RESEARCH PAPER

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Physio chemical response of appropriate zinc application on wheat (*Triticum aestivum* L.) under sodic soil condition

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An experiment was conducted with wheat varieties and zinc application method in sodic soil at Main Experiment Station, N.D.University of Agriculture and Technology, Kumarganj, Faizabad in *Rabi* season 2005-06. The specific objective is to identify the economical and effective method of zinc application with reference to growth, yield and quality of wheat under sodic soil condition. Twelve treatment comprised of four methods of zinc application *i.e.* control and 0.5,1.0, zinc sulphate seed soaking and basal 20 kg ZnS04 ha-[1] and three wheat varieties (NW1012, PBW343 and Malviya 468) were tested in three replications. Seeds were soaked as per treatment for four hours and dried in shade for 24 hours before sowing. Seeds soaking and basal application with $ZnS0_4$ increased plant height, number of tillers plant-[1], chlorophyll content, total soluble sugar and grain yield plant-[1] over control. Overall performance of NW1012 variety of wheat showed superiority over Malviya 468 and PBW 343. Basal application of ZnS04 was found more effective over seed soaking method with respect to yield and quality of wheat under soil condition.

Key words : Soil sodicity, Wheat, Chlorophyll, Total soluble sugar, Yield

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop in the world. Uttar Pradesh is the first in respect of area (9.56 mha and production (25.57 mt) but the average productivity is much lower (2.79 t ha^{-1}) than Punjab and Haryana (Anonymous, 2007).

Wheat is one of the important cereals due to its relatively higher niacin and thiamine content. In addition, it is also rich in “glutein” which provides spongy cellular texture of bread and baked product. With shrinking of arable land due to urbanization and industrialization the wheat cultivation is now also being pushed to marginal lands including salt affected soils. Salt affected soils contain excessive concentration of chloride and sulphate of sodium, calcium and magnesium (saline soil) or an excess of exchangeable sodium (alkaline or sodic soil) along with carbonate and bicarbonates (Ahmed, 1996).

Excessive exchangeable sodium, high pH and poor physical properties of soils are known to adversely affect the growth, yield, chemical composition and nutrient uptake of the plants. The adverse affects of soil sodicity are also mediated through the unavailability of certain micro nutrients like zinc and iron. The availability of zinc in salt affected soil is closely related with variability in pH. The reduced availability of zinc in sodic soil has been attributed to the presence of certain inherent edaphic factors which may cause precipitation of zinc in the form of insoluble hydroxides, carbonates or phosphate due to increased adsorption and fixation of zinc on soil colloids.

In zinc stressed plants, protein synthesis is inhibited and amino acids are accumulated up to inhibitory level (Cakmak and Marschner, 1990). Zinc deficiency also affects the metabolism of phosphorus, nitrogen, carbohydrate and nucleic acid (Cakmak and Marschner, 1988). Zinc is intimately related to protein metabolism and play a key role in regulating the auxin concentration in plants and thus directly and indirectly regulate the crop growth. The sustainable productivity of salt affected soils is possible if appropriate soil and nutrient technology is employed. The present investigation is, therefore, undertaken with to identify effective method of zinc application on physio-chemical property and yield of wheat under sodic soil.

RESEARCH METHODOLOGY

An experiment was conducted to identify the economic and effective method of zinc application with reference to growth, yield and quality of wheat under sodic soil condition at Main Experiment Station, N.D. University of Agriculture and Technology, Kumarganj, Faizabad, U.P. Twelve treatments comprised of four method of zinc application (control, 0.5%, 1% seed soaking and basal 20 kg $ZnSO_4$ ha^{-1}) and three wheat varieties (NW-1012, PBW-343 and Malviya-468) were tested in randomised block design in three replications. Plant height (cm) was measured at flowering stage from the base of the stem to apex of the plants; the average height was calculated over five replications. Tiller number per plant under each treatment was recorded by counting at flowering stage. Days to 50% flowering was recorded by visual counting when at least 50% plants were under spike emergence. Grain (g) yield per plant was recorded from five randomly selected plants and average out to get the grain yield per plant. Total chlorophyll content was estimated according to the method of Arnon (1949). Total soluble sugar was determined to the method described by Yemm and Willis (1954).

RESULTS AND ANALYSIS

Data related to plant height revealed that zinc application in the form of $ZnSO_4$ through seed soaking (0.5 and 1.0%) and basal application (20 kg $ZnSO_4$ ha^{-1}) significantly improved the plant height of all wheat varieties grown under sodic soil (Table 1).Maximum plant height of wheat was recorded with application of 20 kg $ZnSO_4$ ha^{-1} followed by 1% and 0.5% seed soaking in $ZnSO_4$ at all the stages of crop growth tillering stage, booting stage, 50% flowering and at maturity. Plant height of all the wheat varieties was found non significant, while interaction between varieties and zinc treatments were also noticed non-significant at all the growth stages. The reduced growth of plant might be due to inhibitory effect of sodicity on cell division and cell elongation (Singh *et al.*, 1996; Patel *et al.*, 1995).

A perusal of the data clearly indicated that application of zinc sulphate @20kg ha^{-1}as basal and 0.5 to 1% seed soaking influenced the number of tillering $plant^{-1}$ (Table 2). At tillering stage, maximum tiller per plant (8.9) was recorded with the application of 20kg $ZnSO_4$ ha^{-1}. As a basal dose which was at par with the application of with 1% seed soaking while minimum was found with 0.5 % $ZnSO_4$. Same trend was observed at booting, 50% flowering and maturity stage. The number of maximum tiller were observed in NW1012 (9.7) and followed by Malviya and PBW343. Sodicity impaired crown root initiation and tillering at root and shoot premordia formation (Gill *et al.,* 1994 and Singh *et al.,* 1996).

Days to 50% flowering was delayed with increasing level of Zinc (Table 3). The maximum delay of 2-3 days in 50% flowering was observed with 20kg $ZnSO_4$ ha^{-1}as compared to control. Malviya 468 showed early flowering than PBW 343 irrespective of zinc treatment.

Zinc treatment significantly influenced the total chlorophyll content at all the stages (Table 4). At booting stage, the effect of zinc level on chlorophyll content was maximum with 20kg $ZnSO_4$ ha^{-1} which was statistically

Table 1: The response of zinc nutrition on plant height (cm) in wheat varieties under sodic soil condition (pH 9.5)

Treatments / Variety	Tillering stage					Booting stage				
	Control	0.5% $ZnSO_4$	1.0% $ZnSO_4$	20kg $ZnSO_4$/ha	Mean	Control	0.5% $ZnSO_4$	1.0% $ZnSO_4$	20kg $ZnSO_4$/ha	Mean
NW1012	30.91	32.88	35.95	39.25	34.75	44.32	49.47	58.08	69.62	55.37
PBW343	27.70	28.35	31.88	34.35	30.57	39.75	45.52	54.35	63.37	50.72
Malviya468	29.94	30.89	33.88	37.22	32.98	40.01	46.75	56.65	65.46	52.22
Mean	29.52	30.71	33.91	36.94	32.77	41.36	47.21	56.36	66.15	52.77
C.D. (P=0.05)	Zn= 4.74	V=NS	Zn x V= NS			Zn= 8.96	V=NS	Zn x V=NS		
	50% flowering stage					Maturity stage				
NW1012	64.64	66.18	70.10	73.94	68.72	74.74	75.34	78.95	83.53	78.14
PBW343	60.29	62.72	66.43	67.76	64.30	66.88	69.47	72.34	76.86	71.39
Malviya468	63.83	64.16	67.75	70.10	66.46	70.03	72.65	76.17	80.18	74.76
Mean	62.92	64.35	68.09	70.60	66.49	70.55	72.49	75.82	80.19	74.76
C.D. (P=0.05)	Zn= NS	V=NS	Zn x V= NS			Zn= 6.36	V=NS	Zn x V=NS		

Table 2: The response of zinc nutrition on number of tiller plant^{-1} in wheat varieties under sodic soil condition (pH 9.5)

Variety \ Treatments	Tillering stage					Booting stage				
	Control	0.5% $ZnSO_4$	1.0% $ZnSO_4$	20kg $ZnSO_4$/ha	Mean	Control	0.5% $ZnSO_4$	1.0% $ZnSO_4$	20kg $ZnSO_4$/ha	Mean
NW1012	6.4	8.5	9.4	9.7	8.5	8.3	9.5	9.6	10	9.4
PBW343	5.3	7.3	7.5	8.4	7.1	6.4	7.4	7.6	8.5	7.5
Malviya468	6.3	7.5	8.4	8.6	7.7	7.3	7.6	8.5	9.5	8.3
Mean	6.0	7.8	8.4	8.9	7.8	7.3	8.2	8.6	9.4	8.4
C.D. (P=0.05)	Zn= 0.99 V=0.86 Zn x V= NS					Zn= 0.97 V=0.84 Zn x V=NS				
	50% flowering stage					Maturity stage				
NW1012	7.3	7.5	8.3	8.5	7.9	5.4	6.5	7.3	8.2	6.9
PBW343	5.2	6.3	6.4	7.3	6.3	4.2	4.2	4.4	5.3	4.6
Malviya468	6.3	6.5	7.5	8.5	6.2	5.2	5.2	5.6	6.6	5.7
Mean	6.3	6.8	7.4	8.1	6.2	4.9	4.9	5.8	6.7	5.7
C.D. (P=0.05)	Zn= 1.35 V=1.14 Zn x V= NS					Zn= 1.02 V=0.85 Zn x V=NS				

Table 3: The response of zinc nutrition on days to 50% flowering in wheat varieties under sodic soil condition (pH 9.5)

Variety \ Treatments	Days to 50% flowering				
	Control	0.5% $ZnSO_4$	1.0% $ZnSO_4$	20kg $ZnSO_4$/ha	Mean
NW1012	80.0	81.0	82.0	83.0	81.5
PBW343	78.0	80.0	81.0	82.0	80.3
Malviya468	76.0	78.0	80.0	81.0	78.6
Mean	78.0	79.6	81.0	82.0	80.2

Table 4: The response of zinc nutrition on chlorophyll content (mg g^{-1}) plant in wheat varieties under sodic soil condition (pH 9.5)

Variety \ Treatments	Tillering stage					Booting stage				
	Control	0.5% $ZnSO_4$	1.0% $ZnSO_4$	20kg $ZnSO_4$/ha	Mean	Control	0.5% $ZnSO_4$	1.0% $ZnSO_4$	20kg $ZnSO_4$/ha	Mean
NW1012	0.67	0.69	0.72	0.71	1.58	1.58	1.64	1.67	1.70	1.65
PBW343	0.65	0.66	0.68	0.66	1.00	1.00	1.22	1.29	1.32	1.20
Malviya468	0.66	0.68	0.70	0.69	1.54	1.54	1.61	1.65	1.68	1.62
Mean	0.66	0.68	0.70	0.69	1.39	1.37	1.49	1.54	1.56	1.49
C.D.(P=0.05)	Zn=NS V=NS Zn x V=NS					Zn=0.50 V=0.50 Zn x V=NS				
	50% flowering stage					Maturity stage				
NW1012	1.40	1.43	1.48	1.53	1.46	0.32	0.32	0.33	0.33	0.32
PBW343	0.87	0.92	1.05	1.08	0.98	0.31	0.31	0.32	0.32	0.31
Malviya468	1.37	1.39	1.44	1.49	1.42	0.31	0.32	0.32	0.32	0.32
Mean	1.21	1.25	1.32	1.37	1.29	0.31	0.32	0.32	0.33	0.32
C.D.(P=0.05)	Zn=0.06 V=0.06 Zn x V=NS					Zn=NS V=NS Zn x V=NS				

Table 5: The response of zinc nutrition on total soluble sugar content (mg g^{-1}) plant in wheat varieties under sodic soil condition (pH 9.5)

Variety \ Treatments	Harvest stage				
	Control	0.5% $ZnSO_4$	1.0% $ZnSO_4$	20kg $ZnSO_4$/ha	Mean
NW1012	62.70	65.20	68.60	71.80	67.08
PBW343	60.70	63.00	66.00	69.70	64.85
Malviya468	61.40	63.30	66.67	70.00	65.35
Mean	61.60	63.83	67.10	70.50	65.76
C.D. (P=0.05)	Zn=0.06		V=0.06		Zn x V=NS

Table 6: The response of zinc nutrition on grain yield plant^{-1} in wheat varieties under sodic soil condition (pH 9.5)

Variety \ Treatments	Grain yield plant^{-1}				
	Control	0.5% $ZnSO_4$	1.0% $ZnSO_4$	20kg $ZnSO_4$/ha	Mean
NW1012	4.27	5.41	6.73	7.06	5.87
PBW343	2.98	3.96	4.22	5.83	4.25
Malviya468	3.93	4.83	5.28	6.33	5.09
Mean	3.73	4.73	5.41	6.41	5.07
C.D. (P=0.05)	Zn=0.44		V=0.38	Zn=x V=NS	

at par with 1% seed soaking of $ZnSO_4$. The maximum chlorophyll content was recorded in NW1012 and minimum in PBW343. Dwivedi and Mishra (1997) also reported that Zinc iron increased chlorophyll concentration in the leaf of wheat.

Among all the varieties, total soluble sugar was recorded significantly higher in NW1012 followed by Malviya 468 and PBW 343 zinc treatment than control. However, mean effect of zinc on total soluble sugar was recorded maximum (70.50 mg g^{-1}) with basal application of 20kg $ZnSO_4$ ha^{-1} (Table 5). The interaction between varieties and zinc treatments also found statistically non-significant. Zinc deficiency is manifested by disturbed carbohydrate metabolism has been also reported by Rai and Singh (1969) who found decreased starch and protein content of wheat. Zinc application also increased the synthesis and translocation of carbohydrate to site of grain formation.

Seed soaking and basal application of $ZnSO_4$ showed a progressive increase in grain yield in all the varieties (Table 6). The grain yield per plant was observed in NW 1012 significantly higher than Malviya 468 and PBW 343. The mean effect of Zinc was 17 to 34% more grain yield than control. Application of $ZnSO_4$ also increased the synthesis and translocation of carbohydrates to the site of grain formation (Prasad *et al.*, 1983; Gupta and Raj, 1993). Similar findings were also reported by Alla-Gab *et al.* (1986) and Verma and Prakash (2003).

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