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NUTRITIONAL DOSES OF ZINC SUPPLY EFFECT ON GROWTH, YIELD AND METABOLIC STUDIES OF CHICK PEA (*CICER ARIETINUM* L.) VARIETIES

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Abstract

Field experiment was conducted during *rabi* 2016-17 and 2017-18 at Students Instructional Farm at same location of field both year, Chandra Shekhar Azad University of Agriculture and Technology Kanpur-208 002, U,P., India. The experiment design was applied Factorial Randomized Block Design with three replication, four varieties and four treatments. The chick pea varieties viz., V_1(KWR 108), V_2(KGD 1168), V_3(Udai) and V_4(Pragati) with four different doses of $ZnSO_4$ *viz*., T_1(Control), T_2(2.5kg/ha), T_3(5.0kg/ha) and T_4(7.5kg/ha) as soil applied, then total treatment 16at different stages and at harvest. Among these dose of $ZnSO_4$ (5.0 kg/ha) was increased maximum plant height (cm/plant), number of leaves per plant, leaf area per plant, relative growth rate, percentage of pod setting, seed yield (g) per plant and protein content in seed. Result revealed that application of 5.0 kg/ha $ZnSO_4$ were significantly increase all above observation in comparison to other varieties and control (Zn 0 kg/ha) at both the year. However, application of $ZnSO_4$ @5 kg/ha on chick pea produce significantly maximum seed yield in comparison to control. Among the variety V_1 (KWR108) was increased in comparison to other variety.

Key words : Chickpea, zinc nutrient, plant height, number of leaves per plant, leaf area per plant, relative growth rate, percentage of pod setting, seed yield(g) per plant, biological yield(kg/ha), protein content in seed.

Introduction

Zinc has been reported to play an important role in the metabolism of plant. Thus, through their water culture experiment included that relatively larger quality of phenolic materials sterols and lecithin's in zinc deficient leaves or sub-oxidized product of carbohydrates and protein metabolism arising due to disturbed oxidation reduction with in the leaf cells they further concluded that zinc is concerned with the functioning of the sulfhydryl compounds.

The chickpea grains are rich in minerals and vitamins and it is an excellent source of human, animal feed because of high protein content and it plays a major role in agricultural practices by fixing atmospheric nitrogen in the soil. Chickpea is an important source of protein and it is the protein rich supplement to cereal-based diets, especially to the agrarian population of the country and cheaper source of protein in developing countries. Their high protein content is perfect for those wishing to replace red meat in their diet. Deep and tap roots of chickpea improves soil structure and nodules present on roots help in restoration of soil fertility. Besides, crop also offers scope for diversification of cereal based cropping systems and in sustaining agricultural production. The chickpea proteins are rich in lysine and have low sulphur containing amino acids.

Zinc micronutrient is involved in auxin formation activation of carbonic anhydrogenase, dehydrogenase enzyme and stabilization of ribosomal fraction. Zinc play significant role in chlorophyll formation, carbohydrates metabolism synthesis of protein and activation of oxidation process and enzymes. Nitrogen deficiency is the most important which is almost of universal occurrence in Indian soils. Nitrogen is a primary element and to special importance in the formation of protein in plants. It is also present in chlorophyll green pigments that are receptor of high energy in photosynthesis. In present investigation

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application of thiourea might have improved phloem loading of sucrose and hence translocation of photosynthates.

Materials and Methods

Kanpur district, where the experimental site is situated, forms a part of lower Ganga-Yamuna *doab*. It is spread over 115 km from North to South and 105 km east to west. It lies between the parallels of 25^0 26' and 26^0 58' North latitude and 79^0 31' and 80^0 34' East longitude and is situated at an elevation of 129.0 meter above the Mean Sea level. The district falls within sub-tropical zone and has a semi-arid climate. The annual rainfall of the district is about 816 mm, which is mainly received from the middle of June to September with some scattered showers in winter months, particularly in December, January or sometimes even in February. Soil samples from surface layer (0-10 cm) were collected at random from five places of the experimental field before sowing. The soil samples were composited, dried, sieved and analyzed in the laboratory for their physical, physico-chemical and chemical properties.

Treatments and experimental design

The experiment was consists of 16 treatment combinations and laid out in Factorial Randomized Block Design assigning four treatments in plot *viz.* T_1- Control ($ZnSo_4$ @0 kg/ha), T_2- ($ZnSo_4$ @2.5 kg/ha), T_3- ($ZnSo_4$ @5.0 kg/ha), T_4- ($ZnSo_4$ @7.5 kg/ha), and four varieties as V_1(KWR 108), V_2 (Alok or KGD 1168), V_3 (Uday or KPG 59) and V_4 (Pragati or K 3256) with three replications. The fertilizer applied as nitrogen @ 18 kg ha^{-1} through urea as basal, phosphorus as per treatment through di ammonium phosphate (DAP) and zinc as per treatment through zinc sulphate.

Results and Discussion

Plant height (cm/plant)

The data revealed presented in table 1 the maximum plant hight (cm) per plant were recorded with the variety V_4 Pragati followed by V_1 KWR-108, V_2 KGD1168 minimum were recorded with the variety V_3 Uday at 30 DAS, 60 DAS, 90 DAS and at harvest on both the year *i.e.* 2016-17 and 2017-18 data basis. All the differences between verities were found significant.

Application of zinc level 5.0 Kg/ha showed maximum plant height (cm) per plant at all the stages and minimum were recorded under control treatment. Application of zinc 7.5 Kg/ha gave decreasing trend in comparison to 5.0 kg/ha at all the stages on plant height (cm) per plant both the year. All the differences between nutritional levels of zinc were found significant. Interaction effect was not statistically significant.

Number of leaves per plant

The data revealed presented in table 2, the maximum number of leaves per plant were recorded with the variety

Table 1 : Nutritional level of zinc on plant height (cm) per plant on chick pea varieties.

Treatment	Plant height (cm) per plant							
	30 DAS		60 DAS		90 DAS		Harvest	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Varieties								
V_1	12.71	12.83	30.44	32.53	45.80	47.50	54.26	55.06
V_2	12.40	12.52	29.49	31.57	44.47	45.91	53.60	54.49
V_3	12.19	12.31	29.00	31.08	43.04	44.93	52.96	53.70
V_4	12.78	12.94	30.73	32.94	46.90	48.32	54.93	56.13
SE (m)±	0.23	0.25	0.29	0.45	0.65	0.83	0.64	0.74
CD at 5%	N.S.	N.S.	0.85	1.31	1.87	2.41	1.87	2.14
Zinc levels (Kg/ha)								
0	12.11	12.26	28.59	30.77	42.64	43.28	51.32	51.96
2.5	12.63	12.75	30.04	32.16	45.57	46.60	54.92	55.76
5.0	12.86	12.98	31.33	33.35	48.02	51.05	56.74	58.30
7.5	12.48	12.61	29.70	31.84	43.99	45.73	52.98	53.36
SE (m)±	0.23	0.25	0.29	0.45	0.65	0.83	0.64	0.74
CD at 5%	N.S.	N.S.	0.85	1.31	1.87	2.41	1.87	2.14
Interaction V×Zn								
SE (m)±	0.46	0.51	0.58	0.90	1.30	1.66	1.29	1.48
CD at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table 2 : Effect of nutritional level of zinc on number of leaves per plant of chick pea (*Cicer arietinum*L.) varieties.

Treatment	Number of leaves per plant							
	30 DAS		60 DAS		90 DAS		Harvest	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Varieties								
V_1	23.23	24.49	191.88	201.49	205.57	216.15	28.22	29.67
V_2	23.17	24.33	171.08	179.52	183.29	192.34	25.16	26.40
V_3	22.61	23.74	168.06	176.50	180.05	189.10	24.71	25.96
V_4	22.23	23.35	161.68	169.71	173.22	181.82	23.78	24.96
SE (m)±	0.27	0.31	2.53	3.77	2.79	2.94	0.50	0.65
CD at 5%	0.78	N.S.	7.32	10.91	8.08	8.51	1.46	1.89
Zinc levels (Kg/ha)								
0	22.10	23.29	155.98	163.90	167.11	175.62	22.94	24.10
2.5	23.03	24.09	179.92	188.82	192.76	202.29	26.46	27.77
5.0	23.45	24.62	190.51	200.05	204.11	214.58	28.02	29.45
7.5	22.67	23.89	166.28	174.46	178.15	186.91	24.45	25.66
SE (m)±	0.27	0.31	2.53	3.77	2.79	2.94	0.50	0.65
CD at 5%	0.78	0.91	7.32	10.91	8.08	8.51	1.46	1.89
Interaction V×Zn								
SE (m)±	0.54	0.63	5.07	7.55	5.59	5.89	1.01	1.31
CD at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table 3 : Effect of nutritional level of zinc on leaf area (cm^2) per plant.

Treatment	Leaf area (cm^2) per plant					
	30 DAS		60 DAS		90 DAS	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Varieties						
V_1	124.37	128.50	556.56	575.01	560.91	579.52
V_2	121.94	125.99	544.85	562.11	549.34	569.43
V_3	120.08	124.40	537.36	555.20	542.35	560.31
V_4	113.60	117.37	508.35	525.21	513.99	530.34
SE (m)±	1.26	1.74	5.43	7.93	6.30	6.03
CD at 5%	3.63	5.04	15.70	22.93	18.20	17.42
Zinc levels (Kg/ha)						
0	114.17	117.96	510.06	526.17	513.39	532.27
2.5	121.45	125.81	543.49	561.51	548.95	566.97
5.0	123.47	127.57	552.53	570.87	557.69	576.18
7.5	120.91	124.92	541.04	558.98	546.06	564.17
SE (m)±	1.26	1.74	5.43	7.93	6.31	6.03
CD at 5%	3.63	5.04	15.70	22.93	18.20	17.42
Interaction V×Zn						
SE (m)±	2.51	3.49	10.87	15.87	12.60	12.06
CD at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

differences between verities were found significant.

Application of zinc level 5.0 Kg/ha showed maximum number of levels per plant at all the stages and minimum were recorded under control treatment. Application of zinc 7.5 Kg/ha gave decreasing trend in comparison to 5.0 kg/ha at all the stages on number of leaves per plant both the year. All the differences between nutritional levels of zinc were found significant.

Leaf area (cm^2) per plant

The data revealed presented in table 3 the maximum leaf area (cm^2) per plant were recorded with the variety V_1KWR-108 followed by V_2 KGD1168, V_3Uday and minimum were recorded with the variety V_4 Pragati at 30 DAS, 60 DAS, 90 DAS and at harvest on both the year *i.e.* 2016-17 and 2017-18 data basis. All the differences between verities were found significant.

Application of zinc level 5.0 Kg/ha showed maximum leaf area (cm^2) per plant at all the stages and minimum

were recorded under control treatment. Application of zinc 7.5 Kg/ha gave decreasing trend in comparison to 5.0 kg/ha at all the stages on leaf area (cm^2) per plant both the year. All the differences between nutritional levels of zinc were found significant.

Relative growth rate

The data revealed presented in table 4 the maximum relative growth rate (mg/g/day) were recorded with the variety V_1KWR-108 followed by V_3Uday, V_2 KGD1168, and minimum were recorded with the variety V_4Pragati at 30 to 60 DAS, on the year 2016-17 data basis. All the differences between verities were found significant. Application of zinc level 7.5 Kg/ha showed maximum relative growth rate (mg/g/day) at all the stages and minimum were recorded under control treatment. Application of zinc 2.5 Kg/ha gave decreasing trend in comparison to 7.5 kg/ha at all the stages on relative growth rate (mg/g/day) on the year 2016-17. All the differences between nutritional levels of zinc were found significant.

The maximum relative growth rate (mg/g/day) were recorded with the variety V_2 KGD1168 and V_1 KWR-108, V_3 Uday, V_4 Pragati are similar relative growth were recorded with the variety at 30 to 60 DAS, on the year i.e. 2017-18 data basis. All the differences between verities were found significant. Application of zinc level 5.0 Kg/ha showed maximum relative growth rate (mg/g/day) at all the stages and minimum were recorded under control treatment. Application of zinc 2.5 Kg/ha gave decreasing trend in comparison to 5.0 kg/ha at all the stages on relative growth rate (mg/g/day) on the year 2017-18.All the differences between nutritional levels of zinc were found significant.

The maximum relative growth rate (mg/g/day) were recorded with the variety V_2 KGD 1168 followed by V_1 KWR 108, V_3 Uday and minimum were recorded with the variety V_4 Pragati at 60 to 90 DAS, on the year *i.e.* 2016-17 data basis. All the differences between verities were found significant. Application of zinc level 2.5 Kg/ha showed maximum relative growth rate (mg/g/day) at all the stages and minimum were recorded under control treatment. Application of zinc 5.0 Kg/ha gave decreasing trend in comparison to 2.5 kg/ha at all the stages on relative growth rate (mg/g/day) on the year 2016-17. All the differences between nutritional levels of zinc were found significant.

The maximum relative growth rate (mg/g/day) were recorded with the variety V_1 KWR 108 followed by V_2 KGD 1168, V_3 Uday and minimum were recorded with the variety V_4Pragati at 60 to 90 DAS, on the year *i.e.* 2017-18 data basis. All the differences between verities were found significant. Application of zinc level 7.5 Kg/ha showed maximum relative growth rate (mg/g/day) at all the stages and minimum were recorded under control treatment. Application of zinc 5.0 Kg/ha gave decreasing

Table 4 : Effect of nutritional level of zinc on relative growth rate (mg/g/day) studies of chick pea (*Cicer arietinum* L.) varieties.

Treatment	Relative growth rate (mg/g/day)			
	30-60 DAS		60-90 DAS	
	2016-17	2017-18	2016-17	2017-18
Varieties				
V_1	5.38	5.44	1.51	1.40
V_2	5.32	5.45	1.55	1.39
V_3	5.36	5.44	1.49	1.38
V_4	5.22	5.44	1.48	1.29
SE (m)±	0.05	0.05	0.03	0.02
CD at 5%	N.S.	N.S.	N.S.	0.08
Zinc levels (Kg/ha)				
0	5.26	5.36	1.51	1.36
2.5	5.31	5.45	1.51	1.37
5.0	5.34	5.49	1.48	1.35
7.5	5.37	5.46	1.50	1.37
SE (m)±	0.05	0.05	0.03	0.02
CD at 5%	N.S.	N.S.	N.S.	N.S.
Interaction V×Zn				
SE (m)±	0.11	0.11	0.06	0.05
CD at 5%	N.S.	N.S.	N.S.	0.16

Table 5 : Effect of nutritional level of zinc on percentage (%) of pod setting per plant studies of chick pea (*Cicer arietinum* L.) varieties.

Treatment	Percentage (%) of pod setting per plant	
	2016-17	2017-18
Varieties		
V_1	75.36	75.13
V_2	75.05	75.04
V_3	75.07	75.05
V_4	75.04	75.21
SE (m)±	0.24	N.S.
CD at 5%	0.27	N.S.
Zinc levels (Kg/ha)		
0	75.04	75.04
2.5	75.20	75.05
5.0	75.23	75.29
7.5	75.05	75.04
SE (m)±	0.24	N.S.
CD at 5%	0.27	N.S.
Interaction V×Zn		
SE (m)±	0.48	0.55
CD at 5%	N.S.	N.S.

Table 6 : Effect of nutritional level of zinc on seed yield (g) per plant studies of chick pea (*Cicer arietinum*L.) varieties.

Treatment	Seed yield (g) per plant		
	2016-17	2017-18	Pooled
Varieties			
V_1	14.42	15.46	14.94
V_2	12.97	13.94	13.46
V_3	12.83	13.83	13.33
V_4	12.48	13.17	12.82
SE (m)±	0.31	0.37	0.24
CD at 5%	0.91	1.09	0.68
Zinc levels (Kg/ha)			
0	12.32	13.25	12.79
2.5	13.15	14.03	13.59
5.0	13.84	14.80	14.32
7.5	13.39	14.31	13.85
SE (m)±	0.31	0.37	0.24
CD at 5%	0.91	1.09	0.68
Interaction V×Zn			
SE (m)±	0.63	0.75	0.48
CD at 5%	N.S.	N.S.	N.S.

Table 7 : Effect of nutritional level of zinc on protein content (%)in seed of chick pea varieties.

Treatment	Protein content (%) in seed		
	2016-17	2017-18	Pooled
Varieties			
V_1	20.66	20.65	20.66
V_2	20.44	20.50	20.47
V_3	20.35	20.42	20.39
V_4	20.17	20.24	20.21
SE (m)±	0.04	0.06	0.04
CD at 5%	0.12	0.19	0.11
Zinc levels (Kg/ha)			
0	19.91	19.96	19.94
2.5	20.48	20.55	20.51
5.0	20.80	20.82	20.83
7.5	20.40	20.48	20.44
SE (m)±	0.04	0.06	0.04
CD at 5%	0.12	0.19	0.11
Interaction V×Zn			
SE (m)±	0.08	0.13	0.08
CD at 5%	N.S.	N.S.	N.S.

trend in comparison to 7.5 kg/ha at all the stages on relative growth rate (mg/g/day) on the year 2017-18. All the differences between nutritional levels of zinc were found significant.

Percentage (%) of pod setting per plant

The data revealed presented in table 5 the maximum percentage of pod setting per plant were recorded with the variety V_1 KWR 108 followed byV_3 Uday, V_2 KGD 1168 and minimum were recorded with the variety V_4 Pragati at the year 2016-17 data basis. All the differences between verities were found significant. The year 2017-18 maximum percentage of pod setting per plant were recorded with the variety V_4 Pragati followed by V_1KWR 108, V_3 Uday and minimum were recorded with the variety V_2 KGD 1168 on data basis. All the differences between verities were found significant. Application of zinc level 5.0 Kg/ha showed maximum percentage of pod setting per plant and minimum were recorded under control treatment. Application of zinc 7.5 Kg/ha gave decreasing trend in comparison to 5.0 kg/ha percentage of pod setting per plant at both the year. All the differences between nutritional levels of zinc were found significant.

Seed yield (g) per plant

The data revealed presented in table 6 the maximum seed yield (g) per plant were recorded with the variety V_1 KWR 108 followed by V_2 KGD 1168, V_3 Uday and minimum were recorded with the variety V_4 Pragati the year 2016-17 and 2017-18 data basis. All the differences between verities were found significant. Application of zinc level 5.0 Kg/ha showed maximum seed yield (g) per plant at all the stages and minimum were recorded under control treatment. Application of zinc 7.5 Kg/ha gave decreasing trend in comparison to 5.0 kg/ha at all the stages. All the differences between nutritional levels of zinc were found significant.

It is revealed from the data presented in table 6 the maximum seed yield (g) per plant were recorded with the variety V_1KWR 108 followed by V_2 KGD 1168, V_3Uday and minimum were recorded with the variety V_4Pragati on pooled data basis of experimentation. All the differences between verities were found significant. Application of zinc level 5.0 Kg/ha showed maximum seed yield (g) per plant at pooled stage and minimum were recorded under control treatment. Application of zinc 7.5 Kg/ha gave decreasing trend in comparison to 5.0 kg/ha on both year data basis. All the differences between nutritional levels of zinc were found significant.

Protein content (%) in seed

The data revealed presented in table 7 the maximum protein content (%) in seed were recorded with the variety V_1KWR 108 followed by V_2 KGD 1168, V_3Uday and minimum were recorded with the variety V_4 Pragati

at both the year *i.e.* 2016-17 and 2017-18 data basis. All the differences between verities were found significant. Application of zinc level 5.0 Kg/ha showed maximum protein content (%) in seed and minimum were recorded under control treatment. Application of zinc 7.5 Kg/ha gave decreasing trend in comparison to 5.0 kg/ha protein content (%) in seed at both the year. All the differences between nutritional levels of zinc were found significant.

The maximum protein content (%) in seed were recorded with the variety V_1 KWR 108 followed by V_2 KGD 1168, V_3 Uday and minimum were recorded with the variety V_4 Pragati on pooled data basis. All the differences between verities were found significant. Application of zinc level 5.0 Kg/ha showed maximum protein content (%) in seed and minimum were recorded under control treatment. Application of zinc 7.5 Kg/ha gave decreasing trend in comparison to 5.0 kg/ha protein content (%) in seed on pooled data basis. All the differences between nutritional levels of zinc were found significant.

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