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The effects of different plant densities and silage corn varieties on silage yield and some yield parameters in no-till seeding

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Abstract: In this study, the possibility of growing silage corn, which is used as an important nutrient in livestock and whose production is increasing in recent years, by no-till seeding method under Erzurum conditions was investigated. For this purpose, three silage corn varieties (DKC-5783, Prestige, and ADA-9510) suitable for Erzurum's climatic conditions in terms of vegetation period were selected from a large number of silage corn seeds widely grown throughout Turkey and their development conditions under no-till seeding conditions were investigated. A precision vacuum no-till seeder with double disk type furrow opener was used for silage corn seeding. Based on three different intrarow seed spacings (10, 15, and 20 cm), physical properties of soil, plant emergence, yield, and yield parameters as well as the planting performance of the machine were examined. According to the results obtained from the study, it was determined that mean emergence time decreased and seedling emergence increased as intrarow seed spacing increased. Furthermore, it was also found that DKC-5783 had the best emergence time, the best seedling emergence percentage, and the highest emergence rate index. Where yield decreased as intrarow spacing increased, ADA-9510 had the highest yield among varieties. Generally, intrarow seed spacing of 20 cm and DKC-5783 and ADA-9510 gave the best results.

Key words: Direct seeding, intrarow seed spacing, pneumatic no-till seeder, silage corn

1. Introduction

Increasingly sensitivity to the protection of soil and water resources nowadays and the demand to reduce costs obligated the use of alternative production ways in agriculture. As a result of these searches, conservation tillage as an alternative to conventional tillage and the use of devices and machines used for this purposes have become increasingly important (Çelik, 2009). Conservation tillage is an application in which the soil surface is covered with at least 30% residue of pre-plant after seeding in order to prevent water and wind erosion as well as soil moisture loss (ASABE, 2013). The soil is better conditioned by organic residues left on the untilled surface for erosion control, soil moisture conservation, and infiltration (Chen et al., 2004a; Van Oost et al., 2009; Liu et al., 2010).

The consumption rate of corn that was consumed as a human food by being grown mostly for the purpose of grain production is increasing gradually in animal feeding based on the level of development of the countries. Corn has a great importance as silage, besides its importance in animal feeding as a grain. Corn is one of the most important forages, both as green (harvested) and as silage (Gençtürk, 2007). Different methods are applied in the world for tillage in corn agriculture. The main ones are conventional tillage, mulch system, tillage using ditch openers, minimum tillage, and no-till methods. The preparation process of a seedbed with conventional tillage may be prolonged due to the climatic conditions and so the seeding is delayed. Short vegetation period in some regions and consequently the delay in seeding affect plant development negatively. In direct seeding, there is a significant decrease in soil compaction, labor, time, fuel consumption, and correspondingly cost with the reduction in the number of field transitions (Tebrugge and Bohrnsen, 2000; Chen et al., 2004b; Linke, 2006; Sarauskis et al., 2009). In the studies comparing different tillage methods to direct seeding in silage corn agriculture, it was reported that direct seeding had better results for fuel economy, characteristics of plant emergence, silage yield, and some yield parameters (Lithourgidis et al., 2005; Bayhan et al., 2006; Yalcin and Cakir, 2006; Altuntaş and Dede, 2007).

Plant density, seeding time, harvesting time, and varieties as well as climate and soil factors have significant

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effects on the yield and yield parameters (dry matter yield, crude protein yield, etc.) in silage corn (Cusicanqui and Lauer, 1999). In studies conducted by Sencar et al. (1993) under different ecological conditions, it was determined that plant height, stem diameter, and ear yield decreased and silage and dry matter yield increased as intrarow plant spacing increased. Subedi et al. (2006) found that silage yield increased due to the increase in plant density, while Budaklı Çarpıcı et al. (2010) found that dry matter yield, stem ratio, and acid-detergent fiber (ADF) increased as plant density increased.

The aim of the present study was to determine the effects of different silage corn varieties and intrarow seed spacings on plant emergence, silage yield, and some yield parameters by using direct seeding.

2. Materials and methods

This research was conducted in the field of production at the Directorate of Agricultural Research and Publication Center of the Faculty of Agriculture, Atatürk University, under wheat stubble field conditions in 2013–2014. Table 1 shows mean monthly rainfall, temperature, and relative moisture values of the vegetation period for the years 2013–2014 and for long years average in the research area. The study was conducted on three different varieties of silage corn suitable for Erzurum's climatic conditions (Table 1) and geographic location (39°54′N and 40°13′E, altitude 1883 m). Silage corn seeding was carried out under the conditions of wheat stubble fields harvested by harvester. Table 2 shows some physical properties of the research area and information on stubble height, stubble coverage rate of field surface, and stubble density.

In this study where direct seeding facilities of silage corn were investigated under Erzurum conditions, three corn varieties and three different intrarow seed spacings were taken into consideration.

The study was conducted as four replications according to the randomized complete blocks experimental

Table 1. Mean monthly temperature, relative humidity, and total rainfall values of the vegetation period for the years 2013–2014 and for long years average in the research area (TSMS, 2016).

Months	Temperature (°C)			Rainfall (mm)			Relative humidity (%)		
	2013	2014	L. term	2013	2014	L. term	2013	2014	L. term
May	11.6	11.7	10.5	32.3	115.9	65.3	63.5	65.3	63.9
June	15.0	15.9	14.8	25.1	24.5	41.2	57.2	50.6	59.1
July	19.4	21.2	19.1	7.8	44.7	23.8	50.4	43.9	53.6
Aug	19.5	22.2	19.3	5.2	4.2	14.4	45.7	37.2	50.2
Sep	13.6	15.7	13.9	15.0	47.7	19.8	49.8	48.3	52.5
Mean/Tot.	15.8	17.3	15.5	85.4	237.0	164.5	53.3	49.1	55.8

Table 2. Some physical properties of experimental area soil.

Soil physical properties	2013		2014	
	0–5 cm	5–10 cm	0–5 cm	5–10 cm
Soil bulk density (g/cm^3)	1.13	1.17	1.20	1.21
Porosity (%)	57.46	56.03	54.69	54.36
Moisture content (%, d.b.)	14.55	17.81	14.23	16.06
Penetration resistance (MPa)	1.17	1.71	1.10	1.18
Intrarow spacing soil temperature (3–8 cm depth: °C)	19.06		22.5	
Row spacing soil temperature (3–8 cm depth: °C)	19.83		25.2	
Average stubble height (cm)	13		19	
Field surface stubble covering rate (%)	71		80	
Stubble density (kg/ha)	3733		3248	
Soil texture class	(52% silt, 27% clay, and 21% sand) Silt loam			

design. Seeding was carried out so that the length of the experimental plots would be 30 m and the width would be 3 m. During the preliminary evaluation conducted in the research, the seed varieties DKC-5783 (FAO 550-medium early), Prestige (FAO 500-early), and ADA-9510 (FAO 650-medium late) and intrarow spacings 10, 15, and 20 cm were used.

Considering the seeding method, field conditions, plant variety, and seeding time, seeding depth was taken into account as 50 mm and row spacing was considered as 70 cm for silage corn. In both years of the experiment, seeding was carried out in the second week of May and harvesting of corn as silage was performed in the second week of September for both production seasons; 150 kg/ha ammonium sulfate (21% N and 24% S) and 150 kg/ha 15-15-15 fertilizer were given with the seeding. Seeding was carried out at a real tractor forward speed of 5.4 km/h. After seeding, glyphosate spraying was carried out by using a field sprayer and total herbicide, of which the effective substance is glyphosate. During the experiment in which the first irrigation was performed when the plant height was 15–20 cm, irrigation was carried out four times with three-week intervals during the growth period. For no-till seeding of corn, a precision vacuum seeder with double disc type furrow opener was used. A New Holland TD75D tractor (55 kW at 1400 rpm) was used to pull the seeder. During seeding, soil-sampling cylinders of 50 mm in diameter and 50 mm in height were used in the determination of soil bulk density for 0–10 cm and moisture contents (Demiralay, 1993; Celik and Raper, 2012). The soil samples taken from the experimental area as 4 replications were left to dry in a drying oven at 105 °C for 24 h. The soil bulk density, porosity, and moisture content values were calculated considering sample dry weights. A soil penetrometer with an analogue display having a cone tip angle of 60° was used to determine the soil penetration resistance (Çelik, 1998). Penetration resistance measurements made in four replications from each plot were carried out at 0–20 cm depth and 5 cm ranges.

During the germination period, two replicated measurements were carried out in each plot using a digital-type soil thermometer to determine the temperature change of the seedbed and a TDR-type soil moisture meter to determine soil moisture content. Figure 1 shows seedbed moisture content at 0–10 cm depth and temperature data during the germination period. During the germination period, the experimental area was kept under control to determine seedling emergence.

At the beginning of plant emergence, random furrows were selected from each plot and counts were performed to be two replications of 5 m in length. Counting of plant emergence was performed every two days until the end of the emergence. Based on the values obtained by counting, values of mean emergence time (MET), emergence rate index (ERI), and percentage of emergence (PE) were calculated using the following equations (Bilbro and Wanjura, 1982; Karayel and Ozmerzi, 2002; Celik et al., 2013):

$$MET = (N_1 \times T_1 + N_2 \times T_2 + \ldots\ldots\ldots + N_n \times T_n)/N_1 + N_2 + \ldots\ldots N_n$$

$$ERI = STE/MET$$

$$PE = (STE/n) \times 100,$$

where *MET* is mean emergence time (day), *ERI* is the emergence rate index (seedlings number/m × day), *PE* is the percentage of emergence (%), N1…n is the number of seedlings emerging since the time of previous count, T1...n is the number of days after seeding, *STE* is the number of total emerged seedlings per meter, and n is the number of seeds sown per meter.

Silage yield and some yield parameters of silage corn were examined. For the determination of silage yield, plants harvested at a height of 10 cm from the soil surface within a 5-m long area after 2 m on each side were left in the middle

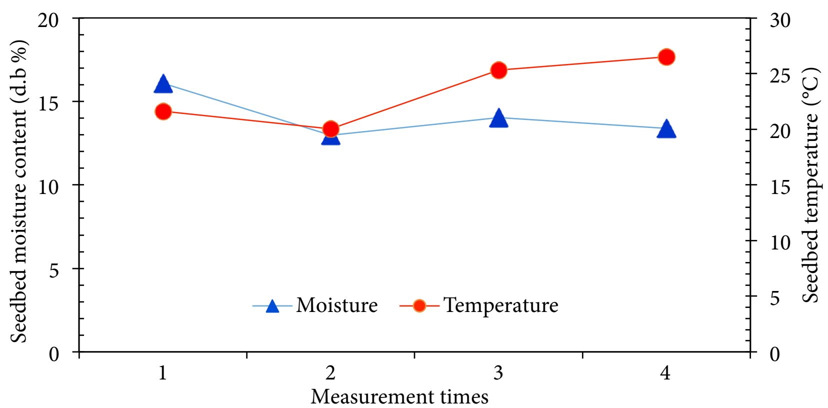

Figure 1. Seed bed moisture content at 0–10 cm depth and soil temperature change during seed germination period.

of each plot were weighed and a wet weight was found for each plot. Silage yield was calculated as kg/ha from wet weight values found. During the harvesting, various plant characteristics were obtained from 10 different plants randomized from each plot. For this purpose, mean plant height (cm) was determined by measuring heights of these plants, number of ears per plant (number/plant), by separating counted ear from stem and by weighing, and measuring ear weight (g/plant) and stem diameter (mm), the part between first and second internodes of plants from soil surface. Dry matter rate, dry matter yield, crude protein ratio, and crude protein yield parameters were investigated to determine matter quality in silage corn. In order to determine the dry matter rate (%), the wet weights of three plant samples taken from each plot during harvesting were determined and they were firstly dried in the open air, then they were degraded and dried for 48 h in a drying oven at 65 °C; consequently dry matter content (%) was found (Duman, 2007). Dry matter yields (kg/ha) were determined by comparing the dry matter rates obtained from the experimental plots to the silage yields. Plant samples taken from each plot were dried and ground in a grinding machine with a 1-mm sieve and total nitrogen was determined by DUMAS method. The obtained values were multiplied by a coefficient of 6.25 and percentage of crude protein was found based on dry matter (Sarı, 2015). Plant crude protein yield was calculated by multiplying crude protein ratio and dry matter yield, and the obtained values were recorded as kg/ha.

Variance analysis was performed to determine the effects of different silage corn varieties to be evaluated and intrarow spacing on plant emergence, plant yield, and yield parameters. Furthermore, means comparison tests were performed at the significance level with the help of SPSS ($P < 0.05$) in order to determine the differences between averages.

3. Results and discussion

3.1. Seed emergence

In the study conducted using a precision vacuum seeder-type no-till seeder with two-disc type furrow openers and three intrarow seed spacings and three silage corn varieties, data on seedling emergences, yield, and yield parameters of silage corn were obtained and evaluated. The emergences at different intrarow silage corn varieties spacing after seeding were observed. Accordingly, Table 3 shows the results of variance analysis and means comparison tests for emergence time, emergence rate index, and percentage of emergence. According to the results obtained, the effects of different intrarow spacing and different varieties on mean emergence time were found to be statistically insignificant. According to intrarow spacing, mean emergence time ranged from 14.6 days to 16.1 days. When evaluated according to the varieties, it was determined that DKC-5783 had a better mean emergence time than the other varieties with 14.8 and 15.7 days in every 2 years. At the time of mean emergence, DKC-5783 was followed by Prestige and ADA-9510. From the mean emergence time, emergence rate index was calculated and the obtained results are given in Table 3. In general, in the study where values in 2014 was lower than in 2013, the effect of intrarow spacing on emergence rate index was found to be statistically significant in 2014, while the effect of the varieties was statistically significant in both years.

Table 3. Analysis of variance (P values) and means comparisons of emergence time (MET), emergence rate index (ERI), and percentage of emergence (PE).

Treatments		MET (day)		ERI (number/m×day)		PE (%)	
		2013	2014	2013	2014	2013	2014
Intrarow spacing	S1[a]	15.5	16.1	0.60	0.43a	87.3	84.0b
	S2	15.4	15.7	0.57	0.32b	84.8	90.4a
	S3	14.6	15.9	0.63	0.24c	87.0	91.9a
	P	0.079	0.846	0.153	0.000	0.638	0.002
Variety	V1[b]	14.8	15.7	0.88a	0.37a[c]	90.9a	94.7a
	V2	15.1	15.9	0.52b	0.34a	81.7b	92.6a
	V3	15.5	16.3	0.40c	0.28b	86.5ab	79.0b
	P	0.257	0.240	0.000	0.000	0.014	0.000

[a] S1 = 10 cm, S2 = 15 cm, S3 = 20 cm
[b] V1 = DKC-5783, V2 = Prestige, V3 = ADA-9510
[c] Means within the same column with the same letter are not significantly different.

DKC-5783 had the highest emergence rate index with 0.88 and 0.37 number/m × day, respectively, by years. The effect of different intrarow spacing and seed varieties on seedling emergence (except intrarow spacing values in 2013) was statistically significant ($P < 0.01$). Accordingly, seedling emergence had better results at 10-cm intrarow spacing in 2013 and 20-cm intrarow spacing in 2014. In both years, the difference between the varieties was statistically significant and DKC-5783 had the best emergence percentage with 90.9% and 94.7%, respectively (Table 3). Altuntaş and Dede (2007) found that mean emergence time was 12.81 days in reduced tillage implementation of the second plant corn, emergence rate index was 0.344/m × day, and percentage of emergence rate was 88.34%. Bayhan et al. (2006) reported that no-till seeding had better results for mean emergence time and percentage of emergence when different tillage methods and no-till seeding in corn silage were compared.

3.2. Silage yield and plant height

Figure 2 shows the results of variance analysis and multiple comparison tests on silage yield. According to these results, the effects of intrarow seed spacing and seed varieties on silage yield were statistically significant in both years ($P < 0.01$). The highest yield was 41,952 kg/ha at 20-cm intrarow spacing in 2013 and 51,550 kg/ha at 10-cm intrarow spacing in 2014. Among the varieties, the highest yield was 41,620 kg/ha in Prestige in 2013 and 52,500 kg/ha in ADA-9510 in 2014. The yield of silage in 2013 was lower than in 2014 due to early autumn frost on September 6. The yield of silage can vary depending on silage corn variety, seeding time, and ecological conditions (weather, soil, water, plant, macro- and microorganisms, etc.). Silage yields of different silage corn seeds under Erzurum conditions were determined as 63,209–68,111 kg/ha (Öztürk and Akkaya, 1996), 50,380–74,270 kg/ha (Güney et al., 2010), and 51,063–58,602 kg/ha (Öztürk et al., 2008) in different plant densities.

Figure 3 shows the results of variance analysis and multiple comparison tests for plant heights. According to the evaluations made about plant height, the effect of intrarow spacing on plant height was statistically insignificant in both years, while the effect of silage corn varieties on plant height was significant ($P < 0.01$). Turgut et al. (2005), Iptas and Acar (2006), Azam et al. (2007), and Yılmaz et al. (2007) found that effects of plant density on plant height were statistically insignificant. According to the intrarow spacing, mean plant heights were found to be between 159.3 cm and 219.0 cm. Yalcin and Cakir (2006) found mean plant height as 210.4 cm in the no-till seeding of the second plant silage corn. The highest plant height was 173.6 cm in Prestige in 2013 and 234.0 cm in ADA-9510 in 2014 (Figure 3). According to the average of the 2 years, it was determined that the plant height increased and ADA-9510 had a better height average than the other varieties as intrarow spacing increased.

3.3. Stem diameter, ear number, and weight

Table 4 shows the results of variance analysis and mean comparison tests for the values of plant stem diameter, number of ears, and ear weight. According to the results obtained for plant stem diameter, the effect of intrarow spacing on stem diameter was statistically significant ($P < 0.01$) in 2013 and 2014. According to these results, the increase in intrarow spacing led to the growth of plant habitat and thus increase in stem diameter. For this reason, the best stem diameter values were determined at 20-cm intrarow spacing. Accordingly, the stem diameter was determined as 30.0 mm at 20-cm intrarow spacing in 2013 and 25.9 mm in 2014. The effects of varieties on stem diameter were statistically insignificant in 2013, but they were significant in 2014 ($P < 0.01$). ADA-9510 had the

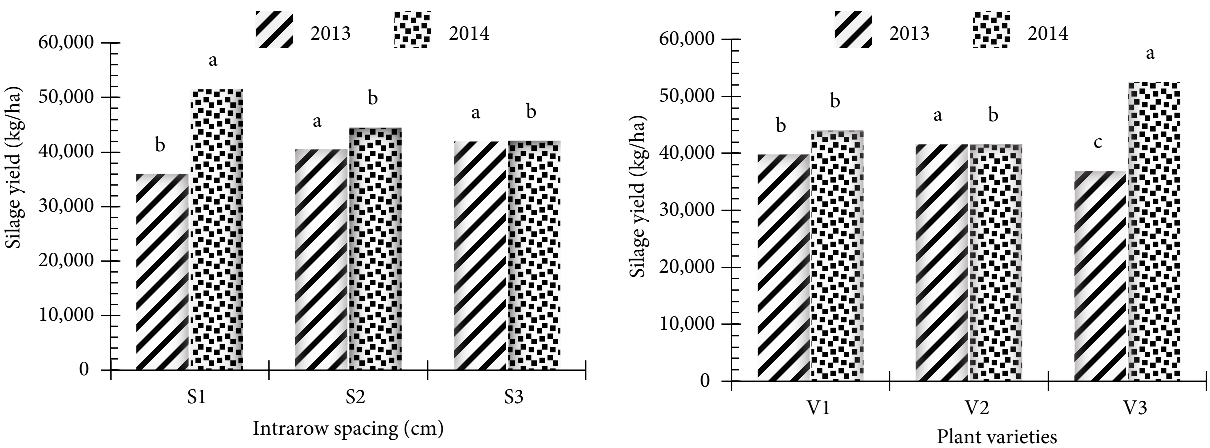

Figure 2. The effects of intrarow spacing and silage corn variety on silage yield (S1 = 10 cm, S2 = 15 cm, S3 = 20 cm, V1 = DKC-5783, V2 = Prestige, V3 = ADA-9510).

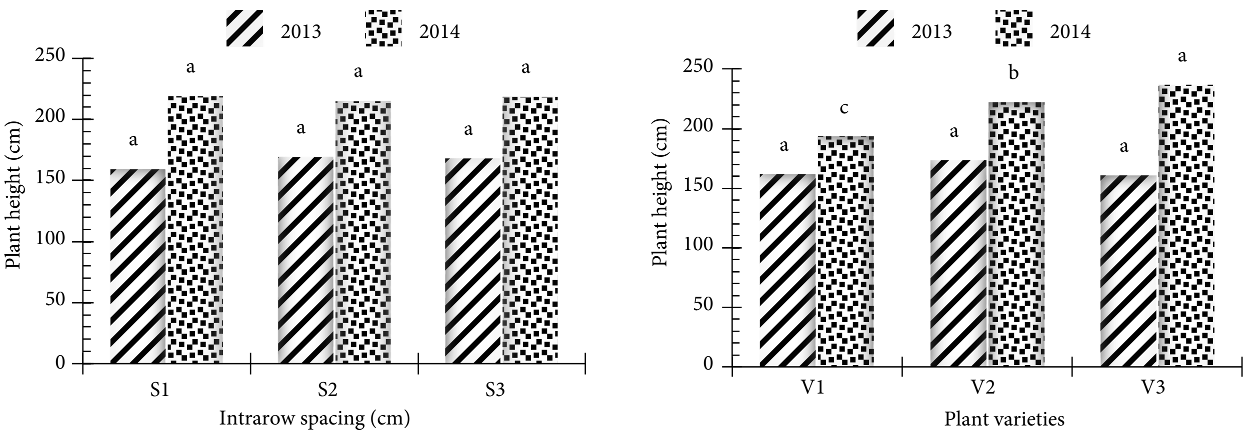

Figure 3. The effects of intrarow spacing and silage corn variety on plant height (S1 = 10 cm, S2 = 15 cm, S3 = 20 cm, V1 = DKC-5783, V2 = Prestige, V3 = ADA-9510).

Table 4. Analysis of variance (P values) and means comparisons of plant stem diameter, number of ears, and weight of ears.

Treatments		Plant stem diameter (mm)		Ear number (number/plant)		Ear weight (g/plant)	
		2013	2014	2013	2014	2013	2014
Intrarow spacing	S1[a]	27.2b	22.5b[c]	1.2	1.1b	137.2b	191.9b
	S2	29.6a	23.2b	1.4	1.2b	186.2a	210.1ab
	S3	30.0a	25.9a	1.4	1.5a	214.7a	230.3a
	P	0.007	0.000	0.317	0.000	0.010	0.016
Variety	V1[b]	29.2	22.9b	1.3	1.2	194.2	204.8
	V2	28.3	22.6b	1.4	1.3	193.3	202.2
	V3	29.3	26.2a	1.4	1.4	150.6	225.3
	P	0.475	0.000	0.907	0.213	0.130	0.142

[a] S1 = 10 cm, S2 = 15 cm, S3 = 20 cm
[b] V1 = DKC-5783, V2 = Prestige, V3 = ADA-9510
[c] Means within the same column with the same letter are not significantly different.

best results with stem diameter of 29.3 mm and 26.2 mm respectively by years (Table 4). In studies conducted in different regions, researchers found plant stem diameters of 25.37–31.32 mm (Olgun, 2011) and 20.05–24.54 mm (Kuşvuran et al., 2015).

The effects of intrarow spacing on the number of ears per plant were statistically significant in 2014 (Table 4). Here, the highest value was an average of 1.5 number/plant ear at 20-cm intrarow spacing in 2014. Öztürk et al. (2008) determined the number of ears as 1.2–1.4 number/plant in different plant densities. The effect of varieties on the number of ear per plant was found to be insignificant. Accordingly, it was determined that the number of ear per plant was between 1.2 and 1.4 number/plant (Table 4). In the study conducted under the conditions of Erzurum, Gençtürk (2007) obtained close values to this study with 0.6–1.6 number/plant for the number of ears in different silage corn varieties.

The effect of intrarow spacing on ear weight per plant was statistically significant in both years ($P < 0.01$). According to these results, the increase in intrarow seed spacing increased the ear weight. Accordingly, the best ear weights were 214.7 and 230.3 g/plant, respectively, at 20-cm intrarow spacing. Zeidan et al. (2006) reported that ear weight per plant increased due to the increase in the intrarow spacing and that the obtained values varied between 178.3 and 243.3 g. While the effects of varieties on ear weight were insignificant, DKC-5783 had the best results with 194.2 g/plant in 2013 and ADA-9510 with 225.3 g/plant in 2014 (Table 4).

3.4. Dry matter rate

In order to determine the effects of the factors emphasized in the study on the dry matter rate on the plants, the plant samples taken from each plot were dried and their dry matter ratios were determined and the results of variance analysis and multiple comparison tests for these values are given in Figure 4. According to the results of the variance analysis, the effect of intrarow spacing on the dry matter rate was found statistically insignificant in 2013–2014. According to the intrarow spacing, dry matter rates varied between 24.2% and 32.3% (Figure 4). Furthermore, according to the average of the years 2013–2014, the dry matter rate also increased as intrarow seed spacing increased. Öztürk et al. (2008) reported that the dry matter rate increased from 27.6% to 28.4% due to the increase in intrarow spacing.

The effect of silage corn seed varieties on the dry matter rate was insignificant in 2013, while it was statistically significant in 2013 ($P < 0.01$). DKC-5783 gave the best result with dry matter rate of 33.1% and 27.4%, respectively, in the 2 years (Figure 4). The dry matter rates of different corn varieties under Erzurum conditions were obtained by Gençtürk (2007) as average of 23.7% and 30.0% and by Güney et al. (2010) as average of 25%, 30%, and 31.58%. They obtained values close to the values in our study.

3.5. Dry matter yield

Dry matter yield, considered an important quality criterion in plants, was obtained by proportioning the dry matter rate to silage yield. Table 5 shows the results of variance analysis and means comparisons tests for dry matter yield values. According to the results obtained, the effect of intrarow spacing on dry matter yield was statistically insignificant compared to the average of the years 2013–2014. It was determined that dry matter yields ranged from 11,371 kg/ha to 12,062 kg/ha in the averages of years according to intrarow spacing, while dry matter yield increased as intrarow spacing increased. Konak (1994) and Pinter et al. (1994) found that the increase in plant density led to a decrease in dry matter rate and dry matter yield in their studies. The effects of silage corn varieties on dry matter yield were statistically significant according to the average of years (Table 5). The rank of varieties according to year's average was DKC-5783 with 12,640 kg/ha, ADA-9510 with 11,680 kg/ha, and Prestige with 10,890 kg/ha. Dry matter yield for silage corn in two studies under different ecological conditions was obtained by Çelebi et al. (2010) as 10,390–15,471 kg/ha and by Özata et al. (2012) as 11,040–18,150 kg/ha.

3.6. Crude protein ratio and yield

Crude protein ratio was investigated to determine the effect of different intrarow spacing in no-till seeding and seed variety on the nutrient value of silage corn. After the silage corn samples taken during the harvesting were dried and ground, nitrogen was determined and crude protein ratios were calculated from this. Table 5 shows the variance analysis applied to the crude protein ratios of silage corn and the mean comparisons tests' results. According to these results, the effect of intrarow spacing on crude protein ratios was found to be insignificant in the average of years. Cuomo et al. (1998) and Soto et al. (2002) reported that the effect of plant density on the crude protein ratio was statistically insignificant. Values between 8.85% and 9.59% were obtained for crude protein ratios in both years' average (Table 5). The effects of varieties on the crude protein ratio were statistically significant at the average of years ($P < 0.01$). Here, ADA-9510 was found to have the highest crude protein ratio of 10.0% (Table 5). The crude protein ratio values obtained from the study are in parallel with the values of 7.75%–10.63% determined by Güney et al. (2010) and 7.09%–9.82% determined by Öz et al. (2012).

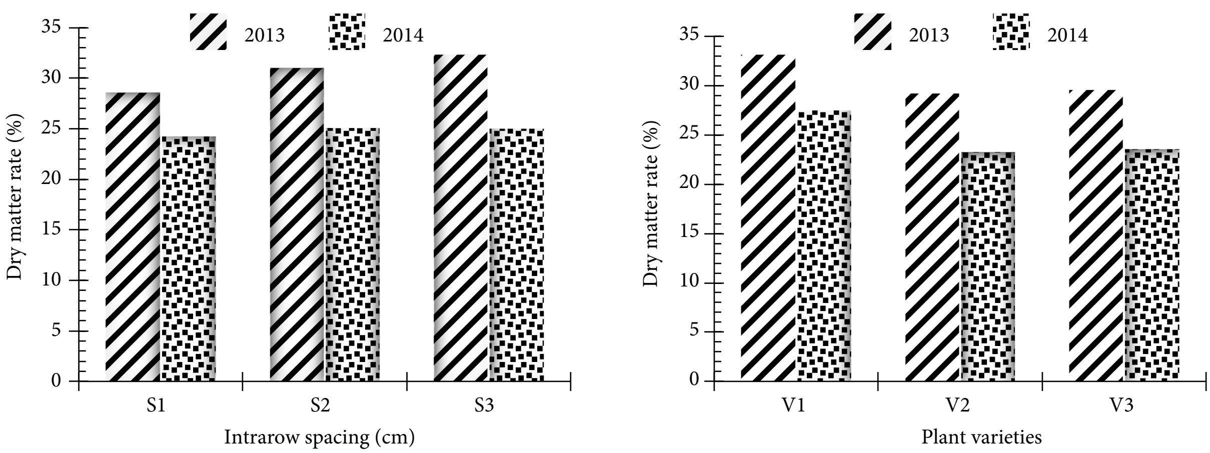

Figure 4. The effects of intrarow spacing and silage corn variety on dry matter rate (S1 = 10 cm, S2 = 15 cm, S3 = 20 cm, V1 = DKC-5783, V2 = Prestige, V3 = ADA-9510).

Table 5. Analysis of variance (P values) and means comparisons of dry matter yield, crude protein ratio and crude protein yield for 2013–2014.

Treatments		Dry matter yield (kg/ha)	Crude protein rate (%)	Crude protein yield (kg/ha)
		2013–2014	2013–2014	2013–2014
Intrarow spacing	S1[a]	11,371	9.59	1096
	S2	11,770	8.85	1038
	S3	12,062	9.45	1141
	P	0.502	0.268	0.431
Variety	V1[b]	12,640a	8.57b	1083a[c]
	V2	10,890b	9.32ab	1013a
	V3	11,680ab	10.0a	1178a
	P	0.016	0.016	0.120

[a] S1 = 10 cm, S2 = 15 cm, S3 = 20 cm
[b] V1 = DKC-5783, V2 = Prestige, V3 = ADA-9510
[c] Means within the same column with the same letter are not significantly different.

In the present study, the effects of intrarow spacing and varieties on crude protein yield, obtained by proportioning crude protein yields to dry matter yield, were statistically insignificant in the averages of years. From this point, crude protein yield values were obtained between 1038 kg/ha and 1141 kg/ha according to intrarow spacing and between 1013 kg/ha and 1178 kg/ha according to the varieties. Crude protein yield was determined by Gençtürk (2007) as 1002–1324 kg/ha under Erzurum conditions, as 844–1023 kg/ha (Çelebi et al., 2010), and 838–1692 kg/ha (Kabakcı, 2014) in some other studies conducted under different ecological conditions.

According to the results obtained from the study, it was determined that as intrarow seed spacing increased, mean emergence time decreased and seedling emergence increased. It was determined that DKC-5783 had the best emergence time, the best percentage of seedling emergence, and the highest emergence rate index at the same time. Where silage yield decreased as intrarow spacing increased, the highest yield of varieties was obtained in ADA-9510. DKC-5783 and ADA-9510 had the best results with 20-cm intrarow seed spacing for general silage yield. Based on these results, DKC-5783 and ADA-9510 silage corn varieties can be suggested to be produced by no-till seeding method at 20-cm intrarow seed spacing under Erzurum conditions.

As expected, the findings related to yield and yield parameters obtained from this research by no-till seeding method were similar to those of the conventional method. However, compared to conventional tillage, no-till seeding has the advantage of lower labor, time, and energy consumption as it has less machinery use intensity. Thus, silage corn production by no-till seeding under Erzurum conditions will, as expected, be more advantageous than the conventional method.

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