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Effects of Tillage and Crop Rotation on Irrigated Winter Wheat Yield in CAP Turkey

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Abstract: Soil tillage is the single most important treatment to the winter wheat production in the Central Anatolian Plateau (CAP) region. Tillage greatly influences the soil structure. In the CAP, soil problems are associated with poor structure and low organic matter content. Surface soil structure is usually degraded and the most important factor that affects degradation is the time of soil tillage. However, conservation tillage represents an effective method for controlling this problem. Improving the soil medium for seedling emergence and plant growth can be made possible by using an appropriate tillage system. The study was carried out over a period over 4 years (2003-2007). A field experiment based on winter wheat was conducted to investigate the effects of tillage on crop yield. Tillage treatments were: (1) ploughing to the depth of 20 cm followed by preparing seedbed by cultivator (conventional tillage (CT)), (2) ploughing to the depth of 10 cm by rototiller (reduce tillage (RT)) and (3) sowing into the untilled soil by special drill (no-till (NT)). Crop rotations were continuous winter wheat and beans-winter wheat-sugarbeet-winter wheat. Wheat yields were strongly affected by the crop rotation. Continuous wheat yield went down by year to year. Crop production with continuous wheat also showed big differences among tillage systems. CT gave the highest yield every year, RT was second and NT had the lowest yields. However, the results differed under the contrasting crop rotations. Bean yield and wheat yield after beans, was not affected by tillage system but sugarbeet yields and wheat yield after sugarbeet, was affected. NT was not suitable for sugarbeet but, on the other hand, wheat yield after sugarbeet was affected by tillage systems. However, it does appear no-till cropping may be a useful alternative to CT in Turkey.
Key words: Tillage**,** no-till, crop rotation, winter wheat, Turkey

INTRODUCTION and LITERATURE REVIEW

For a long time, soil tillage has been used in agriculture. The general purpose of tillage is to create favorable soil conditions for seeding, emergence and plant growth (Hammel 1989). Operations include tilling, planting, fertilization, pesticide application, and residue chopping, etc. However, a great number of scientists have demonstrated that conventional tillage-base systems that use excessive tillage can have quite harmful effects on soil properties. On the other hand, reduced tillage or zero till has been successfully applied in many countries. This practice is generally called conservation tillage abd has been demonstrated around the world to improve the economics of crop production. The implementation of conservation tillage practices is widely considered to be essential to the maintenance, restoration, and/or improvement of the sustainable productivity base of most arable crop production systems (Sayre 1998). Zero-till and minimum-till systems have shown positive effects on water use efficiency and offered grain yield advantages (Lafond et al. 2006). Zero tillage combined with crop residue retention, are obviously promising practices for sustaining the soil resource, also show potential from the point of view of the wheat yield (Fischer et al., 2002).

Crop rotation is one of the oldest and most fundamental agronomic practices to help support sustainable crop production and soil quality. The objective of crop rotation is to maintain soil fertility and to improve of soil structure. (Berzsenyi et al., 2002)

The Central Anatolian Plateau is located in the central part of Turkey and has a cultivated area of 9 million hectares which is completely under conventional tillage systems. Winter wheat is the main crop of the region. Crop rotations continue to be modified in response to economic conditions and available technology. In this region the climate has

low precipitation and high summer temperatures that can lead to soil degradation associated with excessive tillage. In addition, farmers' profitability can be reduced by tillage because of expensive fuel prices

The effect of tillage and rotation has been studied previously in Turkey, but few studies included no-till. The main objective of this study was to evaluate the effect of tillage and crop rotation on yields under irrigated conditions.

MATERIAL and METHOD

The field experiment was established on wheat stubble in the autumn of 2002 and in the spring of 2003 at the Bahri Dağdaş International Agriculture Research Institute in Konya province. The experiment was conducted over 4 years in a split-plot design with two rotation treatments as main plots and three tillage managements as a sub plots. Individual plot size was 10 x 8 = 80 m2 with each plot replicated 3 times. The two rotation treatments were continuous winter wheat (WW) and beans-winter wheat-sugar beet-winter wheat (BWSW). The three tillage management treatments were conventional tillage (CT), reduced tillage (RT) and no-till (NT). For CT, mould board ploughing was used after preplant harvesting and tillage depth was almost 25 cm, followed by two cultivations just before planting with the tillage depth at almost 10 cm. It was sown with seed drill. For RT, glyphosate herbicide was applied, then a rototiller was used before planting. The tillage depth was almost 10 cm and sown with seed drill. For NT, direct drilling was used without any prior tillage but glyphosate herbicide was applied before planting. All plots the soil surface were covered by the retained crop residues.

The fertilizer used for wheat contained 90 kgs phosphorus per hectare and 140 kgs of nitrogen per hectare. Alternative crops were fertilized with different amounts of nitrogen and phosphorus, depending on the crop requirements. All of the tillage treatments were irrigated, providing the same amount of water for each crop.

In Konya, the annual mean air temperature is 11.4 0C, the mean evaporation is 1332 mm and in the growing season (December-July) the mean precipitation is about 300 mm. The field of experiment soil texture was sandy loam, pH is 7.7 with an organic matter content that was less than 1.5%.

Data from individual years and crop rotation treatment were analyzed by ANOVA using Fischer's protected least significant difference at $p<0,05$.

RESULTS and DISCUSSION

All plant growth was normal without any incidence of disease or pest in any of the treatments in this study.

Grain Yield in Continuous Wheat Crop Rotation

Table 1. Effect of tillage management on wheat yield (kg ha-1) in Konya

CR	TM*	2004	2005	2006	2007
WW	CT	4421	2943	1783	2653
	RT	2993	2299	1827	2351
	NT	2316	0	2582	1920
	Tillage	452	1040	311	522

*TM: Tillage Management

Wheat grain yield was affected by tillage management during these four years. There were three years in which the wheat yield was lowest in NT and highest CT and RT was intermediate between NT and CT. Wheat yields were statistically significant. In contrast, grain yield in 2006 was greater under NT than CT.

Yield in Beans-Wheat-Sugarbeet-Wheat Crop Rotation

There were no effects on tillage treatment during the first two years on beans and wheat yields. But during the last two years, sugarbeet and wheat yields were affected by tillage practices. Sugarbeet yield was the best with RT followed by CT and the lowest yielding was NT. The wheat yield was the best for RT, followed by NT with the lowest yields for CT.

Table 2. Effect of tillage management on diffrent crop yield (kg ha-1) for 2004,2005,2006,2007 in Konya

	TM	Beans	Wheat	SB	Wheat
BWSW	CT	2543	5531	67198	3947
	RT	2644	5425	68392	5169
	NT	2648	5421	54745	4967
	Tillage	NS**	NS	2177	717

*TM: Tillage Management; *SB: Sugarbeet; **NS: Non significant

CONCLUSIONS

A four-year period is not of sufficient duration to see all the effects of soil tillage under these conditions. However, according to the data obtained during this study, tillage and crop rotation systems did have a very significant effect over weed population. In the WW crop rotation, it was observed that direct sowing and reduced soil tillage led to increased weed populations. As a result, no yield was obtained in NT in 2005 due to the fact that wild-oat (Avaena fatuna) had covered all the field with the continuous zero till wheat sowing. and consequently we had to apply glyphosate in this field killing both wild oats and the remant wheat. Therefore, no harvest was made.

All the data obtained from the fields where wheat was grown continuously show that the continuous WW rotation is not an effective practice, regardless of whichever soil tillage method was used. The yields in all treatments decreased over the years. Crop rotations in which different crops such as bean, wheat, sugar beet, wheat are grown are more useful. It was determined that bean yields, and the wheat yields following bean were not affected by soil tillage methods, whereas sugar beet yield, and wheat yield following sugar beet were affected. Even though, the direct sowing for sugar beet is not an appropriate model, it was found that the wheat following the direct sown sugar beet was affected positively from this treatment.

Considering the tillage practices commonly used in the region, sowing can often be delayed since the growers can encounter difficulties in soil tillage after sugar beet, and with consequent very low wheat yieldd, it appears that the direct sowing would provide more benefits. In addition, considering the fact that no other chemical is required following sugar beet sowing, this would be a lot more beneficial method.

In summary, NT seeding seems to be a management practice which will take place in proper crop rotation in irrigated fields in this region.

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