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Studies in Seed vigour of different maize (*Zea mays* L.) hybrids and composite varieties under North Indian Condition

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Abstract
Three hybrids and one composite variety of maize (*Zea mays* L.) were studies for seven seed vigour characters to predict the field emergence. The seed of each variety was stored for eight nine months under ambient conditions at Karnal before testing for various parameters during 2010-12. Hybrid ' HQPM -1 was found to show high germination at first and final count, seedling dry weight and accelerated against test. 'HM-4' and 'HM-11' were superior for field emergence, first and final counts of germination. Variety 'HM-4' was also significantly superior for coeloptile length and cold test, whereas hybrid 'J-1006' was better for field emergence and coleoptiles length. Various vigour tests did not uniformly predict field emergence in different cultivars. Field emergence exhibited significant correlation with germination at first count in majority of cultivars, thus can be used to predict field emergence. Correlations of field emergence with accelerated aging test in 'HQPM -1' and with cold test in hybrid 'J-1006' were also observed. None of the test was uniformly correlated with field emergence in all the varieties, thereby suggesting that the behaviour of different varieties in the performance of various seed vigour parameters was different from each other.

Keywords: Field emergence, maize, seed vigour tests, correlation

Introduction
Maize (*Zea mays* L.) is the most grown cereal crop in the world (839 million tons in 2012). According to its agro-economic importance; maize has received tremendous attention from research communities of academic, state, and industry origin. Maize (*Zea mays* L.) has become the most extensively cultivated cereal crop, followed by wheat and rice (world production for year 2012 is estimated to be 839,653 and 465 million tons, respectively, according to United States department of agriculture world agricultural supply and demand estimates report from October 11, 2012). U.S. yields, level at approximately 1.5 mg/ha in the first three decades of the 20th century, started to rise significantly in the 1930s, reaching8.5 mg/haby the end of the century (9).Maize yields in Canada tripled during the period 1940–2000, increasing from 2.5 to 7.5 mg /ha, a linear increase of 80 kg /ha year (10). Maize yields in Germany doubled in the period 1965–2000, going from4 to 8 mg/ha (11). Maize yields in France quadrupled in the period 1950–1984, increasing from 1.5 to 6.0 mg/ha (12).Maize being a source of carbohydrates, fats, protein, important vitamins and minerals is thus a potential source of protein for humans and animals (16). High protein content is a desirable character of the quality protein maize (QPM) particularly in south Asia and Africa area of the world where malnutrition of children's, lactating mothers and pregnant woman is prevalent (,1,3,8,16). Discovery of Opaque-2 (O2) and floury (fl2) mutant opened up possibilities for improvement of protein quality with 70-100% higher lysine and tryptophan, which later lead to the development of quality protein maize (QPM) (1,8). Genetic improvements, as well as

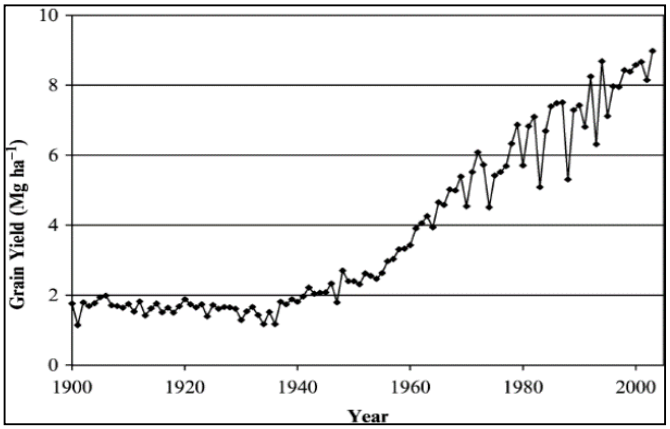

Fig 1: United States maize yields, annual average, 1900–2003

Cultural improvements, can contribute to an increased yield of maize. Farmer breeders, beginning with the people who first domesticated maize, have selected plants and cultivars to fit their wants and needs and, in so doing, have developed thousands of landraces adapted to a multitude of environments, as well as with a wide range of morphological and quality traits (13-14). We can assume that a higher yield, or at least an acceptable and dependable level of yield, was always a desired trait for maize cultivars, as well as for those of other staple grain crops. In the United States, the first hybrids were made from inbreeds that had been developed by selfing some of the better OPCs of the 1920s. Breeders then worked to develop a second generation of improved hybrids using new inbreeds made by selfing the same OPCs. (1,3,8). They found that the second round of hybrids yielded little or no more than the first; it seemed that breeders must have selected most of the superior genotypes in the initial round of selfing in the OPCs(8).

Seedling vigour, being a sum total of seed attributes favour uniform field establishment. Seed vigour has long been recognized as one of the important aspects of seed quality. High yielding varieties with high seed vigour are desirable for their easy adaptation and fast spread. Its impact on crop performance has, however, been variable in different species. Different in vigour is only revealed in practice when routine germination tests fail to indicate emergence differences in the field (1). The basis of difference in seed vigour lies in two processes: aging and imbibitions; and all tests of vigour and their improvement can be explained in terms of these processes. Vigour tests, in general are probably most effective when used as a production and operational tool. Knowing the importance of seed vigour in view, the present study was undertaken to evaluated four genotypes of maize (*Zea mays* L.) to predict the field emergence using different vigour tests, and to study the correlations among different seed vigour tests with field emergence. Seed vigour test is required for proper certification and statutory labelling of the seeds.

Materials and Methods

The seed of three maize hybrids viz, 'HM-4 ', 'HQPM 1' and 'HM-11'; and one composite variety 'J-1006' were stored in five different lots for nine months under ambient conditions. This seed material were subjected to seven seed vigour tests viz, standard germination(%) at first and final count, seedling dry weight, coleoptiles length, germination (%) through accelerated aging, cold test and field emergence. Each test was conducted on five lots each in three replications during the year 2010.

The standard germination (%) for first and final count was conducted as per ISTA protocol (2). The results on accelerated again test and cold test were estimated through the standard test (3), respectively. The data for all the parameters were subjected to analysis of variance. The correlations of field emergence with the vigour tests were analyzed (2).

Results and discussion

Performances of different cultivars for various seed vigour tests is presented in Table 1. Cultivar 'HQPM -1' was found to be superior for first and final count, seedling dry weight and accelerated again test, however, it was poor for field emergence. 'HM-4' was superior for coleoptiles length, cold test and field emergence whereas, 'HM-11' was superior for accelerated aging test; and composite 'J-1006' was so for coleoptiles length only.

Table 1: Mean performance of different varieties over 5 different seed lots for various vigour tests

	Hybrid HM-11	Hybrid HM-4	Hybrids HQPM -1	Composite J-1006	SE±
First count (%)*	91.1	92.5	95.2	81.0	2.1
Final count (%)*	97.0	98.3	99.0	93.0	1.1
Seedling dry weight (mg)	571.5	568.2	614.0	481.2	12.7
Coleoptiles length (cm)	18.0	29.5	21.5	23.6	1.6
Accelerated aging (%)*	61.2	42.2	67.2	35.5	4.3
Cold test (%)*	19.0	46.2	27.0	38.2	5.4
Field emergence (%)*	89.7	92.0	77.0	89.5	2.3

*germination per cent

It is observed that various vigour tests can not uniformly and simultaneously predict field emergence for all the cultivars. The decline in seed quality with respect to germination was affected during storage by the initial seed vigour (1). The results are in conformity with the findings of earlier workers (6, 7, and 16). Results presented in Table 2 on the association of various seed vigour tests with field emergence indicates significant correlations of field emergence with germination per cent at first count of maize seedlings (7, 8).

Table 2: Correlations among different seed vigour parameters with field emergence

		Field emergence (%)	First count germination	Seedling weight	Coleoptiles length (%)	Accelerated aging (%)	Cold test (%)
Final germination (%)	a	0.96*	0.86	0.08	0.02	0.86	0.41
	b	0.99*	0.74	0.91	0.84	0.91	0.71
	c	0.88	0.99*	0.99*	-0.05	0.80	0.55
	d	0.43	0.61	0.67	0.72	0.29	0.24
First count germination (%)	a		0.97*	-0.19	-0.19	0.67	0.49
	b		0.74	0.92	0.83	0.90	0.96*
	c		0.88*	0.67	0.33	0.66	0.97*
	d		0.96	0.92*	0.87	0.96*	0.98*
Seedling dry weight	a			0.80	-0.35	0.48	0.52
	b			0.95*	0.46	0.40	0.50
	c			0.99	-0.05	0.79	0.55
	d			0.99*	0.97*	0.87	0.72
ccoleoptiles length	a				0.07	-0.14	0.46
	b				0.62	0.67	0.70
	c				0.06	-0.32	0.63
	d				0.98*	0.80	0.68
Accelerated aging germination (%)	a					0.48	0.33
	b					0.84	0.26
	c					0.27	0.96*
	d					0.70	0.56
Cold test germination (%)	a						0.29
	b						0.70
	c						***0.6***4
	d						0.97*

a: HM-11, b: HM-4, c: HQPM -1, d: J-1006

Cultivars 'HM-4 ', 'HQPM -1' and Composite 'J-1006'; with accelerated aging in 'HQPM -1'; and with cold test in hybrid 'J-1006' only. Though it can be revealed that germination per cent at first count can be considered a good indicator of field emergence for majority of the cultivars, yet it cannot be attributed uniformly a good indicator for all the genotypes. Among other seed vigour tests, germination per cent at first count was correlated with germination per cent at final count in 'HM-11' and 'HM-4 ' seedling dry weight with final count in 'HQPM -1' and, with first count in 'HM-11' and 'HQPM -1'; coleoptiles; length with final count in 'HQPM -1', with first count in hybrid 'J-1006',and with seedling dry weight with in 'HM-4 ', 'HQPM -1' and hybrid 'J-1006'; accelerated aging showed correlation with seedling dry weight and coleoptiles length in hybrid 'J-1006'; and cold test with germination per cent at first count in hybrid ' J-1006'. Early workers also reported that no single test can be used to predict the field emergence uniformly in all the genotypes. It is concluded from the ongoing discussion that various vigour tests can not uniformly predict length, cold test and field emergence whereas, 'HQPM -1' was so for seedling dry weight and accelerated aging test. Germination per cent at first count showed correlation with field emergence in majority of the cultivars hence, can be used to predict field emergence. In the cultivar 'HQPM -1', the field emergence can also be predicted through cold test.

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