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THE RELATIONSHIP BETWEEN SEED QUALITY MEASUREMENTS AND FIELD EMERGENCE OF SOYBEAN (*GLYCINE MAX* L.)

Hania A.M. Eraky[1]*, A.A.G. Ali[2], H.A. Rabie[2] and M.I. Elemery[1]

[1]Seed Technology Res. Section, Field Crops Res. Institute, A.R.C., Giza- Egypt.

[2]Agron.Dept., Fac. of Agric., Zagazig Univ., Egypt

ABSTRACT

Six soybean (*Glycine max* L.) varities namely, Giza 111, Giza 83, Giza 35, Giza 22, Giza 82 and Crowford were used in this investigation to study the relationship between seed quality measurements and field emergence. Laboratory tests and seed index (Hundred seed weight) were conducted for two successive seasons after harvesting and processing the seed crop during 2008 and 2009 years. Standard germination, Tetrazolium and Cold tests were carried out at Seed Laboratory, Faculty of Agriculture, Zagazig University, while Electrical conductivity test was carried out at Laboratory of Seed Technology Research Department at Giza ARC. Field emergence experiments were conducted during both testing seasons (2008 and 2009) at Kafr El- Hamam Research Station on May, 25th , 2008 and June, 1^{st,} 2009, for the first and the second seasons, respectively. The results indicated that seed weight of soybean had no definite effect on field emergence. Then, it could not be accepted as an indicator to seed viability or a basic trait to predict the field emergence of soybean seeds. The results revealed that Giza 111 and Giza 83 cultivars gave the high values in most results of viability and vigour tests while Crowford and Giza 82 gave the lowest values in that regard. This confirmed the potential differences in viability and vigour between cultivars and seed lots. Then, soybean seed lots should be tested well before planting. The results revealed highly significant correlation between field emergence and vigour tests (Good seedling %, Tetrazolium energy 1-3, Cold germination % and Tetrazolium potential) while it was negatively correlated with Electrical conductivity. These results impressed the importance of those tests to predict the field emergence for soybean seeds and limitation the seed rates based on the results of those seed vigour tests and of course the required density.

Keywords: Germination, field emergence, seed vigour, seed viability, seed quality, soybean.

***Corresponding author:** Hania A.M. Eraky, Tel.: +20182697088
E-mail address: kammoura1982@yahoo.com

INTRODUCTION

Planting high quality seeds is the first basic stone in increasing and improving productivity of field crops. Thus, better knowledge of the viability or germination power of planting seeds is essential. Some are of long duration, while others taken a shorter period of time to obtain results. Accepted method is needed to evaluate seed viability and seed vigour or a basic trait to predict the field emergence of soybean seeds.

The standard germination test can function simultaneously as a vigour test. In many cases the germination test has been shown to be a reliable vigour test under optimum field conditions. This test possesses the same practical advantages as the speed of germination test while suffering identical disadvantages. However, the realization that the germination test was inadequate to predict field emergence in most crops under adverse field conditions spurred further investigation for a more appropriate vigour measurement (Miller and Mcdonald, 1975).

Tiwari *et al.* (1978) in India, investigated germination and field emergence in 21 cultivars of soybean classified on the basis of 100-seed weight as small, medium and bold. They showed that small-seed cultivars showed significantly higher germinability (84.9%) than medium (58.7%) and bold cultivars (62.4%).

Tao (1980) in USA, found that no significant differences between seed lots in standard germination test for soybean and consistent results from different Laboratories were obtained for the standard germination test for soybean. However he found that significant differences between lots in cold test and conductivity test for soybean and the cold test was able to distinguish between different seed lots by viability, particularly in soybean.

Andric *et al.* (2007) in Croatia, studied the influence of cultivar, seed age and planting date on soybean seed vigour and field emergence. They found that soybean speed germinability test over 80% performed quite well in both planting dates, but seeds with lower standard germination emerged much worse in early planting date and cold test showed the highest variability (87.7%) among the laboratory vigour test and the strongest linear correlation in early planting dates was between field emergence and cold test.

Furthermore, Ali (1979) in his study on 20 seed lots of soybean found that the averages of TZ potential were 86.1, 75.3, 52.5 and 21.1% for EC grades A, B, C and D, respectively. The averages of TZ seed energy (vigour) were 67.1, 45.8, 26.7 and 8.6% for EC grades A, B, C and D, respectively. He reported that Ec high vigour grades (A and B) of soybean seeds have higher values in growth measurements and viability tests than the low vigour grades (grad D).

Mason *et al.* (1982) in USA, reported that the tetrazolium test generally over- estimated from 0 to20% in their study on field emergence of mechanically damaged soybean seed as tetrazolium test and the cold test was under-estimated emergence by 5-41%.

Dias and Marcos-Filho (1996) and Colete *et al.* (2004) in Brazil, in their study on conductivity tests were carried out on soybean cultivars concluded that this test was a rapid and efficient in seed vigour as well as an efficient method to discriminate between soybean seed lots of different qualities.

Andric *et al.* (2004) in croatia, in their study on the relationship between standard germination and field emergence with field emergence index showed that seeds with optimum vigour (SG:90%) had very similar SG and FE values (SG=FE, FEI=100). On the contrary, in seeds with reduced vigour (SG< 80%), the SG and FE values were very different (SG> FE, FEI=40-100), and there was a very great possibility of reduced FE. This knowledge can significantly reduce risk in sowing and contribute to improvement of soybean seed performance and stand establishment.

Tekrony (1973) reported that the standard germination test accurately predicted field emergence under ideal field conditions. He further concluded, however, that if soybean seed is planted under adverse field conditions the standard germination test will consistently overestimate field emergence and a vigour test such as artificial-aging germination predicted field emergence more accurately.

Moreover Kulik and Yaklich (1982) in USA reported that the tests with the most consistent linear regression coefficients over years were the cold emergence test, tetrazolium staining of viable seeds and numbers of normal and total live seedlings after accelerated aging. None of the tests are recommended for predicting field emergence.

Yogendra and Ram (2003) in India, reported that field emergence was positively correlated with vigour index, standard germination and index of germination speed; and was negatively correlated with seed weight, number of wrinkled seeds, number of ruptured seeds, and electrical conductivity of the seed leachate.

Schuab *et al.* (2006) in Brazil, in their study on comparing different tests to evaluate relationship with seedling emergence in the field. They found that the standard germination, tetrazolium and electrical conductivity tests showed higher correlations with field emergence.

MATERIALS AND METHODS

Six soybean (*Glycine max* L.) varities namely, Giza 111, Giza 83, Giza 35, Giza 22, Giza 82 and Crowford were used in this study. Seed lots were produced during the two summer seasons of 2007 and 2008 which obtained from Agricultural Research Center, Field Crops Research Institute annually to study the relationship between seed viability and vigour tests and measurements as well as their relation with field emergence of soybean seeds.

Laboratory tests were conducted after harvest and seed processing during 2008 and 2009 seasons. Field emergence experiments were conducted during both testing seasons on May, 25th, 2008 and June, 1st, 2009, for the first and second seasons, respectively. A representative sample of 800 seed for each variety in four replications (200 seed each) were used to evaluate every seed test done on each soybean cultivar investigated in this study.

Laboratory Tests

Standard germination test and its measurements

In an attempt to identify more precisely the differences in performance among samples four sup replications of 25 seed of each seed lot were germinated in rolled paper towels at temperature $27^{\pm}$-1ċ. Other procedures were made according to AOSA rules (1981). Normal seedling were counted after 5 and 8 days from planting and expressed as the percentage germination.

Tetrazolium (TZ) test

TZ procedures, ratings for potential germination and TZ vigour or energy (1-3) consisted of classifying individual seeds on the basis of embryo soundness as explained by Grabe (1970).

A representative sample of 400 seed in four replication 100 seed each used to evaluate the TZ staining patterns of each seed cultivar. In preparation for the test, the seeds were preconditioned overnight at 35° C in water moistened paper towels. The testa (seed coat) was removed and the seeds were covered by the TZ solution and kept in darkness at 35° for six hours. The solution was then discarded and the seeds rinsed in water. The stained seeds were submerged in water after rinsing and then refrigerated until time of evaluation.

Evaluation for viability were made under 7 magnification after bisecting the seed through the embryonic axis. TZ ratings for potential germination consisted of classifying individual seeds on the basis of embryo soundness as out lined by Moore (1969).

Each seed was classified into one of eight possible categories. Categories one to five inculusive represented potentially germinative seeds. Categories six to eight inculusive represented non-germinative seeds (TZ potential 1-5).

Level of seed vigour (TZ 1-3) was obtained by totaling the number of seeds in categories one to three inculusive for seed vigour three.

Cold test

The seeds were placed in soil boxes and watered up to 70% of soil saturation then kepted at 5° ± 10 for 7 days. After this period the boxes were removed from the cold temperature, placed in conditions favorable in to warmer temperature, normally 25° c., for germination to occur. After 8 more days the number of normal seedlings was counted according to the procedures explined by Byrd and Delouche (1971).

Electrical conductivity test "EC"

Conductivity tests are based on the premise that as seed deterioration progresses the cell membranes become less rigid and more water-permeable, allowing the cell contents to escape into solution with the water and increasing its electrical conductivity.

Conductivity was measured on samples of 100 seed of each replicate in four sup replicate 25 seed each according to the procedures outlined by (ISTA., 1999).

The seed were weighed and placed in Erlenmeyer flasks (250 ml) containing 200 ml of deionised water and cover by aluminum foil. The flasks were then placed in an incubator chamber at 25° for 24 hours. The conductivity of seed steep water was measured immediately after the removal of samples from the incubator with a pipette-type conductivity cell attached to a bulk conductivity meter. The seed conductivity values were expressed as μs/gm.

Field Emergence

Seeds were planted at May, 25th and Jun, 1st during 2008 and 2009 summer seasons, respectively. Two seed treatments of untreated (control) and vitavax fungicide treated were planted in rows 20 cm apart and 5 cm between seeds in the row. Four replications of one m^2 each were applied in a randomized complete block design during both years. Field emergence was recorded after 10th days from planting (DAP).

In addition, field emergence index (FEI) was evaluated at 10th day after sowing and the next formula was used

$$FEI = \frac{\text{field emergence}}{\text{standard germination}} \times 100$$

Analysis of Variance

Factorial experiment in a complete randomized block design with four replicates was used. All collected data in each year were subjected to statistical analysis as prescribed by Snedecor and Cochran (1967) for comparison among means.

Comparison and Correlation Study

For the comparison study between seed viability and vigour tests and measurements as well as their relationships with field emergence results, the correlation coefficient among all possible test results and measurements were calculated.

RESULTS AND DISCUSSION

First Count %

The standard germination test can function simultaneously as vigour test. In many cases the germination test has been shown to be a reliable vigour test under optimum field conditions. Thus, the first count % of soybean cultivar in both seasons and its combined are presented in Table 1. Meanwhile, the results revealed highly significant differences between soybean cultivars where

Table1. First Count% of soybean cultivars during two successive seasons and their combined

Cultivars	First Count %		
	1st season	2nd season	Combined
Giza 111	85.00 a	69.50 a	77.25 a
Giza 83	89.25 a	65.75 a	77.50 a
Giza 35	73.00 b	69.25 a	71.12 b
Giza 22	39.25 c	64.75 a	52.00 c
Giza 82	70.50 b	29.25 b	49.87 c
Crowford	40.25 c	27.00 b	33.62 d
F. test	**	**	**
Range	39.25	27.00	33.62
	89.25	69.50	77.50

Giza 83 cv. followed by Giza 111 and Giza 35 cvs gave higher first count percentages during both seasons as well as its combined. Meanthrough, first count % ranged from 39.25 to 89.25 % in the first season and from 27.00 to 69.75% in the second season. The lowest first count % was given by Giza 22 cv. in the first season while it was recorded by Crowford cv. in the second season and the combined. These results followed the same patterns of germination percentage whereas Giza 83 cv. appeared to had higher germination percentage as well as high first count % during both seasons and its combined. The obtained results are in a good line with those reported by Miller and Mcdonald (1975). In addition, Andric *et al.*, (2007) found that soybean speed germinability test over 80% performed quit well in two planting dates, but seeds with lower standard germination emerged much worse in early planting date.

Hundred Seed Weight "g"

The results in Table2 revealed significant differences during both seasons and the combined where Giza 82 cultivar has the heaviest 100-seed weight in the second season and the combined which followed by Crowford cultivar, while in the first season Crowford gave the highest 100 seed weight followed by Giza 22, Giza82 and Giza111 cultivars. On the contrary, Giza 35 cultivar has the lowes

Table 2. Hundred seed weight "g" and Germination % of soybean cultivars during two successive seasons and their combined as well as its correlation with field emergence

Cultivars	Hundred seed weight "g"				Germination %			
	1st season	2nd season	Combined	Corr. With FE.	1st season	2nd season	Combined	Corr. With FE.
Giza 111	16.30 b	16.05 c	16.18 b	0.195	86.25 c	81.50a	83.87 bc	0.677*
Giza 83	15.36 c	14.79 d	15.07 c	-0.902**	97.50 a	79.50a	88.50 a	0.986**
Giza 35	13.74 d	14.77 d	14.26 d	-0.762**	88.00 c	76.00b	82.00 c	0.969**
Giza 22	16.50 ab	14.83 d	15.66 bc	0.322	76.00 d	71.25c	73.62 e	0.645
Giza 82	16.32 b	19.58 a	17.95 a	-0.381	93.00 b	62.00d	77.50 d	0.987**
Crowford	17.24 a	17.49 b	17.37 a	0.591	96.00 ab	74.25 bc	85.12 b	0.970**
F. test	**	**	**		**	**	**	
Range	13.74	14.77	14.26		76.00	62.00	73.62	
	17.24	19.58	17.95		97.50	81.50	88.50	

100 seed weight in the first season and the combined.

Concerning the correlation coefficient between seed weight of soybean cultivars and field emergence, the results revealed highly significant negative correlation between the two lighter seed weight of Giza 82 and Giza 35 cultivars and field emergence. In spite of the negative correlation between lower 100-seed weight and field emergence of soybean cultivars, no significant correlation was detected between the higher 100 – seed weight cultivars and field emergence which indicated that seed weight of soybean had no definite effect on field emergence. Then, it could not be accepted as an indicator to seed viability or vigour to predict the field emergence of soybean seeds. In this connection, Stanway (1974) showed that larger seed of soybean appeared to be more severed and higher mechanical damages resulted in low germination percentage. Also, Tiwari *et al*., (1978) reported that small seed cultivars of soybean showed significantly higher germinability (84.9%) than medium (58.7%) and bold cultivars (62.4%).

Germination Percentage

Data in Table 2 show germination percentage of soybean cultivars during both seasons and its combined as well as their correlations with field emergence.

The results indicate that Giza 83 cv. gave the highest germination % in the first season and the combined which followed by Giza 82 cv. While, in the second season, the same cultivar (Giza83) gave higher germination % with no significant difference with Giza 111 cv. Otherwise, the lowest germination % was recorded by Giza 22 cv in the first season and the combined and by Giza 82 cv in the second season. Such results emphasize that germination potential of soybean seed lots could be changed seasonally according to environmental conditions, seed processing and handling applied. Then, seed viability and vigour tests should be measured just before planting to determine the ideal seeding rate required.

Concerning the results of correlations between germination % and field emergence, the higher germination percentages of Giza 83 cv. (88.5%), Crowford cv. (85.12%) and Giza 35 cv. (82.0%) appeared to be highly significantly correlated with field emergence with r=0.986**, 0.970** and 0.969** for the same following order. The results in accordance with those reported by Abd-Alla (1997) who reported that germination potential and germination percentage of soybean seed lots proved satisfactory for predicting seed performance in the field.

Tetrazolium (TZ) Potential

The TZ test was used as a rapid test for determining the differences among soybean cultivars in terms of TZ-potential and TZ-energy 1-3. Tetrazolium potentional of the soybean cultivars through two following seasons and the combined are given in Table 3. The results revealed significant differences between soybean cultivars in both seasons of investigation and the combined. Meanwhile, TZ potential ranged from 72.50-97.5, 68.25-81.00 and76.75-89.00 % in the two following seasons and the combined, respectively. Giza 83 cv gave the higher TZ potential % which followed by Giza 111 and Giza 35 cvs as compared with other soybean cvs. These results almost followed the same patterns of germination and first count percentages where Giza 83 cv appeared to be the superior one followed by Giza 111 cv. compared with other soybean cvs.

Positive correlations existed between the TZ potential and field emergence of soybean cultivars either with those achieved higher TZ potential or those with lower TZ potential percentages. Such results stated the relationship between TZ-potential % and field emergence which proved satisfactory for predicting seed performance in the field. The results are in accordance with those reported by Ali (1979). However, Mason *et al.* (1982) reported that tetrazolium test generally over estimated from 0 to 20 % in their study on estimators of field emergence of mechanically damaged soybean seed as TZ test.

Electrical Conductivity (EC) Test " μs /g"

Electrical conductivity of soybean seeds through the two seasons and the combined and their correlation coefficients with field emergence are presented in Table 3.

The data reveals highly significant differences among soybean cultivars in both seasons and the combined where Giza 111 cv. recorded the lowest EC values of 79.33, 117.02 and 98.18 μs /g through the two successive seasons

Table 3. Tetrazolium potential % and Electrical conductivity " μs /g" of soybean cultivars during two successive seasons and their combined as well as its correlation with field emergence

cultivars	Tetrazolium potential %				Electrical conductivity " μs /g"			
	1st season	2nd season	Combined	Corr. With FE.	1st season	2nd season	Combined	Corr. With FE.
Giza 111	94.50 ab	80.00 a	87.25 ab	0.962**	79.33 d	117.02 e	98.18 e	-0.981**
Giza 83	97.50 a	80.50 a	89.00 a	0.977**	107.58 c	149.57 b	128.57 d	0.959**
Giza 35	94.00 abc	77.75 a	85.87 ab	0.981**	111.66 c	158.09 a	134.87 c	-0.980**
Giza 22	72.50 d	81.00 a	76.75 c	-0.035	220.19 a	137.21 c	178.70 a	0.252
Giza 82	88.50 c	68.25 b	78.37 c	0.721*	148.31 b	125.47 d	136.89 c	-0.944**
Crowford	89.75 bc	77.50 a	83.62 b	0.949**	140.78 b	152.59 b	146.68 b	-0.978**
F. test	**	*	**		**	**	**	
Range	72.50	68.25	76. 75		79.33	117.02	98.18	
	97.50	81.00	89.00		220.19	158.09	178.70	

and the combined, respectively. On the contrary, Giza 22 cv. gave the highest EC values of 220.19 and 178.70 μs /g in the first season and the combined, respectively. Generally, wide ranges of EC values were observed through the two seasons and the combined which amounted to 79.33-220.19, 117.02-158.09 and 98.18-178.70" μs/g", for the same following order. These results taken the reverse direction of the former presented seed viability and vigour results included G %, GS%, and TZ-potential. Such results indicate that low-EC cultivars have the higher viability and vigour percentages than the high-EC cultivars. Thus, the EC measurements of soybean cultivars highly significantly, but negatively correlated with field emergence results which showed negative correlation coefficients of r = -0.981**, 0.959**, -0.980**, -0.944** and -0.978** between EC values of Giza 111, Giza 83, Giza 35, Giza 82 and Crowford cultivars and their field emergence results for the same respecting order. The results are in accordance with those reported by Bradnock and Matthews (1970) who reported that the conductivity test might give a more reliable prediction of potential field emergence than the laboratory germination test. Also, the obtained results are in agreement with those reported by Tao (1980), Dias and Marcos-Filho (1996), and Vieira *et al.*, (2008), in addition, Ali (1979) indicate that the high vigour grades by the electrical current test (low EC values) have higher values in growth measurement and seed viability tests than low vigour grades (high EC values). But, he conclude that care should be taken in using EC test alone or a seed viability test in the same connection.

Good Seedling %

Data in Table 4 represented good seedling percentages of soybean cultivars in both seasons and its combined. The results indicated highly significant differences where Giza 111 cv had the highest good seedling % in both investigated seasons as well as its combined which followed by Giza 83 and Giza 35 cvs. On the contrary, Crowford cv. recorded the lowest good seedling %. It could be noticed that soybean cultivars differed significantly in their good seedling % in both seasons and the combined which it was ranged from 35.75 to 64.5 and from 27.75 to 48.50% then from 32.50 to 56.50% in both seasons

Table 4. Good seedling% and Tetrazolium- energy (1-3) %of soybean cultivars during two successive seasons and their combined as well as its correlation with field emergence

Cultivars	Good seedling%				Tetrazolium- energy (1-3)%			
	1st season	2nd season	Combined	Corr. With FE.	1st season	2nd season	Combined	Corr. With FE.
Giza 111	64.50 a	48.50 a	56.50 a	0.968**	87.50 a	60.25 b	73.87 a	0.959**
Giza 83	56.75 b	40.50 b	48.62 b	0.976**	85.50 a	64.00 a	74.50 a	0.886**
Giza 35	47.50 cd	39.25 bc	43.37 c	0.826**	79.75 b	58.50 b	69.12 b	0.990**
Giza 22	35.75e	37.25 c	36.50 e	0.00	35.25 e	63.75 ab	49.62 d	- 0.254
Giza 82	51.25 c	28.00 d	39.62 d	0.916**	63.25 c	48.00 c	55.62 c	0.500
Crowford	37.25 d	27.75 d	32.50 f	0.949**	51.75 d	47.50 c	49.62 d	0.984**
F. test	**	**	**		**	**	**	
Range	35.75	27.75	32.50		35.25	47.50	49.62	
	64.50	48.50	56.50		87.50	64.00	74.50	

and the combined, respectively. It could be concluded that most soybean cultivar seeds revealed lower good seedling % than 50% which indicate to gave more attention to improve seed quality of soybeans by different means through harvesting, processing, treatment, handling and storage. The results are in accordance with those reported by Tao (1980), Abd Alla (1997) and Andric *et al.* (2007).

With respecting to the correlation between good seedling % and field emergence, the results indicated highly significant correlation coefficients between good seedling percentages and field emergence percentages of six soybean cultivars either with high or low good seedling percentages. Such results stated the strong relationship between good seedling % and field emergence results, then it could be used as indicator and predictable measurement to field emergence.

TZ-Energy (1-3) %

Regarding TZ-energy (1-3) which included the three more sound grade seeds, the results are presented in Table 4. Meanwhile, statistical analysis indicated highly significant differences between soybean cultivars through the two following seasons and the combined. Likely, Giza 83 and Giza 111 cvs had higher TZ-energy (1-3), while Crowford cv. gave lower values in this respect. Also, TZ-energy (1-3) results showed wide ranges among soybean cultivars which amounted from 35.25-87.50, 47.50-64.00 and 49-62-74.50 in the two following years and the combined, respectively. These results followed the same patterns of germination and first count percentages as well as TZ-potential %.

Tetrazolium energy (1-3) of soybean cultivars appeared to be highly significant correlated with field emergence, since Giza 111, Giza 83, Giza35 and crowford showed correlation coefficients of $r = 0.959^{**}$, 0.886^{**}, 0.990^{**} and 0.984^{**} in the same following order. Then, either the higher TZ-energy (1-3) cultivars or the lower ones significantly correlated with field emergence indicated that such vigour measurement could be the satisfactory for predicting seed performance in the field.

Cold Test

The results revealed highly significant differences between soybean cultivars through the two seasons and the combined in Table 5. Giza 111 cv had the highest cold germination percentage of 58.50,20,00 and 39.25 % in the two seasons and the combined, respectively. Giza 83 cv followed Giza 111 cv while, Giza 22, Giza 82 and Crowford cultivars gave the lower cold germination percentages since, Giza 22 cv gave 3.75 % in the first year and Crowford recorded 2.50 and 4.87% in the second season and the combined, respectively. Therefore, wide range of variation could be noticed between soybean cultivars which amounted from 3.75-58.50, 2.50-20.00 and 4.87-39.25% in the two following seasons and the combined, respectively.

Likely, significant correlation coefficients were observed between cold- germination percentages of soybean cultivars and their field emergences either with higher cold- germination % cultivars or with lower ones, where correlation coefficient values of r = 0.950**, 0.894**, 0.979**, 0.803* and 0.778* were formded for Giza 111, Giza 83, Giza 35, Giza82 and Crowford, respectively.

In this connection, the obtained results are in accordance with these reported by Tao (1980). However, Mason *et al.*, (1982) showed that the cold test under estimated emergence by 5-41 % and Egli and Tekrony (1995) indicated that cold test varied from more than 80% to near Zero. In addition, Andric *et al.*, (2007) in their study on the influence of cultivar, seed age on soybean seed vigour and field emergence found that cold test showed the highest variability (87.7%) among the laboratory vigour test

The results of cold test almost followed the same patterns of good seedling% and TZ potential which indicated the ability of developed cold test to evaluate the vigouristy of soybean lots and cultivars as well as predicting the performance of soybean seed lots when planted in early spring in cold and wet soils.

Field Emergence at 10th Day

Highly significant differences were detected between soybean cultivars either treated or untreated seeds through seasons and the combined in Table 6. Concerning the combined data of untreated seed, both Giza 111 and Giza 83 cultivars recorded higher field emergence percentages of 55.25, 56.25 % at the 10th day from sowing. Otherwise, Crowford and Giza 82 cultivars showed the lower field emergence at the 10th day from sowing in the two seasons

Table 5. Cold test germination%-age of soybean cultivars during two successive seasons and their combined as well as its correlation with field emergence

cultivars	Cold test germination%-age			
	1st season	2nd season	Combined	Corr. With FE.
Giza 111	58.50 a	20.00 a	39.25 a	0.950**
Giza 83	17.00 b	12.75 b	14.87 b	0.894**
Giza 35	15.50 bc	5.00 d	10.25 c	0.979**
Giza 22	3.75 e	9.75 c	6.75 d	-0.395
Giza 82	10.25 cd	3.50 d	6.87 d	0.803*
Crowford	7.25 de	2.50 d	4.87 d	0.778*
F. test	**	**	**	

Range	3.75	2.50	4.87
	58.50	20.00	39.25

Table 6. Field emergence (FE) % at 10th DAP and Field emergence index (FEI) % at 10th day from sowing for untreated and treated seed of soybean cultivars during two successive seasons and their combined

Cultivars	FE % at 10th DAP						FEI % of untreated seed				FEI % of treated seed		
	1st season		2nd season		Combined		1st season	2nd season	Combined	Corr. With FE.	1st season	2nd season	Combined
	Un.	tr.	un.	tr.	un.	tr.							
Giza 111	72.50 a	59.25 b	38.00 a	31.75 a	55.25 a	45.50 b	84.07 a	41.15 a	62.61 a	0.848**	69.96 b	29.32 a	49.64 b
Giza 83	74.25 a	72.75 a	38.25 a	24.50 b	56.25 a	48.62 a	76.19 b	43.72 b	59.63 a	0.990**	76.19 a	30.80 a	53.49 a
Giza 35	52.75 b	51.75 c	13.00 b	5.00 cd	32.87 c	28.37 c	57.68 c	15.46 c	36.57 c	0.990**	58.86 c	4.59 c	31.73 d
Giza 22	40.00 c	36.25 d	38.50 a	23.75 b	39.25 b	30.00 c	52.57c	50.53 a	51.55 b	0.715**	47.64 d	30.18 a	38.91 c
Giza 82	38.50 cd	32.75 de	11.00 b	4.00 d	24.75 d	18.37 d	41.39 d	15.40 c	28.39 d	0.923**	35.21 e	6.42 c	20.82 e
Crowford	34.50 d	30.75 e	13.50 b	7.00 c	24.00 d	18.87 d	39.82 d	17.17 c	28.50 d	0.995**	34.62e	9.43 b	22.02 e
F. test	**	**	**	**	**	**	**	**	**		**	**	**
Range	34.50	30.75	11.00	4.00	24.00	18.37	39.82	15.40	28.39		34.62	4.59	20.82
	74.25	72.75	38.50	31.75	56.25	48.62	84.07	50.53	62.61		76.19	30.80	53.49

and the combined compared with other soybean cultivars. However, the combined data of treated seeds indicated that Giza 83 cv. achieved the highest field emergence of 48.62 % at the10th day from sowing. But, likely Crowford and Giza 82 cultivars treated seeds gave the lower field emergence percentages. These results almost followed the same patterns of germination %, first count %, good seedling %, TZ potential and vigour % and cold-germination%. Such results stated the variability of soybean seed varieties and / or lots in their vigour potential either when treated or untreated with fungicide. Also, the good correlation existed between viability and vigour measurements and the field emergence % and possibility of using such test results for predicting relative field emergence according to its correlation coefficient with field emergence.

Generally, it could be noticed that untreated seeds appeared to had higher field emergence percentages than treated ones through age, seasons and the combined which indicate that fungicide used (Vitavax) had negative response or inhibitor effects on soybean seeds. The obtained results are in agreement with those reported by Lin (1982), Andrie *et al.*, (2004) and Ghuge *et al.*, (2007).

Field Emergence Index (FEI)

Highly significant difference between soybean cultivars were existed through seasons and combined for either untreated or treated seeds in Table 6. Meanwhile, the combined data of untreated seeds showed a wide range of FEI from 28.39 to 62.61 where Giza 111 (62.61) and Giza 83 (59.63) cultivars gave the higher FEI values as compared with other soybean cultivars. However Giza 82 (28.39) and Crowford (28.50) cultivars recorded the lower FEI values.

Regarding the combined FEI of treated seeds of soybean cultivars, the results almost followed the same trend of untreated ones where Giza 83 cv. gave the highest FEI of 53.49 which followed by Giza 111 (49.64), while Giza 82 (20.82) and Crowford (22.02) cultivars also gave the lower FEI values as compared with the other soybean cultivars. Then, FEI values were ranged from 20.82 to 53.49, concerning the combined FEI values of treated seeds of soybean cultivars.

Such evaluated measurement (FEI) gave a clear idea about the relationship between field emergence and laboratory germination results. Thus, the higher FEI values indicate the vigorous potential of such seeds and in turn the strong relation between the laboratory germination and field emergence results. So, the correlation coefficient between FEI and FE of the six soybean cultivars were highly significant which ranged from r=0.715** to r=0.995. In this manner Lin (1982) reported that soybean seeds with a high vigour index emerged better in the field than seed with a low vigour index.. Furthermore, Andric *et al*., (2004) showed that seeds with optimum vigour (SG:90%) had very similar SG and FE values (SG=FE, FEI=100). On the contrary, in seeds with reduced vigour (SG< 80%), the SG and FE values were very different (SG>FE, FEI=40-100), and there was a very great possibility of reduced FE, if we use such seed.

Correlation Among Seed Quality Measurements

To identify the relationship between seed viability and vigour measurements as well as their correlation with field emergence of soybeans, correlations were calculated for all possible combinations in both successive years Tables 7 and 8. It could be noticed that positive highly significant correlation coefficients were existed between field emergence of soybeans in the first year Table 8 and each of FEI, TZ-energy (1-3), GS %, CT-germination and TZ-potential with r=0.951**, 0.818**, 0.809**, 0.694** and 0.599** for the same followed order. However, it was negatively correlated with EC-values (r=-0.702**). Field emergence index appeared to be highly significant correlated with each of GS(r=0.759**), CT-germination (r=0.752**) and TZ-energy (1-3) (r=0.699**), while it was negatively correlated with EC-values(r= -0.594**).

In addition, cold test germination highly significantly correlated with GS(r=0.796**) and TZ-energy 1-3 (r=0.699**) and significantly with TZ-potential (r=0.462*), however it was negatively correlated with EC-values (r=-0.708**). Electrical conductivity values appeared to be negatively highly significant correlated with TZ-energy 1-3, TZ- potential, GS% and germination %.

Furthermore, highly significant correlation coefficients were recorded between TZ energy 1-3 and each of GS% and TZ-

Table 7. Correlation coefficients between all possible combinations of soybean seed viability and vigour measurements as well as their correlation coefficients with field emergence in the first season

	Germination %	Good seedling%	100-seed weight	Tetrazolium potential %	Tetrazolium energy (1-3) %	Electrical conductivity	Cold test germination %	Field emergence index
Field emergence	0.170	0.809**	0.330	0.599**	0.818**	-0.702**	0.694**	0.951**
Field emergence index	0.050	0.759**	-0.252	0.438*	0.699**	-0.594**	0.752**	
Cold test	-0.036	0.796**	-0.021	0.462*	0.699**	-0.708**		
Electrical conductivity	-0.523**	-0.775**	0.325	-0.879**	-0.924**			
Tetrazolium energy (1-3)	0.436*	0.853**	- 0.472*	0.848**				
Tetrazolium potential	0.740**	0.683**	-0.385					
100- seed weight	-0.00	-0.247						
Good seedling%	0.277							

* Denotes significance at 5% probability level

** Denotes significance at 1% probability level

Table 8. Correlation coefficients between all possible combinations of soybean seed viability and vigour measurements as well as their correlation coefficients with field emergence in the second season

	Germination %	Good seedling%	100- seed weight	Tetrazolium potential %	Tetrazolium energy (1-3) %	Electrical conductivity	Cold test germination %	Field emergence index
Field emergence	0.532**	0.703**	-0.580**	0.539**	0.783**	-0.318	0.822**	0.793**
Field emergence index	0.390*	0.598**	0.569**	0.491*	0.789**	-0.301	0.742**	
Cold test	0.621**	0.837**	-0.427*	0.381	0.633**	-0.513*		
Electrical conductivity	0.169	-0.264	-0.409*	0.156	0.020			
Tetrazolium energy (1-3)	0.516*	0.734**	-0.834**	0.519**				
Tetrazolium potential	0.639**	0.544**	-0.684**					
100- seed weight	-0.651**	-0.662**						
Good seedling%	0.738**							

* Denotes significance at 5% probability level
** Denotes significance at 1% probability level

potential, while it was significantly correlated with GI and germination %. Also, highly significant correlation coefficients were existed between TZ-palatial and each of germination %, GS % .

The correlation results in the second year Table 8 almost followed the same patterns of the first one where, field emergence highly significantly correlated with each of CT-germination, FEI, TZ-energy 1-3, GS %, TZ-potential and germination % with r= 0.822**, 0.793**, 0.783**, 0.703**, 0.539**, and 0.532** in the same following order. However, FE negatively highly significant correlated with 100-seed weight (r=-0.580**).

Likely, highly significant correlation coefficients were observed among FEI and each of TZ-energy 1-3, GT-germination%, GS% and negatively correlated with 100-seed weight. Also, highly significant correlation coefficients were observed between CT-germination % and each of GS%, TZ-energy 1-3 and germination %, however it was negatively correlated with EC-values. TZ-energy (1-3) highly significant correlated with GS% and TZ-potential, while it was negatively correlated with 100-seed weight. Furthermore, TZ-potential highly significant correlated with germination % and GS%, however it was negatively correlated with 100-seed weight. However, negatively highly significant correlations were existed between 100-seed weight and each of GS% and germination%. Finally, highly significant correlation of r=0.738** was observed between GS% and germination %.

Several comments can be made about these correlations. The highly significant correlations existed between field emergence and TZ energy (1-3), good seedling%, TZ-potential expressed the important of TZ test as a "quick test" and each of GS % and cold-germination as vigour tests in evaluation of soybean seed viability and vigour and they can predict field emergence more accurately. TZ –tests for determing the extent to which a 24-hour TZ test could be predict the results of a 8 day standard germination test (correlation coefficients between germination % and TZ-potential =0.740** and 0.639** in the two successive years, respectively). In addition the highly significant correlation coefficients of 0.818** and 0.783** existed between FE and TZ energy 1-3 in the two years, respectively indicated the strong relationship between FE and TZ-energy as a vigour test for evaluating the seed vigour of soybeans.

Likely good seedling % and cold test-germination% strongely correlated with FE of soybeans which indicate that those tests could be used in evaluating seed and seedling vigour of soybeans.

The negative significant correlations existed between 100-seed weight of soybeans and field emergence in addition to most seed viability and vigour measurements in the second year indicate that seed weight of soybeans could be not used as an indicator for seed viability or vigour. Similar results were reported by Kulik and Yaklich (1982) and Yogendra and Ram (2003) who found that seed weight of soybeans negatively correlated with FE, germination%, vigour index while it was positively correlated with EC of the seed leachate.

Many comparisons have been made between laboratory tests and field emergence of soybeans, with correlations between the two ranging from excellent to poor. the obtained correlation results are in accordance with those reported by Singh and Ram (1985). Recently, Bauer *et al.*, (2003) indicated that seed vigour as evaluated by TZ test was largely correlated with field emergence of soybeans. Likely, Yogendra and Ram (2003) reported that field emergence of soybeans was positively correlated with vigour index, standard germination and index of germination speed; and was negatively correlated with seed weight and EC of the seed leachate. More recently, Scuab *et al.*, (2006) found that the standard germination, TZ and EC tests showed higher correlations with field emergence of soybeans. Also, Andric *et al.*, (2007) reported that the strongest linear correlation in early planting dates of soybeans was between field emergence and cold test.

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العلاقة بين مقاييس جودة بذور فول الصويا والتكشف الحقلي

هنية أحمد محمد عراقي[1] – أحمد محمد محمد عبدالغنى على[2]
حسن أحمد ربيع[2] – محمود إبراهيم العميرى[1]

[1] قسم بحوث تكنولوجيا البذور – معهد المحاصيل الحقلية – مركز البحوث الزراعية
[2] قسم المحاصيل – كلية الزراعة – جامعة الزقازيق

استخدم ستة أصناف من فول الصويا هى جيزة ١١١، جيزة ٨٣، جيزة ٣٥، جيزة ٢٢، جيزة ٨٢ وكراوفورد بهدف دراسة العلاقة بين حيوية بذور فول الصويا والتكشف الحقلي حيث أجريت اختبارات حيوية البذور(اختبار الإنبات القياسي، اختبار التترازوليم، الاختبار البارد، اختبار التوصيل الكهربي) وتقدير معامل البذور(وزن ال١٠٠ بذرة/جم) وتجربة التكشف الحقلي خلال عامي ٢٠٠٨ و ٢٠٠٩.

ويمكن تلخيص أهم النتائج على النحو التالي :-

١- أوضحت النتائج وجود اختلافات معنوية بين الأصناف المستخدمة في كل الاختبارات وقياساتها والتكشف الحقلي.

٢- تفوق الصنفان جيزة ١١١ وجيزة٨٣ في معظم نتائج اختبارات ومعايير حيوية وقوة البذور بينما كان أقلها الصنفان كراوفورد وجيزة٨٢ في هذا الخصوص مما يؤكد اختلاف القدرة الكامنة للحيوية والقوة بين الأصناف وكذلك بين رسائل البذور مما يستلزم اختبارها جيدا قبل الزراعة سواء كان ذلك داخل رسائل الاصناف او الاصناف المزمع زراعتها فى المنطقة لاختيار افضلها.

٣- لم يكن لوزن بذور فول الصويا تأثير واضح على حيوية وقوة انبات البادرات وبالتالي لا يمكن الاعتماد عليها للتنبؤ بالتكشف الحقلي.

٤- اظهرت النتائج تميزا واضحا لارتباط نتائج اختبارات حيوية البذور وقوة انبات البادرات ارتباطا عالي المعنوية مع التكشف الحقلي حيث اظهرت النتائج ارتباطا عالى المعنوية لكل من النسبة المئوية للبادرات القوية، اختبار التترازوليم للقوة(١-٣) ، إنبات البرودة والتترزوليم للحيوية وكذلك الارتباط السالب للتوصيل الكهربي مع التكشف الحقلي مما يؤهل هذه الاختبارات للتنبؤ بالتكشف الحقلي لتقاوي فول الصويا وإمكانية تحديد معدلات التقاوي المناسبة بناءا على نتائج هذه الاختبارات والكثافة المطلوبة.