The Pharma Innovation Journal 2018; 7(7): 528-531

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2018; 7(7): 528-531

www.thepharmajournal.com
Received: 15-05-2018
Accepted: 16-06-2018

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Influence of seed hardening techniques on vigour, growth and yield in chickpea [*Cicer arietinum* (L.)]

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Abstract
A Field experiment was conducted during the *rabi* season of 2017 at the main research field of department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad U. P. (India).To study the Influence of Seed Hardening Techniques on Vigour, Growth and Yield in Chickpea *[Cicer arietinum (*L.)]. Seven treatment *i.e* Control (T_0), Distilled water (T_1), Hydration with KNO_3 (2%) (T_2), Hydration with NaCl (2%) (T_3), Hydration with $CaCl_2$ (2%) (T_4), Hydration with KH_2PO_4 (2%) (T_5), Hydration with KCl (2%) (T_6) replicated three times each were carried out in the plot in Randomized block design. Maximum increase in growth, yield contributing and seed vigour characters (Plant height, days to 50% flowering, Field emergence, Number of pods per plant, number of grains per plants, test weight, grain yield, germination per cent, root length, shoot length, seedling length, seedling fresh weight and seedling dry weight in chickpea) was observed with seed hardening techniques. More over treatment T_4 [(Hydration with $CaCl_2$ (2%)] showed better result.

Keywords: Chickpea, seed hardening, yield parameter, seed germination, seed vigour

Introduction
Chickpea *(Cicer arietinum* L.) 2n=16 is a self pollinated, major Rabi season pulse crop in India. It is an important pulse crop of India and an important source of protein in the vegetarian diet. It is a small, much branched herbaceous plant rarely exceeding 60-cm height. The botanical description of main parts of gram plant is given as role of pulses in Indian agriculture needs hardly any emphasis; India is a premier pulse growing country. India is likely to produce 264.38 million tons of food grains during 2014-15 (includes *kharif* 2014 and rabi 2014-15 crops) compared to 257.13 million tons last year (Patel *et al.,* 2015).

Chickpea is the world's second largest grown pulse crop after beans and is mainly used for human consumption. During 2013, the global chickpea production reached a record high of 13.1 million metric tons with 84.5 % of the production coming from Asia (75.5 % from Southern, 5.0 % from Western and 3.7 % from South-Eastern), 6.2 % from Oceania, 4.6 % from Americas (2.5 from Northern, 1.6 from Central and 0.5 % from Southern), 4.1 % from Africa (3.4 % from Eastern and 0.6 % from Northern) and 0.7 % from Europe (0.4 % from Eastern and 0.3 % from Southern) (Gaur, P. M., *et al.,* 2015)**.**

Drought is one of the major abiotic stresses in the world. Water stress from anthesis to maturity affects numerous morphological and physiological activities of plant resulting extensively reduces in crop yield and productivity (Hallajian, 2016).

Pre-sowing hardening technique is a repeated soaking and control seed hydration in solution containing organic or inorganic solutes followed by redrying that allows pre-germinative metabolic activities but prevent radical emergence (Basra *et al.,* 2005) [5]. The hardening treatment proved to be better for vigour enhancement than the traditional soaking (Manjunath and Dhanoji, 2011) [12]**.** Seed hardening treatments enhances seeds vigour by protecting structure of the plasma membrane against injury during stress environment (Bewley and Black, 1994; Jun Min *et al.,* 2000) [6, 10].

Henkel (1964) [8] recommended the seed hardening techniques to alleviate the moisture stress condition. Hardening of seeds resulted in the absorption of more water due to increase in the elasticity of cell wall and development of a stronger and efficient root system (Krishnasamy and Srimathi, 2011) [15]. Seed hardening imparts drought tolerance, increases seed germination followed by better and quicker seedling emergence. Seed priming/hardening is a common practice followed to enhance seed performance with respect to rate. In India, nearly 70% of

cultivated land is rainfed and accounts about 42% of the total quantity of food grains produced. It is a practice adopted to alleviate the moisture stress or making the plant resistant to moisture stress. The inorganic salts like NaCI, KCl, Ca Cl_2 are used as pre-hardening agents.

Material and Method

The present investigations was conducted during the *rabi* season of 2017 at the main research field of department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Science, Allahabad U. P. (India). Seeds of chickpea var. Pusa-362 was used in this study. The crop was raised with the spacing of 30×10 cm. The following treatment applications were given to plant before sowing time. T_0= Control, T_1= Hydration for 8 hr in water, T_2= Hydration with KNO_3 (2%) (8hr), T_3= Hydration with NaCl (2%) (8hr), T_4= Hydration with $CaCl_2$ (2%) (8hr), T_5= Hydration with KH_2PO_4 (2%) (8hr), T_6= Hydration with KCl (2%) (8hr). Observation on seed yield and growth parameters viz. Plant height, days to 50% flowering, Field emergence, Number of pods per plant, number of grains per plants, test weight, grain yield, germination per cent, root length, shoot length, seedling length, seedling fresh weight and seedling dry weight were recorded. Plant height was recorded after 30, 60 and 90 days after sowing with the help of scale. Grain yield and test weight was recorded with the help of micro weighting machine.

After harvest standard germination tests for seeds obtained from control and treated plots were carried out between two layers of moist filter paper according to international seed testing association rules to evaluate treatment effect on seed germination capacity. The working sample, consisting of 1000 pure seeds from each treatment, were counted using an electronic seed counter and tested in a completely randomized design (CRD) in two replicates of 100 seeds. Observations on seed quality parameter viz., Germination (%) ISTA, 2011, Root length (cm), Shoot length (cm), Seedling length (cm), Seedling fresh weight (mg), Seedling dry weight (mg), were recorded. The data were statistically analysed using ANOVA.

Results and Discussion

The treatments were categorized as strong, moderate and least. Treatment T_4 was considered best over all other treatments. Plant height was recorded maximum in treatment T_4 (Hydration with $CaCl_2$ (2%) (8hr). The minimum plant height was recorded in T_1 (Hydration for 8 hr in water). Other yield attributes namely Hydration for 8 hr in water Field emergence (50%), Number of pods per plant, Number of grains per plant, 100 grain weight (gm), Grain yield (kg/ha) were maximum in T_4 (Hydration with $CaCl_2$ (2%) (8hr) followed by T_5 (Hydration with KH_2PO_4 (2%) (8hr) and T_6 (Hydration with KCl (2%) (8hr). These results are in accordance with the result of Amaregouda *et al.,* (1994) [1]. Plant height ranged from 63.3 to 81.53 cm with the mean value of 72.52 cm. The minimum plant height was exhibited by treatment T_1 **[**distilled water] (63.3cm), while maximum plant height was recorded for treatment T_4 [$CaCl_2$ (2%)] (81.53cm). Days to 50% flowering ranged from 87.66 to 92 days with mean value of 90.00. The treatment T_1 **[**distilled water] exhibited early days to 50% flowering (87.66) days to 50 % flowering, whereas treatment T_4 [$CaCl_2$ (2%)] exhibited late days to 50% flowering (92.00). The treatments showed non-significant effect of seed hardening on field emergence. Mean value of field emergence ranged from 77.77 to 86.41 with average 82.52 %. The treatment T_0 Control exhibited minimum field emergence (77.77 %) and treatment T_3 [NaCl (2%)] exhibited high field emergence (86.41%). Number of pods per plant ranged from 32.73 to 58.16 pods with the mean value of 49.94 pods. The maximum number of pods per plant was recorded in treatment T_4 [$CaCl_2$ (2%)] (58.16 pods), while minimum number of pods per plant was recorded in treatment T_0 [Control] (32.37 pods).Number of seeds per plant ranged from 37.06 to 79.83 with the mean value 59.03. The maximum number of seeds per plant was recorded in treatment T_4 [$CaCl_2$ (2%)] (79.83), while as minimum number of seeds per plant was recorded in treatment T_0 [Control] (37.06). The 100 seed weight ranged from 60.3 to 75.93 (g) with the mean value of 21.29 (g). The maximum value for 100 seed weight was recorded in treatment T_1 [distilled water] (75.93g), while minimum value for 100 seed weight was recorded in treatment T_0 [Control] (60.30g). The perusal of data for this important character revealed that seed yield per plant ranged from 17.73 to 30.30g with the mean value of 24.69g. The highest yielding treatment was treatment T_4 [$CaCl_2$ (2%)] (30.30g) and treatment T_0 [Control] (17.37g) was the lowest yielder among the all treatments. The results are in agreement with the findings of Mishra and Dwivedi (1980) [14], Who reported that treating wheat seeds with 0.25% $CaCl_2$ or 2.5% KCl increased the grain yield compare to control. On the other hand increased drought tolerance and grain yield in sorghum over control under dry condition was reported by Patil *et al.,* (1987) [16]. The seed hardening chemicals showed profound significant effect over these parameters. However, seed hardening with 2% $CaCl_2$ recorded significantly higher LAI followed by KNO_3 (100 ppm) as compared to other treatments. Maitra *et al.,* (1998) [11] also noticed that seed hardening with 2 per cent $CaCl_2$ recorded significantly higher LAI as compared to control in finger millet. Similarly, Govindan and Thirumurugan (2000) [7] revealed that foliar spray of KCl (1%) or KNO_3 (1%) or in combination, increased the LAI over control in green gram.

All treatments showed more effect when compared to the treatment T_0 (control). The treatment T_4 $CaCl_2$ (2%) recorded highest significant effect on seed germination percent with 95.50 percent among all the treatments. However control (T_0) recorded lower effect than all the treatments with 88.25 percent. The treatments showed non-significant effect on root length. However, T_4 $CaCl_2$ (2%) and T_3 NaCl (2%) recorded highest effect with 10.50 cm followed by treatment T_1 (distilled water) with 10.25 cm. The minimum root length was recorded in treatment T_2 KNO_3 (2%). All the treatments showed significant effect on shoot length. Treatment T_4 $CaCl_2$ (2%) recorded highest effect on shoot length with 11.50 cm. Distilled water recorded lower value than control with 5.00 cm. Control T_0 recorded second highest effect of seed hardening on shoot length with 9.00 cm. Treatment T_4 $CaCl_2$ (2%) recorded highest effect of seed hardening on seedling length with 22.25cm. the lowest seedling length was recorded in distilled water T_1 with 15.25 cm. Treatment T_0 (control) recorded second highest effect of hardening on seedling length with 18.50 cm. The treatments showed non-significant effect of seed hardening on seedling fresh weight. The treatment T_2 KNO_3 (2%) recorded highest significant effect with 5.63g followed by NaCl (2%). The minimum seedling fresh weight was recorded in treatment T_1 distilled water with 4.40 (g). The treatment T_4 $CaCl_2$ (2%) recorded highest significant effect on dry weight with 0.50g followed by NaCl (2%) (T_3). While as, treatment T_1 distilled water with 0.31g

recorded lowest effect among all the treatments. KNO_3 (2%) and KCL (2%) recorded effects with 0.33 g respectively of dry weight. Several research workers have indicated increase in the yield of chickpea due to different seed hardening chemicals. Sen and Misra (1987) [17] reported that treating wheat seeds with 0.25 % $CaCl_2$ or 2.5 % KCl increased the grain yield compared to control. Similarly Patil (1987) [16] opined that seed treatment with 2% $CaCl_2$ for four hours increased drought resistance in sorghum and also increased grain yield by 10 per cent over control under dryland condition. Shindhe *et al.*, (1991) [18] opined that foliar spray of NAA and KNO_3 increased pod yield in cowpea. Singh *et al.*, (1991) [19] found that foliar spray of cycocel, mixtalol and triacontanol effectively enhanced seed yield in chickpea. Masood Ali (1985) [13] indicated that foliar spray of 2% KCl solution significantly increased grain yield in chickpea. Amaregouda *et al.*, (1994) [1] noticed that treatment with $CaCl_2$ (2%) had given higher yield in wheat.

Table 1: Effect of Different treatments on growth & yield parameters in chickpea

Treatments	Plant height (cm)	Day to 50 % flowering	Field emergence	Number of pods per plant	Number of seeds per plant	100 seed weight (g)	Seed Yield per plant
T_0	73.86	91.33	77.77	32.73	37.06	60.30	17.73
T_1	63.30	87.66	81.45	49.63	59.86	75.93	23.96
T_2	67.73	89.66	85.15	48.53	51.40	73.16	23.16
T_3	72.50	90.00	86.41	53.50	68.06	72.80	24.96
T_4	81.53	92.00	80.22	58.16	79.83	75.16	30.30
T_5	74.63	89.66	82.68	54.43	57.53	73.13	26.06
T_6	74.10	89.66	83.94	52.63	59.50	74.93	26.63
Grand Mean	72.52	90.00	82.52	49.94	59.03	72.20	24.69
S E	2.55	0.72	3.29	2.70	3.75	1.80	2.00
CD 5%	7.97	2.24	NS	8.43	11.70	5.60	6.25
CV	6.11	1.38	6.92	9.38	11.02	4.31	14.09

Table 2: Effect of Different treatments on seed quality parameters in chickpea

Treatments	Germination (%)	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Seedling fresh weight (g)	Seedling dry weight (g)
T_0	88.25	9.50	9.00	18.50	4.83	0.31
T_1	93.25	10.25	5.00	15.25	4.40	0.29
T_2	89.00	8.50	7.00	15.50	5.63	0.33
T_3	92.00	10.50	7.50	18.25	4.96	0.43
T_4	95.50	10.50	11.50	22.25	4.63	0.50
T_5	92.50	9.25	7.00	16.25	4.53	0.29
T_6	93.25	8.50	8.50	17.25	4.63	0.33
Grand Mean	91.96	9.57	7.92	17.60	4.80	0.35
S E	0.65	0.99	0.60	0.89	0.34	0.01
CD 5%	1.94	NS	1.79	2..65	NS	0.04
CV	1.42	20.70	15.32	10.20	14.29	8.42

Conclusion

On the basis of present investigation it may be concluded that treatment T_4 [Hydration with $CaCl_2$ (2%)] showed superior performance in terms of growth & yield attributes. Maximum seed vigour characters were observed in treatment T_4 [Hydration with $CaCl_2$ (2%)].

Acknowledgement

The author is greatly thankful to the advisor Dr. A. K. Chaurasia to give this opportunity to do this research work and also thankful to co-advisor Dr. Bineeta M. Bara to give full of knowledge related to this research work and thankful to all teachers of department of Genetics and plant breeding. Also thankful to Sam Higginbottom University of Agriculture, Sciences and Technology for giving this opportunity to pursue post-graduation study.

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