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STUDIES ABOUT THE PHYSIOLOGICAL TRAITS AND PRODUCTIVITY OF WHEAT (*Triticum aestivum* L.) IN RELATION TO FOLIAR SPRAY OF ZINC, UREA AND THIOUREA UNDER RAINFED CONDITION.

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ABSTRACT

A field experiment was carried out during two consecutive seasons i.e. Rabi 2010-11 and 2011-12 in Randomized Block Design with three replications to investigate the effect of foliar application of zinc, urea and thiourea individually as well as in their combinations on two widely cultivated varieties i.e. K-9351 (Mandakini) and K-8027 (Magher). The experiment was conducted with sixteen treatment i.e. K-9351+ water spray, K-9351 + spray of ZnSO4 (0.5%), K-9351 + spray of Urea (2%), K-9351 + spray of Thiourea (500 ppm), K-9351 + spray of ZnSO4+ Urea (@ 0.5% + 2%), K-9351 + spray of ZnSO4 + Thiourea (@0.5% + 500 ppm), K-9351 + spray of Urea + Thiourea (@2% + 500 ppm), K-9351 + spray of ZnSO4 + Urea + Thiourea (@ 0.5% + 2% + 500ppm), K-8027 + spray of water, K-8027 + spray of ZnSO4 (0.5%), K-8027 + spray of urea (2%), K-8027 + spray of Thiourea (500 ppm), K-8027 + spray of ZnSO4 (0.5%) & Urea (2%), K-8027 + spray of ZnSO4 (0.5%) & Thiourea (500 ppm) ,, K-8027 + spray of Urea (2%) & Thiourea (500 ppm) and K-8027 + spray of ZnSO4 + Urea + Thiourea (0.5% + 2% + 500 ppm). The results revealed that the application of ZnSO4 (0.5%) + urea (2%) + thiourea (500ppm) fertilization attained were recorded significantly maximum value in plant height (cm), leaf area per plant (cm2) at 60 and & 90 DAS, dry matter per plant (g) pre anthesis and post anthesis, chlorophyll content (mg/g of fresh weight) and numerically higher value in length of ear (cm), number of spikelet/ear, weight of grains/per plant (g), test weight under rainfed conditions during both the years. The foliar application of ZnSO4 (0.5%) + urea (2%)+thiourea (500ppm) twice at 45 and 65DAS under rain fed condition of wheat were significantly maximum chlorophyll content (mg/g of fresh wt.), RWC (%), yield and its components sown over water sprayed control as well as treatments. Among the varieties of wheat evaluated K-9351 was found more responsive yielded more than K-8027 during both the years under rainfed conditions.

Keyword: **Wheat cultivers, foliar spray of water, zinc, urea, thiourea,**

Wheat (*Triticum aestivum* L.) is most staple and second most important crop after rice of the country which contributes nearly one third of the total food grain production. It is consumed mostly in the form of bread as “Chapati”. Wheat straw is used for feeding the cattle. Wheat contains more protein than other cereals and has a relatively high content of Niacin and thiamine. It is basically concerned in proving the characteristics substance “Gluten” which is very essential for bakery. Zinc is closely involved in nitrogen metabolism of the plant. Zinc is required for synthesis of tryptophan which is precursor of IAA. It is involved in starch formation, starch content and activity of the enzyme starch synthetase reduced in zinc deficient plants and activation of enzymes related to carbohydrate metabolism, protein synthesis and as a key constituent in enzymes like alcohol dehydrogenase, carbonic anhydrase and super-oxide dismutase. Nitrogen deficiency is the most important which is almost of universal occurrence in Indian soils. Nitrogen is a primary element and to special important in the formation of protein in plants. It is also present in chlorophyll green pigments that are receptors of high energy in photosynthesis. In present investigation, application of thiourea might

have improved pholem loading of sucrose and hence translocations of photosynthatis. Bioregulators plays important role in greater poisonsing of photosynthesis to worlds reproductive sink there by improve the harvest index foliar application of thiourea.

Materials and methods

The field experiments was conducted during two *Rabi* seasons of 2010-11 and 2011-12 at Crop Research Farm of C.S. Azad University of Agriculture and Technology, Kanpur under rain fed condition. The soils of experimental sites loam sand having pH 7.7 and 7.8, Ec 0.39 an 0.44 dsm^{-1} and organic carbon 0.32 and 0.35% Hclextractable zinc 1.5 ppm, respectively. The treatments comprised eight combinations of concentration of zinc, urea and thiourea viz, Control (water spray), $ZnSO_4$ (0.5%), Urea (2.0%), Thiourea (500 ppm), $ZnSO_4$ (0.5%) + Urea (2.0%), $ZnSO_4$ (0.5%) + Thiourea (5.00 ppm), Urea (2%) + Thiourea (500 ppm), $ZnSO_4$(0.5%) , + Urea (2.0%) + Thiourea (500 ppm) with widely accepted of wheat varieties viz, K-9351 and K-8027. All the eight treatments were tried in Randomized Block Design with three replications. An uniform dose of NPK 120:60:40 kg/ha through diammoniumn phosphate was applied as basal to all treatment plots, half quantity of nitrogen should be supplied at the time of secondary and top dressing of urea. Sowing of seed 100 kg/ha, should be done at pre irrigation during two years respectively uniforms 23 cm and plant to plant distance were maintained by many equipments i.e. Khurpi, Kudal etc. Spraying of zinc, urea and thiourea at different concentrations as per treatment was done on plant foliage twice, i.e. 45-50 & 65-70 days after sowing in each year by using 800 litre solution/ha. The small amount of tepal was added to the solution as a wetting agent in zinc sulphate solution. At harvest plant height (cm), number of tillers/ plant, leaf area/plant (cm^2), was measured during both the years by method as described by *Lazarove* (1955). Ear length (cm), number of ear per plant were taken randomly. Test weight, grain yield (q/ha) were calculated during both the years. Chlorophyll content (mg/g of fresh weight) in leaf was determined by using the method Arnon *et al.* (1949). Dry matter accumulation of plant pre anthesis & post anthesis were taken in the years of experimentation period, RWC (%) second leaf from top was determined by using the method of measured by Weatherly (1965). The relative water content (RWC) was calculated with following formula:

$$RWC(\%) = \frac{Fresh\ weight - Dry\ weight}{Turgid\ weight \quad Dry\ weight} \times 100$$

RESULTS AND DISCUSSION

Growth attributes

The data indicate (Table-1) that the plant height at harvest was significantly recorded maximum value in treatment of Zincsulphate @ 0.5% + urea 2% + thiourea 500 ppm in comparison to control during both the years. The foliar application of zinc sulphate @ 0.5% + urea@ 2% + thiourea @ 500 ppm was significantly appreciated of 5.1 and 5.3 tillers/plant in compared to spray of water as control of 4.5 and 4.3 tillers plant during both the years, respectively. Significantly higher production of leaf area per plant (cm^2) due to application of Zinc + urea + thiourea (@ 0.5% + 2% + 500 ppm) in comparison to rest concentrations in both the years. The foliar application of zinc sulphate + urea + thiourea (@ 0.5% + 2% + 500 ppm) significantly higher dry matter (g) was produced pre anthesis over rest concentration and post anthesis in both the years of study. These results are similar reported by Verma *et al.* (2004), Prakash *et al.* (2015).

A perusal of data (Table-1) on the variety K-9351 was lowest (80.9 and 82.2 cm) in compared to K-8027 (104.9 and 106.1 cm) in relation to plant height (cm) in first and second year of studies, respectively. The variety of wheat (K-9351) was significantly higher tillers/ plant in comparison to variety of wheat (K-8027) during both the years. The leaf area per plant (cm^2) revealed that it varied

significantly due to variety and spray of different concentrations. Therefore, development of grater assimilating apparatus (leaves) to gather with higher leaf area per plant cm^2 at 60 and 90 days after sowing the significantly higher was produced in variety K-9351 in compared to control K-8027 in both the years. The K-9351 variety of wheat was significantly higher dry matter production in comparison to variety of wheat (K-8027) in both the years of experimentation. The results are in conformity with the findings of Verma *et al.* (2004) and Prakash *et al.* (2015).

Physiological attributes

A scanning of the data Table-1 clearly indicated that the maximum relative water content % was observed by the application of foliar applied zinc + urea + thiourea (0.5% + 2% + 500 ppm) than spray of rest concentration in both the years. The cholorphyll content was significantly higher concentration applied as foliar spray of zinc + urea + thiourea (@ 0.5% + 2% + 500 ppm) in comparison to control and spray of zinc sulphate @ 0.5% during both the years. The results are inconformity with the findings of Burman *et al.* (2007) reports that the treatment in combination with thiourea resulted in significantly higher net photosynthetic rates and concentration of chlorophyll, starch, soluble protein and total free amino acid as well as nitrate reductase activity compared to control plants and both vegetative and flowering stages and similar response of Verma *et al.* (2004) and Sahu and Singh (1995).

A critical examination of the data clearly indicated that the maximum relative water content in variety K-9351 in comparison to K-8027 varieties of wheat during both the years. The variety K-9351 was significantly higher in comparison to K-8027 in respect to chlorophyll content (mg/g of fresh weight) during both the years. These results may be supported the findings of Prakash *et al.* (2015) also reported improved water and chlorophyll content in particular cultivare due to physiological process that is natural Phenolans as varietal characters.

Yield attributes:

The data are presented in Table-2 that the Length of ear was also significantly increased in concentration of $ZnSO_4$ (0.5%) + urea (2%) + thiourea (500 ppm) and $ZnSO_4$ @ 0.5% + urea 2% treatment, respectively whereas, statistically at par length of ear with concentration of ZnSO4 (@ 0.5%) + thiourea (500 ppm) and urea (2%) + thiourea (500 ppm) to each other for both the years. Number of spiklets per ear was also significantly increased the application of zinc + urea + thiourea (@ 0.5% + 2% + 500 ppm) compared with control during both the years. Weight of grains per plant and test weight were also significantly higher in foliar spray of zinc + urea + thiourea (@ 0.5% + 2% + 500 ppm) in compared to control in first and second years studies, respectively. The similar results reported by Mehta *et al.* (2013).

The data pertaining to yield characters as influenced by wheat cultivars are presented in Table-2 that the variety K-9351 was significantly higher length of ear and number of spiklets per ear for compared to K-8027 varieties wheat in both the years. The grains weight/plant were significantly increased with K-9351 variety of wheat in compared to K-8027 variety during both the year. The significantly highest test weight was also recorded in K-9351 over K-8027 variety of wheat during the both years. Mandakini variety is better yield attributes due to growth and physiological attributes improved. The findings was supported by Sahu *et al.* (1993) and Sahu and Singh (1995).

Yield:

A perusal of data (Table-2) revealed that the higher yield of wheat was produced in foliar spray of concentration @ 0.5% + 2% + 500 ppm (zinc + urea + thiourea) in compared result concentration during both the years. The spray of concentration @ 0.5% + 2% + 500 ppm (Zinc + Urea + Thiourea) increased the grain yield of wheat by a margin of 4.7 q/ha (14.87%), 4.3 q/ha (13.44%), 3.6 q/ha (11.01%), 3.6

q/ha (11.01%), 2.7 q/ha (8.04%), 2.2 q/ha (6.45%) and 0.9 q/ha (2.54%) in first year and 5.8 q/ha (18.01%), 4.2 q/ha (12.43%), 4.1 q/ha (12.09%), 3.8 q/ha (11.11%), 3.2 q/ha (9.20%), 2.9 q/ha (8.26%) and 1.9 q/ha (5.26%) in second year, than spray of water, zinc sulphate @ 0.5%, Urea @ 2%, thiourea @ 500 ppm, zinc sulphate + urea (0.5% + 2%), zinc sulphate + thiourea (0.5% + 500 ppm) and urea + thiourea (2% + 500 ppm). The concentration in combination with zinc sulphate, urea dnd thiourea imporve the tillering and vegetative growth and development of the crop. It formed more photo synthesis resulted better yield attributes and finally yield. Similar findings were reported by Verma et al. (2016).

The data pertaining to grain yield have been summarized in Table-2. The variety of wheat (K-9351) was produced significantly higher in comparison to variety (K-8027) in both the years. It improve the grain yield of wheat by a margin of 3.3 q/ha (10.44%) in first year and 1.0 q/ha(2.93%) in second year that Magher variety, respectively. Mandakini variety of wheat produced maximum yield might be due to favourable genotipic characters of variety. The yield variation due to differential in varietal characters have also been reported by Pyare *et al.* (2003). These results are also reported by Sahu *et al.* (1993); Mehta *et al.* (2013).

Table- 1: Influence of zinc urea and thiourea on plant height, tillers/ plants, leaf area/plant and DM/ plant of wheat (*Triticum aestivum* L.) under rainfed condition.

Treatments	Plant height (cm)		Tillers/plant		Leaf area Plant (cm^2)				DM/Plant (g)				RWC %		Chlorophyll content mg/g of fresh weight	
					at 60 DAS		90 DAS		Preanthesis		Post anthesis					
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Different Concentration																
Control (water spray)	89.8	90.6	4.5	4.3	258.5	268.3	290.9	286.8	9.3	10.2	10.6	11.0	67	74	0.890	0.876
$ZnSO_4$ 0.5%	91.3	90.6	4.7	4.6	274.1	289.2	287.3	300.3	11.4	11.5	12.9	12.8	75	74	0.977	0.973
Urea 2%	94.2	91.0	4.9	4.7	268.3	375.9	308.9	292.4	11.8	10.6	12.5	11.4	71	75	1.025	1.032
Thiourea 500 ppm	90.6	92.2	5.6	4.9	286.3	305.3	299.2	313.4	11.8	12.3	13.7	14.6	71	76	1.070	1.054
$ZnSO_4$ + urea (0.5% + 2%)	93.4	93.4	5.3	4.9	277.9	290.4	310.3	302.4	11.8	11.3	14.6	12.9	68	76	1.049	1.069
$ZnSO_4$ + thiourea (0.5% + 500 ppm)	93.2	93.2	5.5	5.0	287.5	302.9	317.8	313.9	12.6	12.6	15.0	14.7	66	77	1.048	1.048
Thiourea + urea (500 ppm + 2%)	93.8	94.4	5.7	5.1	297.7	315.1	324.8	323.8	12.5	13.5	14.5	16.4	71	73	1.062	1.066
$ZnSO_4$ +urea + thiourea (0.5% + 2% + 500 ppm)	97.0	96.7	5.1	5.3	328.1	338.6	333.1	333.1	13.7	14.7	16.6	17.7	73	76	1.061	1.064
SE (Diff.)	**1.2**	**1.1**	**0.3**	**0.3**	**6.4**	**3.2**	**3.5**	**3.5**	**0.13**	**0.33**	**0.18**	**0.13**	**0.012**	**0.007**	**0.014**	**0.007**
CD at 5% P	**2.2**	**2.1**	**0.7**	**NS**	**3.0**	**6.5**	**7.2**	**7.1**	**0.26**	**0.67**	**0.37**	**0.26**	**0.024**	**0.028**	**0.028**	**0.028**
Varieties																
K9351	80.9	80.2	5.3	5.4	297.4	303.7	310.6	314.3	11.4	11.4	14.1	13.8	75	77	1.049	1.052
K8027	104.9	106.1	5.4	4.3	272.2	293.7	294.2	389.8	12.8	12.8	13.5	14.1	66	76	0.994	0.994
SE (diff)	**1.7**	**1.4**	**0.2**	**0.2**	**3.2**	**1.60**	**1.80**	**1.7**	**0.25**	**0.36**	**0.36**	**0.26**	**1.9**	**1.2**	**0.024**	**0.014**
CD at 5% P	**3.5**	**2.9**	**NS**	**0.3**	**1.3**	**4.51**	**7.2**	**3.5**	**0.51**	**0.73**	**0.73**	**0.53**	**3.8**	**2.4**	**0.019**	**0.028**

Table- 2: Influence of zinc urea and thiourea on yield and its attributes of wheat (*Triticum aestivum* L.) under rainfed condition.

Treatments	Length of ear (cm)/ Plant (cm)		No. of spiklets/ear		Weight of grains/ plant (g)		Test weight		Grain yield (q/ha)	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Different Concentration										
Control (water spray)	8.8	8.9	17.0	16.9	3.4	3.9	36.9	36.8	32.0	32.2
$ZnSO_4$ (0.5%)	9.3	9.2	17.5	17.6	3.9	4.4	37.6	36.9	31.6	33.8
Urea (2%)	9.0	9.1	17.2	17.2	3.5	4.2	37.3	37.2	32.7	33.9
Thiourea 500 ppm	10.0	9.8	18.1	18.0	4.6	5.1	39.0	38.4	32.7	34.2
$ZnSO_4$ + urea (0.5% + 2%)	9.4	9.3	17.7	17.7	3.9	4.4	38.0	37.6	33.6	34.8
$ZnSO_4$ + thiourea (0.5% + 500 ppm)	9.8	9.5	18.1	18.0	5.1	5.1	38.5	38.2	34.1	35.1
Thiourea + urea (500 ppm + 2%)	10.3	9.01	18.5	18.2	5.2	5.4	39.4	39.3	35.4	36.1
$ZnSO_4$ +urea + thiourea (0.5% + 2% + 500 ppm)	11.1	10.02	18.7	17.5	5.4	6.2	39.8	37.7	36.3	38.0
SE (Diff.)	**0.14**	**0.13**	**0.19**	**0.15**	**0.13**	**0.11**	**0.2**	**0.1**	**0.90**	**1.8**
CD at 5% P	**0.28**	**0.26**	**0.39**	**0.31**	**0.26**	**0.22**	**0.5**	**0.3**	**1.89**	**3.6**
Varieties										
K9351	10.2	10.2	18.1	18.0	4.6	5.4	38.7	38.6	34.9	35.2
K8027	9.3	9.0	17.7	17.5	4.1	5.7	38.0	37.7	31.6	34.2
SE (diff)	**0.28**	**0.26**	**0.38**	**0.31**	**0.18**	**0.22**	**0.2**	**0.3**	**1.8**	**2.0**
CD at 5% P	**0.57**	**0.53**	**0.78**	**0.63**	**0.37**	**0.45**	**0.6**	**0.7**	**3.6**	**4.0**

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GENE EFFECTS AND HERITABILITY FOR YIELD AND QUALITY TRAITS IN TOMATO (*Solanum lycopersicum* L.)

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ABSTRACT

The generation mean analysis in six populations, namely P1, P2, F1, F2, BC1 and BC2 revealed significant digenic interactions for all the characters in majority of the crosses studied. Character and cross combination revealed the adequacy of simple additive dominance model for titratable acidity (cross 5) indicating the absence of non-allelic interactions. Most of the crosses for all the quality traits showed low magnitude of dominance and environmental variances, revealing higher estimates of broad and narrow-sense heritabilities. Duplicate type of epistasis was observed in total soluble solids (cross 1,2,3,4), ascorbic acid (cross 1), titratable acidity (cross 1,2,3,4) and lycopene (cross 1,2,4) suggesting that the selection intensity should be mild in the earlier and intense in the later generations because it marks the progress through selection. These results indicated that for the improvement of tomato, additive variation is of great importance and makes it possible to successfully select better individuals in segregating populations, since the selective gains will depend only on gametic variation.

Keywords: Epistasis, Gene effects, Quality traits, tomato, yield.

Tomato is universally treated as 'Protective Food' since it is a rich of minerals, vitamins, antioxidants and organic acids (Kumar *et al.*, 2013b). It is a good source of potassium, folate and vitamin E, soluble and insoluble dietary fibers. It has high levels of lycopene (71.6%) and ascorbic acid (12%) (Kaur and Kapoor, 2008). Among the most prominent phytochemicals in tomatoes are the carotenoids, of which lycopene is the most abundant in the ripened fruit, accounting for approximately 8090% of the total pigments (Hernandez *et al.*, 2007, Helyes *et al.*, 2009). Besides lycopene, tomatoes also contain -, -, -, -carotene, zeaxanthin and lutein and also neurosporene, phytoene, and phytofluene (Capanoglu *et al.*, 2010; Ray *et al.*, 2011).

In addition, tomatoes are an excellent source of potassium, pro-vitamin A and vitamin C (ascorbic acid), which are also antioxidants. Overall quality of tomato fruits is comprised of biochemical traits (total soluble solids and titratable acidity), which contribute to flavour, and appearance, which is defined by morphological features and colours. The nutrition importance of

the tomato indicates there is need to formulate breeding programme and to develop cultivar rich in lycopene, processing traits with high quality of fruit as well as yield (Kumar *et al.,* 2013a). These traits in part define quality and are important to consumers (Helyes *et al.,* 2008). The development of tomato varieties with improved quality traits, nutritive value and flavor is a major component of many tomato breeding programs (Rodriguez-Burruezo *et al.,* 2005).

The study was undertaken to estimate the main genetic effects including digenic non-allelic interactions controlling quality components in five tomato cross combinations.