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# The Response of Soil Health to Different Tillage Practices in Organic Viticulture Farming

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## Abstract

Turkish varieties of seedless grapes and raisins are among the most sought after varieties in domestic and international markets. The present study determined the influences of the four different tillage practices; mulching, chisel tillage, plow tillage and conventional tillage under organic. The experiment was distributed using complete randomized block design (RBD) with three replications consisting of 12 vines per plot. Overall, data showed that nitrogen, phosphorus, potassium, calcium, and magnesium were highest under mulching whereas, sodium, iron, and manganese were the highest under conventional tillage, and finally Copper and Zinc were the highest under the control treatment. Soil organic matter content at a depth of 0-30 cm under mulching was significantly higher than those under other tillage practices. The response of soil micronutrients to mulching was higher compared to more intensive tillage practices.



### Keywords

Organic farming; Soil tillage; Mulching; Soil organic matter


## Introduction

The global population is expected to be about 7.5 billion by 2020 and 9.4 billion by 2050 [1]. The rapid growth of world population and associated uncontrolled urbanization and industrialization have created many environmental problems, and ultimately affected human health. In order to provide adequate food for increased population, farmers have applied a wide variety of chemicals onto their crops. While using synthetic fertilizers in farming to increase the production, it causes problems in human health [2] in an indirect way since those chemicals contaminate the soil and water. The chemicals used in farmland accumulate in the plants, leach into groundwater, or discharge to surface waters through runoff and ultimately reach to human body [3]. Pesticides cause problems in neurologic and endocrine systems, birth defects, cancer [4], and other diseases for human being. Because of these problems, a new approach of agricultural production, organic (ecological, or biological) farming, was altered to conventional agriculture.

Interest in organic farming has greatly increased since the beginning of the 21st century in the world. The organic food market value was reported as 25 US $ billion in 2002 [5]. Organic food market has been increased by 63% to over 63 billion US $ in 2007 [6]. Almost 0.9% of total world farmland was worldwide managed as organic in 2009 [7]. The area under organic agriculture annually increased by 8.9% over the years 2001-2011 [8]. Today is described as the most dynamic and rapidly developing global food industry with 20% annual increase in sale of organic products since 1990 [9]. Organic agriculture is practiced and showed a significant development all around the world.

Along with the global demands on organic products in the world market, organic farming practices started in the year of 1984-1985 in Turkey by growing of organic grape, which is Turkey's traditional export product. Viticulture is important in Turkey and has a great value for the agricultural sector and national economy [10]. Turkey is a major producer of grapes in the world and viticulture is one of the major branches of agriculture with respect to production area and its large share of income in Turkish national economy. Grapevine is grown in almost all parts of Turkey and has been produced commercially in many regions of the country for many years. Turkey is among the largest grapevine growing countries of the world with approximately $4.69^{*}10^{5}$ hectares of vineyard area and 4.01 million tons of grape production (5th in area; 6th in production). Grape production mainly consists of 52.80% table grapes, 36.40% raisins and 10.80% must-wine varieties [11].

In the world, $3.12^{*}$ $10^{5}$ hectares of organic grapes are grown constituting 4.6 percent of the world's grape growing area. Since 1985, Turkey producing and exporting organic raisins is a world leader in the production of raisins. In Turkey, 8, $42^{*}$ $10^{3}$ hectares area of grape are grown organically which constitutes 1.80 % of the total grape production area [11]. Therefore, producing healthy and sufficient number of grapes are important for food security and human health for those who but these products.

Turkish varieties of seedless grapes and raisins are among the most sought-after varieties in domestic and international markets. The Aegean Region in Turkey has especially suitable soil and weather condition to grow seedless organic grapes. Organic grapes vineyards are usually located in provinces of Izmir and Manisa in Turkey. Almost all the grapes produced in these areas are dried and processed and exported mainly to European countries. The amount of total organic raisins produced in Turkey represents 3.6% of the total raisin production in the world [12].

Growing high quality of organic grapes are depending on many conditions, including; water availability, soil type, nature of the site (slope, depth, etc.), fertility and nutrient content of the soils, prevailing winds, vineyard operations, and the architecture of the vines. The soil organic carbon (SOC) accumulation, emissions of C and C-sequestration is associated with soil management practices especially tillage [13]. Therefore, the reduction of organic matter in the soil might be adjusted by tillage practices. Practicing cultivation or surface cultivation of the soil provides insufficient oxygen transfer into the soil. Lack of oxygen delays decomposition of organic matter [14].

The present study investigates the impacts of tillage practices on soil properties and soil micro and macronutrients under seedless grapes in organic vineyard farming in the Aegean Region, Turkey. Four different soil tillage practices were studied including; mulching, chisel tillage, plow tillage and conventional tillage.

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## Material and Methods

### Experimental design and site characteristics

The experimental site of the present study was established on 1.3 ha area in 2003 in 15 years old irrigable soil conditions in Sultani Cekirdeksiz grape parcel, Alasehir-Yesilyurt Enterprise of Manisa Viticulture Research Institute in Aegean Region, Turkey. Plots were trained to "T" wire grape trellis training system and can-pruned to 60 buds per vine. The vineyards were completed their three years transition period in the years of 2003-2005 as defined in the regulations and organic products were obtained next two years in 2006 and 2007 [15]. The cultivation of organic grape was continuing in the vineyards starting in 2006. The vines had between-row and within-row spacing's of 3.3 and 2.4 m, respectively in organic parcel.

Field experiments were conducted from 2006 to 2007 in Alasehir-Yesilyurt enterprise of Manisa Viticulture Research Institute in West Turkey (38°20′N, 28°38′W). The area had a transition towards a continental climate from a Mediterranean climate. The annual average temperature of the area during the study was 16.7°C with a mean annual rainfall of 598 mm, The summer months, including the harvest period, were quite hot with mean temperatures of 30°C.

The crop used in this study indicates Sultani Cekirdeksiz is a variety, which ripens in midseason. It grows strong with conical clusters, wings, normal density, small oval shaped berries and average berry skin thickness. Although it is a variety for drying, Sultani Cekirdeksiz is also processed as table grapes through a series of culture practice.

### Study treatments

The experiment was designed as randomized complete block with three replications of three variables including the control (Conventional). Common vetch (*Vicia sativa L.*), Rye (*Hordeum vulgare L.*), and broad beans (*fava beans*) were used as mulch plants. The soil was tilled in spring and autumn in both conventional and cultivator plots, whereas, tillage was applied only in spring for mulch tillage system. In the experiment Massey 240 S (Engine Power 50 hp) tractor was used. The variable application treatments including (1) mulching (M), (2) chisel tillage (Ch), (3) plow tillage (P; Plow + Disk Harrow (or renovator) and tillage) and (4) a control (C; Conventional practice). Conventional tillage refers to plow tillage + dick harrow + inorganic fertilizer application + herbicide use. Every viticulture crop was established on 7.92 $m^2$ whereas total of 36 viticulture was arranged to each plot (285.12 $m^2$).

### Soil sampling and analysis

Soil samples were collected at 0– to 30-cm and 30– to 60-cm depths to determine soil physical and chemical properties according to international methodology [16] in 2003 (initial soil properties), 2006, and 2007. Soil's pH was determined on the soil paste that saturated with de-ionized water (ratio of 1:1 soil/water) using pH glass electrode [17]. Percentage of total soluble salts was determined in saturated soil paste by measuring the electrical resistance [18]. The percentage of limestone ($CaCO_3$) was determined using Scheibler calcimeter [19]. Soil texture analysis was conducted using hydrometric method [20] whereas organic substances were determined with wet digestion method [19]. Soil total nitrogen was determined using Kjeldahl method [21] and available P was measured colorimetric all by doing extraction with water [22]. Available potassium, calcium, magnesium and sodium were extracted with 1 N $NH_4OAC$ and measured using flame photometry [17]. Available iron, zinc, manganese and copper in soil samples were extracted using DTPA and measured by atomic absorption spectrometry [23].

### Initial soil properties

The initial condition of the soils was determined (2003) starting the experimental applications and treatments. The combination of 10 different soil (sandy loam) samples in the seedless grape growing location was collected from two different depths (0–30 and 30–60 cm) to determine the soil physical and chemical properties at the time of experiment setup. First tillage application was initiated just after soil sampling for initial values. The range of initial soil pH data were between 7.60 and 7.65 for 0-30 and 30-60 cm depths, respectively indicated that the soil was in light alkaline condition. The soil was pore based on lime content with 34.4 g $kg^{-1}$ (0-30 cm) and 39.2 g $kg^{-1}$ (30-60 cm). Soil organic matter content was low in initial soils (15.2 g $kg^{-1}$; 0-30 cm and 9.5 g $kg^{-1}$; 30-60 cm). Total nitrogen ($N_T$) ranged from 0.60 g $kg^{-1}$ to 0.38 g $kg^{-1}$ (0-30 cm 30-60 cm) whereas; available phosphorus ($P_A$) was between 0.00332 g $kg^{-1}$ (0-30 cm) and 0.00129 g $kg^{-1}$ (30-60 cm). Available potassium ($K_A$) content was low at the beginning of the experiment (0.175 g $kg^{-1}$; 0-30 cm and 0.155 g $kg^{-1}$; 30-60 cm). The available calcium ($Ca_A$) was reported as sufficient for the initial data ranged from 2.16 to 2.4 g $kg^{-1}$ (0-30 cm and 30-60 cm). The initial available magnesium content ($Mg_A$) ranged between 0.934 g $kg^{-1}$ (0-30 cm) and 0.938 g $kg^{-1}$ (30-60 cm) indicated as sufficient. Similarly, available sodium concentrations ($Na_A$) were monitored as 0.0208 g $kg^{-1}$ (0-30 cm) and 0.019 g $kg^{-1}$ (30-60 cm), which was sufficient. Initial data showed the sufficient levels of soil iron content ($Fe_A$; 0.00851 g $kg^{-1}$; 0-30 cm and 0.00679 g $kg^{-1}$; 30-60 cm). At the beginning of trial, the available copper content ($Cu_A$) of soil samples was varied from 0.00348 g $kg^{-1}$ to 0.00613 g $kg^{-1}$ for both depths, indicates that there was high copper content in the soil. The available zinc content ($Zinc_A$) in all the soil samples under the vineyard production was not in sufficient levels. Average initial soil available manganese concentrations ($Mn_A$) were observed as 0.0072 g $kg^{-1}$ (0-30 cm) and 0.00409 g $kg^{-1}$ (30-60 cm) indicates sufficient.

### Statistical analysis

A statistical test was determined to evaluate the influences of tillage practices on soil macro and micro nutrient concentrations. Estimation for pairwise comparison method among treatments was used in the mixed procedure using SAS 9.3 [24]. Tillage practices were reflected as fixed effects and replications as random effect. The differences among tillage practices were measured at the significant level of $\alpha = 0.05$.

A multiple linear discriminant analysis was established to analyze effects from treatments to soil properties by using JMP package. The diversification between each group was expected multivariate normal and the function was advanced within a parametric method by establishing the method of Discrim as normal. The classification criterion is evaluated by a measure of generalized squared distance. The classification criterion was based on the pooled covariance matrix yielding a linear function; it also takes into account the prior prospects of the groups indicated treatments and soil depth were established as a parameter.

## Results and Discussion

### The response of soil physical and chemical properties to different tillage practices

The physical and chemical properties of the soil can be list as: pH, salt content, limestone ($CaCO_3$), and organic matter. Soil pH and total salt (g kg$^{-1}$) data for 0-30 and 30-60 cm depth under all the treatments for 2006 and 2007 are shown on Figure 1 (pH) and Figure 2 (Total Salt). Treatments significantly influenced the soil pH only at 0-30 cm depth for 2006. Soil pH was not significantly influenced by the treatments at either year beyond 30 cm depth. The entire pH values including control samples were neutral, which varied between 7.6 under mulching (M)

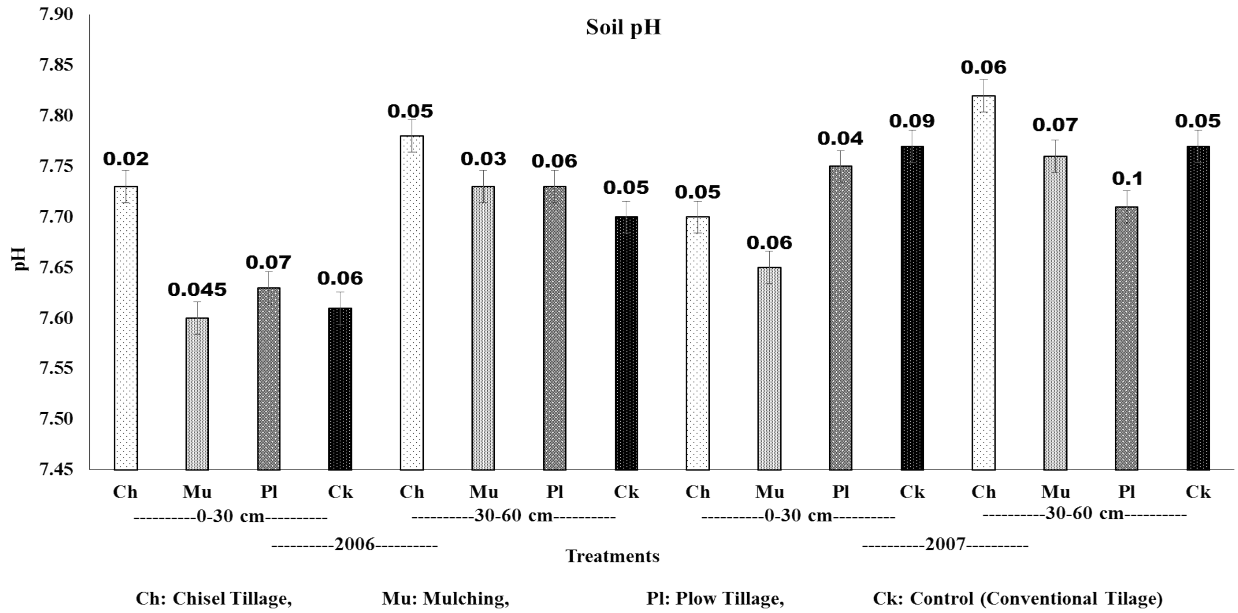


**Figure 1:** Soil pH under impacts of different tillage practices at both 0-30 cm and 30-60 cm depths in 2006-2007.

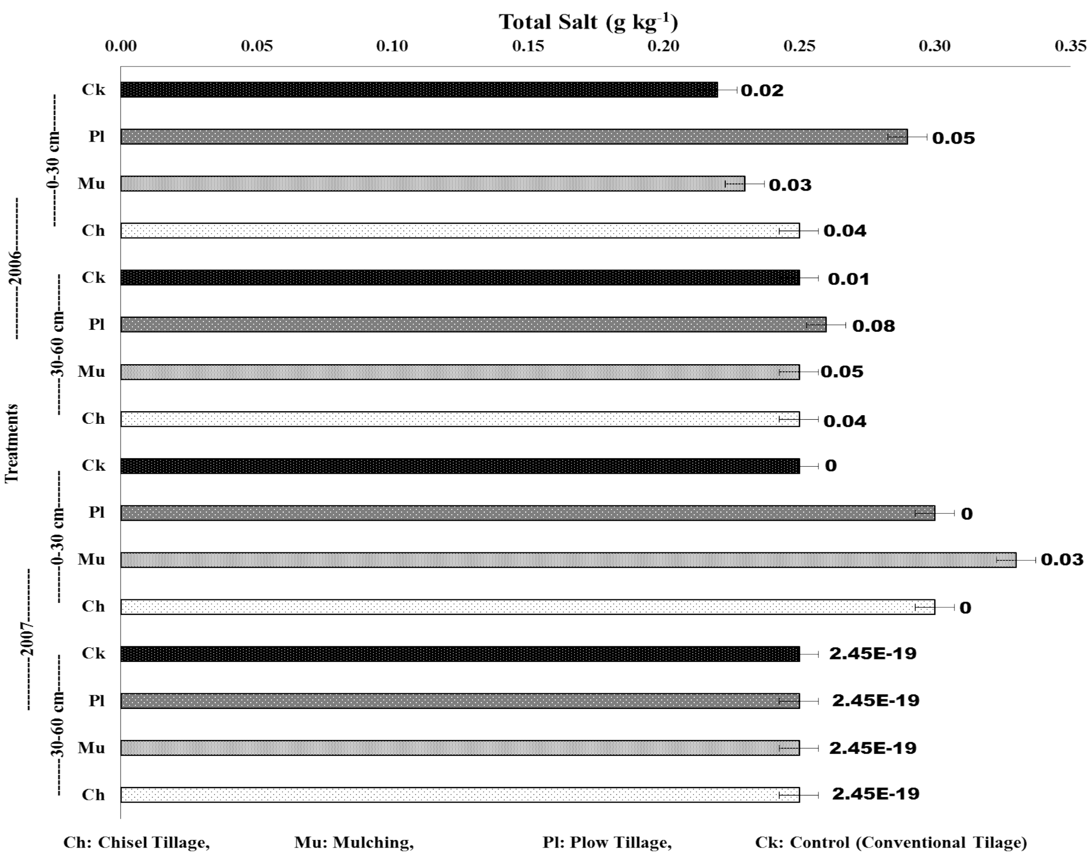


**Figure 2:** Soil total salt content under impacts of different tillage practices at both 0-30 cm and 30-60 cm depths in 2006-2007.

and 7.82 under chisel tillage in either depth. It was also significantly different for chisel *vs*. mulching, chisel *vs*. plow in 2006 and mulching *vs*. plow in 2007 only for 0-30 cm depth. Data showed that the plots under chisel tillage practice rate had the highest pH and those under mulching tillage had the lowest pH at the 0-30 cm depth for 2006. The chisel tillage (7.73) increased the soil pH by 1.7, 0.1 and 1.6%, respectively, compared to mulching (7.6), plow (7.63) and conventional (7.61) tillage practices in 2006. Significant differences on soil pH due to tillage practices were not observed beyond 30 cm depth in 2006 and both 0-30 cm and 30-60 cm in 2007. Soil pH under mulching was higher in 0-30 cm depth compare to 30-60 cm depth; however, those under conventional tillage had lower pH at 0-30 cm depth.

This might be due to disruption and mixing of soil at the depth of 0-30 cm [25] also supported the present study by similar findings of a study with fertilization and tillage effects on soil properties and maize yield. Gadermaier et al. [26] reported that tillage declined the soil pH, which supports the present study. The decline in subsoil acidity improves crop micronutrient uptake [27].

In the tested areas, there were differences between salt contents of the soils. The alkalinity in this area was found as slightly alkaline. Similarly, the salt content of all the soil samples were in acceptable range (total salt less than 0.3 g $kg^{-1}$). These results conclude that the soil was adequate to grow grapes in terms of salinity content (Figure 2). The soil samples collected from the field that applied different tillage methods showed a low alkaline characteristic. Soil sodicity and salinity are associated with crop production, soil structure and water infiltration. In the present study, the soil salt content was significantly impacted by different tillage practices. No-till helps to control field traffic and water characteristics and hence sustain the nature of soil structure. Controlled field traffic by adjusting management practices deliver maintaining in soil temperature, improvement in soil structure, and hence controlling in soil salinity [28]. This might be the reason for non-significant impacts of treatments on soil salt content in the present study. Soil salinity is mainly caused by salt water intrusion due to global and/or local drought conditions and inappropriate land management [29].

Similarly, there was no difference among the sample based on lime content. Soil limestone (g $kg^{-1}$) data for 0-30 and 30-60 cm depths under all the tillage practices for 2006 and 2007 are presented in Figure 3. Data showed that treatments significantly impacted soil limestone at 30-60 cm (P<0.008) in 2006. However, limestone data showed non-significant impact under tillage treatments for 0-30 in 2006 and both 0-30 cm and 30-60 cm depths in 2007. Additionally, soil limestone was also significantly different for contrasts both chisel *vs*. mulching and chisel *vs*. plow for 0-30 cm depth in 2006. The range of limestone was from 29.3 g $kg^{-1}$ to 45.6 g $kg^{-1}$ in 2006 and 30.4 g $kg^{-1}$ to 37.3 g $kg^{-1}$ in 2007. Plots under chisel treatment had the highest limestone contents, whereas, those under mulching had the lowest at 0-30 cm depth in 2006. The soil under application of chisel treatment (45.6 g $kg^{-1}$) was represented as the highest increased value, which is 1.18 times higher than mulching (23.0 g $kg^{-1}$) and 56% higher than plow (26.3 g $kg^{-1}$) treatments at 0-30 cm depth in 2006. Significant differences on limestone due to tillage practices were also significant in chisel *vs*. mulching (P<0.002) and

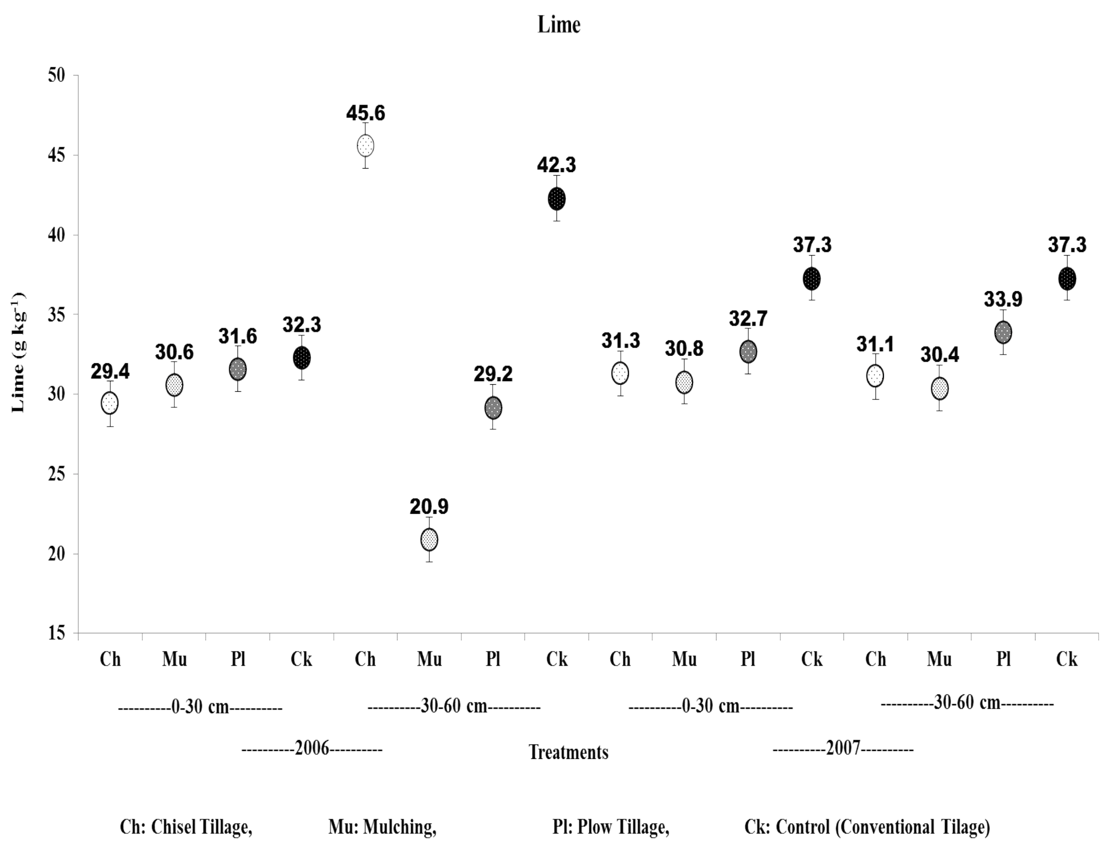


**Figure 3:** Soil lime content under impacts of different tillage practices at both 0-30 cm and 30-60 cm depths in 2006-2007.

chisel *vs*. plow (P<0.02) contrasts for 0-30 cm depth in 2006. However, neither treatments nor contrasts were significantly different for 0-30 cm depth in 2006 and either depth in 2007 in terms of limestone content. Adams and Pearson [30] reported that liming maintains soil chemical restraints. The liming also was reported to decline in the Mn, Fe, B, Zn, and Cu availability in the soil Fageria et al. [27]. Neugschwandtner et al. [31] Supported insignificant differences of tillage on soil $CaCO_3$.These findings supported by our study in 2006, which might be due to greater retention of water in the soil profile under conversation tillage.

Data for soil organic matter content (g $kg^{-1}$) under different tillage practices for 2006 and 2007 in the 0-30 and 30-60 cm depths are shown in Figure 4. Data showed that treatments significantly impacted the SOC for 0-30 cm depth for 2006. Additionally, SOC was also significant for the contrasts chisel *vs*. mulching (P<0.001) and mulching *vs*. plow (P<0.0008) for 0-30 cm in either year, except for mulching *vs*. plow in 2007. The highest SOM content was monitored under mulching (21.1%) treatment, which was significantly higher than control (40.7% higher; 15 g $kg^{-1}$), plow (49.6% higher; 14.1 g $kg^{-1}$) and chisel tillage application (86.7% higher; 11.3 g $kg^{-1}$) at the 0-30 cm depth in 2006. Similar trends were observed for same depths of 2007. However, SOM content were not significant beyond 30 cm depth for both treatments and contrasts in either 2006 or 2007. The soil organic matter contents under all tillage applications were resulted to be inadequate. Soil organic matter content was increased by mulching compare to those under other tillage practices at 0-30 cm depth. This compliment supported by other studies, for example, Ibrahim et al. [32] reported that no-till practice increased soil organic matter at the 0-15 cm depth compared to those under conventional tillage after 14 years study in South Dakota, USA. In addition, Junior et al. [33] reported that conventional tillage decreased soil organic matter due to the mixing soil, enhancing soil aeration and decomposition of soil organic matter by the plowing in depth of 25 cm. Ibrahim et al. [32] and Scopel et al. [34] mentioned that a reason for decline in soil organic matter also can be caused by a higher temperature by leading to more oxidation of soil organic matter. This might be a reason for overall low soil organic matter content. In addition, Ozlu et al. [35] reported that soil organic matter was higher at the surface depth compare to lowers, as it supported that soil organic matter content at the 0-30 cm was higher than those at 30-60 cm depth. Overall, mulching enhanced the soil organic matter accumulation compared with other tillage practices. Reducing tillage was reported to significantly enhance soil organic matter content [27].

## The impacts of different tillage practices on soil macronutrient contents

The data for the soil available N, P, and K contents as impacted by different tillage practices is tabulated on Table 1. Total nitrogen ($N_T$; g $kg^{-1}$) data for 0-30 and 30-60 cm depths under tillage managements for 2006 and 2007 years are tabulated in Table 1. Data showed that mean total nitrogen content ranged from 0.3 to 0.6 g $kg^{-1}$ in 2006 and from 0.7 to 1.2 g $kg^{-1}$ for 0-30 cm; whereas, observations showed a ranged in 0.17-0.44 g $kg^{-1}$ in 2006 and 0.49-0.70 g $kg^{-1}$ in 2007 for 30-60 cm depths. The highest total nitrogen content was monitored under mulching (0.6 g $kg^{-1}$) whereas; the lowest values were represented under chisel treatment (0.3 g $kg^{-1}$) for 0-30 cm soil depth in 2006. A similar trend was observed for 0-30 cm depth in 2007. However, the highest total nitrogen content was monitored under plow tillage (0.44 g $kg^{-1}$) whereas, the lowest values were represented under mulching (0.17 g $kg^{-1}$) for 30-60 cm soil depth in 2006 (Table 1). Not only treatments (P<0.001) but also contrasts chisel *vs*. mulching (P<0.0001), chisel *vs*. plow (P<0.03) and mulching *vs*. plow (P<0.005) were significant for 0-30 cm depth in 2006. A similar trend was represented for 30-60 cm depth in 2006 but neither for 0-30 cm nor 30-60 cm depths in 2007. Data from this study indicate that the total nitrogen content for 0-30 cm soil depth was on average graded whereas; it was low for 30-60 cm soil depth.

Ibrahim et al. [32] Reported that late planting might cause lower N content and nitrogen loses by leaching from the upper soil layer. Ibrahim et al. [32] Mention that decline in the nitrogen content can be represented under conventional tillage due to leaching. This can explain lower soil nitrogen content under conventional tillage and higher under

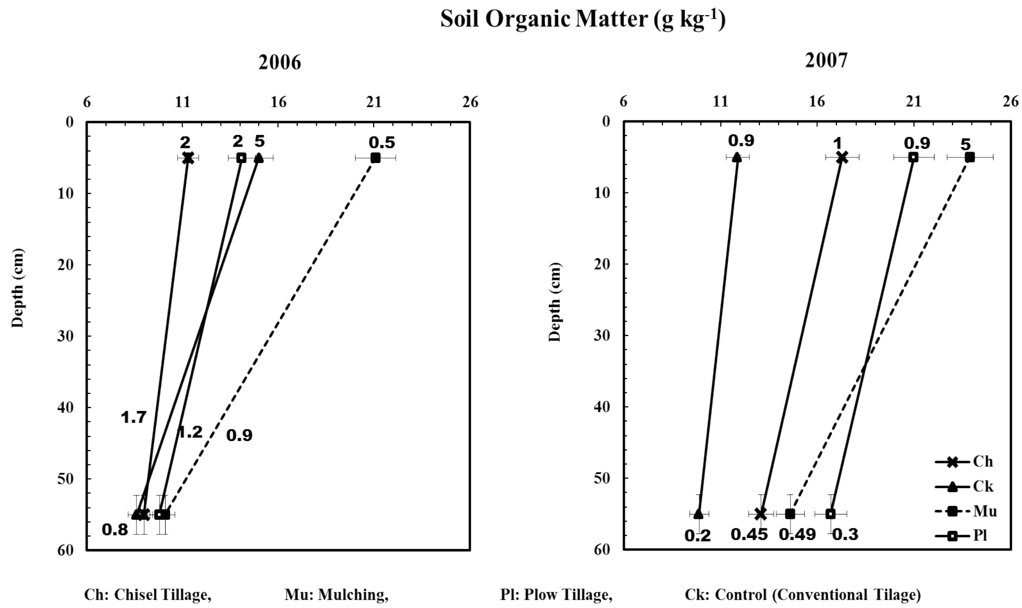


**Figure 4:** Soil organic matter content under impacts of different tillage practices at both 0-30 cm and 30-60 cm depths in 2006-2007.

mulching. Lower nitrogen content under conventional tillage compare to no-till was found under cover crops and tillage vineyard farming by Steenwerth et al. [36]. Similarly, Neugschwandtner et al. [31] studied different tillage impacts on soil nutrients from 1996 and reported in 2014 that reduction in tillage intensity resulted increase in soil nitrogen content at surface soil depth.

The available phosphorus ($P_A$; mg $kg^{-1}$) data for 0-30 cm and 30-60 cm depths under tillage managements for 2006 (P<0.04 and P<0.0001) and 2007 (P<0.01 and P<0.002) years were significantly different and tabulated in Table 1. The observations resulted that $P_A$ content ranged from 2.88 mg $kg^{-1}$ to 4.84 mg $kg^{-1}$ for 0-30 cm depth and 1.19 mg $kg^{-1}$ to 2.43 mg $kg^{-1}$ for 30-60 cm depth in 2006. Data was represented in a range from 3.34 mg $kg^{-1}$ to 5.89 mg $kg^{-1}$ (0-30 cm) and in 1.07 mg $kg^{-1}$ to 2.96 mg $kg^{-1}$ (30-60 cm) in 2007. According to findings obtained, the highest observations for $P_A$ content were represented under mulching (4.84 mg $kg^{-1}$) for 0-30 cm depth and under plow tillage (2.43 mg $kg^{-1}$) for 30-60 cm depth in 2006. A similar trend was represented for either depth in 2007. In addition, contrasts were significant for chisel *vs*. mulching (P<0.03; 0-30 cm), chisel *vs*. plow (P<0.0001; 30-60 cm) and mulching *vs*. plow (P<0.01; 0-30 cm and P<0.0001; 30-60 cm) in 2006 similar to those in 2007.

Overall, mulching increased soil available phosphorus compare to other tillage practices. Wyngaard et al. [25] supported the present study by reporting that lower tillage such as no-till was significantly higher compare to those under conventional tillage. With similar findings, Ibrahim et al. [32] reported a 14 year study in South Dakota indicated that mixing due to plowing may cause distribution and mobility in phosphorus content at the surface depth compare to those at the lower depths. This might be the reason for the lower P content at surface depth in the present study. The phosphorus content under conventional tillage is lower than those less disturbs by tillage. Neugschwandtner et al. [31] also reported that reduction in tillage intensity resulted increase in soil phosphorus content at soil surface layer. P is immobile and accumulates under no-till treatments at the soil surface due to the P stratification and non-residue removal [37].

The available potassium content of the present study indicates that there are no significant impacts due to soil tillage practices. Previous studies also observed similar results indicates insignificant difference in impacts of the mulching and conventional tillage on available K content for 14 years [32]. The insignificant differences under different tillage practices in organic farming were also reported by Gadermaier et al. [26]. Matowo et al. [38] also supported that soil Potassium content was not impacted by tillage practices. The K stratification in no-till system accumulates k at the surface of the soil profile [37].

The available calcium ($Ca_A$; g $kg^{-1}$) data for 0-30 and 30-60 cm depths under tillage managements in 2006 and 2007 years are tabulated in Table 2. The $Ca_A$ concentrations were significantly different under treatments (P<0.02) and for contrast chisel *vs*. mulching (P<0.02) at 0-30 cm depth in 2007. The data showed that $Ca_A$ concentrations were in sufficient level that crop need. The highest values were represented under mulching (2.52 g $kg^{-1}$) treatment and the lowest under control (2.14 g $kg^{-1}$) whereas; values under mulching were 3.5% and 13.3% higher than those under plow (2.44 g $kg^{-1}$) and chisel (2.22 g $kg^{-1}$) for 0-30 cm depth in 2007. A similar trend was observed for 0-30 cm in 2006 however, they were not statistically significant.

The better soil structure by lower intensity in soil tillage and field traffic will help the accumulation of Ca. In addition, Wang et al. [29] reported a study indicated that the flocculation and aggregation requires Ca in the profile. This will help better soil structure. The movement of over Ca to lower depth of soil profile was reported to cause deeper root endnotes and enhanced soil micronutrient concentrations by Sousa et al. [39] for a study in Cerrado acid soils under corn production in Brazil. The present study indicated that the lower tillage, the higher Ca concentration and better soil structure. Soil Ca concentration is positively associated with soil pH [37,40].

**Table 1:** The impacts of different tillage practices on the soil NA, PA, KA contents at 0-30 cm and 30-60 cm depth in 2006-2007.

| Tillage | N‡ (g $kg^{-1}$) | | P† (mg $kg^{-1}$) | | K†† (mg $kg^{-1}$) | |
|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 |
| | | | *---------------0-30 cm depth-----------------* | | | |
| Ch[1] | 0.3 ± 0.02 | 0.7 ± 0.03 | 3.28 ± 0.67 | 3.34 ± 0.18 | 165 ± 63.5 | 201 ± 77.5 |
| Mu[2] | 0.6 ± 0.09 | 1.2 ± 0.4 | 4.84 ± 1.28 | 5.89 ± 1.56 | 201 ± 92.8 | 244 ± 113 |
| Pl[3] | 0.4 ± 0.03 | 1 ± 0.09 | 2.88 ± 0.85 | 3.51 ± 1.03 | 175 ± 41.7 | 212 ± 50.7 |
| Ck[4] | 0.4 ± 0.05 | 0.7 ± 0.1 | 3 ± 0.37 | 3.65 ± 0.46 | 114 ± 13.2 | 138 ± 16.2 |
| | | | ***Analysis of Variance (P>F)*** | | | |
| Treatment | 0.001 | 0.03 | 0.0384 | 0.0149 | 0.3245 | 0.325 |
| Ch[1]vs Mu[2] | 0.0001 | 0.02 | 0.033 | 0.0048 | 0.4493 | 0.4519 |
| Ch[1]vs Pl[3] | 0.03 | 0.1 | 0.5368 | 0.805 | 0.8371 | 0.8416 |
| Mu[2]vs Pl[3] | 0.005 | 0.3 | 0.0116 | 0.0072 | 0.5766 | 0.5757 |
| | | | *---------------30-60 cm depth-----------------* | | | |
| Ch[1] | 0.24 ± 0.03 | 0.57 ± 0.2 | 1.28 ± 0.06 | 1.34 ± 0.07 | 153 ± 60.2 | 187 ± 73.4 |
| Mu[2] | 0.17 ± 0.05 | 0.49 ± 0.06 | 1.19 ± 0.3 | 1.23 ± 0.1 | 113 ± 9.3 | 138 ± 20.4 |
| Pl[3] | 0.44 ± 0.03 | 0.7 ± 0.1 | 2.43 ± 0.05 | 2.96 ± 1 | 123 ± 40.5 | 150 ± 49.4 |
| Ck[4] | 0.27 ± 0.02 | 0.53 ± 0.06 | 1.34 ± 0.1 | 1.07 ± 0.16 | 141 ± 12.3 | 172 ± 14.9 |
| | | | ***Analysis of Variance (P>F)*** | | | |
| Treatment | <.0001 | 0.228 | <.0001 | 0.002 | 0.4582 | 0.4987 |
| Ch[1]vs Mu[2] | 0.0216 | 0.4304 | 0.4944 | 0.775 | 0.1595 | 0.1796 |
| Ch[1]vs Pl[3] | <.0001 | 0.2157 | <.0001 | 0.002 | 0.2806 | 0.2996 |
| Mu[2]vs Pl[3] | <.0001 | 0.0593 | <.0001 | 0.001 | 0.7086 | 0.7311 |

**Note:** [1]Chisel tillage, [2]Mulching, [3]PlowTillage, [4]Control, N‡ -Total Nitrogen, P†-Available Phosphorus, K††-Available Potassium.

**Table 2:** The impacts of different tillage practices on the soil $Ca_A$, $Mg_A$, and $Na_A$ contents at 0-30 cm and 30-60 cm depths in 2006-2007.

| Tillage | Ca† (g kg⁻¹) | | Mg†† (g kg⁻¹) | | Na‡ (mg kg⁻¹) | |
|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 |
| ---------------0-30 cm------------------ | | | | | | |
| Ch[1] | 1.83 ± 0.24 | 2.22 ± 0.08 | 0.90 ± 0.05 | 1.10 ± 0.03 | 33 ± 2.38 | 30 ± 1.71 |
| Mu[2] | 2.07 ± 0.037 | 2.52 ± 0.05 | 0.85 ± 0.02 | 1.03 ± 0.03 | 22 ± 2.16 | 27 ± 2.63 |
| Pl[3] | 2.00 ± 0.037 | 2.44 ± 0.05 | 0.97 ± 0.09 | 1.18 ± 0.12 | 28 ± 2.99 | 34 ± 3.77 |
| Ck[4] | 1.96 ± 0.13 | 2.14 ± 0.28 | 0.83 ± 0.11 | 1.01 ± 0.13 | 20 ± 2.08 | 24 ± 2.5 |
| *Analysis of Variance (P>F)* | | | | | | |
| Treatment | 0.2429 | 0.0224 | 0.1476 | 0.1259 | <.0001 | 0.0007 |
| Ch[1]vs Mu[2] | 0.0579 | 0.0231 | 0.3615 | 0.3386 | <.0001 | 0.0618 |
| Ch[1]vs Pl[3] | 0.1575 | 0.0838 | 0.298 | 0.2808 | 0.0057 | 0.0376 |
| Mu[2]vs Pl[3] | 0.5443 | 0.4499 | 0.0688 | 0.0592 | 0.0005 | 0.0013 |
| ---------------30-60 cm------------------ | | | | | | |
| Ch[1] | 1827 ± 245 | 2224 ± 298 | 904 ± 56.3 | 1101 ± 68.3 | 33 ± 4 | 40 ± 5.2 |
| Mu[2] | 1943 ± 40.6 | 2156 ± 49.5 | 690 ± 22.3 | 839 ± 26.2 | 24 ± 1.3 | 29 ± 1.9 |
| Pl[3] | 1940 ± 36.9 | 2362 ± 44.9 | 929 ± 90.9 | 1131 ± 111 | 21 ± 6.2 | 26 ± 6.6 |
| Ck[4] | 1991 ± 137.7 | 2362 ± 46.1 | 805 ± 68.5 | 980 ± 83.4 | 21 ± 0.96 | 25 ± 1.5 |
| *Analysis of Variance (P>F)* | | | | | | |
| Treatment | 0.5584 | 0.2411 | 0.001 | 0.0013 | 0.006 | 0.0037 |
| Ch[1]vs Mu[2] | 0.3394 | 0.5635 | 0.0008 | 0.0008 | 0.0138 | 0.0059 |
| Ch[1]vs Pl[3] | 0.3494 | 0.2504 | 0.58 | 0.5762 | 0.0021 | 0.0014 |
| Mu[2]vs Pl[3] | 0.9831 | 0.1008 | 0.0004 | 0.0003 | 0.2603 | 0.3546 |

**Note:** [1]Chisel tillage, [2]Mulching, [3]PlowTillage, [4]Control, Ca†-Available Calcium Mg††-Available Magnesium, Na‡-Available Sodium

The available magnesium ($Mg_A$; mg kg$^{-1}$) data for 0-30 and 30-60 cm depths under tillage managements for 2006 and 2007 years are tabulated in Table 2. After application of different tillage practices, observations for available magnesium had been ranged from 1.01 g kg$^{-1}$ to 1.18 g kg$^{-1}$ (0-30 cm depth) and from 0.84 g kg$^{-1}$ to 1.13 g kg$^{-1}$ (30-60 cm depth) in 2007. The available magnesium content was observed as the highest under plow treatment (1.13 g kg$^{-1}$) and the lowest under mulching (0.84 g kg$^{-1}$) for 30-60 cm depth in 2007. Even if treatments were not significantly different for 0-30 cm depth, they were significant for 30-60 cm (P<0.001) in both 2006 and 2007. In addition, contrasts for chisel *vs.* mulching (P<0.0008) and mulching *vs.* plow (P<0.0003) were significant for 30-60 cm depth in 2007 whereas a similar trend was monitored for 30-60 cm depth in 2006.

Houx et al. [37] reported that Mg content was lower at the soil surface and under lower tillage intensity. Intensive tillage increases soil Mg content at the surface soil, which reminds concern due to over Mg concentration. Ca and Mg ions can become insoluble under impacts of high level of soil pH which increase sensitivity in soil degradation from sodium [29]. Therefore, lower tillage may allow Mg leaching which will help lower pH by the time. On the other hand, the significantly lower soil pH under conventional tillage compare to those under no-till might cause greater Mg mineral weathering [37,40].

The available sodium ($Na_A$; mg kg$^{-1}$) data for 0-30 cm (P<0.001 and P<0.0007) and 30-60 cm (P<0.006 and P<0.004) depths under tillage managements were significantly different in both 2006 and 2007 years, tabulated in Table 3. The available sodium contents were in sufficient level. The $Na_A$ concentration was ranged from 20 mg kg$^{-1}$ to 33 mg kg$^{-1}$ (0-30 cm) and from 21 mg kg$^{-1}$ to 33 mg kg$^{-1}$ (30-60 cm) in 2006 whereas those ranged in between 24 mg kg$^{-1}$ and 34 mg kg$^{-1}$ (0-30 cm) and 25 mg kg$^{-1}$ and 40 mg kg$^{-1}$ (30-60 cm) in 2007. The highest sodium concentrations were observed under chisel treatment (33 mg kg$^{-1}$) for either depths (0-30 cm and 30-60 cm) whereas the lowest representatives were monitored under control (20 mg kg$^{-1}$; 0-30 cm and 21 mg kg$^{-1}$; 30-60 cm) in 2006. Similar trends were resulted in 2007 except where the highest values were observed under plow treatment (34 mg kg$^{-1}$) for 0-30 cm depth in 2007. All contrasts were also significant except those for chisel *vs.* mulching for 0-30 cm depth in 2007 and mulching *vs.* plow for 30-60 cm depth in either year. Overall results of present study indicated that lower tillage decrease soil available Na content.

Ateş et al. [41] supported similar findings indicated that conventional tillage increases Na content compare to no-till practices. Higher Na content under intensive tillage practice may also cause soil degradation. Similarly, Wang et al. [29] stated that persistent existence of $Na^+$ ions under impacts of the conventional tillage may cause soil particles dispersion, surface crusting and decline in water infiltration, and hence the soil degradation. Increasing in soil salt content decline in agricultural production owing to delay in nutrient uptake by crops, physiological stress and causing crop diseases and pest attack [42]. Higher Na content may also cause increasing in soil bulk density because of soil degradation. Soil compaction can influence root growth, nutrients and water uptake by crops and hence crop yield [43].

## The impacts of different tillage practices on soil micro nutrient contents

Using reduced tillage can sooner or later enhance plant growth and accumulation of micronutrients [27]. The data for the soil micro nutrient contents including available iron ($Fe_A$), available cupper ($Cu_A$), available zinc ($Zinc_A$) and available manganese ($Mn_A$) as impacted by different tillage practices is tabulated on Table 3. Treatments significantly impacted the *soil* $Fe_A$ at either depth in either year. $Fe_A$ concentrations were significantly influenced by the treatments (P<0.0001; 0-30 cm in both 2006 and 2007, P<0.0007; 30-60 cm in 2006 and P 0.0006; 30-60 cm in 2007). The entire $Fe_A$ values showed significant contrasts for all versus of treatments for both depths and either year. $Fe_A$ concentrations varied between 4.05 mg kg$^{-1}$ and 9.36 in 2006 and between 4.93 and 11.4 mg kg$^{-1}$ in 2007. Data showed that the plots under plow tillage practice

**Table 3:** The impacts of different tillage practices on available Fe, Cu, Zn, and Mn contents at 0-30 cm and 30-60 cm depths in 2006-2007.

| Tillage | Fe‡ (mg kg-1) | | Cu†† (mg kg-1) | | Zn††† (mg kg-1) | | Mn†††† (mg kg-1) | |
|---|---|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 |
| -------------------------------------0-30 cm depth------------------------------------- | | | | | | | | |
| Ch¹ | 5.52 ± 0.55 | 6.72 ± 0.24 | 2.22 ± 0.07 | 2.71 ± 0.11 | 0.35 ± 0.03 | 0.43 ± 0.05 | 2.6 ± 0.43 | 3.17 ± 0.5 |
| Mu² | 8.21 ± 0.38 | 9.99 ± 0.46 | 6.95 ± 1.78 | 8.46 ± 2.17 | 0.8 ± 0.4 | 0.98 ± 0.5 | 9.54 ± 0.86 | 11.62 ± 1.05 |
| Pl³ | 9.36 ± 0.98 | 11.4 ± 1.19 | 4.25 ± 0.48 | 5.17 ± 0.59 | 0.63 ± 0.09 | 0.77 ± 0.1 | 8.03 ± 1.49 | 9.78 ± 1.8 |
| Ck⁴ | 8.2 ± 1.06 | 7.98 ± 1.26 | 4.72 ± 0.59 | 5.75 ± 0.72 | 0.61 ± 0.03 | 0.68 ± 0.04 | 4.66 ± 0.6 | 5.68 ±0.73 |
| **Analysis of Variance (P>F)** | | | | | | | | |
| Treatment | <.0001 | <.0001 | 0.0004 | 0.0004 | 0.1303 | 0.1401 | <.0001 | <.0001 |
| Ch¹vs Mu² | <.0001 | <.0001 | <.0001 | <.0001 | 0.0253 | 0.0278 | <.0001 | <.0001 |
| Ch¹vs Pl³ | <.0001 | <.0001 | 0.0126 | 0.0119 | 0.126 | 0.1377 | <.0001 | <.0001 |
| Mu²vs Pl³ | 0.016 | 0.0132 | 0.0026 | 0.0023 | 0.3475 | 0.3482 | 0.042 | 0.0409 |
| ***-------------------------------------30-60 cm depth-------------------------------------*** | | | | | | | | |
| Ch¹ | 5.52 ± 1.2 | 6.72 ± 1.47 | 2.22 ± 0.4 | 2.71 ± 0.49 | 0.35 ± 0.05 | 0.43 ± 0.05 | 2.6 ± 0.4 | 3.17 ± 0.5 |
| Mu² | 4.05 ± 0.19 | 4.93 ± 0.17 | 1.55 ± 0.17 | 1.89 ± 0.09 | 0.27 ± 0.05 | 0.33 ± 0.02 | 1.8 ± 0.05 | 2.2 ± 0.07 |
| Pl³ | 7.49 ± 0.97 | 9.12 ± 1.18 | 3.9 ± 0.47 | 4.74 ± 0.6 | 0.57 ± 0.09 | 0.69 ± 0.1 | 5.26 ± 1.4 | 6.4 ± 1.8 |
| Ck⁴ | 5.91 ± 0.5 | 7.19 ± 0.6 | 2.12 ± 0.18 | 2.58 ± 0.2 | 0.29 ± 0.02 | 0.35 ± 0.02 | 3.2 ± 0.3 | 3.89 ± 0.3 |
| **Analysis of Variance (P>F)** | | | | | | | | |
| Treatment | 0.0007 | 0.0006 | <.0001 | <.0001 | <.0001 | 0.0001 | 0.0005 | 0.0005 |
| Ch¹vs Mu² | 0.0187 | 0.0169 | 0.0172 | 0.0176 | 0.0621 | 0.0589 | 0.1514 | 0.149 |
| Ch¹vs Pl³ | 0.004 | 0.0035 | <.0001 | <.0001 | 0.0003 | 0.0004 | 0.0006 | 0.0005 |
| Mu²vs Pl³ | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 |

**Note:** ¹Chisel tillage, ²Mulching, ³PlowTillage, ⁴Control, Fe‡ -Available Iron, Cu††-Available Cupper, Zn†††-Available Zinc Mn††††-Available Manganese.

had the highest $Fe_A$ concentration and those under chisel tillage had the lowest $Fe_A$ at all depths and years except where the highest observation was represented under mulching at 30-60cm in 2006. The plow tillage (9.36 mg $kg^{-1}$) increased the soil $Fe_A$ by 14, 14.1 and 69.6%, respectively, compared to mulching (8.21 mg $kg^{-1}$), control (8.2 mg $kg^{-1}$) and chisel (5.52) tillage practices at 0-30 cm depth in 2006. A similar trend was observed in 2007.

Ateş et al. [41] reported that mulching tillage practice enhanced the iron content (17.2 mg $kg^{-1}$, respectively) of organic raisins in the same field and significant level of α<0.05. Williamson et al. [44] and Şimşek et al. [45] also stated similar results in seedless raisin. It is documented that soil pH was associated with soil iron content at the soil surface under soybean whereas Fe content was higher and pH was low under no-till practices stated by Houx et al. [37].

Soil $Cu_A$ (mg $kg^{-1}$) data for 0-30 and 30-60 cm depths under all the tillage practices for 2006 and 2007 are presented in Table 3. Data showed that treatments significantly impacted $Cu_A$ at both depths and years under consideration of P<0.05 significant level in terms of treatment impacts and contrasts. Soil $Cu_A$ concentrations were ranged between 1.55 mg $kg^{-1}$ and 6.95 mg $kg^{-1}$ in 2006 and between 1.89 mg $kg^{-1}$ and 8.46 in 2007. The soil under application of mulching treatment (6.95 mg $kg^{-1}$) was represented as the highest increased value, which is 2.13 times higher than those under chisel (2.22 mg $kg^{-1}$) and 63.5% higher than those under plow (4.25 mg $kg^{-1}$) and 47.2 % than those under control (4.72 mg $kg^{-1}$) treatments at 0-30 cm depth in 2006. Significant differences on $Cu_A$ due to tillage practices were also represented in 2007.

Ateş et al. [41] reported a study in the same field of the present study that tillage practices might have different influences on crop cupper content in organic raisins whereas mulching tillage practices most likely observed to have highest values (7.2 mg $kg^{-1}$) in comparison to those under higher intensive tillage practices, respectively. These findings also supported by Williamson et al. [44] and Şimşek et al. [45] in seedless raisin. On the other hand, it was documented that soil Cu content is associated with soil pH and soil Cu content might have a large variety related to the general nature of Mehlich extractant indicates not inherent to the soil samples [37].

Different soil tillage practices did result significant variability of tillage practices impacts on soil $Zinc_A$ only for 30-60cm depth. The highest available zinc content was 0.57 mg $kg^{-1}$ under plow treatment while the lowest value was 0.27 mg $kg^{-1}$ under mulching treatment for 0-30 cm soil depth in 2006. A similar trend was observed at 30-60 cm in 2007. Not only the treatments (P<0.0001; both 2006 and 2007) impacts under tillage practices were significant but also significant observations were represented for contrast in chisel *vs*. plow (P<0.0003; 2006 and P<0.0004; 2007) and mulching *vs*. plow (P<0.0001 bot 2006 and 2007) at 30-60 cm depth. Soil zinc content was in the permissible level, which indicates that zinc content of present study was low but significantly different under impacts of tillage practices. Hickman et al. [46] reported no significant differences in Zn content [37]. However, Ateş et al. [41] reported a stud of organic raisins which indicates significant impacts of no-till in increasing zinc content of the crop. The higher crop Zinc uptake might cause lower Zinc content in the soil, which can be one of the reasons for lower Zinc content under mulching (no-till) practices. Moreover, soil pH reported to be associated with soil micro nutrients by Houx et al. [37]. This also can be a reason of higher Zinc content under higher intensive tillage.

Average soil $Mn_A$ contents under different tillage practices ranged from 1.8 mg $kg^{-1}$ to 9.54 mg $kg^{-1}$ and from 2.2 mg $kg^{-1}$ to 11.62 mg $kg^{-1}$ (2007) (Table 3). The significant level of P<0.0001 was monitored for treatment differentiations and chisel *vs*. mulching and chisel *vs*. plow contrasts at 0-30 cm depth in 2006 and 2007 whereas significant level of statistics was P<0.04 (Mulching *vs*. Plow; 2006) and P< 0.4 (Mulching *vs*. Plow; 2007) contrasts at 0-30 cm depth. Similar observations were represented at 30-60 cm depth except those for chisel *vs* mulching contrasts in both 2006 and 2007. The highest observations were represented under mulching (9.54 mg $kg^{-1}$) which is higher than those under plow (8.03 mg $kg^{-1}$), control (4.66 mg $kg^{-1}$) and chisel (2.6 mg $kg^{-1}$)

by 18.8%, 1.05 times and 2.67 times at 0-30 cm depth in 2006. A similar trend was represented values in 2007. However, the highest values were under plow treatment (5.26 mg $kg^{-1}$; 2006 and 6.4 mg $kg^{-1}$; 2007) and the lowest values were under mulching treatment (1.8 mg $kg^{-1}$; 2006 and 2.2 mg $kg^{-1}$; 2007) at 30-60 cm. These indicated that plots under mulching treatment were 31%, 44% and 66% lower than those under chisel (2.6 mg $kg^{-1}$), control (3.2 mg $kg^{-1}$), plow (5.26 mg $kg^{-1}$) were represented at 30-60 cm in 2006. Similar trend was monitored for 2007.

The observations showed that Mn content at the surface in higher under mulching but higher values were represented under higher intensive tillage practices such as plow-till at the 30-60 cm. This is due to mixing of the soil at the surface and breaking down in soil structure, which can allow Mn to leach down the profile. Martin-Rueda found greater Mn content under no-till practices at the soil surface. However, Martin-Rueda [37] reported a negative trend and reported a strong and positive correlation of Mn with soil pH. Ates et al. [41] Reported a study of organic raisins and stated an increase in Mn content of the crop under no-till practices, which might be the reason of lower Mn content under this treatment.

## Discriminant analysis

Each group was allocated for each treatment and impacts were determined to distance between each group. Data for the response of soil fertility to different tillage practices in organic viticulture farming is staged in Figure 5a for 2006 and in Figure 5b for 2007. Data reported ($R^2$=0.99) that conventional and plow tillage was not significantly

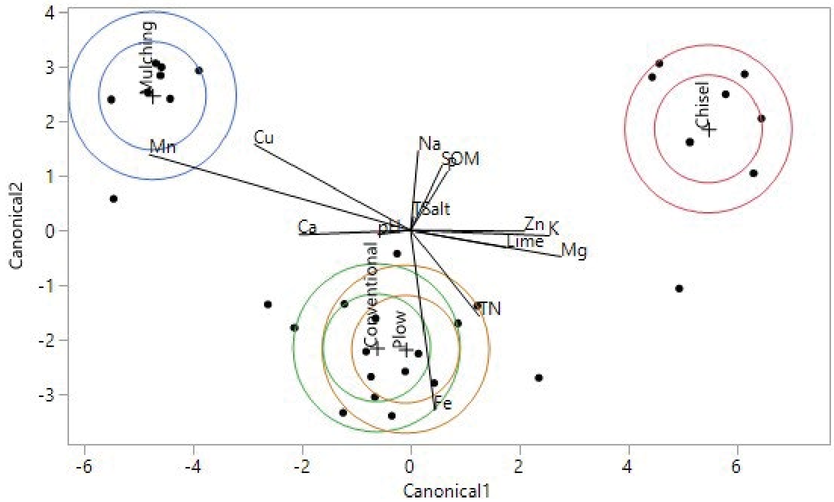


**Figure 5a:** The multiple linear discriminant analysis to analyze soil properties as impacted by Tillage practices for 2006.

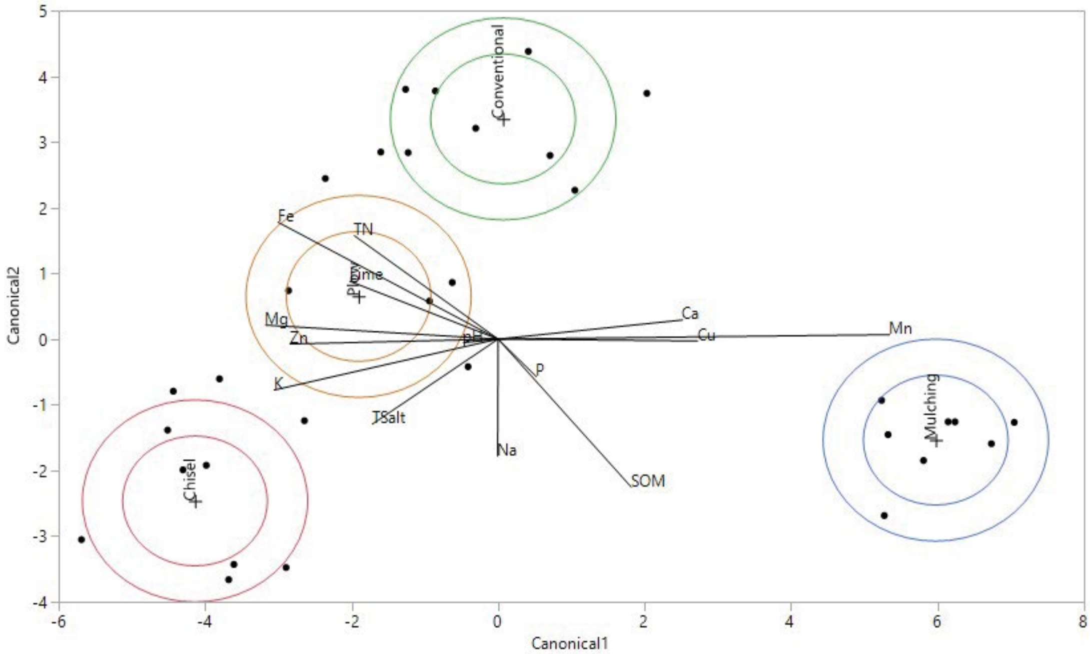


**Figure 5b:** The multiple linear discriminant analysis to analyze soil properties as impacted by tillage practices for 2007.

different whereas mulching treatment was significantly different for 2006. A similar trend was also observed in 2007 except plow was also significantly different with $R^2$=0.99. In addition, decline in intensification of tillage practice was followed by increasing in soil properties under those applications. Differentiation in position of groups in the figures of discriminant analysis from 2006 to 2007 reported that the mulching treatments showed different impacts on soil properties in comparison to plow and chisel practices. It was also observed that plots under chisel tillage had higher correlation with soil properties in comparison to plow tillage and conventional tillage whereas mulching had the highest correlation. Overall results from discriminant analysis indicate significant level of treatment impacts on selected soil properties by declining in intensification of tillage practices.

## Conclusions

Long term experiment data showed that the soil organic matter content at a depth of 0-30 cm under mulching was significantly higher than those under other tillage practices. However, there was no significant difference in soil potassium and salt contents. Soil P and Ca concentrations under mulching was significantly higher compared with those under other treatments. Total nitrogen content under mulching was significantly higher; however, there is no significant difference in terms of available potassium content and the iron concentration. Soil pH was associated with soil micronutrients whereas variability of soil microelements was observed. Response of soil micronutrients to mulching was higher compare to higher intensive tillage practices.

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### References

1. Lal R (2001) Managing world soils for food security and environmental quality. Adv Agron 74: 155-192.
2. Barrett CB and Bevis LEM (2015) The self-reinforcing feedback between low soil fertility and chronic poverty. Nature Geosci 8: 907-912.
3. Gleeson T, Befus KM, Jasechko S, Luijendijk E, Cardenas MB (2016) The global volume and distribution of modern groundwater. Nature Geosci 9: 161-167.
4. Garry VF, Schreinemachers D, Harkins ME, and Griffith J (1996) Pesticide appliers, biocides, and birth defects in rural Minnesota. Environ Health Perspect 104: 394.
5. Yussefi M and Willer H (2003) The world of organic agriculture: Statistics and future prospects.
6. Yussefi M, Willer H (2007) Organic farming worldwide 2007: overview & main statistics. InThe world of organic agriculture-statistics and emerging trends 2007. International Federation of Organic Agriculture Movements IFOAM, Bonn, Germany & Research Institute of Organic, Germany.
7. Paull J (2011) The uptake of organic agriculture: A decade of worldwide development. J soc dev sci 2: 111-120.
8. Willer H (2011) Organic Agriculture Worldwide–The Results of the FiBL/IFOAM Survey. the world of organic agriculture 45: 98
9. Mahajop MMY (2017) Effect of Some Organic Insecticides on the Yield and Quality of Field-grown Tomatoes (Solanumlycopersicum L.), University of Khartoum, Sudan.
10. Kara Z (2014) Sustainable Development in Viticulture Industry in Turkey. In "Dubai International Conference Proceedings by Australian Society for Commerce Industry and Engineering UAE" 67-72.
11. Anonymous (2016) Turkish Statistical Institute.
12. Altındişli FÖ, Altınçağ R, Dündar AA (2004) İzmir ili çilek alanlarında zararlı maymuncuklar (Otiorhynchus spp., Col.: Curculionidae) üzerinde araştırmalar. Bitki Koruma Bülteni.
13. Lal R (2004) Soil carbon sequestration impacts on global climate change and food security. Sci 304: 1623-1627.
14. Anac D, Okur B (1996) Toprak Verimliliğinin Doğal Yollarla Arttırılması. Ekolojik (Organik, Biyolojik) Tarım, eds: Aksoy U. ve Altındişli A., Ekolojik Tarım Organizasyonu Derneği Bornova, İzmir, 37-74.
15. Anonymous (2002) Regulation of Setting Maximum Levels for Certain Contaminants in Foodstuffs. Official Gazette.
16. Kacar B (1972) Chemical analysis of plant and soil. II. Plant Analysis. AUFA.
17. Black CA, Evans D, Dinauer R (1965) Methods of soil analysis, American Society of Agronomy, Madison, USA.
18. Richards LA (1969) Diagnosis and improvement of saline and alkali soils, United States Department Of Agriculture; Washington.
19. Schlichting, E and Blume HP (1966) Bodenkundliches Praktikum: eine Einfu¨hrung in pedologisches Arbeiten fu¨r O¨ kologen, insbesondere Landund Forstwirte und fu¨r Geowissenschaftler. Paul Parey, Hamburg, Germany.
20. Bouyoucos GJ (1962) Hydrometer method improved for making particle size analyses of soils. Agron J 54: 464-465.
21. Bremner JM (1965) Total nitrogen In: Merho & of Soil Analysis, Black CA (edt), American Society of Agronomy, USA, 1149-1178.
22. Bingham FT (1949) Soil tests for phosphate. Agri 11–14.
23. Lindsay WL, Norvell WA (1978) Development of a DTPA soil test for zinc, iron, manganese and copper. Soil Sci Soc Am J 42: 421-428.
24. SAS/ACCESS 9.3 for Relational Databases: Reference (2012) SAS Institute.
25. Wyngaard N, Echeverría HE, Rozas HRS and Divito GA (2012) Fertilization and tillage effects on soil properties and maize yield in a Southern Pampas Argiudoll. Soil Tillage Res 119: 22-30.
26. Gadermaier F, Berner A, Fließbach A, Friedel JK and Mäder P (2012) Impact of reduced tillage on soil organic carbon and nutrient budgets under organic farming. Renew Agr Food Syst Renew Agr 27: 68-80.
27. Fageria N, Baligar V, Clark R (2002) Micronutrients in crop production. Adv Agron 77: 185-268.
28. Peterson GA, Unger PW, Payne WA (2006) Dryland agriculture, American Society of Agronomy, USA.
29. Wang Q, Lu C, Li H, He J, Sarker KK, et al. (2014) The effects of no-tillage with subsoiling on soil properties and maize yield: 12-Year experiment on alkaline soils of Northeast China. Soil Tillage Res 137: 43-49.
30. Adams F, Pearson RW (1984) Soil acidity and liming, American Society of Agronomy, Madison, USA.
31. Neugschwandtner R, Liebhard P, Kaul H, Wagentristl H (2014) Soil chemical properties as affected by tillage and crop rotation in a long-term field experiment. Plant, Soil and Environ 60, 57-62.
32. Ibrahim M, Alhameid A, Kumar S, Chintala R, Sexton P, et al. (2015) Long-Term Tillage and Crop Rotation Impacts on a Northern Great Plainsmollisol. Adv Crop Sci Tech 3, 2.
33. Junior CC, Corbeels M, Bernoux M, Piccolo MDC, Neto MS, et al. (2013) Assessing soil carbon storage rates under no-tillage: comparing the synchronic and diachronic approaches. Soil Tillage Res 134: 207-212.
34. Scopel E, Findeling A, Guerra EC, Corbeels M (2005) Impact of direct sowing mulch-based cropping systems on soil carbon, soil erosion and maize yield. Agron Sustain Dev 25: 425-432.
35. Ozlu E (2016) Long-term Impacts of Annual Cattle Manure and Fertilizer on Soil Quality Under Corn-Soybean Rotation in Eastern South Dakota, South Dakota State University.
36. Steenwerth KL, McElrone AJ, Calderón-Orellana A, Hanifin RC, Storm C, et al. (2013) Cover crops and tillage in a mature Merlot vineyard show few effects on grapevines. Am J Enol Vitic 12119.

37. Houx JH, Wiebold WJ, Fritschi FB (2011) Long-term tillage and crop rotation determines the mineral nutrient distributions of some elements in a Vertic Epiaqualf. Soil Tillage Res 112: 27-35.

38. Matowo PR, Pierzynski GM, Whitney D, Lamond RE (1999) Soil chemical properties as influenced by tillage and nitrogen source, placement, and rates after 10 years of continuous sorghum. Soil Tillage Res 50: 11-19.

39. Sousa D, Lobato E, Ritchey K, Rein T (1992) Response of annual crops and leucaena to gypsum in the Cerrado. 2nd Seminar on the Use of Gypsum in Agriculture, Brazil, 277-306.

40. Peter R, Matowo GMP, Whitney D, Ray EL (1999) Soil chemical properties as in uenced by tillage and nitrogen source, placement, and rates after 10 years of continuous sorghum. Soil Tillage Res.

41. Ateş F, Ünal A, Cakir E, Yağcı A (2016) The effects of different tillage methods on mineral substance of raisins in organic grape growing. Acta Hortic 155-160.

42. Li W, Gu J, Yang Y (2006) Feasibility analysis of salted soils by conservation tillage. J Agric Mechanization Res 7: 223.

43. Wang L-f, Shangguan Z-p (2015) Water–use efficiency of dryland wheat in response to mulching and tillage practices on the Loess Plateau. Scientific reports 5: 12225.

44. Williamson G, Carughi A (2010) Polyphenol content and health benefits of raisins. Nutr Res 30: 511-519.

45. Şimşek A, Artık N, Baspinar E (2004) Detection of raisin concentrate (Pekmez) adulteration by regression analysis method. J Food Comp Anal 17: 155-163.

46. Hickman MV (2002) Long-term tillage and crop rotation effects on soil chemical and mineral properties. J Plant Nutri 25: 1457-1470.

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