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Evaluation of the No-Till Demonstration Studies in South East Anatolia Region of Turkey

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Abstract

The practice of no-till in crop production has gained popularity in recent years because it is a superior soil conservation practice and offers reduction in fuel and labor requirements. But, its adaption is very slow in many countries because of lack of knowledge, experience and machines. A series of demonstration studies was conducted to observe the performance of the no-till systems in farmers' conditions in South East Anatolia region of Turkey. Four demonstration sites were established, each of which was also planted with farmers' application for wheat (Triticum Aestivum L.) after wheat, wheat after lentil (Lens Culinaris, L), wheat after cotton (Gossypium hirsutum L.) and lentil after wheat in 2009-2010 growing season. Yield was higher under no-till planting (1.50 t ha-1) than farmers' application (1.10 t ha-1) for lentil production after wheat. The no-till planting had similar yield to farmers' application for wheat production after wheat and lentil. The yield performance of wheat following cotton for no-till ridge planting and farmers' application was not consistent at three demonstration sites. In conclusion, the studies of the demonstration showed that no-till planting may be used in lentil and wheat production following wheat and lentil under these weather and soil conditions in South East Anatolia Region of Turkey.

Key words

No-till; traditional tillage; wheat; lentil; yield.

Introduction

Soil tillage influences agricultural sustainability through its effects on soil processes, soil properties, and crop growth. An important effect of soil tillage on sustainability is through its impact on the environment e.g. soil degradation, water quality, emission of greenhouse gases from soil-related processes, etc. (Aase and Pikul Jr 1995; Ding et al. 2002; Motta et al. 2002). Conventional tillage (i.e. moldboard plowing) has been used in many countries although its effect on soil degration was reported by many researchers (Kruger et al. 1996; Hulugalle and Entwistle 1997; Etana et al. 1999). Besides, many researchers have reported that conservation tillage protects soil from wind and water erosion and improves soil physical, chemical and biological properties, and reduces production costs (Gemtos et al. 1998; Chan and Hulugalle 1999; Lithourgidis et al. 2006; Thomas et al. 2007; Mann et al. 2008). The European Community agricultural policy has strongly encouraged conservation tillage in order to decrease soil loss and degration (European Union, 2001). But, the effect of conservation practices on yield is sometimes contradictory and depends on soil type, climate and management conditions (Prasad and Power, 1991). Besides, it is dependent on a number of interacting factors, including weed control level, residue management, cultural practices and drill performance (Dawelbeit and Babiker 1997; Gemtos et al. 1998; Carefoot and Janzen 1997). Hao et al. (2001), Jalota et al. (2008), Mann et al. (2008), Schillinger et al. (2010) found that conservation tillage was equal to or better than conventional tillage. Also, Hunt et al. (1997) reported that no yield loss was found when no-till system was used in winter wheat agriculture after cotton. But, Ishaq et al. (2001) determined lower wheat grain yields for minimum tillage than for conventional tillage, or deep tillage. Gwenzi et al. (2009) reported that the effect of tillage methods on crop yields was inconsistent in an irrigated wheat-cotton rotation throughout the 6-year period and the lower wheat yield under minimum and no-tillage resulted from the higher weed infestation and poor crop stand, as well as reported by Karlen and Gooden (1987), Hemmat and Taki (2001), Li et al. (2008). Besides, Javadi et al. (2008) stated that no-tillage did not show promising results due to lack of appropriate equipment.

The no-till planting of wheat on permanent beds has been proven in many parts of the world to reduce the cost of production and irrigation water.

Hobbs et al. (1998); Reeves et al. (1999); Sayre and Hobbs (2004); Gürsoy et al. (2010) stated that permanent raised beds proved to be an excellent option for wheat and offered potential benefits in terms of higher crop yield and quality, lower production costs, improved soil structure through controlled traffic and minimum tillage, initial weed control prior to planting, easy access to crop for timely nutrient (especially N) application, lower seed rate, better stand establishment, and the possibility that furrow-irrigation may be more efficient than flood irrigation. Jin et al. (2008) reported that permanent raised bed cropping system had the potential to make an important contribution to agricultural productivity, but ongoing research is needed on several aspects of this cropping system, including the suitability of current wheat varieties and relationships between tillage and water management practices, productivity and environmental conditions.

The adaption of no-till practices in crop production is very slow due to lower crop yields in such systems, and also differences in management that farmers may not be familiar with although it is a superior soil conservation practice and offers reduction in fuel and labor requirements (Cosper 1983).

The objective of this study was to evaluate the performance of the no-till demonstration studies conducted in farmers'conditions in South East Anatolia region of Turkey.

Materials and methods

Four demonstration sites were established at Bismil and Çınar districts of Diyarbakır in South East Anatolia Region of Turkey in 2009-2010 growing season. The demonstration sites are located 37º55'36" N 40º13'49" E at 670 m above sea level. The climate of the region is characterized by a semi-arid climate (humid winters and dry summers). Rainfall distribution is variable within and among years in this region. Mean annual precipitation, based on long-term average, is 491 mm, about 80% of which occurs from November to May. Monthly rainfall during the demonstration studies years and the monthly average rainfall over the long term (62 years) are shown in Fig. 1. In 2009-10 growing season, rainfall was below long-term average in Feb., Apr. and May, above average in Sep., Oct., Dec. and Jan. There was no considerable rainfall difference in Nov. and Mar. between 2009-10 growing season and long-term average.

Temperature records are summarized in Fig. 2. While Jan., Feb. and Mar. had higher mean, maximum and minimum temperature in 2009-10 growing season than in long-term average, there were no considerable differences in the other months.

Wheat was planted at three sites, each of which was also planted with farmers' applications for wheat after wheat, wheat after lentil, wheat after cotton, while lentil was planted at a site after wheat. The

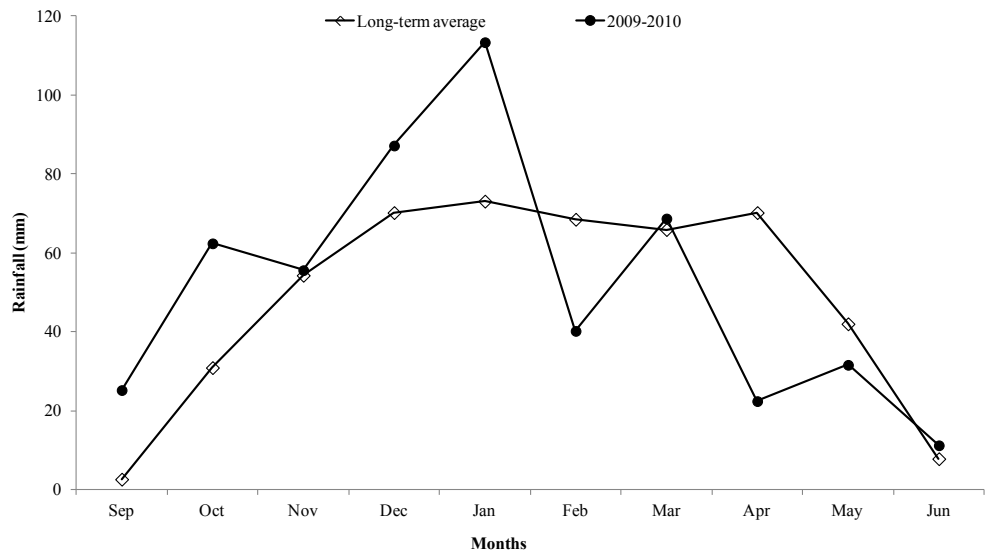

Figure 1. Long-term average monthly rainfall at Diyarbakir and monthly rainfall during 2009-2010 growing season.

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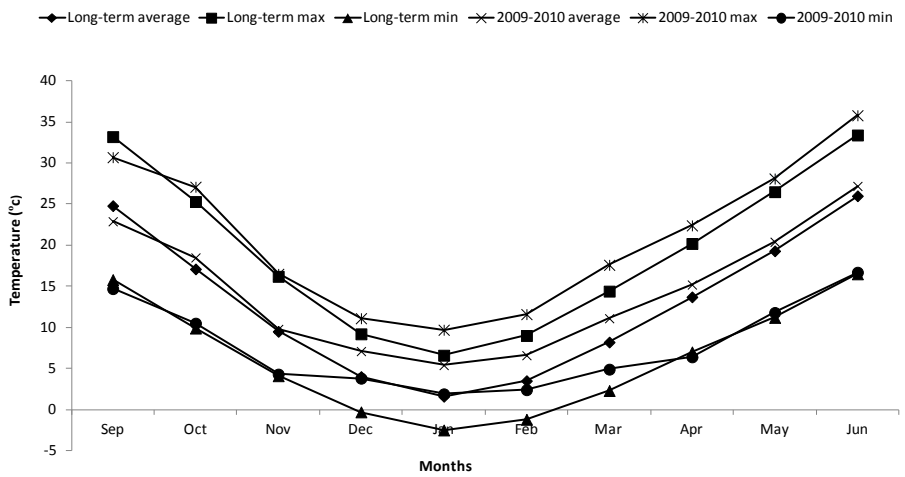

Figure 2. Average, maximum, minimum monthly temperature according to Long-term average and 2009-2010 growing season at Diyarbakir.

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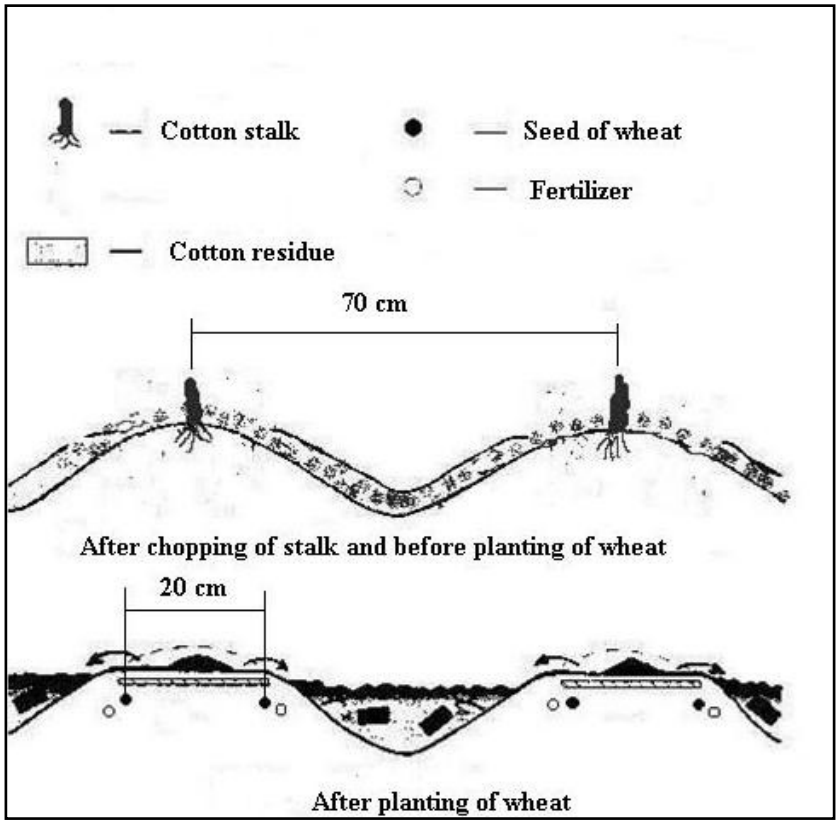

Figure 3. Schematic of no-till planting of wheat on ridge after cotton harvest.

pre-crop wheat was harvested by combine with straw chopper and blower for transporting the straw to trailer before planting wheat and lentil following wheat (Fig. 3). The no-till planter manufactured by Ozdoken Agricultural Machinery Ltd was used to plant wheat and lentil following wheat or lentil (Fig. 4). This planter with 210 cm working width and 1750 kg weight was equipped with 40 cm diameter smooth single disc openers. In no-till ridge planting method of wheat following cotton,

Figure 4. The Ozdoken no-till planter modified for no-till planting of wheat on ridge.

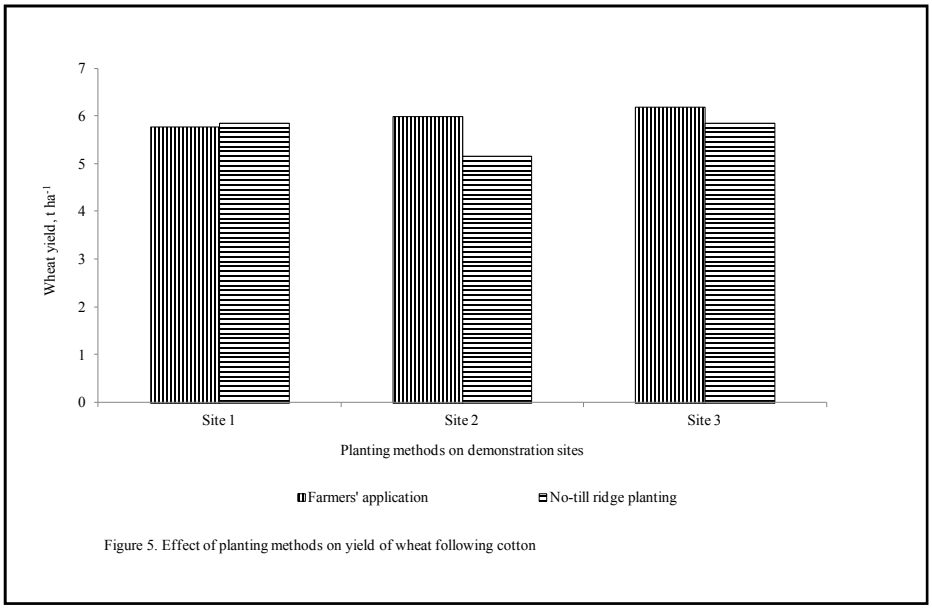

Figure 5. Effect of planting methods on yield of wheat following cotton.

two rows of wheat seed was planted on the top of ridge by using the modified Ozdoken no-till planter. The space between ridges was 70 cm. The space between each row on ridge was 15 cm (Figure 5). Farmers' planting applications included the planting process with conventional planter following cultivator and mouldboard plough after wheat and lentil harvest. The farmers' application for planting wheat after cotton was broadcast planting method. In this method, the seed was broadcasted on field without any previous stalk chopping and/or tillage and covered by cultivator.

Sarıcanak-98, a winter wheat cultivar widely used in the region, was planted at seed rate of 100 kg ha-1 for no-till ridge planting after cotton and 200 kg ha-1 for no-till planting method after wheat and lentil. In no-till ridge planting system, the lower seed rate was used to provide the amount of seed in a row and to keep plant to plant distance within a row similar to other planting/seeding systems/ treatments. The seed rate for farmer's application was 220 kg ha-1 after wheat and lentil and 300 kg ha-1 after cotton.

A compound fertilizer (20-20-0; % N-P2O5-K2O) to supply 80 kg N plus 80 kg P2O5 ha-1 was applied as basal fertilizer at planting, and 80 kg N ha-1 as ammonium nitrate (33% N) was applied at first node stage for each crop. After emergence of the crop and before tillering, grass and broadleaf weeds were controlled by herbicide. The irrigation was applied to flowering and grain-filling stage.

For no-till planting lentil following wheat, Çağıl lentil variety was planted at 100 kg ha-1. The seed rate was 180 kg ha-1 in farmer's application. No fertilizer and irrigation was applied; fertilizer is not normally applied to lentil crops in this region. After emergence of the crop and before tillering, grass weeds were controlled by herbicide.

Grain yield was measured by harvesting the full demonstration area, using combine harvester.

Results and discussion

Functional observations

Penetration of the openers of no-till ridge planter was very good due to soft soil conditions. The openers were not plugged by residues because the pre-crop wheat and lentil was harvested by combine with straw chopper. The planter modified to plant two rows of wheat on top of ridges appeared to have a good performance and was not plugged by cotton residues. The soil and residue flow among openers was very good. The seeding depth observations showed that seeds were placed to the target depths and covered with soil. Weed density and field mice pest in wheat production following wheat were higher in no-till planting than in farmers' application while there was no significant difference between no-till ridge planting and farmers' application in wheat production following cotton.

Grain Yield

The grain yield results are the demonstration plots and indicate trends only and have not been scientifically analyzed because they are not from replicated trial. Figure 5 illustrates the yield performance of wheat following cotton for no-till ridge planting and farmers' application at three demonstration sites. While grain yield of wheat was higher in no-till ridge planting than in farmers' application at site 1, no-till ridge planting resulted in lower yield than farmers' application at site 2 and site 3. The difference between demonstration sites might be resulted from the water availability in the soil profile due to irrigation applied at growing stage. Hobbs et al. (1998), Reeves et al. (1999), Sayre and Hobbs (2004), Govaerts et al. (2005) and Gürsoy et al (2010) stated that permanent raised beds can be an excellent option for wheat and offer potential benefits in terms of both productivity and costs. But, they suggested that subjects such as irrigation, seed rate, fertilization in no-till ridge planting should be researched. The no-till planting in wheat production following lentil resulted in slightly higher grain yield than farmers' application, but wheat yield following wheat was lower in the no-till planting than farmers' application (Fig. 6 and Fig. 7). The lentil yield following wheat was higher in no-till planting (1.50 t ha-1) than in farmers' application (1.10 t ha-1) (Fig 8.). The results of the studies about no-till wheat planting are not consistent due to different experimental conditions because

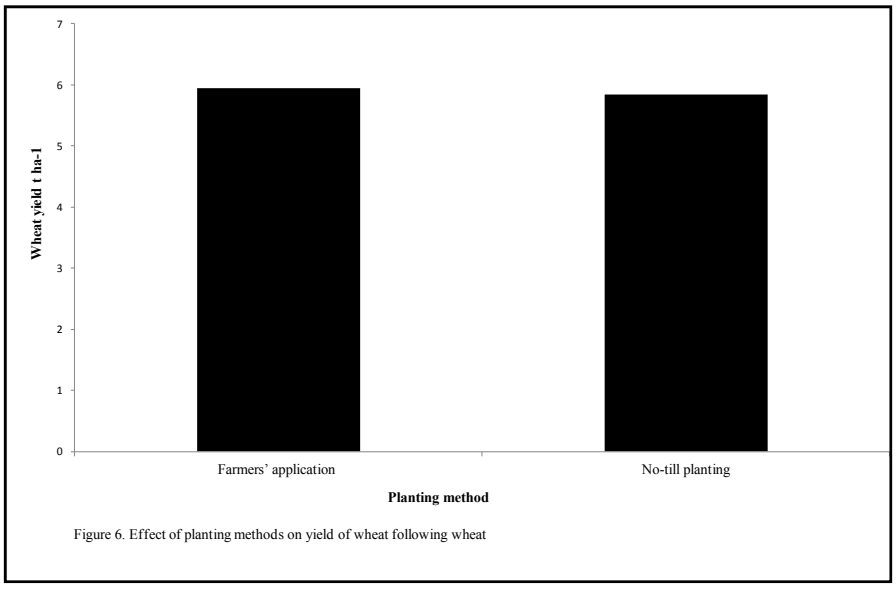

Figure 6. Effect of planting methods on yield of wheat following wheat.

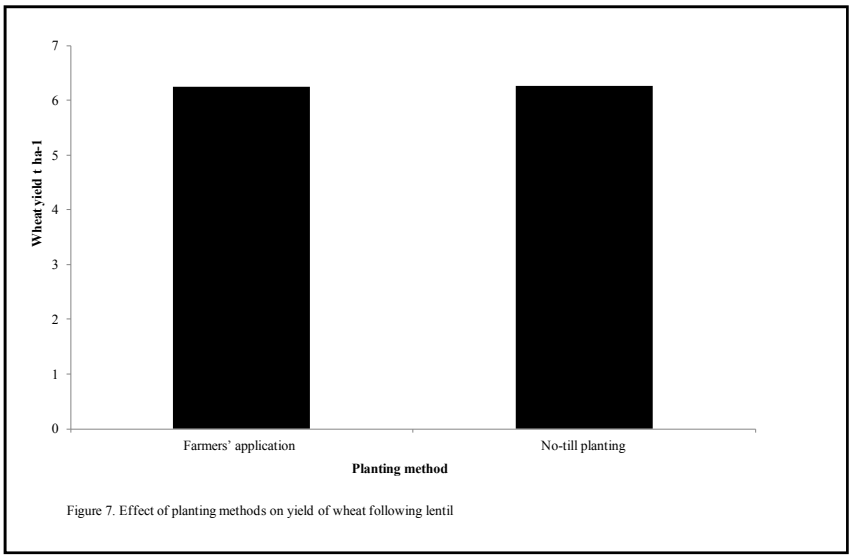

Figure 7. Effect of planting methods on yield of wheat following lentil.

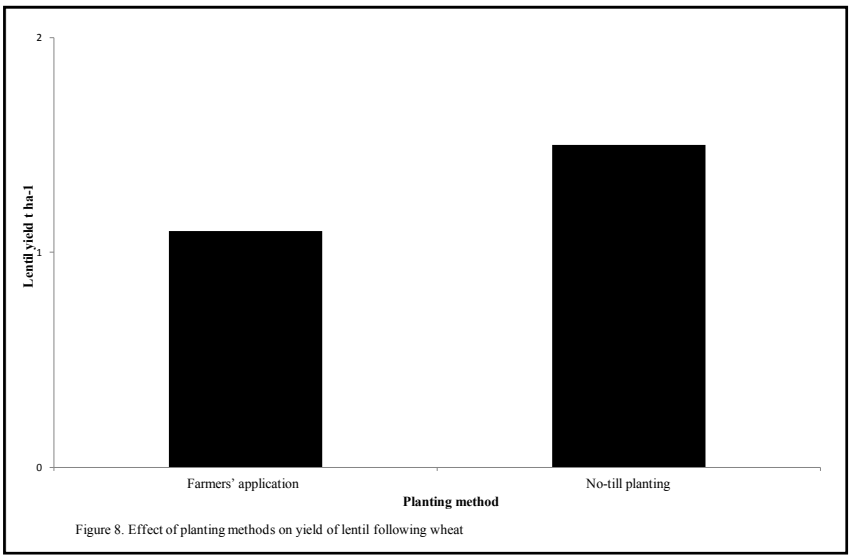

Figure 8. Effect of planting methods on yield of lentil following .

the performance of no-till planting is dependent on number of interacting factors, including soil-climatic conditions, weed control level, residue management, cultural practices and drill performance (Prasad and Power 1991; Dawelbeit and Babiker 1997; Gemtos et al. 1998; Carefoot and Janzen 1997). The yield performance in no-till planting and farmers' application at demonstration sites might be affected by soil conditions and pre-crop management.

Conclusions

Weed density and field mice pest in wheat production following wheat were higher in no-till planting than in farmers' application while there was no significant difference between no-till ridge planting and farmers' application in wheat production following cotton. The yield performance of wheat following cotton for no-till ridge planting and farmers' application was not consistent at three demonstration sites. While the no-till planting in wheat production following lentil resulted in slightly higher grain yield than farmers' application, the wheat yield following wheat was lower in the no-till planting than in farmers' application. The no-till planting resulted in higher yield in lentil production following wheat than in farmers' application.

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