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Full Research Article

Effect of Seed Priming on Yield and Biochemical Characteristic of Wheat in Sodic Soil of Eastern Uttar Pradesh

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Abstract

Field experiments were conducted at Main Experimental Station, N.D. University of Agriculture and Technology, Kumarganj, Faizabad to evaluate the effect of pre-sowing treatments on yield and biochemical characteristic of Wheat in Sodic Soil. Seed priming is a low risk technology to improve poor crop establishment. It improves seed germination, emergence and seedling growth by altering seed vigor, dormancy and the physiological state of the seed. It improves germination by repairing damaged proteins, RNA and DNA of low vigor and aged seeds that may accumulate during seed development. Germination percentage (%) was observed higher in the seeds primed chemical and plant growth regulators (PGRs). Maximum germination percentage (%) was observed in the treatment halo priming with 3% KNO_3 (93%) while minimum in non primed control treatment (78%). Seed priming enhanced the yield and yield components (no. of spikes m^{-2}, no. of grains plant^{-1}, 1000 seed weight and grain yield q ha^{-1}). The maximum increase in all the yield contributing traits were observed with KNO_3 (3%) followed by Salicylic acid (100 ppm), KNO_3 (1%) and salicylic acid (50 ppm) as compared to control. Seed priming treatments significantly affected dry biomass plant^{-1}. Maximum dry biomass plant^{-1} was recorded with KNO_3 (3%) followed by salicylic acid (100 ppm), and 1% KNO_3. It was concluded that seed priming with 3% aqueous solution of KNO_3 is the effective seed priming technique to improve growth and yield of wheat under sodic soil condition.

1. Introduction

Wheat (*Triticum* spp.) belongs to the genus *Triticum* of the Poaceae family originally from the Levant region of the Near East and Ethiopian Highlands, but now cultivated worldwide. The three species of wheat namely, *Triticum aestivum* (bread wheat), *Triticum durum* (macaroni wheat) and *Triticum dicoccum* (Emmer or Khapli wheat) commercial grown in the Indian subcontinent with share of 95%, 4% and 1% in production respectively. Wheat is one the major cereal crop of India and in respect of area it occupies first rank and in production its second rank after China. Wheat is grown in India on an area of about 31.18 mha with annual production of 95.91 mt. The average wheat productivity of the country was 3.1 t ha^{-1} (2013−14). Analysis of area, production and productivity of wheat during the last decade (1999−2000 to 2013−14) indicated that the major wheat producing states that achieved the average productivity of 3 t ha^{-1} and above are Uttar Pradesh (98.56 lakh ha), Punjab (35 lakh ha), Haryana (25.22 lakh ha), Rajasthan (3.080 mha. Agricultural crops are facing various types of biotic and abiotic stresses. Among the abiotic stresses, soil salinity adversely affected the crop production (Hamid et al., 2008; Shafi et al., 2011). Salts may affect plant growth negatively by causing injury to the growing cells and reducing the amount of water reaching the growing region and photosynthates (Mass and Nieman, 1978). Salt stress induces water stress by decreasing the osmotic potential of the soil solutes and thus making it very difficult for roots to extract the required water from its surrounding media. The effects of higher salt stress on plants can be observed in terms of decreased productivity or plant death (Parida and Das, 2004). Plant response to salt stress is very complex and depends upon the duration of salinity, developmental stage of plant at salt exposure, type of salt and many other factors. At higher level of salinity the cultivation of salinity cultivation of crops was uneconomical due to poor yield. About 20% of the world's cultivated area and nearly half of the world's irrigated lands are affected by salinity. Processes such as seed germination, seedling growth and vigour, vegetative growth, flowering and fruit set are adversely affected by high salt concentration. Esfandiari et al. (2007) reported that seed germination and seedling growth of wheat (*Triticum aestivum* L.) was negatively affected by salt stress. Seed characteristics are usually essential process in seedling establishment and plant development to obtain seedling numbers those results in higher seed crop (Almansouri et al., 2001; Murungu et al., 2003). Seed germination and establishment are the most sensitive stages to abiotic stresses (Patade et al., 2011; Ansari et al., 2012). High productivity in saline environment can be achieved through breeding of salinity tolerant crops, but success for salinity tolerant crops through breeding is limited. Crops tolerance to salinity is controlled by many genes, and their simultaneous selection is very difficult (Flowers et al., 2000). Numerous techniques have been developed to invigorate the seeds for better stand establishment and higher yield under normal as well as stressful environment (Basra et al., 2005; Afzal et al., 2008; Farooq et al., 2008; Hussain et al., 2013; Moghadam and Mohammadi, 2013; Kyrychenko, 2014). Seed priming is one of them, a low risk technology (Harris et al., 1999) and low cost solution for poor stand establishment (Farooq et al., 2006). It improves seed germination, emergence and seedling growth by altering seed vigor, dormancy and the physiological state of the seed i.e. (Black and Peter, 2006). Seed priming improves germination by repairing damaged proteins, RNA and DNA of low vigor and aged seeds that may accumulate during seed development (Bray, 1995; McDonald, 2000; Netondoet et al., 2004). Globulins and Cruciferin (proteins) are identified only during priming and not during seed. Also, Ansari and Sharif-Zadeh, (2012) reported that priming by salicylic acid and gibberellins have been used to increase germination characteristics in rye seeds.

In view of these observations a field experiment was conducted to evaluate the effect of pre-sowing treatments on yield and biochemical characteristic of Wheat in Sodic Soil of Eastern Uttar Pradesh.

2. Materials and Methods

Field experiments were conducted during the *rabi* 2013 and 2014 at Main Experimental Station, N.D. University of Agriculture and Technology, Kumarganj, Faizabad to evaluate the effect of pre-sowing treatments on yield and biochemical characteristic of Wheat in Sodic Soil. The experimental site is located at 24°47′ N latitude, 82°12′ E Longitude and 113 m altitude amsl. The soil of the experimental site was gangetic alluvium with silty sandy loam in texture. The pH of the soil is alkaline (9.7) with low organic carbon (0.38%). The chemical examination of the soil revealed that it contains available Nitrogen 203 kg ha^{-1}, phosphorus (P_2O_5) 27.0 kg ha^{-1} and available potassium (K_2O) 234 kg ha^{-1}. The experiment was laid out in randomized complete block design (RCBD) with three replications. The wheat variety NDW 1014 was used as test variety. The experiment was comprised of the eight treatment viz. T_1-1% KNO_3, T_2-3% KNO_3, T_3-1.0 m w GA_3, T_4-1.5 m mole GA_3, T_5-50 ppm Salcylic acid, T_6-100 ppm Salcylic acid, T_7-Hydropriming and T_8- Control (No priming). Solutions of desired strength of plant growth regulators (PGRs) and chemicals were prepared by dissolving required quantity in distilled water. The healthy seeds of wheat variety NDW 1014 were primed in the solutions of PGRs/chemicals as per the treatment for 12 hours before sowing. For hydropriming treatment, seeds were soaked in distilled water. Non primed seeds were taken as untreated control. The seeds were dried in shade for 2 hours and sowing was done with the help of chisel in the last week of November at a row spacing of 20 cm at depth of 4–5 cm. After 15 days of sowing, thinning was done to maintain plant population and provide required spacing for proper plant growth. The crop received full dose of P_2O_5 (60 kg ha^{-1}) and K_2O (50 kg ha^{-1}) and N (60 kg ha^{-1}) as basal and remaining half nitrogen (60 kg ha^{-}) was applied in equal doses, half at tillering and rest half at flowering stage. The sources of nutrient were urea, single super phosphate and muriate of potash for N, P and K, respectively. Standard package of practices were adopted to raise the crop. About 30 uniform plants of same vigour were selected as well as tagged in each plot. Observations on various agro morphological traits were recorded at 30, 60 and 90 days after sowing of seeds. Plants were oven dried at 80 °C for 24 hours and dry weight was taken at each stages of observation. Chlorophyll content was estimated according to the method of Arnon (1949) and expressed as mg g^{-1} fresh weight of leaves. Total soluble sugar (mg g^{-1}) was determined as per the method given by Yemn and Wills (1954) using Anthrone reagent. The statistical analysis of experimental data was done by method described by Fisher and Yates (1949) using Randomized block. Seed germination was recorded upto 15 days after sowing. Germination percentage was calculated using the following formula,

$$\text{Germination (\%)} = \frac{\text{No. of seeds Germinated}}{\text{Total number of seeds}} \times 100$$

3. Results and Discussion

Seed priming had significant positive effect on seed germination, growth and biochemical parameters. Data presented in table-revealed that germination percentage (%)

was observed slightly higher in seeds primed with distilled water, KNO_3, GA_3 and Salicylic acid (SA) than non primed (control). The highest germination percentage (%) was observed in the treatment halo priming with 3% KNO_3 (93%) while minimum in non primed control treatment (78%). Farooq et al. (2006) reported that hydropriming break down seed dormancy by the activation of hydrolytic enzymes like α- amylase. This increase in germination may also be due to the activity of α-amylase due to osmopriming. Amylases are key enzymes that play a vital role in hydrolyzing the seed starch reserve, thereby supplying sugars to the developing embryo. The improved germination of primed seeds was attributed to enhanced counteraction of free radicals and re-synthesis of membrane bound enzymes compared to unprimed seeds (Srinivasan and Saxena 2001). Similar findings were also reported by Ghobadi et al. (2012); Lemrasky et al. (2012) and Abbasdokht (2011) in wheat. In many crop species, seed germination and early seedling growth are the most sensitive stages to salinity stress (Akazawa et al., 1990). Seed priming treatments improved chlorophyll content in leaf at all crop growth stages than the control. In general chrophyll content in leaf increased upto 60 DAS. Maximum chlorophyll content was recorded with seed priming with 3% KNO_3 (1.70 mg g^{-1}) followed by seed priming with 100 ppm Salicylic acid (1.68 mg g^{-1}) at 60 DAS (Table 1). Chlorophyllase enzyme which is responsible for chlorophyll degradation, might have been inhibited by priming treatment. Similar results were also reported by Wasif and Mohammd (2012) in *moringa oleifera,* Azooz (2009) in sorghum, Hamid et al. (2008) in wheat and EI-Tayed (2005) in barley. Effect of seed priming with plant growth regulator (PGR) and inorganic salts on carbohydrate content was also studied. Data presented in Table 1 clearly shows that seed priming significantly enhanced the carbohydrate content. The maximum carbohydrate content was found in seed priming with 3% KNO_3 (128.67, 323.33 and 220.21 mg g^{-1} dry weight) followed by seed priming with 100 ppm salicylic acid over other seed priming treatments. In general, plant height increases with the increase of plant age. Seed priming significantly enhanced the plant height in wheat varieties. Maximum plant height was recorded with 1.0 m mole GA_3 followed by 3% KNO_3 and 100 ppm salicylic acid. However the minimum plant height was recorded in case of hydropriming. The increase in plant height might be due to stimulation of cell elongation, cell division and enlargement as reported by Tolbert (1974). These findings are in accordance with the results reported by Ghobadi et al. (2012).

Seed priming treatments significantly affected dry biomass $plant^{-1}$. Maximum dry biomass $plant^{-1}$ was recorded with KNO_3 (3%) followed by Salicylic acid (100 ppm), and 1% KNO_3 (Table 1). The increase in plant biomass due seed priming may be attributed to increase photosynthetic efficiency of the leaves. The results are in agreement with

Table 1: Effect of seed priming on germination (%), plant height (cm) and biochemical properties of wheat under sodic soil condition (Pooled data)

Sl. No.	Treatments	Germination (%)	Plant Height (cm)			Chlorophyll content (mg g^{-1} fresh wt.)			Carbohydrate (mg g^{-1} dry weight)			Dry Biomass $plant^{-1}$ (g)		
			30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
1.	1% KNO_3	89	22.25	61.34	76.15	1.66	3.16	1.76	124.24	321.09	216.24	0.21	1.83	27.81
2.	3% KNO_3	93	23.83	63.65	77.09	1.70	3.23	1.79	128.67	323.33	220.21	0.24	1.90	30.69
3.	1.0 m mole GA_3	85	24.14	64.52	79.43	1.59	3.00	1.69	117.12	308.98	207.78	0.17	1.55	23.85
4.	1.5 m mole GA_3	87	25.11	65.40	80.15	1.60	3.04	1.71	119.33	309.78	210.91	0.19	1.61	24.82
5.	50 ppm Salicylic acid	83	21.59	61.26	71.70	1.64	3.11	1.75	122.89	319.51	214.54	0.20	1.80	26.72
6.	100 ppm Salicylic acid	82	22.10	62.60	72.76	1.68	3.17	1.77	126.17	322.94	217.34	0.22	1.86	29.52
7.	Hydro priming	80	20.01	54.60	67.66	1.58	2.93	1.67	114.04	234.96	187.53	0.16	1.49	27.81
8.	Non Priming (Control)	78	17.30	52.43	64.51	1.56	2.85	1.60	108.37	232.57	184.86	0.15	1.48	30.69
	SEm±	1.77	0.62	0.43	1.41	0.01	0.04	0.01	1.84	0.99	1.30	0.01	0.01	0.82
	CD (p=0.05)	5.36	1.88	1.30	4.28	0.04	0.13	0.03	5.59	3.00	3.96	0.03	0.04	2.47

the earlier findings Abnavi and Ghbadi (2012), Ghobadi et al. (2012) and Hamid et al. (2008).

Result presented in Table 2. shows that priming with chemicals and plant growth regulators had proved significant effect on yield and yield components. Seed priming enhanced the yield and yield components (No. of spike m^{-2}, No. of grains $plant^{-1}$, 1000 seed weight and grain yield q ha^{-1}). High accumulation of sodium in plant under saline soil leads to high pollen in fertility which results in increased sterility percentage. Yield is a summation of all metabolic processes and growth events during life cycle of a crop plants and any abiotic or biotic stress during their growth and development influence the potential productivity of crop yield. Plants grown under saline soil have chlorotic leaves which reduce their capacity of fix CO_2 as a result total biomass is affected. As we know total biomass is important character of maintain the grain yield under saline condition, poor translocation of metabolites to the reproductive sink may be also are of the reason for lower yield. The maximum increase in all the yield components were observed with KNO_3 (3%) followed by Salicylic acid (100 ppm), KNO_3 (1%) and salicylic acid (50 ppm) as compared to control (Table 2). Similar findings are also reported by Farooq et al. (2008), Yari et al. (2011); Amin et al. (2012).

Table 2: Effect of seed priming on phenology of wheat under sodic soil condition (Pooled data)

Sl. No.	Treatments	Days to 50% flowering	No. of Spike m^{-2}	No of grains $plant^{-1}$	1000 seed weight (g)	Grain yield (q ha^{-1})	Harvest index
1.	1% KNO_3	72	311.60	136.39	38.97	31.10	32.65
2.	3% KNO_3	74	313.60	138.23	40.11	33.12	33.77
3.	1.0 m mole GA_3	71	308.30	131.54	37.95	26.25	33.40
4.	1.5 m mole GA_3	71	309.22	132.25	38.18	28.24	32.47
5.	50 ppm Salicylic acid	72	310.31	136.18	38.50	30.25	32.55
6.	100 ppm Salicylic acid	73	312.26	137.00	39.17	32.54	33.50
7.	Hydro priming	70	285.23	130.95	37.10	24.23	32.21
8.	Non Priming (Control)	70	280.19	128.21	36.30	23.29	32.12
	SEm±	0.85	1.45	1.44	1.22	1.32	NS
	CD (p=0.05)	1.58	4.39	4.38	3.66	7.54	NS

4. Conclusion

Seed priming with chemicals, plant growth regulator (PGRs) and hydropriming improved the physiological efficiency of crop and resulted in better growth and yield. Seed priming with 3% Aqueous solution KNO_3 is the effective seed priming technique to improve growth and yield of wheat crop under sodic soil condition.

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