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Influence of different seed hardening treatments on growth and yield parameters of cowpea (*Vigna unguiculata* L.)

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Abstract
The experiment was conducted in post graduate Seed Testing Laboratory, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) during *Kharif* season 2019, in order to standardize the best treatment of hardening to Cowpea (..var….). Seed hardening treatments with control (Unhardened) were evaluated by screening 12 hour viz., T_0 – Control, T_1 – DH_2O, T_2 – $MnSO_4$, T_3 – $ZnSO_4$, T_4 – Na_2MoO_4, T_5 – NH_4NO_3, T_6 – KCl, T_7 – NaCl, T_8 – GA_3, T_9 – SA, T_{10} – IAA, T_{11} – Pungam leaf extract, T_{12} – Proposis leaf extract. It was found that all the seed hardening treatments showed significance difference with the control and in laboratory condition highest germination per cent observed in T_6- KCl (1%) and seedling length, seedling fresh weight, seedling dry weight, vigour indices were observed for T_8- GA_3 (40 ppm). In field highest field emergence percentage observed in T_6- KCl (1%) and plant height, number of pods per plant, number of seeds per pod, seed yield per plant, seed yield per plot, biological yield, harvest index were observed for T_8- GA_3 (40 ppm). Highest germination was observed in KCl (1%) and yielding parameters in GA_3. Pre-sowing seed treatment with GA_3 enhance germinability and seedling character, its simplicity and no requirement for expensive equipment and chemical could be used as a simple method for overcoming related to a poor germination and seedling establishment.

Keywords: Cowpea, different hardening treatments, quality parameters, vigour and seed yielding attributes

Introduction

Cowpea bean (*Vigna unguiculata* L.) is a dicotyledonous plant belonging to the order Fabales, family - Fabaceae, Faboideae, Phaseoleae tribe, subtribe Phaseolinea, and genus *Vigna*. Cowpea belongs to the family Fabaceae and having chromosome number 2n=22. It is used in different parts of the world in traditional and cultural practices and, therefore, its cultivation is restricted to specialized geographical pockets in different agro-ecological regions, primarily by poor farming communities that derive their sustenance and livelihood from such crops (Carvalho *et al.*, 2012). As a result, the cowpea is commonly referred to as 'poor man's meat', particularly among the inhabitants of rural areas and urban slums in Tabasco, Mexico. The grains are processed into different types of food products such as tamales, bean tortillas, and soup. Green, immature cowpea pods are harvested and sold in local markets for consumption as a vegetable.

Cowpea mainly grown in tropical and sub-tropical regions in the world for vegetable and seed purpose and to lesser extent as a fodder crop. It is a most versatile pulse crop because of its smothering nature, drought tolerant characters, soil restoring properties and multi-purpose uses. As a pulse crop, cowpea fits well into most of the cropping systems. Cowpea being a legume is an important source of food, income and livestock feed and forms a major component of tropical farming systems because of its ability to improve the fertility status of marginal lands through nitrogen fixation (Timko and Singh, 2008). It has considerable adaptation to high temperatures and drought compared to other crop species, making it suitable for cultivation in semiarid areas (Hall, 2004; Tekle, 2014).

Cowpea is called as vegetable meat due to high amount of protein in grain with better biological value on dry weight basis. On dry weight basis, cowpea grain contains 23.4 per cent protein, 1.8 per cent fat and 60.3 per cent carbohydrates and it is rich source of calcium and iron (Gupta, 1988). Apart from this, cowpea forms excellent forage and it gives a heavy vegetative growth and covers the ground so well that it checks the soil erosion. As a leguminous crop, it fixes about 70 – 240 kg per ha of nitrogen per year.

The low productivity in pulses is due to the reason that pulses are grown mostly in marginal and rainfed areas. The main constraint in raising the productivity levels of pulses in drylands are inadequate soil moisture and poor fertility status of the soil. To overcome the adverse environmental conditions like low rainfall and low soil moisture which prevent the germination and establishment of seedlings, seed hardening is given as a pre-sowing treatment. Seed hardening (wetting and drying) appears to impart drought tolerance and increase seed germination followed by better and quicker seedling emergence. Short term hydration of seeds before planting greatly benefits stand establishment but use of chemicals like potassium or sodium phosphate would give additional advantage. Seed priming/ hardening is a common practice followed to enhance seed performance with respect to rate and uniformity of germination (De Lespinay *et al.*, 2010).

Cowpea is treated as an important food legume in tropical and sub-tropical regions of the world, especially where drought is prominent due to low and uneven rainfall patterns thus causing major limitation to crop production. It is widely grown in east Africa and south-east Asia, primarily as a leafy vegetable (Hallensleben *et al.*, 2009) due to its high protein content. Cowpea leaves and seeds are low in fat, high in carbohydrates and proteins and low in anti-nutritive factors.

Seed hardening will modify the physiological and biochemical nature of seeds, so as to get the characters that are favorable for drought tolerance. Although it varies from crop to crop, the principle remains same. When dry seeds are soaked in water/chemical solutions the quiescent cells get hydrated and germination initiated. It also results in enhanced mitochondrial activity leading to the formation of high energy compounds and vital biomolecules. The latent embryo gets enlarged. When the imbibed seeds are dried again, triggered germination is halted.

When such seeds are sown re-imbibition begins and the germination event continues from where it is stopped previously. Beneficial effects of seed hardening includes accelerated rapid germination and growth rate of seedling, hardened plants recover much more quickly from wilting than those from untreated plants, induces resistance of salinity and to drought condition, seeds with stand higher temperature for prolonged period, flowering is slightly accelerated, compete more efficiently with weeds due to early emergence and results in more yield (Basra *et al*., 2006) [3].

Material and Methods

The experiment was conducted in post graduate Seed Testing Laboratory, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) during *Kharif* season 2019, in order to standardize the best treatment of hardening to Cowpea (..var….).. Seed hardening treatments with control (Unhardened) were evaluated by screening 12 hour viz., T_0 – Control, T_1 – DH_2O, T_2 – $MnSO_4$, T_3 – $ZnSO_4$, T_4 – Na_2MoO_4, T_5 – NH_4NO_3, T_6 – KCl, T_7 – NaCl, T_8 – GA_3, T_9 – SA, T_{10} – IAA, T_{11} – Pungam leaf extract, T_{12} – Proposis leaf extract.

Results and Discussions

The analysis of variance and mean value for growth and seed yield parameters was presented in Table1 and 2. The results revealed that the differences among 13 treatments were significant for growth and yield attributing characters, *viz.* field emergence percentage, plant height, number of branches per plant, number of pods per plant, number of seeds per pod, pods weight per plant, seed yield per plant, seed yield per plot, biological yield and harvest index.

Field emergence percentage was significantly higher in Halo hardening with KCl (1%) seeds followed by Hormonal hardening with GA3 (40 ppm) and Hormonal hardening with SA (40 ppm) when compared with control. When the data regarding the field emergence percentage found best in KCl (1%) among all the treatments. Similar results of field emergence percentage was observed by Kumar *et al.,* (2015); Singh *et al.,* (2014); Mukhtar and singh (2004); Kumar and Sundareswaran (2011); Johnson *et al.,* (2005) [15] and Niranjanamurthy *et al*., (2011).

Plant height recorded high in case of hardened seeds than that of unhardened seeds in the experiment. Among different hardening treatments Hormonal hardening with GA3 (40 ppm) found to be highest and control found to be lowest among all the treatments. In case of hardening, plant height was significantly higher in Hormonal hardening with GA3 (40 ppm) seeds followed by SA (40 ppm) and Halo hardening with KCl (1%) when compared with control. When the data regarding the plant height found best in GA3 (40 ppm) among all the treatments. Similar results of Plant height was observed by Emongor (2007) [6]; Dadson *et al.,* (2003) [5]; Abdul *et al.,* (1988) [2]; Tiwari *et al.,* (2011); Khan *et al.,* (2010) and Ali *et al.,* (2012).

Number of branches per plant recorded high in case of hardened seeds than that of unhardened seeds in the experiment. Among different hardening treatments Hormonal hardening with GA3 (40 ppm) found to be highest and control found to be lowest among all the treatments. Similar results of Number of branches per plant was observed by Sarkar *et al.,* (2002); Hermann *et al*., (2007); Newaj *et al.,* (2002); Chauhan *et al.,* (2009) and Rahman *et al.,* (2004) [22].

Number of pods per plant recorded high in case of hardened seeds than that of unhardened seeds in the experiment. Among different hardening treatments Hormonal hardening with GA3 (40 ppm) found to be highest and control found to be lowest among all the treatments.Similar results of Number of pods per plant was observed by Ullah *et al.,* (2007); Deotale *et al.,* (1998); Sharma *et al.,* (2013); Kaur *et al.,* (2008); Abdul *et al.,* (1988) [2] and Noor (2014).

Number of seeds per pod recorded high in case of hardened seeds than that of unhardened seeds in the experiment. Among different hardening treatments Hormonal hardening with GA3 (40 ppm) found to be highest and control found to be lowest among all the treatments. Similar results of Number of seeds per pod was observed by Islam *et al.,* (2006) [11, 12]; Emongor (2002); Zhang *et al.,* (1997) [25]; Deb *et al.,* (2010); Sunil Kumar *et al.,* (2015); Babaji *et al.,* (2011) and Srikant (2003).

Pods weight per plant recorded high in case of hardened seeds than that of unhardened seeds in the experiment. Among different hardening treatments Hormonal hardening with GA3 (40 ppm) found to be highest and control found to be lowest among all the treatments. Similar results of Pods weight per plant was observed by De Lespinay *et al.,* (2010); Singh and Sharma (1996); Noor (2014); Deb *et al.,* (2010); Williams *et al.,* (1984); Sarkar and Pal (2006) and Sedghi (2010).

Seed yield per plant recorded high in case of hardened seeds than that of unhardened seeds in the experiment. Among different hardening treatments Hormonal hardening with GA3 (40 ppm) found to be highest and control found to be lowest among all the treatments. Similar results of Seed yield per plant was observed by Mazid (2014); Maske *et al.*, (1998); Chavan *et al.*, (2014); Karim and Fattah (2007); Alhaji Hamza Ibrahim, (2008) and Hoque and Haque (2002).

Seed yield per plot recorded high in case of hardened seeds than that of unhardened seeds in the experiment. Among different hardening treatments Hormonal hardening with GA3 (40 ppm) found to be highest and control found to be lowest among all the treatments. Similar results of Seed yield per plot was observed by Kumar *et al.*, (2006); Jain *et al.*, (1995); Srikant (2003); Maske *et al.,* (1998); Zhang *et al.*, (1997) [25]; Saglam *et al.*, (2010) and Naim *et al.*, (2012) [19].

Biological yield recorded high in case of hardened seeds than that of unhardened seeds in the experiment. Among different hardening treatments Hormonal hardening with GA3 (40 ppm) found to be highest and control found to be lowest among all the treatments. Similar results of Biological yield was observed by Raut Sabale (2003) [23]; Azizi *et al.*, (2012); Noor (2014); Farooq *et al.*, (2006); Tekle (2014); Singh and Rivas (2012); Diniz *et al.*, (2009) and Rao *et al.*, (2005).

Harvest index recorded high in case of hardened seeds than that of unhardened seeds in the experiment. Among different hardening treatments Hormonal hardening with GA3 (40 ppm) found to be highest and control found to be lowest among all the treatments. Similar results of Harvest index was observed by Musa *et al.*, (2001); Halmer (2004) [10]; Singh and Verma (2002); Azizi *et al.*, (2012); Selvam *et al.*, (2000); Sajid *et al.*, (2008) and Iraj *et al.*, (2011).

Table 1: Analysis of variance for 10 growth and yielding attributes in Cowpea.

S. No.	Characters	Mean sum of square		
		Replications (df=2)	Treatments (df=12)	Error (df=24)
1.	Field Emergence Percentage	16.95	45.66*	7.34
2.	Plant height (cm)	16.23	78.03*	9.21
3.	Number of branches per plant	6.33	2.95*	0.97
4.	Number of pods per plant	17.72	14.63	9.52
5.	Number of seeds per pod	1.56	12.99*	3.84
6.	Pods weight per plant	0.63	2.51*	0.67
7.	Seed yield per plant (g)	96.64	110.98*	7.96
8.	Seed yield per plot (g)	10476.33	76924.21*	2249.64
9.	Biological yield	181694.29	465172.78*	26663.39
10.	Harvest index	0.96	30.84*	0.21

* Significant at 5% level of significance.

Table 2: Mean performances for 10 growth and yielding attributes in Cowpea

S. No.	Treatments	Field Emergence percentage	Plant height (cm)	Number of branches per plant	Number of pods per plant	Number of seeds per pod	Pods weight per plant	Seed yield per plant (g)	Seed yield per plot (g)	Biological yield (g)	Harvest index
1	T_0	75.33	55.32	5.33	14.00	8.33	2.19	18.88	198.90	835.84	23.80
2	T_1	82.00	63.26	7.67	15.00	8.67	3.29	33.28	432.64	1484.34	29.13
3	T_2	78.00	58.19	8.00	16.67	12.00	2.41	24.64	295.68	1155.28	25.67
4	T_3	81.33	62.28	6.33	18.00	9.33	2.98	30.56	397.28	1463.77	27.18
5	T_4	80.67	61.34	7.00	17.00	10.67	2.76	28.64	343.68	1307.08	26.36
6	T_5	83.00	64.52	7.67	19.33	11.00	2.59	32.96	461.44	1543.04	29.92
7	T_6	88.00	67.44	8.33	20.00	14.00	4.69	37.11	618.93	1904.44	32.50
8	T_7	76.67	56.21	7.33	18.33	9.67	2.26	25.76	283.36	1143.83	24.80
9	T_8	86.00	71.63	8.67	21.33	15.33	4.46	39.04	747.09	2260.73	33.05
10	T_9	85.00	69.18	8.00	21.00	12.33	4.31	35.97	564.50	1813.64	31.09
11	T_{10}	84.33	66.25	7.00	18.67	11.67	3.96	34.84	523.07	1724.91	30.33
12	T_{11}	79.00	60.98	7.33	16.00	9.33	3.92	25.92	311.04	1231.92	25.29
13	T_{12}	77.33	57.23	5.67	17.33	10.00	2.32	23.36	256.96	1057.91	24.30
Grand Mean.		81.28	62.60	7.26	17.90	10.95	3.24	30.07	418.04	1455.90	27.96
C.D.(5%)		4.56	5.12	1.66	5.20	3.31	1.38	4.75	79.93	275.17	0.77
SE(m)		1.56	1.75	0.57	1.78	1.14	0.47	1.63	27.38	94.28	0.27
SE(d)		2.21	2.48	0.81	2.52	1.61	0.67	2.30	38.73	133.33	0.38
C.V.		3.33	4.85	13.59	17.24	17.97	25.23	9.38	11.35	11.22	1.64

Conclusion

On the basis of results obtained from the present experiment following conclusions are drawn.

Seed hardening treatment increases the germinability and vigour of cowpea seeds, significantly in both lab and field condition. Hardening with Gibberellic Acid (40 ppm) followed by Potassium Chloride (1%), Salicylic Acid (40 ppm), Indole Acetic Acid (40 ppm) and Ammonium Nitrate (1%) significantly increased the quality parameters of cowpea. Hardening with GA_3 and KCl showed maximum increase in germinability and vigour of cowpea seeds and found to be lowest in control seeds. Hardening of the cowpea seeds for 12 hrs, in which GA_3 best result to enhanced germinability, vigour and quality parameters. These conclusions are based on the results of six months investigation and therefore further investigation is needed to arrive at valid recommendations. The Hardening with GA_3 and KCl are ecofriendly and economic in use.

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