Foliar treatment of Mn deficient 'Golden delicious' apple trees with two Mn fertilizers

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INTRODUCTION

Manganese (Mn) is an essential plant mineral nutrient, playing a key role in several physiological processes, particularly photosynthesis. Mn is used in plants as a major contributor to various biological systems including photosynthesis, respiration, and nitrogen assimilation. Mn is also involved in pollen germination, pollen tube growth, root cell elongation and resistance to root pathogens. Mn deficiency is a widespread problem, most often occurring in sandy soils, organic soils with a pH above 6 and heavily weathered, tropical soils. It is typically worsened by cool and wet conditions (Alloway 2008). Mn has a relatively low phloem mobility in plants, and as a result, typical leaf symptoms of Mn deficiency first develop in younger leaves. (Fernandez et al., 2013). Trials with Golden Delicious apples in Italy showed that foliar Mn, applied at least twice in the spring, has proven to be most effective at improving leaf color and minimizing leaf drop and blotchiness (Porro et al., 2002).

METHODS

Mature trees of the apple cv. Golden Delicious grafted onto M26 rootstock were chosen for the study. These trees showed deficiency symptoms in leaves and low Mn leaf concentration (9 ppm) the previous year of the initiation of the experiment. The trees were 12 years old, planted in a randomized complete block design with 3.5 × 4 m spacing and trained to a palmette system. 25 trees were used for each treatment (five replications × five trees). The orchard was managed with standard horticultural practices regarding irrigation, pruning, and fertilization.

Apple trees were sprayed with the following products: a) microcare Mn (14% Mn EDTA) 1 kg/t (Nature S.A., Nea Efessos, Greece) and b) chelan Mn (7% Mn EDTA) 2 L/t (Nature S.A.) for two successive years in an apple orchard located in northern Greece on the following dates: May 5, May 25 and June 18. Control trees were not sprayed.

Forty apples were collected from each treatment at the stage of their commercial maturity. Fruits were transported immediately to the laboratory for analyses. Fruits were weighted and evaluated for colour, soluble solids, acidity, and flesh firmness, as previously described by Koukourikou-Petridou et al. (2007). Leaf analysis was performed at mid July and fruit analysis at their commercial maturity.

RESULTS AND DISCUSSION

Mean fruit weight was decreased in the following order: microcare Mn>chelan Mn> control. Fruit firmness, soluble solids content and acidity were not different among treatmentes (Table 1). Photosynthetic rate of the control was significantly lower than microcare Mn and chelan Mn treatments.

Mn leaf concentration in the microcare Mn treatment was significantly higher than chelan Mn treatment (Table 2). Control had the lowest value which was in the range of deficiency (Fernandez et al., 2013). Application of both products reduced leaf Zn concentration and chelan Mn reduced Fe concentration in comparison to the control. Concentrations of the other nutrients in the leaves were not significantly affected due to the foliar application of the Mn fertilizers.

Mn fruit concentration was significantly higher and B fruit concentration was significantly lower in microcare Mn treatment compared to chelan Mn and the control (Table 3). Concentration of the other nutrients in the fruits was not significantly affected due to foliar application of the Mn fertilizers. The main differences between microcare Mn and chelan Mn are a) chelan Mn is a potassium salt of EDTA -Mn (fully chelated), b) microcare Mn is a sodium salt of EDTA-Mn (the product is mainly EDTA chelated but moreover includes polycarboxylic acids as co-chelators).

Table 1. Fruit firmness, soluble solids, acidity, mean fruit weight and photosynthetic rate.

Treatment	Fruit firmness (kg/cm^2)	Soluble solids (^{0}Brix)	Acidity (% malic acid)	Mean fruit weight (g)	Photosynthetic rate ($\mu mol\ CO_2\ m^{-2}\ s^{-1}$)
Control	7.44	13.10	1.05	141 c	12.21 b
Microcare Mn	8.08	13.85	1.11	182 a	17.04 a
Chelan Mn	7.70	13.05	0.99	169 b	15.99 a

Table 2. Leaf analysis at the first year of the experiment.

Treatment	N	P	K	Ca	Mg	B	Mn	Zn	Fe
			%				ppm		
Control	1.74	0.24	1.41	1.71	0.44	28	9.01 c	44 a	78 a
Microcare Mn	2.02	0.22	1.48	1.44	0.42	31	47.09 a	35 b	79 a
Chelan Mn	1.79	0.25	1.36	1.44	0.43	29	35.74 b	31 b	59 b

Table 3. Fruit analysis at the first year of the experiment (mg/100g fresh weight).

Treatment	N	P	K	Ca	Mg	B	Mn	Zn	Fe
Control	6.91	9.27 a	72.72	4.56	4.37	0.29 a	0.03 b	0.02	0.13
Microcare Mn	6.52	8.08 ab	62.87	4.99	4.74	0.16 b	0.05 a	0.025	0.12
Chelan Mn	6.14	6.91 b	64.22	4.41	3.84	0.24 a	0.03 b	0.02	0.23

CONCLUSIONS

Both Mn fertilizers improved Mn uptake from foliar sprays, however better results were achieved in this specific investigation through microcare Mn foliar applications.

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