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Reduced Tillage Systems on Second Crop Cotton in Aegean Region*

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Abstract: Aegean region is one of the most important regions for both cotton production and cotton quality in Turkey. Recently, increasing cost in cotton forces farmers to seek new techniques in tillage operations. So, they start to use different tillage systems especially reduced tillage in cotton production.
In this study, reduced tillage systems and direct seeding technique in second crop cotton production were examined for two years to compare with the conventional system. The effect of tillage systems on the soil physical properties and effectiveness of the methods were evaluated along with the yield of cotton.
Key words: Second crop cotton, Reduced tillage, Direct seeding

Ege Bölgesi İkinci Ürün Pamuk Tarımında Azaltılmış Toprak İşleme Yöntemleri

Özet: Ege bölgesi Türkiye'nin en kaliteli pamuğunun üretildiği ve en önemli pamuk üretim bölgelerinden birisidir. Son zamanlarda artan maliyetler pamuk üreticilerini yeni toprak işleme teknikleri araştırmaya zorlamaktadır.. Bu nedenle pamuk üretiminde değişik toprak işleme sistemleri özellikle azaltılmış toprak işleme yöntemleri üreticiler tarafından kullanılmaya başlamıştır.
Bu çalışmada iki yıl süresince ikinci ürün pamuk üretiminde azaltılmış toprak işleme ve doğrudan ekim yöntemlerinin geleneksel yöntemle karşılaştırılması yapılmıştır. Toprak işleme sistemlerinin toprağın fiziksel etkilerine, iş başarılarına ve işletme karakteristiklerine etkisi araştırılmıştır.
Anahtar kelimeler: İkinci ürün pamuk, Azaltılmış toprak işleme, Doğrudan Ekim

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INTRODUCTION

Although cotton is a tropical perennial plant, it is planted as an annual plant in tropic and sub-tropic regions as a result of genetic studies to meet the need of human being. Cotton is getting more important industrial plant since it is basic material for textile, oil and other industries. Cotton's fiber is used in textile and seeds are used in oil industry.

With 715 000 ha planted area, cotton is the most strategic industrial plant in Turkey (Anonymous, 2004).

Intensive tillage is used in Turkey for cotton production. In some regions, 10 to 12 times of tillage are applied for cotton production causing the soil to have a very small granule. This causes water erosion in the sloppy fields and wind erosion in windy regions which ends up with soil loss. For this reason, conservation tillage and minimum tillage techniques should be applied widespread immediately.

Some researches made on this subject were given below.

The effects of different tillage methods on cotton yield were investigated with three years of study (1986-1988) in Louisiana (Hutchinson et al., 1988). They applied conventional tillage, direct seeding and ridge planting in the field. They found the yields 0.834 Mg ha^{-1}, 0.685 Mg ha^{-1} , 0.728 Mg ha^{-1} for conventional , direct seeding and ridge planting methods, respectively.

In the other study made in Louisiana between 1987 and 1993. Boquet et al. (1994) planted cotton with different tillage methods; conventional, conservational and direct seeding in the field with or

without previous crop legumes. After 5 years of the study, they found the yield in the direct seeding plots more than the yields of other methods. They also observed that the yield 43.4 kg higher in the field with previous crop of legumes.

In Alabama, the effects of different tillage methods on CO_2 emission to the air were examined. Roberson et al. (2004) applied conventional tillage, direct seeding and mulch tillage to see the effect. They found that conventional tillage caused 9% and 83% more CO_2 emission to the air comparing to the mulch tillage and direct seeding, respectively.

The objective of this study was to evaluate of using conservation tillage, reduced tillage and direct seeding methods on second crop cotton in Aegean Region. The effects of the methods on the plant growth and the yield along with the field efficiencies of the tools were examined.

MATERIALS and METHOD

The research was conducted in Soke, Aydin region, 37°45'S latitude and 27°24'S longitude, located 130 km away from city of Izmir which is the western part of Turkey, in the years of 2001 and 2002. Each plot was 25 m long and 2.8 m wide totaling 4 rows with loamy soil having a texture of 9.84% clay, 40.32% silt and 49.84% sand (Black, C.A., 1965).

The region has semi-humid mezzo-thermal climate. The average annual temperatures of air and soil, relative humidity, and rainfall in the region are given in Table 1.

The soil temperatures measured 13:30-14:00 just before planting the second crop cotton were given in Table 2.

Cotton variety of Delta-Pine 388-type (early variety) was used in the trials. Nazilli 84 delinted cotton variety, which is common in the region, was used for conventional cotton seeding. Before planting 20-20-20 compose fertilizer 300 kg ha^{-1} and after planting 250 kg ha^{-1} 26% ammonium were applied to the field. After fertilizer application, 2000 cc ha^{-1} humic acid and Trifiluralin were applied for growth incentive and herbicides.

Table 1. Meteorological data collected from the region (Nazilli Meteorology Institute)

	Annual Average of Maximum Temperature (^{0}C)	Annual Average of Minimum Temperature Ort. (^{0}C)	Annual Average of Temperature (^{0}C)	Annual Average of Relative Humidity (%)	Annual Total Rain (mm)	Number of Rainy Days	Ground Temperature (^{0}C)		
							Depth (5 cm)	Depth (10 cm)	Depth (20 cm)
First Year	25.2	11.6	18.2	56.9	693.6	86	20.1	19.7	19.2
Second Year	24.0	10.9	17.2	59.4	610.4	79	18.9	18.5	18.2

Table 2. Soil temperatures before planting (^{0}C)

Depth		First Year		Second Year	
		Dry	Wet	Dry	Wet
Conventional	5 cm	31.4	32.6	31.6	32.8
	10 cm	28.9	31.4	29.1	31.7
	15 cm	28.1	30.3	28.7	30.5
Reduced Tillage	5 cm	30.9	32.4	31.3	32.7
	10 cm	30.0	31.0	30.2	30.9
	15 cm	28.2	29.8	28.2	29.9
Direct Seeding	5 cm	30.4	31.8	30.6	32.0
	10 cm	29.1	31.5	29.5	31.9
	15 cm	28.3	30.7	28.8	31.0

After harvesting wheat, cotton was planted with two different plant spaces of 5.8 and 11.8 cm. in dry and wet soil conditions. For wet soil conditions, the field was first irrigated and after reaching the desired moisture level planted was performed. Tillage and planting was made directly to the dry soil then field was irrigated for dry soil conditions. Three different methods were applied:

- Conventional tillage + planting
- Reduced tillage with rotary tiller + planting
- Direct seeding

Cotton was also planted as a first crop in the control plot by using completely block design with four replications for statistical analysis. For both first and second crop cotton, 70 000 plants were left in per ha^{-1} area after thinning operation.

Measurement set used for measuring working characteristics, fuel consumptions, draft, pull force and PTO power of the machines used in the experiment was given in Figure 1.

The effect of machines on soil compaction was measured with penetrometer device. Seedling emergency (Bilbro et al. 1982) and cotton seed yield were measured for evaluating the effects of the tillage methods on cotton.

Split-split plot design with four replications was used for statistical analysis of the data. The data were analyzed using the SPSS statistical package program for analysis of variance (Anonymous, 2000)

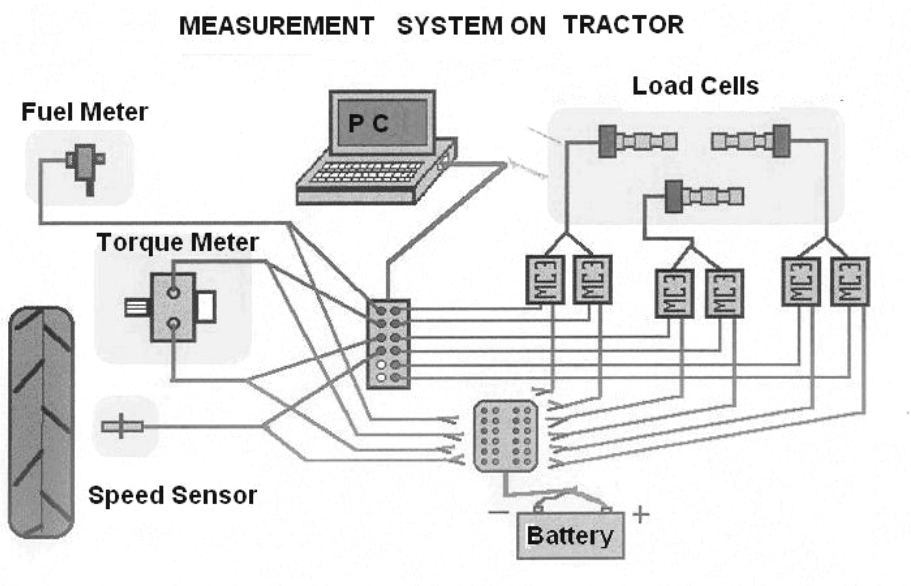

Figure 1. Configurations of the measurement set

RESEARCH RESULTS

Soil physical conditions were quite affected by tillage methods. The penetration resistances of the soil measured just before planting was given in Figure 2 and 3. It was found that, the top soil was rather compacted in wet soil conditions comparing the dry soil conditions. Soil penetration resistance was found 200-250 N cm^{-2} in 5 cm depth in conventional tillage plots since the top soil was compacted quite well with secondary tillage whereas this value was reduced to 150 N cm^{-2} in dry soil conditions. Direct seeding plot provided low penetration resistance in top soil. The maximum penetration resistance in direct seeding was found only 200 N cm^{-2}. When we look at bulk density of the soil, generally maximum values were found in direct seeding method since no tillage was made (Table 3.). Conventional method had the minimum bulk density.

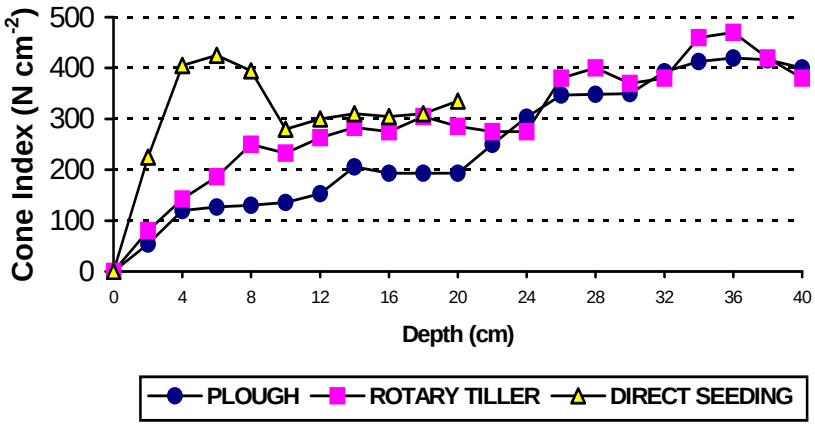

Figure 2. Soil penetration resistance (N cm^{-2}) of the soil just before planting for dry soil conditions

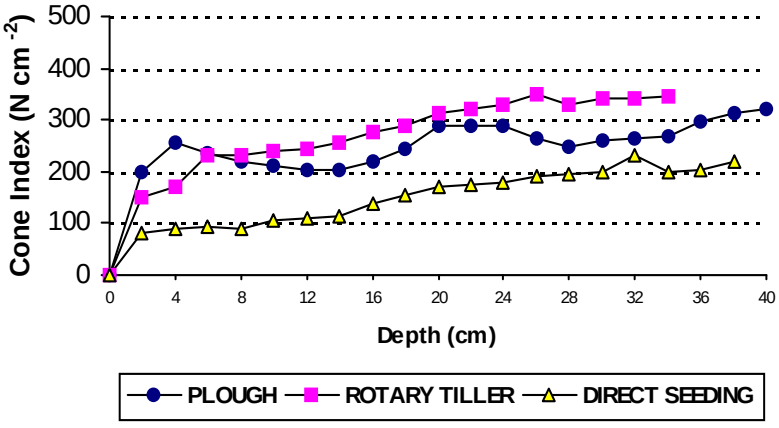

Figure 3. Soil penetration resistance (N cm^{-2}) of the soil just before planting for wet soil conditions

Direct seeding provided better soil conditions for seedling emergence. While seedling emergence was found around 60-70% in direct seeding method, this value did not increase 50% in conventional method (Table 4.)

The yields of second crop cotton were given in Table 5. The second had harvesting could not be performed due to early rain in the first year. As it is seen from the table, planting in dry conditions and then irrigation provided higher yields comparing the planting in wet soil conditions.

The fuel consumptions of tillage methods were given in Table 6. Maximum fuel consumption 89 l ha^{-1} was calculated in conventional method in main crop cotton (control plot), whereas direct seeding method provided similar yield with minimum fuel consumptions as 24 l ha^{-1}. Similar to fuel consumptions, required draft was found maximum as 28.9 kW and 26.2 kW in dry and wet soil conditions. The minimum draft was required by direct seeding method which was around 10 kW.

The calculated PTO power of the machinery's used in the tillage methods were given in Table 7. The maximum PTO power was required by rotary tiller used in the reduced tillage.

Table 3. Bulk density (g cm^{-3}) of the soil as affected by tillage methods

Methods	Year	First Year			Second Year		
	Depth (cm)	0-5	5-10	10-15	0-5	5-10	10-15
Conventional	Dry	1.19	1.31	1.38	1.11	1.21	1.29
	Wet	1.20	1.28	1.43	1.44	1.37	1.26
Reduced Tillage	Dry	0.86	1.14	1.30	1.03	1.21	1.34
	Wet	0.99	1.19	1.33	1.19	1.26	1.36
Direct Seeding	Dry	1.18	1.35	1.47	1.34	1.42	1.36
	Wet	1.19	1.33	1.46	1.48	1.51	1.44

Table 4. Seedling emergence rates (%) of second crop cotton as affected by tillage methods

Methods	Machine	John Deere				Accord				Amazone			
	Year	First		Second		First		Second		First		Second	
	in row space (cm)	5.8	11.8	5.8	11.8	5.8	11.8	5.8	11.8	5.8	11.8	5.8	11.8
Conventional	Dry	53	51	43	55	50	44	54	49	44	45	45	42
	Wet	53	50	57	59	48	52	61	59	45	49	54	56
Reduced Tillage	Dry	59	56	69	66	52	53	64	58	52	55	52	50
	Wet	60	50	61	58	64	58	62	60	55	52	55	49
Direct Seeding	Dry	60	63	63	73	57	65	70	59	51	53	56	53
	Wet	66	55	66	60	65	63	64	69	54	50	56	53

Table 5. Yield (Mg ha^{-1}) of second crop cotton as affected by tillage methods

Methods	Machine	John Deere				Accord				Amazone			
	Year	First		Second		First		Second		First		Second	
	in row space (cm)	5.8	11.8	5.8	11.8	5.8	11.8	5.8	11.8	5.8	11.8	5.8	11.8
Conventional	Dry	2,31	2,14	2,65	2,47	2,03	2,11	2,60	2,88	2,19	1,95	2,42	2,43
	Wet	1,10	1,04	2,31	2,27	0,97	0,85	2,22	2,57	1,02	0,93	2,30	2,18
Reduced Tillage	Dry	2,51	2,10	2,60	2,68	2,10	2,17	2,42	2,59	1,96	1,85	2,37	2,32
	Wet	0,98	1,05	2,29	2,42	0,99	1,04	2,36	2,41	1,06	0,98	2,29	2,22
Direct Seeding	Dry	2,47	2,40	3,22	2,99	2,54	2,41	2,88	3,14	2,43	2,27	2,97	2,71
	Wet	1,25	1,12	2,78	2,63	1,08	1,04	2,29	2,44	1,05	1,02	2,62	2,24

Table 6. Fuel consumptions (l ha^{-1}) of tillage methods

Methods	Fuel Consumption (l ha^{-1})	
	Dry Plots	Wet Plots
Main Crop Conventional	-	89.0
Second Crop Conventional	72.0	64.5
Second Crop Reduced	38.2	37.7
Second Crop Direct Seeding	24.7	24.0

Table 7. Calculated PTO power (kW) of tillage methods

Methods	Tools	Soil Conditions	
		Dry	Wet
Conventional Tillage	Plough	-	-
	Disc-Harrow	-	-
	Float	-	-
	Seeding (John Deere)	5.2	5.0
	Seeding (Accord)	5.4	5.1
Reduced Tillage	Rotary Tiller	24.2	20.8
	Seeding (John Deere)	5.1	5.0
	Seeding (Accord)	5.2	5.2
Direct Seeding	John Deere	4.8	4.9
	Accord	5.1	4.8
	Amazone	-	-

CONCLUSIONS

According to the results, reduced tillage and direct seeding could be easily applied in Turkey for second crop cotton. Especially when we consider very intensive tillage used for main crop cotton in Turkey, reduced tillage and direct seeding should be used not only for saving fuel and time but also for reducing soil erosion.

In this research three times fuel save was made by using direct seeding in dry soil conditions (24.7 l ha^{-1}) when we compare with conventional tillage (72.0 l ha^{-1}).

Seedling emergency rate was found statistical significant at 5% level for tillage methods. Seedling emergency rate was found low especially in planting dry soil conditions (average 47.66%). The highest emergence was obtained in direct seeding method for dry soil conditions (average 60.33%).

Statistical difference was found on yield results in tillage methods at 5% significant level. The second hand harvesting could not be made due to the early rain in the first year. This caused low yields for first year results. When the yield results for the second year were examined, the highest yield was found in direct seeding method made in dry soil conditions (Average 2.98 Mg ha^{-1}). It is so vital, for this reason, that direct seeding should be performed in dry soil conditions before irrigation to have a good yield in second crop cotton.

Two important factors were observed for adapting the direct seeding on second crop cotton in the region. One is to apply direct seeding in dry soil conditions and then irrigate the field. Second is applying direct seeding as early as possible to avoid early rain during harvesting time.

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