The Andhra Agric. J 62(1):180-184, 2015

Relationship of Seedling Quality Tests to Field Emergence in Quality Protein and Normal Maize (*Zea Mays* L.) Genotypes

Lakshmi Prasanna K, Keshavulu K, Sreedhar M, Sudharshan M
Department of Seed Science and Technology, College of Agriculture, Rajendranagar, Hyderabad-500 030

ABSTRACT

An experiment was undertaken with ten maize inbred lines which include both quality protein maize (QPM) and normal maize lines to identify the best seed quality test to predict field early establishment of maize seed under winter season i.e. below 14^0C. Standard germination test, cold test, accelerated aging test and electrical conductivity test of seed leachates were conducted to evaluate the quality of seeds. Seedling parameters like seedling length and dry weight were also measured. The lines like BML 7 and BQPML 5280 had good field emergence even in winter season. All seed quality tests were well correlated with field emergence percentage. However, accelerated aging test predicted field emergence of maize seed better than other tests, suggesting the suitability of the test to evaluate maize seed lots.

Key words : Field emergence, Normal maize, QPM.

In India, maize (*Zea mays* L.) is the third most important food crop after rice and wheat. In the last two decades, it has registered the highest growth rate among all food grains because of newly emerging food habits as well as industrial requirements. Maize is thus potential source of protein for human and livestock. The main prerequisite for achieving economic effects and organizing successful seed production is seed quality. For this reason, it is necessary to put a great effort to improve seed production technology and at the same time to determine the best methods for successful seed quality testing.

Standard germination test is an indicator of seed quality, which can be used to predict the field emergence, if soil conditions are nearly ideal (Duurant and Gummerson, 1990). The major limitation of germination test as an assessment of seed lot potential performance is its inability to detect quality differences among high germinating seed lots (Roberts, 1984). In these circumstances a more sensitive differentiation of potential seed performance (i.e. seed vigour testing) is necessary (Hampton and Coolbar, 1990). Seed vigour tests rank seed lots according to their physiological quality. Vigour test results for a particular seed lot also help to determine the conditions under which it can be successfully planted. Accelerated aging (Woltz and Terkony, 2001) and cold test (Martin *et al*., 1988) are useful for predicting the field emergence potential of maize seed lots. In maize, relationship of seedling quality tests to field emergence under winter season is not investigated in QPM and normal genotypes. Hence, the present study was undertaken to find out relationship between seed quality tests and field emergence and to identify seed quality test for evaluation of early field establishment of maize genotypes.

MATERIAL AND METHODS

The material for investigation comprised of six quality protein and four normal maize inbred lines and four months stored seeds were obtained from maize research station, ARI, ANGRAU, Hyderabad. The stored seed of 10 inbred lines was cleaned, dried and used for the laboratory and field emergence studies conducted at Department of Seed Science and Technology, College of Agriculture, ANGRAU, Hyderabad. Protein and starch content of the seed were estimated by using NIRT (Near Infra Red Transmittance) grain analyzer (Model- Foss Infratech 1241).

Standard germination test was conducted according to ISTA rules (2000). Four replicates of

100 seeds were placed between folded germination paper, moistened with distilled water in plastic containers and placed in an incubator at 25 ^{0}C for 7 days. At the end of the test, number of normal seedlings was recorded. At the end of the standard germination test on final count day, seedling lengths were recorded in cm on randomly selected 10 normal seedlings, then the same normal seedlings were endosperm extracted and weighed after drying in an oven at 70 ^{0}C for two days. Total dry weight of normal seedlings was expressed as mg seedling $^{-1}$. The vigour indices of seedling were calculated by multiplying germination percentage with the total dry weight (mg) and seedling length (cm) of normal seedling (Abdulbaki and Anderson, 1973).

The cold test was carried out following the standard procedure as given in ISTA (2000). For measuring the electrical conductivity ten seeds of each genotype in replications were surface sterilized soaked in 50 ml deionized water at 25$\pm$ 1^{0}C for 17 hours. The electrical conductivity of the leachate was measured at room temperature with a conductivity bridge (model CM-540) and calculated as µS cm^{-1} 10 seed^{-1}. For accelerated aging test seeds of each genotype were packed in nylon net bag and subjected to accelerated aging at 100 per cent relative humidity in a water vapour saturated aging chamber which was maintained at 40 $\pm$ 1^{0}C. Samples were removed after 96 h and evaluated for standard germination test as per the ISTA (2000).

Three hundred seeds were selected randomly from the parental lines and sown in green house with three replications to study the field emergence and establishment during winter season 2010-11 where the temperature was maintained at below 14 ^{0}C. Soil moisture was maintained in the plot throughout the experiment. Number of emerged seedlings was counted daily until no further emergence has occurred. Total number of emerged seedlings at 15 days from seed sowing was used to calculate seedling emergence percentage.

The data were analysed by following Completely Randomized Design (CRD) and Simple correlation coefficients were used to determine the relationship between seedling quality tests and field emergence to know the relationship among the traits of QPM and normal maize as per the procedure suggested by Panse and Sukhatme (1988).

RESULTS AND DISCUSSION

In the present study, protein and starch content, seed quality tests and field emergence were found to be significantly different among quality protein and normal maize genotypes (Table 1). Inbred lines are generally developed and tested under the best agronomic conditions, the conditions which hardly prevail at farmer's field. The parental lines developed and recommended for further development of hybrids should therefore possess genetically highest seedling quality besides high yield, the traits which ensure stability under diverse set of conditions. Significant differences among the maize genotypes for nutritional parameters such as protein and starch contents were found in the present study. In QPM lines, protein content varied from 9.70 to 11.23 per cent while in normal maize lines it was ranged from 11.93 to 13.57 per cent. The protein content of the genotype BML 9105 (13.57%) was significantly higher than other genotypes. The starch content varied from 72.10 (BQPML 5199) to 66.13 (BML 7) per cent. Endosperm protein content however is not the major criterion in comparing the QPM and normal maize genotypes, as it does not indicate the protein quality in terms of lysine and tryptophan concentration in the protein as stated earlier by Kassahun and Prasanna (2004).

In many countries maize is sown in early spring when soil and air temperatures are low, and when seed germination obtained by standard laboratory test is not in positive correlation with field emergence. The cold test has been the standard vigor test for temperate corn (*Zea mays* L.) hybrids; however, it is not known if the cold test is as effective for evaluating seed vigor for subtropical corn lines. The cold test results showed significant differences among the genotypes studied. From the present study it can be concluded that even though the genotypes like BQPML 5199 and BQPML 5204 exhibited high per cent germination in standard germination test, they did not perform well after cold test. This indicates the susceptibility of those genotypes to cold temperatures and may not thrive well under sub optimal conditions.

Germination ranged from 97 (BQPML 5199 and BQPML 5232) to 91 per cent (BML 9105) in different inbred lines in the standard germination test (Table 1). After accelerated ageing the lines

Table 1. Protein content, starch content, seed quality tests and field emergence of QPM and normal genotypes of maize

Genotype	Protein content (%)	Starch content (%)	Cold test	Accelerated ageing	Germ-ination (%)	Seedling length (cm)	Seedling dry weight (mg/10 seedlings)	Seedling vigour index I	Seedling Vigour Index II	Electrical Conductivity (µS/cm/ 10 seed)	Field emergence (%)
BQPML 5204	9.90	70.87	85	85	97	29.98	631.67	2898.55	61066.67	10.17	79
BQPML 5342	9.70	71.40	83	82	95	28.85	632.67	2732.68	59886.67	9.60	75
BQPML 5175	10.50	70.43	78	80	93	29.65	599.33	2767.19	55941.33	8.85	68
BQPML 5280	11.67	70.90	81	88	95	29.70	624.00	2832.19	59484.00	8.86	88
BQPML 5199	10.83	72.10	86	87	97	31.41	701.33	3058.21	68328.00	12.07	85
BQPML 5232	11.23	70.53	87	86	97	30.82	643.33	3001.05	62622.67	9.31	82
BML 40410	12.80	67.00	80	82	94	27.17	596.67	2553.55	56085.33	13.80	76
BML 9105	13.57	66.80	79	78	91	27.04	539.33	2451.20	48899.33	12.57	70
BML 5016	11.93	69.10	85	83	96	28.06	638.00	2694.63	61242.67	11.77	75
BML 7	12.10	66.13	82	88	96	28.37	570.67	2723.16	54789.33	13.33	89
Mean	11.42	69.53	83	84	95	29.10	617.70	2771.24	53795.37	11.03	79
S Em±	0.05	0.23	0.97	1.15	1.21	0.86	3.43	93.24	622.52	0.19	0.36
CD (p=0.05)	0.13	0.68	2.88	3.43	3.56	2.55	10.19	276.99	1849.36	0.56	1.07

Table 2. Correlations co efficient among seed quality tests and field emergence of QPM and normal genotypes of maize

	SGT	*CT*	*AA*	*FE*	*EC*	*SVI-I*	*SVI-II*	*PROTEIN*	*STARCH*
SGT	1.00								
CT	0.88**	1.00							
AA	0.80**	0.57	1.00						
FE	0.67*	0.46	0.96**	1.00					
EC	-0.14	-0.10	-0.08	0.07	1.00				
SVI-I	0.81**	0.72*	0.69*	0.54	-0.48	1.00			
SVI-II	0.84**	0.81**	0.60	0.44	-0.29	0.87**	1.00		
PROTEIN	0.47	0.47	0.26	0.10	-0.75*	0.77*	0.77*	1.00	
STARCH	-0.53	-0.40	-0.23	-0.04	0.67*	-0.66*	-0.60	-0.81**	1.00

*significant at 5% level ** significant at 1% level

SGT- Standard germination test; CT- Cold test; AA-Accelerated ageing;

FE- Field emergence; EC- Electrical Conductivity; SVI- Seedling vigour index

Germination (%) of maize genotypes

like BQPML 5280 and BML 7 exhibited highest germination (Table 1) *i.e.*, 88 per cent while in cold test the germination ranged from 78 (BQPML 5175) to 88 per cent (BQPML 5232). From the germination test results it can be concluded that seed lots that do not differ in germination may differ in deterioration level and may differ substantially in field or storage performance which was earlier reported by Powell and Mathews (1984) and Kolasinska *et al.* (2000). Field emergence of these genotypes ranged from 68 per cent (BQPML 5175) to 89 per cent (BML7) after 15 days of sowing. Compared to other inbred lines BQPML 5175 and BML 9105 recorded poor emergence which indicates the susceptibility of those genotypes to cold temperatures and may not thrive well under sub optimal conditions.

Length of the seedlings ranged from 27.04 (BML 9105) to 31.41cm (BQPML 5199) where as the dry weight of seven day old seedlings ranged from 701.33 (BQPML 5199) to 539.33 mg (BQPML 9105) (Table 2). Seedling vigour index I which was calculated from germination per cent and seedling length ranged from 2451.20 (BML 9105) to 3058.21 (BQPML 5199) while seedling vigour index II which was based on germination per cent and seedling dry weight was in the range of 48899.33 (BML 9105) to 68328.00 (BQPML 5199).

The EC is based on the fact that seeds, when soaked in water, exude ions, sugars and other metabolites, from the starting of the soaking period, due to changes in the integrity of the cell membranes, as a function of water amount and of the level of seed deterioration. Conductivity of seed leachate ranged from 8.85 (BQPML 5175) to 13.80 µS/cm/ 10 seed (BML 40410).

The correlation coefficients based on mean values of laboratory tests and field emergence are presented in Table 3. Accelerated aging has exhibited strong positive correlation (r=0.96) with field emergence in the present study and this association was significant. This strong and positive association was also reported by Lovato *et al*., 2001 while working with maize and many other researchers reported accelerated aging as more useful vigour test for predicting the field emergence potential of maize seed lots (Woltz and Terkony, 2001; Singhabumrung and Juntakool, 2004).The observation that electrical conductivity did not correlate with other vigour tests is in agreement with the conclusion of Wang *et al.* (2004), who found that electrical conductivity may not be a good predictor of seed vigour in grasses. Protein and starch content did not exhibit any significant association with field emergence in the genotypes studied. However, protein content had significant positive association with vigour indices because it positively affects the seedling length and dry weight. However, protein and starch content exhibited strong negative association with each other (r=-0.81).

LITERATURECITED

Abdul-Baki A A and Anderson J D 1973 Vigour determination in soybean seeds by multiple criteria. *Crop science*, 13: 630-633.

Agarwal P K and Dadlani M 1992 Techniques in seed science and technology. South asian publishers, New delhi. 127-133.

Delouche J C and Baskin C C 1973 Accelerated aging techniques for predicting the relative storability of seed lots. *Seed Science and Technology*, 1: 427-452.

Durrant M J and Gummerson R J 1990 Factors associated with germination of sugar-beet seed in the standard test and establishment in the field. *Seed Science and Technology*, 18: 1 -10.

Hampton J G and Coolbear P 1990 Potential versus actual seed performance- can vigour testing provide an answer?. *Seed Science and Technology*, 18: 215-228.

ISTA. 2000. International Seed Testing Rules by International Seed Testing Association, Zurich, Switzerland.

Kassahun B and Prasanna B M 2004 Endosperm protein quality and kernel modification in the quality protein maize inbred lines. *Journal of Plant Biochemistry and Biotechnology*, 13: 57-60.

Kolasinska K, Szyrmer J and Dul S 2000 Relationship between laboratory seed quality tests and field emergence of common bean seed. *Crop Science*, 40: 470-475.

Lovato A, Noli E, Lovato A F S ,Beltrami E and Grassin E 2001 Comparison between three cold test low temperatures, accelerated ageing test and field emergence on maize seed. *Seed Symposium*, ISTA Congres, Angers, France.

Martin B A , Smith O S and Neil M O 1988 Relationships between laboratory germination tests and field emergence of maize inbreds. *Crop Science,* 28: 801-805.

Panse and Sukhatme 1988 Statistical methods for agricultural workers (4th edition), Indian Council of Agricultural Research, New Delhi).

Powell A A and Matthews S 1984 Prediction of the storage potential of onion seed under commercial storage conditions. *Seed Science and Technology,* 12: 641-647.

Roberts E H 1984 The control of seed quality and its relationship to crop productivity. *Proceedings of the Australian seeds research conference*,11-25.

Singhabumrung V and Juntakool S 2004 Vigour test results for prediction of field emergence for sweet corn. *Proceedings of the 42nd Kasetsart university Annual conference*, Kasetsart, Thailand, 3-6 Feb., 2004, 291-299.

Wang Y R, Yu L , Nan Z B and Liu Y L 2004 Vigour tests used to rank seed lot quality and predict field emergence in four forage species. *Crop Science*, 44: 535-541.

Woltz J M and Tekorny D M 2001 Accelerated aging test for corn seed. *Seed Technology*, 23 (1): 21–34.

Woodstock L w and Feeley J 1965 Early seedling growth and initial respiration rates as potential indicators of seed vigour in com. *Proceedings of Association of official seed analysts*. *Seed Anal,* 55 : 131-139.

(Received on 17.05.2013 and revised on 20.10.2013)