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Study on Correlation of Seed Germination Percent of Two Sweet Corn Hybrids with Field Emergence and Some Measured Traits related to yield

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ABSTRACT

Sweet corn is one of the crops that its production is increasing thorough the world. There are a few research about effect of initial germination percent of sweet corn seeds on field performance, so in order to assess the correlation of seed germination and vigor of sweet corn with seedling field emergence and some other yield related traits, this study was conducted as factorial experiment based on randomized complete block design in 3 replications at laboratory and field of seed and plant certification and registration institute in 2 years. The factors were 2 cultivars (PA213 and KSC403) and 4 initial seed germination levels (75,80,85 and 90%) and evaluated traits were seedling dry weight, radicle emergence percent, seedling field emergence percent, seedling emergence rate, leaf area, plant height, ear length, ear diameter, rows number per ear, seed number per row and 1000-seeds weigh. The results of correlation analysis indicated that there was a high positive correlation between seed germination ability and vigor with seedling field emergence and most of the measured traits.
KEY WORDS: corn; correlation; germination; seed.

1. INTRODUCTION

The importance of sweet corn is increasing among several subspecies of corn. It is a worthy crop in all countries due to its good taste and nutritive value. The planting and production of sweet corn is very appropriate because it is a tasty and healthy food for men and also is good fodder for livestock. Therefore, the growers are more eager to plant this crop in recent years [31].

Seed as a major and essential input, plays an important role in crop production. So the use of high quality seeds is an effective ways of crop yield enhancement. Non availability of high quality seeds is one of the main factors of yield reduction [26].

Ghassemi-Golezani *et al.,* (2012) declared that the quality of seed used by farmer determines the status of agriculture they practice. In the field, seed quality means the ability to germinate, to emerge and to produce healthy seedlings rapidly, uniformly, under a wide range of environmental conditions, and to maintain this ability for a long period [11].

High quality seed is an essential factor to ensure good crop establishment. The seed must be viable and possess physiological traits that allow rapid germination and seedling establishment. Important aspects of a good seed are strong vigor, steady germination and good and fast establishment in farm under a wide range of environmental conditions that called seed field performance [22, 23].

Low quality seeds can show a potentially decrease of germination and seedling emergence rate and percentage that leads to poor stand establishment in the field and consequently yield loss in many crops such as corn [12, 25], cotton [18], barley [6, 30] and oilseed rape [10].

The standard germination test is universally accepted as an index of quality for marketing seed [2]. It is popular because it is simple and cheap. However, because germination tests use optimal conditions, they may fail to predict field performance, particularly under adverse field conditions.

Brick (2013) suggested that seed germination tests assess the ability of the seed to produce a healthy plant when placed under favorable environmental conditions. Germination tests are conducted for a prescribed time period under laboratory conditions that assure optimum moisture, temperature and light. Unfortunately, these conditions are seldom encountered in the field, and field emergence may be overestimated by standard germination tests. Seed lots that have low germination also are less vigorous due to seed deterioration. As seeds deteriorate, loss of vigor precedes loss of viability, so seeds with low germination usually will be less vigorous. Hence, in seed lots with poor germination, those seeds that do germinate often produce weaker seedlings with reduced yield potential. However, some species (such as many native grasses) have inherently low germination potential and cannot be assumed to

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have poor vigor due to low germination. Seed vigor usually cannot be assessed by the Consumer. Germination is a good indicator of seed vigor [5].

Martin *et al*.,(1988) suggested that corn is often planted in cool and moist soils in USA and Europe causes decreased seedling field emergence, weak plants and low yields. They investigated the correlation of germination percent at cold test with seedling field emergence of 48 inbred lines of corn in 8 regions for two years. They concluded that there are correlations between laboratory germination tests and field mergence.

Schuch *et al.,* 2000 declared that seeds with low vigor can lead to reduction of emerged seedling percent, emergence rate, and early growth of plant, leaf area and dry matter accumulation.

Vazmondo *et al.,* (2013) investigated seed vigor effects on early plant growth of two corn seed lots with high and low vigor in 2 years. They estimated plant height and leaf area index at two phonological stages. The results indicated that measured traits increased by increasing of seed vigor.

Freitas *et al.,* (2000) conducted standard germination and some vigor tests in different cotton cultivars. They observed that in favorable conditions at field, the results of standard germination indicated high correlation with seedling field emergence. At unfavorable conditions the results of cold test showed better correlation with seedling field emergence.

Nezar *et al.,* (2008) studied the seed quality tests to predict field performance of aged barley seeds of two barley cultivars, "Rum" and "ACSAD176", in the semiarid Mediterranean region in Jordan. Seed germination test and some vigor tests were conducted to evaluate the quality of aged seeds. All seed quality tests were well correlated with field emergence percentage. They proposed that the standard germination and vigor tests can be used to predict field emergence of aged barley seeds.

Perry (1970) conducted emergence trials of five different seed lots of cv. Lincoln and Kelvedon Wonder at six centers for investigating the relation of seed vigor to field establishment of garden pea cultivars. The results of seedling evaluation and conductivity vigor tests correlated well with field emergence, with neither test superior to the other. Grades of vigor were established and related to the performance of the seed lots in the field trials.

Veira *et al.,* (1999) examined standard germination and vigor tests correlation with field emergence of 6 soybean cultivars. They found a significant correlation between seed germination and vigor and seedling field emergence.

Bekendam *et al.,* (1987) examined field emergence of onion, sugar beet, flax and maize seed for two or three years under a range of environmental conditions. Vigor differences were clearly demonstrated between different seed lots of the large-seeded species maize. Under favorable field conditions the germination capacity of maize seed lots correlated better with their field emergence than results of a cold test and a conductivity test, however under unfavorable field conditions the vigor tests showed a better correlation with field emergence than germination capacity.

However, Kulik and Yaklich (1982) and Wang *et al.*, (2004) were unable to predict field emergence using laboratory tests.

Pourhadian and Khajehpour (2010) examined the suitability of various laboratory germination parameters to predict field emergence of eight wheat (Triticum aestivum L. cv. Ghods) seed lots in late fall, early Spring and late Spring plantings in 2005 in Iran, using correlation coefficients. Electrical conductivity of seed leakages, final germination percentage and velocity of germination coefficient in both cold (10°C) and standard (20°C) germination tests were unable to satisfactorily predict field emergence.

Kolasinska *et al.,* (2000) examined the relationships between various seed quality tests and field emergence of common bean seeds. Thirty-nine strains and cultivars of bean were tested in the field and laboratory over 3 year. The standard germination was above 80%, but germination in the cool test (at 10°C) varied from 0 to 99%. Field emergence varied from 0 to 100%. They concluded that early planting of seeds will subject the seeds at unfavorable conditions and standard germination test can't predict seedling field emergence in these conditions. Soil temperature at sowing appeared to be not only the most important environmental factor influencing field emergence but also a factor able to be used to differentiate the field emergence potential of a seed lot.

Goggi *et al.,* (2007) in their examinations on corn reported that the standard germination test results which assess seed viability are more than field performance i.e seedling emergence percent. Therefore vigor tests are used to predict seed germination at stressful conditions.

Although a lot of researches have been conducted to predict the correlation of standard germination test and vigor tests with field emergence of various crops, but there is a little evidence about correlation of seed standard germination and seedling field emergence with yield related traits, so the purpose of this study is assessment of correlation between seed germination and yield related traits of sweet corn at field.

2. MATERIALS AND METHODS

This research was conducted in seed quality analysis laboratory and research field of seed and plant certification and registration institute in Karaj in 2012 and 2013. The study was performed as a factorial experiment based on randomized complete block design in 3 replications. The treatments were 2 cultivars of sweet corn (Chase and KSC403) and 4 levels of seed germination (75, 80, 85 and 90%). First the seed lots of two sweet corn cultivars with considered levels of germination percent were selected and then laboratory tests were carried out and then the seeds were planted at farm in 4 rows with 5 meter length, also the distance between rows was 60 cm and the distance of plants on each row was 20 cm. the measured traits were seedling dry weight, radicle emergence percent, seedling field emergence percent, seedling field emergence rate, leaf area, ear length, ear diameter, number of rows in ear, number of seeds per row and 1000-seeds weight. The statistical analysis was fulfilled by SAS software.

Laboratory Tests:

First standard germination was carried out for selecting the considered germination levels and then seedling dry weight was measured and also radicle emergence test was performed for assessment seed vigor.

Standard germination test:

4 replications of 100 seeds were planted as between paper method and then were placed at 25 ˚C for 8 days in growth chamber. The number of normal and abnormal seedlings was counted on the 8th day and normal seedlings number was considered as germination percent. Also for assessment of seedling dry weight as a vigor index,10 seedlings were selected randomly from each treatment and were placed at 70˚ C for 48 hours [1]. Then the dry weight of seedlings was measured by precise scale (0.001 gram precision).

Radicle emergence test:

It is a new test that international seed testing association represented in 2012 for assessment of corn's seed vigor. According to ISTA Rules, 8 replications of 25 seeds were planted between paper as a sandwich method, then the planted papers were put in plastic bags to prevent from drying and were placed in growth chamber at 20±1. After 66 hours the germinated seeds were counted. The seeds with at least 2mm radicle length were counted and calculated in percent [1].

Field Trials:

Seedling field emergence percent was calculated by counting final seedlings number (approximately, 20 days after planting) in natural conditions of field.

Seedling emergence rate was also calculated by below formula:

$$\text{Seedling emergence rate} = \frac{\text{final seedling numbers}}{\text{number of days from planting to final counting}}$$

Also for height and leaf area measurement, 5 plants were selected from 2 middle rows of each plot and the plant height and length and width of total leaves of each plant were measured by meter, then leaf area was calculated by length ×width ×0.75 [32]. After crop growth duration, 10 plants were harvested from two middle rows of each plot and ear length, ear diameter, rows number in each ear, seeds number in each row and 1000- seeds weight were measured.

3. RESULTS AND DISCUSSION

According to table 1, a high positive correlation was observed between initial seed germination percent with radicle emergence percent. Therefore the seeds with higher initial germination ability will show a better radicle emergence percent compared to seeds with lower initial germination percent. Also a significant correlation was observed in seed germination percent and seedling dry weight in a way that seeds with higher germination percent had more seedling dry weight. So seeds with higher germination ability will produce seedlings with more dry weight, because of faster germination rate and better growth of seedlings. The correlation of initial seed germination percent with seedling field emergence was highly positive, so higher initial germination percent of seeds will result in higher seedling emergence percent at field. Also a correlation of seed germination with seedling emergence rate at field was highly significant. Also a significant positive correlation was found between initial seed germination percent with leaf area, plant height, ear diameter, seed number per row and 1000-seeds weight. But there was no significant correlation between initial seed germination percent with ear length and rows number in each ear (Table 1).

These results are in concordance with Viera *et al*., (1999); Nezar *et al.,* (2008) and Johnson and Wax (1978) for correlation between germination and seedling emergence percent. Perry (1970) reported that the results of germinated seedlings assessment and seed vigor tests in laboratory indicated a good correlation with seedling field emergence percent. Barradas and Lopez-Bellido (2007) also observed a positive linear correlation between standard seed germination and seedling field emergence.

Bekendam *et al*., (1987) and Freitas *et al.,* (2000) reported that at favorable field's conditions, the results of standard germination test indicated higher correlation with seedling field emergence compared to seed vigor tests results, because germination tests are usually conducted at favorable and optimum conditions and vigor tests are performed at stressful conditions to predict seed performance in unfavorable conditions of field. So in favorable conditions of field, seedling emergence percent will be closer to results of germination tests.

However Kolasinska *et al*., (2000) proposed that in unfavorable field conditions, the standard germination test can't predict seedling emergence at field.

Wang *et al*., (1996) and Hegarty (1977) declared that standard germination test and germination index didn't show a significant correlation with seedling field emergence.

The correlation between radicle emergence test results with other traits was also significant, except ear length (Table 1). However a significant correlation was observed between seedling dry weight and other measured traits, except the number of rows per ear. Makkawi *et al.,* (2008) also found a significant correlation between seedling dry weight and vigor test (electrical conductivity) with seedling field emergence. Hampton (2002) reported that seed vigor has high influence on plant establishment and growth that consequently affects crop yield, because high vigor seeds can emergence better and faster in field conditions compared to low vigor seeds that leads to better plant establishment and faster development that will produce stronger plants that have more ability to compete with weeds and also have better efficiency in using resources and can better tolerate environmental stresses that finally will result in higher yield.

According to results there was a positive correlation between seedling field emergence percent with other traits, except ear length, ear diameter and rows number per ear. Also seedling emergence rate showed a significant correlation with all of the traits, except ear length.

Leaf area showed non significant correlation with ear length, rows number per ear, seed number per rows and ear diameter, but it had a positive correlation with other traits.

The correlation of plant height with most of the traits was significant, except ear length, seed number per row and ear diameter.

Ear length indicated non significant correlation with most of the traits, except seedling dry weight, seed number per row and 1000-seed weight. Rows number per ear showed a significant correlation only with radicle emergence percent and seedling emergence rate.

Seed number per row indicated a positive correlation with most of the traits; however its correlation with plant height, rows number per ear and ear diameter was not significant.

1000-seed weight also showed a significant positive correlation with other traits, except rows number per ear.

Ultimately ear diameter showed a significant correlation with germination percent, radicle emergence percent, seedling dry weight and seedling emergence rate, but it had no a significant correlation with other measured traits.

Egli and Rucker (2012) confirmed that high vigor seeds of corn always show more uniform emergence than low vigor seeds. In these cases the plants with delaying emergence at field have lower growth and development than plants that have emerged fast. So seeds with lower vigor can't stand stressful conditions of field and compete well with weeds that will lead to lower performance and yield.

In total it can be suggested that high vigor seeds will emerge better and faster at field, therefore will produce plants that grow well and faster, properly compete with weeds and have better use efficiency of light, water and nutrients, consequently higher yield will be achieved [33].

Table 1. The correlation of standard germination and seedling emergence percent with some traits in field at two years

	1	2	3	4	5	6	7	8	9	10	11	12
	Germination (%)	Radicle emergence (%)	Seedling dry weight (gram)	Seedling field emergence (%)	Seedling emergence rate	Leaf area (cm^2)	Plant height (cm)	Ear length (cm)	Rows number per ear	Seed number per row	1000-seed weight	Ear diameter (mm)
1	1.00											
2	0.88**	1.00										
3	0.74**	0.62**	1.00									
4	0.88**	0.89**	0.63**	1.00								
5	0.85**	0.94**	0.56**	0.87**	1.00							
6	0.69**	0.68**	0.46**	0.69**	0.65**	1.00						
7	0.71**	0.75**	0.54**	0.70**	0.69**	0.65**	1.00					
8	0.25^{ns}	0.04^{ns}	0.30*	0.03^{ns}	0.09 ^{ns}	0.09^{ns}	-0.01 ^{ns}	1.00				
9	0.20^{ns}	0.34*	0.05 ^{ns}	0.29^{ns}	0.30*	0.23 ^{ns}	0.31*	-0.15^{ns}	1.00			
10	0.37**	0.37**	0.36*	0.38**	0.35*	0.28 ^{ns}	0.27 ^{ns}	0.52**	0.05 ^{ns}	1.00		
11	0.83**	0.76**	0.70**	0.75**	0.75**	0.58**	0.70**	0.38**	0.20^{ns}	0.48**	1.00	
12	0.37**	0.44**	0.33*	0.24^{ns}	0.43**	0.12^{ns}	0.12 ^{ns}	0.16^{ns}	0.21 ^{ns}	0.08 ^{ns}	0.34*	1.00

*: significance at 5% level of probability; **: significance at 1% level of probability; ^{ns}: no significant

4. CONCLUSIONS

According to obtained results it can be concluded that the higher initial germination ability and vigor of seeds will result in higher seedling field emergence percent and seedling emergence rate, higher leaf area and higher plant height which affects light and resources use efficiency and ultimately will result in higher yield.

5. REFERENCES

1. Anonymmous. 2008. International Rules for Seed Testing. International Seed Testing Association (ISTA), Zurrich, Switzerland.
2. Barla-Szabo G., Dolinka B. 1988. Complex stressing vigour test: A new method for wheat and maize seeds. Seed Sci and Techno. 36: 63-73.
3. Barradas G., López-Bellido Rafael J. 2007. Seed Weight, Seed Vigor Index And Field Emergence In Six Upland Cotton Cultivars. Journal: Food, Agriculture And Environment. 5 (2): 116-121.
4. Bekendam J., Kraak H. L., Vos J. 1987. Studies on Field Emergence And Vigour Of Onion, Sugar Beet, Flax And Maize Seed. Acta Hort. 215: 83-94.
5. Brick M. A. 2013. Improve Yield With High Quality Seed. Colorado State University Extension. No. 0.303.Www.Ext.Colostate.Edu/Pubs/Crops/00303.Html.
6. Copeland L. O., Mc Donald M. B. 2001. Seed vigour and vigour tests, p. 121-144. In: Copeland LO, Mc Donald MB (Eds.). Principles of Seed Science and Technology, 4thEdn. Kluwer Academic Publishing Group.
7. Egli D. B., Tekrony D. M. 1995. Soybean Seed Germination, Vigor And Field Emergence. Seed Sci And Technol. 23(3): 595-607.
8. Farooq M., Basra S. M. A. 2006. Seed priming enhances emergence, yield, and quality of direct-seeded rice. Intl. Rice Res. Notes.

9. Freitas R. A., Dias D. C. F., Dos S., Reis M. S., Cecon P. R. 2000. Correlation Between Cotton Seed Quality Evaluation Tests And Seedling Emergence In Field. Revista Brasileira De Sementes. 22(1): 97-103.
10. Ghassemi-Golezani K., Bakhshy J., Raey Y., Hosseinzadeh-Mahootchy A. 2010. Seed vigor and field performance of winter oilseed rape (Brassica napus L.) cultivars. Not Bot Hort Agro bot Cluj. 38: 146-150.
11. Ghassemi-Golezani K., Mahmoodi-Yengabad F., Alavikia S. 2012. Seed Quality Of Lentil (Lens Culinaris Medik.) Affected By Salinity Stress. International journal of plant, animal and environmental sciences. 2: 189-193.
12. Ghassemi-Golezani K., Tajbakhsh Z., Raey Y. 2011. Seed Development and Quality in Maize Cultivars. Not Bot HortAgrobotCluj. 39: 178-182.
13. Goggi A. S., Pollak L., Golden J., Devries M., Mcandrews G., Montgomery Maydica K. 2007. Impact of Early Seed Quality Selection On Maize Inbreds. Iowa State University, 52: 223-233, Agron@Iastate.Edu.
14. Hampton J. G. 2002. The Relationship Between Field Emergence, Laboratory Germination, And Vigour Testing Of New Zealand Seed Wheat Lines. New Zealand Journal Of Experimental Agriculture. 2: 191-197.
15. Harris D., Jones M. 1997. On-farm seed priming to accelerate germination in rainfed, dry-seeded rice. Intl. Rice Res. Notes. 22: 30.
16. Harris D., Joshi A., Khan P. A., Gothkar P., Sodhi P. S. 1999. On-farm seed priming in semi-arid agriculture: Development and evaluation in maize ,rice and chickpea in India , using participatory methods. Exp. Agric. 35: 15-29.
17. Hegarty T. W. 1977. Seed Vigour In Field Beans (Vicia Faba L.) And Its Influence On Plant Stand. The Journal Of Agricultural Science. 88(1): 169-173.
18. Iqbal N., Basra S. H. M. A., Rehman K. 2002. Evaluation of vigour and oil quality in cotton seed during accelerated aging. Int J Agric Biol. 4: 318-322.
19. Johnson R. R., Wax L. M. 1978. Relationship Of Soybean Germination And Vigor Tests To Field Performance 70(2): 273-278.
20. Kolasinska K., Szyrmer J., Dul S. 2000. Relationship Between Laboratory Seed Quality Tests And Field Emergence Of Common Bean Seed. Environmental Sciences , Ecology Papers. 40: 470-475.
21. Kulik M. M., Yaklich R. W. 1982. Evaluation Of Vigor Tests In Soybean Seeds: Relationship Of Accelerated Aging, Cold, Sand Bench, And Speed Of Germination Test To Field Performance. Crop Science. 22(4): 766-770.
22. Latifi N., Soltani A., Spanner D. 2004. Effect of temperature on germinationd components in Canola (Brassica napus L.) cultivars. Iranian j Agri Sci. 35(2): 313-321.
23. Lopez–Castaneda C, Richards R. A., Farquhar D. G., Williamson R. E. 1996. Seed and seeding characteristics contributing to variation in early vigour among temperate cereals Crop Sci. 36: 1257-1266.
24. Makkawi M. E., Balla M., Bishaw Z., Van Gastel A. J. G. 2008. Correlation And Path Coefficient Analyses Of Laboratory Tests As Predictors Of Field Emergence In Lentil (Lens Culinaris Medikus). Journal Of New Seeds. 9: 284-302.
25. Moreno-Martinez E., Vazquez-Badillo M. E., Rivera A., Navarrete Rand Fasquivel-Villagrana F. 1998. Effect of seed shape and size on germination of corn (Zea mays L.) stored under adverse conditions. Seed Sci Technol. 26: 439-448.

26. Narayanareddy A. B. 2008. Effect Of Invigouration On Seed Quality, Field Performance And Storability In Sunflower Hybrid KBSH-1. Master Of Science Thesis In Seed Science And Technology. Department Of Seed Science And Technology, Collage Of Agriculture, Dharwad University Of Agricultural Sciences.
27. Nezar H., Samarah Al-Kofahi S. 2008. Relationship Of Seed Quality Tests To Field Emergence Of Artificial Aged Barley Seeds In The Semiarid Mediterranean Region. Jordan Journal Of Agricultural Sciences. 4(3).
28. Perry D. A. 1970. The Relation of Seed Vigour To Field Establishment Of Garden Pea Cultivars. The Journal Of Agricultural Science. 74(2): 343-348.
29. Pourhadian H., Khajehpour M. R. 2010. Relationship Between Germination Tests and Field Emergence of Wheat. Asian Journal of Applied Sciences. 3: 160-165.
30. Samarah N. H., Al-Kofahi S. 2008. Relationship of seed quality tests to field emergence of artificial aged barley seeds in the semiarid Mediterranean region. J AgricSci4: 217-230.
31. Szymanek M., Dfobrzanski J. B., Niedziolka L., Rybczynski R. 2006. Sweet Corn Harvest And Technology Physical Properties And Quality.Center Of Excellence Agrophysics, B. Dobrzanski Institute Of Agrophysics Of Polish Academi Of Sciences Publication.
32. Tarigholeslami M., Zarghami R., Mashhadi Akbar Bujar M., Oveisi M. 2012. Effect of nitrogen fertilizer and Water Deficit Stress on Physiological indices of corn (Zea mays L.) .Journal of Agronomy and plant breeding. 8(1): 161-174.
33. Vaz Mondo V. H., Moure Cicero S., Dourado-Neto D., Lourenço Pupim T., Neves Dias M. A. 2013. Seed Vigor and Initial Growth of Corn Crop. J. Seed Sci. 35(1) Londrina.
34. Vieira R. D., Paiva-Aguero J. A., Perecin D., Bittencourt S. R. M. 1999. Correlation Of Electrical Conductivity And Other Vigor Tests With Field Emergence Of Soybean Seedlings .Seed Sci And Technol. 27(1): 67-75.
35. Wang, Y. R, Yu L., Nan Z. B. 1996. Use Of Seed Vigour Tests To Predict Field Emergence Of Lucerne (Medicago Sativa). New Zealand Journal Of Agricultural Research. 39(2): 255-262.