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STUDIES ON SEED VIGOUR DETERIORATION IN PEA (*Pisum sativum* L.)

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ABSTRACT: Seed vigour evaluation was conducted on ten pea accessions to study their level of deterioration at varying temperature and time durations. The accessions were subjected to different temperature (30°C and 45°C) and storage durations (48 hours and 72 hours) during accelerated ageing. Observations were recorded for seed vigour in terms of germination percentage, germination index, vigour index I, vigour index II and electrolyte leakage. Germination percentage and vigor index was greatly affected after subjecting to large durations of time at high temperature. The higher temperature (45°C) after 72 hours induced more electrolyte leakage from the some accessions. The results revealed that vigour level of seed deteriorates after storage at high temperature. Significant varietal differences were observed in accessions in terms of their inherent capacities to withstand higher temperature treatments both after 48 hours and 72 hours. The rate of seed deterioration was faster in some accessions as compared to other.

Keywords: *Seed treatment, correlation, accelerated ageing, vigour index, seed leakage.*

Pulses on account of their significant contribution in balancing the nutrition and health of man and animals and due to the strategic position in the biospectrum of the earth can not be overlooked. They are only the richest source of protein in agricultural crop galaxy and have been truly referred as "Unique Jewels" for Indian crop husbandry (Swaminathan, 13). The pea has an important status among plants in general and among pulses in particular due to its peculiar qualities and extensive human consumption. A large amount of quality pea seed is required for sowing to ensure successful crop establishment, but non availability of such seeds is a limiting factor in boosting India's pea production. High seed and seedling vigour is required for a good stand establishment and successful crop performance in pea. Varieties with high seedling vigour are also needed for better competitive ability against weeds. Vigorous seeds will produce excellent emergence and stand in proper soil environment. It can improve the chances for satisfactory emergence. Vigor is often implied when discussing seed quality and most growers have to use the terms and quality and vigour interchangeably. Seeds vigour comprises those properties, which determine the potential for rapid uniform emergence and development of normal seedlings under a wide range of field conditions (ASPB, 4). The rapid and synchronous germination rate as well as good field establishment will be characteristic of vigorous seeds.

The vigour levels of seeds get decreased right from the seed is produced on the mother plant. The deterioration of stored seed is a natural phenomenon and the seeds tend to loose viability and vigour even under ideal storage conditions. (Bhatti and Sato, 5). The rate of seed deterioration varies greatly from one species to another and even among varieties of the same species. The performance capabilities of many seeds deteriorate due to variations in temperature, relative humidity and moisture content in storage (Abdul-Baki, 1). An organization of cellular membranes is at its peak by the time a seed reaches physiological maturity (Abdul-Baki, 1). Seeds undergo a structural disorganization process during the drying period before harvest, the lower the water content, the greater the disorganization. The degree of cell membrane leakage in response to ageing can be measured inn terms of rate of seed electrolyte leakage (Larson, 11; Khan *et al.,* 10).

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Seed ageing is an important parameter to assess/estimate the seed vigour. Accelerated ageing is a good vigour test for various crop seeds including pea (Tyagi, 14). Seeds subjected to accelerated ageing lost vigour sooner than viability (Gorecki, 7). The accelerated ageing test is rapid, inexpensive, simple and useful for many species. It has also shown a good correlation with stand establishment in pea (Caldwell, 6). Keeping the above points in view, the present investigation was conducted to study the behaviour of various pea (*Pisum sativum* L.) varieties to varying storage periods through the technique of accelerated ageing.

MATERIALS AND METHODS

Ten genotypes/accessions of pea (*Pisum sativum* L.) were procured from the genetic stock of Division of Germplasm Collection and Evaluation, National Bureau of Plant Genetic Resources, New Delhi. The accessions so collected were raised at experimental farm of Department of Genetics and Plant Breeding, Kisan PG College Simbhaoli Panchsheel Nagar UP during 2010 to increase the number of seeds. The seeds so collected were subjected to a vigour studies in the Seed Testing Laboratory of Department of Seed Science and Technology, Ch. Charan Singh University, Meerut India during Jan.–Feb., 2010. The tests were conducted as per the recommendations of AOSA (3).

Seeds were evaluated for seed germination, vigour index I, vigour index II and electrolyte leakage before subjecting to accelerated ageing. Seeds from each accession were subjected to accelerated ageing treatment at 100% relative humidity at two different temperature (30°C and 45°C) in a controlled chamber for 48 hours and 72 hours. For germination and vigour tests following vigour tests were performed.

1. Germination Test: Germination test was conducted using between paper (BP) method of germination and twenty five seeds per replication were sown on paper towel. Germination test was conducted according to the International Seed Testing Association rules (Anonymous, 2). Seeds were placed on the surface of double sheets of paper towel which were moistened with distilled water. The seeds were covered with other sheet of paper towel. The sheets were rolled and placed vertically in a plastic beaker, covered with polythene bags and placed at 30°C temperature in a germinator. Germination data were recorded from day one (D_1) to day six (D_6). Final count was made at 6th day. Germination was interpreted as the percentage of seeds producing normal seedlings (Anonymous, 2).

Germination percentage

$$= \frac{\text{No of normal seedlings}}{\text{Total no of seeds planted}} \quad 100$$

2. Germination Index: To calculate the germination index, the number of normal seedlings was counted from D_1 to D_6 and the germination index was calculated for each replicate according to following formula suggested by Magurie (12).

$$\text{SGI} = \frac{\text{Number of normal seedlings}}{\text{Days of I}^{\text{st}}\text{ count}} + \ldots.. + \frac{\text{Number of normal seedlings}}{\text{Days of final count}}$$

The high value for this parameter denotes high speed of germination and consequently high vigour.

3. Vigour Index I and Vigour Index II: The germination percentage obtained in the germination test was used to calculate vigour index. The vigour index was calculated adopting the method of Abdul Baki (1).

Vigour Index I = Germination percentage x average seedling length

Vigour Index II = Germination percentage x Seedling dry weight

4. Electrical Conductivity Test: The seed material used for this test was first subjected to accelerated ageing at 100% relative humidity and at two temperature regimes of 30°C and 45°C.

Seventy five seeds in three replications of 25 seeds each were counted and weighed and placed in a glass flask containing 100ml of deionized water. The flasks were covered with aluminum foil to prevent contamination and were shaken intermittently. The flasks were kept at 30°C for 20 hours (Hampton and Tekrony, 8). The exudates so collected were filtered and conductivity measurements were taken using portable conductivity meter (Model LT-17). The average values obtained from each accession were expressed as µ/cm/g.

RESULTS AND DISCUSSION

The results of present investigation showed the varying reaction of different accessions to the accelerated ageing conditions.

1. Germination Percentage: The germination percentage of the accessions (Table 1) under normal conditions ranged from 60.02% (DMR-11) to 89.95% (NBP-82). Under accelerated ageing conditions the varieties behaved positively to temperature and time fluctuations. The mean germination of varieties ranged 53.2% to 88.4%. The interaction between accessions and temperature was significant. The accessions such as EC-342007 and DMR-7 lost the germination of seeds faster than NBP-82, NBP-72 and EC-501259 under both temperature and time durations. A reduction of only 1% was recorded in accession NBP-82. The results showed that varietal differences in germination percentage were present in pea accessions. The results also showed that the rate of deterioration varies with the accessions and some of the accessions showed faster deterioration as compared to others. It can be thus concluded that knowledge is thus important for predicting storage conditions. Iqbal and Smith (9) reported the similar results while studying the accelerated ageing in pea.

2. Germination Index: The accessions exhibited different responses to germination index. The temperature and time durations during ageing process had a positive effect on germination index. Under normal conditions, the mean value of germination index varied from 8.46 to 15.06 (Table 1). The accession number IC-208375 had the highest value (15.06) and lowest value was recorded in IC-424895.

The interaction between accessions and temperature was found significant. The accession IC-208375 again showed a lowest reduction in germination index as compared to other accessions, such as NBP-60 that recorded a highest reduction at both temperatures of 30°C and 45°C (as 8.24 and 8.10). The accession DMR-7, NBP-611 and DMR-11 showed a large decline in germination index under both time durations. The interaction between accessions and time durations was least visible in NBP-82, IC-208375 and IC-424815. NBP-82 showed a slight decrease in germination index in accordance with high germination percentage. The germination index was higher in the varieties exhibiting greater germination percentage.

3. Vigour Index I and Vigour Index II: Different temperature and storage conditions significantly affected vigour index I and vigour index II.NBP-82 exhibited vigor index I and EC-342007 possessed lowest vigour index I. Under the normal conditions IC-208375 possessed highest values of vigour index II and IC-424895 showed lowest values of vigour index II. This variation in vigour index could be attributed to varietal differences.

The interaction of accessions with varying temperature and time durations was significant (Table 2). NBP-82 possessed highest vigour index I and vigour index II at 30°C, while as EC-342007 exhibited lowest vigor index values at the same temperature. DMR-11 was most highly affected by time durations of 72 hours at 45°C, while IC-208375 was least affected by temperature at 45°C. In general a decrease in vigour index values (vigour index I and vigour index II) was found in all accessions with increase in temperature from 30°C-45°C. Reduction in shoot length at higher temperature in pea have also reported.

Table 1: Accession means for different seed vigour parameters.

Name of Accession	Germination percentage	Germination index	Vigour index I	Vigour index II	Electrical conductivity (μ/g)
EC-342007	68.58	9.83	558.79	2276.96	23.43
DMR-11	60.02	9.49	658.61	3014.38	13.63
IC-424895	80.58	8.46	967.21	1491.01	28.20
EC-501259	83.16	14.26	745.35	3174.52	9.43
DMR-7	77.0	9.80	779.53	3031.16	22.10
IC-208375	88.0	15.06	2458.64	4643.29	6.63
NBP-72	80.50	10.11	1436.01	3263.36	16.06
NBP-61	70.83	12.60	2248.83	3725.61	16.90
NBP-82	89.75	14.3	2833.23	4193.96	5.43
NBP-60	85.08	11.27	1577.51	1902.86	19.23

Table 2: Accession means for different seed vigour parameters as affected by accelerated ageing treatments.

Name of Accession	Storage duration (hours)	Germination percentage		Germination index		Vigour index I		Vigour index II		Electrical conductivity (μ/g)	
		30°C	45°C	30°C	45°C	30°C	45°C	30°C	45°C	30°C	45°C
EC-342007	48	67.5	65.3	9.20	9.00	496.30	430.33	2024.90	1982.84	24.52	30.35
	72	63.3	56.5	8.43	8.44	505.30	410.80	1824.56	1776.56	26.02	36.30
DMR-11	48	59.3	57.4	8.22	8.00	633.20	612.14	2929.40	2820.44	18.00	19.24
	72	55.4	53.2	7.49	7.12	523.82	499.24	2680.00	2630.32	22.46	25.28
IC-424895	48	79.3	79.00	8.12	7.32	950.43	930.21	1472.62	1405.42	28.50	42.90
	72	78.2	77.6	7.81	7.00	942.70	908.40	1470.66	1382.49	29.23	44.22
EC-501259	48	81.2	79.4	13.98	13.23	732.21	721.23	3036.22	3006.80	10.22	11.92
	72	78.4	77.10	12.42	12.22	703.80	688.00	2921.29	2918.20	10.88	14.00
DMR-7	48	72.4	70.2	8.24	8.00	703.42	682.82	2916.25	2820.36	28.20	32.30
	72	68.3	66.8	7.33	6.54	700.00	650.40	2728.80	2634.90	27.29	38.82
IC-208375	48	86.4	84.3	15.00	14.66	2444.12	2382.90	4572.10	4458.88	6.92	7.37
	72	80.4	75.9	13.92	13.84	2377.42	2365.81	4492.16	4332.40	7.52	8.22
NBP-72	48	78.4	77.0	10.02	9.23	1410.22	1392.23	3122.80	3025.28	17.16	20.25
	72	76.3	73.2	10.00	8.80	1402.82	1352.36	3003.22	2916.19	21.40	23.94
NBP-61	48	65.4	63.8	12.40	12.36	2120.72	2022.30	3521.20	3329.92	17.49	20.20
	72	58.4	53.7	11.90	11.00	1924.80	1812.16	2822.50	2677.55	22.84	25.28
NBP-82	48	88.4	87.5	14.11	13.80	2742.70	2692.91	4052.66	4009.22	6.00	6.25
	72	85.9	80.8	12.96	10.32	2703.81	2680.06	3922.82	3836.41	6.08	6.40
NBP-60	48	80.4	80.2	10.23	9.22	1421.52	1388.46	1898.22	1830.38	20.28	22.80
	72	80.4	77.4	8.24	8.10	1416.21	1384.33	1822.30	1725.20	21.92	24.28

4. Electrolyte Leakage: Varietal means for electrolyte leakage was significantly affected by different temperature and storage durations (Table 2). Under the normal conditions NBP-82 possessed lower seed leakages and therefore high vigour, however the highest seed leakage was found in IC-424895 and was hence reported to be of lowest vigour category among accessions under study.

The interaction between electrolyte leakage and temperature was highly significant. A significant positive interaction was also reported between time durations and electrolyte leakage. NBP-82 was least affected by temperature treatments both at 30°C and 45°C and only <2% increase was found in seed exudates readings by conductivity meter. The accession DMR-7 was highest affected by higher temperature treatments both at 48 hour and 72 hour durations. An increase of >16μ/g was recorded in DMR-7 at 45°C temperature after 72 hours. In general all the accessions responded positively to the varying temperature and time period durations during accelerated ageing treatments. At 30°C temperature and 48 hours duration, highest electrolyte leakage was recorded in IC-424895, while NBP-82 possessed lowest leakage. The accession NBP-82 was again least affected at 45°C temperature after 72 hours while DMR-7 showed highest electrolyte leakage among the accessions. NBP-82 and IC-208375 maintained lowest leakage when subjected to varying temperature at 48 hours and 72 hours, depicting specific genotype potentials.

The results of this investigation revealed that the rate of seed deterioration increased with the increase in storage periods and storage temperatures. Significant differences in rate of deterioration were observed among accessions. Seeds of some accessions deteriorated faster than others under similar storage conditions. The knowledge of differences in rate of seeds deterioration in different genotypes may be very useful to predict seed vigor after long term storage. It is thus recommended that the germination test of the various genotypes should be conducted at regular intervals for the seeds that are being stored under ordinary storage conditions. Such varieties that show the highest deterioration during testing may be rejuvenated in the field to obtain fresh seed with higher vigor levels. This would certainly saver the germplasm of seed banks from abrupt deterioration and can be saved for longer time periods. In this way, it could be ensured that the germplasm material lying in the seed banks has high vigour percentage.

It is further recommended that the detailed study should be undertaken to know the probable cause of rapid seed deterioration in different varieties of the same species. The information so collected would enable us to generate such storage conditions that would have lowest limiting effect on the vigor of the seeds. In this way, the germplasm evaluation for storage life may be better understood.

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