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THE CORRELATION BETWEEN SEED QUALITY AND DURATION OF THE STORAGE IN MAIZE INBREDS AND HYBRIDS UNDER AMBIENT CONDITIONS

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Abstract– Field emergence, stand establishment and standard germination of maize inbreds (*Zea mays* L.) are considered to be the most important yield-contributing factors. The influence of seed vigour on these factors is vital. Therefore, eleven laboratory tests were conducted on the basis of a complete block design (CBD) with three replications in 2020-21, to evaluate the correlation among the seed vigour tests and field emergence of 14 inbreds and two maize hybrids. In laboratory tests, differences between 14 inbreds and two hybrids for quality parameter *viz.,* germination, seed vigour-I, seed vigour-II, radicle emergence and speed of germination showed significant and positive correlation with field emergence after 8 MAS, while root length, seedling length, seed vigour-I and radical emergence showed a positive and significant association at 0 months. The field emergence percentage had the significant negative correlation with conductivity test. Therefore, the standard germination test was not a good indicator for field emergence percentage. However, vigour test and conductivity tests were the best predictor of field emergence than all the other laboratory tests.

INTRODUCTION

In maize, inbred lines have been a rich source for various fundamental investigations. Inbreds with wide range of genetic diversity in maize have been mostly exploited in various breeding programs. Much work has been seen in hybrids, especially in maize but very less work has been done in maize inbreds. For efficient hybrid seed production, appropriate quantities of potential inbred seed is a prerequisite for seed multiplication to be taken up. But due to frequent multiplication, there are high risks of genetic drift; loss of originality due to continuous inbreeding and the cost of seed also increases. Besides this, inbreds are very weak and the seed is small in size and it is very difficult to produce inbred seed every year due to cross-contamination and low seed set. Hence emphasis has been given to study the storage potential of different maize inbreds.

Regarding storage under ambient conditions, inbred lines and hybrids of maize are facing serious problems. The post-harvest handling of the produce like proper drying, storage environment, type of packaging material being used are some other factors that influence the rate of seed deterioration. Therefore, by controlling the temperature, seed moisture, equilibrium and relative humidity during storage, seeds could be stored for a long time without deterioration of seed. To improve physiological ageing and to reduce insect pests, seeds can be maintained by managing storage conditions and determining the best storage duration. If the storage duration is extended, the natural decay process may be accelerated.

Seed treatment involves the application of fungicides, insecticides, and some other protecting agents onto the surface of the seed *i.e.,* seed coating helps in protecting the seed from insect pathogen attacks and simultaneous increase in seed performance. Among various types of seed treatment, biological seed treatment is an eco-friendly approach that utilizes a biological agent for coating over the seed surface within a thin film of a biodegradable polymer. But as this biological seed treatment involves timely availability of active bio inoculants, skill and time, so farmers mostly adopt chemical seed treatment (Mastouri *et al*., 2010).

One of the main problems observed in the field is poor seedling establishment, which is influenced by seed quality, climatic conditions and field management practice (Zhu *et al.,* 2010). Seed quality includes several attributes leading to near maximum germination capacity to produce seedlings, which emerge rapidly from the seedbed and continue to grow uniformly thereafter (McDonald, 2000). Sometimes standardized laboratory germination procedures are criticized as not predicting field performance very well (Fawad *et al.,* 2002). These critics suggest using a variety of test conditions to find an optimum for each seed lot. Vigour testing is one possible solution (AOSA, 2009). Seed vigour tests, therefore, have been proposed to detect differences in potential seed lot performances.

The growth tests principles are based on vigorous seeds grow at a faster rate than poor vigour seeds even under favourable environments (AOSA, 2009). Vigorous seeds rapidly germinate, metabolize and establish in the field. Therefore, any method used to determine the rapidity of seedling growth will give an indication of seed vigour level (AOSA, 2009). Conductivity test principles are based on weakening of cell membrane in poor vigour seeds causes leakage of water-soluble compounds like sugars, amino acids, electrolytes and etc. when immersed in water (AOSA, 2009). On the other hand, fresh seeds having intact membrane leach less quantity of these chemical. The measurement of electrical conductivity of the leachate by a good and sensitive conductivity meter gives an accurate estimation of membrane permeability. The EC has been positively correlated with the emergence percentage of peas and broad beans (Panobianco *et al.,* 2007). The cold test has been developed in USA to evaluate the seed vigour of maize. High vigour seed lots may improve crop yield in two ways: firstly, because the seedling emergence from the seedbed is rapid and uniform and the resultant plants are vigorous, and secondly because the percentage seedling emergence is high, the optimum plant population density can be achieved under a wide range of environmental conditions (Ghassemi-Golezani, 2008). The objectives of this research were to the correlation between seed quality and duration of the storage in maize inbred lines under ambient conditions.

MATERIALS AND METHODS

The study was carried on 16 (14 lines+2 hybrids) maize inbred lines that include KML-95, KML-106, KML-109, KML-116, KML-121, PFSR3, BML-7 KML-97, KML-133, KML-134, KML-113, KML-127, KML-128 KML225, KNMH-4010131, and KNMH-4010141. Freshly harvested seeds were obtained from seed lot produced during the *Rabi* at Agricultural Research Station (ARS), Karimnagar. All the seeds of inbred lines were stored under ambient conditions such as average temperature (22 ^{0}C) and relative humidity (60 %). The experiment was conducted with the facilities available at the Department of Seed Science and Technology, Seed Technology Research Centre (SRTC), Rajendranagar, Hyderabad during *Kharif,* 2020 under ambient conditions.

The effects of thiamethoxam on the seed quality of maize inbreds were investigated at the SRTC's Laboratory for Seed Testing in Rajendranagar, Hyderabad. The control group consisted of untreated seeds. All the seeds were treated with the insecticide thiamethoxam as per the recommended concentrations.

The seed samples drawn bimonthly up to 8 months of the storage period and were evaluated for various seed quality attributes to determine the optimum storage.

Standard germination test was conducted in the laboratory as per ISTA (Fawad *et al.,* 2002).

$$\text{Germination \%} = \frac{\text{Total number of normal seedlings}}{\text{The total number of seeds tested}} \times 100$$

The ten normal seedlings which were selected for measuring seedling length were kept in a butter paper, dried in a hot air oven at 130 °C temperature for 24 hrsand later allowed to cool for 30 minutes and the dry weight was recorded and expressed in milligrams.

As per Abdul Baki and Anderson, (1973) seedling vigour index was calculated using the formula

seedling vigour I = Seedling length (cm) × Germination percentage (%).

Seedling vigour II = seedling dry matter (mg) × Germination percentage (%).

Field Emergence (%)

As per the method suggested by Shenoy *et al*. (1990)(17) field emergence potential of seed was calculated. From each treatment in three replications, 100 seeds were selected randomly and were sown in well-prepared soil at a depth of 2.0 to 2.5 cm and covered with soil. On the 7th day of sowing, field emergence count was taken and the percentage of field emergence was calculated by using the following formula.

$$\text{Field emergence (\%)} = \frac{\text{The number of seedlings emerged}}{\text{Total number of seeds tested}} \times 100$$

Electrical conductivity (dSm-1)

The method consists of soaking 50 seeds in a measured quantity of deionized water, sufficient to ensure that all seeds are completely immersed for 24 h period at room temperature. At the end of the period, the contents of the beaker are gently stirred and the stirred liquid was filtered into a beaker. The seeds were discarded. The electrical conductivity was measured in dSm-1 by inserting a cell connected to a conductivity bridge into the solution in the beakers (Mathews and Whitbread, 1968)[(6).]

Speed of germination

Speed of germination = N1/T1 + N2/T2 + N3/T3 .... Nx/Tx

where N is the number of seeds germinated at days T.

The statistical analyses were conducted by using different software packages. Analysis of variance (One-Way ANOVA) was conducted using software GenStat Release 9.1. (Rothamsted Experimental Station), after transforming the percentage data to arcsine value to homogenize the variance (Panes and Sukhatme, 1985)(8). The critical differences (CD) were calculated at a 5 per cent probability level. The data were tested for statistical significance (*).

RESULTS AND DISCUSSION

Correlation between traits is critical for determining if selection for one characteristic has an impact on another. Correlation is a method that can be used to investigate the relationship between characters. The correlation coefficient was determined among seed germination and vigour parameters for 14 inbreds and 2 hybrids (*Rabi* harvested seed of 2020). It was found that a significant correlation exists among the initial and final count of germination, root length, shoot length, seedling length, seedling dry weight, radical emergence, speed of germination, seedling vigour index I and II, Electrical conductivity and field emergence at initial and final months.

Parental lines retained high germination (>80%) after eight months of storage under ambient condition though the later showed a greater impact on seed quality. Correlation studies were carried out to assess association of various seed quality characters both initially and after storage (Table 4.25). Field emergence has shown a significant positive correlation with root length (0.441*), seedling length (0.425*), seed vigour-I (0.550**) and radical emergence (0.444*) initially, while at eight months after storage it showed a positive and significant correlation with germination, seed vigour-I (0.838***), seed vigour-II (0.700***), radical emergence (0.373*) and speed of germination (0.572***) and a negative correlation with electrical conductivity (-0.134). Germination showed a significant and positive association with root length, seedling length, seed vigour-I, seed vigour-II, radical emergence initially with seed vigour-I, seed vigour-II, radical emergence and speed of germination under storage and seed vigour-II with seedling dry weight, root length and radical emergence initially and seed germination, seedling dry weight and seed vigour-I under storage. This indicates the various vigour parameters under study helps in predicting the longevity of the maize inbreds and hybrids contrary to our finding Kapoor *et al.* (2010) findings, which found a negative correlation between germination and field emergence at the end of the ageing time.

Electrical conductivity showed a negative correlation with all the quality parameters under study indicating that as the storage period increases seed leachates increase thereby increasing the electrical conductivity. The results are in agree Usha and Dadlani (2015) in maize seeds revealed that as the storage period increase, the electrical conductivity gradually increases and has a negative correlation with germination, implying that as the electrical conductivity of seed leachate increases, the percentage of seeds that germinate decreases. The present study also concluded it as a potential tool for assessing and reliably predicting the seed storability and vigour of maize genotypes, but its utilization as a test for simulating and predicting effect of natural ageing in maize needs further standardization (duration, temperature and R.H. conditions).

Character	Duration	Germination (%)	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Seedling dry weight (mg)	Seed vigour-I	Seed vigour-II	Electrical conductivity	Radical emergence	Speed of germination	Field emergence
Germination (%)	Initial	1.000	0.441 *	0.289	0.425*	0.084	0.550 **	0.326	-0.293	0.444 *	0.038	-0.178
	Final	1.000	0.323	0.100	0.198	0.311	0.838 ***	0.700 ***	-0.134	0.373 *	0.572 ***	0.544**
Root length (cm)	Initial		1.000	0.255	0.576 ***	0.433*	0.560 ***	0.520 **	-0.166	0.404 *	0.098	-0.319
	Final		1.000	0.366*	0.662 ***	0.136	0.623 ***	0.262	-0.155	0.260	0.339	0.288
shoot length (cm)	Initial			1.000	0.928 ***	0.116	0.899 ***	0.183	-0.285	0.224	-0.028	-0.057
	Final			1.000	0.940 ***	-0.078	0.581 ***	0.002	-0.334	0.200	0.440 *	0.178
Seedling length (cm)	Initial				1.000	0.251	0.983***	0.345	-0.324	0.355 *	0.041	-0.191
	final				1.000	-0.014	0.696 ***	0.096	-0.327	0.256	0.479 **	0.248
Seedling dry weight (mg)	initial					1.000	0.220	0.969 ***	-0.169	0.429 *	0.339	-0.213
	final					1.000	0.233	0.894 ***	-0.240	0.136	-0.100	0.231
Seed vigour-I	initial						1.000	0.346	-0.355	0.387 *	0.040	-0.219
	final						1.000	0.573 ***	-0.278	0.401*	0.656***	0.532 **
Seed vigour-II	initial							1.000	-0.234	0.516 **	0.328	-0.248
	final							1.000	-0.243	0.293	0.198	0.429*
Electrical conductivity	initial								1.000	-0.626 ***	-0.389 *	0.181
	final								1.000	-0.037	-0.340	-0.418*
Radical emergence	initial									1.000	0.558 ***	-0.113
	final									1.000	0.332	0.472 **
Speed of germination	initial										1.000	0.236
	final										1.000	0.501**
Field emergence	initial											1.000
	final											1.000

CONCLUSION

When seed bed and environmental conditions are close to ideal, a field emergence will correlate well with germination and seed lot vigour is an important factor. Several studies have been demonstrated that vigorous seeds generally show high stand establishment in variable field conditions. Therefore, the yield of crops that raised from high vigour seeds is high. The different performance of the tested hybrids may be related to the other aspects of seed vigour, *i.e.,* genetic structure, possibly mechanical damage, seed filling conditions on mother plant etc. The results of experiments showed that conductivity test and vigour test can be used to evaluate of maize seed lot performance in the field condition. As the EC test is a simple, low-cost and fast method so as a result, this test is preferable to the other seed vigour evaluating methods.

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