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SEED PRIMING AND FOLIAR SPRAY OF THIOUREA FOR IMPROVING GROWTH AND PRODUCTIVITY OF RAINFED WHEAT IN KANDI REGION OF PUNJAB

A. K. KHOKHAR*, SATVINDER SINGH, VIJAY KUMAR, S. C. SHARMA, S. S. BAWA, SHER SINGH, VIVEK SHARMA AND MANMOHANJIT SINGH
Regional Research Station (Punjab Agricultural University),
Ballowal Saunkhri, Teh. Balachaur, S.B.S. Nagar -144 521, INDIA
e-mail: anilkhokhar@pau.edu

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***Corresponding author**

ABSTRACT

A study was conducted to access the effect of thiourea on growth and productivity of rainfed wheat during 2012-14 with seven treatments of seed priming alone and in combination with foliar spray after 50 and 80 days after sowing (DAS).The physiological traits like dry matter accumulation at 60 DAS (33.8 g/m), 90 DAS (61.6 g/m) and at harvest (150 g/m), leaf area index at 60 DAS (1.57), 90 DAS (2.31) and at harvest (1.01) and crop growth rate 0 to 60 DAS (0.56 g/m/day), 60 to 90 DAS (0.93 g/m/day) and 90 DAS to harvest (1.01 g/m/day) as well as the yield attributes like ear length (10.5 cm), grains/spike (40.0) and 1000-grain weight (46.8 g) were significantly higher in seed priming with 1000 ppm thiourea + spray of 1000 ppm thiourea at 50 and 80 DAS than other treatments. The per cent increase in yield with seed priming and foliar spray of thiourea over control ranged from 2.91 (seed priming with 1500 ppm) to 17.64 (seed priming + spray of 1000 ppm thiourea at 50DAS and 80DAS). Hence, seed priming (1000 ppm) and foliar spray (1000 ppm) of thiourea can improve the productivity of rainfed wheat under moisture stress conditions.

INTRODUCTION

Wheat (*Triticum aestivum*) is the second most important cereal in India cultivated on 31.2 m ha with production of 94.5 mt and an average productivity of 30.29 q/ha (FAO, 2014). In Punjab it is grown on 3.5 m ha area with production of 16.6 m ton and productivity of 47.3 q/ha (Anonymous, 2013). In *Kandi* region of Punjab it is the most important *rabi* crop and is cultivated under rainfed conditions as only 20% of the cultivated area has assured irrigation in this region (Saini, 2012). The *rabi* crops are mostly grown with the conserved soil moisture from the preceding season under rainfed situations (Singh *et al.,* 2011). The low soil moisture at the time of sowing of wheat results in poor crop stand and this coupled with high temperature may kill the seedlings at the time of germination. Also the terminal heat coupled with moisture stress during the reproductive stage of wheat severely affects the grain yield.The pre-conditioning of seeds may improve the seed vigour thereby germination and optimum plant stand (Meena *et al.,* 2014).Thiourea helps to overcome such environmental stresses as thiourea offsets the effect of ABA, increases K^+ uptake and decrease the level of cytokinin in plant tissues subjected to water stress due to drought or supra optimal temperatures (Anjum *et al.*, 2008 and Pandey *et al.*, 2013). Thiourea application enhances canopy photosynthesis and metabolic transport of photosynthetic assimilates to grains via an effect on phloem loading and is reported to be effective in enhancing the productivity of wheat under adverse environmental conditions (Sahu and Singh, 1995). Dhikwal *et al.* (2012) in barley, Dadhich *et al.* (2014)in mustard and Meena *et al.* (2014) in corriander also reported significant improvement in plant stand, growth and yield parameters with thiourea seed priming and foliar spray.

Keeping in view above rationales, experiment was planned to find out the optimum dose, time and method of thiourea application and its effect on yield of rainfed wheat.

MATERIALS AND METHODS

A Field experiment was conducted under rainfed conditions in *Kandi* region of Punjab during 2012-14 at Regional Research Station (Punjab Agricultural University), Ballowal Saunkhri. The experiment was conducted under the auspices of All India Co-ordinated Research Project for Dryland Agriculture to study the effect of seed priming with thiourea and foliar spray of thiourea on the growth and productivity of rainfed wheat. The total rainfall received during 2012-13 and 2013-14 was 165.6 mm and 238.5 mm, respectively. Soil of the experimental site was loam in texture, with pH 8.3, EC 0.14 dS/m and containing 0.24% organic C, 227 kg/h available N, 16.4 kg/ha available P and 312 kg/ha available K in the top 0-15 cm surface soil. The experiment was laid out in randomized block design with three replications and seven treatments *viz.*seed priming with water, seed priming with 1000 ppm thiourea, seed priming with 1500 ppm thiourea, 1000 ppm thiourea spray at 50 & 80 DAS, 1500 ppm thiourea spray at 50 & 80 DAS, seed priming with 1000 ppm thiourea + 1000 ppm thiourea spray at 50 and 80 DAS and seed priming with 1500 ppm thiourea + 1500 ppm thiourea spray at 50 and 80 DAS. Wheat variety PBW 175 was sown at a row spacing of 30 cm using 100 kg seed/ha. The recommended N (80 kg/ha), P_2O_5 (40 kg/ha) and K_2O (30 kg/ha) were applied through urea, single super phosphate and MOP respectively. The full amount of super phosphate and MOP was applied at the time of sowing, while urea was applied in two splits, half at the time of sowing and remaining half one month after sowing. The wheat seed was soaked for 6 hours in solutions of different concentrations of thiourea as per treatments followed by drying in shade. The foliar sprays of thiourea were done at the time of maximum tillering (50 DAS) and heading (80 DAS) stages of the crop using spray volume of 600 l/ha. Plants from 1.0 m row length were selected randomly for dry matter estimation. Plants were cut from the base at 60, 90 days and at maturity. Samples were sun-dried and finally oven-dried at 70æ%C to a constant weight for estimation of dry matter accumulation. Leaf area was estimated using Sunscan Plant Canopy Analyzer SS1-STD.Crop growth rate (CGR) was computed by the following formula given by Watson (1958):

$$\text{CGR (g/m}^2\text{/day)} = (W_2 - W_1)/(T_2 - T_1) \times 1/p$$

Where, $W_1$and $W_2$are dry weights of plants at times $T_1$and T_2respectively and p represents the ground area.Yield attributes and rain water use efficiency were recorded as per Pask *et al*. (2012). The RWUE was calculated by dividing the grain yield (kg/ha) with cumulative rainfall (mm) from sowing to harvest and this indicates yield attained by a treatment per millimeter of rainwater received during the study period. Cost of cultivation was calculated based on the prevailing market price of the inputs and gross returns were calculated based on the market price of the grain and straw. The experimental data was analyzed statistically using F-test as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth parameters

The seed priming (1000 ppm thiourea) + thiourea spray (1000 ppm) at 50 and 80 DAS resulted in significant improvement in dry matter accumulation at 60 and 90 DAS (33.8 and 61.6 g/m, respectively) and at harvest (91.0 g/m) over other treatments but was at par with seed priming with 1500 ppm thiourea + 1500 ppm thiourea spray at 50 and 80 DAS (Table 1). The increase in dry matter accumulation at respective stages was to the tune of 27, 32 and 31 per cent over seed priming with water. Plant height at harvest(91 cm) was significantly higher in seed priming (1000 ppm thiourea) + thiourea spray (1000 ppm) at 50 and 80 DAS closely followed by seed priming with 1500 ppm thiourea + 1500 ppm thiourea spray at 50 and 80 DAS and both these treatments registered statistical superiority over seed priming with water. Seed priming and foliar spray of thiourea, alone as well as in combination resulted in significant improvement in LAI and CGR as compared to seed priming with water alone (Table 2). Seed priming (1000 ppm thiourea) + thiourea spray (1000 ppm) at 50 and 80 DAS significantly produced more LAI during most of the crop season i.e at 60 DAS (1.57), 90 DAS (2.31) and at harvest (1.01)) over seed priming with water or thiourea alone and foliar spray of thiourea alone. The beneficial effect of thiourea on growth characters might be attributed to improved seed vigour and

Table 1: Effect of thiourea application on growth of rainfed wheat

Treatments	Dry matter accumulation (g/m)									Plant height (cm)		
	60 DAS			90 DAS			At harvest					
	12-13	13-14	Pooled	12-13	13-14	Pooled	12-13	13-14	Pooled	12-13	13-14	Pooled
Seed priming with water	21.1	28.2	24.6	40.5	43.6	42.1	97	110	103	75.7	91.2	83.5
Seed priming with thiourea (1000 ppm)	24.1	30.4	27.3	50.0	54.9	52.4	119	133	126	80.1	93.6	86.9
Seed priming with thiourea (1500 ppm)	23.0	29.4	26.2	50.0	50.7	50.2	114	128	121	79.3	95.3	87.3
Thiourea (1000 ppm) spray at 50 and 80 DAS	26.8	33.2	30.0	59.5	52.5	56.0	128	143	135	80.7	98.3	89.5
Thiourea (1500 ppm) spray at 50 and 80 DAS	25.9	30.9	28.4	54.3	53.2	53.8	124	139	132	80.3	93.6	87.0
Seed priming withthiourea (1000 ppm) + thiourea (1000 ppm) spray at 50 and 80 DAS	31.9	35.8	33.8	64.8	58.4	61.6	142	158	150	84.7	97.4	91.0
Seed priming withthiourea (1500 ppm) + thiourea (1500 ppm) spray at 50 and 80 DAS	28.2	34.8	31.5	61.9	53.3	57.6	130	147	138	81.6	96.6	89.1
CD (P=0.05)	3.55	4.55	2.73	7.48	7.43	5.00	12	15	9.1	4.7	NS	3.9

Table 2: Effect of thiourea application on growth of rainfed wheat

Treatments	Leaf area index									Crop growth rate (g/m/day)								
	60 DAS			90 DAS			At harvest			0 to 60DAS			60 DAS to 90 DAS			90 DAS to Harvest		
	12-13	13-14	Pooled	12-13	13-14	Pooled	12-13	13-14	Pooled	12-13	13-14	Pooled	12-13	13-14	Pooled	12-13	13-14	Pooled
Seed priming with water	1.20	1.57	1.39	1.77	1.87	1.82	0.75	0.75	0.75	0.35	0.47	0.41	0.65	0.51	0.58	0.66	0.73	0.70
Seed priming with thiourea (1000 ppm)	1.35	1.66	1.51	2.00	2.25	2.13	0.85	0.87	0.86	0.40	0.51	0.46	0.86	0.81	0.84	0.82	0.87	0.85
Seed priming with thiourea (1500 ppm)	1.31	1.69	1.50	1.95	2.05	2.00	0.87	0.85	0.86	0.38	0.49	0.44	0.89	0.71	0.80	0.77	0.86	0.81
Thiourea (1000 ppm) spray at 50 and 80 DAS	1.29	1.62	1.46	2.08	2.38	2.23	0.80	0.98	0.89	0.45	0.56	0.50	1.09	0.64	0.87	0.81	1.00	0.91
Thiourea (1500 ppm) spray at 50 and 80 DAS	1.27	1.60	1.44	2.05	2.30	2.18	0.93	0.97	0.95	0.43	0.52	0.47	0.95	0.74	0.85	0.83	0.95	0.89
Seed priming withthiourea (1000 ppm) + thiourea (1000 ppm) spray at 50 and 80 DAS	1.43	1.71	1.57	2.15	2.45	2.31	0.95	1.07	1.01	0.53	0.60	0.56	1.10	0.75	0.93	0.91	1.10	1.01
Seed priming withthiourea (1500 ppm) + thiourea (1500 ppm) spray at 50 and 80 DAS	1.39	1.69	1.54	2.10	2.42	2.26	0.83	1.00	0.92	0.47	0.58	0.53	1.12	0.62	0.87	0.81	1.04	0.93
CD (P=0.05)	0.12	NS	0.07	0.22	0.36	0.20	NS	0.15	0.10	0.06	0.08	0.046	NS	0.15	0.16	0.13	0.22	0.12

Table 3: Effect of thiourea application on yield attributes of rainfed wheat

Treatments	No. of tillers /mrl			Ear length (cm)			Grains/ spike			1000-grain wt. (g)		
	12-13	13-14	Pooled	12-13	13-14	Pooled	12-13	13-14	Pooled	12-13	13-14	Pooled
Seed priming with water	55.2	71.4	63.3	8.9	9.77	9.5	33.4	35.8	34.6	41.6	44.2	42.9
Seed priming with thiourea (1000 ppm)	56.0	73.8	64.9	9.54	10.03	9.8	35.3	37.9	36.6	43.1	46.7	44.9
Seed priming with thiourea (1500 ppm)	55.1	75.3	65.2	9.47	9.93	9.7	34.7	36.8	35.7	41.6	46.3	43.9
Thiourea (1000 ppm) spray at 50 and 80 DAS	60.1	77.3	68.7	9.43	10.37	9.9	37.0	38.1	37.5	43.8	47.4	45.6
Thiourea (1500 ppm) spray at 50 and 80 DAS	56.3	76.9	66.6	9.05	10.27	9.66	35.6	38.1	36.8	43.6	47	45.3
Seed priming withthiourea (1000 ppm) + thiourea (1000 ppm) spray at 50 and 80 DAS	64.5	80.9	72.7	9.81	11.27	10.5	40.4	39.6	40.0	45.2	48.5	46.8
Seed priming withthiourea (1500 ppm) + thiourea (1500 ppm) spray at 50 and 80 DAS	62.9	78.6	70.7	9.43	10.67	10.0	39.9	38.5	39.2	45.5	47.6	46.5
CD (P=0.05)	6.5	NS	NS	0.52	0.79	0.45	4.70	NS	2.70	2.5	2.18	2.2

Table 4: Effect of thiourea application on yield and rain water use efficiency (RWUE) of rainfed wheat

Treatments	Grain yield (kg/ha)			% increase over control			RWUE (kg/ha/mm)		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Mean
Seed priming with water	2003	2301	2153	-	-	-	12.10	6.53	9.32
Seed priming with thiourea (1000 ppm)	2168	2378	2273	7.47	2.91	5.19	13.09	6.49	9.79
Seed priming with thiourea (1500 ppm)	2128	2320	2225	5.32	0.50	2.91	12.85	6.79	9.82
Thiourea (1000 ppm) spray at 50 and 80 DAS	2429	2509	2469	17.20	8.29	12.74	14.67	7.18	10.93
Thiourea (1500 ppm) spray at 50 and 80 DAS	2241	2464	2352	10.4	6.25	8.34	13.53	6.95	10.24
Seed priming withthiourea (1000 ppm) + thiourea (1000 ppm) spray at 50 and 80 DAS	2531	2716	2623	20.14	15.14	17.64	15.28	7.23	11.26
Seed priming withthiourea (1500 ppm) + thiourea (1500 ppm) spray at 50 and 80 DAS	2481	2616	2549	18.8	11.9	15.34	14.98	7.38	11.18
CD (P=0.05)	318	249	191	8.3	NS	6.29	-	-	-

germination due to seed priming and thiourea spray might have enabled the crop to maintain higher photosynthetic rate as well as better translocation of photosynthetic assimilates towards active sink. This ultimately resulted in higher dry matter accumulation, CGR and LAI. Similar effect of thiourea on the growth of different crops has also been reported by Dhikwal *et al.* (2012), Dadhich *et al.* (2014) and Sharma *et al.*(2008).

Yield attributes

The yield attributes of wheat improved with seed priming and foliar spray of thiourea treatments as compared to seed priming with water alone (Table 3). Maximum improvement in yield attributes was recorded in seed priming (1000 ppm thiourea) + foliar spray (1000 ppm thiourea) at 50 and 80 DAS. Ear length (10.5 cm) and 1000 grain weight (46.8 g) significantly increased by 13.3 and 8.9 % due to seed priming (1000 ppm thiourea) + foliar spray (1000 ppm thiourea) as compared to seed priming with water (9.5 cm and 42.9 g, respectively) but, it was at par with seed priming in 1500 ppm thiourea + spray of 1500 ppm thiourea. The thiourea with its sulphydryl group regulates several metabolic reactions in the plant both under normal as well as stress conditions. Under stress conditions it acts as an antioxidant by protecting primary photochemical reactions of photosystem 1 and photosystem 2 and enhances the activities of antioxidant enzymes (Nathawat *et al.,* 2007). The thiourea application might have favoured the greater translocation of assimilates from source to sink for longer period in comparison to control treatment which lead to effective grain filling. Sahu *et al.* (1993) and Shanu *et al.* (2013) also reported improvement yield attributes of coriander with seed priming and foliar spray of thiourea.

Yield

The seed priming (1000 ppm) + sprays (1000 ppm) with thiourea 50 and 80 DAS recorded highest grain yield of 2623 kg/ha which was significantly higher than other treatments but at par with seed priming with 1500 ppm thiourea + spray of 1500 ppm thiourea (Table 4). The per cent increase in grain yield over control due to seed priming and foliar spray of thiourea treatment ranged from 2.91 per cent (seed priming with 1500 ppm) to 17.64 per cent (seed priming with 1000 ppm + sprays of 1000 ppm thiourea at 50 and 80 DAS). The higher yield in seed priming and foliar spray of thiourea treatments may be attributed to higher tillers/m row length, grains/spike and 1000- grain weight. The seed priming with thiourea might have improved the seed vigour and helped the plants to establish well and delays leaf senescence, while its application at vegetative and boot stage improved the photosynthetic activity. Thus thiourea application favourably affects both carbohydrates and nitrogen metabolism which in turn enhance plant performance (Balai and Keshwa, 2011 and Mathur *et al.*, 2006). The rain water use efficiency (RWUE) was highest (11.26 kg/ha/mm) in seed priming with 1000 ppm thiourea + spray of 1000 ppm thiourea (Table 4). Effect of seed priming in enhancing RWUE was also reported by Sarma *et al.* (2014).

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