CHAPTER 5

WHEAT AGRICULTURE AND APPLIED OF CONSERVATION TILLAGE METHODS IN ADANA

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1. INTRODUCTION

With the environmental awareness that developed after the 1970s, alternative methods have been developed that minimize the field traffic and work the soil without turning it inside out. The main criterion in this method, which is defined as conservation tillage, is that the field surface is covered with at least 30% plant residue (Köller, 2003; Hobbs and Gupta, 2004; ASABE, 2013).

Purpose and benefits of conservation tillage systems;

- Prevents wind and water erosion,
- Protects and increases the amount of organic matter,
- It reduces moisture loss in the soil,
- Field traffic is minimized,
- Stable and sustainable product yield,
- It saves time,
- Less fuel consumption occurs and provides energy savings,
- Prevents deadly damage caused by burning stubble (Barut, 2009; Kassam and Friedrich, 2012).

There are many studies on the conservation tillage methods

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applied in wheat farming in the world. Some of those;

In a study conducted in North and South America. Soil erosion by wind or water was a serious problem in North and South America. When no tillage or reduced tillage is used to control erosion, the density of certain annual and perennial weeds can increase and new weed control techniques are often required. According to the research results; Conservative tillage system was found to be more successful than conventional tillage system. The amount and cost of herbicides used were similar to herbicides used in conventional tillage systems (Moyer, 1994).

In a trial conducted in India, field trials were conducted with farmers for 3 consecutive years dominated by the paddy-wheat system. It has been determined that zero tillage-based crop production emits less greenhouse gases and provides sufficient economic benefits. Wheat production in each farmer's field compared to conventional tillage was tested for three consecutive years, from 2009 to 2012. According to the results of the research, considering the input costs, the conservation tillage method was found to be more successful than the conventional tillage method according to environmental and economic effects (Aryal, 2014).

In a study on wheat production in the interior Pacific Northwest region of the USA. Wind erosion control is critical in the region. Conventional tillage practices are intensive and involve eight or more tillage operations during the fallow cycle. In this study, conservation tillage management systems were evaluated for 6 years. According to the results of the research, there was no difference between the applications in the average grain yield over the years. The results found that long-term application of minimal tillage had no adverse effects compared to conventional tillage. It shows that the conservation tillage method significantly increases the surface residue and clod retention for erosion control (Schillinger, 2001).

As a result of these researches carried out in the world, the conservation tillage method applied in wheat farming was found to be more successful than conventional tillage methods. No significant difference was found in weed control. It is thought to be a method that can prevent wind and water erosion.

In this study, wheat cultivation and conservation tillage methods applied in Adana region are discussed. It is aimed in this research to determine an efficient conservartion technique by protecting our soil.

AGRİCULTURE İN ADANA REGİON

Adana is an agricultural city with a 160 km coastline to the Mediterranean, a typical Mediterranean climate, and fertile agricultural lands with maquis vegetation. Winters are warm and rainy, and summers are hot and dry. Average annual precipitation is 625 mm. The percentage of precipitation is 51% in winter, 26% in spring, 18% in autumn and 5% in summer. As for the soil structure of the Adana region, in a study conducted with the average of soil samples taken from different parts of the region, the average total salt content was determined as 0.09%, the average pH value was 6,7, the average lime content was 23,6%, and the average organic matter was 1,2%. In another study conducted with soil series taken from different parts of the region, the average analysis of soil samples is given in **Table 1.**

Table 1. Soil properties of the trial plot where the study was carried out

Soil properties	**%**	**Evaluation**
Sand	21,2	Clay loam
Silt	40,45	
Clay	38,4	

As it can be seen in **Table 1**, the structure of the researched soil is a clay loam structure consisting of 21,2% sand, 40.45% silt and 38,4% clay (Irmak, 2012).

In this region, which is enriched with alluviums carried by the Seyhan and Ceyhan rivers and can be irrigated, a wide variety of products can be grown with a yield above the average of Turkey and many developed countries due to the favorable ecological conditions. The main agricultural products produced in the Adana region are; Citrus fruits are watermelon, soybean, grapefruit, peanuts, grain corn, cotton, sunflower and wheat. Adana province is in the 6th place in Turkey production, meeting approximately 3,8% of Turkey's wheat production. According to 2020 TUIK data, 621,724 tons of production was realized in an area of 1.586,016 da in Adana. Although the average yield of Adana province is 483 kg/da, the highest yield varies between 500 - 750 kg per decare. The wheat yield of the region is about 200-300 kg/da in dry conditions and between 500-750 kg/da in irrigated conditions. Although the wheat planting time is in a wide range such as October 1st and December 31st, wheat planting in the region is generally done between November 15th and December 15th. These dates are stated as the most suitable planting time by the researchers according to the average of many years (TUIK, 2021; TOB, 2021).

WHEAT AGRİCULTURE İN ADANA REGİON

Wheat cultivation in the region is in the form of flat sowing and conventional tillage is generally applied. For this purpose, previous crop residues are either completely buried in the ground or burned for various reasons, although it is prohibited. These reasons; The hesitant approach to new applications can be listed as the lack of tools and machines suitable for stubble cultivation in the manufacturer's machinery, the inability to provide good ger-

mination and emergence after planting, the fight against diseases and pests, etc (Aykanat and Barut, 2018).

In conventional tillage; if it is desired to bury crop residues in the soil immediately after the previous crop harvest or in the fall, plows are used in primary tillage. In order to break up the clods formed after the plow and prepare the appropriate seed bed, the soil is processed with at least two or three passes with second class soil cultivation machines such as harrows or cultivators. After processing, the seed bed is prepared by pulling a plug or roller to press the swelling soil a little and to break up the small clods. If the base fertilizer is to be spread before planting, the fertilizer is applied after doubling and mixed with the soil with a harrow or cultivator. After the seed bed preparation, sowing is generally done at 18-22 kg/da sowing norm with continuous sowing machines that sow in narrow rows. In scattering sowing, the sowing norm is usually 30-35 kg/da (TOB, 2022).

SOİL TİLLAGE METHODS APPLİED İN WHEAT AGRİCULTURE İN ADANA REGİON

Conventional tillage methods and industrial agricultural practices with intensive inputs applied in the region cause long-term degradation of agricultural lands and environmental damage. Especially these degradations and damages have accelerated in the last 30-40 years. It is extremely important to adopt agricultural production methods that will protect the natural resources that our future generations can produce in a healthy way. Conserved tillage practices that can be suggested for wheat farming for Adana Region depend on three basic principles:

- Previous product residues
- Less field traffic
- Crop rotation

In conservation tillage, it is essential that at least 30% of the previous crop residues remain on the soil surface (ASABE, 2013; Barut, 2006). Plant residues on the soil surface reduce the risk of water or wind erosion or completely eliminate it depending on the amount of residue. In addition, plant residues on the soil surface in places with water problems maintain soil moisture and reduce evaporation from the soil to the atmosphere.

Due to industrial agricultural practices, there is an intense loss of organic matter, especially in our coastal soils. Organic matter, which is depleted by conservation tillage, can be restored to the soil. For this, it is important to mix the plant residues into the top layer of the soil by using tools and machines that do not overturn the soil, tear and mix it without overturning it. In case the previous crop stubble density is high, it is recommended to use stalk shredding before tillage for better seed bed preparation and plant emergence. In addition, field traffic should be reduced by using less tools and machines or combined machines in seed bed preparation. Less field traffic will reduce the input costs of the enterprise and prevent soil compaction. Some tillage practices that can be recommended for humid and warm coastal areas:

- Chisel + Disc Harrow (Diskaro) + Roller + Sowing
- Chisel+Rotatiller (with rotary harrow)+Sowing
- Heavy Disc Harrow (Goble)+Cultivator+Roller+Sowing
- Heavy Disc Harrow (Goble)+ Disc Harrow (Diskaro)+Roller+Sowing
- Rotatiller (with rotary harrow)+Showing
- Direct Sowing

For arid regions with water problems, when cultivating the soil, tools and machines that work from below without breaking and mixing the soil should be preferred. It is important to be careful when using disc harrows and horizontal spindle rototillers in these areas.

ROTATİON SYSTEMS İN WHEAT AGRİCULTURE İN ADANA REGİON

Corp rotation systems application is one of the most important factors of sustainable agriculture. Rotation systems (crop cycle) is mandatory in terms of maintaining the fertility of the soil, eliminating soil fatigue, and combating diseases and pests. In **Table 2**, the examples of rotation systems that can be applied and applied in Adana Region are presented. This application can be expanded on a per product basis.

Table 2. Different rotation systems applications in Adana region

Application	Winter	Summer	Winter	Summer	Winter	Summer
1	Wheat	-	-	Cotton	Wheat	-
2	Wheat	Sesame	Vetch / Oat	Cotton	Wheat	Vetch / Oat
3	Wheat	Peanut	-	Cotton	Wheat	-
4	Wheat	Soybean	-	Cotton	Wheat	-
5	Wheat	Corn	Legume	Soybean	Wheat	-
6	Wheat	Corn	-	Soybean	Wheat	-
7	Wheat	Soybean	-	Corn	Wheat	Soybean
8	Wheat	-	Legume	Corn	Wheat	-

STUDİES ON WHEAT AGRİCULTURE İN ADANA REGİON

Aykanat and Barut (2018), was carried out a research in the Adana region between November 2015 and June 2016. Trials were set up according to Random Blocks split-plot design with 4 replications. Wheat variety was used as seed material. Three different plantings methods were tried. When the wheat was harvested, plant height, ear length, biological yield, stem yield and grain yield were examined. According to the plant height and ear length criteria, they found a statistically significant difference of 1% at the

level of significance. Wheat stem and grain yields were found to be statistically significant at 1% significance level both in planting methods. According to the results they obtained, the grain yield in irrigated wheat was 326,66 kg/da in flat sowing method, 267,46 kg/da in back planting method and 140,91 kg/da higher yield in wide back planting method.

Aykanat et al. (2019) made a technical and economic comparison of the conservation tillage and sowing systems applied in wheat farming in Cukurova Region. As a result of the research, the highest wheat yield was obtained in the reduced tillage method, while the lowest yield was obtained in the two-row planting method. The lowest value in terms of time and fuel consumption among the methods; In addition, the highest value in terms of work efficiency was obtained in the direct sowing method. The direct sowing method has saved approximately 81-86% compared to other methods in terms of time consumption, fuel consumption and work efficiency.

Acar et al. (2017) investigated the long-term 2006-2014 effects of six different tillage systems on soil water content and wheat yield in a clay soil in the Cukurova region of Turkey. İn their research, tillage practices; conventional tillage with, conventional tillage with stubbles burned, heavy disc harrow reduced tillage, rototiller reduced tillage, heavy disc harrow zero soil tillage and no-tillage systems. Soil moisture content was measured at different times of the 2014-2015 rainfed wheat production season. They found statistically significant effects of tillage practices on soil water content. in February, March, April and May of 2015. Although the moisture values measured in February and March are optimal for plant growth, soil water content was found to be higher in conservation tillage applications than in conventional tillage. Still, tillage practices did not have a significant effect on wheat yield. These results showed that reduced and no-tillage

applications can be an alternative to conventional tillage applications.

Barut and Celik (2017) were tested six different tillage systems as conventional tillage and conservation tillage. In their study, the main cause of degradation is either over-cultivation or the use of incorrect tillage methods. This role was usually determined using indicators of soil quality such as bulk density, aggregate stability, water available to the plant, organic carbon content, soil compaction and other properties. Their experiment was started with summer soybeans, followed by winter wheat and summer corn, and ended with winter wheat production. Bulk density, aggregate stability, organic matter content and soil penetration resistance were evaluated as indicators of soil quality in this study. According to the results of the research, conservation tillage systems (No-Tillage) improved soil organic carbon content and aggregate stability. Different tillage systems showed a significant effect on the amount of organic matter and aggregate stability in the soil. Organic matter values were lower (49-60%) in conventional applications and residue burning accelerated the loss of organic carbon content. The highest aggregate stability values were found for No-Tillage (>38%). Penetration resistance and bulk density of plowed soils were lower than that of uncultivated plots, while heap density was 1.26-1.32 g/cm3 at all soil depths in conventional tillage. As a result of their experiments, it has been shown that conservation tillage practices can provide better soil characteristic values than conventional practices in soils of the Adana region.

Barut and Celik (2010) compared conventional and conservation tillage systems in terms of plant emergence and stand establishment. The tillage systems were formed conventional tillage, minimum tillage and no-tillage for wheat and corn. Mean emergence day, emergence rate index, percentage emergence, multiple

index, skip index, quality of feed index, mean spacing between plants for corn and plant density for wheat were evaluated for uniformity of plant emergence and stand establishment. emergence rate index and percentage emergence were found to be significantly higher under conventional and minumum tillage compared with no-tillage treatments in corn. No-till treatment had the poorest stand establishment. According to the results of their study In wheat, the highest plant density was obtained under conventional tillage and minumum tillage treatments. Based on the average of 2 years, the highest yield of wheat was obtained under conventional tillage and the lowest in no-tillgage. Corn yield had similar results. According to the results of their study the lower yield in no-till was related to the weaker plant emergence and stand establishment. The comparable effect of minumum tillgage with conventional suggests that minumum tillage can be an alternative tillage method for sustainable agriculture.

Barut et al. (2010) investigated the effects of conventional tillage and alternative conservation tillage systems on some soil properties in wheat cultivation in Cukurova conditions. Conventional tillage, reduced tillage and direct sowing methods were used in the study conducted in clay textured soil between 2006 and 2009. According to the results they obtained the study, the total porosity values increased by 12-23% in conventional tillage, 10% in reduced tillage, and decreased by 4-6% in direct sowing. It was determined that the mass weight of the methods increased in the soil layer of 0-100mm, and there was a decrease in the lower layer of the soil and plantings from the east. According to the results of their study conventional tillage method significantly increased penetration resistance and caused soil compaction compared to conservation tillage methods.

Celik et al. (2021) compared the effects of conventional tillage and conservation tillage methods practices on soil quality of a clay soil for a ten-year experiment. In 2006, they established the field

trials with six tillage methods for winter wheat, soybean and corn. Fourteen soil quality indicators, including physical, chemical and biochemical properties, were determined to evaluate soil quality. They calculated soil fertility, water relations, resistance and flexibility, and physical stability. The physical stability support and resistance-resilience function scores were found to be significantly higher in conservation tillage sytems compared to conventional sytems. The resistance-resilience function at 0–100 mm depth in no-till sytems was 103 % and 72 % higher than conventional tillage sistems respectively. Significantly improved physical stability support and water relations functions at all sampling depths and overall soil quality at 100–200 and 200–300 mm depths compared to the long-term No-Tillage sytems. In addition, according to the results of the study, soil quality assessment using soil functions provides an overview to distinguish the pros and cons of tillage practices regarding the sustainability of crop production.

Celik et al. (2017) compared the effects of long-term tillage and crop residue management on nitrate leaching and some physical properties of a typical Haploxerert soil under double cultivation of winter wheat -soybean per year. As tillage systems, conventional tillage with stubble, conventional tillage by burning stubble, heavy disc harrow reduced tillage, rototiller reduced tillage, reduced tillage with heavy tandem disc harrow followed by no-tillage created from the application. In their study, tillage practices significantly affected the soil properties at both soil depths. As a result of this study, they revealed that reduced tillage and no-tillage treatments can significantly improve the physical quality of the soil, reduce NO3-N leaching of Typical Haploxerert soil in Cukurova Region.

Mujdeci et al. (2005) in this study, field trials of wheat plant were carried out. They made a mathematical modeling of the yield for three years (2000-2002). In the study, physiological de-

velopment dates, maximum leaf area index, minimum leaf area index, maximum photosynthesis rate, respiration rate and leaf area index constant data were determined for the wheat plant every year. Daily gross photosynthesis, maximum respiration rate and daily leaf area index were used for the model for the prediction of daily photosynthesis rate. These were two models for yield estimation. While only photosynthesis rate was taken as a basis in the model, in the other model, the total plant water consumption, the maximum evaporation rate from the soil surface and the maximum increase rate of the daily dry matter amount for the flowering period were used. In this study, the comparison of the model's values with the actual experimental values and the statistical evaluation applied for the daily photosynthesis rate revealed that the model results and the observed values showed good correlations. As a result of the research carried out, it has been shown that these models are used for wheat yield estimation.

2. CONCLUSIONS

Adana region is an agricultural city with flat, wide lands that can be enriched and irrigated by the alluviums carried by the Seyhan and Ceyhan rivers, and where a wide variety of products can be grown with a yield above the average of Turkey and many developed countries due to the favorable ecological conditions. Although many agricultural products are grown in the region, wheat production is of great importance for the region. Unfortunately, crop cultivation is mostly practiced intensively (agriculture applied in such a way that the highest yield can be obtained) with conventioal tillage methods. Intensive tillage and field traffic with conventioal tillage method triggers soil compaction and erosion to a large extent and our soils are destroyed.

In addition, it requires more energy and more fuel consumption with very high costs increasing in today's economic condi-

tions. More importantly, it is a tillage management that is not sustainable in the long run. In this context, it should be aimed to improve environmental factors, increase productivity and reduce production costs by developing an efficient production technique of conservation tillage method in wheat agriculture. For wheat cultivation in Adana region, it is necessary to switch from conventioal methods to conservation tillage and reduced tillage methods. The academic studies conducted in the region show that it is of great importance for the development and implementation of conservation tillage methods to be applied in wheat farming for the Adana region.

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