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Effects of Various Strip Widths and Tractor Forward Speeds in Strip Tillage on Soil Physical Properties and Yield of Silage Corn

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ABSTRACT

In this study, a 2 year experiment was conducted in field conditions in order to determine the effects of various strip widths on seedling emergence, plant growth and yield of silage corn. A row crop rotary hoe with C type blades, which was equipped for this purpose, was used for strip tillage. In the experiment, 30%, 40% and 50% of the field area was tilled respectively with the strips in 22.5, 30 and 37.5 cm widths, which were obtained by changing the positions of flanges and blade connections of the rotary hoe. The rotary hoe, which was used with a constant rotor rotation speed of 370 min^{-1} and a tillage depth of 10 cm, was operated at 3 different tractor forward speeds such as 1.8, 3.6 and 5.4 km h^{-1} in order to get various soil fragmentation values. The seeds were sown by using precision seed planter at 70 cm row intervals. According to the results obtained from the study, since increasing the strip width also increased the soil temperature and accelerated the evaporation, it resulted in a reduction of the soil moisture content. While seedling emergence, plant height and the silage yield increased with the increase of the strip width, the average emergence time decreased. Tractor forward speed had an effect on soil fragmentation. When the tractor forward speed increased, there seemed to be a reduction in the breaking of soil particles. It was found that the tractor forward speed did not have a statistically significant effect on other parameters.

Keywords: Strip tillage; Conservation tillage; Strip width; Silage corn

Şeritsel Toprak İşlemede Farklı Şerit Genişliklerinin ve Traktör İlerleme Hızlarının Toprak Fiziksel Özellikleri ve Silajlık Mısır Verimine Etkileri

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ÖZET

Bu çalışmada, farklı şerit genişliklerinin silajlık mısırda tarla filizi çıkışı, bitki gelişimi ve silaj verimine olan etkilerinin belirlenmesi amacıyla tarla koşullarında 2 yıllık bir deneme yürütülmüştür. Şeritsel toprak işleme için, bu amaca uygun hale getirilen C tipi bıçaklara sahip bir frezeli ara çapa makinasından yararlanılmıştır. Frezeli ara çapa makinası bıçaklarının flanş bağlantı konumları değiştirilerek elde edilen 22.5, 30 ve 37.5 cm genişliklerindeki şeritlerle tarla yüzeyinin sırasıyla % 30, 40 ve 50'si işlenmiştir. Farklı toprak parçalama değerleri elde etmek için 370 min^{-1} sabit r otor dönme hızı ve 10 cm iş derinliğinde kullanılan frezeli ara çapa makinası ile 1.8, 3.6 ve 5.4

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km h^{-1}'ten oluşan 3 farklı traktör ilerleme hızında çalışılmıştır. Ekim, hassas ekim makinası kullanılarak 70 cm sıra aralığında yapılmıştır. Elde edilen sonuçlara göre, şerit genişliğinin artışı toprak sıcaklığını arttırırken, buharlaşmayı hızlandırdığından dolayı, toprak nem içeriğinin azalmasına neden olmuştur. Tarla filizi çıkışı, bitki boyu ve silaj verimi şerit genişliğinin artmasıyla artarken, ortalama çıkış süresi şerit genişliği artışı ile azalmıştır. Traktör ilerleme hızı toprağın parçalanması üzerinde etkili olmuştur. İlerleme hızı arttıkça, küçük toprak parçacıklarının dağılımında azalma meydana gelmiştir. Traktör ilerleme hızının diğer parametreler üzerinde istatistiksel olarak önemli bir etkiye sahip olmadığı ortaya çıkmıştır.

Anahtar sözcükler: Şeritsel işleme; Koruyucu toprak işleme; Şerit genişliği; Silajlık mısır

1. Introduction

Conservation tillage is a method in which at least 30% of the field area is left to be covered with plant residues after the cultivation and the sowing is performed together with soil tillage. This method anticipates preventing erosion and conserving the soil moisture content (ASAE 2000). Conservation tillage is composed of the applications of reduced tillage, no-till, mulch tillage, ridge tillage and strip tillage. Strip tillage is a tillage technique which combines the advantages of no-till and full width tillage. In strip tillage, the processes such as preparation of seedbed, seeding, fertilizing, and the application of pesticides can generally be applied at one pass (Wysocki 1986). Thanks to it, while it is possible to reduce time, labor, fuel consumption, use of equipment and the number of field-pass, it is also possible to conserve the soil.

Strip tillage is a technique which is applied generally to row-crops such as corn and sunflower after wheat and soybean. By means of this method which is also known as an adaptation of no-till for row-crops, the soil loosens in the tilled strips and water permeability and warming increase (Reeder 2002). Strip tillage can be applied to various summer and winter plants. The most appropriate period is autumn for grains. The strips tilled in this period are softened after the moisture they get in winter and the height difference between the tilled strips and the strip intervals is reduced by pushing them mildly.

In strip tillage technique, only up to 25 - 30% of the total field surface is tilled in strips (Wysocki 1986, ASAE 2000). Generally strip width varies between 10-30 cm and although the space between the strips varies according to the plant type, it varies between 40-100 cm (Wysocki 1986; Bolton & Booster 1981; Morrison 2002a; Morrison 2002b; Licht & Al-Kaisi 2005; Lowther et al 1996). Cultivators, subsoilers, soil rotary tillers, and special tools and machines which are designed for this purpose are used in strip tillage (Bolton & Booster 1981; Morrison & Sanabria 2002; Lee et al 2003).

By tilling the soil in strips, the infiltration of rain and snow water into soil increases in dry farming areas and the evaporation of soil moisture in upper soil layer into the atmosphere accelerate. For this reason, depending on the place, it can be sufficient to apply shallow tillage as much as 5-6 cm (Reeder 2002). There are also some advantages such as the tilled strips are warmer and softer and the soil is less compacted with reduced pass number than the no-till (Cruse 2002). According to Cruse (2002), strip tillage provides optimum soil conditions for high production at minimum cost with its soil and water conservation.

As the soil tillage intensity decreases, carbon dioxide gas emitted to the atmosphere also decreases at the same rate (Reicosky 1998). According to Al-Kaisi &Yin (2005), the amount of CO_2 gas emitted to the atmosphere after soil tillage with moldboard plow was found to be 19-41% more than with strip tillage and no-till. These and some other similar results have shown that strip tillage is worth being emphasized for environmental advantages. Erosion can be taken under control with strip tillage by storing organic matter and plant nutrients in the soil (Reicosky 1998).

Wysocki (1986) reported that about 3% less crop yield was obtained with strip tillage than conventional soil tillage. According to Morrison

(2002a), because shallow tillage increases corn yield as much as deep tillage, there is no need for deep tillage in strip tillage. Lowther et al (1996), who determined that 56-63% of the area of pasture cultivated by strip tillage was covered with the seeded plants 5 months after the seed, suggested that strip tillage was the most ideal method for pasture area and renewal. In a study, plant emergence in tilling the soil in strips was found to be similar to tilling the whole area with chisel plow, yet soil water content was found to be similar to no-till (Licht & Al-Kaisi 2005). Leaving the crop residues between strips increases the production of the crops with small grains such as corn and sorghum (Mc Charty et al 1993). It was determined that strip tillage practice caused 14% and 30% more yield than conventional tillage in silage corn and grain corn production respectively (Mullins et al 1998). Opoku et al (1997) found that production in strip tillage was higher than in no-till, but it was similar to conventional tillage composed of moldboard plow + disc harrow. In corn production conventional soil tillage method caused 5 and 3% more production than in strip tillage and no-till respectively (Lamm & Aiken 2006). Cruse (2002) found that average corn production was higher in conventional method, but its total cost was less in strip tillage.

In the strip tillage the temperature of strips are higher than no-till and closer to conventional tillage in early spring (Cruse 2002). In a study in which the effect of various soil tillage systems on seedbed temperature was compared, conventional soil tillage caused higher seedbed temperature and it was found that the temperature in a depth of 4 cm was 2-4°C higher than those in 8 cm (Cavalaris et al 2003).

As the advantage of no-till, crop residues which remain at the strip spaces reduce evaporation and surface flow by rain drops' contacting with soil more softly. Bosch et al (2005) reported that water lost in surface flow in conventional tillage was 81% more than in strip tillage. Licht & Al-Kaisi (2005) reported that strip tillage accelerated the soil moisture loss a little more than no-till and it increased soil temperature as much as 1-1.4°C at top 5 cm depth.

Strip tillage which is fairly a new tillage technique in Turkey, is a simple, practical and effective alternative conservational tillage method. This type of tillage has the potential to increase soil temperatures in-row while using inter-row residue cover to conserve soil moisture for plant growth and development and lowers input costs. Strip tillage is performed with special equipments having arrangements that can provide various strip widths. However, little research has been done to determine suitable strip width for favorable seed emergence and growth of corn. The aim of this study is to compare various strip widths and tractor forward speeds in strip tillage in terms of effects on seedling emergence, plant growth, and yield of silage corn along with soil physical properties.

2. Materials and Methods

The experiment was performed in a wheat stubble field at the Atatürk University, Faculty of Agriculture Farm in years of 2004 and 2005. In order to till the soil in strips, a row crop rotary hoe was used.

Silage corn, which followed spring wheat, was planted at a field harvested by a combine with 10 cm stubble height. A pneumatic precision planter with 4 rows was used for seeding. The seed metering system of planter was adjusted for a target seed spacing of 0.14 m in the row and 0.7 m between rows. Szegedi TC 513 F1 corn seed variety was selected and sowing was performed at 5 kg da^{-1} seed rate. Some of 18 kg da^{-1} AN and 7 kg da^{-1} DAP fertilizers were applied together with sowing and the rest was applied when the plant was at a height 15 cm. Soil tillage and sowing were applied in the second week of May each year.

The first irrigation was applied when plant height was around 15-20 cm. During growing period, 3 surface irrigations were applied with three weeks intervals. In the experiment, a Ford 5000 S tractor, which had 49.4 kW (2100 min^{-1}) power and was equipped with speed radar, was used. Some of the important physical properties of the experiment field soils are given in Table 1. The experiment was conducted on 3 various strip widths (SW1=22.5, SW2=30 and SW3=37.5 cm) and 3 various tractor forward speeds (FV1=1.8, FV2=3.6 and FV3=5.4 km h^{-1}) and it was conducted as randomized complete block design with three replication. For strip tillage, a row crop rotary hoe adapted for this purpose was used. By changing the positions of the blades and flange connections of the rotary hoe, strips at widths of 22.5, 30 and 37.5 cm were obtained and 30, 40 and 50 % of the field surface were tilled with these strip width respectively. With a 370 min^{-1} constant rotor rotational speed and 10 cm tillage depth, various soil breaking values were aimed to be obtained in 3 different tractor forward speeds such as 1.8, 3.6 and 5.4 km h^{-1}. In order to use the experiment tractor at the determined speeds, a multi-purpose DJCMS 100 type monitor and a DJRVS II speed radar were used.

Table 1-Some of the important physical properties of the experiment field soils

Çizelge 1-Deneme alanı topraklarının önemli bazı fiziksel özellikleri

Soil properties	*2004*	*2005*
Soil moisture content, % d.b.	11.04	13.17
Soil bulk density, Mg m^{-3}	1.11	1.18
Penetrasyon resistance, MPa	0.94	1.02
Organic matter, %	2.13	2.3
Residue cover rate, %	62.5	67.1
Soil texture class (%: clay:47.5; sand:30.7; silt:21.8)	Clay loam	

After strip tillage, in order to determine the soil particle size distribution, the soil samples were collected from the tilled strips directly into the 400 × 400 × 50 mm sample boxes with a sampling shovel and taken to the laboratory and air dried. Dried soil samples were sieved through a set that contained eight sieves of the mesh sizes of; 63, 32, 16, 8, 4, 2 and 1 mm. The sieving was done by a sieving machine, Retsch type S-S, 80 W, with the manual adjustable frequency. The sieving time was 30 s, the frequency was approximately 50 Hz and the oscillation amplitude was 2 mm. The amounts of remaining soil particles on each sieve were weighed by a 0.01 g precision scale. In the sieve analysis, 1-8 mm diameter group which was considered to be the optimum particle size for seedbed and particle diameters which were bigger (>8 mm) and smaller (<1 mm) than this diameter group were taken into consideration (Celik 1998). The particles smaller than 1 mm are not recommended because of the wind erosion risk (Lyles & Woodruff 1962). Soil bulk density was measured for the depth ranges of 0-10 cm using stainless steel rings having dimensions of 50 mm diameter by 50 mm height (Demiralay 1993). Each plot was sampled three times. The same cores collected for bulk density were also used to determine the soil moisture content by the oven drying method (Blake & Hartge 1986). The soil cores were weighed, dried at 105°C for 24 h, and weighed again to determine gravimetric water content (kg kg^{-1}). Soil moisture content during emergence period was measured using a time domain reflect meter, TDR (Spectrum Equipment, Model Field Scout TDR 300). 15 measurements were taken randomly in each plot by using 12 cm rods. The data were saved into the data logger and then transferred to a computer.

During the seed emergence period, periodical measurements at 0-10 cm depth in each plot were conducted to determine seedbed temperature and soil moisture content. Seedbed temperature was measured using a Barnat 90 type digital soil thermometer. Temperature data were taken randomly for 10 cm depth by using 12 cm rods, with 5 replications in each plot. The average monthly temperature and rainfall values in the experiment area are given in Table 2.

Table 2-Average monthly temperature and rainfall data (DMI 2007)

Çizelge 2-Aylık ortalama sıcaklık ve yağış değerleri (DMI 2007)

Months	*Temperature, °C*		*Rainfall, mm*	
	2004	*2005*	*2004*	*2005*
May	9.71	10.56	121.7	92.1
June	14.48	13.86	40.7	70.0
July	17.90	20.23	2.4	20.3
August	19.58	20.43	1.3	24.3
September	13.84	14.04	6.0	15.4
Average/Total	15.10	15.82	172.1	222.1

In order to determine the penetration resistance, an Eijkelkamp analog penetrometer with 60° cone angle was used. Measurements were made at the depth of 15 cm in 5 cm increments with three replications in each plot before and after soil tillage.

In order to determine seedling emergence, the experiment field was observed throughout the emergence time and along with the beginning of the emergences, emergence counts were taken at two day intervals on spaces of 500 cm from each row. The values of average emergence time (*MET*), emergence rate index (*ERI*), and seedling emergence degree (*PE*) were calculated by using the values obtained from the counts in the equations given in Bilbro & Wanjura (1982):

$$MET = \frac{(N_1T_1 + N_2T_2 + ...N_nT_n)}{(N_1 + N_2 + ...N_n)} \quad (1)$$

$$ERI = \frac{Ste}{MET} \quad (2)$$

$$PE = \frac{Ste}{n}100 \quad (3)$$

where *MET* is mean emergence time, day; *ERI* is emergence rate index, seedlings/day-m; *PE* is percentage of emergence, %; $N_1 \ldots n$ is number of seedlings emerging since the time of previous count; $T_1 \ldots n$ is number of days after the sowing; *Ste* is number of total emerged seedlings per meter; n is number of seeds sown per meter.

In order to determine the plant growth, the size of the corn in harvest period was taken into consideration, whereas in order to determine silage production, its wet weight values in harvest were taken into consideration. Silage harvest was performed when the plant humidity content was between 63-65% (Roth 2001).

Analysis of the variance (ANOVA) was performed on the average values on all obtained data to assess the effects of the strip widths and tractor forward speeds on soil physical properties, seed emergence and yield. Significant differences among the means were determined using the protected least significant difference (LSD) tests at 0.05 probability level.

3. Results and Discussion

The result obtained from the sieve analysis to determine the fragmenting condition of the soil tilled in strips is given in Table 3. In this table, 1-8 mm diameter group, which is known as the optimum particle size dimension for the seedbed varied between about 28.9-45.8% of the total of the samples. Generally, while there was not an effect of strip width on particle size, there seemed to be an increase in particle size when the tractor forward speed increased.

The effect of forward speed on the soil fragmentation was not significant in 2004 in comparison with the three particle size groups. However, statistically significant differences were found between tractor forward speeds in 2005 (Table 3). In 2005, as the forward speed increased, the amount of particle size smaller than 1 mm decreased and the amount of 1-8 mm size increased. In 2004, the soil moisture content was approximately 20% lower than 2005. It is expected that lower soil moisture content caused tractor forward speed not affect soil particle size distribution as 2005.

The soil bulk density of experiment area varied between 1.0 - 1.21 Mg m^{-3} (Table 4). A relative reduction occurred in the bulk density of upper soil layer which was loosened as a result of tillage. Although the soil bulk density did not change with strip width, the increase in tractor forward speed generally caused an increase in the bulk density. The values of soil moisture content measured one day after the soil tillage are seen in Table 5. Soil moisture content in tillage depth varied between 15.1 and 25.1%. Although it was not statistically significant, the soil was fragmented less with the increase in tractor forward speed. Increase in tractor forward speed increased soil particle size and as a result of this, soil moisture loss increased. Soil moisture content in the seedbed depth increased in proportion to the tractor forward speed.

The penetration resistance of tilled soil in terms of years, strip width and tractor forward speed is given in Figure 1. As it is expected, while there was not an effect of strip width on penetration resistance, there occurred an increase in the penetration resistance values as in the bulk density when tractor forward speed increased. It was found that while the penetration resistance data in 2005 were lower than in 2004 at top 5 cm depth, they were higher in the values after 5 cm. As the measurement depth increased, the penetration resistance also increased.

One of the important aims of tilling soils in strips is to conserve soil moisture and to make the seedbed warm enough for germination. In 10 days after the seeding, along with the beginning of the seedling emergences, soil moisture and temperature

Table 3-Distribution of soil particles

Çizelge 3-Toprak parçacıklarının dağılımı

Treatments		2004 - Particle diameter			2005 - Particle diameter		
		<1 mm	1-8 mm	>8	<1 mm	1-8 mm	>8
Strip width	SW1[a]	24.8b[d]	45.8a	29.4a	33.2a	31.5a	35.3a
	SW2	32.3a	41.6a	26.2a	34.1a	31.3a	34.6a
	SW3	28.5ab	42.2a	29.2a	33.0a	31.6a	35.4a
	P	0.048	0.610	0.724	0.144	0.910	0.423
Tractor forward speed	FV1[b]	30.5a	39.6a	30.0a	38.6a	34.1a	27.3c
	FV2	25.3a	45.4a	29.3a	31.9b	31.4b	36.7b
	FV3	29.8a	44.6a	25.6a	29.8c	28.9c	41.3a
	P	0.165	0.389	0.596	0.000	0.000	0.000
SEM[c]		1.260	1.840	1.750	0.768	0.477	1.160

[a] SW1=22.5 cm, SW2=30 cm and SW3=37.5 cm
[b] FV1=1.8 km h^{-1}, FV2=3.6 km h^{-1} and FV3=5.4 km h^{-1}
[c] SEM: Standard error of means
[d] Means within the same column followed by the same letter are not significantly different at α = 0.05 (LSD test)

Table 4-Values of soil bulk density

Çizelge 4-Toprak hacim ağırlığı değerleri

Treatments		2004		2005	
		Depth (0-5 cm)	Depth (5-10 cm)	Depth (0-5 cm)	Depth (5-10 cm)
Strip width	SW1[a]	1.01a[d]	1.03b	1.07a	1.13a
	SW2	1.04a	1.02b	1.09a	1.13a
	SW3	1.09a	1.13a	1.09a	1.13a
	P	0.370	0.006	0.933	0.966
Tractor forward speed	FV1[b]	1.05a	1.05a	1.04a	1.06c
	FV2	1.08a	1.07a	1.10a	1.13 b
	FV3	1.00a	1.07a	1.11a	1.21a
	P	0.320	0.718	0.337	0.000
SEM[c]		0.023	0.018	0.020	0.015

[a] SW1=22.5 cm, SW2=30 cm and SW3=37.5 cm
[b] FV1=1.8 km h^{-1}, FV2=3.6 km h^{-1} and FV3=5.4 km h^{-1}
[c] SEM: Standard error of means
[d] Means within the same column followed by the same letter are not significantly different at α = 0.05 (LSD test)

Table 5-Soil moisture content values

Çizelge 5-Toprak nem içeriği değerleri

Treatments		2004		2005	
		Depth (0-5 cm)	Depth (5-10 cm)	Depth (0-5 cm)	Depth (5-10 cm)
Strip width	SW1[a]	19.8ab[d]	18.7a	23.9a	25.1a
	SW	23.1a	19.3a	22.9a	24.0a
	SW3	15.1b	15.6a	21.6a	22.7a
	P	0.025	0.137	0.109	0.196
Tractor forward speed	FV1[b]	17.8a	18.1a	23.1a	24.7a
	FV2	19.6a	19.9a	22.9a	24.0a
	FV3	20.5a	15.7a	22.5a	23.2a
	P	0.607	0.118	0.857	0.516
SEM [c]		1.230	0.880	0.475	0.530

[a] SW1=22.5 cm, SW2=30 cm and SW3=37.5 cm
[b] FV1=1.8 km h^{-1}, FV2=3.6 km h^{-1} and FV3=5.4 km h^{-1}
[c] SEM: Standard error of means
[d] Means within the same column followed by the same letter are not significantly different at α = 0.05 (LSD test)

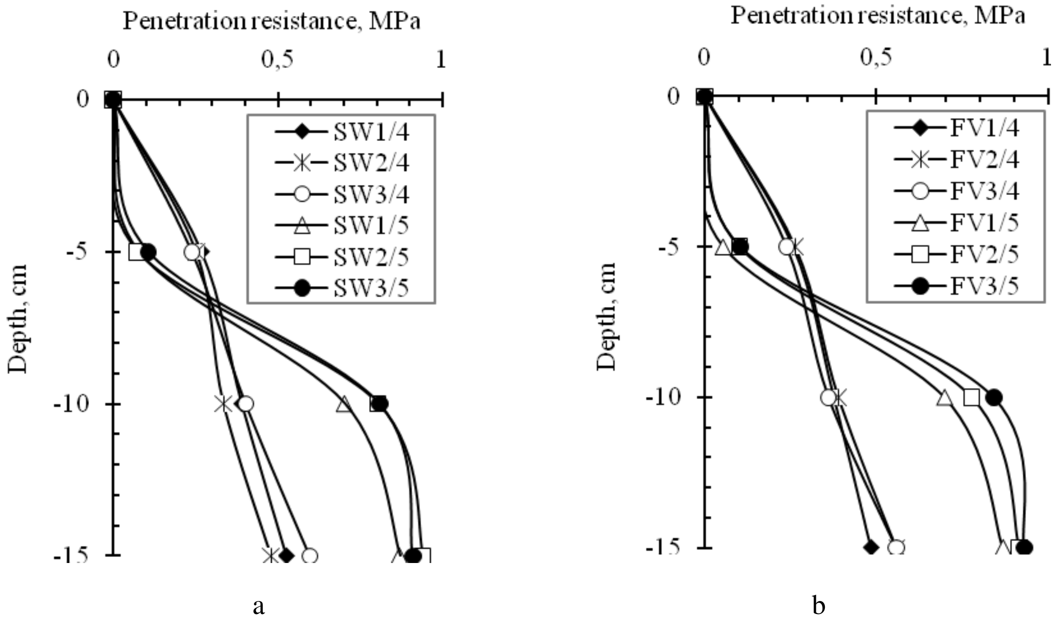

Figure 1-Penetration resistance values in terms of a) strip width, b) tractor forward speed (SW1=22.5 cm, SW2=30 cm and SW3=37.5 cm, and FV1=1.8 km h^{-1}, FV2=3.6 km h^{-1} and FV3=5.4 km h^{-1})

Şekil 1-a)Şerit genişliği, b) traktör ilerleme hızına göre penetrasyon direnci değerleri

measurements were conducted periodically. The data obtained from the first measurement are given in Figures 2 &3. In the study in which soil moisture content of year of 2004 was determined to be lower, the strip width appeared to have a statistically significant effect on moisture content. As the strip width increased, the moisture loss also increased with evaporation from the soil. As a consequence, soil moisture content was conserved in relatively narrower strips. It is evident that as the strip width got reduced, it could be possible to reach the advantages of no-till. Because soil fragmentation was reduced by increasing tractor forward speed, it became difficult to conserve soil moisture in seedbed which was made up of bigger soil particles. As a result of the increases of tractor forward speed in both 2004 and 2005, the soil moisture content decreased. Results obtained from many studies have reported that by reduced soil tillage, plant residues left at the surface can conserve soil moisture. The results obtained from these studies have shown that strip tillage could be as effective in conserving soil moisture as no-till (Licht & Al-Kaisi 2005).

As the soil is tilled, the pass of air temperature to tillage layer gets easier. For this reason, temperature values measured in tilled strips were found to be 1-2°C more than in no-till. Soil temperature values of 2004 year were found to be significantly different from 2005. As strip width increased in 2004, the temperature at top soil layer increased significantly. Although this increase tendency was not considered to be statistically significant, it appeared in 2005 data too (Figure 3). Although the increase in tractor forward speed was not statistically significant for seedbed temperature in both 2004 and 2005, it caused an increase. These bigger soil particles obtained from tractor speed increase made it easier for the warmed air to pass to soil.

The analytical results and averages of data about average emergence time, emergence rate index, seedling emergence, silage production, and plant height are given in Table 6. In analysis in which years are considered as factors, the effect of the years is found to be statistically significant in all parameters except emergence rate index. The year 2005 resulted in getting more productive results than the year 2004 in terms of emergence and yield.

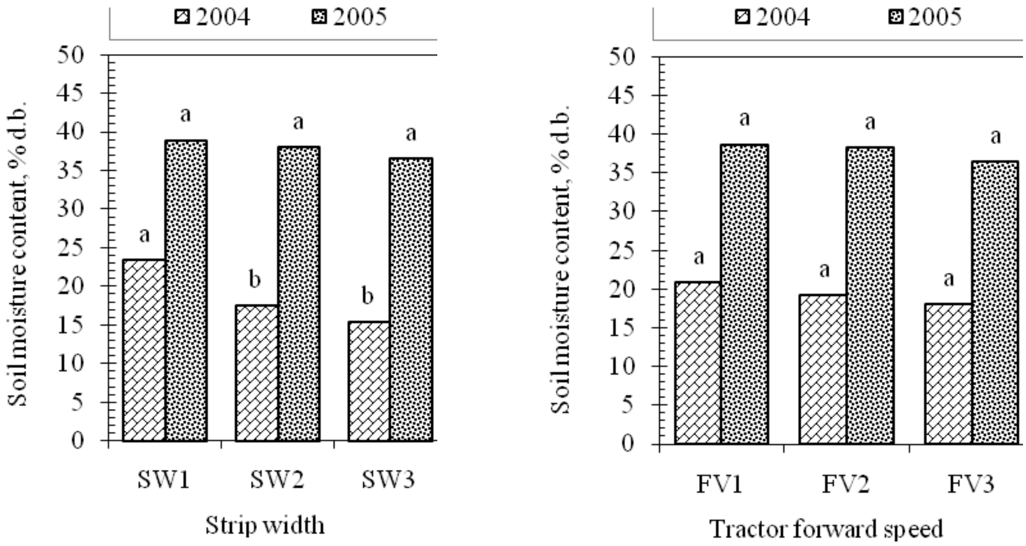

Figure 2-Soil moisture content in terms of strip width and tractor forward speed in 10 days after the seeding (SW1=22.5 cm, SW2=30 cm and SW3=37.5 cm, and FV1=1.8 km h^{-1}, FV2=3.6 km h^{-1} and FV3=5.4 km h^{-1})

Şekil 2-Ekimden 10 gün sonra şerit genişliği ve traktör ilerleme hızına göre toprak nem içeriği değerleri

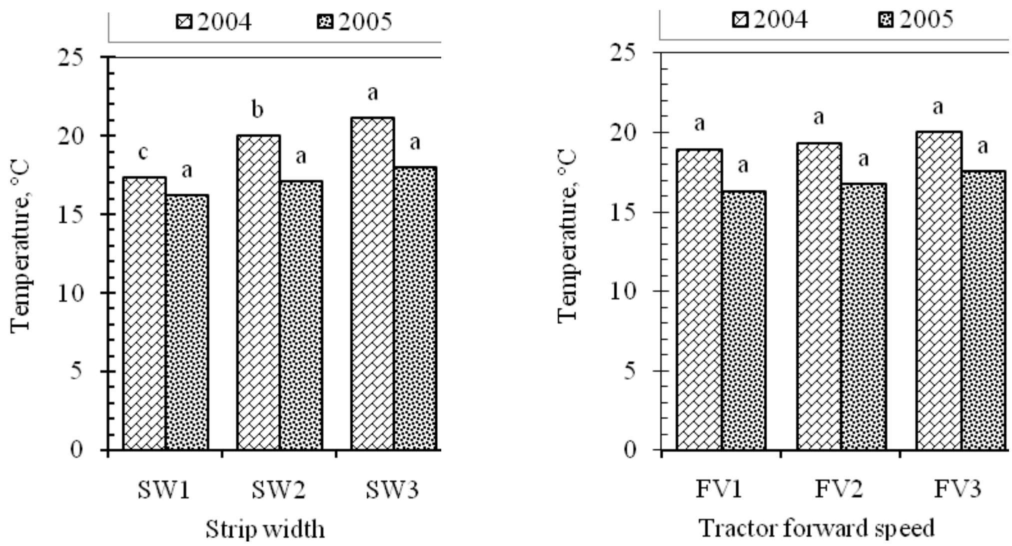

Figure 3-The seedbed temperature in terms of strip width and tractor forward speed in 10 days after the seeding (SW1=22.5 cm, SW2=30 cm and SW3=37.5 cm, and FV1=1.8 km h^{-1}, FV2=3.6 km h^{-1} and FV3=5.4 km h^{-1})

Şekil 3-Ekimden 10 gün sonra şerit genişliği ve traktör ilerleme hızına göre tohum yatağı sıcaklığı değerleri

Table 6-Variance analysis of average emergence time (MET), emergence rate index (ERI), seedling emergence (PE), silage yield (SY), plant height (PH) and the results of mean comparisons

Çizelge 6-Ortalama çıkış süresi (MET), çıkış oranı indeksi (ERI), tarla filizi çıkış derecesi (PE), silaj verimi (SY), bitki boyu (PH) ve ortalamalara ilişkin çoklu karşılaştırma sonuçları

Treatments	*DF*	*MET, day*	*ERI, number (m day)$^{-1}$*	*PE, %*	*SY, t ha^{-1}*	*PH, cm*
Years (Y)						
2004	27	15.9a[d]	1.43	63.4b	33.0b	133b
2005	27	13.3b	1.33	73.4a	56.9a	224a
Strip width (SW)						
SW1[a]	18	14.7a	1.23b	61.2b	46.5a	175a
SW2	18	14.6b	1.37ab	68.0ab	44.0a	182a
SW3	18	14.5c	1.54a	76.1a	44.3a	179a
Tractor Speed (FV)						
FV1[b]	18	14.6a	1.42a	69.7a	44.8a	178a
FV2	18	14.6a	1.30a	65.0a	45.8a	181a
FV3	18	14.6a	1.42a	70.4a	44.2a	178a
SEM[c]		0.182	0.042	2.140	0.205	6.640
Analysis of Variance						
Years	1	***	ns	***	***	***
		0.000	0.150	0.006	0.000	0.000
Strip width	2	***	***	***	ns	ns
		0.000	0.005	0.005	0.754	0.481
Tractor speed	2	ns	ns	ns	ns	ns
		0.138	0.295	0.384	0.896	0.849
*Y*SW*	9	*	ns	*	ns	ns
		0.093	0.202	0.082	0.783	0.257
*Y*FV*	9	ns	*	*	ns	ns
		0.830	0.057	0.070	0.896	0.849
*SW*FV*	6	ns	ns	ns	ns	ns
		0.761	0.856	0.857	0.994	0.889
*Y*SW*FV*	3	ns	*	*	ns	ns
		0.968	0.066	0.065	0.994	0.889

[a] SW1=22.5 cm, SW2=30 cm and SW3=37.5 cm
[b] FV1=1.8 km h^{-1}, FV2=3.6 km h^{-1} and FV3=5.4 km h^{-1}
[c] SEM: Standard error of means
[d] Means within the same column followed by the same letter are not significantly different at $\alpha = 0.05$ (LSD test)
*: $P<0.1$; **: $P<0.05$; ***: $P<0.01$: ns: not significant

It can be said that the amount of rainfall in May-September periods containing the processes of seeding and harvesting, the rainfall in 2005 was about 30% more than in 2004 and that the current rainfall ranged appropriately in months had an effect on the seedling emergence and plant growth (Table 6). It was found that the average emergence time was shorter in 2005, seedling emergence rate was higher and to be parallel with this, silage yield was significantly higher. In the lights of the results obtained from the study, it can be stated that if the climate conditions are suitable in strip tillage period, the emergence time can be shorter and the emergence rate and yield can be higher.

It was reported that strip width had a statistically significant effect on seedling emergence. As the strip width increased, the average emergence time decreased. It can also be understood here that as parallel to the increase of the seedbed temperature with the strip width in germination period, the emergence time also gets shorter. Although the average emergence time got shorter, there occurred an increase in the emergence rate index and seedling emergence values. It can also be said that with the increase of strip width, the environment needed for the seed to germinate became better. However, this condition which appeared in plant emergence could not be observed in silage yield.

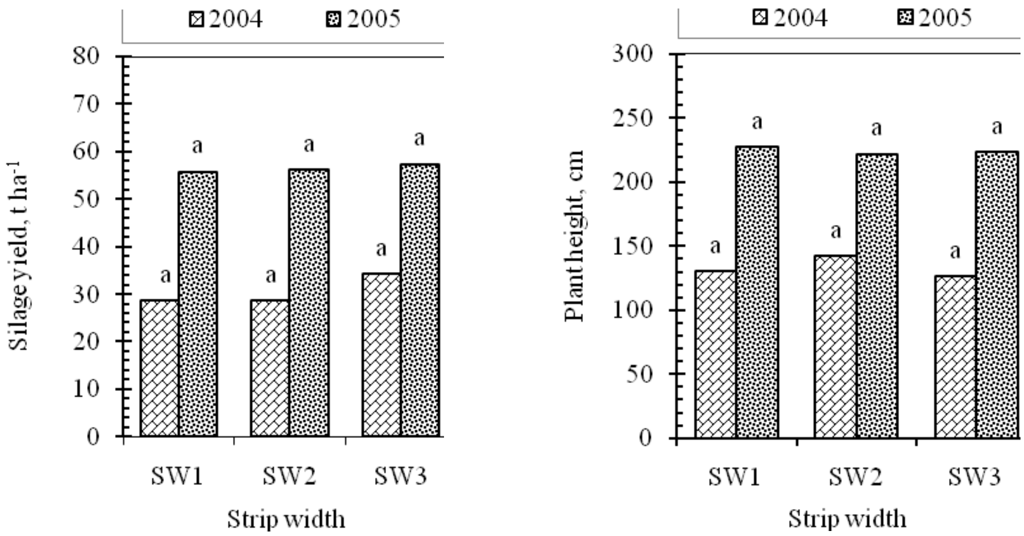

Figure 4-Silage yield and the change of plant height with strip width (SW1=22.5 cm, SW2=30 cm and SW3=37.5 cm)
Şekil 4-Bitki boyu ve silaj veriminin şerit genişliğine göre değişimi

and plant height. It was specified that tractor forward speed did not have a significant effect on the parameters such as seedling emergence and silage yield (Table 6).

The average emergence time, emergence rate index, seedling emergence, silage yield, and change of plant height with strip width in years are given in Figure 4 and Table 6. The average emergence time was affected significantly in terms of strip width, and as the strip width increased, the emergence time decreased. The effect of strip width on seedling emergence was found not to be significant in 2004, but it was found to be very significant in 2005. The increase of strip width increased the seedling emergence too. Plant height and silage yield were not affected by strip width. As the strip width increased in years, there occurred an increase in silage yield.

4. Conclusion

According to obtained results from the study, as the strip width increased, there resulted in an increase in soil temperature. However, because of the increase of the tilled soil surface, evaporation increased, and as a result of this, the soil moisture could not be conserved. While seedling emergence, plant height and silage yield increased as the strip width increased, the average emergence time decreased. In widely tilled strips, there occurred a reduction in the average germination time and an increase in the germination percentage. However, it was reported that strip width did not have a statistically significant effect on silage yield as it did in the germination. Tractor forward speed became an effective on soil fragmentation and as a result of this; there occurred a reduction in the distribution of smaller soil particles with the increase of the speed. Apart from this, it appeared that the speed did not have a statistically significant effect on other parameters.

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