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RESEARCH PAPER

Study on seed priming methods on growth, seed yield and production economics of desi chickpea

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Abstract : A field trial to evaluate the effects of priming methods and sowing depth of desi chickpea variety JG-14 was conducted at College of Agriculture, CAU, Imphal (Manipur) during *Rabi* season of 2014-15 and 2015-16 with two factors *viz.*, priming methods (Distilled water, Mannitol, NaCl and KNO_3) and sowing depth (5 cm, 7.5 cm and 10 cm). Hydro-primed seeds of chickpea sown at 10 cm recorded significantly highest growth parameters, yield attributes and seed yield (852.73 kg/ha) while lowest grain yield was recorded in NaCl primed seeds with 5 cm sowing depth. Higher root length and root dry matter were obtained from the plants primed with KNO_3 with sowing depth of 7.5 cm while hydro-primed seeds sown at 5 cm exhibited earliest germination while hydro-primed seeds sown at 10 cm recorded the highest field emergence (75.42%). Highest net return and B:C ratio (1.38) was obtained with hydro-priming and sowing depth of 10 cm which be recommended for desi chickpea in North eastern region.

Key Words : Chickpea, Growth, Seed priming, Sowing depth, Yield

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INTRODUCTION

Bengal gram or chickpea (*Cicer arietinum* L.) belonging to sub family Papilionaceae of the family Leguminaceae, is an important pulse crop of the semi-arid tropics, particularly in the rainfed ecology of the Indian subcontinent. It is the world's third-most important food legume (pulse) and is consumed as a high-quality protein food with India being the world's largest producer and consumer of pulses. Chickpea contains 17-22 per cent protein and 60-64 per cent carbohydrates (Sindhu *et al.*, 1974). Chickpea helps in sustaining the productivity of the cropping systems through their ability to fix atmospheric nitrogen. India is the largest chickpea producing country accounting for 64 per cent of the global chickpea production. Seed priming is a commercially used technique for improving seed germination and vigour. It involves imbibitions of seeds in water under controlled conditions upto the point of radical emergence followed by drying the seed back to the initial moisture content of the seeds. Priming of seeds in mannitol (osmo-priming), sodium chloride (halo-priming) and water (hydro-priming) has been reported to be an economical, simple and a safe technique for increasing the capacity of seeds to

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osmotic adjustment and enhancing seedling establishment and crop production under stressed conditions. This could be due to faster emergence of roots and shoots, lower incidence of re-sowing, more vigorous plants, better drought tolerance, earlier flowering, earlier harvest and higher grain yield under adverse conditions (Passam and Kakouriotis, 1994). Seed priming is a pre-sowing strategy for influencing seedling development by modulating pre-germination metabolic activity prior to emergence of the radicle and generally enhances rapid, uniform emergence and plant performance to achieve high vigour and better yields. Common priming techniques include osmo-priming (soaking seeds in osmotic solutions such as mannitol), halo-priming (soaking seeds in salt solutions) and hydro-priming (soaking seeds in water). Priming of chickpea seeds with mannitol and water improved seedling growth under salt stressed conditions. The effect of seeding depth is more important in rainfed areas, where crops are raised on conserved moisture. Deeper seeding may cause poor emergence and shallow depth may lead to poor germination on account of low soil moisture in the surface layer. Germination of all the cool season pulses is hypogeal and, therefore, they can be planted relatively at deeper depth depending on availability of adequate moisture in particular soil layer. In rainfed areas, deep sowing of chickpea was proved better than shallow depth. Further, deep planting reduces incidence of *Fusarium wilt* as compared to shallow planting and also promotes better root development. The benefits accrued due to deep sowing may be attributed to the optimum use of moisture stored in soil from monsoon rainfall. Besides the above facts, there is limited information available pertaining to the agronomic practices of chickpea in Manipur particularly study on seed priming and sowing depth. Hence, in depth study on these aspects of chickpea was undertaken.

MATERIAL AND METHODS

A field trial was conducted during *Rabi* season of 2014-15 and 2015-16 at Research Farm of Agronomy, College of Agriculture, Central Agricultural University, Imphal. Soil of the experimental site was clay in texture. A composite soil sample was collected from the site at 0-15cm depth before starting the experiment and was analysed for physico-chemical properties. Soil was medium in nitrogen (280.53 kg/ha), medium in phosphorus (18.20 kg/ha), medium in potassium (210.44 kg/ha) and acidic in reaction (pH 5.2). The average monthly maximum and minimum temperature during the crop growth period was 22.70°C and 28.55°C and 6.25°C and 11.67°C, respectively during both the years. The field experiment consisted of two factors *viz.*, priming methods (Distilled water, 4% Mannitol, 1%NaCl, 1%KNO_3) and sowing depth (5.0 cm, 7.5 cm and 10.0 cm). Field emergence (%) was calculated for all the treatments by using the formula:

$$\text{Field emergence (\%)} = \frac{\text{No. of healthy seedlings}}{\text{Total seed sown}} \times 100$$

The ratio of economic yield (seed yield) to the biological yield (seed and haulm yield) was worked out as harvest index (Donald, 1962) and expressed in percentage (%).

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}\left(\frac{\text{kg}}{\text{ha}}\right)}{\text{Biological yield}\left(\frac{\text{kg}}{\text{ha}}\right)} \times 100$$

The benefit cost ratio was worked out by using the following formula:

$$\text{Benefit cost ratio} = \frac{\text{Net return}\left(\frac{\text{Rs.}}{\text{ha}}\right)}{\text{Cost of cultivation}\left(\frac{\text{Rs.}}{\text{ha}}\right)}$$

One life saving irrigation and two irrigations at branching and pod formation stage were given. All the experimental data obtained were subjected to statistical analysis using FRBD with three replications.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Seed germination:

The number of days to germination was found least (12.67 days) in treatment combination of distilled water priming with 5 cm followed by treatment combination of mannitol priming at 5 cm sowing depth (13.38 days).However, treatment combination of NaCl priming at 10 cm sowing depth took maximum days in field emergence (14.32 days) (Table 1). These may be due to the stimulatory effects of priming at the early stages of the germination process by mediation of cell division in germinating seeds as reported by Sivritepe *et al.* (2003). Field emergence hydro priming with distilled water and sowing depth of 10 cm recorded the highest field emergence of 75.42 per cent followed by mannitol priming and 10 cm sowing depth (71.42%). It is presumed that superiority of hydro priming on germination could be due to its ability to imbibe water for a longer time and went through the first stage of germination without protrusion of radicle. The adverse effect of germination synchrony in osmo-priming treatments may be related to the decreased water uptake in osmo-priming treatments and resulted in less advanced metabolic processes and slower germination. Similar results have been reported by Elkoca *et al.* (2007) for highest germination percentage in lentil. This may be related to rapid water uptake in priming treatment with hydro-priming and more availability of conserved moisture in deeper layer of soil which is required for seed germination, thus reducing the like hood of lodging.

Branching:

Branching potential was significantly remarkable from 50 DAS onwards. Highest number of branch was recorded as 4.95 in treatment combination of distilled water priming at 10 cm sowing depth which was followed by 3.95 at harvest recorded with treatment combination of Mannitol priming with 10 cm sowing depth. Least no of branch was found in treatment combination of NaCl priming with 7.5 cm sowing depth accounting for 2.87 branches/plant. The better crop growth due to seeds treatment may also be attributed to the fact that water treatment activates the synthesis of proteins, RNA, free amino acids and soluble sugars in the first phase of germination which could be advantages for subsequent phases of growth as observed by Jyotsna and Srivastava (1998).

Rooting potential:

Root length was found highest with 10.11cm in treatment combination of KNO_3 with 10cm sowing depth that was followed by 9.54 cm at harvest recorded with treatment combination of mannitol priming with 10 cm sowing depth. This may be due to better development of lateral root near soil surface. Root system in terms of length, lateral branches and nodules was more developed in water and mannitol primed plants than other primed plants. Similar results were reported on chickpea by Kaur *et al.* (2005). Deeper sown crop perform better than shallow sown crop, which may be due to better establishment of chickpea as availability of more moisture in soil at deeper sowing (10 cm) than shallow sowing (5 cm). Similar results were reported by Gan *et al.* (2003).

Root biomass:

Root weight was found highest (1.15 g/plant) in treatment combination of KNO_3 with 10cm sowing depth at harvest which was followed by 1.08 g recorded with treatment combination of mannitol priming with 10 cm sowing depth. Least result (0.74g) was found in treatment combination of NaCl priming with 5 cm sowing depth.

Table 1: Growth parameters of desi chickpea as influenced by priming methods and sowing depth (Pooled mean of two years)

Treatments	Days to germination	Field emergence (%)	Plant height (cm)	Branches/ plant	Root length (cm)	Root weight (g)
Hydro priming x Sowing at 5 cm	12.67	70.79	36.47	7.12	8.92	0.83
Hydro priming x Sowing at 7.5 cm	13.65	73.69	38.51	7.20	9.35	0.89
Hydro priming x Sowing at 10 cm	14.02	75.42	40.60	7.30	9.54	0.99
Mannitol priming x Sowing at 5 cm	13.38	69.01	33.52	6.60	9.42	1.02
Mannitol priming x Sowing at 7.5 cm	13.53	69.73	34.63	6.83	9.43	1.04
Mannitol priming x Sowing at 10 cm	13.66	71.42	35.41	6.94	9.55	1.08
NaCl priming x Sowing at 5 cm	13.53	63.95	30.67	5.20	8.40	0.70
NaCl priming x Sowing at 7.5 cm	13.87	65.70	31.46	5.28	8.60	0.75
NaCl priming x Sowing at 10 cm	14.32	67.25	32.12	5.54	9.15	0.76
KNO_3 priming x Sowing at 5 cm	13.46	69.07	32.41	5.60	9.79	1.08
KNO_3 Priming x Sowing at 7.5 cm	13.81	69.68	32.67	5.63	9.83	1.10
KNO_3 priming x Sowing at 10 cm	14.05	71.41	33.81	6.40	10.21	1.15
S.E.±	0.035	0.05	0.074	0.010	0.019	0.003
C.D. (P= 0.05)	0.100	0.14	0.212	0.027	0.055 NS	

NS= Non-significant

This may be due to greater biomass and number of nodules in primed plants. The increased biomass of nodules could be due to allocation of more photosynthate to nodules because of greater growth of primed plants. This was supported by Kaur *et al.* (2005). Deeper sown crop perform better than shallow sown crop which may be due to better establishment of chickpea as availability of more moisture in soil at deeper sowing (10 cm) than shallow sowing (5 cm). Similar results were achieved by Gan *et al.* (2003).

Plant height:

The interaction effects of methods of seed priming and sowing depth on the plant height at 25 DAS was found non-significant while significant results were found on 50, 75 DAS and at harvest with hydro-priming and sowing depth of 10 cm recording highest values (17.62, 23.66, 40.60 cm, respectively). However, least values of plant height were found in priming with NaCl and sowing depth of 5 cm. The enhanced plant height as a result of seed priming might be due to cell enlargement and increase in normal cell division was also reported by Karivaratharaju and Ramakrishnan (1985).The enhancement of plant height may also be due to the improvement and faster plant emergence in invigorated seeds which might have created co-operative competition among the plants for light and resulted in taller plants.

Dry matter production:

The interaction effects of methods of seed priming and sowing depth on the dry weight at 25 DAS was found non-significant while significant result were found at harvest with highest values when primed with distilled water and sowing depth of 10cm were undertaken. However, least dry weight as found in priming with NaCl at 5 cm sowing depth. Seed primed with water were significantly superior in dry weight than KNO_3 and NaCl primed seed as reported by Eskandari and Kazemi (2011). The enhanced in dry weight as a result of seed priming might be due to cell enlargement and increase in normal cell division (Karivaratharaju and Ramakrishnan, 1985). Deeper sown crop perform better than shallow sown crop which may be due to better establishment of chickpea as availability of more moisture in soil at deeper sowing (10 cm) was more than shallow sowing (5 cm). Similar results were obtained by Gan *et al.* (2003).

Yield attributes:

Priming methods and sowing depth significantly increased the pods/plant in chickpea. The number of pods/plant was found highest (66.27) on priming with distilled water followed by priming with mannitol. With respect to sowing depth, sowing depth of 10 cm showed maximum number of pods (59.58) followed by sowing depth of 7.5 cm (57.35). Significantly highest number of pods was found in seed priming with distilled water and

Table 2: Growth, yield attributes, yield and harvest index as influenced by different priming methods and sowing depth of desi chickpea (Pooled mean of two years)

Treatments	Days to maturity	Pods /plant	100 seed weight (g)	Grain yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)	Economics (B:C ratio)
Hydro priming x Sowing at 5 cm	110.15	65.20	19.93	841.45	1170.00	42.56	1.35
Hydro priming x Sowing at 7.5 cm	109.79	66.20	20.07	842.59	1207.24	41.83	1.35
Hydro priming x Sowing at 10 cm	109.33	67.40	20.53	852.73	1209.15	42.07	1.38
Mannitol priming x Sowing at 5 cm	110.63	54.60	19.70	767.47	1108.00	41.52	1.10
Mannitol priming x Sowing at 7.5 cm	110.50	61.80	19.70	768.57	1110.00	42.07	1.10
Mannitol priming x Sowing at 10 cm	110.00	63.20	19.92	807.23	1147.16	42.07	1.21
NaCl priming x Sowing at 5 cm	113.78	47.00	19.13	754.30	1089.00	41.56	1.10
NaCl priming x Sowing at 7.5 cm	112.67	47.60	19.13	754.97	1090.96	41.71	1.10
NaCl priming x Sowing at 10 cm	111.89	50.10	19.17	755.93	1095.41	41.64	1.10
KNO_3 priming x Sowing at 5 cm	111.00	51.60	19.43	757.60	1097.00	41.58	1.11
KNO_3 priming x Sowing at 7.5 cm	110.88	53.80	19.56	758.33	1100.05	41.50	1.11
KNO_3 priming x Sowing at 10 cm	110.05	57.60	19.67	765.33	1106.00	41.61	1.13
S.E.±	0.26	0.16	0.06	0.877	1.14	0.08	–
C.D. (P= 0.05)	0.75	0.44	NS	2.499	3.25	NS	-

NS= Non-significant

sowing depth of 10 cm recording 67.40 followed by treatments of combination involving priming with mannitol and 10 cm sowing depth (63.20). Maximum branches/ plant (7.30) and test weight (20.53 g) were also observed in this treatment. Similar finding was also observed by Mehri (2015) in soybean. The interaction of methods of seed priming and sowing depth on 100 seed weight and seeds/pod at harvest were found non-significant.

Days to maturity:

Data in respect of days taken for maturity is presented in Table 2. Number of days taken in maturing desi chickpea was significantly recorded least (109.33 days) in treatment combination of distilled water priming with 10 cm followed by (110.00 days) in treatment combination of mannitol priming with 10 cm sowing depth. However, treatment combination of NaCl priming with 5 cm sowing depth took maximum days in maturity (113.78 days). This may be due to proper crop establishment in deeper sowing depth and effect of hydro-priming. Similar results were found by Harris (1996) in sorghum. However, priming with NaCl at 5 cm sowing depth took maximum days for germination (113.78 days).

Seed yield:

The effect of methods of seed priming and sowing depth on grain yield at harvest was found significant with a highest yield (852.73 kg/ha) under distilled water priming and sowing depth of 10 cm and lowest yield (754.3 kg/ha) was found with NaCl priming and sowing depth of 5 cm. The improved seed yield may be due to early and improved emergence, more pods per plant and better yield attributes. Higher productivity with deeper sowing seems to be due to better tolerance of chickpea at deeper sowing through better crop establishment and seed germination (Siddique and Loss, 1996). The results of increased in seed yield due to such priming method and sowing depth are in conformity with the findings of Gupta and Singh (2012).

Economics:

Economics of the system of treatments were studied and it was found that gross returns, net returns and B: C ratio were found maximum under priming with distilled water at 10 cm sowing depth. This treatment recorded a gross return of Rs. 51164/ha, net returns of Rs. 29259.82/ha and B:C ratio of 1.38. However, maximum cost of cultivation of Rs. 21942.23/ha was recorded in P_2 (Priming with mannitol @ 4%). The highest income in P_1D_3 (priming with distilled water at 10 cm sowing depth) could be attributed due to more grain production.

Conclusion:

Hydro-priming (distilled water) with 10 cm sowing depth with significantly highest growth, yield attributes and yield parameters was the most effective treatment followed by manitol (4%) priming with 10 cm sowing depth. Highest gross return, net return and B:C ratio was obtained with the practice of seed priming using distilled water under sowing depth of 10 cm which was considered the best treatment combination.

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