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Effect of seed enhancement treatment on field performance of chickpea (*Cicer arietinum* L.)

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Abstract: Chickpea (*Cicer arietinum* L.) is an important winter season pulse crop in India grown in drought prone semi-arid and tropical regions. The aim of present investigation was to find out the effect of seed enhancement treatment on field performance of chickpea. Seeds of Chickpea Desi cultivar Pusa 256, Pusa 2028, and Kabuli cultivar Pusa1053, Pusa1108, each of fresh and 4 yrs old lots were taken for seed enhancement treatments like osmo-priming, halo-priming, fungicidal, botanical and polymer coating alone and in combination with thiram and neem oil. It was observed that seed treatment with thiram alone or in combination with polymer (PVP or PEM) significantly enhances germination and field emergence. Old seed lots of particularly Pusa 256 gives better result. The speed of emergence was invariably high in fresh seed lot (9.43) than old seed lots (4.84). However, in old seed lots, only halo-priming and polymer (PVP) in combination with thiram improved the speed of emergence significantly. Thus seeds treatment with thiram or in combination with hydrophilic polymers could be used for enhancing the performance of chickpea.

Keywords: Chickpea, Field emergence, Speed of emergence, Seed priming

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is a rainfed, low inputs, winter leguminous crop used in various foods in several developing countries, particularly in India as a source of dietary protein. It is a rich source of highly digestible dietary protein (17-21 per cent), carbohydrate (61.5 per cent) and fat (4.5 per cent). It is also rich in calcium, iron, niacin, vitamin B and vitamin C. The major chickpea producing countries in Asia are India (65%), Pakistan (7.5%) and Turkey (6.5%). India grows chickpea on 8.56 million ha are producing 7.65 million tonnes (FAO, 2011) and having productivity 858 kg/ha. There are two type of chickpea *viz* desi and kabuli, grown in the world recognized visually by seed coat colour and seed size. The desi types is characterized by small seed size and thick seed coat with pale to dark brown in colour, where as kabuli type is large seed size cream in colour with thick seed coat. The productivity level of pulses is not sufficient due to unavailability of quality seeds of improved varieties, several biotic and abiotic stresses and poor crop management practices. The planting value of seed is one of the key factors for proper plant establishment and performance, particularly under moisture stress conditions. Use of quality seed alone has been reported to improve productivity in chickpea from 15-20 percent (Dahiya *et al.*, 1997). The most cost effective method available for better stand establishment is to sow the seed with high germination which shows quick early growth. The major constraints of good establishment are due to low quality seed in addition to lack of soil moisture (Gurumu and Naylor, 1991). These conditions result in poor emergence that may subsequently cause sparse plant stands (Saxena *et al.,* 1997). One way of improving productivity of chickpea in drought prone area is seed enhancement treatment. Pre-sowing seed treatment including chemical, polymer coating, botanical and priming treatments are known to improve seed performance. Priming applied to commercial seed lots is widely used by seed technologists to enhance seed vigour in terms of germination potential and increased stress tolerance. The seed priming process simply involves soaking the seed overnight (for about 8 hrs), surface drying them and sowing within the same day (Musa *et al.,* 2001) to hasten germination, enhances crop establishment and promotes seedling vigor (Harris *et al.*, 1999). Treating the seed before sowing with fungicide prevent fungal invasion particularly in young seedlings. Seed treatment with captan, thiram, mancozeb and

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carbendazim shows significant improvement in field emergence and yield (Anuja and Aneja, 2000). The effects of seed coating with different polymeric formulations in general deteriorate at slower pace as manifest in high germination percentage (Kumar *et al*., 2007). The effect of seed treatment with powdered neem and neem oil formulations was to suppress nematode population growth and increased grain yield significantly in chickpea (Vijaylakshmi and Majumdar, 1999). Quick and synchronized germination is desirable to set crop successfully in order to compete with weed species and better seed performance. This was achieved by priming, which involves controlled hydration that restricts germination but permit pre germinative physiological and biochemical changes to occur (Bradford *et al*., 1990; Khan, 1992). Osmo-priming has shown to promote in rate and uniformity of germination in several crops. Seed treatment with PEG-6000 was found to increase germination per cent and seedling growth in Tomato, Capsicum, Cauliflower, Brinjal and Onion (Pandita and Nagarajan 2000, Cantliffe 2003, Pandita *et al*. 2007, Singh, *et al*. 2014; Usha and Dadlani, 2014). Field performance of seeds with low and average planting value was enhanced by seed enhancement treatment. Keeping this fact in view the present investigation was undertaken to find most appropriate seed enhancement treatment for better field performance in chickpea.

MATERIALS AND METHODS

Seeds and treatment materials: The seed material for this study constituted eight seed lots *i.e.* two each of desi (Pusa 256 and Pusa 2028) and kabuli (Pusa1053 and Pusa1108) from both freshly harvested and four year old seed lots. The fresh seed lots were available from Division of Seed Science and Technology, Indian Agricultural Research Institute, New Delhi and four years old seed lots were collected from Pulse Laboratories, Indian Agricultural Research Institute, New Delhi. Seeds selected for experiment were bold and free from any damage. The polymer polyvinyl pyrrolidane (PVP) and polyethyl methyl acrylate (PEM) were obtained from Division of Agriculture Chemical, Indian Agricultural Research Institute, New Delhi

Seed treatments: 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 20^0C. Similarly, treatment T_3 *i.e.* halo-priming was done by taking 2 percent solution of KNO_3 instead of PEG. Primed seeds were rehydrated for next 24 hrs at room temperature before sowing. Fungicidal treatment T_4 and botanical seed treatment T_5 were done with thiram @ 2g per kg of seed and neem oil @ 4ml per kg of seed respectively. The details of seed treatments are given in table 1. For preparation of seed coating formulation 4.0g of each polyvinyl pyrrolidone (PVP) and polyethyl methyl acrylate (PEM) and mixture of 0.10g sodium lauryl sulphate (act as binder) and 0.15g Sodium lingosulfonate (act as surfactant) were added to water and a wet grind was prepared individually for both the polymers. These polymer alone @ 4.0ml per kg and in combination with thiram and neem oil were applied to seed by seed coating machine.

Germination (%): Eight replicate of 50 seeds of each variety and each treatments were tested for germination studies as per ISTA method (Anonymous, 2004). 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 germinator in an upright position under 20 ± 1°C and 95 % RH for 8 days. On the day of final count *i.e.* 8^{th} day, it were evaluated for normal seedling, abnormal seedling, dead and hard seed. All the damaged, decayed and deformed seedling which were not able to produce normal seedling were counted and considered as abnormal seedling. Germination percentage was calculated on the basis of normal seedling.

Field emergence and speed of emergence (SOE): 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.

Speed of emergence calculated by following formula

$$SOE = \sum (N/T)$$

Where N is number of seeds emerging at time T and T is days from sowing.

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

RESULTS AND DISCUSSION

Germination (%): The effect of seed enhancement treatments on germination in both fresh as well as old seed lots as shown in table 2. In the fresh seed lots, varieties differed significantly for germination and maximum germination was observed in desi types. When viewed over treatment, Pusa 256 had significantly (P=0.05) higher germination (95.73%) than Pusa 2028. The treatments also differed significantly in their effect on germination (%). Among different seed treatments, thiram, neem oil, polymer (PVP and PEM) in combination with thiram had significantly increased germination over control (Table 2).

Among old seed lots, desi types were significantly higher germination than kabuli Type. Pusa 256 had significantly higher germination (84.73%) than other three varieties. The seed treatment with thiram followed by osmo-priming had increased germination significantly over the control.

Table 1. Details of seed enhancement treatments on chickpea.

S.N.	Treatments	Code	Dosage
1	Control	T_1	-----------
2	Osmo-priming	T_2	25 % Solution (w/v)
3	Halo-priming	T_3	2 % Solution (w/v)
4	Thiram	T_4	2.5 g/Kg
5	Neem oil	T_5	4 ml/Kg
6	Polymer(PVP)	T_6	4ml/Kg
7	Polymer(PVP) + Thiram	T_7	4ml/Kg + 2.5 g/Kg
8	Polymer(PVP) + Neem oil	T_8	4ml/Kg + 4 ml/Kg
9	Polymer(PEM)	T_9	4 ml/Kg
10	Polymer(PEM) + Thiram	T_{10}	4ml/Kg + 2.5 g/Kg
11	Polymer(PEM) + Neem oil	T_{11}	4ml/Kg + 4 ml/Kg

Table 2. Effect of seed enhancement treatments on germination (%) of fresh and old seed lots of chickpea.

	Treatments		T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	Mean
Lot	**Type**	**Variety**												
Fresh	Desi	Pusa 256	95	95	97	96	96	97	95	95	95	97	95	95.73
		Pusa2028	93	95	92	96	95	93	96	93	93	96	95	94.27
	Kabuli	Pusa 1053	92	93	91	96	93	92	95	93	94	95	93	93.36
		Pusa1108	91	93	92	95	95	93	96	95	92	95	94	93.73
		Mean	92.75	94.00	93.00	95.75	94.75	93.75	95.5	94.00	93.50	95.75	94.25	94.27
CD= (0.05) Varieties 1.07 Treatment 1.77 Interaction 3.53														
Old	Desi	Pusa 256	81	85	87	87	84	83	86	85	85	87	82	84.73
		Pusa2028	81	79	75	84	81	82	83	83	85	81	89	82.09
	Kabuli	Pusa 1053	65	67	67	65	62	60	57	56	58	59	56	61.09
		Pusa1108	58	61	60	63	62	58	61	57	58	58	60	59.64
		Mean	71.25	73.00	72.25	74.75	72.25	70.75	71.75	70.25	71.50	71.25	71.75	71.89
CD= (0.05) Varieties 0.71 Treatment 1.168 Interaction 2.34														

Field emergence: Analysis of variance for field emergence data generated for fresh and old seed lots revealed significant difference for varieties and treatments (Table 3). The interaction effect between varieties and treatments were significant only in old seed lots. In fresh seed lots, field emergence (92.45%) was quite high in both desi and kabuli types. However emergence was significantly high in desi type (93.41%) than in kabuli type (91.50%). In old seed lots, in contrast, desi varieties has quite high field emergence *i.e.* more than 78% but in kabuli type, there is significant reduction in field emergence in old seed lots with value 15.64% in Pusa1053 and 21-18% in Pusa 1108. The field emergence data for fresh seed lots revealed that all treatment has higher value than control. However, treatment with thiram and polymer (PVP or PEM) in combination with thiram and neemoil improve the emergence significantly.

Speed of Emergence: Speed of emergence data is revealed that interaction between varieties and treatments were significant only in old seed lots (Table 4). It is invariably high in fresh seed lots (9.43). However, the difference in old and fresh seed lots in speed of emergence was more pronounced in kabuli type varieties Pusa 1053 and Pusa 1108. In kabuli types speed of emergence was drastically reduced on aging. Treatment response of fresh seed lots was more toward thiram, neemoil and polymer (PVP) in combination with thiram. However, in old seed lots, only halopriming and polymer in combination with thiram improve the speed of emergence significantly over control. The correlation matrix indicated that field emergence was significantly correlated with germination percentage (r=0.48*) but there was no significant correlation observed with speed of emergence.

The above results showed the effect of seed enhancement treatments to improve the seed quality of chickpea. All eleven seed enhancement treatment showed enhancing impact on field performance of chickpea cultivar. Seed enhancement treatments influenced the

Table 3. Effect of enhancement treatment on field emergence (%) of fresh and old seed lots of chickpea.

Lot	Type	Vari-ety	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	Mean
Fresh	Desi	Pusa 256	91.00	95.00	94.00	94.00	94.00	93.00	95.00	93.00	92.00	95.00	94.00	93.64
		Pusa2028	91.00	94.00	91.00	96.00	93.00	91.00	95.00	92.00	92.00	96.00	94.00	93.64
	Ka-buli	Pusa 1053	87.00	90.00	89.00	95.00	88.00	91.00	95.00	90.00	92.00	94.00	92.00	91.18
		Pusa1108	89.00	91.00	90.00	94.00	93.00	89.00	94.00	95.00	90.00	93.00	92.00	91.82
CD= (0.05)	Varieties 1.320													
	Treatment 2.191													
	Interaction NS													
Old	Desi	Pusa 256	74.00	75.00	82.00	86.00	72.00	72.00	84.00	82.00	82.00	86.00	79.00	79.45
		Pusa2028	84.00	75.00	69.00	81.00	78.00	79.00	73.00	78.00	79.00	81.00	81.00	78.00
	Ka-buli	Pusa 1053	14.00	8.00	19.00	25.00	10.00	17.00	37.00	4.00	10.00	16.00	12.00	15.64
		Pusa1108	24.00	12.00	19.00	34.00	24.00	16.00	25.00	18.00	17.00	31.00	13.00	21.18
CD= (0.05)	Varieties 4.260													
	Treatment 7.078													
	Interaction 14.157													

Table 4. Effect of enhancement treatment on speed of emergence of fresh and old seed lots of chickpea.

Lot	Type	Variety	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	Mean
Fresh	Desi	Pusa 256	9.54	9.81	10.15	9.63	9.77	10.30	9.94	9.40	9.52	9.76	9.46	9.75
		Pusa2028	8.64	8.59	9.57	8.75	9.70	8.84	9.20	9.50	9.49	9.26	9.24	9.16
	Kabuli	Pusa 1053	9.06	9.65	8.35	9.92	9.63	9.51	9.58	8.82	9.62	9.59	9.40	9.38
		Pusa1108	9.64	7.57	9.54	9.98	9.66	9.07	10.14	9.65	9.27	9.40	9.74	9.42
CD= (0.05)	Varieties 0.304													
	Treatment NS													
	Interaction NS													
Old	Desi	Pusa 256	7.10	7.20	7.81	7.32	7.40	8.12	8.64	8.66	8.38	8.28	8.35	7.93
		Pusa2028	7.75	7.35	6.87	8.13	7.75	7.57	7.69	8.06	7.24	7.63	7.39	7.58
	Kabuli	Pusa 1053	1.21	0.77	6.86	2.06	1.20	1.51	3.53	0.47	1.37	1.45	1.05	1.95
		Pusa1108	1.21	1.19	1.75	3.12	2.24	1.60	2.17	1.67	1.77	2.74	1.27	1.88
CD= (0.05)	Varieties 0.420													
	Treatment 0.707													
	Interaction 1.415													

physiological and biochemical process in the seeds, and thereby contribute to greater vigor and improved crop stand. The highest improvement in germination and seedling vigor and emergence due to hydro-priming were observed in poor vigor seed lot of chickpea (Ghassemi-Golezani *et al.*, 2012). Usha and Dadlani (2014) showed the effect of pre-sowing treatments *i.e.* polymer coating polykote with fungicides thiram and Royalflo were most effective in enhancing the germination, seedling growth and field emergence in all the cultivars of soybean. The osmo-priming (–1.0 MPa for 2 days) and solid matrix priming(20°C for 24 hrs) can be successfully used to improve germination and field emergence of onion seeds (Singh *et al.*, 2014). The priming response was attributed mainly to rapid seedling establishment, with higher plant stand and earlier crop maturity allowing escape from end-of -season stresses in on-farm priming study in chickpea. Priming also reduced the incidence of stem and root diseases, and increased nodulation by native rhizobia (Musa *et al.*, 2001). The effect of osmotic priming on onion (Allium cepa L.) seedling emergence was evaluated in the field and in a controlled environment and showed that Seedlings from primed onion seed emerged 7% to 18% sooner than seedlings from unprimed seed in all field and laboratory experiments (Murry and Swensen, 1992). Such enhanced performance has also been reported in other crops (Musa *et al.*, 2001; Murry and Swensen, 1992; Pandey *et al.*, 2005; Usha and Dadlani, 2014; Singh *et al.*, 2014). Field emergence was varieties specific with desi types having more emergences largely because of high germination and more seedling length. On ageing not only reduced emergence but also slow in speed of emergence. Hence seed enhancement treatment plays important role in better plant establishment.

Conclusion

The poor crop establishment is one of the major bottlenecks for chickpea production. Seed enhancement treatments have maximized the probability of obtaining a good stand of healthy and vigorous plants that would be appropriate to improve the livelihood of resource-poor farmers. The present study revealed that varieties were diverse for various vigour parameters. In general, desi varieties showed higher germination and field emergence in both fresh as well as old seed lots in comparison to kabuli types. Field emergence and speed of emergence were significantly very low in old seed lots of Kabuli types. The seed treatment with thiram alone or in combination with polymer (PVP or PEM) had significant effect in enhancing germination and field emergence. It was also observed that old seed lots were more responsive to treatments than fresh seed lots and effect of priming treatments were specific to varieties. Thus, it was concluded that seeds treated either with thiram or in combination with hydrophilic polymers could be used for enhancing the planting value in chickpea.

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