RESEARCH ARTICLE

RESPONSE OF ZINC ON GROWTH AND BIOCHEMICAL CHANGES OF WHEAT (*TRITICUM AESTIVUM* L.) UNDER SODIC SOIL

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Received-27.11.2017, Revised-29.04.2018

Abstract: The present investigation was carried out under field condition at main experiment station (MES) of Narendra Deva University of agriculture & Technology, Narendra Nagar, Kumarganj, Faizabad U.P. during Rabi season 2010-11. The experiment was executed in completely randomized block design (factorial) with three replications. Six treatments comprised of zinc application *i.e.* (control 1%, 1.5% $ZnSO_4$ seed soaking, 15 kg and 25 kg $ZnSO_4$ ha^{-1} basal application and 1% $ZnSO_4$ +2.5% urea foliar spray and three wheat verities (Raj-3077, NW-1014, UP-2425). Seed soaking, basal application and foliar spray of $ZnSO_4$ increased growth characters in all varieties of wheat. Wheat variety UP-2425 responded better in comparison to NW-1014 and Raj-3077. Variety UP-2425 performed maximum plant height number of tiller, Leaf area, dry weight $plant^{-1}$ as compared to Raj-3077 and NW-1014 at the crop growth stages. A control sets was also maintained. Seed soaking, basal application and foliar spray of $ZnSO_4$ increased growth characters and biochemical changes in all varieties of wheat. Application of 25kg $ZnSo_4ha^{-1}$ in soil significantly increased in chlorophyll content, carbohydrate content obtained. Wheat variety UP-2425 responded better in comparison to NW-1014 and Raj-3077. It is concluded from the results that basal application of 25 kg $ZnSo_4$ ha^{-1} was found superior and economical in comparison to other treatments.

Keywords: Zinc, Foliar application, Growth, Soluble carbohydrate, Chlorophyll

INTRODUCTION

Wheat (*Triticum aestivum* L.) a crop of poaceae family which is a major staple food crop of the world after rice. It is primarily grown in temperate region at higher altitude and medium altitude of tropical climate. However, it is cultivated widely around the world due to wide adoption and greater role in human nutrition as well as agricultural economy. With shrinking of arable land due to urbanization and industrialization, the wheat cultivation is also being pushed to marginal lands including salt affected soils. Sodic soil are widespread in the world and in India it occurs mainly in Indo-Gangetic alluvial plains, where it is estimated to cover about 2.8mha in India, salt affected soils are spread 7.0mha of which 1.29mha. exists in U.P. alone (Abrol and Bhumbla 1971). However information of salts affected area in India indicates for 13.0mha. (Yadav and Gupta 1984).Salt affected soil contain excessive concentration of chloride and sulphate of sodium, calcium and magnesium (saline soil) or and excess of exchangeable sodium (alkaline or sodic soil) along with carbonate and bicarbonates. Excessive exchangeable sodium, high pH and poor physical properties of soils are known to adversely affect the growth, yield, chemical composition and nutrients uptake of plant. The adverse effect of soil sodicity is also mediated through the unavailability of certain micronutrients like zinc and iron. The available zinc in Indian soil ranges between 0.08-20.5ppm, Application of zinc have been found to boost the growth and yield of crops to a great extent (Zaid et al. 1977) Zinc deficiency includes rooting and poor tillring leading to decreased productivity in crop plants, since zinc is co-factor of carbonic anahydrase and aldase there fore it may adversely affect enzyme activities and carries corresponding metabolic reaction when zinc is deficient in soil. Zinc is also involved in synthesis of protein tryptophan (amino acid), superoxide dismutase (SOD) activity is much lower but can be restored in vitro by resupplying zinc to the assay medium (Vaugh an et al. 1982).

MATERIALS AND METHODS

The present study was conducted to investigate the response of wheat genotypes Raj-3077, NW-1014, UP-2425, to different treatmentT_{1-} Control,T_{2-} Seed soaking- .0% ZnSo4 (Soaking for 4 hours and drying in shade for 24 hours before sowing). T_{3-} Seed soaking-1.5% ZnSo4 (Soaking 4 hours and drying in shade for 24 hours before sowing). T_{4-}ZnSo4-15 Kg/ha basal application. T_{5-} ZnSo4-25 Kg/ha basal application. T_{6-} Foliar Spray at tillring and booting stage-1.0%ZnSo4+2.5%Urea.Wheat genotypes was collected from seed resource centre of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.). Seed soaking with respectively $ZnSo_4$ solution was done for four hours and then soaked seed were dried in shade for 24-

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hours before sowing. Treated seeds of wheat varieties viz NW-1014, Roj -3077, UP-2425 were sown on 14.12.2012 in rows, spacing 22 cm. at depth of 5.cm as soon as possible planked immediately after sowing. Frequent and light irrigation was given to each plot as and when required. The frequency of irrigation was higher during March and April months. Growth observations were recorded at 30, 60 and 90 DAS stages of crop. Plant height (cm) of five plants was measured from the base of stem up to the apex of the plants; the average height was calculated over three replications. No. of tillers per plant under each treatments were recorded by counting at 30, 60 and 90 DAS. The leaf area (cm) ^{2} was measured by automatic leaf area meter (LICOR-USA model L1-3000). Plant material was oven dried at 70 $^{\pm 0}$C separately and their dry weight was added to obtain total biomass of plant. Chlorophyll content was estimated according to the method of Arnon (1949) and expressed as mg g-1 fresh weight of leaves. Total soluble carbohydrate was measured by the method of Yemm and Willis (1954). The statistical analysis of experimental data was done by method described by Fisher method of analysis of variance (Fisher and Yates, 1949) randomized block design.

Table 1. Effect of zinc application on plant height (cm) at various growth stages of wheat varieties under sodic soil.

Varieties / Treatment	30 DAS				60 DAS				90 DAS			
	RAJ-3077	NW-1014	UP-2425	MEAN	RAJ-3077	NW-1014	UP-2425	MEAN	RAJ-3077	NW-1014	UP-2425	MEAN
T_1	15.66	17.45	16.33	16.48	48.21	54.71	53.90	52.27	56.55	61.10	59.70	59.12
T_2	19.33	20.33	20.00	19.89	51.33	59.41	61.60	57.46	4.88	66.90	65.33	64.37
T_3	22.33	23.50	22.15	22.66	53.10	6032	61.10	58.17	64.10	68.35	66.10	66.18
T_4	22.0	24.10	23.10	23.07	54.10	61.50	61.44	59.01	66.77	70.0	69.40	68.72
T_5	24.33	26.56	25.66	25.52	56.44	63.64	62.97	61.02	69.50	73.15	71.0	71.22
T_6	22.24	24.78	24.31	23.78	55.72	60.33	60.10	58.72	66.90	71.30	69.78	69.33
Mean	20.98	22.79	21.93	21.90	53.15	59.94	60.19	57.78	64.12	68.47	66.89	66.49
SEM±	0.566	04.00	0.980		1.316	0.930	2.279		1.681	1.188	2.911	
CD at 5 %	Zn = 1.625, V =1.15 Zn × V= NS				Zn=3.78, V=2.67, Zn x V =NS				Zn = 483,V=3.415,Zn x V=NS			

Table 2. Effect of zinc application on number of tillers plant^{-1} at various growth stages of wheat varieties under sodic soil.

Varieties / Treatment	30 DAS				60 DAS				90 DAS			
	RAJ-3077	NW-1014	UP-2425	MEAN	RAJ-3077	NW-1014	UP-2425	MEAN	RAJ-3077	NW-1014	UP-2425	MEAN
T_1	3.90	3.40	3.00	3.43	7.50	6.50	6.20	6.73	7.40	6.20	6.0	6.53
T_2	4.20	3.70	3.30	3.73	7.80	7.0	7.50	7.43	7.50	6.90	7.40	7.27
T_3	4.50	3.90	3.30	3.90	8.10	7.40	7.60	7.70	7.90	7.0	7.40	7.43
T_4	4.90	4.20	4.50	4.20	8.30	7.90	7.90	8.30	8.0	7.60	7.6	7.73
T_5	5.40	4.50	3.10	4.67	9.0	8.30	8.0	9.0	8.30	8.0	7.90	8.07
T_6	4.70	3.70	3.60	4.00	8.50	8.00	7.50	8.50	7.80	7.70	7.0	7.50
Mean	4.60	3.90	3.47.	3.99	7.52	7.52	7.45	7.72	7.23	7.23	7.22	7.42
SEM±	0.096	0.068	0.166		0.182	0.129	0.315		0.170	0.120	0.294	
CD at 5 %	Zn = 0.276, V=0.195, V x Zn =NS				Zn = 0.5, V= 0.369, V x Zn =NS				Zn=0.48, V=NS, V x Zn =NS			

Table 3. Effect of zinc application on leaf area plant $^{-1}$ (cm^2) at various growth stages of wheat varieties under sodic soil.

Varieties / Treatment	30 DAS				60 DAS				90 DAS			
	RAJ-3077	NW-1014	UP-2425	MEAN	RAJ-3077	NW-1014	UP-2425	MEAN	RAJ-3077	NW-1014	UP-2425	MEAN
T_1	159.5.	161.10	170.53	163.71	175.35	180.92	182.60	179.62	181.45	183.95	185.77	183.72
T_2	172.53	175.30	179.51	175.78	191.76	192.92	195.45	193.37	193.20	194.75	197.45	195.13
T_3	177.86	178.40	184.32	180.19	195.25	194.56	197.83	195.88	195.90	197.10	199.80	197.60
T_4	180.96	182.43	187.32	183.70	198.78	202.70	205.10	202.19	199.10	201.80	202.45	201.22
T_5	185.33	187.63	191.85	188.34	190.00	205.95	209.87	235.27	205.78	207.60	208.30	207.22

T_6	179.60	184.35	186.18	183.34	196.85	203.43	206.77	202.35	205.10	204.35	203.75	203.40
Mean	176.0	178.20	183.35	179.18	208.00	196.74	199.60	201.45	196.26	198.26	199.64	198.05
SEM±	4.20	2.973	7.281		4.44	3.142	7.697		4.894	3.461	8.477	
CD at 5 %	Zn = 12.08, V = NS, V x Zn=NS				Zn=12.77, V=NS, V x Zn=22.12				Zn=14.06, V=0.345, V x Zn=NS			

Table 4. Effect of Zinc application on dry matter plant^{-1} (g) at various growth stages of wheat varieties under sodic soil.

Varieties	**30 DAS**				**60 DAS**				**90 DAS**			
Treatment	**RAJ-3077**	**NW-1014**	**UP-2425**	**MEAN**	**RAJ-3077**	**NW-1014**	**UP-2425**	**MEAN**	**RAJ-3077**	**NW-1014**	**UP-2425**	**MEAN**
T_1	2.05	2.10	2.46	2.20	3.50	4.15	4.43	4.03	7.28	7.65	8.33	7.75
T_2	2.80	2.81	3.10	2.90	4.60	4.94	4.97	4.66	8.28	8.64	8.78	8.55
T_3	2.86	2.95	3.26	3.02	4.65	5.03	5.03	4.89	8.65	8.75	8.95	8.78
T_4	3.00	3.23	3.40	3.21	5.10	5.35	5.51	5.12	8.97	9.15	9.34	9.15
T_5	3.20	3.45	3.75	3.47	4.78	5.74	5.83	5.56	9.03	9.43	11.16	9.87
T_6	2.90	2.86	3.24	3.00	4.78	5.24	5.26	5.09	8.90	9.17	9.45	9.17
Mean	2.80	2.90	3.20	2.97	4.39	5.08	5.23	4.90	8.51	8.80	9.34	8.88
SEM±	0.069	0.49	0.119		0.136	0.0096	0.236		0.205	0.145	0.356	
CD at 5 %	Zn= 0.198, V=0.14, V x Zn = NS				Zn= 0.392, V= 0.277, V x Zn =NS				Zn=0.59, V= 0.418, V x Zn= NS			

Table 5. Effect of zinc application on total chlorophyll content in leaf (mg/g fresh wt.) at various growth of wheat varieties under sodic soil.

Varieties	**30 DAS**				**60 DAS**				**90 DAS**			
Treatment	**RAJ-3077**	**NW- 1014**	**UP-2425**	**MEAN**	**RAJ-3077**	**NW-1014**	**UP-2425**	**MEAN**	**RAJ-3077**	**NW-1014**	**UP-2425**	**MEAN**
T_1	**1.21**	**1.31**	**1.31**	**1.29**	**1.27**	**1.29**	**1.27**	**1.27**	**1.118**	**1.236**	**1.298**	**1.217**
T_2	**1.27**	**1.35**	**1.28**	**1.30**	**1.27**	**1.35**	**1.46**	**1.36**	**1.207**	**1.285**	**1.312**	**1.268**
T_3	**1.28**	**1.35**	**1.46**	**1.37**	**1.35**	**1.37**	**1.47**	**1.39**	**1.245**	**1.293**	**1.324**	**1.287**
T_4	**1.38**	**1.35**	**1.47**	**1.37**	**1.36**	**1.37**	**1.53**	**1.42**	**1.323**	**1.295**	**1.346**	**1.321**
T_5	**1.36**	**1.31**	**1.52**	**1.39**	**1.36**	**1.37**	**1.54**	**1.42**	**1.357**	**1.312**	**1.379**	**1.349**
T_6	**1.29**	**1.39**	**1.52**	**1.41**	**1.37**	**1.38**	**1.56**	**1.44**	**1.369**	**1.375**	**1.412**	**1.385**
Mean	**1.28**	**1.34**	**1.53**	**1.35**	**1.33**	**1.35**	**1.47**	**1.38**	**1.270**	**1.299**	**1.345**	**1.305**
SEM±	**0.03**	**0.02**	**0.05**		**0.03**	**0.02**	**0.06**		**0.033**	**0.023**	**0.057**	
CD at 5 %	**Zn= 0.09, V=NS, V x Zn = NS**				**Zn =0.10, V=0.07, V x Zn = NS**				**Zn= 0.08, V=0.06, V x Zn = NS**			

Table 6. Effect of zinc application on carbohydrate content in leaf (mg/g dry wt.) at various growth of wheat varieties under sodic soil.

Varieties	**30 DAS**				**60 DAS**				**90 DAS**			
Treatment	**RAJ-3077**	**NW-1014**	**UP-2425**	**MEAN**	**RAJ-3077**	**NW-1014**	**UP-2425**	**MEAN**	**RAJ-3077**	**NW-1014**	**UP-2425**	**MEAN**
T_1	107.03	109.05	112.07	109.38	284..30	228.01	212.07	241.46	180.20	182.60	188.84	183.88
T_2	113.2	114.23	122.03	116.43	291.11	297.73	310.82	299.89	192.54	192.31	195.08	193.31
T_3	115.07	115.05	121.51	117.21	292.23	299.54	311.90	301.22	194.30	193.03	197.31	194.88
T_4	112.23	119.53	128.05	119.94	298.96	305.82	318.75	307.71	199.74	201.23	208.83	203.20
T_5	127.54	130.36	137.33	131.74	312.03	323.01	334.20	323.08	206.93	212.93	223.85	214.57
T_6	125.73	129.30	136.05	130.36	310.01	320.93	322.90	317.95	205.21	211.07	221.74	212.67
Mean	116.77	119.59	126.17	120.84	298.04	262.51	285.11	281.88	196.49	198.86	205.91	200.42
SEM±	2.791	1.973	4.834		6.448	4.559	11.168		0.037	0.026	0.64	
CD at 5 %	Zn = 0.019, V = 0.013, V x Zn = NS				Zn=18. 53, V=13.10, V x Zn = 32.09				Zn=13.54, V=NS, V x Zn = NS			

RESULTS AND DISCUSSION

Overall the results indicated that Sodicity decreased the plant height in all the wheat varieties which was taken in the investigation. The maximum plant height was observed with the basal application of 25 kg & 15 kg Zn SO_4 ha^{-1} followed by 1% and 1.5% seed soaking $ZnSO_4$ and 1% $ZnSO_4$ +2.5% Urea spray. Higher plant height was observed in variety UP-2425 as compared to other varieties, it may be because of genetical characters of the varieties. Similar findings are in agreement with Patel et al. (1995) and Singh et al. (1996) in which they reported that application of zinc sulphate has improved plant height significantly.

It was generally observed that plant height increased up to the stage of 90 DAS which might be because of physiology of the plant (gradual growth from germination to the maturity). Significantly higher number of tillers was found with application of 25 kg zinc and 1% seed soaking as compared to control which might be due to role of zinc particularly under sodic soil condition, where generally zinc deficiency was found variety NW-1014 performed significantly profuse tillring as compared to other verities at 30 and 60 days and maturity. Significant influence of tillers by the varieties might be due to its genetically characters coupled with positive role of zinc towards profuse tillring these results are in the accordance with that of Singh *et al.* (1996). Leaf area of the wheat crop has significant role in assimilation production and photosynthesis activities in this experiment. Leaf area of wheat is significantly influenced by application of $ZnSO_4$. The higher leaf area recorded in UP-2425 it might be due to cell elongation and cell enlargement of the leaves. The fact that zinc is directly involved in the formation of amine acid tryptophan (Tsui, 1948) itself a precursor of indole acetic acid hormone. Similar findings was also reported by Mishra and Mehrotra (1986) and Agrwal *et al*. (1977) in which they reported that application of zinc in zinc deficient soil favored expansion of leaf lamina which is indicator of leaf area expansion. Maximum total dry weight was recorded with the basal application of 25 kg/ha $ZnSO_4$ than control. The more prominent effect was observed in UP-2425 followed by NW-1014, and Raj-3077. These finding are in conformity to Singh and Shukla (1985) and Mail *et al.* (1993) who obtained similar improvement in dry matter production by leaves and stem by the use of zinc application through seed soaking, basal application and foliar spray. Increase in chlorophyll content in all the varieties up to stage of 60 DAS. The maximum increase in chlorophyll content was observed in variety UP-2425 followed by NW-1014 and Raj-3077 and with the basal application of 25 kg $ZnSO_4$ ha^{-1} Dwivedi and Mishra (1979) also reported that zinc and iron increase chlorophyll concentration in the leaf of wheat similar finding were reported by Phaselus vulgaris Marschner (1986) reported that chlorophyll content was considerable lower in zinc deficient plant in comparison to zinc sufficient plants. Singh and sigh (2004) reported that the zinc application increased chlorophyll and raised the tissue concentration of Zn, Ca, Mg, K and P whereas N content decreased. Sharms et al. (1994) observed that decreased photosynthetic rates and reduced leaf chlorophyll content in Zn deficient levels of cauliflower. The effect of zinc sulphate on carbohydrate content in wheat plant were significantly increased with various levels of $ZnSO_4$ (basal, seed soaking and foliar spray) under sodic soil. The maximum carbohydrate was recorded with the basal application of 25 kg ha^{-1} among the varieties, higher carbohydrate content was recorded in UP-2425 as compared to NW-1014 and Raj-3077. Zinc deficiency is manifested by carbohydrate metabolism has been also reported by Rai Singh (1969) who found decrease starch and protein content of wheat Ashor (1971) Observed that total carbohydrate content of wheat was increased by spray of zinc application also increased the synthesis and translocation of carbohydrate to site of grain formation.

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