dedicated to the importance of seed vigor. Included are the other non-destructive and rapid methods for establishment of the vegetable seed quality and their relation with vigor. Some of the suitable and available indexes and parameters of vegetable seed for estimation of the current status and for prevention of the losses are pointed out. In this article are presented the results of last years investigations form which concern the different means for establishing the quality and viability status of vegetable seeds.

Key words: *vegetable seeds, quality, viability, vigor test, germination*

1. World vegetable seed production and seed qualities

The attainment of high qualities of vegetable seeds and their accurate determination, preservation and creation of favorable conditions for development of normal sprouts are very important tasks of seed production and seed science. The world annual production of vegetable seed is characterized with a constant increase. This is shown on the Table 1 and it is obvious that this production marked a significant increase, especially in the initial years of the studied period, after which a consistent trend for maintenance of a high values was observed. Very good sowing qualities of vegetable seeds are achieved through adherence to the technological rules and are provided with sufficient nutrient and energy reserves of the seeds to enable their germination. In this meaning the knowledge of seed science are the connection between theory and practice.

Accurate determination of sowing qualities and of whole viability potential of vegetable seeds is one of the basic targets of the contemporary seed science. Now to give an idea for seed status is not enough to be determining only the germination, but a special attention must be paid on the vigor, as a complex characteristics of seed potential. Most of the laboratories established besides seed acceptability for germination and seed vigor to evaluate and to take more information about seed activity and performance of seedlings in different environmental conditions. The parameters of seed vigor are with high significance for vegetable seeds, which usually are expensive, with low storability and slow growth.

2. Seed vigor

2. 1. What the seed vigor is?

There are too many attempts the seed vigor to be defined. Most of them used as a start point the hypothesis that the high percentage of normally germinated seeds is not a guarantee that they will develop normal seedlings and plants (Dentcheva et al., 1985). Therefore the scientists are searching for new methods of evaluation of seeds potential ca-

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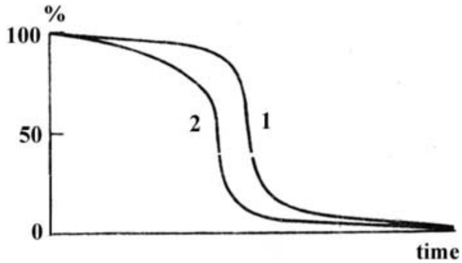
pacity. The necessity for definition of seed vigor is highly significant, because "without it the ability to measure or test this undefined entity is difficult or impossible" (Copeland L. and Mc Donald, 1995).

At the beginning the first definition emphasized that the vigor is "the sum total of all seed attributes which favor stand establishment under favorable conditions". Later on the researcher added that this attributes must be rapid and uniformity stand establishment. Whereupon the definition was pr čised with supplement, described the factors which determined the vigour. It can be pointed out that there is not an unanimously opinion and methods for determination the seed vigor. At the end in 1977 ISTA defined vigor as "the sum total of those properties of the seed which determines the potential level of activity and performance of the seed lot during germination and seedling emergence" (Copeland L. and Mc Donald, 1995), i.e. the abilities of the seeds not only to germinate, but also to develop normal plants. In one of the last edition of the International Rules for Seed Testing (2003) was given the following definition of seed vigor "Seed vigor is the sum of those properties that determine the activity and performance of seed lots of acceptable germination in wide range of environments."

2.2. Why the seed vigor is too important for vegetable seeds?

One of the advantages of the seed vigor is that it allows establishing the changes of seeds and the losses of viability earlier than the standard germination test. This was pointed out form Justice and Bass (1978) (cited from Dentcheva et al., 1985). The changes in vigor occurred earlier and can be established before the aberrations of germination. This is shown on their figure (Fig. 1). The both curves - of the germination and of the vigor can be divided in three periods. Dentcheva et al. (1985) described this processes very well. During the first period the decrease of seed function was slow. This stage completed when the vigor reached to 75% from the initial values, but the germination was 90% and more. In the second period the rate of changes to the worse was faster. Most of the seeds dead and were survived only 10-25%. During the last period all seeds perished and this process was also slow. The development of the curves of germination and vigour was similar with one difference that the losses of vigour get ahead of the losses of germination. When the vigour decreased with around 25% the values of germination was around 90%. These opportunities to predict the changes in seed status are very important and must be used more widely for assessment of the vegetable seeds, especially during the storage period, because as it was mentioned above more of them are with low storability.

Fig. 1. Changes of viability (1) and seed vigour (2) (According to Justice and Bass, 1978, cited from Dentcheva et al., 1985)



2.3. History of seed vigor

The first concept of the seed vigor was made by Frederich N bbe in 1876. He distinguished differences of seed vigor from seed germination. He initiated the term "*triebkraft*" which means driving force or shooting strength. In the beginning there were some differences between European and American understanding - in Europe seed quality mostly determinated under the optimum conditions, while American laboratories emphasized on soil test and determine the plant-producing ability of seed lot (Coplenad L. and Mc Donald, 1995).

2.4. Types of seed vigor tests

According to Mc Donald (1980) (cited from Coplenad L. and Mc Donald, 1995) the seed vigor tests must answer the following characteristics: to be inexpensive, rapid, uncomplicated, objective, reproducible and to correlate with field performance. Presently most popular and used tests for vegetable seeds are: cold germination test, biochemical (tetrazolium) test, conductivity test and accelerated aging test. More seldom the seedling vigor classification test, cool test, speed of germination, seedling growth rate test and osmotic test are applied.

3. Application of different vigor test and methods for establishment the vegetable seed status

Qualities of vegetable seeds are assessed in time of extraction as well as during storage period. The seed viability and vigor also are established for determination of maturity of vegetable seeds and for evaluation of their readiness for harvesting.

The vigour tests are suitable to be used for determination not only of values of germination of vegetable seeds but also for the quality and potential during their overall cycle of development, maturity, harvesting, storage, deterioration and aging and especially for their performance in different field and ecological conditions.

Panayotov (2005) pointed out that is important to be able to predict the effect of environment on the longevity of seeds ranging from the rapid loss of viability which can occur during the hot-air drying of wet seeds to the very slow loss of viability in long-term storage for genetic conservation. The prediction of viability of stored seeds is important both for the management of germination collections and for the management of commercial seed production and storage. Application of vigor test usually gives the great opportunity in this direction. Many authors reported for possibilities to preliminary understanding of what status of vegetable seeds is.

In research literature there are many studies about different methods and tests in any particular case of seed life. Exception of the above mentioned test the researchers elaborate other methods and use additional elements to determinate the qualified parameters of seed of vegetable crops. In the previous publication (Pnayaotov, 2005) it was described very well the application of seed vigour test in vegetable crops and all examples indicated in this presentation are a quotation from this article.

3. 1. Application of Cold test in vegetable seeds

Copeland L. and Mc Donald (1995) pointed out that cold test is one of the oldest methods for evaluation of seed vigor. The data of cold test allow placing seeds under favorable conditions and sowing time. However in this test can occur some difficulties concerning the identity of the soil.

For vegetable seeds the cold test was applied mostly for evaluation the seed performance in the field, overall seed status, best time of seed extraction etc.

Piana et al. (1995) obtained by a cold test (7 days at 10°C, followed by 7 days at ambient temperature) and in an accelerated aging test (48 hours at 42°C) with transplanting of onion seedlings, cv. Pira Ouro data closest to field emergence. The results from the standard test (germination assessment after 6 days and 12 days at 20°C) overestimated the potential viability of seeds.

To assess the efficiency of cold test for seed vigor determination, Miguel M. and Cicero (1999) evaluated two bean cultivars by three different methods, under two temperatures (10°C and 15°C) and three cold period regimes (3, 5 and 7 days). The results were compared to the routine seed quality tests, such as the standard germination test, first germination count, accelerated aging, electrical conductivity and emergence in the field. Better correlation with the standard vigor tests, especially the first germination count and field emergence, was found out for paper rolls without soil for a period of three to five days at 10°C and 15°C.

On the basis of cold test Demir et al. (2003) determined the suitable period of extraction studied the quality of winter squash (*Cucurbita maxima* L.) seeds during storage in the fruit for up to 150 days after fruit harvest. Seeds were extracted from the fruits 12, 35, 63, 92, 150 days after harvest in 1999 and 30, 60, 90, 120, 150 days after harvest in 2000. The total seed germination, following drying, changed between 87 and 97% in 1999, between 98 and 100% in 2000. Normal germination percentages and seed vigor assessed by a cold test, accelerated ageing and by emergence tests, gradually increased until 60 days, however subsequently declined significantly. Maximum seed quality in winter squash was obtained for the seeds of 60-day post-harvest period.

3. 2. Application of Conductivity test for assessment of vegetable seeds

Many scientists pointed out that through application of the electrical conductivity test reliable information is obtained about the seed potential and activity. One of the priority of this method is its fast application, precise and cheap determination, but also this is one of too discussion vigor test, because the data some time depend on the initial seed moisture content, seed cover and size (Copeland L. and Mc Donald Mc, 1995). In vegetable seed production electrical conductivity is appropriate to rapid establishing of the storage potential, the overall seed status, the losses of viability, the maturity, the harvesting time etc.

There are a significant number of tests for assessing the changes in vegetable seeds during storage. Comparing the various methods applied, it was proved that the most significant correlation with seed viability was when using electrical conductivity. This was a very suitable and applicable approach providing rapid and objective information about seed status (Andrade et al., 1995 and Torres, 1996).

Tab. 1. Seed world production of vegetables and melons, total (FAO, cited from Panayotov, 2005)

Year	Seed production (Mt)
1990	76.749
1991	74.225
1992	150.783
1993	153.722
1994	158.842
1995	172.949
1996	192.326
1997	185.264
1998	176.023
1999	204.521
2000	195.877
2001	149.367
2002	141.763
2003	109.930
2004	142.646
2005	131,548

Other authors, however, reported the existence of pronounced cultivar differences (Prusinski J. and Borovska, 1993) and that the aforementioned tests had limited application for predicting seed status (Ratajczak K. and Duczmai, 1991). It is seen that the problem of using electrical conductivity as a parameter for characterizing seed status is still under discussion. Dong et al. (1998) established a negative correlation between the laboratory and field germination and electrical conductivity in onion seeds. With the increase of the storage period, the viability of onion seeds decreased, and the electrical conductivity increased.

A similar tendency was observed by Aladzhadjiyan A. and Panayotov (1994) in tomato seeds, stored for 2 to 15 years under room conditions - the increase in the storage period led to a decrease in electrical resistance, i.e. the electrical conductivity increased, and seed viability decreased. The authors, however, established a species-specific response - in pepper seeds, subjected to the same conditions for 2 to 8 years, the electrical conductivity decreased. In both species this was accompanied by a decrease in the percentage of germination of seeds.

The sowing quality of pepper (*C. annuum*) and watermelon [*Citrullus lanatus (Thunb) Matsum & Nakai*] seeds stored at 10 and 20°C, with 8, 10, 12, and 14% moisture contents for 18 months were determined by Ozoban M. and Demir (2002).

At both storage temperatures, seeds that had 8-10% moisture contents maintained high viability up to 18 months, but at higher moisture levels (12-14%) a reduction in total germination of its first count and emergence were observed.

The researchers also established that the conductivity tests did not give consistent readings with changes in viability and emergence. In conclusion, they suggested that pepper seeds of 8 and 10% and watermelon of 8 and 14% of moisture could be stored at a room temperature (20°C) and 70-75 % air relative humidity for up to 18 months.

The development of seeds and the increase of their viability induced some changes in their physical parameters and electrical properties, in particular. Table 2. shows the results obtained for the specific electrical resistance during the development of pepper- and pea seeds. It was estimated that with the advance of growing and the increase of seed germinability, its values decreased, a strong correlation being established. It was pointed out that this parameter characterized the status of seeds and could be used as an indicator for determining the stage of their development (Panayotov N. and Aladzhadjiyan, 1999 and Aladzhadjiyan, A. and Panayotov, 1999).

3. 3. Use of the Accelerate aging test to evaluate vegetable seed vigor

According to Copeland, L. and Mc Donald (1995) accelerate aging test included more of the traits which a vigour test must possess. Mostly it is used for assessment of the seed storability. It is rapid, inexpensive, simple and useful for all species. It is appropriate for vegetable seeds for determination of storability, deterioration and aging.

Yanmaz et al. (1999) proposed the most suitable accelerated aging test conditions and constructed survival curves for seeds of water melons, melons, and cucumbers. Based on the results obtained from the storage of these seeds at temperatures of 40^{o}C and 50^{oC} and relative humidity of 12.0% and 17.0% for 30 days and at a temperature of 50^{o}C and 17.0% relative humidity for 168 hours, the authors recommended as a good seed aging test for cucurbit seeds to use a relative humidity of 17.0% and a temperature of 50^{o}C for a period of 3, 6 and 10 days for cucumbers, water melons and melons, respectively.

Accelerated aging with a saturated-salt solution controlled deterioration and potassium leachate test, suggested by Marcos (1998), provided new opportunities for assessing seed qualities with good precision and applicability.

In above was mentioned that in comparative testing with onion transplanting seedlings, Piana Z. (1995) established that, the data obtained by a accelerated and cold test were closest to field emergence and that the results from the standard test overestimated the seeds potential.

3. 4. Biochemical test for evaluation of vegetable seed status

Under this appellation are include the methods for seed evaluation which are based on some specific chemical reaction of the seed related to the expression of germination and hence vigour (Copeland, L and Mc Donald, 1995). The most popular is a tetrazolium test, but lately the researchers and practics pay attention to the use of more different elements and reactions for estimation of seed potential. They emphasized on the enzyme activity, content of ethanol, DNA amount and replication. These methods are useful to establish some measurement parameters as indicators for prediction the seed status and losses of germination.

Tab. 2. Sowing quality and specific electrical resistance of water extract of pepper and pea seeds through different stages of development (Panayotov and Aladzhadjiyan, 1999; Aladzhadjiyan and Panayotov, 1999, cited from Panayotov, 2005)

Days after flowering	Germination energy %	Percentage germination %	Specific electrical resistance (.m)	Germination energy %	Percentage germination %	Specific electrical resistance (.m)
Pepper cultivars						
Dzhulunska shipka 1021				Chorbadzzhijski		
20	0.0	0.0	44.1	0.0	0.0	30.0
30	0.0	0.0	20.5	0.0	0.0	28.4
45	2.2	2.2	14.8	0.0	0.0	18.8
55	14.7	36.0	17.1	8.6	11.3	15.5
70	54.6	87.6	11.0	37.0	77.3	10.1
Pea cultivars						
Ran 1				Prometei		
10	0.0	0.0	17.1	6.0	26.3	36.2
20	9.0	10.2	33.3	11.3	49.3	83.8
25	13.7	92.8	132.9	12.0	94.0	86.2
30	25.0	97.5	115.0	12.6	96.6	41.2
40	33.8	86.3	85.5	27.3	85.3	38.9

A common and rapid method for assessing seed material is the tetrazolium test. Using this method, non-viable seeds of carrots, for example, were identified for approximately three hours, while by the conventional method, seed vigour was determined for three days, and the percentage germination - for seven days (Andrade et al., 1996). The advantages of the tetrazolium test for assessing seed viability were established by Menze et al. (1994), who emphasized that the establishment of the initial 4 mm radicle emergence and the tetrazolium test were the two most rapid methods for assessing seed qualities.

Other biochemical test for determination of the vegetable seed potential is based on the released ethanol content from the seeds.

Ethanol production by seed, as a sensitive indicator, could be used as a rapid biochemical test for seed assessment (Kataki et al., 1997). Using immobilized enzyme electrode technology with verification by gas chromatography, the authors determined ethanol content. Under aerobic conditions, ethanol increased more sharply than under anaerobic ones, its content being in a strong correlation with the decreased viability and the coefficient of germination rate.

The ethylene could be used as a biochemical indicator of seed vigour in seed lots of reduced vigor but high germination capacity (Siriwitayawan et al., 2003). They carried out experiments with naturally aged tomato seeds for 18 months or artificially aged ones using saturated salt accelerated aging. They established that the ethylene evolution of the germinating tomato seeds correlated positively with seed quality. Exogenous application of 1-aminocyclopropane-1-carboxylic acid provoked differences in ethylene evolution between non-aged and aged seeds. The quantity of ethylene increased 15-fold for seeds treated with 5 ml of 1-aminocyclopropane-1-carboxylic acid compared to untreated seeds. Naturally and artificially aged seeds responded similarly and reduced ethylene production compared to non-aged seeds. Exogenous application of 1-aminocyclopropane-1-carboxylic acid did not completely reverse the age-related effects on vigor, but reduced the time of radical protrusion of artificially aged seeds. The researchers concluded that the reduction of the ability of the aged seeds to produce ethylene was related to the synthesis or to the activity of 1-aminocyclopropane-1-carboxylic acid oxidase.

Tab. 3. Total sugar content of dry seeds, the total sugar percentage leaked into the soak water of control (non-aged) and non-germinable and analysis of mono- and oligosaccharides present in leachate from non-germinable leek, onion and cabbage seeds (Lee et al., 1995, cited from Panayotov, 2005)

Crops	Total sugar content of dry seeds				Mono- and oligosaccharides in non-germinable seeds mg.g^{-1} seed				
	Control		Non-germinable		Glucose	Fructose	Sucrose	Raffinose	Stachyose
	mg g^{-1}	%	mg g^{-1}	%					
Leek	28.1	9.6	21.9	63	4.44	3.11	1.30	0.15	0.54
Onion	23.7	3.3	23.3	51	0.91	0.75	0.93	<0.01	1.21
Cabbage	25.7	9.4	20.7	90	19.62	8.59	0.51	0.66	2.76

Enzyme activity is other parameter which may be used as biochemical vigour test method. In seed science were described many investigations with different enzymes and their correlation with seed viability. The most analyzed enzymes are catalase, alcohol dehydrogenase, hydrolysis, acid phosphatase- and ATP-se activities. These methods are being discussed, because the results are not always similar and the standardization is too difficult. It could due on the fact that the different researchers used for analysis not equalized and standardized seeds lots, stored in different conditions.

Percentage of germination was established to be in a strong positive correlation with catalase activity. In cucumber seeds (stored for 1-2 years under room conditions), it initially decreased more slowly, while after a four-year period of storage, this decrease became more significant (Meng, 1995). A reverse tendency was reported for the same seeds in other investigations. Yin M. and Cui (1995) showed that catalase activity in freshly harvested cucumber seeds was lower than that in seeds which had been stored for one year. Based on this fact, the authors made the conclusion that the vigor of freshly harvested seeds was lower than that in seeds stored for one year. In this study, a correlation was established between seed germination and the changes occurring at storage. Ethylene production by stored seeds was higher during the first 25 hours of germination and peaked at 25 hours. In contrast ethylene production by fresh seeds peaked 35 hours after the start of germination.

Germinability of cucumber seeds with moisture contents of 2.4 -7.2% and stored for more than a year at a temperature of 27.8°C, declined and the aging rate increased with the increase of water content. The activity of antioxidant enzymes - catalase, peroxydase and superoxide dismutase declined and the leakage of electrolytes from the stored seeds increased, greater changes being observed in seeds stored at progressively increasing water contents. This showed that aging resulted in a general deterioration of seed cells and these changes could be slowed by drying seeds to water contents as low as 2.4 % (Zeng, 1998).

Not always, however, the catalase activity best reflected the changes in seed viability. At the storage of tomato seeds for 2 to 15 years under warehouse conditions, greater changes were observed in the activities of the enzymes acid phosphatase and ATP-se, which increased with storage duration, while the total soluble protein content decreased. In these seeds, the catalase and peroxidase activities were less affected by storage (Panayotov N. and Stoeva, 1995). An increase in acid phosphatase- and ATP-se activities was also observed in pepper seeds stored in paper bags for 2-8 years under warehouse conditions, as well as a decrease in their contents of crude fats and total soluble proteins. In these seeds, the reaction of oxidizing and reducing enzymes to storage duration was more clearly expressed - catalase activity decreased, and that of peroxidase increased. At the same time, the viability of these seeds declined strongly (Panayotov N. and Stoeva, 2000).

The storage of lettuce and pea seeds was related to the occurrence of interconversion between acetaldehyde and ethanol and with the increase of storage relative humidity this process decreased. However conversion of acetaldehyde into ethanol did not occur when seeds were heat-killed prior to storage. As a competitive alcohol dehydrogenase inhibitor, suppressing the conversion of ethanol into acetaldehyde, Zhang et al. (1995) pointed 2-methoxyethanol. This showed that alcohol dehydrogenase pre-existing in dry seeds might be involved in the interconversion between ethanol and acetaldehyde. Ethylacetate applied to seeds during storage was hydrolysed in lettuce seeds and the amount of hydrolysis increased with the increase of relative humidity.

The results for the changes in the enzyme activity of vegetable seeds during storage, obtained by various authors, are controversial, the problem is still under discussion, and future researches in this field are expected to find more facts and to better elucidate this issue.

One of the modern method in biochemical seed vigour test, especially applicable for vegetable seeds is the assessment the parameters of DNA and their relation to seed viability.

Through the potential use of nuclear DNA amounts, a method for predicting the response of tomato seeds to imbibitions was developed, which gave an indication of their performance and also predicted their storage behavior and germination rate (Bino, 1998).

Aging of vegetable seeds was accompanied by changes in DNA synthesis. Under controlled deterioration of seeds from pepper cv. Quadroto di Carmagnola for 6 days at a temperature of 40°C and 75.0% relative humidity and subsequent osmopriming before germination in PEG-6000 1.1-1.5 MPa solution for 6-12 days, obvious signs of b

4. Other new non-destructive and rapid tests for estimation of viability and quality of vegetable seeds

Recently it is very modern and many universities and laboratories work to find a new rapid, easy applicable and precise method for seed evaluation. It is significant for vegetable seeds which lose quickly the viability. The properties of chlorophyll fluorescence, X-ray, pH, UV etc were suggested as parameters for assessment of this seeds.

On the basis of the amount of chlorophyll fluorescence signal of intact seeds, it was possible to estimate their maturity and quality. The amount of chlorophyll was directly related to the degreening process and hence the maturity. Seeds of cabbage, cultivar Bartolo, with a lowest amount of chlorophyll fluorescence had the highest percentage of germination and normal seedlings. Seeds with a lower chlorophyll fluorescence signal, subjected to a controlled deterioration test, showed an insignificant decrease as compared to non-treated seeds, while in the seeds with higher chlorophyll fluorescence signal the loss of viability was much greater. Advantages of the chlorophyll fluorescence method for determining seed maturity and seed quality were its high sensitivity and fully non-destructive nature and the high speed at which the fluorescence was generated and measured (Jalink et al., 1998).

Other two non-destructive tests, suggested by Brug et al. (1994) were X-ray and acoustic analyses. The X-ray analysis of tomato seeds enabled the prediction of seedling morphology. The acoustic analysis of pea seeds provided a rapid physical assessment of seeds, correlating with seed coat conditions. Both techniques could be automated and provided potential new sorting techniques. The X-ray technique provided with some evidence for the origin of vigour differences in tomato seeds: morphological differences in seed embryos and the availability of endosperm proved to be crucial.

Lee et al. (1995) suggested for the rapid germinability test, based on the sugar leakage from each seed lot. The sugar content of dry seeds was relatively unchanged. The total sugar percentage in the leachate after a 24-hour soak of leek-, onion- and cabbage seeds with decreased germinability, increased (Table 3). Glucose, fructose, sucrose and stahyose were detected in the leachate from non-germinable treated seeds. In these seeds, the content of total sugars was 18.0, 6.0 and 2.5 times higher than that in non-aged seeds, respectively for the seeds of cabbage, leek and onion. The authors reported that a future standardization of this method was necessary to grade seeds of different vegetable crops. A similar tendency was established by Hong S. and Lee (1995) for seeds of turnip, Chinese cabbage, and radishes. The sugar leakage from dead seeds during an 8-24 hour soaking period was much higher than in viable seed. This showed that sugar content was an efficient indicator for assessing the total viable state of seed lots.

The pH of the seed exudate was one of the rapid and reliable tests for vegetable seed grading. This method was based on the fact that when soaked in distilled water seed cells released compounds changing water pH. Experiments were conducted on beans with embryo axis excised and soaked in 2.5 ml distilled water for 30 min at a temperature of 25°C. A drop of sodium carbonate-phenolphthalein was added to the exudates. The exudate of viable seeds turned pink, while non-viable seeds had colourless exudates (Peske and Amaral, 1994).

A rapid verification of seed viability could be also made by UV-treatment. The viable seeds, able to develop normal sprouts, did not fluoresce, their germinability in Chinese cabbage and radishes being 97.0 - 98.0% and 84.0 - 87.0%, respectively. The dead seeds fluoresced and only 4.0-7.0% of them (in turnip) succeeded in germinating (Lee et al., 1997).

5. Conclusions:

From the review of the special literature, dedicated on the problems of seed quality, it can be summarized that for estimation of vegetable seed viability very perspective are the vigour tests.

Vegetable seeds have many qualities which are economically significant. Their precise and rapid evaluation is too important for seed science, seed production and for vegetable producers too.

In front of the researchers, who work in the field of the seed science, stand many challenges to find more appropriate methods and index for assessment the seed vigour and also for prediction of seed status and potential. These tests should be standardized and to answer the request for vigour determination.

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