

Conservation Tillage Practices in Organic Vineyard

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Abstract: For sustainable agriculture, conservation tillage applications are used widely in the world. Only recently, some conservational tillage practices are applied in vineyards for sustainable viticulture. Although these practices are not common in Turkey, yet, some farmers starting to apply conservation tillage or even no-tillage in the vineyards due to increasing fuel costs and for environmental purposes.

The objective of this research was to examine the conservation tillage effects on organic grape production. The research was carried out in Alasehir Viticulture Research Centre located in the West side of Turkey. In this research, conventional tillage and two conservation tillage methods; Mulch tillage and cultivator with rotary harrow were used. The effect of tillage methods on the soil physical properties such as bulk density and penetration resistance was examined. Tillage speed, fuel consumptions, and tillage efficiency were measured for the effectiveness of the tillage method. According to the results, tillage methods were found statistically significant for bulk density, penetration resistance of the soil and plant yield at 5% significant level. Although minimum fuel consumption was obtained (39,31 l ha⁻¹) in much tillage comparing the other methods, cultivator tillage system was selected as the best method since it provided less fuel consumption (51,21 l ha⁻¹) comparing the conventional tillage method (71,21 l ha⁻¹) and had maximum field efficiency of 0,104 ha h⁻¹ comparing the other methods.

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Key words: Conservation tillage, tillage, vineyard, organic grape production

INTRODUCTION

Conservation tillage is increasingly applied in agriculture to obtain sustainable farming and to decrease the negative effect of cost of fuel in tillage operations. Recently, conservation tillage is started to use in vineyard also. Especially in organic grape production, this environmental friendly tillage technique is almost necessary. Conservation tillage includes reduced tillage and no-tillage in which no tillage is performed. Erosion and fuel consumption can be reduced by conservation tillage.

Harold and Edward (1974) found that no-till systems prevent soil erosion especially after heavy rain. They found the soil loss 23 ton ha⁻¹ for conventional tillage and 2.5 ton ha⁻¹ for no-till systems. Freebaim and Wockner (1991) reported that soil erosion decreased from 29-62 ton ha⁻¹ to 5 ton ha⁻¹ by keeping residues on the soil surface. Besides reducing erosion, keeping residues on the soil surface

also increases water holding capacity by 18-24% and decreases water loss by 10-17% (Freebaim and Wockner (1991).

Rajan and Khera conducted the field study to estimate the effect of tillage and different modes of mulch application on soil erosion losses. Treatments comprised minimum and conventional in the main plots and five modes of straw mulch applications; mulch spread over whole plot (M_w), mulch spread on lower one-third of plot ($M_{1/3}$), mulch applied in strips (M_s), vertical mulching (M_v) and unmulched control (M_0). Mulch spread over whole plot reduced runoff by 33%. Runoff and soil loss were 5 and 40% higher under conventional tillage conditions. Straw mulching reduced maximum soil temperature and helped in conserving soil moisture. Minimum tillage coupled with mulch spread over whole plot was highly effective in reducing soil erosion losses, decreasing

soil temperature and increasing moisture content by providing maximum surface cover (Glenn McGourty 2004).

Soil degradation is responsible for making from 2 million ha to 12 million ha or 0.3–0.8% of the world's arable land, unsuitable for agricultural production every year, with wind and water erosion accounting for 84% of the soil degradation (den Biggelaar et al., 2004a).

Ike (1987) reported that although yield was found low for direct seeding of cotton and corn, this system allowed quite time save. Clark et al., (1991) found less soil crust problem and better water use efficiency and water storage in reduced tillage system (Coulouma et al 2005).

According to the research findings, fuel consumptions of different tillage methods were found as 49,4 L ha⁻¹ (100%), 31,2 L ha⁻¹ (63,2%), 28,3 L ha⁻¹ (57,3%), 25,2 L ha⁻¹ (50,9%), 13,3 L ha⁻¹ (27,08%) for plough, chisel, disk harrow, ridge-tillage and direct seeding respectively. Direct seeding saved 73% fuel energy comparing the conventional method (Köller, 2003).

The objective of this study was to evaluate the effect of two conservation tillage methods; mulch tillage and reduced tillage comparing to conventional

tillage system in the vineyard for organic grape production in Alaşehir - Manisa region, located in the west region of Turkey. Cultivator with rotary harrow combination was used as a reduced tillage. In mulch tillage, conventional tillage was applied but spring tillage was not performed instead, planted mulch material was chopped and laid in the row. The effect of tillage methods on the soil physical properties such as bulk density and penetration resistance was examined. Tillage speed, fuel consumptions, and tillage efficiency were measured for the effectiveness of the tillage method.

MATERIALS and METHODS

The research was carried out in Alasehir Viticulture Research Centre located in the West side of Turkey in years of 2005-2007. Research was conducted in 15 Years old vineyard. The grape variety was seedless Sultanas. Each plot (row) was 60 m long and 3 m wide with sandy loam soil. The distance between the rows and plants were 3 m and 2.5 m.

The effect of different tillage methods on organic grape production was examined. In this research, conventional tillage and two conservation tillage methods; Mulch tillage and cultivator with rotary harrow were used (Table 1).

Table 1. Applied tillage methods

No	Method	Application
1	Conventional Method	Plough + Disk Harrow (two passes)
2	Mulch Tillage	Plough + Disk Harrow (two passes) (No tillage in Spring)
3	Reduced Tillage	Disk Harrow (one pass) + Cultivator with rotating harrow combination (two passes)

Table 2. The specifications of the tools used in the experiment

Tool	Type	Working Depth (cm)	Working Width (cm)
Plough	5-furrow, 8"	22	125
Disc-Harrow	24 Disks-Tandem	15	220
Cultivator with rotary harrow	11 tine cultivator with spiral rotary harrow	14	210
Residue Chopper	L-type blades	-	180

For conventional tillage method, rows first were ploughed and then harrowed by disc harrow. Two conservation tillage methods; Mulch tillage and cultivator with rotary harrow were used. Cultivator with rotary harrow combination was used as a reduced tillage. In mulch tillage, conventional tillage was applied but spring tillage was not performed instead, planted mulch material was chopped and laid in the row. The specifications of the tools used in the experiment are given in Table 2. Common vetch (*Vicia sativa* L.), Rye (*Hordeum vulgare* L.), and broad beans (fava beans) were used as mulch plants. In November, the soil was tilled using conventional method before planting mulch plants. The mix was planted by using fertilizer spreader. After planting, the soil was disked to incorporate the seeds with soil. 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.

The effect of tillage methods on the soil physical properties such as bulk density and penetration resistance was examined. Tillage speed, slip, fuel consumptions, tillage efficiency and yield were measured for the effectiveness of the tillage method. In the experiment Massey 240 S (Engine Power 50 hp) tractor was used.

For comparison purposes, tillage speed, slip and fuel consumptions were measured in each method. From the data, fuel consumption per area and effectiveness of each tillage method were

calculated. The organic grape yield was calculated from the samples taken from 3 m² area to examine the effect of tillage methods. Three replications were used for statistical analysis of the data. The data were analyzed using the SPSS statistical package program for analysis of variance. Means were compared by Duncan tests at $P \leq 0.05$.

RESULTS and DISCUSSION

Results were given according to the yearly calculation. So results included autumn and spring tillages along with chopping mulch materials for mulch tillage method.

3.1. Soil Conditions

Although some differences were observed, tillage systems do not change the soil conditions much. Bulk density of the soil after tillage is given in Figure 1. The difference was examined only at 0-10 cm depth of the soil, whereas bulk densities were similar at 10-20 and 20-30 cm depths. Generally, reduced tillage methods supplied higher bulk density at 10-20 and 20-30 cm depths. The highest bulk densities were found in mulch tillage due to intensive tillage.

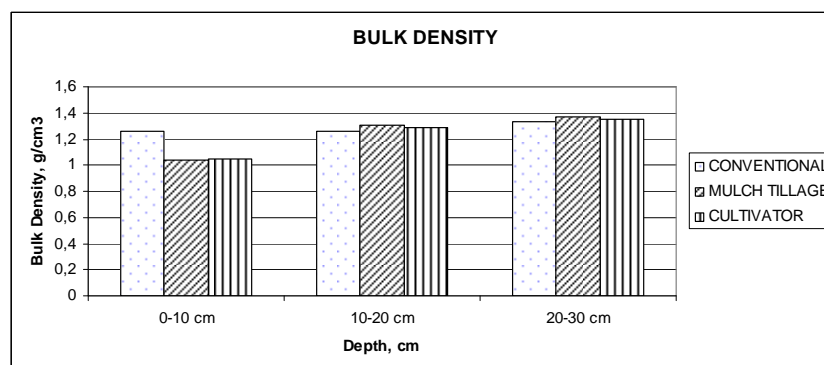


Figure 1. Bulk density of the soil as affected by tillage methods

When the penetration resistance of the soil was examined (Figure 2), conventional tillage method had better soil penetration resistance comparing the reduced tillage methods. Especially, after the 10 cm depth of the soil, penetration resistances increased

quite above the 2 MPa value over which no development can be seen on roots.

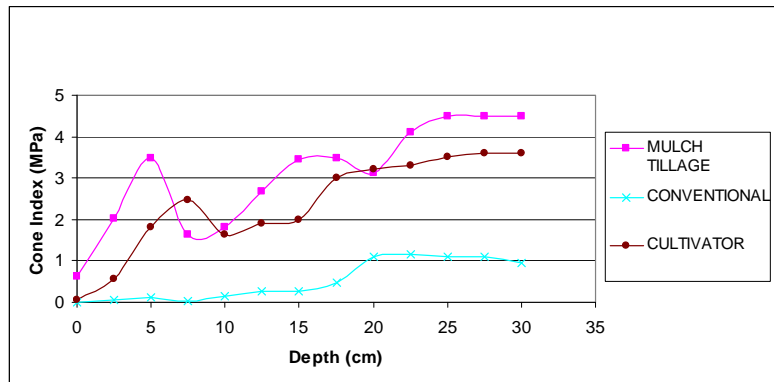


Figure 2. Penetration resistance of the soil as affected by tillage methods

3.2. Fuel Consumption

Each tillage method required fuel consumption differently (Figure 3). The effect of tillage method was found statistically significant on fuel consumption. While mulch tillage was requiring the

minimum fuel consumption, 39,3 l ha⁻¹, conventional method had the highest fuel consumption with 71,2 l ha⁻¹. Cultivator combination tillage method required 51,2 l ha⁻¹ fuel consumption.

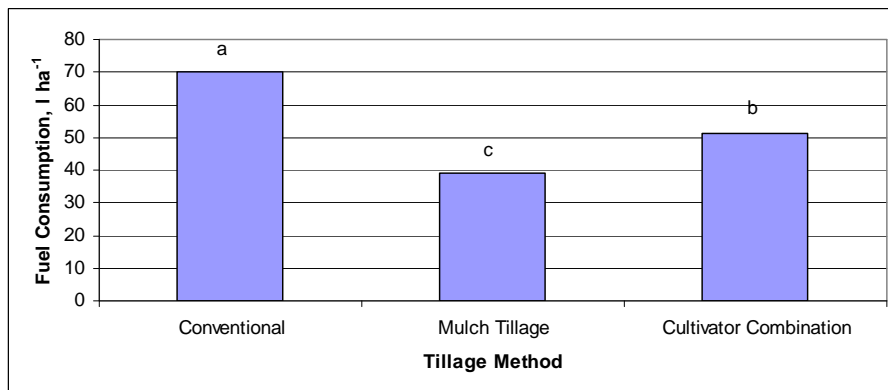


Figure 3. Average values of fuel consumptions of tillage methods

3.3. Tillage efficiencies of methods

Tillage efficiencies of the methods were given in Figure 4. The maximum tillage efficiency, 0,104 ha h⁻¹ was obtained from cultivator combination tillage method (keeping in mind that this value included all year tillage process). The lowest tillage efficiency, 0,086 ha h⁻¹ was measured in mulch tillage method

due to intensive tillage. Conventional tillage method had 0,095 ha h⁻¹ tillage efficiency. Tillage efficiency was affected from the tillage method and its effect was found statistically significant.

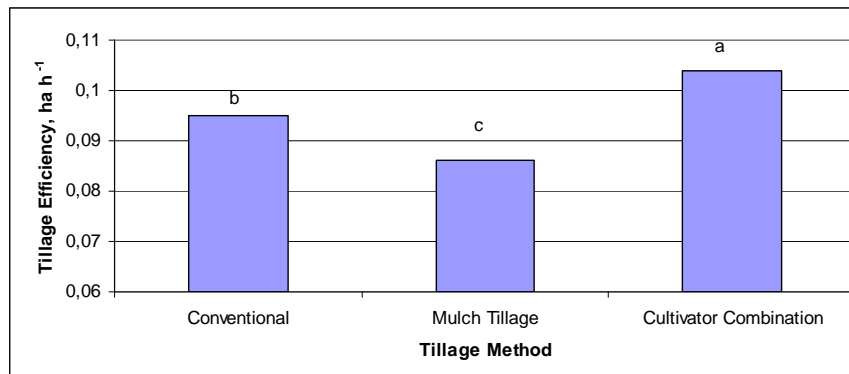


Figure 4. Average values of field efficiencies of tillage methods

CONCLUSIONS

While the tillage methods affect the soil conditions slightly, its effect on fuel consumption and field efficiency was found statistically significant. Generally, reduced tillage methods supplied higher bulk density at 10-20 and 20-30 cm depths. The highest bulk densities were found in mulch tillage due to intensive tillage. Regarding the penetration resistance of the soil, conventional tillage method had better soil penetration resistance comparing the reduced tillage methods. Among tillage methods, mulch tillage required the minimum fuel consumption, 39,3 l ha⁻¹, whereas conventional method had the highest fuel consumption with 71,2 l ha⁻¹. Cultivator combination method had the best tillage efficiency with, 0,104 ha h⁻¹. The lowest

tillage efficiency, 0,086 ha h⁻¹ was measured in mulch tillage method due to intensive tillage.

Although mulch tillage required minimum fuel consumption, 39,3 l ha⁻¹, when we consider the effect of tillage on the soil structure and the maximum tillage efficiency of cultivator combination method, we should say that cultivator combination method should be applied in organic grape production due to its conservation effect on the soil. So that sustainable agriculture could be practiced with environmental friendly method. According to the results, we can say that reduced tillage methods can be applicable in vineyards easily.

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