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Pre Sowing Seed Treatments of Magnetic, Electric, Polyethylene Glycol, Sodium Chloride on Seedling Parameters of Desi Chickpea (*Cicer Arietinum* L.)

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A B S T R A C T

This present study was elucidated the effects of different pre sowing seed treatments on stored seeds of Desi Chickpea seeds. Seeds were stored in plastic bags for one planting season, i.e. 8 months under ambient and control conditions of Prayagraj. After storage, seeds were treated with different doses of Polyethylene Glycol 6000, sodium chloride, magnetic and electric seed treatments. Observations showed that the seeds stored in plastic bags for eight months ageing treatments displayed that the seedling parameters were also found more affected in Polyethylene Glycol as compared to sodium chloride, magnetic and electric seed treatments. Germination and vigour percentage decreased with the period of ageing. Seeds of Chickpea (DCP-92) are stored in plastic bags were affected due to storage but the effects were more pronounced in PEG 6000 as compared to other treatments.

Introduction

Chickpea is the third most important food legume crop and is grown in several countries worldwide as a food source. Seed is the main edible part of the plant and is a rich source of protein, carbohydrates and minerals especially for the vegetarian population. As in case of other legume crops, even chickpea can fix atmospheric nitrogen through its symbiotic association with Rhizobium sp.; thus helping in enhancing the soil quality for subsequent cereal crop cultivation. Even though India is the largest producer of chickpea; it still imports chickpea from other countries. Keeping in view, the ever-increasing demand for this legume crop; it is essential to improve the production and area under cultivation, at the same time minimizing the stress on this crop plant. Two types of chickpeas are recognized, the white-seeded "Kabuli" and the brown colored "Desi" types. Kabuli chickpeas are relatively bigger in size having a thinner seed coat while the Desi type seeds are relatively smaller in size having a thicker seed coat. The Desi type chickpea contributes to around 80% and the Kabuli type around 20% of the total production.

Packaging is an important part of product processing and preservation and has direct influence on the system in respect to physical and chemical changes. The packaging materials used are decided by kind and quantity of seed to be packed, the type of package, duration of storage, storage temperature and relative humidity of the storage area, etc. The farmers practice of storing crop seeds in gunny bag as well as in cloth bags hastens up the seeds quality deterioration process, thus resulting in poor seed quality. The use of high density polythene bag packaging materials in seeds storage were found to retain the quality, but for a limited period.

In agriculture, seed is a vehicle to deliver almost all agro based technological innovations so that the farmers can exploit the genetic potential of new varieties. Ageing is an universal physiological phenomenon occurring in living organisms. It is one of the most intriguing and challenging scientific problems of universal concern. The poor seed storability is a major problem in chickpea. The changes associated with seed deterioration are manifested in various seed and seedling characters at different stages. Among these deteriorative changes, membrane degradation has been proposed as the primary event in ageing (Rai *et al*, 2011).

Seed treatments have played and are still playing a pivotal role in sustainable crop production which is also evidenced from the history of mankind. Seed treatments have helped to improve the yields of many different crops by providing the protection from pre and post-emergent insects and diseases and insurance of a uniform stand across a wide variety of soil types, cultural practices and environmental conditions. Seed treatments provide an economical crop input that is applied directly on the seed using highly effective technology. Seed priming is a technique controlling hydration and drying, that results in more rapid germination when the seeds are re-imbibed. Seed priming technique has been found to be a feasible technology to improve seedling emergence in some field crops, such as cotton, common maize, rice and wheat. In Chickpea, seed priming commonly used to reduce the time between seed sowing and seedling emergence and to improve the percentage of emergence. The benefits of seed priming had been reported, including improving stand establishment in semi-arid condition and at drought stress, enhancing seed with low vigor, improving dormancy breakdown, or increasing productivity. The appropriate water holding capacity, consistency, and high porosity of peat moss are qualities that have contributed to its worldwide use as an ingredient of growing substrates and as a carrier for commercial bacterial inoculants.

Physical methods mainly include ultrasound treatment, plasma processing, electromagnetic field and static processing, magnetized water or temperature treatment, microwave processing etc. Enzyme activity, which is beneficial to transfer starch, protein or other substances into soluble matters that could be absorbed by embryos, can be improved by different methods of treating seeds and then it can enhance the seeds germination rate, promote seeds growth and increase the crop yield. However, the current methods have some shortcomings. Chemical agents may damage the seeds and thus have negative effects on the growth and development of crops due to the high residual medicine in seed. Moreover, the physical treatments, *e.g.* high pressure electrostatic processing, consume too much energy and have low safety coefficient. Thus, it is necessary to take a safe and low consumption method, electrochemical method, to treat the seeds. Seeds treatment using electrochemical method has great advantages, such as low energy consumption, normal temperature, atmospheric pressure; the system has strong electromagnetic field effect (Zhao *et al.* 2012).

Magnetic field may play an important role in cation uptake capacity and has a positive effect on immobile plant nutrient uptake. Studies on the meri-stematic cells of plants have shown that magnetic field effects normal metabolisms and has impact on cellular division. Magnetic fields affect the synthesis of DNA and RNA as well as the cellular proliferation (Rostami *et al*, 2014). Hence, present studies were undertaken to assess the effect of different pre sowing seed treatments on seedling parameters of Desi Chickpea (DCP-92-3) seeds under ambient and control conditions of Prayagraj.

Materials and Methods

Chickpea (DCP-92-3) seeds were obtained from Indian Institute of Pulses Research (I.I.P.R), Kanpur. Seeds were stored in plastic bags for one planting season, *i.e.* 6 months under ambient and control conditions of the Post Graduate Laboratory, Department of Genetics and Plant Breeding, SHUATS, Prayagraj. The treated seeds and control seeds (fresh seeds) were grown in petridishes in Laboratory same day after storage with four replications. The petridishes were placed in incubator maintained at 25+10C. For each treatment ten seeds were used in each replication. The seeds from each sample were then germinated on moist filter paper in petridishes.

For seedling characters, the germination test was conducted using four replications of 100 seeds from each sample in petridish as per procedure described by ISTA (2010). Seedling dry weight and vigour index I and II were determined by Baki and Anderson (1973).

Data analysis

In order to calculate the Germination (%), Vigour Index (I and II), Root and Shoot length, Seedling Dry Weight and Root Shoot ratio, formula 1, formula 2, formula 3, formula 4 and formula 5 were used

Germination (%)

$$= \frac{\text{Number of normal seedlings}}{\text{Total seeds used for germination test}} \times 100$$

V.I. (I) = Germination percentage (Normal seedling) X Seedling length (cm)

V.I. (II) = Germination percentage (Normal seedling) X Dry weight of the seedling (gm)

Root and shoot length: Root and shoot length of five fresh seedlings was measured in centimetres up to one decimal. Total seedling length was calculated by adding root and shoot length.

Seedling dry weight: The seedlings used for recording were dried in an oven at 103^0C+10C for 12 hours. Measurement of dried samples was record on an electronic balance upto three decimals in mg.

Results and Discussion

The results of germination percentage as influenced by treated with different priming treatments during 2017-2018 and pooled data are presented in Table 1 and 2.

Perusal from table that significantly maximum increase in germination percentage occurs by T_2 [Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 8 hrs] was (94.50, 95.41 and 94.96 %) followed by T_6[Halopriming with NaCl (9%) for 10 hrs] was (93.99, 94.10 and 94.04%) while lowest germination percentage (85.50, 86.25 and 85.88%) was observed with unprimed control treatment during the year 2017-018 and in the pooled data, respectively. However, T_1, T_6, T_7,T_9, T_{10}, T_{11} in first year while, T_1, T_3, T_6, T_7,T_8, T_9, T_{10} T_{11}, in 2nd year and T_5, T_6, T_8, T_9 in pooled data found at par with T_2 [Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 8 hrs].

Seedling length

Perusal from table that significantly maximum increase in seedling length (cm) occurs by T_2 [Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 8 hrs] was (37.88, 37.72and 37.80 cm) followed by T_6[Halopriming with NaCl (9%) for 10 hrs] was (32.34, 32.45 and 32.39cm) while lowest seedling length (cm) (13.16, 14.66 and 13.91) was observed with unprimed control treatment during the year 2017-018 and in the pooled data, respectively. However,T_2, T_6 was found to be at par in first year while, T_6, in 2nd year and T_6 in pooled data found at par with T_2 [Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 8 hrs].

Seedling fresh weight (g)

Perusal from table that significantly maximum increase in seedling fresh weight (g) occurs by T_2 [Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 8 hrs] was (6.60, 6.71and 6.66) followed by T_6[Halopriming with NaCl (9%) for 10 hrs] was (6.30, 6.53 and 6.41g) while lowest seedling fresh weight (g) (5.11, 4.84 and 4.98g) was observed with unprimed control treatment during the year 2017-018 and in the pooled data, respectively. However, T_1, T_6, T_7,T_9, T_{10}, T_{11} in first year while, T_1, T_3, T_6, T_7,T_8, T_9, T_{10} T_{11}, in 2nd year and T_5, T_6, T_8, T_9 in pooled data found at par

with T_2 [Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 8 hrs].

The results regarding root and shoot fresh and dry weights are in agreement with those of Ashraf and Rauf (2001) who reported that fresh and dry weights of seedlings from haloprimed seeds were significantly higher, as compared to other unprimed seeds. Seed priming may help in dormancy breakdown may be due to embryo development or leaching of emergence inhibitors (Yamauchi and Winn, 1996), which resulted in increased FEP these results are in agreement with Haigh and Barlow (1987) who found that KNO_3 was beneficial in decreasing the emergence spread of tomato, carrot, onion and sorghum seeds.

Seedling dry weight

Perusal from table that significantly maximum increase in seedling dry weight (g) occurs by T_2 [Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 8 hrs] was (1.65, 1.68and 1.66g) followed by T_6[Halopriming with NaCl (9%) for 10 hrs] was (1.58, 1.60 and 1.59g) while lowest seedling dry weight (g) (1.28, 1.21 and 1.24g) was observed with unprimed control treatment during the year 2017-018 and in the pooled data, respectively. However,T_6, T_8, T_9, was found to be at par with in first year while, T_6 in 2nd year and T_6, T_8, T_9 in pooled data found at par with T_2[Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 8 hrs]. The present results are in accordance with observation of Bennett and Waters (1987) who reported that seedling dry weight, seed germination and vigor in sweet corn decreased with osmo-conditioning, although germination significantly enhanced by water soaking. However, osmopriming has been shown to activate processes related to germination, for instance, by affecting the oxidative metabolic such as increasing superoxide dismutase (SOD) and peroxidase (POD) (Jie *et al.,* 2002) or by the activation of ATPase as well as acid phosphatase and RNA syntheses (Fu *et al.,* 1988).

Seedling vigour index I

Perusal from table that significantly maximum increase in vigour index-I occurs by T_2 [Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 8 hrs] was (3579.70, 3598.9 and 3589.30) followed by T_6[Halopriming with NaCl (9%) for 10 hrs] was (3039.6, 3053.5 and 3046.6) while lowest vigour index-I (1125.2, 1264.4 and 1194.8) was observed with unprimed control treatment in the pooled data, during the year 2017-018 respectively. However, T_3, T_4, T_6, $T_9$was found to be at par in first year while, T_4, T_6, T_9 in 2nd year and T_4, T_6, T_9 in pooled data found at par with T_2 [Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 8 hrs].

Perusal from table that significantly maximum increase in vigour index-II occurs by T_2 [Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 8 hrs] was (155.93, 160.29 and 158.11) followed by T_6[Halopriming with NaCl (9%) for 10 hrs] was (148.50, 142.09 and 145.30) while lowest vigour index-II (109.44, 104.36 and 106.90) was observed with unprimed control treatment in the pooled data during the year 2017-018, respectively. However, T_3 [Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 10 hrs] to T_9 [Magnetic priming (75Mili Tesla for 5minutes] was found to be at par in first year while, T_1, T_3, T_6, T_7,T_8, T_9, T_{10} in 2nd year and T_1, T_6,T_7, T_9, T_{11} in pooled data found at par with T_2 [Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 8 hrs].

Priming with PEG and NaCl, significantly improved MGR and SVI. Comparison of seedling vigor index means of seeds exposed to priming in the PEG and NaCl solutions. Liu *et al.* (1996) have found that osmopriming improves both germination rate and speed in tomato seeds, especially when they utilized freshly harvested seeds. Our data confirmed that the primed seed with PEG-6000 or NaCl solution is a simple and effective way to improve all seed characteristics investigated, compared to those of the control treatment. These are similar finding results reported by Pallais (2006), Venkatasubramanian and Umarani (2007), Mohamed and Hannachi (2012).

Table.1 Mean performance of seedling characters of Chickpea Desi (DCP-92-3-3)

Treatments	Seed germination(%)		Root length (cm)		Shoot length (cm)		Seedling length (cm)		Fresh weight of seedlings (gm)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
T_0	85.5	86.25	5.04	5.79	8.12	8.87	13.16	14.66	5.11	4.84
T_1	86.75	87.58	12.05	12.88	14.63	14.46	26.68	27.34	6.13	5.86
T_2	94.5	95.41	16.12	16.25	20.76	20.67	37.88	37.72	6.6	6.71
T_3	92	92.91	13.24	13.07	15.59	15.6	28.33	28.67	5.15	5.42
T_4	89	89.93	9.68	10.61	12.05	12.98	21.73	23.59	6	6.27
T_5	86.5	87.46	10.99	10.95	13.46	13.42	24.45	24.37	5.39	5.66
T_6	93.99	94.1	14.67	14.5	17.67	17.95	32.34	32.45	6.3	6.53
T_7	89.5	90.51	13.13	13.17	14.36	14.37	27.49	27.54	5.8	6.07
T_8	93.5	94.35	12.31	12.22	15.13	15.25	27.44	27.47	5.93	5.66
T_9	93.57	93.83	13.97	14.11	15.89	15.8	29.86	28.98	6.2	6.37
T_{10}	91.5	92.35	12.69	13.54	14.24	14.33	26.93	27.87	5.27	5.38
T_{11}	86.49	87.24	12.12	12.03	13.25	13.4	25.37	25.43	6.11	6.22
F- test	S	S	S	S	S	S	S	S	S	S
S. Ed. (±)	2.264	2.771	0.997	1.366	1.139	1.05	1.316	1.502	1.024	1.332
C. D. (P = 0.05)	4.799	5.874	2.115	2.896	2.415	2.226	2.79	3.184	2.171	2.823
C.V.	0.102	0.124	0.298	0.383	0.64	0.526	0.26	0.284	0.559	0.651

Legends: T_0 – Control, T_1 - Hydro priming (HP) with distilled water 12 hrs , T_2 - Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 8 hrs , T_3 - Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 10 hrs , T_4 - Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 12 hrs, T_5 - Halopriming with NaCl (9%) for 8 hrs, T_6 - Halopriming with NaCl (9%) for 10 hrs, T_7 - Halopriming with NaCl (9%) for 12 hrs, T_8 - Magnetic priming (50Mili Tesla for 5minutes), T_9 - Magnetic priming (75Mili Tesla for 5minutes), T_{10} - Electric priming (0.5 Ampere for 5 minutes), T_{11} - Electric priming (1.0 Ampere for 5 minutes) , F- test, S. Ed. (±) - Standard Error of difference (±),C. D. (P = 0.05) - Critical Difference, C.V.- Coefficient of variation (%)- Percentage, (cm) – Centimeter, gm- Gram ,ISTA -International Seed Testing Association

Table.2 Mean performance of seedling characters of Chickpea Desi (DCP-92-3-3)

Treatments	Dry weight of seedlings(gm)		Vigour index I		Vigour index II		Root shoots Ratio	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
T_0	1.28	1.21	1125.2	1264.4	109.44	104.36	0.62	0.65
T_1	1.53	1.47	2314.5	2394.4	132.73	128.74	0.82	0.89
T_2	1.65	1.68	3579.7	3598.9	155.93	160.29	0.82	0.82
T_3	1.29	1.36	2652.4	2663.7	118.68	126.36	0.85	0.84
T_4	1.5	1.51	1934	2121.4	133.5	141.19	0.8	0.82
T_5	1.35	1.42	2114.9	2131.4	116.78	124.19	0.82	0.82
T_6	1.58	1.6	3039.6	3053.5	148.5	142.09	0.83	0.81
T_7	1.45	1.52	2460.4	2492.6	129.78	137.58	0.91	0.94
T_8	1.48	1.42	2565.6	2591.8	138.38	133.98	0.81	0.8
T_9	1.55	1.59	2794	2719.2	145.03	149.19	0.88	0.83
T_{10}	1.32	1.35	2464.1	2573.8	120.78	124.67	0.89	0.92
T_{11}	1.52	1.56	2194.3	2218.5	132.33	136.09	0.91	0.9
F- test	S	S	S	S	S	S	S	S
S. Ed. (±)	0.618	0.624	125.87	149.472	50.612	51.508	0.618	0.624
C. D. (P = 0.05)	1.31	1.323	266.845	316.88	107.297	109.198	1.31	1.323
C.V.	0.713	0.576	0.274	0.308	0.639	0.516	0.713	0.576

Legends: T_0 – Control, T_1 - Hydro priming (HP) with distilled water 12 hrs , T_2 - Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 8 hrs , T_3 - Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 10 hrs , T_4 - Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 12 hrs, T_5 - Halopriming with NaCl (9%) for 8 hrs, T_6 - Halopriming with NaCl (9%) for 10 hrs, T_7 - Halopriming with NaCl (9%) for 12 hrs, T_8 - Magnetic priming (50Mili Tesla for 5minutes), T_9 - Magnetic priming (75Mili Tesla for 5minutes), T_{10} - Electric priming (0.5 Ampere for 5 minutes), T_{11} - Electric priming (1.0 Ampere for minutes) , F- test, S. Ed. (±) - Standard Error of difference (±),C. D. (P = 0.05) - Critical Difference, C.V.- Coefficient of variation (%)-Percentage, (cm) – Centimeter, g- Gram

On the basis of result obtained from the present experiment, following conclusions are drawn. Among all the seed priming treatments, seed priming with PEG 6000 (osmo priming) was found to be the best priming treatment followed by organic priming. Among all seed priming treatments PEG 2% having more pronounced effect on germination behavior and vigour in kabuli chickpea seeds.

Root shoot ratio

Perusal from table that significantly maximum increase in root shoot ratio occurs by T_7 [Halopriming with NaCl (9%) for 12 hrs] was (0.91, 0.94 and 0.93), while lowest root shoot ratio (0.62, 0.65 and 0.64) was observed with unprimed control treatment during the year 2017-018 and in the pooled data, respectively. However, T_1, T_6, T_7,T_9, T_{10}, T_{11} in first year while, T_1, T_3, T_6, T_7,T_8, T_9, T_{10} T_{11}, in 2nd year and T_5, T_6, T_8, T_9 in pooled data found at par with T_2 [Osmopriming with poly ethylin glycol PEG 6000 (0.5 Mega Pascal) for 8 hrs].

Seed primed in NaCl solution and distilled water had the lngest radical and plumule compared to the other primers. Seeds were treated with halo-priming with NaCl solution could improved seed germination under free-stress condition and also alleviated effects of salinity and drought stresses on seedling growth. However, mean comparison of seedling fresh and dry weight showed that hydro primed seed produced the maximum seedling weight followed by NaCl.

Considering the above findings achieved from the present study it may be concluded that osmopriming has a positive significant effect on germination, seedling growth and water relation behavior on wheat seed under salt stress condition. The germination, seedling growth and water relation behavior of Chickpea seeds decreased with increasing of salt concentrations but the decrease was gradually slow. This might be due to the osmoprimed agent (PEG) which triggers the germination, seedling growth and water relation behavior of wheat genotypes though under salt stress conditions. So, it can be concluded that priming helps to improve the germination, seedling growth and water relation behaviors of Chickpea seeds under salt stress condition

Chickpea DCP-92-3 seeds were treated with PEG 6000 (0.5%) for 8 hours showed better germination and vigour traits of the treated seed samples showed better performance when compared to untreated ones as they were treated with NaCl (9%) for 10 hours.

During storage period, germination, viability, seed moisture and health status of the seeds depends upon packaging materials, duration and environmental conditions where plastic bags [700 gauge] can be used for maintaining the shelf-life of seeds during storage period at [8%] moisture level.

The results also indicates that the application of magnetic seed treatments with 75 mT [militesla] for 5 minutes duration can be an eco-friendly practice that improves plant characteristics in all the stages, from germination to final yield. This study should give a better understanding of the response of seeds to electric fields.

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