International Journal of Applied and Pure Science and Agriculture
ISSN Online - 2394-5532 Impact Factor : 4.446 by SJIF ISSN Print - 2394-823X

ANALYSIS OF RESPONSE OF DIFFERENT CHELATED ZINC SOURCES ON MICRO AND MACRO NUTRIENTS UPTAKE IN MOONG PLANT AND SEED (VIGNA RADIATA)

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Abstract

A field study was conducted at St. John's College, Agra to evaluate the effect of different chelated zinc sources on micro and macro nutrients of moong (Vigna radiata.). Crop was sown on well prepared soil. The experiment was laid out according to randomized complete block design. The treatments comprised of different chelated zinc sources: $ZnSO_4$ and Zn EDTA+ Zn DTPA along with control (no zinc), repeated three times. Results showed that N, P and K were significantly higher with medium doses but decreases with increase in concentration. Similarly Ca, Mg and Fe also follow the same tread. The same pattern is also observed in seed mineral contents. Moreover, results also revealed that ZnSO4 along with Zn EDTA and Zn DTPA was found the most effective Zn chelated source among all the treatments.

Keywords: Chelated Zn, Moong, $ZnSO_4$, Fe, Zn

I. INTRODUCTION

Green gram is an important pulses crop in India and believed to be originated from India. It is shrub short duration legume crop grown mostly as a fallow crop in rotation with rice. it enriches soil nitrogen content. More than 70% of world's green gram production comes from India and is a largest consumer of it. The nutritional value per 100gm is energy 1452KJ, carbohydrate 62.62g, protein, 23.86g and rest vitamins. The mineral content is Ca 13%, Fe 52%, Mg 53%, Mn 49%, Zn 28%, P 52% and K 27%. Zinc is essential for plants, animals and man. Today still its deficiency persists in our soils which creates problem in many physiological processes to function normaly [1]. A critical small concentration of zinc is required to perform several key pathways in plants. These pathways have important roles in growth regulation, photosynthesis and sugar formation, fertility and seed production, and defense against disease. These physiological functions will be impaired and the health and productivity of the plants will be adversely affected due to zinc deficiency. Thus resulting in lower yields (or even crop failure) and frequently in poorer quality crop products [2]. Zinc deficiency is the most widespread micronutrient disorder among different crops [3].

On calcareous soils, adsorption and fixation reactions can substantially reduce the efficacy of micronutrients. Therefore, chelating agents, such as Ethylenediaminetetraacetic acid (EDTA) and Diethylenetriamenepentaacetate (DTPA), are commonly used to increase the persistence of Zn and other trace elements in the soil solution. Zinc fertilizers could potentially be improved by using chelates that facilitate metal absorption by plant roots [4]. Several studies showed that chemical amendments such as chelating agents increase metal availability and uptake by plants [5] [6] [7] [8] [9]. EDTA effectively increased the mobility of total water-soluble macronutrients (Ca, K, Mg, and P) and micronutrients (Fe, Mn) in the soil solution.

The aim of this work was to study if complexes of Zn with chelating agents could improve availability of Zn to plant for improving micro and macro nutrients of moong on alkaline and calcareous soil". In countries with a high incidence of micronutrient deficiencies, cereal-based foods represent the largest proportion of the daily diet [10].

II. MATERIALS AND METHODS

Soil samples were taken before sowing of crop at a depth of 30cm for physicochemical analysis.

Physicochemical Characteristic	Value
Texture	Sandy loam
pH	7.34
Organic matter	8.5%
Organic carbon	4.8gKg^{-1}
Nitrogen available	0.14%
Phosphorous available	0.12%
Potassium available	0.30%
CEC	12.90cmol(p+)kg-^{1}
SAR	0.18 (mmol L^{-1})$^{1/2}$
$CaCO_3$	13.3%

The experiment was conducted using randomized complete block design (RCBD) having three replications. The experiment was comprised of following treatments with doses of $ZnSO_4$ (0, 5, 10 and 15 ppm) and Zn EDTA + Zn DTPA (0, 5 and 10 ppm) of each with different combinations as follows

$ZnSO_4$	Zn EDTA + Zn DTPA		
Treatment	**ZnE_0ZnD_0 (X)**	**ZnE_5ZnD_5 (Y)**	**$ZnE_{10}ZnD_{10}$ (Z)**
Zn_0 (A)	AX	AY	AZ
Zn_5 (B)	BX	BY	BZ
Zn_{10} (C)	CX	CY	CZ
Zn_{15} (D)	DX	DY	DZ

About 10 seeds of moong were sown and the pots were randomized in the greenhouse. After sprouting, seedlings were thinned to 5 plants pot^{-1}. Zn chelates were applied as fertigation after 20 days of emergence of seedlings using recommended dose in distilled water to avoid any contamination. Soil application was done in late evening and morning. After harvesting, the moong plant and seeds were dried in oven at 60^{0}C, weighed and ground to powder. The concentration of Ca, Mg, Zn and Fe in the soil, plant and seed samples was determined by using AAS. The nitrogen is determined by Kjeldhal method [11] and P by colorimeter method [12]

Statistical Analysis-

The observed quantitative data was tabulated to statistical analysis with the help of ANOVA. The F test was used to determine whether any real difference between the treatments exists or there were only error of sampling. The composition of testing the significance was made at 5% level.

III. RESULT AND DISCUSSION

Application of chelated zinc improved the N, P and K significantly. Comparative study of mean values (Table 1) for N in plant revealed significant results varying from 4.40 ppm to 4.93ppm. Maximum N (4.93ppm) was recorded in ZnE_5ZnD_5treated pots followed by ZnE_0ZnD_0 (4.69ppm while least N was observed in $ZnE_{10}ZnD_{10}$ (4.40ppm). The maximum N content in seed was found in $ZnE_{10}ZnD_{10}$ (5.57ppm) (Table 2). Similar results are reported [13] that addition of Zn to the soil at the recommended rate substantially increased the micronutrients of maize. Bukvic [14] also reported positive effects of phosphorus and zinc fertilization on uptake of maize. The increased N content with chelating agent application may be ascribed to increased root system and higher absorbing capacity.

Phosphorus is an essential element in plants, and deficiency can significantly limit plant growth. The highest phosphorus concentration in plant and seed was obtained at ZnE_5ZnD_5 level i.e. 0.06 ppm and 0.06 ppm respectively. It was observed that there was no effect of Zn chelates on P content. It may be concluded that Zn chelates applied were not found to be effective in enhancing the P content.

It is further noted that Potassium content increased significantly to a greater extent at ZnE_5ZnD_5 concentration level in plant and seed (Table-1 & 2). The maximum K concentration was observed at ZnE_5ZnD_5 treatment i.e. 44.42ppm while minimum was recorded at $ZnE_{10}ZnD_{10}$ level i.e. 41.92ppm.The potassium concentration in the seed also follow the same trend. The maximum K concentration recorded at ZnE5ZnD5 i.e. 33.75ppm while minimum was recorded at $ZnE_{10}ZnD_{10}$ i.e. 41.92ppm. The minimum values of Na content in the plant was recorded in control. The increase in Na content is due to higher concentration of Na in soil solution. The maximum value of sodium concentration of plant and seed was found at ZnE5ZnD5 level at 37.08ppm and 5.67ppm respectively. From the data (Table-1 & 2), it is further revealed that interaction effect of compounds is found to be significant in both plant and seed. It is obvious from the data pertaining to uptake in plant and seed that higher concentration of different Zn chelate sources did not significantly increase the Magnesium content in appreciable manner in both plant and seeds. It is found that these results were significant at 5% level of significance.

TABLE: 1 Interaction effect of chelates in plant.

$ZnSO_4$(ppm)		Zn EDTA +Zn DTPA (ppm)		
Element	Treatment	ZnE_0ZnD_0	ZnE_5ZnD_5	$ZnE_{10}ZnD_{10}$
N	MeanSEm ±0.28	4.69	4.93	4.40
P	MeanSEm ±0.00	0.05	0.06	0.05
K	MeanSEm ±0.94	42.33	44.42	41.92
Na	MeanSEm ±1.01	36.00	37.08	36.17
Ca	MeanSEm ±0.55	13.00	11.75	11.42
Mg	MeanSEm ±0.05	0.35	0.41	0.41
Fe	MeanSEm ±0.03	0.51	0.59	0.65
Zn	MeanSEm ±0.66	24.09	34.56	39.56

TABLE: 2 InteractioneEffect of chelates in seed.

ZnSO4(ppm)		Zn EDTA +Zn DTPA (ppm)		
Element	Treatment	ZnE0ZnD0	ZnE5ZnD5	ZnE10ZnD10
N	MeanSEm ±1.32	5.09	5.53	5.57
P	MeanSEm ±0.46	0.05	0.06	0.06
K	MeanSEm ±1.13	28.08	33.75	30.5
Na	MeanSEm ±0.73	5.42	5.67	2.92

Ca	MeanSEm ±0.40	1.42	1.83	0.75
Mg	MeanSEm ±0.17	0.00	0.00	0.25
Fe	MeanSEm ±0.02	0.18	0.18	0.24
Zn	MeanSEm ±0.03	0.34	0.45	0.54

Interaction effect of Ca, Fe and Zinc-

From the examined data, it was found that there was significant difference within the levels of chelates which slightly incrased the Fe uptake over control. It was further observed from the data (Table-1 & 2) that higher concentration of Zn sources increased the Fe content in plant and seeds whereas low values were obtained at lower concentration. The maximum Ca was observed at control in plant while in seed at ZnE5ZnD5 level.

From the results it was found that the zinc content increased in appreciable proportion in all treatments positively correlated with increasing concentrations of Zn in the sample ($p< 0.05$). It is evident from the data that due to interaction effect of $ZnSO_4$ and Zn EDTA with Zn DTPA ,zinc concentration went high(table-1&2) It is further revealed that these results are found to be more encouraging as compared from the other treatments. These results are in consonance with the findings [15]. Gangloff [16] also suggested that $ZnSO_4$ and Zn-EDTA were always the most effective material in supplying the plant's need. EDTA is an effective chelate for mobilizing the metal from the contaminated soils and for enhancing the uptake of metal by the hyperaccumulater.

Statistical Analysis-

The observed quantitative data tabulated to statistical analysis with the help of variance (ANOVA) technique. The F- test was used to determine whether any real difference between the treatments existed or there were only error of sampling, the composition for treating the significance was made at 5% level. The results were analyzed and found significant at 5% level (Table-3)

Table-3 Result of ANNOVA for nutrients concentration in black gram crop

Sources/ Variables	Df	Micro and Macro nutrients in plants						
		N	P	K	Na	Ca	Fe	Zn
factor-1	3	6.41**	4.65**	66.75**	74.47**	3.03**	3.12**	249.05**
factor-2	2	3.36**	7.82**	8.08**	1.2*	9.38**	21.25**	564.76**
Interaction	6	4.47**	4.15**	32.5**	22.31**	7.93**	0.38*	15.37**
		Micro and Macro nutrients in seed						
factor-1	3	25.55**	4.23**	6.8**	3.95**	4.28**	16.11**	103.63**
factor-2	2	16.3**	7.75**	25.23**	19.58**	7.39**	8.18**	51.93**
Interaction	6	8.1**	3.03**	17.06**	3.58**	2.5*	3.31**	3.41**

df- degree of freedom
** Significant $p<0.05$
*non significant

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