Int.J.Curr.Microbiol.App.Sci (2020) Special Issue-11: 3731-3739

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Special Issue-11 pp. 3731-3739**
Journal homepage: http://www.ijcmas.com

Original Research Article

To Study the Effect of Zinc Sulphate on Germination, Growth and Yield of Wheat (*Triticum aestivum*.) Grown at different ESP Level of Soil

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Keywords

Zinc Doses, Sodicity level, Germination, wheat and yield

A B S T R A C T

The present investigation was carried out in complete randomized design at experimental form of Deptt. Crop Physiology at Narendra Dev University of Agriculture and Technology, Kumarganj, Faizabad, U.P. India and in sodic soil condition during Rabi season 2012-2013. The experiment of comparises of nine treatments wheat variety NW1014 tested with 20 kg $ZnSO_4ha^{-1}$ applied as basal in normal soil (10ESP), 15 ESP and 20 ESP sodicity level, subsequently 30 kg $ZnSO_4ha^{-1}$ and 40 kg $ZnSO_4ha^{-1}$ were also applied at above sodicity level. Addition of higer $ZnSO_4$ doses not significantly enhanced germination per cent, plant growth and yield of NW1014 wheat variety. Fresh seed of NW1014 wheat variety released recently was used for present study. High germination percentage was obtained in 30 kg $ZnSO_4ha^{-1}$ at 15 ESP. Maximum improvement in plant height was also obtained @ 30 kg $ZnSO_4ha^{-1}$ applied as basal 15 ESP of sodicity as well as phenology and yield. At higher ESP level even higher dose $ZnSO_4$ did not found effective so far.

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. Bread wheat is an allohexaploid (an allopolyploid with six sets of chromosomes two sets from each of the three different species). Wheat is one of the important cereals crops due to the relatively higher niacin and thiamine content. In addition, it is also rich in "gluten" which provides spongy cellular texture of bread and baked product. With shrinking of arable land due to urbanization and industrialization, the wheat cultivation is also being pushed to marginal lands including salt affected soils. Wheat has acreage of 223 million/ha with production 694 million tonnes worldwide (Anonymous, 2011-12). It ranks next to rice consumed by nearly 35 percent of the world population and provides 20 percent food calories. India is the second largest producer in the world, production of wheat 93.9 million tonnes from an area of 29.8 million/ha with a productivity of 2602 kg/hectare in 2004-05 and has increased to 3140 kg/hectare in 2011-12 and it contributes about 34 per cent of total food grain production of the country. Uttar Pradesh ranked first in the country in respect of area and production, area under wheat in Uttar Pradesh is about 9.76 mha, with total production of 27.5mt and the productivity 31.13q/ha (Anonymous, 2012). But the average productivity in our state is comparatively much lower than that of Punjab and Harayana.

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 7.0 mha of which 1.29 m.ha exists in U.P. alone (Abrol and Bhumbla 1971). 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. These affected soils are extensively distributed in arid and semi-arid parts of Harayana, Uttar Pradesh, Punjab, Rajasthan, Gujarat and Maharastra. The salt affected soil in U.P. are spread over several district including Sultanpur, Raebareily, Azamgarh, Etawah, Pratapgarh, Ballia, Mau, Manpuri, Hardoi, Kanpur, Faizabad, Jaunpur, and Fatehpur (Singh and Tyagi, 1980).Excessive exchangeable sodium, high pH and poor physical properties of soils are known to adversely affected the growth, yield, chemical composition and nutrients uptake of plant. The adverse effects of soil sodicity are also mediated through the unavailability of certain micronutrients like zinc and iron. The reduced availability of zinc in sodic soil has been attributed to the presence of certain inherent edaphic factor while may cause precipitation of zinc in the form of insoluble hydroxides, carbonates, phosphate due to adsorption and fixation of zinc on soil colloids. Zinc (Zn) is also involved in key metabolic processes such as respiration, photosynthesis and assimilation of some major nutrients. Zinc plays an important role in enzymes activation as well. The efficiency of such type of elements is improved when it is used in combination with other elements like N and K (Rajput *et al.,* 1995). The detrimental effect of sodicity on biomass production is attribute to osmotic as well as effects of the ions on the physiological and biochemical function of the cell. The increasing level of soil sodicity resulted reduction in plant growth, tiller, production, root and shoot growth (Dargan *et al*., 1976). Soil sodicity has been found to depress protein synthesis and accelerate its degradation in plants. In general the level of reducing sugar and starch decreased in chloroplast, while those of no reducing sugar increased under saline condition. Zinc is the last element in the first transition series to be required by plants the normal concentration of zinc in plants, ranges from 20-30 kg ha^{-1} on dry matter basis. Corn and beans are particularly sensitive to zinc deficiency. Zinc deficiency often identified by distinctive visual symptoms which occurs most frequently in the leaves.

Materials and Methods

The present investigation “Response of Zinc nutrition on plant growth & yield of wheat (*Triticum aestivum L.*) grown in sodic soil" was carried out during Rabi season of 2012-13. The experimental was conducted in pot culture with one varieties of wheat (*Triticum aestivum* L.) NW1014.

Location and Climatic Conditions

The experiment was conducted at the experimental site of the Department of Crop Physiology, Narendra Deva University of Agriculture & Technology (Kumarganj), Faizabad (U.P.). The experimental site is situated 42 km away in south direction from Faizabad and lies between a latitude 24.47^0

and 26.56^{0}North and longitude of 81.12 and 83.90^0 East on an elevation of about 113 meters above mean sea level in the Gangetic alluvium of Eastern Uttar Pradesh.

The Faizabad district falls in semi-arid zone, receiving a mean annual rainfall of 1100 mm, of which about 80 % of total precipitation occurs during monsoon season (January to April) with few shower in winter. Meteorological data *i.e.* temperature, rainfall, relative humidity and sunshine hours of experimental site were collected from meteorological observatory situated at Kumarganj the main campus of the University.

Fertilizer application

Nitrogen, phosphorus and potash were added at the rate of 120, 60 and 60 kg ha^{-1}, through urea, D.A.P. and murate of potash respectively. Half of the nitrogen, total phosphorus and total potash were added as a basal dose before sowing of seeds.

Remaining nitrogen was added in two equal split doses one at tillering stage and the other at the time of flowering. Standard cultural practices were adopted for normal plant growth

Irrigation schedule

All the pots were irrigated uniformly as and when irrigation was required.

Characteristics of Experimental Soil

Treatment details

Zinc Doses : 3

T_1 : 20 kg ha^{-1} $ZnSO_4$

T_2 : 30 kg ha^{-1} $ZnSO_4$

T_3 : 40 kg ha^{-1} $ZnSO_4$

Sodicity level : 3

S_1 : 10 ESP (Normal soil)

S_2 : 15 ESP

S_3 : 20 ESP

Genotypes **:** NW1014

Type of soil **:** Sodic soil

Replications **:** 03

Fertility **:** As per recommended dose (120, 60 and 60 kg ha^{-1}, through urea, DAP and muriate of potash)

Germination (%)

The data pertaining to germination percentage as influenced by various treatments of growth have been presented in Table-4.1.1. A perusal of data showed that sodicity delayed the germination in the wheat variety as compared to normal soil (ESP 10). Various level of $ZnSO_4$ significantly enhanced germination at all ESP level. In control condition (10 ESP), maximum germination was recorded with 30 Kg $ZnSO_4$ ha^{-1}. However, 40 Kg $ZnSO_4$ ha-1did not increase much Similarly, significant increase in germination i.e. 17.33 and 26.67persent at 15 ESP and 20 ESP were recorded with 30 Kg $ZnSO_4$ ha^{-1} over 20 Kgha^{-1}$ZnSO_4$ respectively, whereas higher dose (40 Kg $ZnSO_4$ ha^{-1}) did not showed significant increase in germination at higher ESP (sodicity) level.

Table.1 Meteorological data of *Rabi* season during 2012-2013

Met. Week	Tmin. (^{0}C)	Tmax. (^{0}C)	R.H. (%)	Rainfall (mm)	Bright sunshine (hrs)
49	10.9	27.6	70.7	0.00	2.2
50	9.8	19.7	85.5	0.00	0.4
51	5.5	15.3	84.0	0	1.2
52	5.1	23.4	65.5	0	6.6
01	11.5	19.8	83.7	59.8	1.7
02	8.0	17.6	82.9	3.4	2.3
03	7.9	21.0	77.2	1.4	3.9
04	5.5	22.2	71.5	0	7.0
05	5.0	23.0	72.3	0	7.3
06	6.0	22.9	74.7	15.2	5.9
07	8.6	24.3	67.7	0	5.0
08	11.0	27.5	64.8	0	8.3
09	9.8	28.4	58.7	0	8.6
10	10.8	30.0	59.6	0	7.9
11	10.7	28.4	61.3	0	5.6
12	13.2	32.1	52.0	0	7.1
13	14.9	35.8	42.1	0	7.2
14	19.0	36.5	50.2	0	6.5
15	19.5	37.5	48.7	0	7.7
16	20.4	38.4	35.2	0	8.5

Table.2 The physical and chemical properties of the experimental soil used are given below

Particular		**Description/ values**
Texture class	:	Silt loam
PH	:	9.155
Electrical conductivity (dS m^{-1})	:	1.00 ECe
Organic carbon	:	0.32 %
Available nitrogen (kg ha^{-1})	:	106.00
Available phosphorus (kg ha^{-1})	:	13.52
Available potassium (kg ha^{-1})	:	230.50
CEC (meq/l)	:	3.56
ESP (%)	:	28.9275
Available Zn (%)	:	0.34

Table.3 Experimental details

Design	**:**	Complete Randomized Block Design
Treatments	**:**	9

Table.4 Effect of various doses of zinc sulphate on germination percentage in wheat variety under sodic condition

Treatment	S_1(Normal)	S_2(15ESP)	S_3(20 ESP)	Mean
T_1(20kg $ZnSO_4ha^{-1}$)	73.33	66.00	53.33	64.22
T_2(30kg $ZnSO_4ha^{-1}$)	80.00	83.33	80.00	81.11
T_3(40kg $ZnSO_4ha^{-1}$)	69.67	80.00	76.67	75.45
Mean	74.33	76.44	70.00	
	T	S	TxS	
SEm±	3.07	3.07	5.32	
CD at (5%)	9.12	9.13	15.81	

Table.5 Effect of various doses of Zinc sulphate on number of ear length (cm)of wheat variety under sodic condition

Treatment	S_1(Normal)	S_2(15ESP)	S_3 (20 ESP)	Mean
T_1(20kg $ZnSO_4ha^{-1}$)	7.30	6.36	6.25	6.64
T_2(30kg $ZnSO_4ha^{-1}$)	7.48	7.49	6.72	7.23
T_3(40kg $ZnSO_4ha^{-1}$)	7.04	7.04	6.63	6.90
	7.28	6.96	6.53	
	T	**S**	**TxS**	
SEm±	0.13	0.13	0.23	
CD at (5%)	0.41	0.41	0.71	

Table.6 Effect of various doses of Zinc sulphate on number of ear plant^{-1}of wheat variety under sodic condition

Treatment	S_1(Normal)	S_2(15ESP)	S_3(20 ESP)	Mean
T_1(20kg ZnSO4ha^{-1})	5.00	4.39	3.81	4.40
T_2(30kg ZnSO4ha^{-1})	5.00	5.18	4.63	4.94
T_3(40kg ZnSO4ha^{-1})	4.52	4.92	3.86	4.43
	4.84	4.83	4.10	
	T	**S**	**TxS**	
SEm±	0.09	0.09	0.15	
CD at (5%)	0.27	0.27	0.46	

Table.7 Effect of various doses of Zinc sulphate on Grain yield plant^{-1}(g) (g) of wheat variety under sodic condition

Treatment	S_1(Normal)	S_2(15ESP)	S_3 (20 ESP)	Mean
T_1(20kg $ZnSO_4ha^{-1}$)	2.95	2.34	2.05	2.45
T_2(30kg $ZnSO_4ha^{-1}$)	3.06	3.88	2.87	3.27
T_3(40kg $ZnSO_4ha^{-1}$)	2.58	2.79	2.11	2.49
Mean	2.87	3.00	2.34	
	T	**S**	**TxS**	
SEm±	0.17	0.17	0.29	
CD at (5%)	0.50	0.50	0.87	

Table.8 Effect of Zinc sulphate on plant height (cm) at various days after sowing (DAS) under sodic soil

	30DAS				60DAS				90DAS			
Treatment	**S_1 (Normal)**	**S_2 (15ESP)**	**S_3 (20 ESP)**	**Mean**	**S_1 (Normal)**	**S_2 (15ESP)**	**S_3 (20 ESP)**	**Mean**	**S_1 (Normal)**	**S_2 (15ESP)**	**S_3 (20 ESP)**	**Mean**
T_1 (20kg $ZnSO_4ha^{-1}$)	21.30	19.50	16.92	19.24	54.08	52.23	48.63	51.65	71.45	68.03	67.92	69.13
T_2 (30kg $ZnSO_4ha^{-1}$)	21.48	22.80	21.98	22.09	54.55	56.12	55.04	55.24	73.26	75.27	73.57	74.03
T_3 (40kg $ZnSO_4ha^{-1}$)	19.98	20.95	18.74	19.89	51.52	54.18	49.18	51.63	71.19	72.79	70.14	71.37
Mean	20.92	21.08	19.21		53.38	54.18	50.95		71.97	72.03	70.54	
	T	**S**	**TXS**		**T**	**S**	**TXS**		**T**	**S**	**TXS**	
SEm±	0.61	0.61	1.05		0.83	0.83	1.44		0.71	0.71	1.23	
CD at (5%)	1.81	1.81	3.14		2.47	2.47	4.29		2.12	2.12	3.67	

Table.9 Effect of Zinc sulphate on dry matter plant^{-1} (g) at various days of growth in wheat variety grown under sodic soil

	30DAS				60DAS				90DAS			
Treatment	**S_1 (Normal)**	**S_2 (15 ESP)**	**S_3 (20 ESP)**	**Mean**	**S_1 (Normal)**	**S_2 (15 ESP)**	**S_3 (20 ESP)**	**Mean**	**S_1 (Normal)**	**S_2 (15 ESP)**	**S_3 (20 ESP)**	**Mean**
T_1 (20kg $ZnSO_4$ ha^{-1})	0.56	0.45	0.44	0.48	1.52	1.08	0.53	1.04	4.01	3.59	1.82	3.14
T_2 (30kg $ZnSO_4ha^{-1}$)	0.57	0.64	0.62	0.61	1.72	2.17	2.03	1.97	4.23	5.47	5.19	4.97
T_3 (40kg $ZnSO_4ha^{-1}$)	0.50	0.56	0.47	0.51	1.35	1.62	1.42	1.46	3.90	4.15	3.85	3.97
Mean	0.54	0.55	0.51		1.53	1.62	1.33		4.05	4.40	3.62	
	T	**S**	**TXS**		**T**	**S**	**TXS**		**T**	**S**	**TXS**	
SEm±	0.02	0.02	0.04		0.15	0.15	0.27		0.32	0.32	0.55	
CD at (5%)	0.07	0.07	0.13		0.47	0.47	0.81		0.95	0.95	1.66	

Plant height (cm)

Overall the results indicated that Sodicity decreased the plant height in wheat variety which was taken in present investigation. Various level of $ZnSO_4$ significantly enhanced plant height corresponding to various ESP level. In control condition (10 ESP), maximum plant height (21.48) at 30 DAS was recorded with 30 Kg $ZnSO_4$ ha^{-1}.

However, 40 Kg $ZnSO_4$ ha^{-1} did not increase plant height significantly. Significant interaction between Zinc doses and sodicity levels were obtained. Moreover, maximum response of addition of $ZnSO_4$ was observed at 15 ESP level. At higher ESP level (20 ESP) plant height was decreased subsequently. Similarly 40 Kg $ZnSO_4$ ha^{-1} increased plant height up to 15 ESP whereas at higher 20 ESP plant height was decreased.

At 60 DAS was recorded In control condition (10 ESP), maximum plant height recorded (54.55) with 30 Kg $ZnSO_4$ ha^{-1}. However, 40 Kg $ZnSO_4$ ha^{-1} plant height decreases.. Significant interaction between Zinc doses and sodicity levels were obtained (56.12) 30 $Kgha^{-1}$ $ZnSO_4$ significantly increased the plant height at all ESP level. Moreover maximum response of addition of $ZnSO_4$ was observed at 15 ESP level. At higher ESP level (20 ESP) plant height was decreased subsequently. Similarly 40 Kg $ZnSO_4$ ha^{-1} increased plant height up to 15 ESP at higher 20 ESP plant height was decreased.

At 90 DAS was recorded in control condition (10 ESP), maximum plant height recorded (73.26) with 30 Kg $ZnSO_4$ ha^{-1}. However, 40 Kg $ZnSO_4$ ha^{-1} plant height decreases. Significant interaction between Zinc doses and sodicity levels were obtained (75.27) 30 $Kgha^{-1}$ $ZnSO_4$ significantly increased the plant height at all ESP level. Moreover maximum response of addition of $ZnSO_4$ was observed at 15 ESP level. At higher ESP level (20 ESP) plant height was decreased subsequently. Similarly 40 Kg $ZnSO_4$ ha^{-1} increased plant height up to 15 ESP at higher 20 ESP plant height was decreased.(Table 4.1.2)

Total dry weight plant^{-1} (g)

Overall the results indicated that Sodicity decreased the Total dry weight in wheat variety which was taken in the investigation. In control condition (10 ESP), maximum dry weight i.e. 0.57, 1.72 and 4.23 at 30 DAS, 60 DAS at 90 DAS were observed with 30 kg $ZnSO_4$. However higher dose of $ZnSO_4$ did not enhanced interaction between sodicity level and Zinc were also observed. At 15 ESP, maximum dry weight i.e. 0.64, 2.17 and 5.47 at 30 DAS, 60 DAS at 90 DAS were observed with 30 kg $ZnSO_4$. However higher dose of $ZnSO_4$ did not enhanced interaction between sodicity level and Zinc were also observed. At 15 ESP, Maximum response of $ZnSO_4$ on dry weight 40 kg $ZnSO_4$ is 0.56, 1.62 and 4.15 at 30 DAS, 60 DAS at 90 DAS respectively. At 20 ESP, minimum response of $ZnSO_4$ on dry weight 20 kg $ZnSO_4$ is 0.44, 0.53 and 1.82 at 30 DAS, 60 DAS at 90 DAS respectively (Table. 4.1.3).

Ear length (cm)

It is clear from the data presented in Table-4.4.1. Zinc nutrient and sodic soil condition showed a progressive increase ear length plant-1 in the variety. Various level of $ZnSO_4$ significantly enhanced ear length plant-1 at ESP level. In control condition, maximum ear length i.e. 7.48cm were observed with 30 kg $ZnSO_4$. However higher dose of $ZnSO_4$ did not enhanced interaction between sodicity level and Zinc were also observed. At 15 ESP, maximum ear length i.e 7.49cm were observed with 30 kg $ZnSO_4$. However higher dose of $ZnSO_4$ did not enhanced interaction between sodicity level and Zinc were also observed. At 15 ESP, Maximum response of $ZnSO_4$ on ear length 40 kg $ZnSO_4$ is 7.04. At 20 ESP, minimum response of $ZnSO_4$ on ear length 20 kg $ZnSO_4$ is 6.25 (Table. 4.4.1).

Number of ear plant^{-1}

Various level of $ZnSO_4$ significantly enhanced number of ear at ESP level. In control condition, maximum number of ear i.e. 5.00 were observed with 30 kg $ZnSO_4$. However higher dose of $ZnSO_4$ did not enhanced interaction between sodicity level and Zinc were also observed. At 15 ESP, maximum number of ear i.e 5.18 were observed with 30 kg $ZnSO_4$. However higher dose of $ZnSO_4$ did not enhanced interaction between sodicity level and Zinc were also observed. At 15 ESP, Maximum response of $ZnSO_4$ on number of ear 40 kg $ZnSO_4$ is 4.92. At 20 ESP, minimum response of $ZnSO_4$ on number of ear 20 kg $ZnSO_4$ is 3.81 (Table. 4.4.2).

Grain yield plant^{-1}(g)

The data on the effect of zinc nutrient and ESP on grain yield in wheat grown under sodic soil are presented in Table-4.4.4. Various level of $ZnSO_4$ significantly enhanced grain yield at ESP level. In control condition, maximum grain yield i.e. 3.06 were observed with 30 kg $ZnSO_4$. However higher dose of $ZnSO_4$ did not enhanced interaction between sodicity level and Zinc were also observed.

At 15 ESP, maximum grain yield i.e 3.88 were observed with 30 kg $ZnSO_4$. However higher dose of $ZnSO_4$ did not enhanced interaction between sodicity level and Zinc were also observed. At 15 ESP, Maximum response of $ZnSO_4$ on yield 40 kg $ZnSO_4$ is 2.79. At 20 ESP, minimum response of $ZnSO_4$ on grain yield 20 kg $ZnSO_4$ is 2.05 (Table. 4.4.4).

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