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Research Articles

Seed priming with growth regulators ameliorates salt stress in wheat (*Triticum aestivum)*

T N TIWARI[1], DIPTI KAMAL[2] and S RAJENDRA PRASAD[3]

ICAR–Indian institute of Seed Science, Kushmaur, Mau, Uttar Pradesh 275 103

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ABSTRACT

Field experiment was conducted for three consecutive years (2008-09 to 2010-11) to study the effect of seed priming with IBA, GA_3, kinetin and salicylic acid separately on germination, growth and yield of wheat (*Triticum aestivum* L.) under salt-affected soils at Directorate of Seed Research, Mau. Seeds primed @100 ppm with IBA, GA_3, kinetin and salicylic acid separately for 12 hr significantly enhanced the seed germination (18-26%), seedling dry weight (25-72%), vigour index (32-116%), plant height (4-8.4%), number of tillers (2-14.6%), total dry matter (3-11%), number of grains (13-18%) and finally test weight (5.3-6.1%) and grain yield (2-14%) over unprimed control in variety HUW 234. Among the treatments, kinetin showed maximum values as well as percent improvement over control in almost all the characters studied followed by GA_3, IBA and salicylic acid. Improvement observed through seed priming indirectly reflects role of growth regulators in amelioration of salt stress.

Key word: Plant Growth Regulator, Salt stress, Seed Priming, Wheat

Salt stress is one of the most serious environmental factors limiting the productivity of crop plants (Ashraf 1999). Salt concentration completely inhibits germination at higher levels or induces a state of dormancy at low levels, it also reduces imbibitions of water because of lowered osmotic potentials of the medium and causes changes in metabolic activity (Rafiq *et al.* 2006, Tiwari *et al.* 2014). For the maintenance of high yield of crops under salt stressed conditions, various research tools are being tried to counteract the effects of salinity and alkalinity. Seed priming treatments are simply applied practices that can reduce the effects of salts with small inputs of capital and energy. Pre-soaking seeds with optimal concentration of phyto-hormones was shown to be beneficial for growth and yield of some crop species under saline conditions by increasing nutrient reserves through increased physiological activities and root proliferation (Singh and Dara 1971). Typical responses to priming are faster and closer spread of times to emergence over all seedbed environments and wider temperature range of emergence, leading to better crop stands, and hence improved yield and harvest quality, especially under sub-optimal and stress growing conditions in field (Halmer 2004). Seeds performance of various crops can be improved by inclusion of plant growth regulators during priming and other pre-sowing treatments (Lee *et al.* 1998). Hormone like salicylic acid has also been found beneficial for alleviating salinity stress in wheat (Afzal *et al.* 2005). The beneficial effects of seed priming with different priming agents have already been reported in many crop plants, for instance mustard (Srivastava *et al*. 2010), chickpea (Harris *et al.* 2008)), maize (Nawaz and Ashraf 2010), sunflower (Kaya *et al.* 2006), wheat (Iqbal and Ashraf 2007, Perveen *et al*. 2010), cotton (Casenave and Toselli 2007), rice (Tiwari *et al*. 2015), sugarcane (Patade *et al.* 2009), mungbean (Tiwari *et al.* 2013) and pigeonpea (Tiwari *et al.* 2014) . Therefore, the present study was aimed to explore the possibility of using various plant growth regulators as priming agent for improving germination, early stand establishment and growth in wheat seedlings and finally grain yield of wheat (*Triticum aestivum* L.) under salt-stress conditions.

MATERIALS AND METHODS

Field experiment was conducted for three consecutive years (2008-09 to 2010-11) during *rabi* season at the research farm of Directorate of Seed Research, Kushmaur, Mau, UP. Experimental fields were sodic/alkaline in nature having pH range of 8.8 to 9.2 and ESP ranged between 17 to 21% and soil was dominated with bicarbonate ion of sodium showing white powdery appearance. The seed material of wheat variety HUW-234 were obtained from Seed production and Processing Unit of Directorate of Seed Research and were initially surface sterilized with 0.2% $HgCl_2$. After surface sterilization and thoroughly washing of seeds, they were primed (w/2v) with 100 ppm concentration of various growth regulators, viz. Indol-butyric acid (T_1), Giberallic acid (T_2),

[1] Senior Scientist (e mail: tntdsr@gmail.com), [2] Research Scholar (e mail: dipti.lotus@gmail.com), [3] Project Director (e mail: pddsrmau@gmail.com).

Kinetin (T_3), Salicylic acid (T_4) separately for the period of 12 hr and one unprimed set of seed lots were kept as control (T_0). At the completion of priming period the seeds were taken out from PGR solutions and allowed for shade drying. The primed seeds were sown in field using factorial RBD in 3 replications and recommended doses of NPK (120:60:40) were applied. In the laboratory, observations on seed quality parameters including germination, seedling dry weight and vigour index were recorded as per the ISTA rules (Anon. 1999) and method suggested by Abdul-baki and Anderson (1973). Field trial was carried out to verify further efficacy of the treatment and for studying the effect of treatment on growth parameters and yield attributes. Number of tillers was recorded manually and carefully at 60 DAS (days after sowing). At the harvesting total biological yield, test weight and grain yield were observed. The experimental data were pooled and statistically analyzed following the method suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSIONS

Wheat seeds primed with various growth regulators responded well towards the seed priming treatments over unprimed control. Among the treatments, seed primed with kinetin showed maximum enhancement in seed quality parameters followed by GA_3, IBA and salicylic acid.

Seed quality parameters

Seeds treated with kinetin enhanced the maximum germination from 70.67 to 89.07% with a per cent increase of 26.03, seedling dry weight from 0.43 to 0.74gm with a per cent increase of 72.09 and ultimately the vigour from 30.40 to 65.65 with a per cent increase of 115.95, respectively over control (Table 1 and Fig. 1). The beneficial effects of seed priming with different priming agents have already

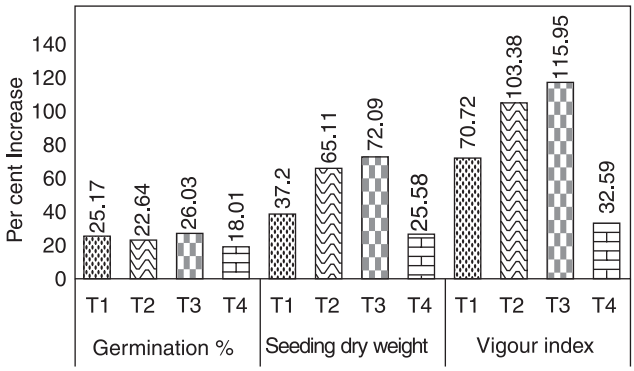

Fig 1 Per cent increase in seed quality parameters

been reported in many crop plants including wheat by Iqbal and Ashraf (2007) and Perveen *et al*. (2010). The increase in germination and seed quality parameters in primed seeds with growth regulators under salt affected soil may be due to enhanced oxygen uptake, increased alpha amylase activity and the efficiency of mobilizing nutrients from the cotyledons to the embryonic axis (Karthiresan *et al.* 1984). Greater membrane integrity in primed seed was also reported for the enhanced germinibility in egg plant and radish by Rudrapal and Naukamura (1998) and in hybrid maize by Afzal *et al.* (2002). Better performance of seedlings treated with kinetin and GA_3 might be due to increased invertase and starch synthetase level in wheat (Sekhon and Singh1994) and our results are very similar in term s of improvement in seedling dry weight by priming treatments with the findings of Patel and Saxena (1994). Growth attributes including plant height, tillers/r. m and total dry matter production/plot were also influenced by seed priming treatments and maximum values were recorded in seeds primed with kinetin followed by GA_3, IBA and salicylic acid in 100 ppm

Table 1 Response of plant growth regulators priming on seed quality parameters.

	Germination per centage				Seedling dry weight (g)			
Treatment	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean
T_0-Control	72.00	70.00	70.00	70.67	0.45	0.42	0.42	0.43
T_1-IBA-100 ppm	88.60	88.40	88.46	88.46	0.60	0.58	0.58	0.59
T_2-GA_3 100 ppm	88.00	86.00	86.00	86.67	0.72	0.71	0.71	0.71
T_3-Kinetin-100 ppm	96.00	85.60	85.60	89.07	0.75	0.73	0.73	0.74
T_4-Salicylic acid-100 ppm	86.60	81.80	81.80	83.40	0.58	0.52	0.52	0.54
Mean	86.24	82.36	82.36		0.62	0.592	0.592	
	SE±	CD (.05)	CV%		SE±	CD (.05)	CV%	
	2.4876	5.5427	3.64		0.0091	0.0209	1.85	

Vigour index (Germination % × Dry weight)

	2008-09	*2009-10*	*2010-11*	*Mean*
T_0-Control	32.40	29.40	29.40	30.40
T_1-IBA-100 ppm	53.16	51.27	51.27	51.90
T_2-GA_3 100 ppm	63.36	61.06	61.06	61.83
T_3-Kinetin-100 ppm	72.00	62.48	62.48	65.65
T_4-Salicylic acid-100 ppm	50.22	42.54	42.54	45.10
Mean	54.228	49.35	49.35	

Table 2 Response of plant growth regulators priming on growth characters

Treatments	Plant height (cm)				Tiller/running m.				Total dry matter/plot (kg.)			
	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean
T_0-Control	92.37	88.80	88.80	89.99	80.70	80.20	80.20	80.37	19.18	18.80	18.80	18.93
T_1-IBA-100 ppm	95.20	94.80	94.80	94.93	90.55	88.22	88.22	89.00	19.73	19.60	19.60	19.64
T_2-GA_3 100 ppm	97.5	97.10	97.10	97.23	90.55	88.55	88.55	89.22	20.03	20.00	20.00	20.01
T_3-Kinetin-100 ppm	97.80	97.90	96.90	97.53	91.22	92.55	92.55	92.11	21.26	20.96	20.96	21.06
T_4-Salicylic acid-100 ppm	95.40	92.40	92.40	93.40	83.25	82.22	82.22	82.56	19.97	19.26	19.26	19.50
Mean	95.65	94.20	94.00		87.25	86.35	86.35		20.03	19.72	19.72	
	SE±	CD (P=0.05)	CV%		SE±	CD (P=0.05)	CV%		SE±	CD (P=0.05)	CV%	
	1.0105	2.2515	1.31		0.6833	1.5757	0.97		0.1238	0.2854	0.76	

concentration over unprimed control (Table 2). The enhancement in plant height was 8.37%, in tiller/running m 14.6% and in total dry matter 11.25% over unprimed control by kinetin. Among growth regulators, the performance of salicylic acid was the lowest. Improvement in growth parameters might be the result of exogenous application of plant growth regulators through seed priming which could enhance the seed quality parameters during seedling stage by reducing the depressive effect of salts on germination, could be related to a decline in endogenous level of hormones (Debez *et al*. 2001).

Yield attributes and yield

There was no response of seed priming on spike length. Priming with growth regulators showed positive and significant response on number of grains/spike, test weight and finally the grain yield over unprimed control. Among growth regulators evaluated, the response of kinetin was maximum followed by GA_3, IBA and salicylic acid. The enhancement in number of grains/spike was from 44.50 to 52.83, having 18.71% increase and test weight increased from 33.80 g to 35.87 g with a per cent increase of 6.12%, resulting in enhanced grain yield from 8.30 to 9.52 kg with per cent increase of 14.69 when compared with untreated control (Table 3 and Fig. 2).

Salt tolerance was improved in the wheat seeds subjected

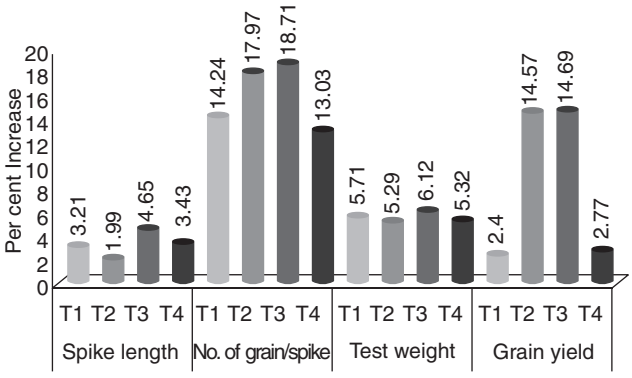

Fig 2 Per cent increase in yield attributes and yield

Table 3 Response of plant growth regulators priming on yield attributes and yield.

Treatment	Spike length (cm)				No. of grains/spike				Test weight (g)			
	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean
T_0-Control	9.05	9.00	9.00	9.02	45.10	44.20	44.20	44.50	33.20	34.10	34.10	33.80
T_1-IBA-100ppm	9.32	9.30	9.30	9.31	51.47	50.53	50.53	50.84	36.00	35.60	35.60	35.73
T_2-GA_3 100ppm	9.21	9.20	9.20	9.20	53.10	52.20	52.20	52.50	35.70	35.54	35.54	35.59
T_3-KINETIN-100ppm	9.52	9.40	9.40	9.44	53.50	52.50	52.50	52.83	36.00	35.80	35.80	35.87
T_4-Salicylic acid-100 ppm	9.36	9.32	9.32	9.33	50.10	50.40	50.40	50.30	36.00	35.40	35.40	35.60
Mean	9.29	9.24	9.24		50.65	49.97	49.97		35.38	35.29	35.29	
	SE±	CD P=0.05	CV%		SE±	CD (P=0.05)	CV%		SE±	CD (P=0.05)	CV%	
	0.0204	NS	0.27		0.2611	0.6020	0.64		0.2491	0.5549	0.86	

Grain yield (kg)/plot

	2008-09	*2009-10*	*2010-11*	*Mean*
T_0-Control	8.50	8.20	8.20	8.30
T_1-IBA-100 ppm	8.65	8.42	8.42	8.50
T_2-GA-3 100 ppm	9.27	9.63	9.63	9.51
T_3-Kinetin-100 ppm	9.55	9.50	9.50	9.52
T_4-Salicylic acid-100 ppm	8.80	8.40	8.40	8.53
Mean	8.95	8.83	8.83	
	SE±	CD (P=0.05)	CV%	
	0.1390	0.3098	1.92	

to 100 ppm concentration of different plant growth regulators for 12 hr as observed by increased germination, seedling dry weight, vigour index (G × SDW) plant height, tiller number and total dry matter production which ultimately enhanced the yield attributing characters and yield recorded in the present investigation. Kinetin followed by GA_3 was the key hormone which has brought the maximum enhancement in seed quality parameters, growth and ultimately the number of grain, test weight and grain yield. These results are also in accordance to some extent with the studies of Patel and Saxena (1994), Iqbal and Ashraf (2007) and Perveen *et al*. (2010) in wheat.

Economic analysis

The expenditure incurred over control on different treatments are ₹ 1 107, 1 361.9, 5 718 and 4 10.4 with the net economic return of ₹ 423, 7 308, 3 122 and 1 289.6 in IBA, GA_3, kinetin and salicylic acid priming, respectively. Conclusively priming with GA_3 gave maximum return with the investment of ₹ 1 361.90, though the cheapest treatment was found salicylic acid with investment of ₹ 4 10.4, only but the return is not as much as GA_3 therefore the use of GA_3 @ 100 ppm may be recommended to the farming community to adapt and get the benefit of more than 7 000 ₹/ha with the very little investment.

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