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EFFECT OF FOLIAR APPLICATION OF ZINC SULPHATE AND THIOUREA ON PRODUCTIVITY OF WHEAT (*TRITICUM AESTIVUM* L.) IN DAUSA DISTRICT OF RAJASTHAN, INDIA

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Abstract

A field experiment was conducted during *Rabi* 2009-10 and 2010-11 at farmers fields in different locations of Dausa district of Rajasthan (India), which falls in agroclimatic zone III a (Semi arid eastern plain zone). The study consists four treatments namely T_1- Control (No spray), T_2- 0.5% Zinc sulphate spray at tillering and grain initiation stage, T_3- 500 ppm thiourea spray at tillering and grain initiation stage, T_4- 500 ppm thiourea + 0.2% zinc sulphate (mixed solution) spray at tillering and grain initiation stage. These four treatments were replicated 25 locations in the year 2009-10 and 34 locations in the year 2010-11 at farmers' fields of the different villages of Dausa district (Rajasthan), India. The results of the experiment indicated that ear length (cm), number of grains/ear, test weight (g), grain yield and straw yield (q/ha) was found superior in treatment T_4- 500 ppm thiourea + 0.2% zinc sulphate (mixed solution) spray at tillering and grain initiation stage *i.e.* 8.92, 54.40, 41.40, 50.47 and 67.36 respectively during 2009-10 8.74, 52.34, 40.78, 38.35 and 48.12 respectively, during 2010-11 and 8.83, 53.37, 41.09, 44.41 and 57.74 respectively, mean values of both the years of experimentation. The grain yield (q/ha) of wheat was found significantly superior in treatment T_4 followed by treatment T_2 at par T_3 by the tune of 11.80, 6.66 and 6.38 per cent respectively, as compared to control during 2009-10 and The grain yield (q/ha) of wheat was found significantly superior in treatment T_4 at par T_3 followed by T_2 19.06, 15.42 & 8.66 per cent respectively as compared to control during 2010-11. The mean of two year of grain yield was found 14.81 per cent higher than control. The straw yield of wheat (q/ha) was found significantly superior in treatment T_4 followed by treatment T_2 at par T_3 in the tune of 12.86, 5.58 & 5.56 per cent respectively during 2009-10 and the straw yield of wheat (q/ha) was found significantly superior in treatment T_4 at par T_2 followed by T_3, 28.12, 23.20 & 9.32 per cent respectively, as compared to control during 2010-11. The mean increase in straw yield of the two years was found 18.61 per cent higher than control. The net returns (Rs/ha) was found highest in T_4 Rs 41859 as compared to control Rs. 35975. The overall study revealed that the treatment T_4- 500 ppm thiourea + 0.2% zinc sulphate (mixed solution) spray at tillering and grain initiation stage found significantly superior and farmer can increased their yield of wheat by adopting this technology and gave their input in changing the scenario of green revolution to evergreen revolution.

Key words : Wheat, thiourea, zinc sulphate, yield and economics.

Intorduction

With increasing population growth and diminishing water availability Indian agriculture facing severe challenge to produce more food per unit of land and water. Use of high yielding varieties and higher dose of macro nutrients and growing of wheat year after year has resulted in depletion of micro nutrients like zinc resulting declining or stagnating productivity of wheat due to unfavorable climatic condition especially temperature during seedling to tillering phase resulted in stagnating or decline the productivity even after the increasing the seed rate and macro nutrients application. For sustainable agriculture, it is imperative to renewable inputs which can maximize the ecological benefits and minimizing the environmental hazards. One possible way of achieving this is to decrease dependence on use of macro nutrients by foliar application of SH bio-regulators (thiourea) and zinc sulphate, which helps in better transportation mechanism in the plants phloem system and increasing the yield potential of wheat.

Wheat is an important staple cereal in India both from the point of view of gross hectarage cultivated and grain production, after successful story of green revolution the country has made an impressive progress in enhancing productivity of wheat. However, realizable yield level at

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cultivators end in most part of the country (26.19 q/ha) and especially in Rajasthan (31.75 q/ha) are still deplorably low as compared to its genetic (60-70q/ha) and feasible (50-60 q/ha) potential (Anonymous, 2008-09). Rajasthan Agricultural Statistics at a glance (2008-09 pp. 88), this calls for renewed efforts for analyzing the production constraints and evaluating location specific monetary and non monetary technology for improving the existing productivity level.

The mineral fertilizer application went so high that it has shown its ill effect like soil fertility degradation, adverse effects on soil physical properties, over exploitation of natural resources, ground water pollution and eutrophication. Soils have not only become hungry for major plant nutrients (N.P.K. & S.), but are also showing deficiency symptoms of base elements like zinc manganese and ferrous. Wheat demand in India is increasing continuously due to ever increasing population day by day. To meet the wheat demand there is an urgent need to increase the production and productivity of the wheat. Wheat yield can also be increased by high yielding variety, disease and lodging resistant varieties; synchronized tillering, irrigation facility and use of need base amount of macro and micro nutrients either as soil or foliar application. The foliar application of the micro nutrients is more effective than soil application (Sahu and Singh, 1995 & Narang *et al*., 1977). Zinc is also involved in various metabolic activities of plant such as photosynthesis, respiration and assimilation of organic compound to sink. The efficacy of such type element is improved when, it is used in combination with other elements like N & K (Rajput *et al*., 1995 and Fathi *et al*., 1990).

The concentration of the zinc in the soil is lower than that present in the material from which they are derived which resulted in yield stagnation and/or depletion. Thiourea is one of the options to combat the adverse climatic conditions such as drought stress and maintain or increase the productivity of wheat (Abdelkader *et al*., 2012 and Anjum *et al*., 2008). Field use of thiourea is feasible for enhancing wheat yield under stress full condition. To overcome this problem a study has been conducted by Krishi Vigyan Kendra, Dausa (Rajasthan), India by framing a on farm testing at farmers fields at different locations in Dausa district of Rajasthan during *Rabi* 2009-10 and 2010-11.

Materials and Methods

The field experiment was conducted during *Rabi* 2009-10 and 2010-11 at farmers fields in different locations of Dausa district of Rajasthan, which falls in agroclimatic zone IIIa (Transitional plain zone of inland drainage). Soils of the experimental sites were sandy to sandy loam in texture, slight alkaline (pH 7.6) in reaction, low in nitrogen and phosphorus and medium in potassium status. The study consists four treatments namely $\mathbf{T_1}$- Control (No spray), $\mathbf{T_2}$- 0.5% zinc sulphate spray at tillering and grain initiation stage, $\mathbf{T_3}$- 500 ppm thiourea spray at tillering and grain initiation stage, $\mathbf{T_4}$- 500 ppm thiourea+ 0.2 % zinc sulphate (mixed solution) spray at tillering and grain initiation stage. The above four treatments were replicated 25 times in the year 2009-10 and 34 times in the year 2010-11 at farmers fields of the different villages of Dausa in Randomized Block Design. The wheat variety Raj 4037 was grown in the second and third week of November in both the years. The crop was irrigated at critical growth stages during both the years of experimentation. The crop was raised with the recommended dose of major nutrients in the zone III a *i.e*. 45 kg DAP and 250 kg Ure a per hectare. The weed control was done by 2, 4-D spray at 30 DAS. The crop was harvested in the first week of April in both the years of experimentation. The harvesting and threshing was done in separate strips of treatments. The observations of yield attributes and yield like ear length, number of grains/ ear, test weight, grain and straw yield were recorded treatment and replication wise at every location and then statistical analysis for the test of significance were done. Observations of ten competitive plants at maturity stage from each treatment and replication were randomly selected, average of these plants in respect of different plant characters like ear length, number of grains/ ear and test weight was taken. The length of ear excluding awns were recorded in centimeters, the ear of plants were hand threshed and the number of grains/ear were counted, 1000 grains were counted and weighted for test weight and recorded. After separate threshing of different treatments the grain and straw yield was recorded and then converted into q/ha for further statistical analysis.

The economics was calculated by simple mathematical formula. The cost of cultivation included all the expenditure. Right from land preparation, cost of irrigation, cost of inputs, cost of treatment with spray cost and other expenditures. Gross return was calculated by multiplying of produce to prevailing market price. B; C ratio was calculated as gross return divided by cost of cultivation Additional cost was calculated as additional amount spent to the treatment given and additional return was calculated as difference between net return of control & net return of treatment.

Results and Discussion

Yield attributes

Data in table 1 revealed that the ear length was increased by all the three treatments as compared to control or no spray. Significantly the highest ear length was recorded in treatment T_4- 500 ppm thiourea + 0.2% zinc sulphate (mixed solution) spray at tillering and grain initiation stage which is 8.92, 8.74 and 8.83 during the year 2009-10, 2010-11 and mean value, respectively. The above treatment recorded 3.96, 2.58 and 3.27 per cent higher than control. In respect of number of grains/ ear treatment T_4- 500 ppm thiourea+ 0.2% zinc sulphate (mixed solution) spray at tillering and grain initiation stage were found significantly superior over control during both the years. The treatment T_4- 500 ppm thiourea + 0.2% zinc sulphate (mixed solution) spray at tillering and grain initiation stage were recorded 3.09 per cent in 2009-10, 6.71 per cent in 2010-11and 4.83 per cent of mean value as compared to control. Test weight of wheat during 2009-10 was significantly superior in the treatment T_4 (41.40) at par T_3 (41.09) in 2009-10 and there was no significant difference in test weight during 2010-2011. The test weight of wheat was found significantly increased in the treatment T_3 500 ppm thiourea spray at tillering and grain initiation stage and treatment T_4- 500 ppm thiourea+ 0.2 % Zinc sulphate (mixed solution) spray at tillering and grain initiation stage, which is 1.73 and 2.50 per cent higher during 2009-10, than as control. T_4- 500 ppm thiourea + 0.2% Zinc sulphate (mixed solution) spray at tillering and grain initiation stage significantly superior by 1.24 per cent over control during 2010-11 and mean value of test weight was 1.86 per cent higher over control. In nut shell all three treatment found better as compared to control in respect of all yield attributes. The treatment T_4- 500 ppm thiourea + 0.2% Zinc sulphate (mixed solution) spray at tillering and grain initiation stage recorded significantly the highest values for all the yield attributes like ear length, number of grains/ear and test weight during both the years. The spray of thiourea and zinc sulphate has a favorable impact on dry matter partitioning between source and sink. Better translocation of assimilates from source to sink is one of the possible reason for increasing the yield attributes of wheat crop resulting in increased

Table 1 : Effect of zinc sulphate and thiourea spray on yield attributes of wheat.

Treatments	Ear length (cm)			Number of grains/ear			Test weight (g)		
	2009-10	2010-11	Mean	2009-10	2010-11	Mean	2009-10	2010-11	Mean
T_1- Control (No spray)	8.58	8.52	8.55	52.77	49.05	50.91	40.39	40.28	40.34
T_2- 0.5% Zinc sulphate spray at tillering and grain initiation stage	8.75	8.65	8.70	53.54	50.23	51.88	40.77	40.46	40.62
T_3- 500 ppm thiourea spray at tillering and grain initiation stage	8.81	8.52	8.67	53.67	50.38	52.02	41.09	40.34	40.72
T_4- 500 ppm thiourea+ 0.2% Zinc sulphate (mixed solution) spray at tillering and grain initiation stage	8.92	8.74	8.83	54.40	52.34	53.37	41.40	40.78	41.09
SEm ±	0.098	0.086	-	0.468	1.637	-	0.276	0.733	-
CD (P=0.05)	0.195	0.169	-	0.936	3.242	-	0.552	1.451	-

Table 2 : Effect of zinc sulphate and thiourea spray on yield of wheat.

Treatments	Grain yield (q/ha)			Fodder yield (q/ha)		
	2009-10	2010-11	Mean	2009-10	2010-11	Mean
T_1- Control (No spray)	45.14	32.21	38.68	59.68	37.53	48.68
T_2- 0.5% Zinc sulphate spray at tillering and grain initiation stage	48.15	37.18	42.67	63.20	46.24	54.72
T_3- 500 ppm thiourea spray at tillering and grain initiation stage	48.02	35.00	41.51	63.00	41.03	52.02
T_4- 500 ppm thiourea+ 0.2 % Zinc sulphate (mixed solution) spray at tillering and grain initiation stage	50.47	38.35	44.41	67.36	48.12	57.74
S.Em. ±	0.521	1.243	-	1.083	1.459	-
CD (P = 0.05)	1.041	2.462	-	2.165	2.888	-

Table 3 : Economics (Rs/ha) of wheat as influenced by foliar spray of thiourea and zinc sulphate.

Treatment	Cost of cultivation			Gross return			Net return			Additional cost			Additional return			B:C ratio		
	2009 -10	2010 -11	Mean	2009 -10	2010 -11	Mean	2009 -10	2010 -11	Mean	2009 -10	2010 11	Mean	2009 -10	2010 -11	Mean	2009 -10	2010 11	Mean
T_1 - Control (No spray)	25570	25700	25635	78040	45180	61610	52470	19480	35975	-	-	-	-	-	-	3.05	1.75	2.40
T_2 - 0.5% Zinc sulphate spray at tillering and grain initiation stage	31570	31700	31635	83060	52746	67903	51490	21046	36268	6000	6000	6000	-980	7566	3734	2.63	1.66	2.15
T_3 - 500 ppm thiourea spray at tillering and grain initiation stage	26830	27482	27156	82904	47436	65170	56074	19954	38014	1260	1782	1521	3604	2256	2930	3.08	1.72	2.40
T_4 - 500 ppm thiourea+ 0.2% Zinc sulphate (mixed solution) spray at tillering and grain initiation stage	28830	29482	29156	87508	54522	71015	58678	25040	41859	3260	3782	3521	6208	9342	7735	3.03	1.85	2.44

ear length, number of grains/ear and test weight. Similar results were also recorded by Sahu and Singh (1995) with the application of thiourea spray at tillering and flowering stage. Dayanand *et al*. (2013) also recorded significantly higher yield attributes of wheat like plant height, grains per ear and test weight with 500 ppm thiourea + 0.2% zinc sulphate (mixed solution) spray at tillering and grain initiation stage. Gul *et al*. (2011) recorded two times spray of 0.5% zinc solution on wheat was highly influenced in plant height, no of tillers and other yield attributes characters.

Yield

Data presented in table 2 depicts that treatment $\mathbf{T_2}$- 0.5% zinc sulphate spray at tillering and grain initiation stage and $\mathbf{T_3}$- 500 ppm thiourea spray at tillering and grain initiation stage being statistically at par with each other were significantly superior over control by the tune of 6.67 and 6.34 per cent higher over control during 2009-10. During the same year the treatment $\mathbf{T_4}$- 500 ppm thiourea + 0.2% zinc sulphate (mixed solution) spray at tillering and grain initiation stage recorded the significantly the highest grain yield *i.e*. 11.81 per cent higher over control and also found significantly superior over rest of the treatments and control. During 2010-11 treatment $\mathbf{T_2}$- 0.5% zinc sulphate spray at tillering and grain initiation stage and $\mathbf{T_4}$- 500 ppm thiourea + 0.2% zinc sulphate (mixed solution) spray at tillering and grain initiation stage being statistically at par with each other found significantly superior over control by the tune of 15.43 and 19.68 per cent higher over control. Similarly fodder yield of wheat was also recorded significantly superior in the treatment $\mathbf{T_2}$- 0.5% zinc sulphate spray at tillering and grain initiation stage and $\mathbf{T_4}$- 500 ppm thiourea + 0.2% Zinc sulphate (mixed solution) spray at tillering and grain initiation stage by the tune of 5.56 and 12.87 per cent as compared to control during 2009-10. During 2010-11 treatment $\mathbf{T_2}$- 0.5% Zinc sulphate spray at tillering and grain initiation stage and $\mathbf{T_4}$- 500 ppm thiourea + 0.2% zinc sulphate (mixed solution) spray at tillering and grain initiation stage being statistically at par with each other found significantly superior by the tune of 23.21 and 28.21 per cent over control. The mean value of both the year in grain yield and straw yield recorded higher 14.81% and 18.61% respectively, than control.

Dayanand *et al*. (2013) also recorded 5.7, 10.4 and 12.7% higher grain yield over control with two foliar spray of,500 ppm thiourea, 0.5% zinc sulphate and + 500 ppm thiourea + 0.2% zinc sulphate (mixed solution) spray at tillering and grain initiation stage. Sahu and Singh (1995) also found similar results that thiourea spray at both tillering

and flowering increased the grain yield, biological yield and harvest index. Grain yield increased by 23.9% over control.

Economics

Data in table 3 revealed that highest net return was found in $\mathbf{T_4}$ of Rs. 58678/-followed by $\mathbf{T_3}$ of Rs. 56074/- as compared to control (52470) during 2009-2010 and the highest net return was found in $\mathbf{T_4}$ of Rs. 25040/- followed by $\mathbf{T_2}$ of Rs. 21046/-during 2010-2011 as compared to control (19480). The mean value of net return of two year was recorded the highest in $\mathbf{T_4}$ of Rs. 41859/- followed by $\mathbf{T_3}$ Rs. 38014/-. The highest additional return was calculated in $\mathbf{T_4}$ of Rs. 6208, 9342 and 7735 per hectare during 2009-2010, 2010-2011 and mean of two years, respectively. B : C ratio was also found the highest in $\mathbf{T_4}$ (2.44) during mean of the two years. Dayanand *et al*. (2013) also recorded higher return in two foliar application of thiourea @ 0.05% + $ZnSO_4$ @ 0.2 per cent.

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