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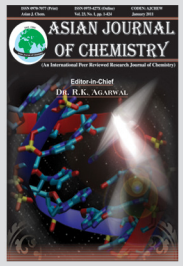

NOTE

Molybdenum Application on the Growth and Nutrient Element Contents of Head Lettuce (*Lactuca sativa* L.) in Acid Soils

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This work was carried out in order to determine the effects of increasing molybdenum application on some nutrient element contents of head lettuce plant in acid soil under greenhouse conditions. For this purpose, an experiment was done under greenhouse conditions with three replications and head lettuce was grown. Three different doses of Mo (0; 0.25 and 0.50 mg kg^{-1}) (in $(NH_4)_6Mo_7O_2{\cdot}4H_2O$ form) were applied to plants. Nitrogen fertilizer was applied to experiment area 100 mg kg^{-1} as NH_4NO_3 whereas phosphorus fertilizer was applied to experiment area 50 mg kg^{-1} as KH_2PO_4. According to the results, N, P and K contents of head lettuce increased with increasing of Mo applications. Fe, Zn and Mn contents of plant decreased with increasing of Mo applications, while Cu content of plant was not affected. All these effects were statistically significant at the confidence level of 1 %.

Key Words: Head lettuce, Acid soil, Molybdenum, Macro elements, Trace elements.

The aim of the agriculture is to produce maximum yield from a unit area and purpose, more and more fertilizer has been applied to soil and plant[1]. The low soil pH value is associated with a number of soil chemical and biological characteristics that manifest themselves as the components of the problem acid soil syndrome. These components may adversely affect plant growth. These specific problems in acid soil conditions as; Al toxicity, Mn toxicity and especially Mo deficiency[2].

Nitrogenase and nitrate reductase enzymes activity in plants decreases in Mo deficient soils[3]. Therefore, Mo deficiency in soils may be hindered Mo uptake by plants in this soil conditions. On the other hand, head lettuce is the most sensitive to Mo deficiency[4].

Kannan and Ramani[5] applied increasing rates of Mo to bean plant. N, P and K contents of plant increased, while Fe, Cu, Zn and Mn contents decreased with Mo applications.

Günes *et al.*[6], applied increasing rates of boron and zinc to tomato plant. Boron concentration of plant increased under no Zn applied conditions. According to researchers, boron toxicity may prevent by zinc application to plants.

Iron, copper, zinc and manganese contents of plant decreased with increasing Mo application to acid soils[7-10]. In this research, the effect of increasing Mo application on some nutrient elements (N, P, K, Fe, Cu, Zn and Mn) content of head lettuce plant in acid soil under greenhouse conditions was determined.

Head lettuce was grown in greenhouse conditions with three replications. The experiment was conducted in a randomized blok design. Plant seeds were sown in distance of between order 50 cm and distance of upper order 30 cm in 200 m^2 area. Experimental soil had a sandy loam (SL) texture, 0.60 % $CaCO_3$, pH of 6.02; 2.44 % organic matter; 100.8 kg ha^{-1} available phosphorus (P_2O_5); 186.5 kg ha^{-1} exchangeable potassium as measured by the standard methods given by Jackson[11]. DTPA extractable[12] Fe, Cu, Zn and Mn content were 3.8, 1.2, 1.0 and 3.2 mg kg^{-1}, respectively. Acid ammonium oxalate extractable Mo content[13] was 0.1 mg kg^{-1}.

Three different doses of molybdenum (Mo_0: 0, Mo_1: 10.25 and Mo_2: 0.50 mg kg^{-1}) in the from $(NH_4)_6Mo_7O_2{\cdot}4H_2O$ were applied to the experiment area for each plant with sowing. 100 mg kg^{-1} N (in NH_4NO_3 form), 50 mg kg^{-1} P_2O_5 (in KH_2PO_4 form) were applied to experiment area. Four plants were harvested each replication after 60 days and well develped leaves dried at 70 ºC and ground for analysis. Total N content of plant leaves were determined by Kjeldahl method, total P contents were determined by vanadomolybdo phosphoric acid yellow colour method, total K contents were determined by flame photometer and Fe, Cu, Zn and Mn contents were determined by inductively coupled plasma optical emission spectromety (ICP- OES)[14]. The results of experiment were evaluated statistically[15].

Effect of molybdenum application on some macro element contents of head lettuce: The effect of increasing

Mo application on average N, P and K contents of head lettuce plant are given in Table-1. Table-1 shows that N content of head lettuce increased with Mo application. The effect of Mo application on N content of head lettuce was found to be statistically significant at the confidence level of 1 %.

TABLE-1
EFFECT OF INCREASING RATES OF Mo APPLICATION ON SOME MACRO ELEMENT CONTENTS OF HEAD LETTUCE*

Treatment	Some macro elements** (%)		
	N	P	K
Mo_0	3.40 a	0.40 a	5.87 a
Mo_1	3.60 b	0.49 b	6.20 b
Mo_2	3.72 c	0.62 c	6.40 b

*Macro elements are evaluated individually and same letter signs no statistically significant differences between them at the confidence level of 0.01. **Values are average of three replications.

Organic N mineralization and atmospheric N fixation in soils were increased with Mo fertilizer application to soils. Therefore, N uptake of plants increased under Mo fertilization conditions[6,16,17].

Phosphorus content of plant increased with Mo application (Table-1). This increase in phosphorus was found to be statistically significant at the level of 1 %. Nutrient element content of soils increased with Mo application in neutral pH conditions. Consequently P availability was affected positively by this situation[5,18].

Potassium content of head lettuce plant increased with Mo fertilization (Table-1). The effect of Mo application on K content of head lettuce was found to be statistically significant at the level of 1 %. The same results were also obtained by earlier researchers for different vegetables. Increase in K content of different plants by Mo fertilization was also found by some earlier researchers[19, 20].

Effect of molybdenum application on some trace element contents of head lettuce: The effect of increasing Mo application on average Fe, Cu, Zn and Mn contents of head lettuce plant are given in Table-2; which shows that Fe content of head lettuce decreased with Mo application. The effect of Mo application on Fe content of head lettuce was found to be statistically significant at the confidence level of 1 %. This may be attributed antagonism between Mo and Fe.

TABLE-2
EFFECT OF INCREASING RATES OF Mo APPLICATION ON SOME TRACE ELEMENT CONTENTS OF HEAD LETTUCE*

Treatment	Some trace elements** (mg kg^{-1})			
	Fe	Cu	Zn	Mn
Mo_0	242 c	10.3 a	55.6 c	83.0 c
Mo_1	196 b	8.0 a	42.2 b	71.5 b
Mo_2	158 a	6.7 a	26.5 a	46.6 a

*Trace elements are evaluated individually and same letter signs no statistically significant differences between them at the confidence level of 0.01. **Values are average of three replications.

Copper content of head lettuce decreased with Mo fertilization. But this decrease was not found statistically significant (Table-2). This is probably because Cu content of the soil sample is high and therefore, Mo application was not affected by Cu content of head lettuce, statistically.

Zinc content of head lettuce decreased with Mo application. This decrease was found to be significant statistically at the confidence level of 1 % (Table-2). Similarly, Mn content of head lettuce was negatively affected by Mo fertilization (Table-2). The present trace element (Fe, Cu, Zn and Mn) results are consistent with the earlier observations for different vegetable plants under different soil conditions with Mo applications[21-24].

Conclusion

According to the results of these studies, N, P and K content of head lettuce plant increased with increasing rates of Mo application to acid soil under greenhouse conditions. While trace element (Fe, Cu, Zn and Mn) contents of head lettuce decreased with Mo application. These increasing and decreasing, except Cu, were found statistically significant at the confidence level of 1 %. These results are important for head lettuce with Mo fertilization conditions. Because Fe, Cu, Zn and Mn deficiencies are seeing frequently in head lettuce plant with increasing Mo applications. Therefore, care should be taken in the interaction and dynamic equilibrium between nutrient elements in these soil conditions. Otherwise, quality and quantity of head lettuce may decrease in increasing Mo application to low soil pH conditions.

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