

The Effects of Reduced Tillage and Direct Seeding Systems on the Yield of Maize and Barley - Vetch in Ege Region

Engin ÇAKIR, Erdem AYKAS, Harun YALÇIN, Anıl ÇAY, İkbal DERELİ

Ege University, Faculty of Agriculture, Agricultural Machinery Department,
35100 Bornova, İzmir
engin.cakir@ege.edu.tr

Received (Geliş Tarihi): 19.07.2010

Accepted (Kabul Tarihi): 17.08.2010

Abstract: More researches are needed for each region to implement direct seeding method correctly which is started to use recently in our country, but brings lots of problems to be answered along with its use. Proper direct seeding machine and suitable seeding technique are important factors for successful direct seeding. It is necessary to adapt this technique which is used widely in the world for each region in our country

The objective of this study was to compare the conventional tillage system with reduced tillage and direct seeding systems for maize (*Zea Mays L. ssp.*) and barley (*Hordeum vulgare L.*) – common vetch (*Vicia Sativa*) production. Corn was planted on wheat residue in May 2008, after harvesting corn, barley-common vetch was sown in November 2008 in the wet field conditions where conventional, reduced tillage, and direct seeding systems were applied in Menemen, Ege Region. Experiment was finished with second year corn planting in May 2009. Tillage systems used in the experiment were conventional tillage in which plough is used, reduced tillage with heavy duty disk harrow, direct seeding in which secondary tillage are allowed and no-till. The effect of tillage systems on the soil physical properties such as bulk density, penetration resistance, and organic content were examined. Grain yield, stalk yield, and grain/stalk ratio were also measured to assess the effect of tillage systems.

According to the results, soil tillage systems were found statistically significant on soil physical parameters and plant yield. In general, No-till system had minimum yield, whereas, minimum tillage method in which heavy duty disk harrow was used provided maximum yield comparing other tillage systems. Weeding is still a problem in no-till plots and proper direct seeding machine with on time herbicides use are essential for successful direct seeding.

Keywords: Corn, barley-vetch, reduced tillage, direct seeding, no-till

INTRODUCTION

The soil on which we all live is still generous to human being throughout the history. But to get higher yield from the unite field area because of increasing population and industrialization became a main objective in farm application which required heavy tillage. Intensive tillage method which is used widely by farmers recently causes soil compaction, erosion and high fuel consumption. Due to sustainable farming, economic agricultural production and worldwide energy bottleneck, conservation tillage, no-till and direct seeding concepts become an agenda for researchers.

Turkey is one of the self sufficient countries for corn production in the world. There are many researches in the field of corn production as a main

crop or second crop on which different tillage methods and rotation were applied.

Conventional tillage method was compared with reduced tillage I and II and direct seeding method in the study in which energy requirements of conventional and direct seeding methods were examined. According to the results, fuel was saved 16.1% in reduced tillage method I in which tillage combination used, 26.9% in conservation tillage method I, 40.8% in conservation tillage method II, and 87.0% in direct seeding method (Kositic et al, 1999).

Aykas and his friends (2006) studied on different tillage methods for second crop cotton. They found that fuel consumptions were 7,14 L ha⁻¹ , 2,25 L ha⁻¹,

and 0,61 L ha⁻¹ in conventional, reduced tillage and direct seeding methods, respectively. They also calculated cost of cotton according to the tillage method applied. Costs were 808,12 TL kg⁻¹, 766,13 TL kg⁻¹, and 597,19 TL kg⁻¹ for conventional, reduced tillage and direct seeding methods, respectively.

Bayhan and his friends (2001) investigated the possibilities of using reduced tillage and direct seeding methods alternative to the conventional tillage. They determined the power requirements, fuel consumptions and field work rate of the tillage methods and examined the effects of tillage methods on soil and plant. According to the results minimum power requirement and fuel consumption were found in direct seeding method. When it is considered the cost of plant production, direct seeding method provided the least production cost although it had lower yield comparing the other methods.

Qin and his friends (2006) examined the effect of conventional tillage and no-till methods on the root developments of corn. They found that roots of plants in conventional method penetrated much deeper comparing no-till method, but the roots of no-till planted corn were found to be much thicker comparing the conventional method. As a result, they recommended no-till method since they found no differences between two methods regarding root developments after certain soil depth.

Carter and his friends (2002) examined the effects of conventional and conservation tillage methods on the development of corn, soil quality and weeding. They found no differences regarding soil organic carbon, soil nitrogen, and soil pH in tillage methods. They emphasized that no-till method should be used due to the reason of soil compaction and soil conductivity. They also declared that corn should be used in rotation with other methods since it improves the soil physical conditions.

Basama and his friends (2006) declared that corn should be rotated with barley, common vetch, and soybean especially in conservation tillage and no-till methods. Reduced tillage provided the best yield according to the 7 years research results. They also recommended no-till method since it improved soil parameters. They recommended that researches in this area should include soil biophysical parameters and also social economic structures of the region due to the fact that reduced tillage and no-till methods

effect the socio-economic in the region and some problems arise during transition of conservation tillage in the region.

Conservation tillage methods are hardly accepted by farmers in developing countries like our country due to lacking knowledge (Anonymous, 2007).

In this study, the effects of conventional tillage, reduced tillage, no-till and direct seeding methods on soil, plant growth and yield of corn and barley- vetch were examined in Menemen, Izmir located in the west region of Turkey.

MATERIALS and METHOD

The experiments were conducted in the fields of Ege University's research farm in the years of 2008-2009. Research farm is located in the western part of Turkey. Prior plant was second crop silage corn in the field where the experiment was carried out. In the field, no action was taken during winter season of 2008. Main crop corn was planted in spring season of 2008 and right after barley-vetch was planted in autumn, 2008. Research was completed with planting corn again in spring 2009. Tillage systems applied to both plants are given in Table 1.

This study includes some of the results taken from 2 years research of conservation tillage and direct seeding project (Çakır et al., 2010).

Reduced tillage, direct seeding and no-till systems were compared with conventional tillage system in the experiment. No-till and direct seeding plots were sprayed for weeds.

Each plot was 70 m long and 6 m wide with "sandy loam" soil having a texture of 10,12 % clay, 22% silt and 67,88% sand. For preparation of the soil, silage machine was used to harvest the previous plant second crop corn. The field was left with residue covered 30% of the soil surface. The mean stubble height was measured as 15 cm.

For conventional tillage method, the soil was first ploughed with three-bottom mouldboard general purposed plough. After plowing, the field was harrowed with disc harrow and levelled with spike-tooth harrow. For direct seeding and no-till application, seeding was made without tillage. After emergency of seedlings, the plant rows were harrowed with row harrower for fertilizing and furrow making before irrigation for all trials except no-till method. The specifications of the tools used in the experiment are given in Table 2.

Seeding was made with specially designed "accord" direct seeding machine. In the experiment New Holland-Trakmak 80-66 (Engine Power 60 kW) tractor was used. The seed varieties of Pioneer 3245 and kubilay for maize (*Zea Mays L. ssp.*) and barley (*Hordeum vulgare L.*) – common vetch (*Vicia Sativa*) were used in the experiment, respectively. Corn was planted in May 16, 2008 and harvested in October 24, 2008. Plant spacing was 18 cm and row spacing was 76 cm for corn planting. Compose fertilizer (15-15-15) 15 kg/da was applied to the field

Barley-common vetch was planted in January 16, 2009 with the rate of 15 kg da⁻¹ (10 kg da⁻¹ common vetch + 5 kg da⁻¹ barley) and was harvested in May 6, 2009. Before planting, similar to corn, compose fertilizer (15-15-15) 15 kg da⁻¹ was applied to the field. Similar tillage practices were applied to corn field in 2009.

To determine the effects of tillage practices on soil, soil bulk volume of weight, soil penetration resistance and soil organic carbon were measured. Beside soil physical parameters, plant height and yield were also measured to examine the effects of tillage on plant growth and yield. Yield of barley-common vetch was calculated from the samples taken from 1 m² area in the plot.

Completely randomized experimental design with three replications was used for statistical analysis of the data. The data were analyzed using the COSTAT statistical package program for analysis of variance (Anonymous, 1988). Means were compared by LSD tests at P ≤ 0.05.

Table 1. Applied tillage systems

No	Tillage Systems	Applications
1	Conventional Tillage	Moldboard Plough + Disk harrow + spike-tooth harrow + direct seeding machine
2	Reduced Tillage	Heavy duty disk harrow + spike-tooth harrow + direct seeding machine
3	Direct seeding	Direct seeding machine
4	No-till	Direct seeding machine

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

Tool	Type	Working depth (cm)	Working width (m)
Moldboard plough	3- furrow	30	1,0
Disk harrow	32 Disks-Tandem	16	2,5
Spike-tooth harrow	-	-	2,6
Heavy duty Disk harrow	20 Disks - Offset	20	2,5
Direct seeding machine	Accord	4-6	2,8

RESULTS and DISCUSSIONS

Effects on Soil Conditions

Soil penetration resistance, soil bulk density, and soil organic carbon were measured to examine the effects of different tillage systems on soil conditions. The effects of tillage systems on soil conditions were found statistical significant according to the research results. While the soil penetration values at 7-15 cm soil depth were reaching the 1,5 – 2 MPa in direct seeding and no-till systems, this value was found to be lower than 1 MPa in conventional and reduced tillage systems (Figure 1).

Soil bulk densities were statistically significant only in conventional plots whereas it was found no differences in other tillage systems statistically. The highest soil bulk density were measured just before tillage in conventional plots as 1,21 g cm⁻³. Soil bulk density values were higher in other tillage methods comparing conventional system (Figure 2). As it is well known fact that soil bulk density value higher than 1,60 g cm⁻³ restricts water deposition and root penetration in the soil (Usda, 2008). There was found no statistical differences among the values of soil bulk densities measured at different soil depths. Generally, tillage systems did not change soil organic carbon so its effect was found statistically not significant (Figure 3). Soil organic carbon was measured over 1,5% in all plots. The highest soil organic carbon was found as 2,7% at 0-10 cm soil depths in the plots of direct seeding system.

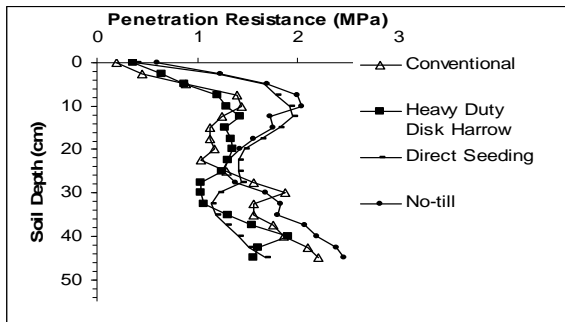


Figure 1. Soil penetration resistance as affected by tillage systems

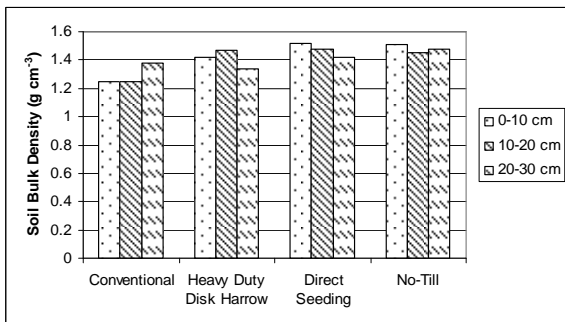


Figure 2. Soil bulk density as affected by tillage systems

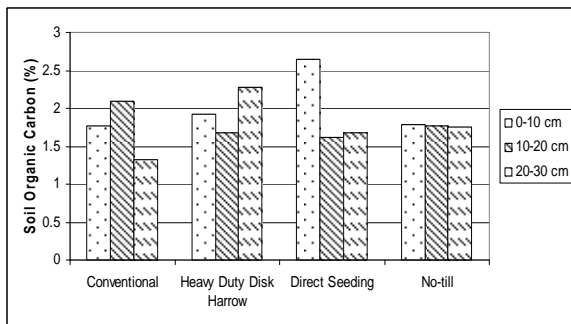


Figure 3. Soil organic carbon as affected by tillage systems

Effects on Yield

The effects of tillage systems on plant height and yield were found statistical significant for corn and barlev-vetch. The effects of years were found statistically not significant on plant height and yield of corn. For plant height, there was found no differences among the tillage system except no-till system. Plant heights were found low in no-till plots. In no-till plots, the average plant height was measured as 168 cm (Figure 4).

When we examine the tillage effects on corn yield, the differences were found to be statistically significant in both years. In the first year, the lowest yield was obtained as 472 kg da⁻¹ in no-till plots. Second year, the lowest yields were measured as 546 kg da⁻¹ and 470 kg da⁻¹ in reduced tillage and no-till systems, respectively (Figure 5).

The highest yields were obtained in reduced tillage system as 889 kg da⁻¹ followed by conventional and direct seeding systems (775 kg da⁻¹ and 742 kg da⁻¹). When we examine the barley-vetch yields, similar results with corn yield were obtained in the first year. The highest and the lowest yields were measured in reduced tillage and no-till systems as 3530 kg da⁻¹ and 1100 kg da⁻¹, respectively (Figure 6). While the yield of corn in direct seeding method were found to be similar to the yield of conventional system, as for yield of barley-vetch direct seeding comes after no-till system for obtaining the lowest yield (2203 kg da⁻¹). It was observed that very dense weed manifestation in the barley-vetch plots could be the reason for it.

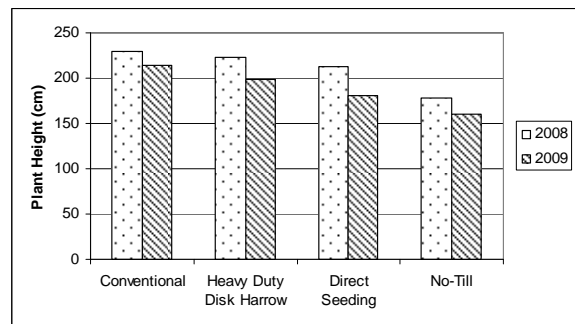


Figure 4. Corn plant height as affected by tillage systems

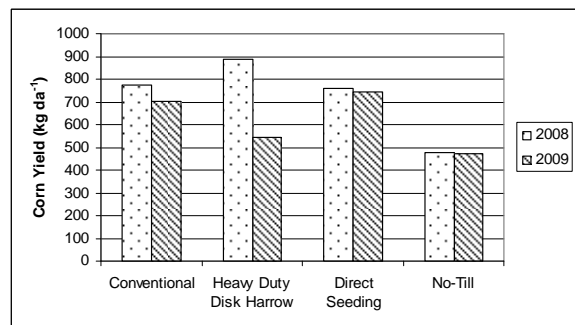


Figure 5. Corn yield as affected by tillage systems

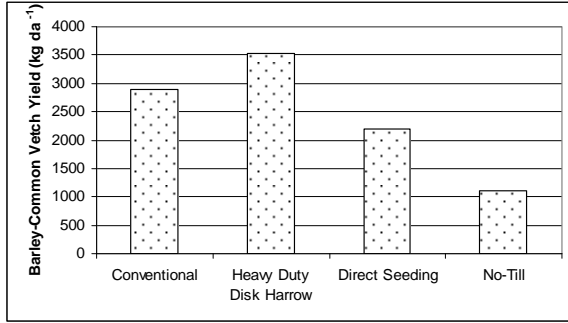


Figure 6. Barley-vetch yield as affected by tillage systems

CONCLUSION

This research was conducted in Menemen research and application center of Ege University with connection to the conservation tillage research conducted for a long time.

In this study, the effects of tillage systems on soil conditions, plant growth, and yield of corn and barley-common vetch rotation were examined.

According to the results, no-till application had the lowest yield, whereas reduced tillage system in which heavy duty disk harrow was used had the highest yield.

REFERENCES

- Anonymous, 1988. COSTAT statistical package for analysis of variance.
- Anonymous, 2007. Constrains to adopting no-till farming in developing countries. Editorial, *Soil & Tillage Research*, (94), pp: 1-3.
- Aykas, E., Yalçın, H., Önal, İ., Evcim, Ü., 2006. İkinci Ürün Pamuk Üretiminde Doğrudan Ekim Uygulama Olanakları. TÜBİTAK Proje No: TOVAG 2675, 118 s., Bornova- İzmir.
- Basama, T.A., Barrios, E., Amezcua, E., Rao, I.M. and Singh, B.R., 2006. Tillage effects on maize yield in a Colombian savana oxisol: Soil organic matter and P fractions *Soil & Tillage Research*, (91), pp:131-142.
- Bayhan, Y., Gönülol, E., Yalçın, H., Kayışoğlu, B., 2001. İkinci ürün silajlık mısır tarımında azaltılmış toprak işleme ve doğrudan ekim uygulamaları. Tarımsal Mekanizasyon 20. Ulusal Kongresi. 13-15 Eylül. Şanlıurfa.
- Carter, M.R., Sanderson, J.B. Ivany, J.A. and R.P. White, 2002. Influence of rotation and tillage on forage maize productivity, weed species, and soil quality of a fine sandy loam in the cool-humid climate of Atlantic Canada. *Soil & Tillage Research*, (67), pp:85-98.
- Çakır, E., H.Yalçın, E. Aykas, E.Gülsoylu, B.Okur, S.Delibacak, A.R.Ongun, 2006, "Koruyucu Toprak İşleme ve Doğrudan Ekimin İkinci Ürün Mısır Verimine Etkileri: Birinci Yıl Sonuçları" *Tarım Makinaları Bilimi Dergisi*, Cilt 2 Sayı 2, S.139-146, ISSN:1306-0007, Bornova-İZMİR, (2006)
- Çakır, E., E. Aykas, H.Yalçın, A. Çay, İ. Dereli, 2010. "Ege Bölgesinde Azaltılmış Toprak İşleme, Toprak İşlemesiz (No-Till) Tarım Ve Anıza Doğrudan Ekim Uygulamalarının Toprağa Ve Ürün Verimine Etkileri". 2008-ZRF-21 No'lu Bilimsel Araştırma Projesi, Bornova-İzmir (Basımda).
- Kosutic, S., Filipovic D. ve Gospodaric, Z., 1999. Energy Requirement in Winter Production Using Conventional, Conservation and Direct Drilling System. *Trends in Agricultural Engineering*, (TAE 1999), pp.194-198, Czech University of Agriculture Prague, Czech Republic.
- Qin, R., Stam, P. and Richner, W., 2006. Impact of tillage on maize rooting in a Cambisol and Luvisol in Switzerland. *Soil & Tillage Research*, (85), pp:50-61.
- Usda, 2008. United States Department of Agriculture Natural Resources Conservation services. "Soils" <http://soils.usda.gov>.

Generally, yield in direct seeding in corn plots was found close to the yield of conventional system, while the lowest crop yield was obtained from no-till application in barley-common vetch production.

The no-till application systems caused serious weed problems. The plots in which direct seeding and no-till applications was applied had intensive weed problem when compared to the other plots.

Especially in no-till applications, weed problem was not controlled and had problems in main crop seeding throughout the research.

Yield naturally drops at not-till applications in which no tillage is applied. Generally, direct seeding and no-till methods provides 8 times less fuel consumption and 6 times more field efficiency comparing the conventional method (Cakir et al., 2006).

In spite of its advantages, difficulty in application of direct seeding in not proper field and climate conditions, and the problem of uncontrolled weeding were observed in the research field.

The proper and on time herbicide application and right use of direct seeding machine will be helpful for implementing no-till application and its widespread use.