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Presowing seed invigouration treatment for better crop stand establishment and seed yield in Bajra (*Pennisetum typhoides*) cv. CO 7

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Abstract: An experiment was conducted to ascertain the effect of pre-sowing seed invigouration treatment on both high and low vigour seeds of pearlmillet. The various treatments namely water hydration for 16 h and drying at room temperature below 25°C (T_1), cold hydration for 72 h at 10°C and surface drying (T_2), gibberellic acid hydration (50 ppm) for 16 h and surface drying at room temperature below 25°C (T_3), Osmo conditioning with PEG 6000 solution (-10 bars) at 15°C for 7 days (T_4), water hydration + dry dressing with thiram (0.25%) (T_5) and 2 per cent KH_2PO_4 hydration for 16 h at room temperature (T_6) were employed and tested for germination, seedling growth, crop stand establishment and seed yield. Among the seed lots tested, irrespective of the treatments, high vigour seed lot (S_1) registered higher germination per cent, seedling dry weight (mg 10 seedlings^{-1}), field stand per cent and number of plants/4m row and less number of days to 50% flowering compared to low vigour seed lot (S_2). Among the treatments, the seeds invigourated with 2% KH_2PO_4 for 16 h (T_6) improved the germination per cent and seedling dry weight followed by hydration with GA_3 at 50 ppm (T_3) for 16 h. The field stand per cent and number of plants per 4 m row was maximum in T_3 followed by T_6 and seed yield (kg ha^{-1}) was also maximum in T_6 followed by T_3 and T_5.

Key words : Bajra, Presowing seed invigouration, Crop stand establishment, Yield.

Introduction

Seeds are often exposed to changing and adverse environments in the soil for considerable long period from sowing until it completes its emergence. The period of imbibition is extremely sensitive to changes in the environment and slight and sudden changes appear to profoundly affect the seedling emergence (Dey and Mukherjee, 1988). Numerous efforts have been made to decrease the period between sowing and emergence of seed in order to have early germination or emergence by over coming the prolonged exposure of seeds to hostile environment to achieve better crop stand. Presowing hardening or imbibition and drying of seed is one of the methods, which result in modifying physiological and biochemical natue of seed so as to get the characters that are favourable for drought resistance (Henckel, 1964). Presowing hardening promotes early germination, production of vigorous seedlings and yield (Krishnasastry *et al.* 1969). Seed hardening (wetting and drying) appears to impart drought tolerance, with increased seed germination followed by better and early seedling emergence. Short term water hydration of seed before planting greatly benefits stand establishment but use of chemicals in soaking water like potassium or sodium phosphate would give additional advantage (Basu, 1994). Seeds treated with gibberellic acid results in improved germination, rapid emergence and vigorous seedlings (Sandhu and Akhtar Husain, 1961). The presowing seed invigouration treatments with inorganic minerals, growth regulators and osmoticant will be much useful in improving the productivity of crop plants under both garden

Table 1. Influence of presowing seed invigouration treatments on germination (%) of pearlmillet cv. CO 1

Seed lots/treatments	Seed lots		
	S_1 high (92%) germination	S_2 low (78%) germination	Mean
T_0) Untreated control	92.0 (73.7)	78.0 (62.0)	85.0 (67.8)
T_1) Hydration (16h) and drying at room temperature below 25°C	94.0 (75.9)	82.5 (65.4)	88.3 (70.6)
T_2) Cold hydration (72h) at 10°C and surface drying at room temperature below 25°C	92.0 (73.7)	80.0 (63.5)	91.3 (73.7)
T_3) Hydration with 50 ppm GA_3 (16h) and surface drying at room temperature below 25°C	96.0 (78.9)	86.5 (68.5)	91.3 (73.7)
T_4) Osmo conditioning in PEG 6000 (-10 bars) at 15°C for 7 days	93.5 (75.3)	82.0 (65.1)	87.8 (70.2)
T_5) as in T_1 followed by dry dressing with thiram @ 0.25%	95.5 (77.8)	84.0 (66.6)	89.8 (72.2)
T_6) 2% KH_2PO_4 hydration (16h) drying at room temperature below 25°C	97.0 (80.1)	88.0 (69.8)	92.5 (74.9)
Mean	94.3 (76.5)	83.0 (65.8)	88.6 (71.2)
	SEd	CD (P=0.05)	
S (Seed lot)	0.780	1.575	
T (Treatments)	1.459	2.947	
S at T	2.064	NS	

(Figures in parantheses indicate arcsine values)

and dryland situation. Therefore the present study is envisaged.

Materials and Methods

The bajra cv. CO 7 seeds having germination of 92 per cent (S_1, higher vigour seed lot) and 78 per cent germination (S_2, low vigour seed lot) were obtained and the laboratory study was conducted during June 2002. Seeds of both the seed lots were subjected to the following treatments *viz.* Hydration (16h) and drying at room temperature below 25°C (T_1); Cold hydration (72 h) at 10°C and surface drying (T_2); Hydration with 50 ppm GA_3 (16 h) and surface drying at room temperature below 25°C (T_3); Osmo conditioning in PEG 6000 solution (-10 bars) at 15°C for 7 days (T_4); As in (T_1) followed by dry dressing with thiram @ 0.25 per cent (T_5); 2% KH_2PO_4 hydration (16 h) and drying at room temperature (T_6) and Untreated control (T_0).

PEG(-10 bar) solution was prepared by dissolving 273 g of PEG crystals in one litre of water (Michel and Kaufmann, 1973). The seeds were primed in single layer between two filter papers moistened with 15 ml of PEG 6000 solution in transparent plastic boxes (140 x 130 x 150 mm) (Brocklehurst and Dearman, 1984). The treated seeds were subjected to laboratory germination test using roll towel method. The completely randomized design was adopted with four replications comprising 100 seeds/replication. The treated seeds were evaluated for seed quality characters *viz.* germination percentage, shoot and root length (cm) and

seedling dry weight (mg/10 seedlings) were recorded (ISTA, 1999).

The field study was also conducted during kharif (June-September) adopting split plot design with three replications. The seed lots *viz.* high vigour seed lot (92% germination) and low vigour seed lot (78% germination) were taken as main plot treatments. While the presowing seed treatments were adopted in subplot. The crop was sown in a plot size of 5 x 4 m (20 sq.m) with 45 x 20 cm spacing. The observations namely speed of emergence (index) was calculated (Baskin, 1969) as follows:

$$\text{Speed of emergence index} = \frac{n_1}{dn_1} + \frac{n_2}{dn_2} + \ldots\ldots\ldots + \frac{nx}{dnx}$$

where, n_1 and n_2 are the number of seeds emerged on first (dn_1) and final day (dnx

Final stand (%) and number of plant 4 m row were also recorded besides assessin the days to 50% flowering and seed yiel (kg/4m row and kg ha^{-1}).

Results and Discussion

Germination (%)

The germination per cent was significantl increased due to the status of seed lots. Irrespectiv of treatments, high vigour seed lot S_1 (94 recorded increased germination of 14 per cer over low vigour seed lot S_2 (83). Irrespectiv of seed lots, among the treatments, KH_2PO (95) and GA_3 @ 50 ppm (91) increased germinatio by 12 and 7 per cent respectively over cont (85). Similar result was obtained by Smai *et al.* 1997. The probable reason for hig

Table 2. Influence of presowing seed invigouration treatments on speed of emergence (index) o pearlmillet cv. CO 1

Seed lots/treatments	Seed lots		Mean
	S_1 high (92%) germination	S_2 low (78%) germination	
(T_0) Untreated control	27.9	22.9	25.4
(T_1) Hydration (16h) and drying at room temperature below 25°C	32.0	28.7	30.2
(T_2) Cold hydration (72h) at 10°C and surface drying at room temperature below 25°C	25.0	22.6	23.8
(T_3) Hydration with 50 ppm GA_3 (16h) and surface drying at room temperature below 25°C	33.4	29.9	31.7
(T_4) Osmo conditioning in PEG 6000 (-10 bars) at 15°C for 7 days	35.2	31.3	33.2
(T_5) as in T_1 followed by dry dressing with thiram @ 0.25%	32.3	29.3	30.8
(T_6) 2% KH_2PO_4 hydration (16h) drying at room temperature below 25°C	33.6	30.4	32.0
Mean	31.3	27.8	29.6
	SEd	CD (P=0.05)	
S (Seed lot)	0.754	3.245	
T (Treatments)	0.425	0.876	
S at T	0.937	NS	

Table 3. Influence of presowing seed invigouration treatments on seedling dry weight (mg/10 seedlings) pearlmillet cv. CO 1

Seed lots/treatments	Seed lots		Mean
	S_1 high (92%) germination	S_2 low (78%) germination	
T_0) Untreated control	74.5	69.0	71.8
T_1) Hydration (16h) and drying at room temperature below 25°C	79.5	73.0	76.3
T_2) Cold hydration (72h) at 10°C and surface drying at room temperature below 25°C	78.0	71.5	74.8
T_3) Hydration with 50 ppm GA_3 (16h) and surface drying at room temperature below 25°C	83.5	78.5	81.0
T_4) Osmo conditioning in PEG 6000 (-10 bars) at 15°C for 7 days	82.5	78.0	80.3
T_5) as in T_1 followed by dry dressing with thiram @ 0.25%	81.0	76.0	78.5
T_6) 2% KH_2PO_4 hydration (16h) drying at room temperature below 25°C	84.0	80.5	82.3
Mean	80.4	75.2	77.8
	SEd	CD (P=0.05)	
S (Seed lot)	1.180	2.382	
T (Treatments)	2.28	4.457	
S at T	3.122	NS	

germintion could be of greater hydration of colloids, higher viscosity and elasticity of protoplasm, increase in bound water content, lower water deficit and increased metabolic activity (Joseph and Nair, 1989). The enhanced germination in gibberellic acid hardened seeds may be attributed to a stimulation of hydrolytic enzyme activity/ synthesis known to be induced by gibberellic acid. In high vigour seed lot, seeds hardened with (S_1) KH_2PO_4 (97) improved the germination by 5.4 per cent over control (92). This was followed by GA_3 (96) hydration and hydration followed by dry dressing with thiram (96). Similar results were also reported for the low vigour seed lot (S_2) (Table 1; Fig. 1).

Speed of emergence (index)

Irrespective of presowing and invigouration treatments, high vigour seed lot S_1 (31.3) improved the speed of emergence by 12.6 per cent over low vigour seed lot S_2 (27.8). Among the treatments, osmo-conditioning of seeds in PEG 6000 solution (-10 bars) at 15°C for 7 days recorded the higher speed of emergence index followed by KH_2PO_4 (32.0) and GA_3 (31.7) hydration over untreated seeds (25.4). Similar trend was also observed within the seed lots due to presowing seed invigouration treatments (Table 2). The interaction between seed lots and treatment were not significant. The results are in accordance with the findings of Mandal *et al.* (2000). The improved speed of emergence in PEG 6000 hardened seeds is due to reduction of sensitivity of osmoconditioned seeds to adverse germination factors and which renders them capable of germinating faster under wide range of temperature and hypoxia. Osmo priming improved tolerance of seeds to low water potential

of the germination medium (Mauromicale and Cavallro, 1995). The more rapid germination of seeds primed with KH_2PO_4 solution may be explained by more advanced stage of germination process that may be related to higher water absorption rate. This is because of the accumulation of more K^+ ions in embryo and decreased osmotic potential facilitating the water absorption (Mauromicale and Cavallro, 1995). The shoot and root length also followed the similar trend as that of the germination (%).

The increased seedling growth observed in this treatment might be due to greater early vigour and higher percentage of germination of seeds that had reached autotropic stage well in advance than others (Nagaraj, 1996). Similar results were also observed for seedling dr weight (Table 3). The increase in dry weig might also be due to enhanced lipid utilizatic through glyoxalate cycle, a primitive pathwa leading to faster growth and development c seedlings to reach autotropic stage well in advanc of others and enabling them to produce relativel more quantity of drymatter (Kavitha, 2002

Field stand and days to 50% flowering

Higher vigour seed lot scheduled at S (93.6) increased the field stand by 7.5 pe cent over low vigour seed lot S_2 (87.1), irrespectiv of the treatments. Seeds hardened with GA (95.3) recorded the increased field stand b 11.7 per cent over untreated seeds among a other treatments. This was followed by th

Table 4. Influence of presowing seed treatments on field stand (1% and no. of plants/4 metre row) pearlmillet cv. CO 1

Seed lots/treatments	Seed lots		Mean
	S_1 high (92%) germination	S_2 low (78%) germination	
(T_0) Untreated control	90.0 (18.0)	81.7 (16.3)	85.8 (17.2)
(T_1) Hydration (16h) and drying at room temperature below 25°C	91.7 (18.3)	84.0 (17.3)	87.8 (17.8)
(T_2) Cold hydration (72h) at 10°C and surface drying at room temperature below 25°C	88.3 (17.7)	83.3 (16.7)	85.8 (17.2)
(T_3) Hydration with 50 ppm GA_3 (16h) and surface drying at room temperature below 25°C	98.3 (19.7)	93.3 (18.7)	95.8 (19.2)
(T_4) Osmo conditioning in PEG (-10 bars) at 15°C for 7 days	96.7 (19.3)	90.0 (18.0)	93.3 (18.7)
(T_5) as in T_1 followed by dry dressing with thiram @ 0.25%	93.0 (18.7)	86.7 (17.3)	89.3 (18.0)
(T_6) 2% KH_2PO_4 hydration (16h) drying at room temperature below 25°C	97.0 (19.3)	91.0 (18.3)	94.0 (18.8)
Mean	93.6 (18.7)	87.1 (17.5)	90.4 (18.1)
	SEd	CD (P=0.05)	
S (Seed lot)	1.164	5.006	
T (Treatments)	2.177	4.494	
S at T	3.079	NS	

(Figures in parantheses indicate arcsine values)

able 5. Influence of presowing seed invigouration treatments on number of days to 50% flowering in pearlmillet cv. CO 1

Seed lots/treatments	Seed lots		Mean
	S_1 high (92%) germination	S_2 low (78%) germination	
T_0) Untreated control	65.0	68.0	66.4
T_1) Hydration (16h) and drying at oom temperature below 25°C	63.0	67.0	65.0
T_2) Cold hydration (72h) at 10°C and urface drying at room temperature below 25°C	65.0	69.0	67.0
T_3) Hydration with 50 ppm GA_3 16h) and surface drying at room emperature below 25°C	59.0	64.0	61.5
T_4) Osmo conditioning in PEG -10 bars) at 15°C for 7 days	60.0	65.3	62.7
T_5) as in T_1 followed by dry ressing with thiram @ 0.25%	62.0	65.0	63.5
T_6) 2% KH_2PO_4 hydration (16h) rying at room temperature below 25°C	59.3	63.0	61.2
Mean	61.9	65.9	63.9
	SEd	CD (P=0.05)	
S (Seed lot)	0.297	1.279	
T (Treatments)	3.200	NS	
S at T	4.202	NS	
	4.527	NS	

(Figures in parantheses indicate arcsine values)

seeds hardened with KH_2PO_4 and osmoconditioned with PEG 6000 (Table 4). The increase in field stand may be due to higher mitochondrial activity, rapid embryo enlargement and improved germination, growth and establishment (Kavitha, 2002).

Irrespective of the presowing seed invigouration treatments, high vigour seed lot S_2 (61.9) significantly reduced the number of days to 50% flowering over low vigour seed lot S_2 (65.9). The reduction in number of days to 50% flowering due to seed lot was four days. Among the treatments seed hardened wth KH_2PO_4 (61.2) followed by GA_3 (61.5) and osmoconditioned with PEG 6000 (62.7) recorded the less number of days to 50% flowering over control (66.5) (Table 5). The early field emergence and better crop stand establishment in these treatments could have been attributed to the early initiation of the flowering. Early flowering due to seed impregnation with various chemicals have been reported by Kavitha (2002).

Seed yield

Significantly maximum seed yield (g/4 m row) was obtained in high vigour seed lot S_1 (529) over low vigour seed lot S_2 (501). Among the seed invigouration treatments, KH_2PO_4 (590) recorded higher seed yield g/4m row followed by GA_3 (585) and thiram (531) over the control (461). Within the seed lots also similar trend was observed due to presowing seed invigouration treatments. The interaction

Fig.1. Effect of presowing seed invigouration treatments on germination of pearlmillet cv. CO 7

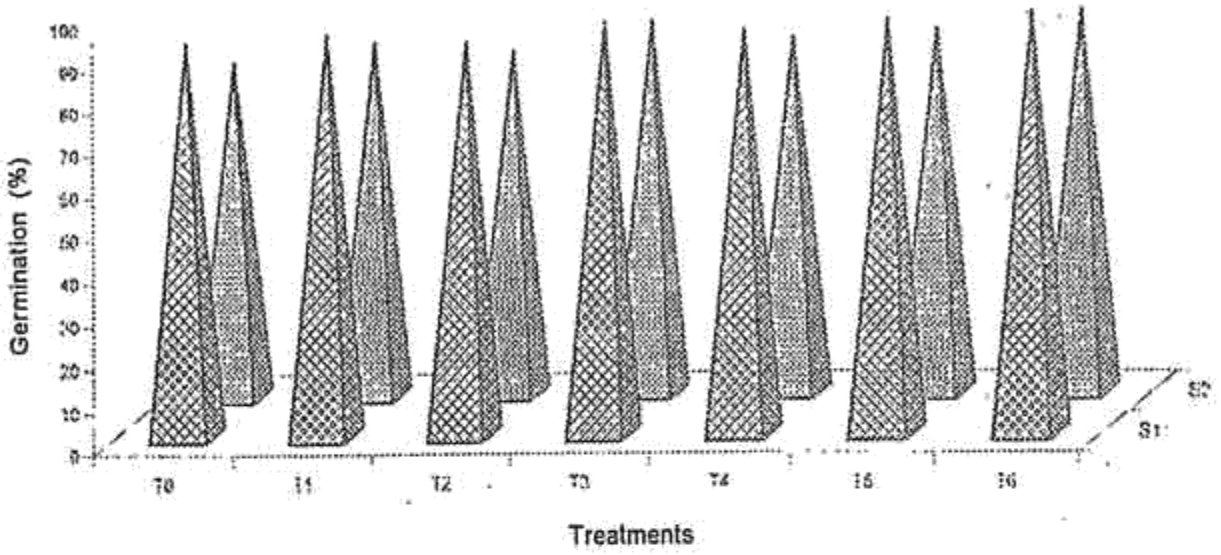
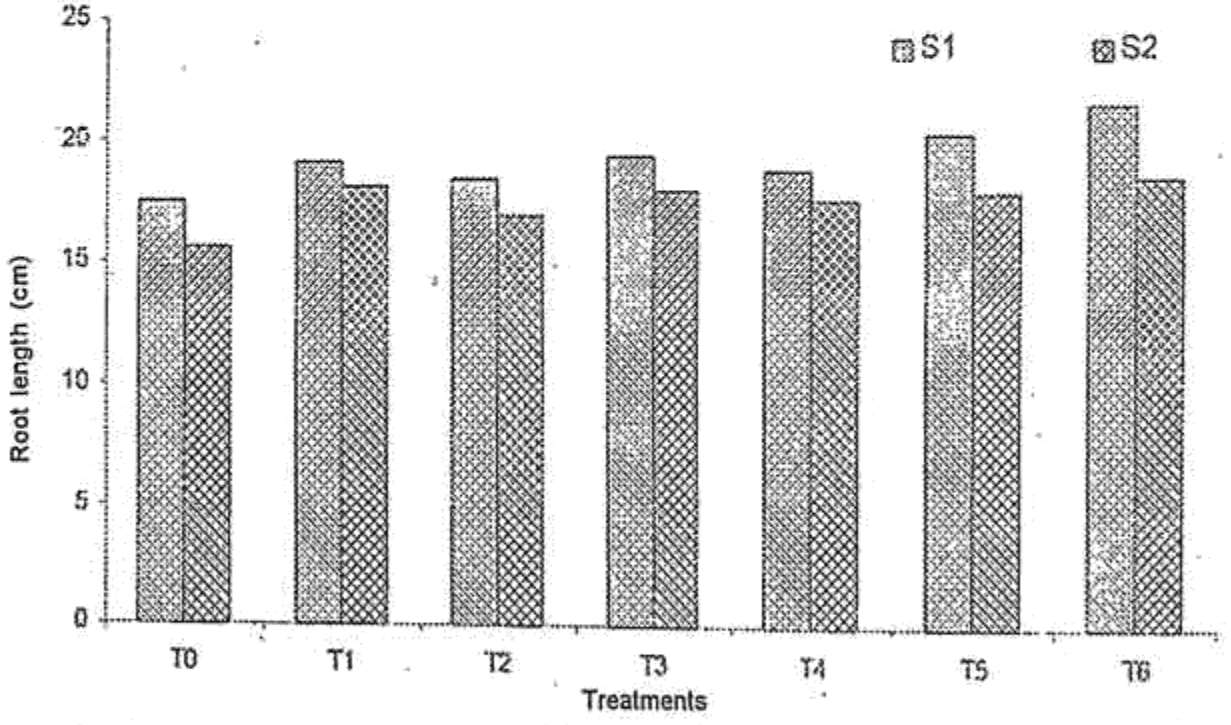


Fig.2. Influence of presowing seed invigouration treatments on root length (cm) of pearlmillet cv. CO 7



influenced the seed yield g/4m row significantly (Table 6). Similar trend of results was also obtained for seed yield kg ha^{-1} (Table 7; Fig. 2). This results are in accordance with the findings obtained by Maitra *et al.* (1999). The increased yield might be due to the higher physico-chemical triggering the biosynthesis of nucleic acids, proteins and the consequential enhancement of cell division besides the enhanced metabolic activity of the plants resulting on the increased uptake of nutrients. This could have possibly accounted for improvement in crop performance (Kavitha, 2002). Presowing seed hardening enables the plant to resist soil moisture stress more efficiently causing rapid embryo enlargement, improving seedling vigour and effecting the productivity of crops (Chatterjee *et al.* 1985).

Table 6. Influence of presowing seed invigouration treatments on seed yield (g/4m row) of pearlmillet cv. CO 1

Seed lots/treatments	Seed lots		Mean
	S_1 high (92%) germination	S_2 low (78%) germination	
(T_0) Untreated control	470	452	461
(T_1) Hydration (16h) and drying at room temperature below 25°C	478	454	466
(T_2) Cold hydration (72h) at 10°C and surface drying at room temperature below 25°C	469	433	451
(T_3) Hydration with 50 ppm GA_3 (16h) and surface drying at room temperature below 25°C	620	551	585
(T_4) Osmo conditioning in PEG (-10 bars) at 15°C for 7 days	522	520	521
(T_5) as in T_1 followed by dry dressing with thiram @ 0.25%	528	534	531
(T_6) 2% KH_2PO_4 hydration (16h) drying at room temperature below 25°C	616	564	590
Mean	529	501.1	515.1
	SEd	CD (P=0.05)	
S (Seed lot)	0.595	2.559	
T (Treatments)	3.328	6.869	
S at T	4.393	9.257	

(Figures in parantheses indicate arcsine values)

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Table 7. Influence of presowing seed invigouration treatments on seed yield (kg ha-1) of pearlmillet cv. CO 1

Seed lots/treatments	Seed lots		Mean
	S_1 high (92%) germination	S_2 low (78%) germination	
(T_0) Untreated control	2385	2485	2535
(T_1) Hydration (16h) and drying at room temperature below 25°C	2535	2535	2535
(T_2) Cold hydration (72h) at 10°C and surface drying at room temperature below 25°C	2605	2420	2512
(T_3) Hydration with 50 ppm GA_3 (16h) and surface drying at room temperature below 25°C	3420	3050	3235
(T_4) Osmo conditioning in PEG (-10 bars) at 15°C for 7 days	2830	2915	2897.5
(T_5) as in T_1 followed by dry dressing with thiram @ 0.25%	2910	2970	2940
(T_6) 2% KH_2PO_4 hydration (16h) drying at room temperature below 25°C	3400	3115	3257.50
Mean	2905	2784.28	
	SEd	CD (P=0.05)	
S (Seed lot)	3.0210	6.5825	
T (Treatments)	1.48690	3.1894	
S at T	4.1087	8.8845	

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