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Seed Quality Enhancement for Improving Planting Value of Fresh and Aged Seed Lots of Chickpea

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ABSTRACT

Background: Chickpea is the largest produced food legume in South Asia. It is mainly grown in dry or rainfed area, where patchy plant stand often results due to delayed and non-uniform emergence. Moreover, genotypes vary for seed germination and seedling vigour. Therefore, the study was undertaken to find most appropriate seed treatment for enhancement of planting value of desi and kabuli type chickpeas.

Methods: Study was conducted at ICAR-IARI, New Delhi with fresh, 2 and 4 years stored seed lots of desi (Pusa 2028) and kabuli (Pusa 1108) varieties. The lots were compared with untreated (control) for quality and vigour parameters after giving seed enhancement treatments (SET); osmopriming, halopriming, solid matrix priming (SMP), thiram and neem khali.

Result: Investigations revealed that SMP and thiram seed treatments significantly enhanced germination and field performance of fresh as well as aged seeds in these varieties. Effectiveness of treatments was found more pronounced in kabuli than desi type and thus confirmed the usefulness of SETs for poor vigour seeds. Results also showed that seed quality and vigour of both the types were significantly affected with time in storage. However, desi variety maintained satisfactory germination and field performance up to 2 years under ambient conditions of storage.

Key words: Chickpea, Seed enhancement treatments, Seed quality, Seed vigour, Storage.

INTRODUCTION

Legumes are plants belonging to the family Leguminosae also called as Fabaceae that produce seeds within a pod (Kouris-Blazos and Belski, 2016). Common food legumes used for human consumption include; field peas, chickpeas, broad beans, lentils, soybeans, lupines, lotus, sprouts, mung bean, green beans and peanuts. Chickpea/ Bengal gram/ garbanzos (*Cicer arietinum* L.) is the largest produced food legume in South Asia and the 3rd largest produced food legume globally after common bean and field pea (Yorgancilar and Bilgici, 2014). There are two type of chickpeas; desi and kabuli, grown in the world recognized visually by seed coat colour and seed size. Chickpea is grown in more than 50 countries with 89.7% production area in Asia alone. India is the largest chickpea producing country accounting for 75% of the global chickpea production. It is an important pulse crop in India sharing 29.7 and 45% of the total area and production of total pulses, respectively (Maurya and Kumar, 2018). *Desi* and *kabuli* chickpea seeds show large variability among genotypes in seed germination and seedling vigour. There are biotic and abiotic constraints like; *Fusarium* wilt, pod borer *etc*. and drought, salinity, temperature etc. that are still hampering chickpea production. Moreover, it is mainly grown in dry or rainfed area, where patchy plant stand often result from failure of crop to emerge quickly and uniformly. Additionally, five insects are reported to infest the chickpea in storage and cause losses up to 14% (Sharma *et al*., 2013), but effect on quality could be more.

For sustainable production under uncertain/less favorable growing conditions, good-quality seed has a significant potential of increasing on-farm productivity and enhancing food security (Afzal, 2013). Low-vigour seeds can be improved using a variety of seed enhancement technologies that will thrive under small holder cultivation conditions and also improve the supply of good-quality seed in the local seed industry. A wide range of techniques are now used to help sowing seeds and to improve or protect seedling establishment and growth under the changing environments and seedbed constraints. Harris, *et al*. (1999) reported seed priming as one of the important practices which ensures rapid and uniform germination under adverse environmental conditions. Shinde and Hunje (2020) reported significant improvement in values of all quality and yield parameters of kabuli chickpea seeds primed with Sprint (Mancozeb 50% + Carbendazim 25% WS) @ 2g per kg of

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seed. The effect of seed treatment with powdered neem and neem oil formulations suppressed nematode population growth and increased grain yield significantly in chickpea. The beneficial effect of thiram treatment is attributed to its role in reducing the fungal infection, control of pre and post mortality (Solenke *et al.*, 1997) on the germinating seeds. In view of the above, the study was undertaken to find most appropriate seed treatment for enhancement of planting value of desi and kabuli type chickpea.

MATERIALS AND METHODS

Two years old seed lots were taken from Division of Seed Science and Technology and four years old lots were collected from Pulse Laboratories, ICAR- Indian Agricultural Research Institute, New Delhi. Seeds selected for experiment were bold and free from any damage. The details of materials and methods adopted in the present investigation conducted at Division of Seed Science and Technology, ICAR-Indian Agricultural Research Institute, New Delhi are given below.

A total of five different treatments were compared with untreated control (T_1). The treatment, T_2 *i.e.* Osmo- priming was done by polyethylene glycol (PEG8000) solution containing 25g PEG dissolved in 100ml water. The eight replicate of 50 seeds placed in PEG saturated two layers of filter paper in petri plate for 48 hrs at 20°C. Similarly, treatment T_3 *i.e.* halo-priming was done by taking 2 percent solution of KNO_3 instead of PEG. The solid matrix priming (SMP) treatment T_4 *i.e.* carried out by mixing seed, vermiculite and water in the ratio of 1:2:2.5 and kept at 20°C for 6 and 8 hours in kabuli and desi types, respectively. Primed seeds were then fan dried at room temperature under shade till the seed moisture came down to initial levels. Fungicidal treatments; T_5 and T_6, were done with thiram @ 2g per kg of seed and neem khali @ 10g per kg of seed, respectively.

Seed germination was determined as per ISTA (2007), with minor modifications. Eight replicates of 50 seeds of each variety and each treatment were tested for germination. In this method, seed were placed between two layer of wet germination paper which was then rolled and wrapped in wax sheet and placed in walk-in-germinator in an upright position maintained at 20 ± 1°C and 95 % RH for 8 days. On the day of final count *i.e.* 8^{th} day, evaluated for normal seedling, abnormal seedling, dead and hard seed. Germination percentage was calculated based on number of normal seedlings on final count.

The damaged, decayed and deformed seedlings which were not able to produce normal seedling were counted and considered as abnormal seedling, expressed in percentage.

Ten normal seedlings were taken at random from each replication and shoot and root lengths of each seedling were measured in centimeter. The mean value was taken for analysis.

Ten normal seedlings were taken at random from each replication for observing seedling length were dried in hot air oven maintained at 70 ± 1°C for 48 hr and cooled in desiccator. The mean value of seedling dry weight in mg was taken for analysis.

The vigour indices (I and II) were computed by adopting the method of Abdul Baki and Anderson (1973) by using following formula:

Vigour Index I =

Germination (%) X Total Seedling Length (cm)

Vigour Index II =

Germination (%) X Seedling Dry Weight (mg)

Field emergence was estimated by sowing 100 seeds in 4 replications in the field. Observations were recorded on alternate day till 30^{th} day of sowing. The emergence was expressed as percentage of seedling emergence.

Five seedlings from each replication and treatments were randomly extracted from soil and washed of the debris and soil particles. Care was taken that no root is damaged, while removing 30 days old seedlings from the plot of field emergence studies. The excess water on the seedlings was wiped with blotter paper and seedlings were placed on the machine "WinRHIZO Pro" for image acquisition (Fig 1). Before analysis, the roots were first digitized with the scanner during 2014-15. The software was run to measure Root length, Surface area, Volume, Average diameter, Numbers of tips *etc*.

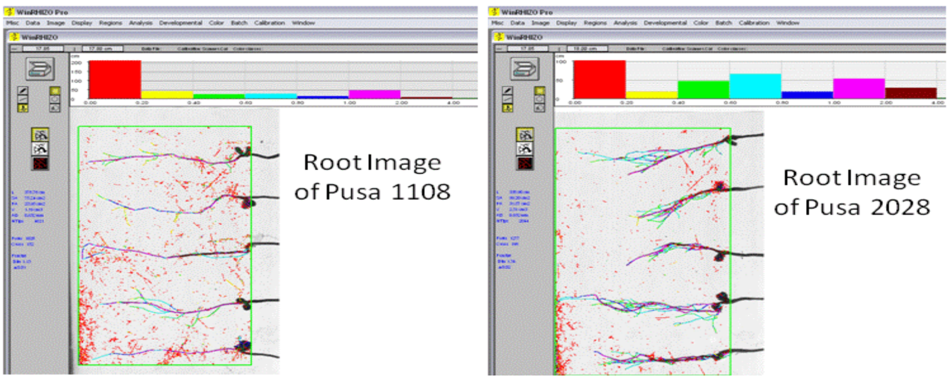

Fig 1: Analysis of digitized images of chickpea roots with WinRHIZO Pro.

Statistical analysis

The data from laboratory experiment were collected by adopting complete randomized design (CRD), while data collected from field experiment were through randomized block design (RBD) as prescribed by Panse and Sukhatme (1985). The data were analyzed using the software SPSS10.0.

RESULTS AND DISCUSSION

The experiment was undertaken keeping in view two main objectives first to observe the loss in vigour of desi and kabuli chickpea stored under ambient condition and second to see effect of seed enhancement treatment on planting value. The germination percentage of fresh seed lots (Table 1) revealed that both desi and kabuli variety *i.e.* Pusa 2028 and Pusa 1108 had more than 90 percent germination. However, it was higher in desi type chickpea. This is largely because desi type is basically a semi tropic crop thus is more suited to Indian conditions compared to *kabuli* types a temperate crop. In the two year old seed lot, loss of germination was more in kabuli type. The mean germination of Pusa 2028 and Pusa 1108 were 87 and 73, respectively (Table 2 and 3). Similar trend with respect to loss in germination was observed in four year old seed lots as presented in Table 4 and 5. In the fresh seed lots, because of higher value of most of vigour parameters, the effect of seed enhancement treatment was not significant. But in the two year and four year old seed lots; SMP, thiram and neem khali improved the germination significantly. The comparative effectiveness of treatment on two types was more pronounced in *kabuli* type. *Kabuli* types suffer more loss of vigour and injury due to faster imbibitions of water and pathogenic incidence due to cracking in large seeded varieties (Yadav and Sharma, 2001).

The proportion of abnormal seedling in the fresh seed lot of *kabuli* type *viz.* Pusa 1108 was more than desi type *viz.* Pusa 2028. In storage, the number of abnormal seedling increased was much faster in kabuli lot. It was observed that in the fresh, two year old and four year old lot the number of abnormal seedling in *kabuli* were 7, 11.33 and 13.16 respectively, where as in desi type it were 3, 6 and 8.16, respectively. It was observed that SMP and thiram were among the two seed enhancement treatment which significantly reduced the number of abnormal seedling in both desi and kabuli type. Kabuli chickpea seeds treated with Sweet flag rhizome @ 10 g/kg, an alternative to chemicals, also reported to have maintained higher seed quality during storage (Shinde and Hunje, 2019).

Table 1: Mean values of seed quality parameters of fresh seed lots of chickpea genotypes.

Parameters	Pusa 2028 Desi	Pusa 1108 Kabuli
Germination	93.0	91.0
Abnormal Seedling	3.0	7.0
Seedling Length	21.5	17.5
Seedling Dry Wt	0.570	0.657
Vigour Index I	1999	1592
Vigour Index II	53.01	59.79
Field Emergence	91.0	88.0

Table 2: Effect of enhancement treatments on the performance of two year old seed of *desi* variety Pusa 2028 of chickpea.

Treatments	Germination (%)	Abnormal Seedling (%)	Seedling Length (cm)	Seedling Dry Wt. (mg)	Vigour Index I	Vigour Index II	Field Emergence (%)
Control	84.0	6.0	18.2	0.560	1528.8	47.0	81.0
Osmopriming	86.0	6.0	18.7	0.562	1608.2	48.3	82.0
Halopriming	87.0	7.0	18.7	0.561	1626.9	48.8	82.0
SMP	88.0	5.0	19.9	0.575	1751.2	50.6	92.0
Thiram	89.0	5.0	19.2	0.570	1708.8	50.7	89.0
Neemkhali	88.0	7.0	18.4	0.565	1619.2	49.7	84.0
Mean	87.0	6.0	18.9	0.565	1640.5	49.2	85.0
CD (p=0.05)	3.0	0.2	0.7	NS	56.4	15.7	2.6

Table 3: Effect of enhancement treatments on the performance of two year old seed of *kabuli* variety Pusa 1108 of chickpea.

Treatments	Germination (%)	Abnormal Seedling (%)	Seedling Length (cm)	Seedling Dry Wt. (mg)	Vigour Index I	Vigour Index II	Field Emergence (%)
Control	70.0	12.0	16.4	0.643	1148.0	45.01	36.0
Osmopriming	69.0	14.0	16.4	0.654	1131.6	45.13	31.0
Halopriming	69.0	13.0	16.2	0.651	1117.8	44.92	29.0
SMP	77.0	9.0	17.5	0.685	1347.5	52.75	56.0
Thiram	78.0	9.0	17.1	0.658	1333.8	51.32	49.0
Neemkhali	75.0	11.0	16.8	0.649	1260.0	48.68	44.0
Mean	73.0	11.3	16.7	0.656	1223.1	47.96	40.8
CD (p=0.05)	2.3	0.4	NS	NS	38.0	13.99	1.5

Table 4: Effect of enhancement treatments on the performance of four year old seed of *desi* variety Pusa 2028 of chickpea.

Treatments	Germination (%)	Abnormal Seedling (%)	Seedling Length (cm)	Seedling Dry Wt. (mg)	Vigour Index I	Vigour Index II	Field Emergence (%)
Control	81.0	8.0	16.5	0.502	1336.5	40.66	75.0
Osmopriming	85.0	9.0	16.5	0.542	1402.5	46.07	76.0
Halopriming	87.0	8.0	16.9	0.521	1470.3	45.33	83.0
SMP	87.0	8.0	17.0	0.544	1479.0	47.32	88.0
Thiram	87.0	7.0	17.2	0.522	1496.4	45.41	87.0
Neemkhali	84.0	9.0	16.2	0.516	1360.8	43.34	76.0
Mean	85.2	8.2	16.7	0.524	1424.2	44.69	80.8
CD (P=0.05)	3.4	0.2	0.6	0.18	51.9	14.31	3.3

Table 5: Effect of enhancement treatments on the performance of four year old seed of *kabuli* variety Pusa 1108 of chickpea.

Treatments	Germination (%)	Abnormal Seedling (%)	Seedling Length (cm)	Seedling Dry Wt. (mg)	Vigour Index I	Vigour Index II	Field Emergence (%)
Control	67.0	12.0	16.0	0.647	1072.0	43.35	13.0
Osmopriming	69.0	15.0	16.1	0.660	1110.9	45.54	7.0
Halopriming	69.0	13.0	16.4	0.650	1131.6	44.85	18.0
SMP	68.0	12.0	17.1	0.679	1162.8	46.17	17.0
Thiram	67.0	14.0	16.7	0.642	1118.9	43.01	24.0
Neemkhali	64.0	13.0	15.7	0.648	1004.8	41.47	19.0
Mean	67.3	13.2	16.3	0.654	1100.1	44.07	16.3
CD (P=0.05)	2.1	0.6	0.5	NS	31.4	15.97	0.8

Generally, the standard germination of a seed lot does not give the actual estimate of field performance. So, there is need to have some reliable parameters, for evaluation of the seed quality. Moreover, decreased field emergence and uniformity is directly related with low seed vigour potential of a variety. It was observed that seed vigour index-I was higher in fresh seed lot compared with 2 and 4 year old seed lot. The SVI-I was more in *desi* type compared to kabuli type (1592) in fresh seed lot (Table 1). After two and four years of storage the SVI-I declined due to reduction in both germination percentage and seedling length. Similar trend was observed in SVI-II. The decline in SVI-II in two year and four year old seed lot in comparison to fresh lot was due to loss in germination and seedling dry weight. As the storage period was increased there was a decrease in root, shoot length and seedling vigour. This may be attributed to seed deterioration leading to loss of seed viability owing to depletion of food reserves and decline in biological activity of embryo due to fungal invasion, insect damage, fluctuating temperature and relative humidity. Similar results on decline in germination and other quality parameters due to seed treatments in storage were also reported by Morshed *et al.* (2014) in chickpea.

However, among the different priming treatments used, SMP and thiram were found significantly effective to maintain SVI-I and SVI-II compared to control in both desi and kabuli types. It could be because these act as protective agents against seed deterioration due to pest infestation, fungal invasion thereby preventing free radical damage as a result of which all the seed protectants have maintained seed viability satisfactorily for longer period of storage as against control. Low and medium vigour seed lots were found more responsive to priming treatments as reported earlier by other workers (Nagarajan *et al.*, 2005; Lee and Kim, 2000).

Planting value is determined by the field emergence which ultimately is the indicator of seed vigour. The field emergence data of fresh seed lots revealed that desi variety *viz.* Pusa 2028 had more than 90 per cent field establishment. However, it was only 88 percent in kabuli variety Pusa 1108. This is largely because of high germination and seedling length in *desi* variety. In the two year old seed lot, effect of ageing was more pronounced in *kabuli* type. The mean field emergence in control of Pusa 2028 and Pusa 1108 were 81 and 36, respectively. The differences in comparison to fresh seed lot were much widened at incremental rate in both *desi* and *kabuli* variety. With increased storage period of four year, the field emergence dropped to 75 and 13% in the field for Pusa 2028 and Pusa 1108, respectively. This could be due to initiation of pre-germination metabolic activities in seed during imbibition. Cantliffe (2003) reported that priming including solid matrix priming of seeds enhanced germination and increased seedling emergence uniformity under adverse conditions. Pandita *et al.* (2010) also suggest that solid matrix priming in combination with *Trichoderma viride* can be successfully used to improve seedling emergence and productivity of okra under low temperatures.

It was observed that after enhancement treatment significantly helped in narrowing the gap of field emergence value. The effect of SMP and thiram improved the field emergence very significantly which was followed by neem khali. The comparative effectiveness of treatment was more pronounced in *kabuli* type. The effect of osmo priming and

Table 6: Electrical conductance of all seed lots of chickpea genotypes.

Type	Variety	EC(µmhos/cm/g)		
		Fresh lot	Two year old lot	Four year old lot
Desi	Pusa 2028	9.35	11.25	12.79
Kabuli	Pusa 1108	17.09	18.26	20.59

halopriming was not very much significant in increasing field establishment of chickpea. But it was observed that primed seed exhibits greater germination rate and faster and uniform field emergence. The evidence was in agreement with Basar *et al*. (2005) and Lin and Sung (2001). There was also differential treatment effect observed between desi and kabuli types. The desi type shows better response to treatments in respect of faster and uniform field emergence. The mean values of all root parameters; root length, surface area, volume *etc*. were found to be non significantly affected by the variety, treatment and their interactions and therefore values are not given. Total length of all roots was 307 cm and 414 cm in desi variety where as it was 305 cm and 440 cm in kabuli variety in control and SMP treated seedlings, respectively. Similar observations were recorded for all other parameters in differentially aged seed lots of both the varieties.

Conductivity test measure leakage of electrolytes from seed and can be used as a vigour test to predict field emergence. Electrical conductivity (EC) test which measures the leakage of electrolytes was also studied on all the lots of desi and *kabuli* chickpeas. The mean EC value of fresh lots (9.35 µmhos/cm/g) of *desi* type was lower than value of 17.09 µmhos/cm/g present in *kabuli* type. With increase in aging period to 2 and 4 years the EC value also increased significantly (Table 6). The differences were more pronounced in *kabuli* types. Degree of seed leakage during imbibitions is influenced by stage of seed maturation, degree of seed ageing and incidence of damage (Powell *et al.*, 1987). One of the factors affecting storability of *kabuli* chickpea varieties is the presence of thin seed coat leading to damage to membranes resulting in the loss of semi permeability, thereby causing higher leakage of ions in aged seed. Increased membrane permeability resulting in an increased EC of seed leachate has been reported in different crops with ageing (Gnyandev, 2015; Singh and Dadlani, 2003).

CONCLUSION

Seed enhancement treatments were found more effective in seeds with less viability and poor vigour. *Desi* varieties of chickpeas could maintain the seed quality above IMSCS under ambient conditions of storage for 2 years, but *kabuli* type loses seed quality may be because of damaged thin seed coat. The solid matrix priming and seed treatments with thiram could be effectively used for improving the planting value of both types and aged seed lots of chickpeas.

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