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Full Length Research Paper

Investigating the effect of iron and zinc enriched vermicompost on growth and nutritional status of peach trees

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Micronutrients deficiency especially iron and zinc in orchard trees is a common problem of calcareous soils. Application of mineral sources of these elements has no performance in alkaline soils. Because of high cost, consumption of synthetic chelats is limited in the country. To determine the effect of compost and iron and zinc enriched vermicomposts on iron and zinc nutritional status of peach tress, an experiment was conducted in a completely random blocks design with three replications in the garden of Moghan Agro-industrial company. The experimental treatments were cow manure compost, cow manure vermicompost, iron and zinc enriched vermicompost, vermicompost enriched by iron dust, and control. Soil samples were taken from 0 to 30 cm and 30 to 60 cm and the treatments applied before flowering of trees. Two months after the full blooming stage, the leaf samples were collected from different treatments. At this time, the chlorophyll content of leaves was also measured. Chemical composition of composts and nutrients concentration of leaf samples was determined. Fruit yield and quality of trees in different treatment was determined at the harvesting time. Results of soil and leaves samples analysis showed the iron deficiency and copper excess of soils in the region. Enrichment of vermicompost with iron and zinc increased total and available content of these elements. All treatments caused to higher iron, zinc, and chlorophyll content of leaves and yield of peach fruits compare to control. The effect of iron and zinc vermicompost was greater than those of other treatments. Consumption of compost and vermicomposts improved the peach fruit's quality. Measuring chlorophyll of leaves is a suitable and easy method for evaluation of iron and zinc nutritional status of orchards.

Key words: Peach, vermicompost, enrichment, iron, zinc.

INTRODUCTION

Micronutrients deficiency especially iron and zinc in orchard trees is a common problem of calcareous soils. Application of mineral sources of these elements has no performance in alkaline soils, since this compound precipitates immediately afterwards and becomes unavailable for plants (Mortvedth et al., 1991). Because of high cost, consumption of synthetic chelats is limited and in some cases constitute up to 60% of total fertilizer cost (Pesanta et al., 2003). Another problem is the low quality of commercial chelates. Using ion pair HPLC method. Hernández-Apolaza et al. (2000) reported that none of the tested commercial products reached their nominal or legal composition and several products did not meet the requirements of the 76/116/EC directive. Therefore, use of alternative means to prevent and cure Fe chlorosis is necessary. Natural organic compounds are able to produce stable chelates with micronutrients and increase the solubility of these elements in soil solution. Application of organic matter in soil can decrease the incidence of iron chlorosis or help to remedy this disorder (Loeppert, 1986). Some organic compounds produced from decomposition of organic materials in soil or microbial secretions, called

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Table 1. Chemical composition of compost and vermicomposts used in study.

Compost properties	Manure compost	Manure vermicompost	Vermicompost + Fe & Zn	Vermicompost + iron dust
pH	8.78	8.33	8.48	7.71
EC (dS/m)	7.27	3.94	0.962	8.73
OC (%)	27.3	25.3	21.4	24.7
Total N (%)	1.58	1.90	1.44	1.93
Total P (%)	0.39	1.11	0.72	0.74
Total K (%)	0.46	0.29	0.30	0.33
Total Fe (mg/kg)	7670	5207	7188	9780
Total Mn mg/kg)	428	472	416	348
Total Zn (mg/kg)	141	377	188	224
Total Cu (mg/kg)	54	35	64	41
Ava. Fe (mg/kg)	89	164	153	823
Ava. Mn (mg/kg)	332	295	318	177
Ava. Zn (mg/kg)	91	134	110	836
Ava. Cu (mg/kg)	37	65	55	35
C:N	14.77	13.29	13.50	12.84

sidrophore, create stable natural chelates with micronutrients (Marschner, 1995). Tagliavini et al. (2000) in an experiment on pear grown in calcareous soil could treat the iron deficiency with addition of blood powder and enriched compost with ferrous sulphate. In several studies carried out about the use of compost made of mixing iron soluble salts with organic materials such as manure, compost, sewage sludge, and peat in Israel, it was found that these composts could successfully treat the iron chlorosis (Chen and Barak, 1982; Chen et al., 1982; Bazak et al., 1989; Barness and Chen, 1991). Nutrient contents of vermicomposts are much higher than those of commercial horticultural composts (Dickerson, 1999). Humic substances in vermicompost are 3 to 4% more than composts (Dominguez et al., 1997). The objectives of this research are:

1) To elevate the availability of iron and zinc of manure by enrichment and vermicomposting.

2) To investigate the effect of iron and zinc enriched vermicompost on yield, fruit quality and nutrition of peach threes.

MATERIALS AND METHODS

The experiment was conducted in the peach orchards of Moghan Agro-Industrial Company in 2007 growth season. The study design was a completely random block design with three replications. Each replication was composed from 3 trees. The experimental treatments were cow manure compost (MC), cow manure vermicompost (VC), iron and zinc enriched vermicompost (mixture of manure with $FeSO_4$ (19% Fe) (VC+Fe and Zn) and $ZnSO_4$ (34% Zn), 5% w/w), vermicompost enriched by iron dust (5% w/w) (VC+ID), and control. The materials were added to 30×40×60 cm wooden boxes and 200 mature worms were added to vermicomposts treatments. After 4 months, vermicomposts and compost were harvested. Soil samples were taken from 0-to 30 and 30 to 60 cm and 10 kg of each treatment applied to a 60 cm holes under drippers (two for each tree) before flowering of trees. The chemical properties of soil samples include pH, EC, OC, N, P, K, CCE, texture, and available micronutrients content were measured. Two months after the full blooming stage the leaf samples were collected from different treatments. At this time, the chlorophyll content of leaves was also measured using a SPAD apparatus. Chemical composition of composts and nutrients concentration of leaf samples was determined. Fruit yield and quality of trees in different treatment was determined at the harvesting time. Data were statistically analyzed using SAS software. ANOVA and multiple range tests were used to investigate the effects of treatments on yield, quality of fruits, and nutritional status of peach threes.

RESULTS AND DISCUSSION

Results of soil and leaves samples analysis showed the iron deficiency and copper excess of soils in the region. Addition of $FeSO_4$ and $ZnSO_4$ to manure decreased pH and increased the EC of produced vermicompost (Table 1). Enrichment of vermicompost with iron and zinc increased total and available content of these elements and the effect of iron sulfate in improvement of available iron content of vermicomposts was higher than iron dust (Table 1). Hashemimajd et al. (2006) showed that incorporation of converter sludge (an iron melting refuse) to manure caused to increase of available iron content of vermicompost.

All treatments induced higher iron, zinc, and chlorophyll content of leaves compare to control and the effect of iron and zinc vermicompost were greater than those of other treatments (Figure 1). Because of similar trend observed for Fe concentration and chlorophyll content of leaves in

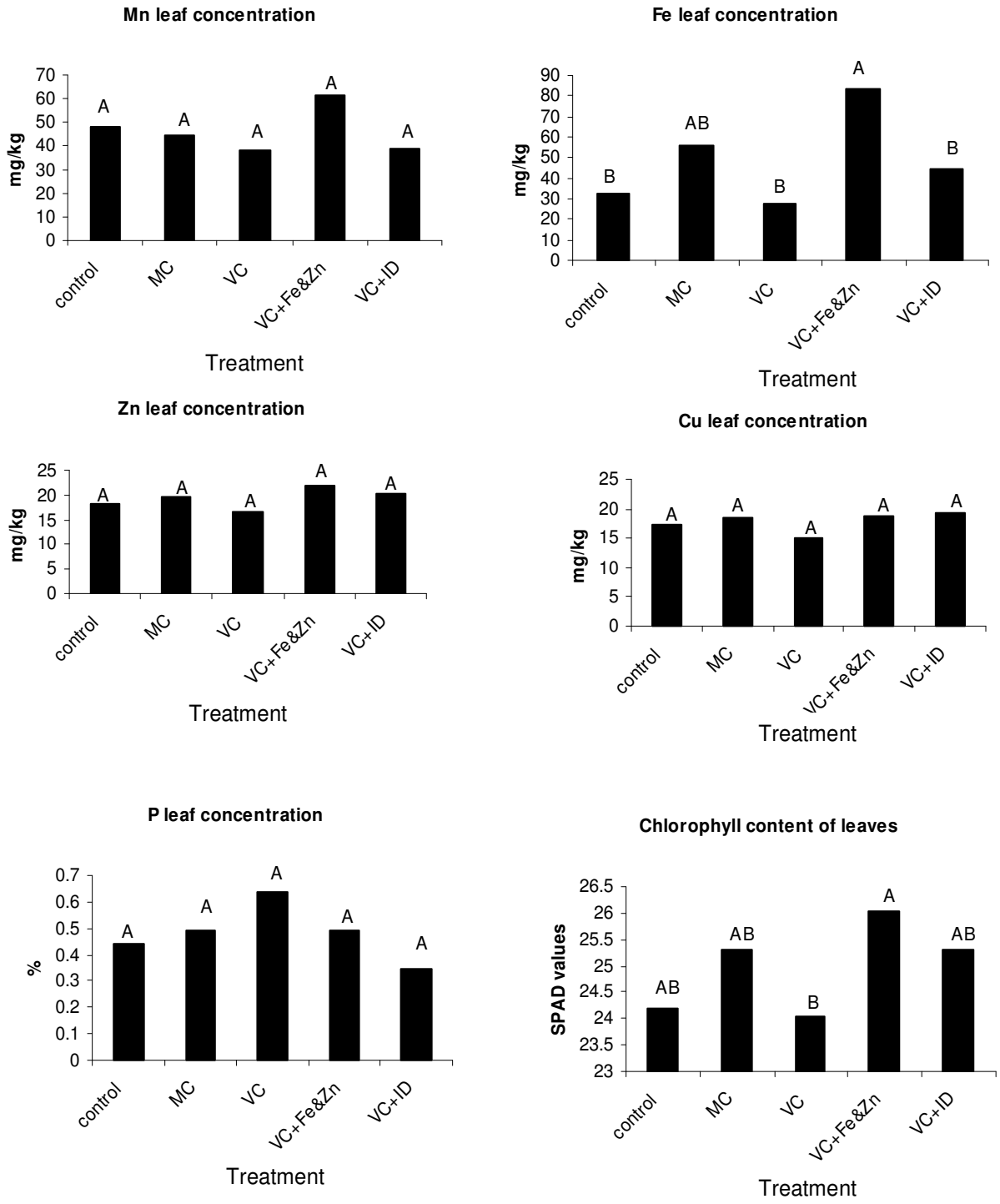

Figure 1. Effects of treatments on concentration and chlorophyll content of peach leaves. Bars with common letter are not significantly different at the 5% level (Duncan Multiple Range Test).

different treatment (Figure 1), it might conclude that measuring chlorophull content of leaves is suitable method to evaluate Fe nutritional status of peach trees. Zarrouk et al. (2005) revealed that there was positive and significantly correlation between P, Fe, and Zn concentration and chlorophyll content of peach leaves.

Consumption of compost and vermicomposts significantly improved the peach fruit yield and the maximum yield was obtained from VC+Fe and Zn treatment (Figure 2). Therefore, mixing of iron sulfate with

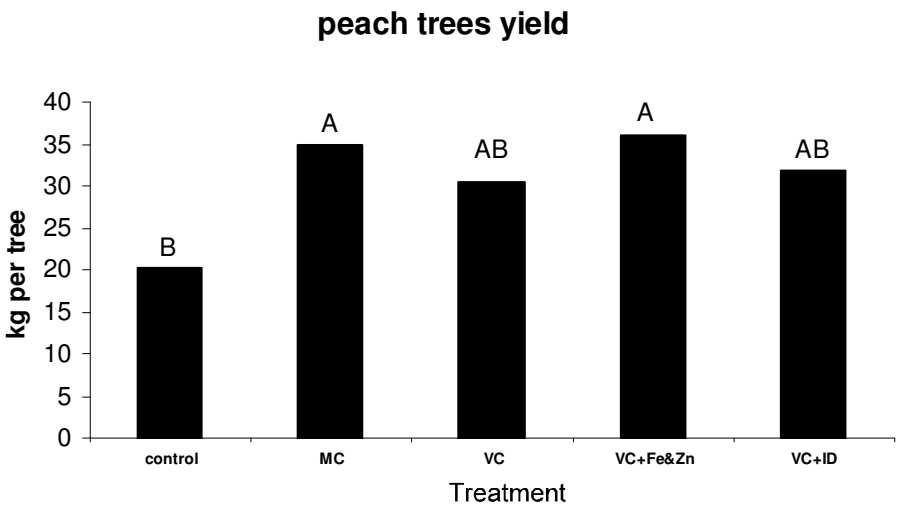

Figure 2. Effect of treatments on yield of peach trees. Bars with common letter are not significantly different at the 5% level (Duncan multiple range test).

organic material elevates its effectiveness. Tagliavini et al. (2000) reported that incorporation of iron mineral salts and their incubation with organic materials improves their efficiency in treatment of iron chlorosis.

Some of fruit's quality indices such as weight, volume and diameter were greater in all treatment in comparison with control. This result showed the beneficial effect of organic amendments on fruit quality of peach trees.

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