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The comparative effects of Different Cover Crops on DTPA-Extractable Micronutrients in Orchards with Loam and Clay Textured Soils

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Abstract: This study was conducted to compare the effect of different cover crops on DTPA-Ext micronutrients (Fe, Mn, Zn, Cu) and soil pH in a kiwi orchard with loam texture and a persimmon orchard with clay texture located in Samsun province of Turkey. *Trifolium repens* (TR), *Festuca rubra subsp. rubra* (FRR), *Festuca arundinacea* (FA), *T. repens* (40%) + *F. rubra rubra* (30%) + *F. Arundinacea* (30%) mixture (TFF), *Vicia villosa* (VV) and *Trifolium meneghinianum* (TM) were used as cover crops in the experiments. Mechanically cultivated (MC), herbicide treated (HC) and bare control (BC) plots were also included in the experiment. Soil samples of each plot were taken from two different depths (0-20 and 20-40 cm). Experiments were conducted in completely randomized blocks design with four replications. The highest Ext-Zn in the kiwi and persimmon orchards were obtained in the TR (2.9 and 1.4 mg kg^{-1}, respectively), the highest Ext-Fe in the VV in the kiwi orchard (14.2 mg kg^{-1}) and in the persimmon orchard (19.1 mg kg^{-1}). The highest Ext-Mn in the VV (11.4 mg kg^{-1}) in the kiwi orchard, and in the TR (9.4 mg kg-1) in the persimmon orchard was found. Generally, we suggest the use of cover crops to increase the micronutrients concentration of soils in the orchards.

Keywords: Clay texture, cover crops, DTPA-extractable micronutrients, loam texture, soil pH

Tınlı ve Killi Tekstürlü Meyve Bahçelerinde DTPA ile Ekstrakte Edilebilir Mikroelementler Üzerine Farklı Örtücü Bitkilerin Karşılaştırılması

Öz: Bu çalışma, Ülkemizin Samsun ilinde yeralan tınlı tekstürlü bir kivi bahçesinde ve killi tekstürlü bir Trabzon hurması bahçesinde DTPA ile ekstrakte edilebilir mikro besin elementleri (Fe, Mn, Zn, Cu) ve toprak pH'sı üzerine farklı örtücü bitkilerin etkilerini karşılaştırmak için yürütülmüştür. Denemede örtücü bitki olarak *Trifolium repens* (TR), *Festuca rubra subsp. rubra* (FRR), *Festuca arundinacea* (FA), *T. repens* (%40) + *F. rubra rubra* (%30) + *F. Arundinacea* (%30) karışımı (TFF), *Vicia villosa* (VV) ve Trifolium meneghinianum (TM) kullanılmıştır. Kontrol parseli olarak mekanik mücadele (MC), herbisitle mücadele (HC) ve yalın kontrol (BC) parselleri de denemede yer almıştır. Toprak örnekleri her parselden iki faklı derinlikten (0-20 ve 20-40 cm) alınmıştır. Denemeler, tesadüf blokları deneme desenine göre dört tekerrürlü olarak yürütülmüştür. En yüksek Ekst-Fe içeriği kivi bahçesinde (14.2 mg kg^{-1}) ve Trabzon hurması bahçesinde (19.1 mg kg^{-1}) VV uygulamasında elde edilirken, en yüksek Ekst-Zn içeriği kivi bahçesinde (2.9 mg kg^{-1}) ve Trabzon hurması bahçesinde (1.4 mg kg^{-1}) TR uygulamasında belirlenmiştir. Kivi bahçesinde en yüksek Ekst-Mn içeriği ise VV uygulamasında (11.4 mg kg^{-1}) tespit edilirken, Trabzon hurması bahçesinde TR uygulamasında (9.4 mg kg^{-1}) bulunmuştur. Genel olarak, meyve bahçelerinde toprakların microelement içeriklerini artırmak için örtücü bitkilerin kullanımını önerebiliriz.

Anahtar Kelimeler: Killi toprak, mikro besin elementleri, örtücü bitkiler, tınlı toprak, toprak reaksiyonu

1. Introduction

Micronutrients are necessary elements that are needed in small quantities for plant and human health (Miller and Welch, 2013). Notwithstanding the fact that plants need only very small amount of these nutrients to make use of them for physiological process, they have considerable impacts both in plant growth and in quantity and quality of yield (Shukla et al., 2015). Micronutrients promote biological processes such as maintenance of biological membranes, auxin metabolism, gene expression, protein synthesis, protection against disease, heat stress, photooxidative damage and so forth.

Micronutrient deficiencies in soil have been described as one of the primary factors which are influential on human health, food quality and crop yield. The World Health Organization (WHO) has estimated that over 3 billion people in the World suffer from malnutrition of these nutrients and that approximately 2 billion people in this huge population have Fe deficient diet (WHO, 2002; Long et al., 2004). Deficiencies of these nutrients in soils have also become a primary constraint to the soil sustainability, stability and efficiency (Kumar and Babel, 2011). The deficiencies of Mn, Cu and Fe are less common than that of Zn (Imtiaz et al., 2010).

The availability of micronutrients to plants is a result of concentrations of soil micronutrients which are affected by soil components such as organic matters and minerals. These soil nutrients are also influenced by different biological and edaphic factors including reaction with coexisting ions, organic matter dynamics, soil microbiology, interedox potential and soil reaction. The abilities of different plants to take up any individual these nutrients from the soil vary; however, concentrations of these nutrients in plants reflect the nutrient status of the soils where the plants are grown (Knez and Graham, 2013). Soil reaction and the properties of the organic matter in the soil are significant soil characteristics which affect the nutrient availability.

Methods of providing these nutrients to plants generally involve the use of organic matters like green manure, tree leaves, organic wastes and grass clippings (Sekhon, 2003; Demir and Gülser, 2010). Cover crops as a source of organic matter are important components of cropping systems to enhance soil quality and ultimate crop yields. The effect of cover crops in enhancing soil chemical, physical and biological attributes is well established (Gülser, 2004; Gülser, 2006; Cunha et al., 2012; Demir et al., 2019a). Unfortunately, manufactured surfactants may have an unfavourable effect on the environment during their lifecycle. Most of these matters pose important environmental risks due to their harmful chemical compounds and their incomplete degradation in soil and water environment. These matters are declared to cause long-term inverse effects, whereas bio-products are more likely to degrade smoothly and thus do not pollute the environment (Ying, 2006). Therefore, organic farming relies on the use of residue management of cover crops and rotations as several vital applications are employed to increase the organic matter content in the soil, which eventually enrich the chemical, physical and biological properties (Olesen et al., 2007). Cover crops with distinct root lengths and densities can mobilize and extract nutrients and water from deeper soil profiles. Cover crops are subscribed to increase research on site specific soil management strategies (Lal, 2009). Thus, new approaches should be evaluated for sustainable human health, soil management and environmental protection. Intercropping trees with cover crops is a well-known strategy in some cash-crop production systems. Intercropping can improve nutrient use. Cover crops may improve the Fe-nutrition of fruit trees grown on calcareous soils by enhancing Fe-availability (Cesco et al., 2006).

There are many studies on cover crops, which deal with effects on DTPA-extractable micronutrients of the *Trifolium repens* L. (TR), *Festuca rubra rubra* L. (FRR), *Festuca arundinacea* (FA), *Trifolium repens* (40%)+*Festuca rubra rubra* (30%)+*Festuca arundinacea* (30%) mixture (TFF), *Vicia villosa* Roth. (VV) and *Trifolium meneghinianum* Celm. (TM) in orchards are very limited. The aims of this study were: i) to compare the effect of different cover crops on DTPA-extractable micronutrients (Fe, Mn, Zn and Cu) and soil pH in a kiwi orchard with loam texture soil and in a persimmon orchard with clay texture soil, ii) to identify cover crop induced relations between soil pH and DTPA-extractable Fe, Mn, Zn and Cu.

2. Methodology

Experiments were conducted on the experimental fields of Black Sea Agricultural Research Institute between the years 2013-2014. The experimental sites are located in the Middle Black Sea region of Turkey. Monthly average temperature was 14.5 °C and annual average precipitation was 685.5 mm. The cover crop treatments consisted of *Trifolium repens* L. (TR), *Festuca rubra rubra* L. (FRR), *Festuca arundinacea* (FA), *Trifolium repens* (40%)+*Festuca rubra rubra* (30%)+*Festuca* *arundinacea* (30%) mixture (TFF), *Vicia villosa* Roth. (VV) and *Trifolium meneghinianum* Celm. (TM). The species chosen for cover cropping are usually those which are familiar to the grower and are known to perform well in the region, and for seeds of these species can be cheaply and readily obtained. The experiments were arranged in a completely randomized block design with four replications. Mechanically cultivated (MC), herbicide treated (HC) and bare control plots (BC) were also included in the experimental set-up. Soil samples were collected from two depths (0-20, 20-40 cm) in each plot. Each soil sample was separately air-dried, ground and passed through a 2 mm sieve prior to determining the DTPA-extractable micronutrients and soil pH. Some soil attributes were identified as following; particle size distribution by hydrometer method (Demiralay, 1993); soil reaction (pH) in 1:1 (w:v) soil water suspension by pH meter; electrical conductivity ($EC_{25°C}$) in the same soil suspension by EC meter (Kacar, 1994); exchangeable cations by ammonium acetate extraction (Kacar, 1994); micronutrients by the extraction with DTPA solution by using atomic absorption spectrophotometers (Kacar, 1994). Organic matter (OM) content was measured by modified Walkley-Black method (Kacar, 1994). Initial soil characteristics are provided in Table 1.

Table 1. Initial physical and chemical properties of the experimental soils
Çizelge 1. *Denemenin başlangıcında toprakların fiziksel ve kimyasal özellikleri*

Kiwi orchard			Persimmon orchard		
Soil properties	Depth, cm		Soil properties	Depth, cm	
	0-20	20-40		0-20	20-40
Sand, %	44.35	42.72	Sand, %	31.05	27.55
Silt, %	32.62	35.78	Silt, %	14.15	15.32
Clay, %	23.03	21.50	Clay, %	54.80	57.13
Soil textural class	L	L	Soil textural class	C	C
pH (1:1)	7.55	7.61	pH (1:1)	7.46	7.43
$EC_{25°C}$, ds m^{-1}	0.518	0.506	$EC_{25°C}$, ds m^{-1}	0.39	0.38
OM, %	1.53	0.98	OM, %	0.94	0.90
Ca, me 100 g^{-1}	19.93	20.38	Ca, me 100 g^{-1}	37.96	37.59
Mg, me100g^{-1}	4.45	4.32	Mg, me100g^{-1}	6.61	5.06
Na, me 100 g^{-1}	0.43	0.42	Na, me 100 g^{-1}	0.40	0.42
K, me 100 g^{-1}	0.87	0.87	K, me 100 g^{-1}	0.56	0.42

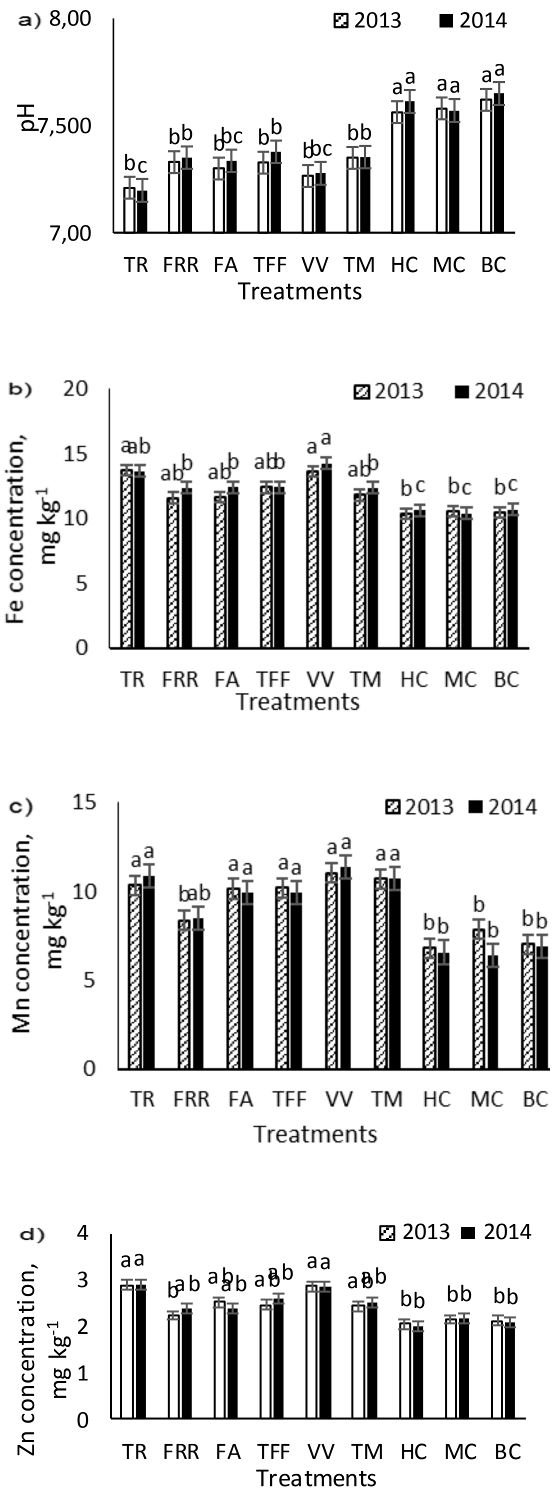
Initial analyses revealed that experimental soil of kiwi orchard were loam in texture with slightly alkaline and poor organic matter content. Persimmon orchard soil was classified non-saline, clay textured, neutral soil reaction and poor organic matter content (Soil Survey Staff, 1993).

Experimental results were subjected to statistical analyses with SPSS software. Means were compared with Duncan's multiple range test and Pearson coefficients of correlation were performed to express the relationships between experimental parameters (Yurtsever, 1984).

3. Results and Discussion

The DTPA-extractable micronutrients and soil pH values were significantly influenced by the cover crop treatments at 0-20 cm soil depth.

While cover crop treatments in the kiwi orchard (Figure 1) and in the persimmon orchard (Figure 2) significantly reduced pH values of soils according to the bare control, the cover crop treatments increased the DTPA-extractable micronutrients of soils in the 0-20 cm soil depth. The effect was more observed in the second year of the experiments. No significant differences were determined in pH and the micronutrient concentrations of both soils for mechanically cultivated, herbicide treated and bare control plots. There are variety of soil and environmental factors such as soil pH, cation exchange capacity, calcium carbonate, organic matter, texture, climate, and salinity (Najafi-Ghiri et al., 2013) that can influence the geochemistry of micronutrients.



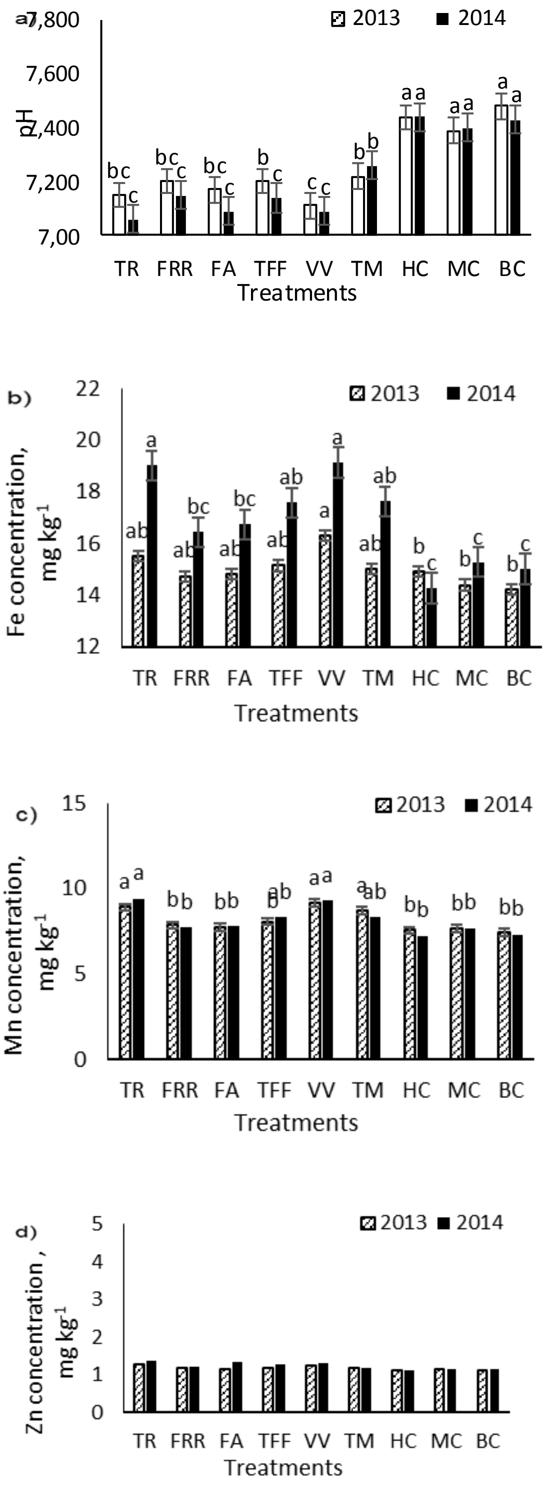


Figure 1. Effects of cover crops and other treatments on a) pH, b) Fe, c) Mn and d) Zn at 0-20 cm soil depth in the kiwi orchard

Şekil 1. *Kivi bahçesinde 0-20 cm toprak derinliğinde a) pH, b) Fe, c) Mn and d) Zn* üzerine ö*rtücü bitkilerin ve diğer uygulamaların etkileri*

Figure 2. Effects of cover crops and other treatments on a) pH, b) Fe, c) Mn and d) Zn at 0-20 cm soil depth in the persimmon orchard

Şekil 2. *Trabzon hurması bahçesinde 0-20 cm toprak derinliğinde a) pH, b) Fe, c) Mn and d) Zn üzerine örtücü bitkilerin ve diğer uygulamaların etkileri*

PH of the soils had a tendency to decline upon cover crop usage comparing to the bare soil in both orchards. This effect was apparently significant in the second year of TR treatment at 0-20 cm soil depth in the kiwi orchard that the measured pH was lower than 0.45 pH unit (Figure 1a).

Soil pH in the kiwi orchard was ordered as: TR (7.20) < VV (7.28) < FA (7.34) < FRR (7.35) = TM (7.35) < TFF (7.38) < MC (7.57) < HC (7.61) < BC (7.65). Compared to bare control, percentage decreases in soil pH values at 0 - 20 cm soil depth varying between 3.56% in TFF and 5.92% in TR treatments in the kiwi orchard (Figure 3a.).

Mathur et al. (2006), Yadav (2011), Yadav and Meena (2009), and Sidhu and Sharma (2010). Franzluebbers and Hons (1996) also pointed out raises in Fe availability mediated by cover crop treatments. Cover crops increase the concentrations of micronutrients in the soil and decrease the fertilizer requirements, leading to lower costs of production while contributing to the soil sustainability (Bernardi et al., 2003) and environmental protection. Humified substances of soil organic matter have critical direct positive influences on the availability of these nutrients (Marschner and Rengel, 2007). The availability of the micronutrients further increases as the organic matter supplies chelating agent for complexation of these micronutrients. Thus, management of carbon stocks (organic residues, etc.) enhances their availability to the plants (Srinivasan and Poongothai, 2013).

Mn concentrations of cover crop treated soils were generally higher than the one obtained in the bare controls in both orchards. The highest Mn concentration (11.4 mg kg^{-1}) in the second year of the experiment was obtained in the VV treatment whereas the lowest Mn concentration (6.4 mg kg^{-1}) was in the MC treatment in 0-20 cm soil depth in the kiwi orchard (Figure 1c). Mn concentrations (mg kg^{-1}) in the kiwi orchard was ascending order: MC (6.39) < HC (6.57) < BC (6.92) < FRR (8.50) < FA (9.92) < TFF (9.93) < TM (10.72) < TR (10.85) < VV (11.37). Compared to bare control, there was as high as 22.88% - 64.38% increase in the availability of Mn in the kiwi orchard (Figure 3c). The highest Mn concentration (9.40 mg kg^{-1}) was obtained in the TR treatment while the lowest Mn concentration (7.24 mg kg^{-1}) was in the HC treatment in the persimmon orchard (Figure 2c). Mn concentrations (mg kg-1) in the persimmon orchard was ordered as: HC (7.24) < BC (7.31) < MC (7.68) < FRR (7.73) < FA (7.81) < TFF (8.30) < TM (8.33) < VV (9.29) < TR (9.40). In comparison to bare control, relatively smaller treatment-induced availabilities of Mn ranging 5.79% in FRR - 28.64% in TR treatments were observed in the persimmon orchard (Figure 4c). There are numerous reports in the literature agreeing with the current results (Sharma et al., 2003; Mathur et al., 2006; Yadav, 2011; Yadav and Meena, 2009 and Sidhu and Sharma, 2010; Demir and Işık, 2019; Demir et al., 2019b). In this study, cover crop treatments caused notable changes of available Mn. The increase might be due to decline in soil reaction and improved dissolution of Mn compounds. Application of organic fertilizer to soils increases available Mn concentration (Li et al., 2009) depending on the redox reactions because fresh carbon sources enhance the reduction of Mn compounds that eventually decreases the pH and the availability of Mn (Oren, 2018). High pH values in soils (> 6.5) may have limited nutrient availability to plants; thus, it requires fertilizer amendment (Poh et al., 2009). The solubility of Mn bearing minerals like pyrolusite, manganite etc. increases with reduction in soil reaction and results in greater release of Mn in the soil solution (Das, 2000). Availability of Mn to plants depends on its oxidation state: the oxidized form (Mn^{4+}) is not available to plants, whereas the reduced form (Mn^{2+}) is. Mn^{2+} concentration in soil solution should theoretically reduce 100-fold for every unit of pH raise (Barber, 1995).

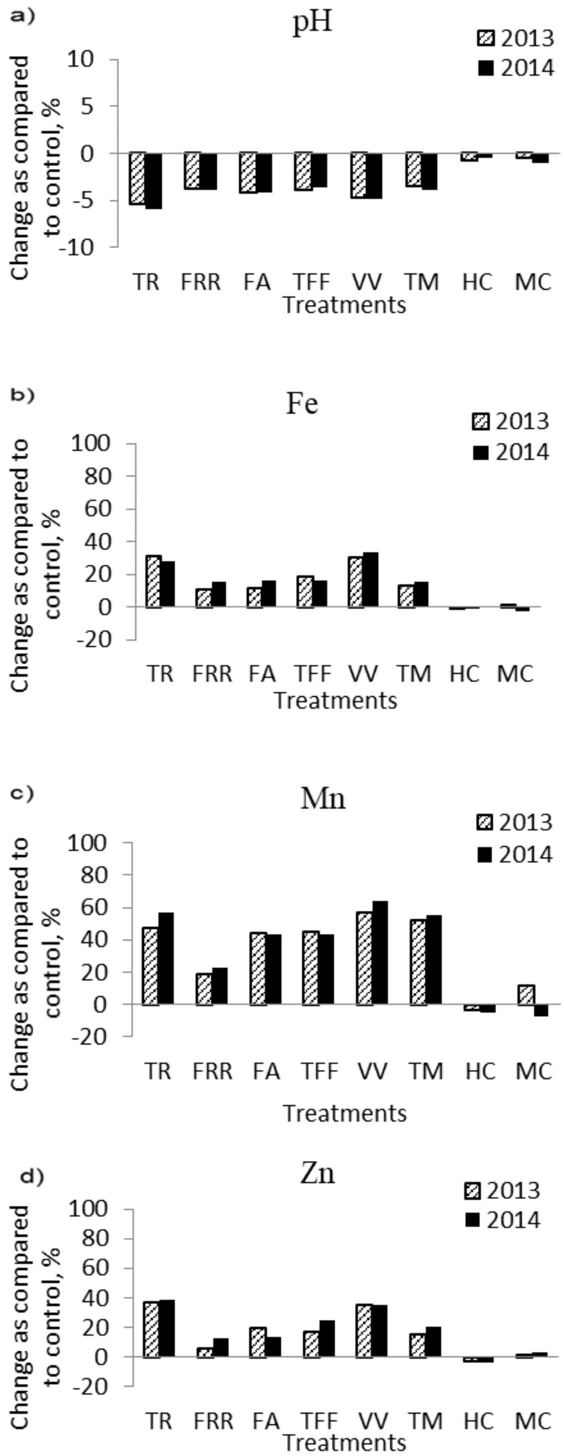


Figure 3. Relative changes (%) in pH (a), Fe (b), Mn (c) and Zn (d) concentrations at 0-20 cm soil depth as compared to the bare control in the kiwi orchard

Şekil 3. *Kivi bahçesinde yalın kontrolle karşılaştırıldığında 0-20 cm toprak derinliğindeki pH (a), Fe (b), Mn (c) and Zn (d) içeriğindeki oransal değişimler*

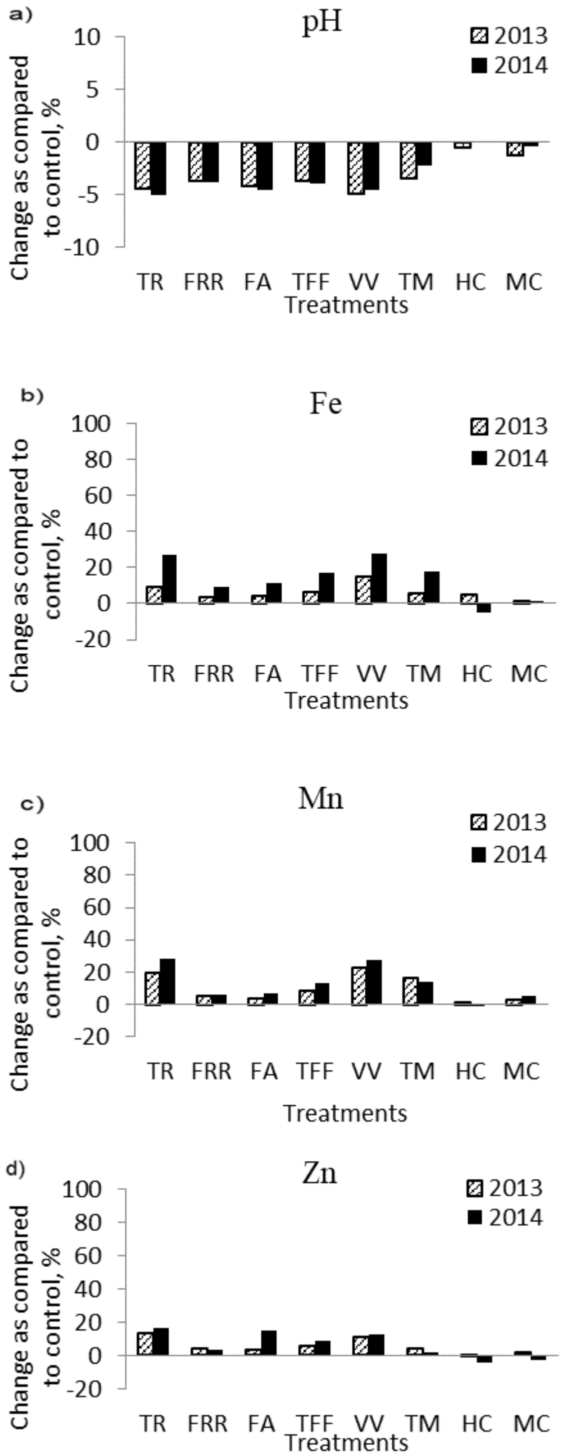


Figure 4. Relative changes (%) in pH (a), Fe (b), Mn (c) and Zn (d) concentrations at 0-20 cm soil depth as compared to the bare control in the persimmon orchard

Şekil 4. *Trabzon hurması bahçesinde yalın kontrolle karşılaştırıldığında 0-20 cm toprak derinliğindeki pH (a), Fe (b), Mn (c) and Zn (d) içeriğindeki oransal değişimler*

Zinc concentrations of the soils had a tendency to increase cover crops used. The highest Zn concentration (2.91 mg kg^{-1}) in the second year of the experiment was obtained in the TR treatment while the lowest Zn concentration (2.01 mg kg^{-1}) was in the HC treatment in 0-20 cm soil depth in the kiwi orchard (Figure 1d). Zinc concentrations (mg kg^{-1}) in the kiwi orchard was in ascending order as: HC (2.01) < BC (2.10) < MC (2.16) < FRR (2.37) < FA (2.38) < TM (2.53) < TFF (2.61) < VV (2.84) < TR (2.91). In comparison to bare control, there were 12.74% in FRR and 38.71% in TR treatments in the kiwi orchard, which increased the availability of Zn (Figure 3d). Franzluebbers and Hons (1996) also reported a cover crop induced availability. In this study, it was reported that the higher organic matter content in soils means the higher availability of Zn (Iratkar et al., 2014). High soil reaction decreases the mobility and solubility of Zn in soils by stimulating its adsorption to soil constituents and limiting its diffusion to soil solution and plant roots (Sherene, 2010). Regarding available Zn concentration of the experimental plots, all soils were well above the deficiency treshold (0.8 mg kg^{-1}) (Dobermann and Fairhurst, 2000). The highest Zn concentration (1.35 mg kg^{-1}) in the second year of the experiment was obtained in the TR treatment while the lowest Zn concentration (1.12 mg kg^{-1}) was in the HC treatment in the persimmon orchard (Figure 2d). Zinc concentration (mg kg^{-1}) in the persimmon orchard was ordered as: HC (1.12) < BC (1.16) < TM (1.19) < FRR (1.20) < MC (1.23) < TFF (1.27) < VV (1.31) < FA (1.34) < TR (1.35).

Table 2 Descriptive statistics for the soil properties
Çizelge 2. *Toprak özellikleri için tanımlayıcı istatistikler*

		Minimum	Maximum	Mean	Std. Dev.	CV,%	Skewness	Kurtosis
				Kiwi orchard				
2013	pH	7.06	7.73	7.39	0.157	2.12	0.376	-0.572
	Fe, mg kg^{-1}	9.00	14.69	11.79	1.494	12.67	0.164	-0.928
	Mn, mg kg^{-1}	6.02	12.30	9.17	1.714	18.69	-0.281	-1.119
	Zn, mg kg^{-1}	1.50	3.39	2.41	0.422	17.51	0.166	-0.379
2014	pH	7.12	7.75	7.41	0.162	2.19	0.339	-0.938
	Fe, mg kg^{-1}	9.78	15.49	12.12	1.441	11.89	0.199	-0.675
	Mn, mg kg^{-1}	4.38	13.16	9.02	2.226	24.68	-0.279	-0.635
	Zn, mg kg^{-1}	1.53	3.52	2.43	0.473	19.47	-0.067	-0.135
				Persimmon orchard				
2013	pH	7.03	7.52	7.26	0.137	1.89	0.404	-1.043
	Fe, mg kg^{-1}	13.37	17.00	14.90	0.875	5.87	0.335	0.315
	Mn, mg kg^{-1}	7.03	9.51	8.11	0.660	8.14	0.459	-0.781
	Zn, mg kg^{-1}	1.04	1.36	1.17	0.71	6.08	0.556	1.126
2014	pH	7.01	7.52	7.23	0.155	2.14	0.303	-1.395
	Fe, mg kg^{-1}	14.00	20.16	16.86	1.689	10.02	0.225	-0.735
	Mn, mg kg^{-1}	6.24	10.00	8.12	0.974	12.00	0.246	-0.594
	Zn, mg kg^{-1}	1.00	1.53	1.24	0.127	10.28	0.245	0.218

The increasing ratio for persimmon orchad was smaller than those observed in kiwi orchard as between 2.06% in TM and 16.4% (Figure 4d). However, these increments in the Ext-Zn concentration were not significant in the persimmon orchard. Although Zn availability in soil was regulated by varieties of factors (Sadeghzadeh, 2013), the reestablishment of aerobic conditions, decrease of soil reaction and precipitiation of Fe in non-available form were likely to be the primary factors controlling Zn availability in the current study.

The DTPA-extractable copper concentrations of soils were not affected by cover cropping treatments in both depths. Copper concentration ranges were 5.44 - 6.19 mg kg^{-1} and 7.56 - 8.10 mg kg^{-1} for kiwi and persimmon orchards, respectively. It was reported that soil organic matter exerts an important and direct effect on the availability of Fe, Mn and Zn but has little effect on the availability of soil Cu (Zhang et al., 2001). Fageria (2009) claimed that copper is taken up by the plants in only very small amounts.

It is evident from the table that the pH of the soils under cover crop showed as little as 7.12 - 7.68% and 7.01 - 7.52% for kiwi and persimmon orchards, respecitvely. The Fe and Cu concentrations in the persimmon orchard with clay texture soil were higher than the ones in the kiwi orchard with loam texture soil. The available DTPA-extractable micronutrient concentrations,

The differences in the micronutrients and pH values of soils in the orchards were not significant for 20 - 40 cm soil depth in both years of the experiments. Descriptive statistics of orchard soils were given in Table 2. except Mn were above the deficiency tresholds (Lindsay and Norvell, 1978). The correlation cofficients between the DTPA-extractable micronutrients and pH were significant at $p< 0.05$ and $p<0.01$. Similar significant negative correlations in the VV and TR treatments were observed between soil pH and Fe, Mn, Zn in the kiwi orchard (Table 3).

Table 3. The highest correlations between soil pH and available Fe, Mn, and Zn
Çizelge3. *Toprak pH'ı ve mevcut Fe, Mn ve Zn arasındkia en yüksek korelasyonlar*

	Vicia villosa (VV)					
	Kiwi orchard			Persimmon orchard		
	Fe	Mn	Zn	Fe	Mn	Zn
pH	-0.853**	-0.905**	-0.590*	-0.833**	-0.668*	-0,581
	Trifolium repens (TR)					
	Kiwi orchard			Persimmon orchard		
	Fe	Mn	Zn	Fe	Mn	Zn
pH	-0.853**	-0.952**	-0.802**	-0.835**	-0.744*	-0.678*

The general response of persimmon orchard was also in the same direction (Table 3). Similar findings about relationship between available micronutrients and pH of soil were reported in previous studies (Kumar and Babel, 2011). Many of researchers have stated significant negative correlations between soil pH and available Fe, Mn, and Zn (Sharma et al., 2003; Mathur et al., 2006; Yadav and Meena, 2009; Sidhu and Sharma, 2010).

4. Conclusions

This study showed that cover crop treatments generally increased the micronutrients at 0-20 cm soil depth both in the kiwi orchard with loam texture soil and in the persimmon orchard clay texture soil. Regarding the effect of cover crop treatments on the Ext-Fe, Mn, Zn and soil pH, higher improvement rates were observed in the kiwi orchard according to the bare control in both years of the experiment. While the micronutrients increased, soil pH decreased with cover crop treatments. The micronutrients concentrations showed high degree of crop dependency. Soil pH was the main soil parameter in the availability of the micronutrients. *Vicia villosa* (VV) and *Trifolium repens* (TR) treatments mediated in the highest availability level of the indigenous micronutrients. In both years of the experiment, there were no significant differences in measured variables at 0-20 cm soil depths of mechanically cultivated, herbicide treatment and bare control plots.

It is revealed in the current study that when cover crops are used as fresh carbon source, they offer significant rise in the concentrations of micronutrients in the soil. Decreasing or increasing the rate of soil pH affects the micronutrient availability to plants and is considered to be the main factor for inadequacy of these nutrients. Therefore, using cover crops may be a significant alternative to enhance the sustainment of agricultural systems, which can prefer increasing soil fertility, and restoring remarkable quantities of micronutrients to crops. It was concluded based on the current findings that cover crops, especially *Vicia villosa* and *Trifolium repens* treatments could be incorporated into cropping systems to improve micronutrients and to provide a sustainable soil management.

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