The Effects of Fulvic acid on Micronutrients Uptake of *Citrus medica* under Condition of Lime

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***Abstract*—**The effects of soil application of fulvic acid on Physiological traits of *Citrus medica plants* grown at various lime conditions were examined. Lime concentrations were 0, 15 and 30%. The liquid fulvic acid were put into the soil pots three times on 15, 30 and 45th day after bud emerged. The application doses of fulvic acid were 0, 50 and 100 mg/l. Each application consists of four replications. The experiment was conducted in Pot experiment under controlled conditions in completely randomized factorial design in mazandaran province. The interaction effect between lime & spray for Mn was found statistically significant ($P < 0.05$) and the interaction effects between lime & spray for Zn, Fe and Cu was found statistically significant ($P < 0.01$). According to the analysis results, the most measurement of Mn, Zn, Fe and Cu in the level of lime (0%) and the least measurement of Cu by the level of lime (15%) and Mn, Zn, Fe by the level of lime (30%) obtained.

Keywords*—Citrus medica*, Fulvic Acid, Lime, Micronutrient.

I. Introduction

In many studies, fulvic acids were reported to increase the uptake of both macro and micronutrients, such as N, P, K, Fe, and Zn thereby improving the nutritional status of the plant (Maggioni et al. 1987;Mackowiak et al. 2001, Rauthan and Schnitzer,1982). fulvic acids may also reduce plant uptake of certain toxic metal ions,adsorbing them from the soil solution (Strickland et al., 1979). Fulvic acids may also reduce plant uptake of certain toxic metal ions, adsorbing them from the soil solution (Strickland et al., 1979).

High amounts of lime in soils have negative effects on the plant growth. The plant growth and yield are reduced in lime-affected soils because of the excess uptake of potentially toxic ions (Grattan & Grieve 1999). A high lime content decreases the osmotic potential of the soil water and, consequently, this reduces the availability of the soil water for plants. One negative effect of increasing lime concentration is inhibited uptake of essential micronutrients such as N, P, and K (Ahmad, et al.,1981; Peacock et al., 1993). Briefly, high lime concentrations in the soil reduce the absorption of nutrients by plants which negatively affects the fertility of the soil (KHaled and Hassan, 2011). Many laboratory and glasshouse studies have shown that high amounts of lime can reduce total nitrogen accumulation (Alam 1994), P concentrations and the uptake of K in plants (Lopez & Satti 1996). In lime soil, the content of water is particularly low and the plants grown in these soils often show deficiencies of Relative Water Content (Page et al. 1990). Fulvic acids may enhance uptake of chlorophyll a and chlorophyll b, one might reason that application of fulvic acid could improve plant response to lime. However, there is a lack of research regarding fulvic acid and application and its impacts on Citrus medica under lime tolerance. So, The goal of this study was to compare the effect of fulvic acid on the qualitative traits of Citrus medica under lime condition.

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II. Material And Methods

The soil used in this study was collected from 0–30 cm depth of the field located in mazandaran province. The planting dates were on 15th March, 2015. The physical and chemical traits of the soil were determined and as a basal fertilization, the fertilizer crystalon comprised of nitrogen, phosphorus, potassium, Fe, Mn and Cu were applied to the pots before planting. The experiment was conducted in Pot experiment micronutrients is particularly low and the plants grown in these soils often show deficiencies of these elements (Page et al. 1990). Since fulvic acids may enhance uptake of some mineral nutrients and reduce the uptake of certain toxic elements, one might reason that application of FA could improve plant response to lime. However, there is a lack of research regarding FA and application and its impacts on *Citrus medica* lime tolerance. Therefore, The aim of this study was to compare the effect of fulvic acid on the micronutrient uptake of *Citrus medica* under lime condition.The statistical analysis was performed using EXCEL, SAS,MSTATC statistical soft wares, and mean values were grouped with Duncan multiple range test ($P < 0.05$).

III. Results And Discussion

3.1. Micronutrients

According to the analysis results, the most measurement of Cu in T0f100 treatment, and the least measurment by the treatment of T15blank obtained (table2). These Results corroborate findings of Chen & Aviad (1990), Fagbenro & Agboda (1993) & David et al., (1994) regarding Cu uptake of plants. According to the analysis results, the most

measurement of Zn in T0f100 treatment, and the least measurment by the treatment of T30blank obtained (table2). These results corroborate findings of Chen & Aviad (1990), Fagbenro & Agboda (1993) & David et al.,(1994) Regarding Zn uptake of plants. According to the analysis results, the most measurement of Fe in T0F100 treatment, and the least measurment by the treatment of T30f50 obtained (table2). According to the analysis results, the most measurement of Mn in T0blank treatment, and the least measurment by the treatment of T30f50 obtained (table2). These Results approve findings of Chen & Aviad (1990), Fagbenro & Agboda (1993) & David et al.,(1994) regarding Fe uptake of plants. Also Khaled and Fawy (2011) reported that foliar application in 0.1% FA treatment increased Fe, Zn, and Mn amounts in plants which 30% lime treatment when compared with the control and 0.2% humic acid treatment. Liu and Cooper (2002) in creeping bentgrass reported that lime significantly increased the content of Mn and did not affect the content of Fe, Cu, and Zn. Neeraja et al., (2005) found that foliar and root application of organic acids product from animal origin led to a severe plant growth depression. Anjum et al., (2008) in citrus reported that lime condition increased the accumulation of proline. Abdalhamid et al., (2003) reported that the application of exogenous organic acid on desert plants stimulated the growth and protein accumulation by neutralizing destructive effects of

IV. Conclusion

Fulvic acids can ameliorate negative soil properties and improve micronutrients uptake. They may be used in the case of the negative effect of lime that would inhibit nutrient elements uptake. Regarding our finding, fulvic acids are effective or ineffective on nutrients uptake. This study indicated that the application doses are important for deriving benefit from FA under lime conditions. However, there are not many researches into FA application and their effects on plant lime tolerance. Therefore, more research is necessary to explain the positive impacts of fulvic acid on *citrus medica* plants under lime condition.

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TABLE I
THE ANALYSIS OF VARIANCE OF MICRONUTRIENTS UPTAKE

	cu	mn	fe	zn
Lime	567.58**	136.20**	28843.2**	2916.6**
Spray	282.87**	9.84*	3411.7**	219.4**
Spray*Lime	155.1**	6.86*	730.5**	167.2**
Error	0.66	2.66	16.66	44.33
CV	5.06	7.92	4.01	23.20

Ns,*,**Nonsignificant or significant at P = 0.05, 0.01 respectively.

TABLE II
THE MEAN VALUE OF IMPACTS OF FULVIC ACID ON MICRONUTRIENTS UPTAKE

Lime*Spray	cu	mn	fe	zn
T0blank	18.0c	26.0a	113.0c	45.0b
T0f100	33.2a	23.8c	156.0a	61.0a
T0f50	11.8h	20.8e	111.0c	36.2cd
T15blank	8.1ij	18.5fg	101.0g	21.0g
T15f100	19.4d	18.9f	130.0b	24.2ef
T15f50	14.9ef	19.2f	88.0h	20.0gh
T30blank	13.0g	18.1fgh	67.0i	18.0hi
T30f100	10.0hi	19.4f	58.0ij	23.1f
T30f50	9.0i	18.0gh	51.0jk	19.1h

F50 & F100 = fulvic acid 50 & 100 mg/l, T0, T15 & T30 = lime %,respectively, microelements= (ppm)