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DETERMINATION OF HERBAGE YIELD AND QUALITY OF DIFFERENT SOYBEAN VARIETIES

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Abstract
Objectives of the present study are to determine the variations in forage yield and quality of soybean cultivars. Experiments were conducted in randomized complete blocks design with 3 replications during the growing season of 2016. A total of 10 cultivars were used as the plant material of the experiments (Bravo, A3127, Traksoy, İlksoy, Mersoy, Nova, SA-88, Arısoy, Safir, Atakişi). Cultivars had a significant effect on yield and chemical composition.
Results revealed that green herbage yields varied between 826.39 - 1199.17 kg/da, dry hay yields between 247.71 - 357.90 kg/da, crude protein yields between 16.91 - 39.86 kg/da, acid detergent fiber (ADF) ratios between 26.56 - 34.61%, neutral detergent fiber (NDF) ratios between 38.43 - 44.85%, crude ash contents between 7.20 - 11.22%, crude protein contents between 6.66 - 13.53%, dry matter digestibility (DDM) values between 61.94 - 68.21%, dry matter intake (DMI) values between 2.68 - 3.12% and relative feed values (RFV) between 2.68 - 3.12. The results of the study showed that A3127 cultivar was found to be prominent with green herbage yield (1199.17 kg/da) and dry hay yield (357.90 kg/da) and Safir cultivar was found to be prominent with crude protein yield (39.86 kg/da). It was concluded that the soybean cultivars A3127 and Safir could be recommended for hay production.

Keywords: cultivar, forage quality parameters, hay yield, protein yield, Soybean.

1. INTRODUCTION

The farmers and livestock operations who wish to improve yield and quality in animal production activities should develop alternative production systems. Quality production and high-income levels largely depend on development of different systems. Forage crops constitute the greatest source in meeting feed requirements of livestock. They are also essential elements of sustainability of soil resources. World leading countries in agriculture have given due importance to forage crops and allocated at least 25-30% of agricultural lands to forage crops farming, then achieved significant outcomes in livestock raising and prevention of soil erosion (Mohammed, 2008).
Soybean, alfalfa, clover, trefoil, vetch, forage pea and bitter vetch-like forage legumes have various advantages over the other green forage crops in terms of nutritional values and growing conditions. They play a great role in animal feeding. Forage legumes have greater protein contents than the other forage crops, thus, reduce the cost of rations in animal feeding. Since legume protein has higher quality than graminae protein, they aid in protein feeding (Kutlu and Celik, 2010).

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Soybean is an important forage legume. Besides human nutrition, it is also used in animal feeding as green herbage and grain feed with a rich protein, vitamin and mineral content. In Turkey, soybean is commonly intercropped with maize for green herbage and silage material production (Tansı, 1987).
Soybean kernels or meal are used as a significant source of feed for ruminants. Dairy cattle and young heifers exhibit similar performance when they were supplied soybean dry hay or alfalfa. Soybean could be ensiled alone or in combination with different graminae species (maize, sorghum, sudan grass) (Ayaşan, 2011). This study was conducted to investigate hay yield and quality of different soybean cultivars.

2. MATERIALS AND METHODS

Ten different soybean cultivars (Bravo, A3127, Traksoy, İlksoy, Mersoy, Nova, SA-88, Arısoy, Safir, Atakişi) were used as the experimental material of the study. Experiments were conducted in randomized blocks design with 3 replications over the experimental fields of Agricultural Research and Implementation Center of Erciyes University Agricultural Faculty during 2016 growing season. Sowing was performed on 10th of May and harvest was performed at flowering period of each cultivar. Before sowing, 20 kg/da DAP fertilizer was applied as base fertilizer. Row spacing was 70 cm, on-row plant spacing was 4-5 cm, row length was 4 m (4 rows x 70 cm spacing x 4 m length: 8.4 m^2) and each plot had 4 rows. Two-meter sections of the second and third rows were harvested. Three hoeing and 5 sprinkler irrigations were practiced throughout the growing season.
Soil samples taken from research fields were analyzed and experimental soils were found to be “sandy-loam” in texture, slightly alkaline and unsaline. Soil available phosphorus and organic matter content were “low”. Available potassium content was “high” and soils were slightly limy (Table 1).

Table 1. Physical and chemical characteristics of experimental soils

Property	Depth	
	0-30 cm	30-60 cm
Clay (%)	12.75	9.05
Silt (%)	5.27	10.65
Sand (%)	81.98	80.3
Class	Sandy-Loam	Sandy-Loam
pH	7.93	7.87
Organic Matter (%)	1.25	1.05
$CaCO_3$ (%)	0.35	0.27
K_2O (kg ha^{-1})	1184.18	794.49
P_2O_5 (kg ha^{-1})	98.45	12.36
EC(mmhos cm^{-1})	0.72	0.23

Monthly average temperature (°C), total precipitation (mm) and relative humidity (%) values of April, May, June, July, August, September and October months of 2016 and long-term averages are provided in Table 2. In May, June, July and August of 2016, average temperature (°C) continuously increased, total precipitation (mm) and relative humidity (%) continuously decreased.

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Table 2. Temperature, precipitation and relative humidity data of the experimental site

Months	Temperature (°C)		Precipitation (mm)		Relative Humidity (%)	
	2016	LT*	2016	LT	2016	LT
April	14.1	10.8	10.3	53.2	44	61.9
May	14.7	15.1	129.2	53.2	63.5	60.6
June	20.8	19.2	30.3	40.3	51.8	55.3
July	23.5	22.6	10.4	9.9	41.7	49.0
August	25.3	22.1	0.0	6.0	40.2	49.3
September	17.1	17.3	21.0	14.5	49.5	54.0
October	12.2	11.6	4.2	30.3	51.4	63.9
Mean	18.2	17			48.9	56.3
Total			205.4	207.4		

*LT: Long Term, *from 1970 to 2016*

Plants harvested at flowering period were dried at 70 °C for 48 hours. Dried samples were then ground in a mill with 1 mm sieve and prepared for analyses. Crude ash content of samples was determined through ashing in an ash oven at 550 ºC for 8 hours. Crude oil analysis was conducted with the use of ether extraction method and a Soxhlet collector (AOAC, 1990). Kjeldahl method was used to determine nitrogen (N) content of soybean hay. Crude protein ratio was calculated as N x 6.25 (AOAC, 1990). ANKOM 200 Fiber Analyzer (ANKOM Technology Corp. Fairport, NY, USA) was used to determine NDF and ADF contents of the samples in accordance with the methods specified respectively Van Soest and Wine (1967) and Van Soest (1963).
Relative feed value (RFV) of soybean hays was calculated from the estimates of dry matter digestibility (DDM) and dry matter intake (DMI) (Rohweder et al. 1978).
DMD % = 88.9 - (0.779 x ADF %); **DMI** = 120 / NDF %; **RFV** = (DDM % x DMI %) /1.29
Experimental data were subjected to statistical analyses in accordance with randomized blocks design with the use of SAS (SAS Inst., 1999) software. Significant means were compared with the use of Duncan's test.

3. RESULTS AND DISCUSSIONS

Green herbage yield, dry hay yield, crude protein yield and chemical composition (protein, ash, ADF and NDF) of soybean cultivars are provided in Table 3. Effects of cultivars on yield and chemical composition parameters were found to be significant ($p \leq 0.05$). Green herbage yields varied between 826.39 - 1199.17 kg/da, dry hay yields varied between 247.71 - 357.90 kg/da and crude protein yields varied between 16.91 - 39.86 kg/da. The lowest green herbage and dry hay yields were obtained from Traksoy cultivar and the greatest values were obtained from A3127. The lowest crude protein content was obtained from SA-88 cultivar and the greatest from Safir cultivar. The lowest ADF and NDF values were respectively identified as 26.56% and 38.43%, the greatest values were respectively identified as 34.61% and 44.85%. The lowest ADF value was obtained from A3127 cultivar and the lowest NDF from SA-88 cultivar. The greatest ADF and NDF values were obtained from İlksoy cultivar. The lowest crude ash content (7.20%) was obtained from İlksoy cultivar and the greatest (11.22%) from Traksoy cultivar. The lowest crude protein content (6.66%) was obtained from SA-88 cultivar and the greatest (13.53%) from Safir cultivar.

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Table 3. Yield and chemical composition of soybean cultivars

Cultivars	GHY* (kg/da)	DHY* (kg/da)	CPY* (kg/da)	ADF* (%)	NDF* (%)	CA^{NS} (%)	CP* (%)
Bravo	969.44^{abc}	333.93^{ab}	39.14^{ab}	32.01^{cde}	41.62^{b}	10.31	11.72^{c}
A3127	1199.17^{a}	357.90^{a}	30.75^{cd}	26.56^{f}	38.55^{c}	10.63	8.58^{g}
Traksoy	826.39^{c}	247.71^{d}	31.72^{bcd}	33.38^{b}	41.58^{b}	11.22	12.82^{b}
İlksoy	1045.83^{abc}	304.62^{a-d}	27.42^{cd}	34.61^{a}	44.85^{a}	7.20	8.98^{fg}
Mersoy	905.56^{bc}	263.53^{b-d}	25.39^{d}	31.63^{ed}	39.8^{c}	9.66	9.64^{e}
Nova	1076.39^{ab}	329.25^{abc}	34.47^{abc}	32.27^{bcd}	41.66^{b}	10.44	10.49^{d}
Sa-88	888.89^{bc}	253.35^{cd}	16.91^{e}	31.61^{ed}	38.43^{c}	9.34	6.66^{h}
Arısoy	952.78^{bc}	303.25^{a-d}	28.35^{cd}	32.00^{cde}	39.82^{c}	9.25	9.34^{ef}
Safir	1124.00^{ab}	295.22^{a-d}	39.86^{a}	33.07^{bc}	39.49^{c}	9.97	13.5^{a}
Atakişi	934.44^{bc}	286.24^{a-d}	33.59^{abc}	30.87^{e}	43.07^{b}	9.27	11.75^{c}
Means	**992.29**	**297.5**	**30.76**	**31.80**	**40.88**	**9.73**	**10.35**

****:** p≤0.05; **NS:** non-significant; **GHY:** Green Herbage Yield; **DHY:** Dry Hay Yield; **CPY:** Crude Protein Yield; **ADF:** Acid Detergent Fiber; **NDF:** Neutral Detergent Fiber; **CA:** Crude Ash; **CP:** Crude Protein*

Dry matter digestibility, dry matter intake and relative feed value of soybean hay are provided in Table 4. Effects of cultivars on these parameters were found to be significant (p≤0.05). The lowest digestible dry matter content (61.94%) was obtained from İlksoy cultivar and the greatest (68.21%) from A3127 cultivar. Dry matter intake value varied between 2.68 - 3.12% with the lowest value from İlksoy cultivar and the greatest values from A3127 and SA-88 cultivars. The lowest relative feed value (45.95) was obtained from İlksoy cultivar and the greatest (50.46) from A3127 cultivar.

Table 4. Dry matter digestibility, dry matter intake and relative feed value of soybean cultivars

Cultivars	Dry Matter Digestibility (%)	Dry Matter Intake (%)	Relative Feed Value
Bravo	63.97^{bcd}	2.88^{b}	47.3^{bcd}
A3127	68.21^{a}	3.12^{a}	50.46^{a}
Traksoy	62.90^{e}	2.89^{b}	46.52^{ef}
İlksoy	61.94^{f}	2.68^{c}	45.94^{f}
Mersoy	64.26^{bc}	3.01^{a}	47.47^{bc}
Nova	63.76^{cde}	2.88^{b}	47.19^{cde}
Sa-88	64.28^{bc}	3.12^{a}	47.40^{bc}
Arısoy	63.97^{bcd}	3.01^{a}	47.25^{cde}
Safir	63.14^{ed}	3.04^{a}	46.59^{def}
Atakişi	64.85^{b}	2.79^{b}	48.11^{b}
Means	**64.13**	**2.94**	**47.43**

****:** p≤0.05*

Significant effects of genetic structure, sowing time, agronomic practices, climate, soil and environmental factors on green herbage, dry hay and crude protein yields were reported in previous studies (Dumlu et al., 2017; Engin and Mut, 2017). Present green herbage yields were lower than the values of Erdoğdu (2004) and Nazlıcan (2010) and greater than the values of Sheaffer et al. (2001). Present dry hay yields were lower than the values of Açıkgöz et al. (2007) and Kökten et al. (2014). Açıkgöz et al. (2007) reported crude protein yield of soybean harvested at R2, R4 and R6

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stages respectively as 82.19 kg/da, 122.27 kg/da and 135.45 kg/da, Erdoğdu et al. (2013) reported crude protein yield as 108 kg/da. Present differences in crude protein yields were attributed to colder climate conditions of the present research site.

Differences in dry matter and protein ratios of the genotypes largely resulted from genetic structure, but leaf, spike and stem ratios, ripening period, climate factors and fertilization practices were also effective in these parameters (Ball et al., 2001). Present crude protein values were similar with the values of Açıkgöz et al. (2007), Nazlıcan (2010) and Kökten et al. (2013). Increasing NDF and ADF levels result in feeling of fullness and thus reduce feed consumption of animals. It was reported that ADF and NDF ratios reduced digestible energy. NDF and ADF ratios have a great impact on digestibility of feeds and usually low values are desired (Van Soest, 1994; Bozkurt, 2011; Canbolat and Karaman 2009). Present ADF and NDF ratios were similar with the values of Kökten et al. (2013) and Açıkgöz et al. (2013).

Crude ash is made up of unburned remains of dry matter and it is accepted as an indicator of feed mineral content (Gençtan, 1998). Since it is impossible to be synthesized by animals, they should definitely be taken from outside. Feed mineral content of 5% is a standard value for all types of feeds and upper limit of mineral content vary from feed to feed (Anonymous, 2011). Rohweder et al. (1978) grouped forage crops based on relative feed value and placed soybean into the fifth rank. Such a case revealed relative low quality of present hay materials.

4. CONCLUSIONS

Soybean offers a quality animal feed and may have significant contributions to agricultural fields when incorporated into intercropping systems. Present findings revealed that A3127 cultivar was prominent for green herbage yield and Safir cultivar was prominent for quality traits. The cultivars Safir, Bravo, Nova and Atakişi were also prominent for crude protein contents.

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