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Aims and Scope

Turkish Journal of Range and Forage Science is the official publication of Society of Rangeland and Forage Science. The Journal is dedicated to publishing quality original material that advances rangeland management and forage crops production.

Turkish Journal of Range and Forage Science is a peer-reviewed, international, electronic journal covering all aspects of range, forage crops and turfgrass management, including the ecophysiology and biogeochemistry of rangelands and pastures, terrestrial plant–herbivore interactions, rangeland assessment and monitoring, effects of climate change on rangelands and forage crops, rangeland rehabilitation, rangeland improvement strategies, conservation and biodiversity goals. The journal serves the professions related to the management of crops, forages and grazinglands, and turfgrass by publishing research, briefs, reviews, perspectives, and diagnostic and management guides that are beneficial to researchers, practitioners, educators, and industry representatives.

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SOCIETY OF RANGE AND FORAGE SCIENCE

TURKISH JOURNAL OF RANGE AND FORAGE SCIENCE (TJRFS)

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When a revision is required by the reviewer or reviewers, the author(s) are to consider the criticism and suggestions offered by the reviewers, and they should be sent back the revised version of manuscript in twenty days. If revised manuscript is not sent in twenty days, the manuscript is removed from reviewer evaluation process. Reviewers may request more than one revision of a manuscript. Manuscripts which are not accepted for publication are not re-sent to their authors.

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The peer review process that has long time is an important problem. Naturally, the author(s) wish to take an answer about their submissions. Turkish Journal of Range and Forage Science aims to complete the all peer review process within 8 weeks after submission (one week for initial evaluation, 6 weeks for reviewer evaluation and one week for final evaluation).

The author(s) that submit an article to the Turkish Journal of Range and Forage Science consider accepting of these peer review conditions and procedures.

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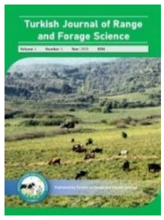

Yield and quality characteristics of alfalfa (*Medicago sativa* L.) cultivars

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A B S T R A C T

The aim of the research was to determine the forage yield and quality of alfalfa (*Medicago sativa* L.) cultivars. As research materials, five alfalfa cultivars were used, including domestic Albatur and Bilensoy in addition to cultivars Gea, Planet and Verko of foreign origin. The investigation was evaluated under Isparta and Kırşehir conditions in the 2015-2017 growing seasons. Plots were established in a randomized complete block design with 4 replicates in both locations. Five cuttings were done during the 2016 and 2017. Average values of all parameters examined are as follows: DMY-2182 kg da^{-1}, CP-20.21%, ADF-33.18%, NDF-41.43%, ADL, 7.97%, TDN-63.06%, RFV-142%. As average of two years, the highest dry matter yield was obtained from cultivar Albatur in both locations. Results of stability analysis, it was found that Albatur the most stable cultivar in terms of dry matter yields.

1. Introduction

Alfalfa (*Medicago sativa* L.) is a high quality forage used worldwide. The superiority of alfalfa lies in its high yield, high protein content and high digestibility. It is considered by researchers as the 'queen of forages' (Dale et al. 2012). Alfalfa is widely grown on 35 million hectares worldwide and is the most important forage in Turkey with 700.000 hectares grown. Since alfalfa is a perennial plant and it is a lot of cutting, the amount of forage obtained is higher than other forage crops.

The climatic and soil conditions of the region in which it is planted directly affect the yield and quality of alfalfa (Albayrak et al. 2018). According to the results obtained from different researches on alfalfa; DMY varied from 873 to 1610 kg/da (Altınok and Karakaya, 2002; Kır, 2010; Albayrak and Türk, 2013). CP varied from 17.28-24.36% (Kavut and Avcıoğlu 2015; Albayrak et al. 2014, Kertikova et al. 2014). ADF contents differed in studies conducted in different ecologies with different alfalfa cultivars (Malushi et al. (2017) 31.40%, Yüksek et al. (2016) 31.33-34.92, Ahmad et al. (2016) 28.74-35.71%). NDF contents were determined 26.70-46.81% depending on different ecological regions and varieties in alfalfa. (Malushi et al. 2017; Sulc et al. 2017; Yüksek et al. 2016).
The aim of the study was to determine of forage yield and quality features of some alfalfa cultivars in Mediterranean and Central Anatolia region conditions.

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2. Materials and Method

The research was conducted during the 2015-2017 growing seasons in Isparta Province (37°45' N, 30°33' E; elevation 1035 m) and Kırşehir Province (39°35' N, 34°44' E; elevation 1089 m). Soil types were clay or clay loam, slightly alkaline (pH, 7.5–7.8), rich in potassium (710–930 kg ha^{-1}), poor to medium in phosphorus (70-75 kg ha^{-1}) and containing 1.5-1.6% organic matter. The climate data of the experiments are given in Table 1.

Albatur, Bilensoy, Gea, Planet and Verko alfalfa (*Medicago sativa* L.) cultivars were used as materials in the research. Each plot was of 8 rows, each 5 m in length. The row spacing was 20 cm. The seeding rates were 20 kg ha. The plots were fertilized in establishment year using DAP (18% N and 46% P) at 100 kg ha. The plots were irrigated once after each harvest. Plots were cut five times each year. The harvest time was based on the 10% flowering stage of alfalfa. The plots were not harvested in the year of establishment (March, 2015). After the harvest, samples were dried at 70 °C for 48 h, and weighed. The crude protein (CP) content was calculated by multiplying the Kjeldahl nitrogen concentration by 6.25 (Kacar and Inal, 2008). The acid detergent fiber (ADF), neutral detergent fiber (NDF) and the acid detergent lignin (ADL) contents and total digestible nutrient (TDN) were determined according to methods from Ankom Technology (Komarek, 1993). The relative feed value (RFV) was estimated according to the following equation adapted from Albayrak and Turk (2013): RFV = [120/NDF]×[88.9 – (0.779 ×ADF)] × [0.775].

The trial was conducted in a randomized complete block design with 4 replications both locations. A split plot design was used for unified analysis of the 2 years (Table 2). The statistical analysis of the yield and quality data was performed using the SAS general linear model procedure (SAS Institute, 1998). The means were compared using LSD test at the 0.05 probability level. For stability analysis in dry matter yield, proc REG process was applied. Average yield (x), regression coefficient (b), regression constant (a), coefficient of variation (CV), coefficient of determination (r2) and deviation from regression (S2d) were used as stability parameters to determine the alfalfa cultivars (Albayrak and Sevimay, 2005).

3. Results

The results of the variance analysis showed that the effects of the cultivars on the dry matter (DM) yield were significant both Isparta and Kırşehir locations (Table 2). Cultivars and years were significant for the CP content. Differences in ADF concentrations occurred between the years only Kırşehir location. Cultivars and years were significant for the NDF content in Isparta. Only differences for NDF were determined between cultivars in Kırşehir.

There was no statistically difference between the ADL contents of cultivars. The effects of cultivars in Isparta location and years in Kırşehir location were found to be statistically significant for TDN. RFV was affected by year and cultivars in both locations (Table 2).

In stability analysis, cultivars Albatur, Gea and Bilensoy had DMY above the general average, while cultivars Planet and Verko showed the lower yield value as the overall average (Table 4). The closest cultivar to the regression line was found as Albatur.

Table 1. Total monthly precipitation and mean temperature of locations during the growing seasons of 2016 and 2017 with long-term averages.

	Precipitation (mm)			Temperature (°C)		
	LT*	2016	2017	LT*	2016	2017
ISPARTA						
March	52.9	70.5	63.4	5.90	6.1	6.4
April	58.8	26.1	38.6	10.6	10.8	11.5
May	46.0	41.8	56.8	15.5	14.7	16.4
June	31.5	92.2	30.2	20.7	20.8	21.7
July	14.5	3.0	12.4	23.5	22.6	24.8
August	10.7	43.4	15.8	22.2	23.7	24.2
September	16.9	20.8	19.4	18.6	17.6	18.9
Total/mean	231.3	297.8	236.6	16.7	16.6	17.7
KIRŞEHİR						
March	37.4	89.0	32.4	5.50	6.9	5.8
April	45.7	26.8	25.6	10.7	8.8	10.7
May	44.1	54.8	45.8	15.4	16.4	16.5
June	36.8	60.4	42.7	19.7	18.9	18.8
July	15.3	16.8	16.7	23.7	22.5	23.7
August	9.8	13.7	5.9	22.6	23.7	23.4
September	29.7	37.2	31.4	17.4	16.5	18.7
Total/mean	218.8	298.7	200.5	16.4	16.2	16.8

LT: long-term (1951–2015).

Table 2. Results of variance analysis and mean squares of dry matter yield (DMY), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), acid detergent lignin (ADL), total digestible nutrient (TDN) and relative feed value (RFV) treatments in combined years (2016-2017)

Coefficients of variation	df	DMY	CP	ADF	NDF	ADL	TDN	RFV
ISPARTA								
Block	3	9005	1.52	9.57*	1.58	0.21	5.80*	6.83
Cultivar	4	251392**	7.10**	6.78	8.72**	0.20	4.11	224**
error1	12	10996	1.58	2.12	1.39	0.16	1.23	35.26
year	1	14848	5.69*	8.31	13.09*	0.41	5.04	297*
Year x cultivar	4	3654	0.26	0.94	0.64	0.02	0.57	7.96
error 2	15	13489	1.27	5.97	2.88	0.28	3.62	52.51
KIRŞEHIR								
Block	3	26858	1.30	2.56	0.55	0.04	1.55	5.02
Cultivar	4	23280**	8.77**	3.98	10.69*	0.13	2.41	202**
error1	12	9522	0.98	2.19	2.29	0.20	1.33	31.27
year	1	21060	17.37**	7.26*	4.95	1.09	4.38*	148*
Year x cultivar	4	3171	0.27	0.24	0.14	0.14	0.15	2.85
error 2	15	7776	1.68	0.93	1.65	0.28	0.56	26.19

df = degrees of freedom, *P < 0.05 and **P < 0.01.

4. Discussion

The highest DMY both Isparta and Kırşehir locations were determined Albatur cv. (2468 and, 2351 kg da^{-1}, respectively). DMY yields of other cultivars varied from 2343-1952 kg da^{-1}. Dry matter yield in alfalfa, cultivar (Avcıoğlu et al., 1989; Şengül et al., 1992), leaf / stem ratio (Popovic et al., 2001), climate (Mohammed, 2008), soil characteristics (Demiroğlu et al., 2008), cutting time (Shroyer et al., 1984) etc., are influenced by many factors. DMY in alfalfa are 873-1205 kg da^{-1}in Central Anatolia (Altınok and Karakaya, 2002), 1131-1518 kg da^{-1} in the Black Sea region (Kır, 2010) and 1480-1610 kg da^{-1} in the Mediterranean conditons (Albayrak and Türk, 2013) reported by different researchers. It can be said that the similarities / differences in the results of the research are due to the variety of variations used in these trials and the ecological conditions in which the trials were carried out, especially the total precipitation and temperature differences falling during vegetation and irrigation (Yılmaz and Albayrak, 2016).

The studied cultivars differed significantly in crude protein content. Cultivars Albatur, Gea and Bilensoy had higher crude protein contents than cultivars Planet and Verko in both locations (Table 3). In present study, CP contents of cultivars varied from 21.79 to 18.22 %. In studies conducted in different ecologies, crude protein ratios have been reported to change in alfalfa (Kavut and Avcıoğlu (2015) 19.83-20.11%, Albayrak et al. (2014) 18.69%, Kertikova et al. (2014) 17.28-24.36%, Öten (2014) 17.52%, Aioanei and Pop (2013) 16.02-17.01% Cinar (2012) 20.60%). Our findings are generally similar to those of the above mentioned researchers. Nevertheless, it should be kept in mind that the varieties and ecological factors as well as the changes in the harvest time, were effective factors in the change of the crude protein content of alfalfa (Albayrak et al., 2018).

In both locations, the ADF contents of alfalfa cultivars varied from 31.72 to 34.22 5 and there was not found statistically difference between them. ADF contents differed in studies conducted in different ecologies with different alfalfa cultivars (Malushi et al. (2017) 31.40%, Yüksek et al. (2016) 31.33-34.92, Ahmad et al. (2016) 28.74-35.71%, Min (2016) 27.70% -35.2, Jafrarian et al. (2016) 30.60-33.70%, Karayılanlı and Ayhan (2016) 35.34%). It has been stated that there are significant differences between the ADF contents in alfalfa and this may have an effect on the genetic factors as well as the cutting time (Katic et al. 2008).

Cultivars Albatur and Gea had lower NDF contents than cultivars Bilensoy, Planet and Verko in both locations (Table 3). In present study, NDF contents of cultivars varied from 40.06 to 43.22 %. NDF contents were determined 26.70-46.81% depending on different ecological regions and varieties in alfalfa. (Malushi et al. 2017; Sulc et al. 2017; Yüksek et al. 2016; Ahmad et al. 2016). The average NDF contents obtained in our study were higher than the results reported by some researchers and lower than others. Our research findings are generally similar to the results of the researchers mentioned above. In addition to this, it is stated that the varieties and ecological factors used in alfalfa are the most effective factors in changing the NDF ratio of the herbage in the changes in harvest time (Rimi et al. 2012).

ADL content of alfalfa cultivars in both locations was found between 8.14-7.76% (Table 3). Results for

ADL content of alfalfa hay, were within the range found in the literature from 4.0 to 7.40% (Malushi et al. 2017; Sulch et al. 2017; Boziskovic et al. 2014;

Table 3. Dry matter yield (DMY), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), acid detergent lignin (ADL), total digestible nutrient (TDN) and relative feed value (RFV) of alfalfa cultivars (average of 2years).

	DMY (kg da^{-1})	CP (%)	ADF (%)	NDF (%)	ADL (%)	TDN (%)	RFV (%)
ISPARTA							
Albatur	2468 a	21.79 a	31.72	40.06 b	7.76	64.19	149 ab
Gea	2343 b	21.26 ab	32.02	39.81 b	8.04	63.96	150 a
Bilensoy	2255 b	21.01 ab	33.16	41.09 a	8.09	63.07	143 bc
Planet	2084 c	20.17 bc	33.05	41.96 a	7.80	63.16	140 c
Verko	2043 c	19.40 c	33.99	42.06 a	8.05	62.42	138 c
CV %	5.19	5.45	7.45	4.14	6.68	3.01	5.03
KIRŞEHİR							
Albatur	2351 a	20.99 a	32.55	40.43 c	7.79	63.55	146 a
Gea	2119 c	20.03 ab	33.18	40.91 bc	8.14	63.06	144 ab
Bilensoy	2233 b	20.04 ab	33.73	42.40 ab	8.06	62.63	138 bc
Planet	1952 d	19.15 bc	34.16	43.22 a	8.04	62.30	134 c
Verko	1972 d	18.22 c	34.22	42.37 ab	7.95	62.25	136 c
CV %	4.15	6.59	2.87	3.07	6.60	1.20	3.67

Means in the same columns are not significantly different at the P = 0.05 level, CV% = coefficient of variation,

Kertikova et al. 2004). The average ADL rates obtained in our study were higher than the results reported by some researchers and lower than others. Ecological differences and cultivars can cause the difference.

The TDN refers to the nutrients that are available for livestock. This variable is related to the ADF concentration of the forage. As ADF increases, TDN declines. As a result, animals are unable to utilize the nutrients that are present in the forage (Albayrak et al., 2011). In present study, the alfalfa cultivars had TDN content in the range of 64.19 to 62.25 % (Table 3). Forages with an RFV of over 151, 150–125, 124–103, 102–87, 86–75, and less than 75 are categorized as prime, premium, good, fair, poor, and rejected, respectively (Albayrak and Türk, 2013). Based on the average of the 2 years and locations, the alfalfa cultivars had relative feed values ranging from 150-134 and, thus, may be categorized as premium quality.

In order for a variety to be stable, it is reported that the regression coefficient (b) should be close to 1, the regression constant (a) should be positive, the coefficient of determination (r2) should be high, coefficient of variation (CV) and the deviation from the regression (S2d) should be low (Albayrak and Sevimay, 2005). DMY of cultivar Albatur is high and b value is close to 1 (Table 4).

Table 4. Values related to stability parameters of alfalfa cultivars for total dry matter yield

Cultivars	X mean	b	a	r^2	CV	S^2d
Albatur	2410	1.03	158.13	0.89	1.22	867
Gea	2230	1.84	-1796.17	0.90	2.28	2592
Bilensoy	2244	0.27	1661.59	0.48	1.07	572
Planet	2017	1.22	-654.60	0.98	0.76	235
Verko	2008	0.63	631.19	0.99	0.08	2.51

5. Conclusion

According to present study results; cultivar Albatur had the highest dry matter yields 2468 and 2351 kg da in Isparta and Kırşehir respectively. The lowest dry matter yield was obtained from Planet and Verko cultivars in both locations. Albatur, Gea and Bilensoy had higher CP contents than Planet and Verko. Albatur and Gea had the lowest NDF contents. ADF, ADL and TDN values of cultivars were found to be similar to each other. All cultivars were in premium group in terms of RFV value. According to the results of the stability analysis, Albatur was found to be the most stable cultivar in terms of dry matter yield.

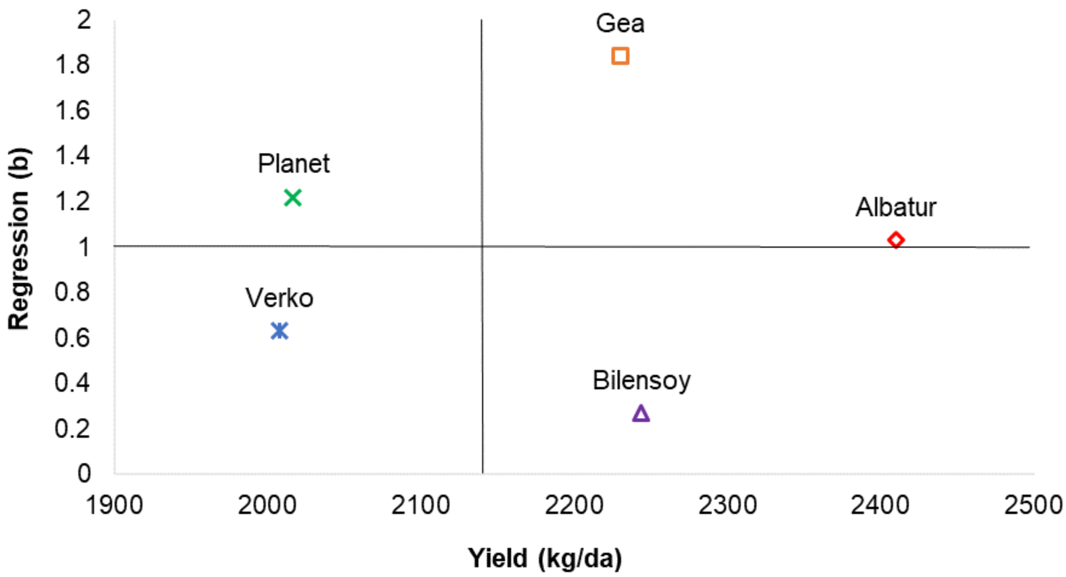

Figure 1. Stability statues of alfalfa cultivars according to DMY and regression coefficient.

References

Ahmad, J., A. Iqbal., M. Ayub., J. Akhtar. 2016.Forage yıeld potentıal and qualıty attrıbutes of alfalfa (Medicago sativa L.) under varıous agro-management technıques. The Journal of Animal & Plant Sciences, 26(2): 2016, Page: 465-474.

Aioanei, N.M., I.M. Pop. 2013. Research on chemıcal compositıon of alfalfa hay obtaıned ın dıfferent productıon systems (Conventıonal And Organıc). University of Agricultural Sciences and Veterinary Medicine. 60: 60-64.

Albayrak, S., M. Öten, M. Türk., M. Alagöz. 2018. An investigation on improved source population for the alfalfa (Medicago sativa L.) breeding. Legume Research. 41(6): 828-832.

Albayrak, S., M. Türk., C.S. Sevimay., S. Kazaz., M. Tonguç. 2014. Göller yöresinde adi yonca (Medicago sativa L.) populasyonlarının toplanması ve karakterizasyon çalışmaları TUBİTAK Proje No: 110O257 Sonuç raporu.

Albayrak, S., M. Türk. 2013. Changes in the forage yield and quality of legume-grass mixtures throughout the vegetation period. Turk J. Agriculture and Forestry. 17(2): 139-147.

Albayrak S., Türk, M., O. Yüksel., and M. Yılmaz. 2011. Forage yield and the quality of perennial legume-grass mixtures under rainfed conditions. Notulae Botanicae Horti Agrobotanici Cluj-Napoca. 39(1):114-118.

Albayrak, S ve C.S. Sevimay. 2005. Ankara ve Samsun koşullarında bakteri aşılamasının yaygın fiğ (Vicia sativa L.) çeşitlerinin kuru ot ve tohum verimleri üzerine etkileri ve stabilite analizi. Ankara Üniv. Zir.Fak. Tarım Bilimleri Dergisi. 11(3) 263-269.

Altınok, S., A. Karakaya. 2002. Forage yield of different alfalfa cultivars under Ankara conditions., Tr.J. of Agric. For., (26) s: 11-16.

Avcıoğlu, R., M.B. Yıldırım., N. Budak. 1989. Ege Bölgesine uygun yonca hatlarının geliştirilmesi ve adaptasyonu. E.Ü. Ar. Fonu, 1987-154, İzmir.

Bozickoviç, A.D., G.A. Grubiç., N.Z. Dordeviç., B. D. Stojanoviç.2014. Changes ın alfalfa cell wall structure durıng vegetatıon. Journal of Agricultural Sciences. 59(3): 275-286.

Çınar, S. 2012. Çukurova taban koşullarında bazı çokyıllık sıcak mevsim buğdaygil yembitkilerinin yonca (Medicago sativa L.) ile uygun karışımlarının belirlenmesi, Çukurova Üniversitesi, Fen Bilimleri Enstitüsü (Doktora tezi), 151s, Adana.

Dale, L.M., I. Rotar., A. Thewıs., R.Vıdıcan., V. Florıan., A. Cıure. 2012. Determınatıon of alfalfa crude fıber, NDF, ADF and lıgnın content by NIR spectrometry. Agronomie. 5: 245-249.

Demiroğlu, G., H. Geren., R. Avcıoğlu. 2008. Farklı yonca (Medicago sativa L.) genotiplerinin Ege bölgesi koşullarına adaptasyonu. Ege Üniversitesi, ziraat fakültesi dergisi. 45(1): 1-10.

Jafarian, S., M.R. Chaichi., M.M.Ghahderijani. 2016. Effects of surfactant and limited irrigation on forage yield and quality of alfalfa (Medicago sativa L.). Australian J. of Crop Science. 10(1):76-80.

Kacar, B., A. İnal. 2008. Bitki Analizleri. Nobel yayınları. No: 1241, Ankara, 892s.

Karayılanlı, E., V. Ayhan (2016) Investigation of feed value of alfalfa (Medicago sativa L.) harvested at different maturity stages. Legume Research, 39 (2) 2016 : 237-247.

Katıç S., Mıhaılovıç V., Mılıç D., Karagıç D., Glamociç D., Jajıç I. 2008. Genetic and seasonal variations of fibre content in lucerne. Proceedings of the XXVIIth EUCARPIA Symposium on Improvement of Fodder Crops and Amenity Grasses, Copenhagen, Denmark, 19-23 August 2007, 130-135.

Kavut, Y.T., R. Avcıoğlu. 2015. Yıeld and qualıty performances of varıous alfalfa (Medicago sativa L.) cultıvars ın dıfferent soıl textures ın a medıterranean envıronment. Turkish Journal of Field Crops2015, 20(1), 65-71.

Kertikova, D., Y. Naydenova., D. Yankov.2014. Evaluation of the productivity and quality of elite alfalfa clones. Agrarni Nauki. 6 (16): 25-31.

Kır, H. 2010. Tokat-Kazova şartlarında bazı yonca çeşitlerinin performanslarının belirlenmesi, Gaziosmanpaşa Üniversitesi, Fen Bilimleri Enstitüsü (Yüksek Lisans tezi), 44s, Tokat.

Komarek A.R., 1993. An improved filtering technique for the analysis of neutral detergent fiber and acid detergent fiber utilizing the filter bag technique. Publication No 101, ANKOM Company, Fairport, NY. 1-10.

Malushi, N., L. Papa., M. Maia., H. Oliveira. 2017. Determınatıon of chemıcal content and dry matter dıgestıbılıty of some under- utılızed feeds ın rumınants feedıng through two ın vıtro methods. Scientific Papers. Series D. Animal Science. Vol. LX: 91-96.

Min, D. 2016. Effects of Cutting Interval between Harvests on Dry Matter Yield and Nutritive Value in Alfalfa. American Journal of Plant Sciences, 2016, 7, 1226-1231.

Mohammed, A. S., 2007. Farklı lokasyonlarda bazı yonca çeşitlerinin yem verimleri ve bitkisel özellikleri. Ankara Üniversitesi Fen Bilimleri Enstitüsü Tarla Bitkileri Anabilim Dalı Yüksek Lisans Tezi, Ankara.

Öten, M. 2014. Batı Akdeniz Sahil Kuşağında adi yonca (Medicago sativa L.) populasyonlarının toplanması ve karekterizasyon çalışmaları, Süleyman Demirel Üniversitesi, Fen Bilimleri Enstitüsü (Doktora tezi), 115s, Isparta.

Popovic. S., M. Stjepanovic., S. Grljusic., T. Cupic., M. Tucak. 2001. Protein and fiber contents in alfalfa leaves and stems. Centre International de Hautes Etudes Agronomiques Mediterraneennes.

Rimi, F., S. Macolino., B. Leinauer., L.M. Lauriault., U. Ziliotto.2012. Fall Dormancy and Harvest Stage Effects on Alfalfa Nutritive Value in a Subtropical Climate. Agron. J. 104:415–422.

SAS Institute. 1998. INC SAS/STAT users' guide release 7.0, Cary, NC, USA.

Shroyer. J., D. Fjell., M. Mikesell. 1984. Timely cutting of alfalfa. Kansas State Universty Cooperative Extension Service.

Sulc, R.M., A. Parker., K. Albrecht., K. Cassida., M. Hall., D. Min., S. Orloff., X. Xu., D. Undersander. 2017. Tri-State Nurtition Conference. April 17-19; 79-87.

Şengül, S, L.Tahtacıoğlu., A. Mermer. 1992. Dogu Anadolu Bölgesi şartlarına adapte olabilecek yüksek verimli yonca çeşit ve hatlarının belirlenmesi üzerine bir araştırma. Dogu Anadolu Tarimsal Araştırma Enstitüsü Müdürlüğü Yayınları No: 15, Erzurum.

Yılmaz, M., S. Albayrak. 2016. Isparta ekolojik koşullarında bazı yonca (Medicago sativa L.) çeşitlerinin ot verim ve kalitelerinin belirlenmesi. Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi, 25(1):42-47.

Yüksel, O., S. Albayrak., M. Türk., C.S. Sevimay. 2016. Dry Matter Yields and Some Quality Features of Alfalfa (Medicago sativa L.) Cultivars under Two Different Locations of Turkey. Süleyman Demirel Üniversitesi Fen Bilimleri Enstitüsü Dergisi. 20 (2): 155-160.

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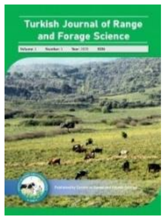

Forage Yield Performance of Soybean Genotypes for Spring Seeding and Double Cropping

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Soybean, an annual broadleaf legume, may be grown as hay and pasture crop or ensiled with corn and sorghum for livestock. Field experiments in a Mediterranean-type climate were conducted in the 2013, 2014 and 2015 growing seasons to evaluate DM yield and some yield components of soybean genotypes [*Glycine max* (L.) Merr.] in Bursa, Turkey. In the study's first step, seventy soybean genotypes and five check cultivars were evaluated in augmented design in 2013 and then selected genotypes were grown in a completely randomized block design with three replications in 2014 and 2015 experimental years. All field studies were established in main (spring planting) and double cropping conditions, simultaneously. There were statistically significant differences between soybean genotypes in dry matter (DM) yield, yield components and partitioning of soybean plant parts in both main and double cropping. In main cropping conditions, DM yield of fifteen selected soybean genotypes averaged 15931 kg ha^{-1} in first and 9645 kg ha^{-1} in the second year of the study. Indicating planting date and year-to-year genotype differences, the DM genotypes ranged from 5683 to 26028 kg ha^{-1} in the main cropping system. Nine genotypes were also evaluated over two years for plant height, branching, leaflet size, and DM yield in a double cropping system with significant differences in evaluated traits and DM yield. Even in the double cropping system, soybean genotypes averaged well over seven tonne per hectare DM with a range of 4568 to 13293 kg ha^{-1}. As an indication of soybean forage quality, leaflet percentage increased and stem percentage decreased in the double cropping system. In a Mediterranean climate, soybeans for forage can provide a high-yield annual broadleaf alternative to annual grass or perennial forages by critically evaluating cultivar selection.

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1. Introduction

Soybean [*Glycine max* (L.) Merr.] is a productive, high-quality warm season forage legume that can be used for hay, silage, grazing, cover crop, wildlife cover, or green manure. Historically, soybeans in the USA were used as a nutritious annual hay, pasture, and silage crop. Early research extensively investigated forage yield, but demand for high protein feed grain in the early 1940s shifted soybean production and research from primarily forage to seed yield. As a result, forage quality deteriorated with seed-focused genotype selection. In recent decades, soybean forage research has shifted from planting soybeans for forage to harvesting soybean grain varieties for emergency forage due to hail, drought, or early frost (Barnhart, 2007; Heinrichs et al., 1997; Undersander, 2001). Consequently, farmers have limited research available for determining proper selection of soybean as an intended forage or pasture crop.

Although recently several soybean cultivars and experimental lines have been bred for forage production (Asekova et al., 2014; Devine and Hatley, 1998; Devine et al., 1998; Hintz et al., 1992), farmers have been forced to use a century-old cultivar with public and private research strikingly inadequate. International forage research is found wanting when one of the top performing forage soybean genotypes in our study is a variety that was introduced in the USA in 1914, as PI40658, first planted there in 1915 and named, Laredo, by 1919 (Morse, 1919; Piper et al., 1923; Taylor, 1920). Laredo, that annually sold and farmer-tested acclaimed forage soybean (Bennett, 2001; Handcock, 2016; WMS, 2016), originated from Yangpingguan (Yangping), China where it was an established high performer untold years in order to justify that century-old international transfer (Bernard et al., 1987; Shurtleff and Aoyagi, 2013).

As would be expected, soybean forage yield and nutritive value varied depending on genotype, location and maturity stage at harvest (Hintz et al., 1992; Altinok et al., 2004; Bilgili et al., 2005). Munoz et al. (1981) indicated when soybean pods were filled and leaves began to turn yellow, the percentages of leaves, stems, and pods were 28, 36, and 36, respectively, with a total DM yield of 12.4 t ha^{-1}. When grown for forage, Sheaffer et al. (2001) found no dry matter (DM) yield differences between forage-type and grain-type soybeans cultivars, which averaged 8.8 t ha^{-1}. In the southern Great Plains Region, USA, DM yields of forage soybeans ranged from slightly less than 1 to 5.4 t ha^{-1}, depending on climatic conditions (Rao et al., 2005). In USA, forage soybean cultivars Derry, Donegal, and Tyrone produced DM yields varying from 5216 to 13900 kg ha^{-1}, depending on location and year (Nayigihugu et al., 2000). Dry matter yields of Derry and Donegal reached 7.95 t ha^{-1} in UK conditions (Koivisto et al., 2003). Soybeans grown for forage averaged 9.3 and 11.3 t ha^{-1} DM yield at R4 and R6 stages, respectively, containing 13.3% crude protein, 8.2% degradable protein, and 60.6% in vitro dry matter digestibility at three different locations with Mediterranean climates in Turkey (Acikgoz et al., 2007).

A cereal/soybean double cropping system has been used successfully in the southern USA (Touchton and Johnson, 1981; Hume et al., 1985) and in the southern Pampas, Argentina (Calvino et al., 2003). In this system, soybean is seeded immediately after cereal crop harvest. Double-cropping soybeans behind wheat can lead to increased farm income if satisfactory soybean grain yields can be obtained with suitable weather and normal frost dates. In shorter growing season areas, double cropping forage soybean after cereals was practical in the north central USA environment. Forage yields of double cropping soybean following barley, winter wheat, and winter rye ranged from 60 to 105% of the main cropping soybean, and after oat (the latest planted crop) double cropping soybean yielded 38 to 57% of the main cropping soybean (LeMahieu and Brinkman, 1990). In the USA southern Great Plains dryland double-cropping soybean after winter wheat (*Triticum aestivum* L.) provided high quality summer forage, but soybean forage yield ranged only from 1.35 to 1.90 t ha^{-1} when soybean was grazed or harvested at beginning seed fill (Mackown et al., 2007). Double cropping soybean based on maturity and branching characteristics to maximize forage or grazing potential has not been established.

In Mediterranean regions of Turkey, soybean can be grown as a main cropping system (spring seeding) or double cropped after cereal harvest where soybean growers generally prefer to plant soybean for grain immediately following winter cereal harvest (mostly barley or wheat). Fall seeded annual forage legumes such as pea (*Pisum sativum* L.) and common vetch (*Vicia sativa* L.) have produced satisfactory forage yield under rain-fed conditions in a Mediterranean environment. However, forage yield of these species was dramatically reduced as spring-seeded crops due to high temperatures and water deficits (Aydogdu and Acikgoz, 1995; Uzun et al., 2005). There are currently very limited alternative high yield summer forage legume crops for grazing, hay or silage production in the region. Soybean offers a high quality forage legume for summer production as pasture and hay in Mediterranean climate environment or other areas of the world where soybean forage is adapted. However, little is known about variation of morphological traits, DM yields, and plant components of different soybean genotypes under spring seeded, or double cropping conditions. The objectives of these studies were to evaluate soybean genotypes from diverse origins for some morphological traits, DM yield, and plant components in the Mediterranean-type climate of Bursa, Turkey.

2. Materials and Method

Field studies were conducted on irrigated experimental plots at Uludag University, Bursa, Turkey during the 2013, 2014 and 2015 growing seasons. At a level 70 m altitude located in the coastal zone of northwest Turkey (40° 11′ North, 29° 04′ East), it is characterized as a Mediterranean type climate.

The specific site soil type is clay loam and classified as vertisol typic habloxrert with 7.2 pH value. Soil is medium in P (73 kg ha^{-1}), and rich in K (1130 kg ha^{-1}) with 1.4 % organic matter. Long-term annual rainfall averages 579 mm with only 20% falling in the soybean growing period (April-September). Mean temperature during the growing period is 21.0 °C with relative humidity of 75%.

Experimental fields were fall moldboard plowed and cultivated level in early spring. Soybeans were not inoculated. 50 kg ha^{-1} N-P-K fertilizer was applied uniformly after hand seeding in all growing seasons. Weed control was achieved manually. Irrigation was applied three times (V5, R2 and R5 stages) with a rotary sprinkler to maintain the soil near field capacity. Irrigation timing was estimated visually as the soil surface dried. Sunflower was the previous crop in all experimental years.

Soybean genotypes used in this study were mainly provided by IPK (Leibniz-Institute of Plant Genetics and Crop Plant Research, Germany) and collected from different countries, mostly China, Japan, USA and Russia. Some experimental lines and local genotypes from Turkey were also included. Five standard checks (Derry, Greencastle, and Laredo from USA and Yemsoy and Yesilsoy from Turkey) were added for this study. Derry, Greencastle, and Laredo are typical forage type soybean cultivars (Group VI) registered in USA, and Yemsoy and Yesilsoy (Group IV) are soybean cultivars registered for forage production in Turkey.

Two experiments were performed using two sets of soybean genotypes. In the first set, all genotypes collected were evaluated in augmented design in 2013; then the selected genotypes were seeded in a completely randomized block design in 2014 and 2015. All simultaneous experiments were spring-seeded (referred to as “main” cropping) and double cropped.

A total of 70 soybean genotypes were grown in the 2013 augmented design with five standard checks replicated in five blocks, 3 m long rows spaced 70 cm. Seeding rate was 60 seeds per row. Seeding was made on 30 April 2013 for main cropping and 16 July 2013 for double cropping.

In the 2013 augmented study, ten soybean genotypes and five cultivars were selected for main cropping and the five soybean genotypes and four cultivars were selected for double cropping production system based on their DM yield performances. In the main cropping system, 15 different soybean genotypes were seeded in a completely randomized block design with three replications in experimental years 2014 and 2015. Each genotype was sown in 14.0 m^2 (2.4 by 5.0 m) plots consisting of 4 rows with 70 cm row spacing. Main crop seedings were done on 10 April 2014 and 14 May 2015 at seeding rates of 100 seeds per row. In the double cropping experimental design, plot size and seeding rate were similar to those used in the main cropping system. Double crop seedings were done on 14 July 2014 and 9 July 2015.

All plots were monitored regularly and days to 50% flowering of genotypes were recorded. Forage yield data was collected at R4 stage in all experiments. Plants were hand-cut at soil surface. In the 2013 augmented trials, 0.7 m^2 area was cut for forage yield, and 2.8 m^2 area of the center rows was harvested in randomized block trials in the 2014 and 2015. Before cutting, 5 randomly selected plants from each plot were measured for plant height and branch number per plant; then each of those plants were dissected into leaflet, petiole, stem, and flower plus pods components before weighing. Components were dried and weighted again. All samples were dried at 70 °C for 48 h for DM yield determination.

Different experimental groups (augmented and completely randomized block design) were subjected to analysis of variance for each character using MINITAB (University of Texas, Austin), MSTAT-C (Version 2.1 Michigan State University, 1991) and JMP (version 7.0, SAS Institute Inc.) software. The significance of treatment, main effects and interactions were determined at the 0.05 and 0.01 probability levels, by the F-test. The F-protected least significant difference (LSD) was calculated at the 0.05 probability level.

3. Results

Variance analysis of the 2013 augmented study showed significant effect ($P<0.01$ and $P<0.05$) of check cultivars and genotypes on DM yield, plant constituents, and all characteristics measured in both main and double cropping conditions; wherein both plantings, blocks affects were not statistically significant.

Days to flower, plant height, branches per plant, and plant constituent data are presented in Table 1. To simplify interpretation of results, only average and variation limits of measured characteristics of soybean genotypes and check cultivars are summarized in that Table. There was considerable variation in flowering time among soybean genotypes. Some early soybean genotypes flowered 55 and 35 days after seeding in main and double cropping conditions, respectively, compared to later flowering genotypes (119 and 76 days).

Table 1. Average and variation limits of measured traits of 70 soybean genotypes and check cultivars in main and double cropping conditions tested at maturity stage R4 (2013)

	Soybean genotypes			Check cultivars*		
	Average	**Min.**	**Max.**	**Average**	**Min.**	**Max.**
				Main Cropping		
Days to flower (days)	72.5	55.0	119.0	94.0	77.0	110.0
Plant height (cm)	76.1	14.1	243.1	127.9	105.4	162.6
Branches/plant	3.4	0.1	7.6	3.7	2.4	4.9
Dry Matter Yield (g/row)	756.0	8.4	3227.0	1481.9	961.1	2811.4
Stem (%)	34.4	20.6	64.7	38.2	33.1	41.8
Leaflet (%)	38.1	16.3	50.6	36.5	32.3	43.8
Petioles (%)	16.7	9.1	29.8	12.2	11.4	16.3
Flower + pods (%)	10.8	3.3	30.6	13.1	11.3	25.3
				Double Cropping		
Days to flower (days)	49.6	35.0	76.0	55.0	49.0	68.0
Plant height (cm)	43.9	13.6	92.0	89.6	67.6	111.4
Branches/plant	2.5	0.0	5.8	2.9	2.1	5.2
Dry Matter Yield (g/row)	279.9	14.2	751.1	615.1	443.4	806.0
Stem (%)	25.4	15.4	39.6	30.3	27.1	32.2
Leaflet (%)	42.4	27.4	57.2	45.1	38.8	52.5
Petioles (%)	13.7	6.2	20.0	14.0	11.9	17.7
Flower + pods (%)	18.5	2.7	51.0	10.6	4.7	15.1

*Average of 5 block

Plant height differences between the soybean genotypes varied from 14.1 to 243.1 cm in main cropping and from 13.6 to 92.0 cm in double cropping conditions. In general, average plant height of soybean genotypes was much lower than typical forage type soybeans cultivars. However, some soybean genotypes reached heights of 243.1 cm. As may be expected, all soybean genotypes tested in double crop conditions were clearly shorter on average than main crop conditions (76.1 vs. 43.9 cm). Maximum plant heights of soybean genotypes and check cultivars were 92.0 and 111.4 cm, respectively, in double crop conditions. Very little branching was seen in some genotypes, whereas some soybean genotypes branched profusely in both main and double cropping conditions. Check cultivars had more consistent branching and were generally comparable between main and double crop plantings.

Unexpectedly wide variation occurred among soybean genotypes in DM yield per 1 m row ranging from 8.4 to 3227 g in main cropping and 14.2 to 751.1 g in the double crop system. Average DM yield of soybean genotypes was much lower than the check cultivars in main cropping (756.0 vs. 1481.9 g) and in double cropping conditions (279.9 vs. 615.1 g). However, some soybean genotypes produced higher DM yield than check cultivars in main cropping conditions supported by increased days to flower, plant height, and branches per plant. Dry matter yield of soybean genotypes sown in main cropping produced a maximum of 3227.0 g while the double cropping maximum was DM yield of 751.1 g. Some soybean genotypes exceeded check cultivars in DM yield in main cropping conditions.

The DM yield of soybean genotypes and check cultivars at R4 maturity averaged approximately equal proportions of leaflet and stem material with far less yield from petioles and flower + pods especially for the check cultivars. Since the purpose of our study was to evaluate forage performance and quality characteristics, it is important to note leaflet percentage of double cropping was consistently higher than the main crop for both soybean genotypes and check cultivars, very likely due to shorter plant height and smaller stem percentage in the double cropping system. Furthermore, for forage quality characteristics, double cropped soybean genotypes had nearly three fourths (74.6%) of their aerial dry matter from leaflet, petioles, and flower + pods and it was 69.7% for check cultivars. Comparatively, the main crop system had approximately two thirds (65.6%) and 61.8% of those components respectively for main soybean genotypes and check cultivars.

In 2014 and 2015 field studies established in a completely randomized block design, the analysis of variance for the main cropping showed statistical differences among soybean genotypes and significant year x genotype interactions detected for measured morphological traits and DM yield (Table 2).

Large differences were observed between the two years for the morphological traits measured and DM yield (Table 3). Plant height of the 15 soybean genotypes averaged 123.8 cm in combined years. However, in the first year of the study (2014), plants were taller on average than in 2015 the second year (137.1 vs. 110.3 cm), which likely was caused by rain-delayed planting difference of a month (10 April 2014 vs. 14 May 2015). Average height of plants in forage type soybean cultivars Greencastle, Laredo and Derry (reaching heights of 172.8 – 175.7 cm in 2014 and 133.7 – 171.9 cm in 2015) was significantly greater than those in other soybean genotypes and check cultivars.

Table 2. Variance analysis of measured quality characteristics in main cropping conditions (combined years 2014 and 2015)

	DF*	Plant height	Branch/ plant	Leaflet width	Leaflet length	Dry matter yield
Genotypes (G)	14	**	**	**	**	**
Years (Y)	1	**	ns	**	*	**
G x Y	14	**	**	**	**	**
Blocks	4	ns	ns	ns	ns	ns
Error	56					

*: degree of freedom, *, **: F-test significant at $P < 0.05$, and $P < 0.01$ levels, respectively; ns, not significant.

Table 3. Plant characteristics of soybeans genotypes and cultivars in main cropping conditions (combined years 2014 and 2015)

Genotypes	Plant height (cm)	Branch/ plant	Leaflet width (cm)	Leaflet length (cm)
A-38	93.7	4.5	7.2	12.4
A-1523	109.4	4.7	5.3	9.4
A-1725	90.8	3.7	7.7	12.6
A-4232	115.6	3.1	8.1	11.8
A-4548	147.7	2.7	7.3	12.8
M-1	111.1	3.7	6.7	11.6
M-14	96.6	4.8	6.5	11.4
MDY-7	132.9	2.3	6.6	11.9
MDY-8	122.7	2.3	6.9	12.6
MDY-9	138.1	1.2	6.4	11.5
Derry	153.3	2.8	7.1	12.4
Greencastle	173.4	1.9	7.9	12.6
Laredo	162.8	3.5	6.9	10.2
Yemsoy	96.9	2.7	7.5	13.5
Yesilsoy	110.3	2.6	8.3	12.9
Average	123.8	3.1	7.1	12.0
LSD (0.05)	6.1	0.5	0.6	0.8

A significant interaction existed between soybean genotypes between years in morphological traits and DM yield in experimental years (Table 4). Dry matter yield of 9645 kg ha^{-1} in the second year of the study was only about 60% the average yield of the first year 15931kg ha^{-1}. The tall, later-maturing, forage-type soybean cultivar Greencastle had about the average DM drop, but consistently out-yielded the other soybean genotypes and forage type cultivars in both years

Dry matter yield of Greencastle was 26028 kg ha^{-1}, compared to other high-yielding A-4548 (24631 kg ha^{-1}) and Derry (23883 kg ha^{-1}) in 2014. Greencastle produced 16185 kg ha^{-1} DM yield followed by A-4548 (12749 kg ha^{-1}) and MDY-7 (12007 kg ha^{-1}) in 2015 while Derry (10097 kg ha^{-1}) dropped to fifth place in total DM the second year.

Table 4. Dry matter yield of soybeans genotypes in main cropping conditions (kg ha^{-1})

Genotypes	Years	
	2014	2015
A-38	13308	5683
A-1523	10007	8779
A-1725	11530	10141
A-4232	9878	9611
A-4548	24631	12749
M-1	15723	8528
M-14	10402	7819
MDY-7	19674	12007
MDY-8	22924	9911
MDY-9	15297	10449
Derry	23883	10097
Greencastle	26028	16185
Laredo	13641	8982
Yemsoy	9670	7340
Yesilsoy	12371	6399
Average	15931	9645
LSD (0.05)	1662	288

Although weather conditions vary by year, the later spring planting date in 2015 appears to have made a significant difference in individual genotype DM performance. Some genotypes decreased DM over 50% (e.g. Derry down 57.5%, A-38 down 57.3%, and MDY-8 down 56.8%) while other genotypes declined less than 15% (e.g. A-4232 down 2.7%, A-1725 down 12.0%, and A-1523 down 12.3%). Optimum planting dates for soybean forage yield in this location have not been established.

The analyses of variance indicated significant effects for genotypes and years for each of the traits evaluated and DM yield in the double cropping soybean trial. Significant genotype x year interactions also occurred for all measured traits and DM yield (Table 5).

Table 5. Variance analysis of measured quality characteristics in double cropping conditions (combined years 2014 and 2015)

	DF*	Plant height	Branch/Plant	Leaflet width	Leaflet length	Dry matter yield
Genotypes (G)	8	**	**	**	**	**
Years (Y)	1	**	**	**	*	**
G x Y	8	**	**	**	**	**
Blocks	4	ns	ns	ns	ns	ns
Error	32					

*degree of freedom, *, **: F-test significant at P < 0.05, and P < 0.01, respectively; ns, not significant.

Average across years, plant height, branch/plant, and leaflet dimensions in double crop soybeans were summarized in Table 6. Soybean genotypes differed significantly in those traits. Plant height, branching and leaflet dimensions were significantly influenced by the genotypes. Plant height of soybean genotypes averaged 89.7 cm, while plant height of forage-type cultivars Laredo and Derry were well over 100 cm. Branches per plant varied from 1.6 to 3.4; leaflet width varied from 7.2 cm to 8.9 cm, and leaflet length varied from 10.4 cm to 12.7 cm among soybean genotypes in 2014 and 2015 (Table 6).

Table 6. Plant characteristics of soybeans genotypes double cropping conditions (combined years 2014 and 2015)

Genotypes	Plant height (cm)	Branch/ Plant	Leaflet width (cm)	Leaflet length (cm)
A-4232	81.6	2.3	8.7	12.4
M-14	71.6	3.3	7.6	11.3
M-42	68.1	2.8	7.7	12.0
MDY-2	66.4	3.4	7.9	11.8
MDY-4	75.8	3.1	7.2	11.5
Derry	115.7	2.0	7.9	10.4
Laredo	137.4	1.6	8.5	11.7
Yemsoy	93.8	2.4	8.9	12.7
Yesilsoy	96.6	1.9	8.8	12.7
Average	89.7	2.5	8.1	11.8
LSD(0.05)	5.9	0.3	0.6	0.7

When double cropped, soybean genotypes differed significantly in DM yield in both experimental years. In 2014, DM yields of double crop ranged from a low of 5499 kg ha $^{-1}$ to 13293 kg ha^{-1}, while two forage-type cultivars Laredo and Yesilsoy produced more than 12500 kg ha^{-1} DM yield, which was up over 150% of the average. In the second season (2015), Laredo and Yesilsoy were also the highest DM yielding cultivars 130% above the average (Table 7). Just as genotype DM average was down about 40% in 2015 vs. 2014 in the main planting season, likewise 2015 double crop DM yields averaged 23.6% less than 2014 even though 2015 double crop was planted 9 July 2015 five days earlier than in 2014 indicating year-to-year weather differences.

Table 7. Dry matter yield of soybeans genotypes in double cropping conditions (kg ha^{-1})

Genotypes	Years	
	2014	2015
A-4232	5499	5814
M-14	7396	5519
M-42	7276	6394
MDY-2	5999	5533
MDY-4	6835	4568
Derry	9264	6524
Laredo	12509	8513
Yemsoy	6557	5859
Yesilsoy	13293	8332
Average	8292	6339
LSD (0.05)	1102	329

4. Discussion

In this study, soybean genotypes flowered approximately two and half months after seeding in main cropping conditions compared to over three months to flowering for check cultivars. Whereas, soybean genotypes flowered under two months after seeding (averaging 49.6 days) compared to 55 days to average flowering for check cultivars in double cropping conditions. Soybean genotypes and cultivars flowered about 23 and 39 days, respectively, earlier in double cropping than main cropping conditions. This supports Calvino et al. (2003) who reported that double crop soybean cultivars flowered earlier in cooler environments in the southern Pampas, Argentina. It is well known that soybean flowering may begin within 25 to 50 days after seeding, depending on cultivars and environmental conditions (Hume et al., 1985) which was the case in our double cropping trials, but flowering averaged 72.5 days for soybean genotypes and 94 days after planting for our check cultivars.

Earlier reports indicated that delayed seedings shortened season length, leading to overall growth reductions in soybean (Calvino et al., 2003; Lawn and Hume, 1985; Purcell et al., 1987;). Our studies clearly showed that both soybean genotypes and check cultivars in double crop conditions were shorter than main crop conditions. In close agreement with our results, several researchers indicated that late seedings were shorter than plants in early seedings (Anderson and Vasilas, 1985; Pedersen and Lauer, 2004a, 2004b; De Bruin et al., 2010; Gulluoglu et al., 2016). Similarly, the genotypes had more branched plants in main cropping conditions. However, there was extensive branch development on some soybean genotypes, and was little branch production on other genotypes in both main and double cropping conditions.

It is well known that as soybeans mature, the leaf proportion rapidly declined, stem and petiole proportions were stable or declined slowly, and pod proportion rapidly increased (Hintz and Albrecht, 1994; Acikgoz et al., 2007, 2013). In this study, stem, leaflet, petioles and flower + pod proportions of soybean genotypes tested were 34.4, 38.1, 16.7 and 10.8%, respectively and forage type cultivars had slightly higher stem and lower leaflet percentages in main cropping conditions. Similarly, Hintz and Albrecht (1994) reported that average leaf (including petioles), stem and pod proportions were 51.2, 38.3 and 10.5%, respectively at R5 stage of early soybean (Corsoy 79) and late (Pella and Willams 82) soybean cultivars. The proportions in this study were in the range of our previous reports (Bilgili et al., 2005; Acikgoz et al., 2007, 2013). Double cropping soybeans genotypes had more leaflet and less stem proportions. Soybeans in double cropping initiated flowering earlier than main cropping soybeans, resulting in shorter plant height and lower stem yield.

Based on the one year augmented study, it clearly showed that there was significant DM yield and morphological traits differences between the seventy soybean genotypes. This indicated variability among soybean genotypes enabling selection for DM traits to develop new forage soybean genotypes for main and double cropping conditions.

The forage yield potential of soybeans was tested in detailed studies in 2014 and 2015. A genotypes x years' interaction occurred for DM yield in both seeding times, particularly in main cropping conditions. Dry matter yield averaged 15931 kg ha^{-1} in first year and 9645 kg ha^{-1} in the second year of the study. Lower DM yield in the second year of study was attributed to 34 days late seeding, because of heavy rains, although the second year also had lower DM yields when double cropped but planting occurred five days earlier in 2015. Consequently, year-to-year differences should be expected with some cultivars showing more differences than others providing trait selection criteria for subsequent forage soybean development.

Late maturing forage type varieties tend to grow taller and produce more DM yield. DM yield potential of some soybeans can exceed 20-25 tonnes per hectare in main crop conditions with the average of 15 genotypes yielding nearly 16 tonnes per hectare. Even late seeding in our second year, DM yield potential exceeded 16 tonnes per hectare on one genotype with an average of 9.6 tonnes. Our average and maximum DM yields for main cropping soybeans exceeded those of previous studies conducted in different regions of USA. Hintz et al. (1992) reported DM yield ranges from 2400 to 7400 kg ha^{-1}, Seiter et al. (2004) obtained DM yields ranged from 4500 to 13,900 kg ha^{-1}, and Sheaffer et al. (2001) had 8800 kg ha^{-1}. Dry matter yields of Derry and Donegal reached 7.95 t ha^{-1} in UK conditions (Koivisto et al., 2003). Mostly oil type soybeans produced 7343 kg ha^{-1} DM yield in Ankara, Turkey (Altinok et al., 2004). Reports of DM yield of soybeans in regions with a typical Mediterranean-type climate were limited. In our previous studies, DM yield of some soybean genotypes was comparable or slightly less than this study, ranging 12 to 13 ton per hectare in regions with Mediterranean-type climate (Bilgili et al., 2005; Acikgoz et al., 2007, 2013).

Even planting the 9th and 14th of July, dry matter yield of double crop soybeans averaged 8292 and 6339 kg ha^{-1} in first and second experimental years of this study, respectively. Forage-type cultivars Laredo and Yesilsoy produced more than 10 tonnes ha^{-1} combining two-year average DM yield. Since Laredo is the oldest continually produced soybean variety in the USA (introduced from China in 1914), surely improvements can be made on soybean DM performance compared to a variety that has been continuously used by soybean forage growers for over a century.

Proper seeding rates by branching affect to maximize soybean forage yield and quality have not been established. Effect of disease, nematodes, nutrient efficiency, solar radiation, proper maturity by latitude, proper planting dates by maturity, and feed quality characteristics based on livestock category in main 13 double cropping systems are considerations for selecting forage soybean genotypes, but were not covered in this study. All those factors have potential to influence soybean forage yield and quality when seed selection of cultivars is made by growers with planned forage use intensions.

As expected, DM yield of double cropping soybeans was lower than those of main cropping caused by later planting. Average across years and genotypes, DM yield of main cropping was 12788 kg ha^{-1} while only 7316 kg ha^{-1} when double cropping. In the absence of pests, soybean yield and yield components can be affected by growth habit, planting date, and climatic conditions.

Soybean forage quality varies by genotype, harvest timing, and environmental factors. When anticipating grazing or timing forage harvest, realize easily digestible grass and broadleaf soluble sugars vary by forage type; are impacted by environmental stress, and influence plant growth by regulating genes affecting metabolism (Brown, 1999; Mariana et al., 2009; Wietgrefe, 2014). Plants progress to maturity accumulating indigestible lignin (not uniformly) and decrease crude protein in plant DM (Altinok, 2004; Bellaloui, 2012; Hintz et al., 1992; Hintz et al., 1994). Therefore, soybean genotypes that maximize seed yield may not be suitable for forage use regardless of plant height, which does not correlate with DM yield (compare Tables 3 and 4).

Studies conducted in different regions showed that maximum seed yield was achieved with early seedings, then yields declined with soybean seeding date delayed (Beatty et al., 1982; Keim et al., 1999; Calvino et al., 2003; Pedersen and Lauer, 2004a, 2004b; De Bruin et al., 2010; Zhi-gang et al., 2011). Our studies tentatively indicate the same is true for forage soybeans although maximizing forage quality by quantity is a necessary consideration.

Following the delayed planting trend, the average seed yield of double-crop soybean was clearly less than monoculture soybeans (Sanford, 1981; Gesch et al., 2014). Despite several published studies on the effect of seeding time on seed yield and seed yield performances of double cropping of soybean, the effect of seeding time on DM yield, DM yield genotype performance of double cropping, and main cropping vs. double cropping soybeans DM differences is not presently available. In close agreement with our results LeMahieu and Brinkman (1990) and Mackown et al., (2007) indicated that double cropping forage soybeans yielded clearly less than main cropping, particularly under dryland conditions.

As indicated by Darmosarkoro et al., (2001) and Rao et al., (2005), late-maturing forage type soybean cultivars tend to grow taller and produced greater DM yield. Our results suggested that soybeans cultivars, particularly forage type, would produce higher DM yield in double cropping conditions if harvested at R4 stage and likely feed quality would increase as stem percentage drops. In Bursa, tall forage soybean in maturity groups V, VI, and VII reached this stage at harvest in late September before a killing frost or heavy rains.

In this study, plants were cut at R4 stage for DM yield in order to obtain high quality hay production. It is well known that DM yield of soybeans increased from early to late harvest stage. Several researchers indicated DM increases in soybean up to R7 stage, and soybean grown for forage may be harvested near the R7 stage for maximum yield (Munoz et al., 1983; Hintz et al., 1992; Sheffer et al., 2001; Acikgoz et al., 2007; 2013) but forage quality is expected to decline with decreased leaflet compared to stem and flower+pod percentage. Whereas due to leaflet loss, R7 harvest increases feed protein characteristics supplied by mature seed, assuming seed shattering can be minimized during the wilting process. R7 bypass protein and higher oil content may limit palatability and milk production for dairy and negatively affect the ensilage fermentation process (Heinrichs et al., 1997).

In main crop conditions, cutting may be delayed until R7 stage to increase DM yield, which may not be allowable in double crop situations. Late maturing cultivars and genotypes may not reach the desired R7 stage of development because of fall temperature conditions. Also, hay production and condition may be effected negatively by low temperatures, heavy rains and wind causing lodging that could delay harvest, and lower DM yield when mechanically harvested. Therefore, earlier maturing forage genotypes may be advisable in double cropping system if later stage harvesting is sought.

5. Conclusion

In many countries, there is renewed interest in developing new soybean grazing and feed cultivars with improved DM yield and forage value for farmers seeking high-yielding annual legumes, annual plantings to allow more intense crop rotations, and planting date flexibility to maximize labor and equipment availability. The number of soybean genotypes tested in this study is limited when compared with soybean germplasm in different gene banks. However, our study clearly showed that a considerable range of variation is available in maturity, morphological traits, and DM yields for breeders to develop new forage soybean genotypes for main and double cropping conditions.

Our results from testing 70 diverse soybean genotypes showed DM yield varied by over two orders of magnitude. Regarding soybean forage quality, some of those genotypes had more than three times more s 14 weight and significantly less leaflet area than others. Therefore, growers would be ill advised to plant untested grain-type genotypes for grazing or forage expecting high and consistent yields.

Soybean forage is greatly affected by planting date, fall harvest conditions, temperature, amount and distribution pattern of precipitation, soil type, nutrient availability, and pest pressure. Plant heights were clearly shorter and flowering occurred three to five weeks earlier when our broad genotype selections were double cropped. When planting is delayed and quality soybean forage is sought for R4 harvest, clearly we confirmed leaflet percentage of double cropping was consistently higher than the spring planted main crop system. Main and double cropping showed yield components, plant part partitioning, and DM had statistically significant differences. Our study also clearly showed that properly selected forage soybean cultivars and genotypes could provide significant DM yields in both main and double cropping conditions in regions with a Mediterranean-type climate.

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References

Acikgoz, E., M. Sincik, M. Oz, S. Albayrak, G. Wietgrefe, Z.M. Turan, A.T. Goksoy, U. Bilgili, A. Karasu, O. Tongel and O. Canbolat. 2007. Forage soybean performance in Mediterranean environments. Field Crops Res. 103: 239-247.

Acikgoz, E., M. Sincik, G. Wietgrefe, M. Surmen, S. Cecen, T. Yavuz, C. Erdurmus and A.T. Goksoy. 2013. Dry matter accumulation and forage quality characteristics of different soybean genotypes. Turk J. Agric. For. 37: 22-32.

Altinok, S., I. Erdogdu and I. Rajcan. 2004. Morphology, forage and seed yield of soybean cultivars of different maturity grown as a forage crop in Turkey. Can. J. Plant Sci. 84: 181–186.

Anderson, L.R. and B.L. Vasilas. 1985. Effects of planting date on two soybean cultivars: Seasonal dry matter accumulation and seed yield. Crop Sci. 25: 999–1004.

Asekova, S, J.G. Shannon and L. Jeong-Dong Lee. 2014. The current status of forage soybean. Plant Breed Biotech. 2: 334-341.

Aydogdu, L. and E. Acikgoz. 1995. Effect of seeding rate on seed and hay yield in common vetch (Vicia sativa L.). J. Agron. Crop Sci. 174: 181–187.

Barnhart, S.K. 2007. Time is running out for planting an ‘emergency’ forage crop. Iowa State University, Ames, IA, USA.

Beatty, K.D., I.L. Eldridge and A.M. Simpson Jr. 1982. Soybean response to different planting patterns and dates. Agron. J. 74:559–562.

Bellaloui, N. 2012. Soybean seed phenol, lignin, and isoflavones partitioning as affected by seed node position and genotype differences. Crop Genetics Research Unit, USDA-ARS, Stoneville, USA, Food and Nutrition Sciences, Vol. 3, No. 4, Article ID: 18486.

Bennett, D. 2001. Food plots and forage soybeans. Delta Farm Press, Clarksville, MS, USA.

Bernard, R.I., G.A. Juvik and R.I. Nelson. 1987. USDA soybean germplasm collection inventory. Vol. 1 INTSOY Series No. 30: 12-13.

Bilgili, U., M. Sincik, A.T. Goksoy, Z.M. Turan and E. Acikgoz. 2005. Forage and grain yield performances of soybean lines. J. Cent. Eu.r Agr. 6:405–410.

Brown, C. 1999. Soybean as a forage crop. Ministry of Agriculture, Food, and Consumer Affairs, Ontario, Canada.

Calvino, P.A., V.O. Sadras and F.H. Andrade. 2003. Development, growth and yield of late-sown soybean in the southern Pampas. European J. Agronomy. 19: 265-275.

Darmosarkoro, W., M.M. Harbur, D.R. Buxton, K.J. Moore, T.E. Devine and I.C. Anderson. 2001. Growth, development and yield of soybean lines developed for forage. Agron. J. 93: 1028-1034.

De Bruin, J.L., J.W. Singer, P. Pedersen and J.L. Rotundo. 2010. Soybean photosynthetic rate and carbon fixation at early and late planting dates. Crop Sci. 50: 2516–2524.

Devine, T.E. and E.O. Hatley. 1998. Registration of ‘Donegal’ forage soybean. Crop Sci. 38: 1719–1720.

Devine, T.E., E.O. Hatley and D.E. Starner. 1998. Registration of ‘Derry’ forage soybean. Crop Sci. 38: 1719.

Gesch, R.W., D.W. Archer and M.T. Berti. 2014. Dual cropping winter camelina with soybean in the Northern Corn Belt. Agron. J. 106: 1735-1745.

Gulluoglu, L., H. Bakal, and H. Arioglu 2016. The effects of twin-row planting pattern and plant population on seed yield and yield components of soybean at late double-cropped planting in Cukurova Region. Turk. J. Field Crops, 21: 60-66

Hancock Seed Company, Laredo seed advertisement, 2016. Hancock Farm & Seed Co., Inc., 18724 Hancock Farm Rd., Dade City, FL 33523, USA

Heinrichs, A.J., V.A. Ishler and R.S. Adams. 1997. Feeding during shortages of home-grown feeds. PennState Extension, Bellenfonte, PA, USA, DAS 97-17.

Hintz, R.W., K.A. Albrecht and E.S. Oplinger. 1992. Yield and quality of soybean forage as affected by cultivar and management practices. Agron. J. 84: 795-798.

Hintz, R.W. and K.A. Albrecht. 1994. Dry matter partitioning and forage nutritive value of soybean plant components. Agron. J. 86: 59-62.

Hume, D. J, S. Shanmugasundaram and W.D. Bevensdorf. 1985. Soyabean (Gylcine max. L. Merrill.). In: Grain Legume Crops, ed. Summerfield, R.J. and Roberts, E.H.William Collins Sons & Co. Ltd. London, p. 391-432.

Keim, K.R., A. Eren and L.H. Edwards. 1999. Long-term study of planting date effects on seed yield in soybean. J. Prod. Agric. 12: 288-292.

Koivisto, J.M., T.E. Devine, G.P.F. Lane, C.A. Sawyer and H.J. Brown. 2003. Forage soybeans [Glycine max (L.) Merr.] in the United Kingdom: Test of new cultivars. Agronomie. 23: 287-291.

Lawn, R.J. and D.J. Hume. 1985. Response of tropical and temperature soybean genotypes to temperature during early reproductive growth. Crop Sci. 25: 137-142.

LeMahieu, P.J. and M.A. Brinkman. 1990. Double-cropping soybean after harvesting small grains as forage in the North Central USA. J. Prod. Agric. 3: 385-389.

MacKown, C.T., J.J. Heitholt and S.C. Rao. 2007. Agronomic feasibility of a continuous double crop of winter wheat and soybean forage in the southern Great Plains. Crop Sci. 47: 1652-1660.

Mariana R., C. Prado, G. Podazza, R. Interdonato, J.A. Gonzalez, M. Hilal and F.E. Prado. 2009. Soluble sugars-Metabolism, sensing and abiotic stress, a complex network in the life of plants. Plant Signal Behav. 4(5): 388-393.

Morse, W.J. 1919. Sept. 26 Letter to Prof. C.V. Piper at USDA Bureau of Plant Industry. Washington, DC. USA.

Munoz, A.E., E.C. Holt and R.W. Weaver. 1983. Yield and quality of soybean hay as influenced by stage of growth and plant density. Agron. J. 75: 147–148.

Nayigihugu, V., W. Kellogg, D. Longer, Z. Johnson and K. Anschutz. 2000. Performance and ensiling characteristics of tall growing soybean lines used for forage. Anim. Sci. Dep. Rep. 470. Arkansas Agric. Exp. Stn., University of Arkansas, Fayetteville, USA, p. 142-147.

Pedersen, P. and J.G. Lauer. 2004a. Soybean growth and development in various management systems and planting dates. Crop Sci. 44: 508–515.

Pedersen, P. and J.G. Lauer. 2004b. Response of soybean yield components to management system and planting date. Agron. J. 96: 1372–1381.

Piper, C.V. and W.J. Morse. 1923. The soybean. New York, NY: McGraw-Hill Book Co., USA, xv+329, p. March. See p. 166.

Purcell, L.C., D.A. Ashley and H.R. Boerma. 1987. Effects of chilling on photosynthetic capacity and leaf carbohydrate and nitrogen status of soybean. Crop Sci. 27: 90-95.

Rao, S.C., H.S. Mayeux and B.K. Northup. 2005. Performance of forage soybean in the southern great plains. Crop Sci. 45: 1973–1977.

Sanford, J.O. 1981. Straw and tillage management practices in soybean-wheat double-cropping. Agron. J. 74: 1032-1035.

Seiter, S, C.E. Altemose and H.M. Davis. 2004. Forage soybean yield and quality responses to plant density and row distance. Agron. J. 96:966-970.

Sheaffer, C.C., J.H. Orf, T.E. Devine and J.G. Jewett. 2001. Yield and quality of forage soybean. Agron. J. 93: 99-106.

Shurtleff, W. and A. Aoyagi. 2013. Early named soybean varieties in the United States and Canada, Ref. 689, p. 317.

Shurtleff, W., H.T. Haung and A. Aoyagi. 2013. History of soybeans and soyfoods in China and Taiwan. Ref. 2018, p. 878.

Taylor, W.A. 1920. Soybean. USDA Department Circular No. 120, p. 4.

Touchton, T. and J.W. Johnson. 1981. Soybean tillage and planting method effects on yield of double-cropped wheat and soybeans. Agron. J. 74: 57-59.

Undersander, D. 2001. Soybeans for hay or silage. University of Wisconsin, Madison, WI, USA.

Uzun, A., U. Bilgili, M. Sincik and E. Acikgoz. 2005. Yield and quality of forage type pea lines of contrasting leaf types. Eur. J. Agron. 22: 85–94.

Wietgrefe, G. 2014. Systems and processes for producing biofuels from biomass. Assignee: Syngenta Participations AG, Basel (CH), US Patent No. 8641910 B2, table 9.

WMS, Laredo soybean advertisement. 2016. Wildlife Management Solutions, Inc., 14281 Hwy. 11 S., Eutaw, Alabama, USA

Zhi-gang, Z., L. Rui-ping, J.I. Yue-mei, H. Ji-bing and S. Wen-ping. 2011. The effect of different sowing dates on yield and properties of Ningxia soybean. Chinese Seed.2: 24-25.

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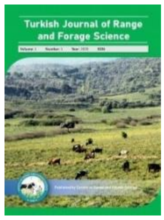

Seed Dormancy and Germination in F_5 Strains from *Vicia sativa* subsp. *sativa* x *Vicia sativa* subsp. *macrocarpa*

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The objectives of this study were to determine the seed dormancy and germination characteristics of F_5 strains from common vetch x big seeded vetch hybrids. White flowered common vetch accessions and red-flowered accessions were crossed and a total 24 high forage and seed yielding strains were developed from F_5 generation of different hybrid combinations. Standard germination tests were performed at a temperature of 20°C, without light, for 14 days. The seeds were subjected to (a) no treatment (control); (b) chilling; (c) mechanical scarification; and (d) mechanical scarification + chilling. The first counts were taken on day-5 and the final counts were made on day-14.

Hard seed percentages were very low in the tested common vetch cultivars and strains. Chilling slightly increased the germination rate in some accessions. Big seeded vetch seeds showed very high hard seed contents with the germination percentage of Ericek strain were only 5-15% and almost nil in ICARDA-5283. Big seeded vetch seeds required scarification + prechilling treatments to overcome seed dormancy. The strains differed in the persistence of hard seed in all hybrid combinations. Untreated control seeds of some strains had very high germination rates. Contrarily, some hybrid seeds required prechilling and/or scarification treatments to induce germination.

1. Introduction

Vicia sativa L. is a genetically and phenotypically variable genus comprised of several subspecies, and known as a *Vicia sativa* complex. Common vetch (*Vicia sativa* subsp. *sativa* L.) is widespread around many parts of the world.

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It is commonly grown winter cover crops, or green manure, and is also used as past pasture, silage, and hay (Seymour et al., 2002; Uzun et al., 2011). Big seeded vetch (subsp. macrocarpa) is late maturing vigorous subspecies with limited agronomic uses as a fodder. It has a small number of pods per plant, but it seeds are very large (Berger et al., 2002; Van de Wouw et al., 2003). Its hard seed coat and physiological dormancy did not allow high germination during the one-year period after harvest (Uzun et al., 2013). Shattering is also a major problem in seed production of big seeded vetch. Most species of *Vicia* have an impermeable seed coat that imposes a physical exogenous dormancy (Elkins et al., 1966; Mosjidis and Zhang, 1995; Ortega-Olivencia and Devesa, 1997). In our previous studies, the *Vicia sativa* subsp. *macrocarpa* seeds had very low final germination rates (2-4%) throughout the 12 months periods in two experimental years. Mechanical scarification did not enhance the germination and chilling slightly increased. The germination rates maximized 74% in the seeds subjected to both scarification and chilling treatments (Uzun et al., 2013). Mechanical scarification improved the germination rate in several *Medicago* and *Trifolium* species (Aydin and Uzun, 2001; Can et al., 2009; Khaef et al., 2011).

Hard seeds have a survival advantage than soft seeds, but it causes problems in the short term rotations. Hard seed content results in poor stand establishment because of reduced germination and non-uniformed seedling emergence. Therefore, hard seeds require dormancy-breaking treatments before using in short term crop rotations for successful stand establishment. The treatments to break the seed dormancy are tedious and time-consuming applications. This problem is overcome by developing the cultivars which have a very high percentage of soft seeds. Contrarily, hard seeded annual Medicago and Trifolium species have superior self-reseeding characteristics in the dryland rangelands. The plants can regenerate in later years from residual hard seeds. Hard seeded vetches with pod-shattering traits may re-establish themselves by natural reseeding. Limited information is available in the published literature about the seed dormancy characteristics of common vetch x big seeded vetch hybrids. This present study was conducted to assess the dormancy characteristics of selected high yielding strains *of Vicia sativa* subsp. *sativa* x *Vicia sativa* subsp. *macrocarpa* hybrids, and to determine the effects of some pretreatments on the release of seed dormancy.

2. Materials and Method

Two white flowered common vetch (*Vicia sativa subsp. sativa* L.) accessions (W-1 and Soner) and two red-flowered big seeded vetch (*Vicia sativa* subsp. *macrocarpa* (Moris) Archang.) accessions (Ericek and ICARDA-5283) were crossed in 2009-2010 growing season under greenhouse conditions. White-flowered sativa accessions were used as a female and purple-flowered macrocarpa accessions were used as a male in the hybridization studies. Purple flower color is completely dominant to white (Donnelly and Clark, 1962; Chowdhury et al., 2004). Therefore, hybrid plants were easily detected by purple flowers during the flowering stage. F1 and F2 plants were grown in the greenhouse conditions. Selections were started in F3 generation in field conditions and continued in F4 and F5 generations for high seed and forage yields. The research material of this study consisted of the 13 strains from W-1 x Ericek hybrid, 9 strains from W-1 x Soner hybrid and 2 strains from W-1 x ICARDA 5283 hybrid selected for high seed and forage yields. The fall-seeded strains were grown under rain-fed conditions of Uludag University research plots in Bursa, Turkey. No fertilizers or chemicals were applied. The seeds of all strains were harvested in June 2016, threshed and cleaned by hand. The seeds were stored in paper bags at room temperature (20-21°C) during the experimental period.

Germination studies of each hybrid combination were done separately in the October – December period of 2016. Standard germination tests (ISTA, 2007) were performed using a completely randomized block design. Two replications of 50 seeds for each treatment were placed on blotter paper in 9-cm-diameter Petri dishes in a germination chamber at a temperature of 20°C, without light, for 14 days. First counts were taken on day-5 and final counts were made on day-14. The seeds were subjected to (a) no treatment (control); (b) chilling; (c) mechanical scarification; and (d) mechanical scarification + chilling, as applied in our previous study (Uzun et al., 2013).

For each test, analysis of variance (ANOVA) was performed separately with the statistical package JMP 5.0.1 (SAS, 1989-2002). Statistically significant differences among the mean values were determined with the least significant difference (LSD) test at the 0.05 level.

3. Results and Discussion

According to analysis of variance, genotypes, treatments and genotype x treatments were statistically significant at 0.01 level in all tests. The results of analysis of variance and LSD values of the treatments were summarized in Table 1.

In close agreement with previous studies (Sattell et al., 1998; Samarah et al., 2004; Uzun et al., 2013), hard seed percentages were very low in tested common vetch cultivars and strains. Particularly W-1 strain showed very high germination (95 – 100%) in the tests. Germination rate was 79% in untreated normal seeds and reach 99% after chilling period in cv. Soner seeds. Big seeded vetch was very hard in all tests. The germination percentage of Ericek strain at 14 days after planting was only 5-15% in the two tests. No germination was obtained in ICARDA-5283 normal seeds. This finding was consistent with our previous study (Uzun et al., 2013). The scarification treatment did not improve seed germination in both stains of big seeded vetch. The chilled seeds of big seeded vetch germinated to a higher percentage, 47-57% in Ericek strain and 47% in ICARDA-5283, at 14 days. If scarified seeds are subsequently subjected to the chilling period, the final germination rates were reached

82-92% in Ericek and 75% in ICARDA-5283. This result clearly showed that dormancy cannot be broken by scarification or chilling treatment only, but big seeded vetch seeds required scarification + prechilling treatments to overcome seed dormancy largely (Table 2, 3, 4).

In W-1 x Ericek hybrids, untreated control seeds of several strains (6a1, 6b, 6c, and 8a1) had more than 75% germination at after 5 days and 89% at after 14 days. The other strains had very high percentage of hard seeds, some of the hybrid strains (1, 10, 11, 2a1, 2b, 5b1 and 5b2) showed less than 50% germination at after 14 days. After scarification, 84-97% of the seed germinated, and after scarification + chilling nearly all seeds germinated in those strains (Table 2).

Table 1. Results of variance analysis of germination speed and rates with lsd values in the tests

Source	df	Germination speed		Germination rate	
		F values	Lsd (0.05)	F values	Lsd (0.05)
W-1 x Ericek hybrids					
Genotypes (G)	14	**	8.52	**	6.94
Blocks (B)	3	**	4.40	**	3.58
G x B Interaction	42	**	17.04	**	13.88
Soner x Ericek Hybrids					
Genotypes (G)	10	**	10.53	**	9.34
Blocks (B)	3	**	6.35	**	5.63
G x B Interaction	30	**	21.06	**	18.68
W-1 x ICARDA-5283 Hybrids					
Genotypes (G)	3	**	10.3	**	9.2
Blocks (B)	3	**	10.2	**	9.3
G x B Interaction	9	**	20.4	**	18.3

df: degree of freedom, **: F-test significant at 0.01 level,

Table 2. Germination speed (after five days) and germination rates (after 14 days) of common vetch W-1 and big vetch Ericek hybrids (%).

Genotypes	Germination speed (%)					Germination rate (%)				
	N*	S	C	S + C	Average	N	S	C	S + C	Average
1	6	59	11	86	40.5 d**	40	84	32	91	61.8 ef
10	13	44	17	90	41.0 d	27	78	32	95	58.0 efg
11	36	89	16	96	59.3 c	44	97	18	98	64.3 e
2a1	4	48	9	84	36.3 de	13	80	13	94	50.0 h
2b	5	41	2	65	28.3 e	27	87	17	80	52.8 gh
5a	55	72	70	77	68.3 b	74	77	77	86	78.5 d
5b1	12	77	84	94	66.8 bc	24	91	86	94	73.8 d
5b2	7	26	6	92	32.8 de	35	84	15	95	57.3 fg
6a1	86	99	92	93	92.5 a	96	99	95	100	97.5 a
6b	75	85	86	99	86.3 b	97	99	97	100	98.3 a
6c	84	80	83	92	84.8 a	90	90	88	94	90.5 bc
8a1	90	89	73	97	87.3 a	90	95	86	98	92.3 abc
8b1	78	72	72	74	74.0 b	89	92	76	87	86.0 c
W-1	82	86	91	91	87.5 a	95	93	97	94	94.8 ab
Ericek	2	8	23	84	29.3 e	15	21	57	92	46.3h
Average	42.3 D	65.9 B	48.0 C	87.6 A		57.1 C	86.7 B	56.7 C	93.2 A	

*: N: untreated control, S: scarification, C: chilling, S+C: scarification + chilling

**: The percentages within germination speed and rates that are followed by the same letter are not significantly different at the 0.05 level using the LSD test.

Table 3. Germination speed (after five days) and germination rates (after 14 days) of common vetch Soner and big vetch Ericek hybrids (%).

Genotypes	Germination speed (%)					Germination rate (%)				
	N*	S	C	S + C	Average	N	S	C	S + C	Average
1	16	30	48	72	41.5 fg**	33	40	70	79	55.5 ef
2b	24	32	66	86	52.0 def	33	51	83	92	61.8 cde
2c	13	28	44	69	38.5 g	23	44	50	70	48.8 f
2d1	28	35	53	94	52.5 de	51	50	79	98	69.5 bc
3a	39	50	93	95	69.3 ab	47	55	97	96	73.8 bc
3b	39	32	81	90	60.5 bcd	47	40	88	91	66.5 cd
3c	58	47	79	81	66.3 abc	74	59	89	88	77.5 b
3d	23	17	93	63	49 efg	44	27	66	98	58.8 de
4b	25	39	86	74	56 cde	44	46	96	80	66.5 cd
Soner	45	69	94	98	76.5 a	79	89	99	99	91.5 a
Ericek	1	1	22	69	23.5 h	5	2	47	82	34.0 g
Average	28.3 C	34.6 C	69.0 B	81.0 A		43.6 B	45.7 B	81.5 A	85.5 A	

*: N: untreated control, S: scarification, C: chilling, S+C: scarification + chilling

**: The percentages within germination speed and rates that are followed by the same letter are not significantly different at the 0.05 level using the LSD test.

Untreated normal seeds of most strains in Soner x Ericek hybrids showed very low germination speed and germination rates (Table 3). No soft seeded strain was detected in this hybrid combination. Chilling treatments significantly increased germination. Some strains (3a, 3b and 4b) had more than 80% germination after chilling treatments at after 5 days and more than 90% after 14 days. Scarification + chilling treatment increased the germination rate slightly in some strains but there was no significant difference between the average values of two treatments.

Scarification did not affect the germination rate of big seeded vetch strain ICARDA-5283 with completely no germination (Table 4). Chilling treatment and scarification + chilling treatment resulted in final germination rate of 47% and 75%, respectively. Germination speed and rates of the hybrids were intermediate between the two parents. Chilling treatment alone and scarification + chilling treatment showed the same final germination rate in the hybrids (91 and 95%).

The results of these experiments showed that seeds the hybrid strains of all combinations exhibited different levels of dormancy. Some strains produced more than 79% soft seeds. The normal seeds of some strains had very low germination rates. Germination pretreatments to break hard-seed dormancy in *Vicia sativa* subsp. *macrocarpa* parents and hybrid strains significantly improved germination. In general, the germination speed and rate of the scarified seeds increased compared to the untreated normal seeds but were lower than the germination of the scarified + chilled seeds. This indicated that dormancy was not imposed only by the impermeable seed coat.

Table 4. Germination speed (after five days) and germination rates (after 14 days) of common vetch W-1 and big vetch ICARDA 5283 hybrids (%).

Genotypes	Germination speed (%)					Germination rate (%)				
	N*	S	C	S + C	Average	N	S	C	S + C	Average
1	7	23	73	72	43.8 b**	28	28	79	91	56.5 b
2	21	26	58	87	48.0 b	28	33	84	95	60.0 b
W-1	94	84	81	89	87.0 a	100	90	96	88	93.5 a
5283	0	0	9	63	18.0 c	0	0	47	75	30.5 c
Average	30.5 C	33.3 C	55.3 B	77.8 A		39.0 B	37.8 B	79.5 A	84.3 A	

*: N: untreated control, S: scarification, C: chilling, S+C: scarification + chilling

**: The percentages within germination speed and rates that are followed by the same letter are not significantly different at the 0.05 level using the LSD test.

As indicated in our previous study (Uzun et al., 2013), the seeds of *Vicia sativa* subsp. *macrocarpa* parents and some hybrid strains possessed physiological dormancy rather than just physical dormancy, scarification alone did not allow high germination. The combined scarification and chilling treatment was a suitable method to release the seeds from dormancy.

The experiments clearly showed that both soft seeded and hard seeded strains can be developed from *Vicia sativa* subsp. *sativa* x *Vicia sativa* subsp. *macrocarpa* hybrids. The hybrids combined with the high hay and seed yields with the soft seed are suitable for use in the crop rotations, without the risk of a weed problem in the following crops. Contrarily, several strains in this study had very high percentage of hard seeds and some of them showed severe pod-shattering during seed harvest. Those characteristics permit natural reseeding and persist continuously in the pastures grazed properly. It is well known that self-regenerating and hard seeded annual legume species are widely grown in dryland pastures in some parts of Australia and New Zealand. Subterranean clover (*Trifolium subterraneum* L.) and annual medics (*Medicago* spp.) are the most successful species in those regions. However, new species could be considered in the future to overcome the constraints of existing species (Nichols, et al., 2012). Most cultivated *Vicia* species used as forage crops are not suitable for self-regenerating pastures. However, Christiansen et al. (1996) indicated that the hard seeded subterranean vetch (*Vicia sativa* ssp. *amphicarpa*) compares favorably with the annual *Medicago* spp. in most respects, and it has great potential for pasture improvement in dry areas. High hard seed content and pod shattering characteristics of *Vicia sativa* subsp. *sativa* x *Vicia sativa* subsp. *macrocarpa* hybrids make them suitable for self-regenerating pasture systems in those regions. Certainly, further breeding and selection activities will be included greater hardseededness, pod shattering and high forage yielding for pastures of low-rainfall regions, and tested under grazing conditions.

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References

Aydin, I. and F. Uzun. 2001. The effects of some applications on germination rate of Gelemen clover seeds gathered from natural vegetation in Samsun. Pakistan Journal of Biological Sciences. 4, 181-183.

Berger J.D., L.D. Robertson and P.S. Cocks. 2002. Agricultural potential of Mediterranean grain and forage legumes: Key differences between and within Vicia species in terms of phenology, yield, and agronomy give insight into plant adaptation to semi-arid environments. Genetic Resources and Crop Evolution. 49, 313–325.

Can, E., N. Celiktas, R. Hatipoglu and S. Avcı. 2009. Breaking seed dormancy of some annual Medicago and Trifolium species by different treatments. Turkish Journal of Field Crops. 14, 72-78.

Chowdhury, D.M.S., J.M. Rathjen, M.E. Tate and G. McDonald. 2004. Genetics of colour traits in common vetch (Vicia sativa L.). Euphytica. 136, 249–255.

Christiansen, S., A.M. Abd El Moneim, P.S. Cocks and M. Singh. 1996. Seed yield and hardseededness of two amphicarpic pasture legumes (Vicia sativa ssp. amphicarpa and Lathyrus ciliolatus) and two annual medics (Medicago rigidula and M. noeana). The Journal of Agricultural Science. 126, 421-427.

Donnelly, E. D. and E.M. Clark. 1962. Hybridization in the genus Vicia. Crop Science. 2, 141–145.

Elkins, D. M., C.S. Hoveland and E.D. Donnelly. 1966. Germination of Vicia species and interspecific lines as affected by temperature cycles. Crop Science. 6, 45-48.

ISTA. 2007. International rules for seed testing. International Seed Testing Association. Bassersdorf, Switzerland.

Khaef, N., H. Sadeghi and M. Taghvaei. 2011. Effects of new strategies for breaking dormancy of two annual medics (Medicago scutellata and Medicago polymorpha). American-Eurasian Journal of Agricultural and Environmental Sciences, 11, 626-632.

Mosjidis, J.A. and X. Zhang. 1995. Seed germination and root growth of several Vicia species at different temperature. Seed Science and Technology. 23, 749–759.

Nichols, P. G. H., C.K. Revell, A.W. Humphries, J.H. Howie, E.J. Hall,. G.A. Sandral, K. Ghamkhar and C.A. Harris. 2012. Temperate pasture legumes in Australia—their history, current use, and future prospects. Crop and Pasture Science. 63, 691–725.

Ortega-Olivencia, A. and J.A. Devesa. 1997. Seed set and germination in some wild species of Vicia from SW Europe (Spain). Nordic Journal of Botany. 17, 639-648.

Sattell, R., R. Dick, J. Luna, D. McGrath and E. Peachey. 1998. Common vetch (Vicia sativa L.). Oregon State Univ. Publ. EM 8695.

Samarah, N.H., N. Allataifeh, M.A. Turk and A.M. Tawaha. 2004. Seed germination and dormancy of fresh and air-dried seeds of common vetch (Vicia sativa L.) harvested at different stages of maturity. Seed Science and Technology. 32, 11-19.

Seymour, M., K.H.M. Siddique, N. Brandon, L. Martin and E. Jackson. 2002. Response of vetch (Vicia spp.) to plant density in southwestern Australia. Australian Journal Experimental Agriculture. 42, 1043-1051.

Uzun, A., S. Gucer and E. Acikgoz. 2011. Common vetch (Vicia sativa L.) germplasm. Correlations of crude protein and mineral content to seed traits. Plant Foods Human Nutrition. 66, 254–260.

Uzun, A., E. Sozen and E. Acikgoz. 2013. Seed dormancy and germination of Vicia sativa subsp. nigra and Vicia sativa subsp. macrocarpa. Seed Science. and Technology. 41, 137-142.

Van de Wouw, M., N. Maxted and B.V. Ford-Lloyd. 2003. A multivariate and cladistic study of Vicia L. Ser. Vicia (Fabaceae) based on analysis of morphological characters. Plant Systematics and Evolution. 237, 19-39.

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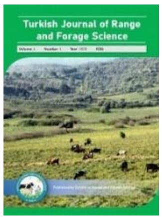

Determination of Leaf Yield and Quality Features Different Fodder Beet (*Beta vulgaris* var. *rapacea*)

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The aim of study was to compare the yield components of 5 different fodder beets (Rota, Brigadier, Feldherr, Nedimbey, Rekord poly) under Bingöl ecological conditions. The experiment was established in the trial area of the Genç Vocational School Application and Research area in Genç district of Bingöl province in 2018 growing period. The research was conducted with randomized block design with four replications. In this study, leaf posture, green leaf yield, dry leaf yield, crude ash ratio, crude protein ratio, crude protein yield, acid detergent fiber (ADF), nötral detergent fiber (NDF), dry matter digestibility (DMD), dry matter intake (DMI), relative feed value (RFV) of fodder animal varieties were examined. According to the results of the research; the highest green leaf yield (1748.0 kg da^{-1}), dry leaf yield (197.7 kg da^{-1}), crude protein yield (27.19 kg da^{-1}) in Brigadier cultivar; the highest crude ash ratio (7.55%), DMD (74.14%) in Rota cultivar; the highest crude protein ratio, DMI and RFV (14.48%, 3.27% and 187.9, respectively) in Feldherr cultivar were recorded.

1. Introduction

One of the indispensable parts of animal feeding is roughage, and roughage deficit is a very important problem in our country. Compared to other forage crops, fodder beet is of great importance in the feeding of dairy animals in terms of its nutrient, digestibility, high energy supply rate, it can be fed to animals at the end of harvest as well as preserving it for a long time.

The types of forage crops grown in our country for many years are vetch, alfalfa, vetch and sainfoin. In addition to these forage crops, silage corn and fodder beet have gained importance in recent years and they have taken place in field agriculture enough to be included in statistics. Animal beet, which has been produced in our country for many years, is an important forage plant especially for dairy farming. Animal beet production was made in 2012 on an area of 30,397 decares and 125,610 tons (TÜİK, 2012).

Animal beet is an important fodder plant with a high digestibility rate of 80-90%, providing the most nutrients and energy from the unit area compared to other fodder plants (Çetin, 1998). Fodder beet leaves are high in protein, but rich in Mg, Fe, K, Ca, Na, Cl and Mn (Ergül, 1988). Since the root-stem part develops above the ground compared to sugar beet, it is easier to remove it and keep it in winter for its durability. It is also content in terms of soil demands and is resistant to

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salinity (Sağlamtimur et al., 1995). Feeder beet tubers, which are used especially for dairy farming, are a very tasty and nutritious feed source (Albayrak and Çamaş, 2005). The aim of this research is to determine the leaf yield and quality characteristics of different fodder beet varieties in Bingöl province.

2. Material and Method

The research was carried out in 2018 cultivation period in the field of Application and Research in Bingöl University Genç Vocational School. The average height of the research area above sea level varies between 1100-1180 m. When the climatic data of Bingöl province are examined, it has been determined that the average monthly temperature for the 6-month period (between April and September) is 19.8 °C, total precipitation amount is 488 mm and the average relative humidity value is 45.2%. It is understood that the 2018 cultivation period in which the research was conducted is warmer (21.7 °C), less rainy (281 mm) and the relative humidity value (43%) is lower than the average of many years. Representative soil sample was obtained by mixing the samples taken from 0-30 cm soil depth from various parts of the cultivation area where the experiment was conducted. The analysis of the soil sample was done in Bingöl University Faculty of Agriculture, Department of Soil Science and Plant Nutrition. According to the analysis result; the soil structure of the research area was found to be sandy clay loam. The soil is poor in terms of organic matter content (1.88%), slightly basic in pH (7.41), less lime (0.22%), potassium (47.55 kg da^{-1}) and phosphorus (5.19 kg da^{-1}) was not sufficient in terms of content.

In the study, fodder beet varieties named Rota, Nedimbey, Feldherr, Brigadier and Rekord Poly were used as materials. The research was set up with 4 replications according to the randomized block design. The parcel area consists of 5 m length and 4 rows. Sowing was done in a row spacing of 40 cm and using 3 kg of seed per decare. DAP fertilizer was given to the soil where the experiment was carried out, with 4 kg nitrogen and 10 kg phosphorus (P_2O_5) per decare. After planting, when the rows are fully clear and the plants have 3-5 leaves, hoeing, singing and fertilizing were done as 5 kg pure nitrogen per decare. Plants were irrigated when needed by drip irrigation method.

Leaf posture patterns of the plant were determined according to 1-5 leaf posture scale (1-Vertical, 2-Semi-vertical, 3-Medium, 4-Semi-widespread, 5-Widespread) of 10 plants randomly selected from each plot. In the experiment, after the outermost row in each parcel and 0.5 m from the parcel heads, the leaves of the plants were cut from the root-stems in the remaining area and the weights of the green parts were taken and the weights obtained were converted into decares. After the 500 g leaf sample taken from each parcel was left to dry at 70 °C for 48 hours, the dry matter ratio was determined by weighing. Then, dry matter ratios and green leaf yield were multiplied by each other and dry leaf yield was determined. The nitrogen (N) content of the ground dry leaf samples was determined by Kjeldahl method. Crude protein ratio is obtained by multiplying the obtained nitrogen ratio by 6.25. (Anonymous, 1995). Crude protein yield per decare was obtained by multiplying the crude protein ratio in dry leaf with the dry leaf yield. ADF and NDF ratios were obtained using ANKOM 200 Fiber Analyzer (ANKOM Technology Corp. Fairport, NY, USA) device (Van Soest et al., 1991). Dry matter digestibility (DMD = 88.9- (0.777x% ADF)) amounts with the help of the obtained ADF ratio, dry matter intake (DMI = 120 / (% NDF)) with the help of NDF ratio and relative feed value with the help of DMD and DMI values (RFV = DMD x DMI) / 1.29) calculated (Morrison, 2003).

The data obtained in the study was analyzed by JUMP statistics package program in accordance with the random blocks experiment pattern. The comparison of factor averages that were statistically significant as a result of variance analysis was made with the Tukey test (Kalaycı, 2005).

3. Results and Discussion

Leaf Posture

Considering the leaf postures of fodder beet varieties, according to the scale of 1-5 (1. Vertical, 2. Semi-vertical, 3. Medium, 4. Semi-widespread, 5. Widespread) Rekord poly and Nedimbey types are semi-widespread, Rota and Feldherr types are semi-vertical and Brigadier variety is observed to have a medium leaf posture. In the study carried out by Güleş (2009) in Ankara conditions in some types of fodder beet, it was determined that Rota variety has a semi-widespread leaf and Feldheer variety has a widespread leaf posture. Although some of the varieties used in the experiments are the same, it can be said that the reason for the different leaf postures of the fodder beet varieties is due to the different ecological conditions such as soil and climate.

Table 1. Leaf postures determined in fodder beet varieties

Varieties	Leaf Postures (1-5 Scale)
Rekord poly	4
Rota	2
Nedimbey	4
Brigadier	3
Feldheer	2

Green Leaf and Dry Leaf Yields (kg da^{-1})

The difference between the green leaf and dry leaf yields of fodder beet varieties was found to be significant at 1% level.

When Table 2 is examined, the highest green leaf yield is obtained from Brigadier (1748.0 kg da^{-1}) variety, followed by Rekord poly (1661.0 kg da^{-1}) variety in the same statistical group. The lowest green leaf yield was obtained from Rota (1215.5 kg da^{-1}) cultivar. The average green leaf yield of fodder beet varieties was determined to be 1462.4 kg da^{-1}. When we look at the table, the highest dry leaf yield was obtained from Brigadier (197.7 kg da^{-1}) cultivar, as in green leaf yield, followed by Rekord poly (185.35 kg da^{-1}) which is in the same statistical group. The lowest dry leaf yield was obtained from Nedimbey (140.08 kg da^{-1}) variety. The average dry leaf yield of fodder beet varieties was determined to be 168.47 kg da^{-1}.

When studies on leaf yield are examined; Güleş (2009) reported that it varied between 1200-1514 kg da^{-1} in Ankara conditions, Erdoğdu et al. (2011) between 1436-1676 kg/da. These results are similar to results obtained. On the other hand, Acar (2000) reported that green leaf yield varied between 1316.3-3189.2 kg da^{-1} under Konya conditions, Albayrak and Çamaş (2006) between 1190-1230 kg da^{-1} in the Central Black Sea Region, Özaslan Parlak and Ekiz (2008) between 1763-2060 kg da^{-1} in Ankara conditions, Karadağ et al. (2014) between 2913-3270 kg da^{-1} under the conditions of Tokat-Kazova and Yilmaz (2018) reported that the green leaf yield varied between 1760-2548 kg da^{-1} and dry leaf yield between 218-344 kg da^{-1} under the conditions of Sakarya-Pamukova. It was determined that the results obtained were different from the findings obtained by the above researchers. The reason for the different results regarding the green and dry leaf yield is different; It can be said that the varieties used, the ecological conditions, the cultural processes applied and the cultivation times may be different.

Table 2. Average values of green leaf and dry leaf yields in fodder beet varieties

Varieties	Green Leaf Yield (kg da^{-1})	Dry Leaf Yield (kg da^{-1})
Rekord poly	1661.0 A**	185.35 A**
Rota	1215.5 C	154.18 B
Nedimbey	1257.0 C	140.08 C
Brigadier	1748.0 A	197.7 A
Feldheer	1427.5 B	165.05 B
Average	**1462.4**	**168.47**

**) Values shown with the same letter are statistically different from the LSD test within the error limits of 1% (P≤0.01).

Crude Ash and Crude Protein Ratios (%) and Crude Protein Yield (kg da^{-1})

It was determined that the difference between crude ash ratio and crude protein yields of fodder beet varieties was significant at 1% level and crude protein ratio was insignificant.

When Table 3 is examined, the highest crude ash ratio was obtained from Rota (7.55%) cultivar. The lowest crude ash ratio was obtained from Rekord poly (6,65%) variety. The average crude ash ratio of fodder beet varieties was determined to be 7.4%. Regarding the crude ash ratio in the leaf, it was determined as 19.7% in the study conducted by Dündar (2013), and 19.67% in the study conducted by Karadağ et al. (2014). These values obtained by the researchers are quite higher than the crude ash rate in the study.

Table 3. Average values of crude ash and crude protein ratios and crude protein yield in fodder beet varieties

Varieties	Crude Ash Ratio (%)	Crude Protein Ratio (%)	Crude kg da^{-1})
Rekord poly	6.65 B**	14.40	26.66 A**
Rota	7.55 A	13.05	20.17 B
Nedimbey	7.05 B	14.30	20.04 B
Brigadier	6.95 B	13.78	27.19 A
Feldheer	6.97 B	14.48	23.83 B
Average	**7.03**	**14.00**	**23.58**

**) Values shown with the same letter are statistically different from the LSD test within the error limits of 1% (P≤0.01).

When we look at the table, the crude protein ratios of the varieties ranged from 13.05% to 14.48%. The average of crude protein ratio of fodder beet varieties was determined as 14.00%. In the studies on the crude protein ratio of the leaves of fodder beet varieties, it was found to be 16.51% by Karadağ et al. (2014) and 22.2% by Yılmaz (2018). The findings of the researchers regarding the crude protein ratio were higher than the findings obtained in the study. When Table 3 is examined, the highest crude protein yield was obtained from Brigadier (27.19 kg da^{-1}) cultivar, followed by Rekord poly (26.66 kg da^{-1}) cultivar in the same group. The lowest crude protein yield was obtained from Feldherr (23.83 kg da^{-1}) variety. The crude protein yield average of fodder beet varieties was determined to be 23.58 kg/da. In studies conducted in different ecologies; Crude protein yield of fodder beet was determined as 15.3 kg da^{-1} by Özen et al (1981), 13.6 kg da^{-1} by Özgen (1993), 16.3 kg da^{-1} by Yazgan and Bahtiyarca (1996), 60.8 kg da^{-1} by Yılmaz (2018).

ADF, NDF, DMD and DMI ratios (%) and RFV

The difference between ADF, NDF, SKM and KMT ratios and NYDs of fodder beet varieties was found to be statistically insignificant.

When Table 4 is examined, ADF ratios of fodder beet varieties vary between 18.95-19.68%. The average ADF ratio of fodder beet varieties was determined to be 19.28%. NDF ratios vary between 36.70-38.28%. NDF average of fodder beet varieties was determined to be 37.58%. In studies conducted on ADF and NDF ratios of fodder beet leaves, Dündar (2013) reported 26.6% and 43.1%, Karadağ et al. (2014) 26.54% and 43.08%. The results obtained from the study were lower than the findings of the researchers.

When we look at the table, DMD ratios of varieties vary between 73.73-74.14%. The average DMD ratio of fodder beet varieties was determined to be 73.88%. In the studies on the ratio of dry matter digestibility in fodder beet, Özen et al. (1981) found 78.0%, Dündar (2013) 68.2%, Karadağ et al. (2014) 68.23%. The DMI ratio of fodder beet varieties varies between 3.14-3.27%. The average DMI ratio of fodder beet varieties was determined to be 3.20%. Relative feed values are between 179.51-187.92. The average of relative feed value of fodder beet varieties was determined to be 183.10. Karadağ et al. (2014) determined the relative feed value of fodder beet leaves as 147.32 in their study under Tokat-Kazova conditions.

Table 4. Average values of ADF, NDF, SKM and KMT ratios and RFV determined in fodder beet varieties

Varieties	ADF (%)	NDF (%)	DMD (%)	DMI (%)	RFV
Rekord poly	19.25	36.83	73.91	3.26	186.83
Rota	18.95	38.28	74.14	3.14	180.33
Nedimbey	19.68	37.85	73.58	3.17	180.93
Brigadier	19.48	38.23	73.73	3.14	179.51
Feldheer	19.05	36.70	74.06	3.27	187.92
Average	**19.28**	**37.58**	**73.88**	**3.20**	**183.10**

4. Conclusions and Recommendations

According to the results of this study conducted in the ecological conditions of Bingöl province, when the feeder beet is considered in terms of wet leaf, dry leaf and raw protein yields, Brigadier and Rekord poly varieties will be suitable for the region conditions, however, it was concluded that it would be more appropriate for us to reach definitive judgments by repeating this study for a few more years under the same conditions

References

Acar, R. 2000. Bazı yemlik pancar (Beta vulgaris L. rapacea Koch.) Çeşitlerinde farklı ekim zamanı ve bitki sıklıkları uygulamalarının verim, verim unsurları ve kalite üzerine etkileri, Selçuk Üniversitesi, Fen Bilimleri Enstitüsü, Tarla Bitkileri Ana Bilim Dalı, Doktora Tezi, s. 173.

Albayrak, S., N. Çamaş. 2005. Influence of row spacing on root yield and yield ponents of Fodder beet (Beta vulgaris var. crassa Mansf.) in the Black Sea Coastal Region, Tarım Bilimleri Dergisi 11(2): 160-164.

Albayrak, S., N. Çamaş. 2006. Yield components of fodder beet (Beta vulgaris var. crassa Mansf.) under the Middle Black Sea Region conditions, Tarım Bilimleri Dergisi 12(1): 65-69.

Anonymous. 1995. Tecator Application Note AN 300. The Determination of Nitrogen According to Kjeldahl

Using Block Digestion and Steam Distilation, Tecator AB Sweden, s. 1-11 .

Çetin, Y. 1998. Hayvan Pancarının Yetiştirilmesi, Tarım ve Köy, Tarım ve Köyişleri Bakanlığı Dergisi, Ankara, 123: 53-56.

Dündar, Z. 2013. Tokat-Kazova Ekolojık Koşullarında Bazı Yemlik Pancar (Beta vulagaris L. var. rapacea Koch.) Çeşitlerinin Verim ve Verim Özelliklerinin Belirlenmesi, Yüksek Lisans Tezi, Fen Bilimleri Enstitüsü, Tarla Bitkileri Anabilim Dalı, Gaziosmanpaşa Üniversitesi, Tokat, s. 27-57.

Erdoğdu, İ., A.L. Sever, A.K. Atalay. 2011. Eskişehir koşullarında hayvan pancarında yem verimleri ve bazı bitkisel özellikler, Gıda ve Yem Bilimi Teknolojisi Dergisi 11: 57-63.

Ergül, M. 1988. Yemler Bilgisi ve Teknolojisi, Ege University, Faculty of Agriculture Publications, No: 487, İzmir.

Güleş, A. 2009. Bazı hayvan pancarı (Beta vulgaris L. ssp. crassa Mansf.) çeşitlerinin verim ve verim öğeleri bakımından karşılaştırılması, Ankara Üniversitesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi.

Kalaycı, M. 2005. Örneklerle Jump kullanımı ve tarımsal araştırma için varyans analiz modelleri, Anadolu Tarımsal Araştırma Enstitüsü Müdürlüğü Yayınları, s. 21.

Karadağ, Y., Z. Dündar, M. Özkurt. 2014. Tokat-Kazova ekolojik koşullarında bazı yemlik pancar (Beta vulgaris L. var. rapacea Koch.) çeşitlerinin verim ve verim özellikleri, Gaziosmanpaşa Üniversitesi Ziraat Fakültesi Dergisi 31(2): 1-6.

Morrison, J.A. 2003. Hay and Pasture Management, Chapter 8.Extension Educator, Crop Systems Rockford Extension Center.

Özaslan Parlak, A., H. Ekiz. 2008. Ankara koşullarında bazı yemlik pancar (Beta vulgaris L. ssp. crassa Mansf.) çeşitlerinin verim ve verim öğeleri bakımından karşılaştırılması, Tarım Bilimleri Dergisi 14(2): 95-100.

Özen, N., A. Çakır, S. Haşimoğlu, A. Aksoy. 1981. Yemler Ders Teksiri, Atatürk Üniversitesi Ziraat Fakültesi Zootekni Bölümü, Erzurum.

Özgen, H. 1993. Hayvan Besleme, Selçuk Üniversitesi Veteriner Fakültesi Yayın No: 5, Konya.

Sağlamtimur, T., V. Tansı, H. Baytekin. 1995. Yem Bitkileri Yetiştirme Ders Kitabı, Çukurova Üniversitesi Ziraat Fakültesi Yayın No: 74, Adana.

TÜİK. 2012. http://www.tuik.gov.tr (Accessed 16.04.2019)

Van Soest, P.J., J.B. Robertson, B.A. Lewis. 1991. Methods for Dietary Fiber, Neutral Detergent Fiber and Non-starch Polysaccharides in Relation to Animal Nutrition. Journal Dairy Science 74: 3583-3597.

Yazgan, O., Y. Bahtiyarca. 1996. Yüksek verimli süt sığırlarının beslenmesi, S.S. Konya Pancar Ekicileri Eğitim ve Sağlık Vakfı Yayın No:3. Konya.

Yılmaz, M. 2018. Sakarya/Pamukova ekolojik koşullarında bazı yemlik pancar çeşitlerinin verim ve kalite özelliklerinin belirlenmesi, Sakarya Üniversitesi Fen Bilimleri Enstitüsü Dergisi 22(3): 977-985.

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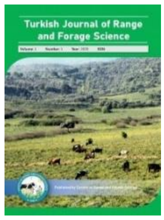

A Review on The Factors Causing Deterioration of Rangelands in Turkey[2]

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A B S T R A C T

In Turkey, the quality and production power of the rangelands have decreased over time by uncontrolled grazing, carelessness and without improvement of rangelands in time because they are medium benefited. Sustainability has not been achieved in rangeland improvement and management projects that implemented by the Turkish Ministry of Agriculture and Forestry for last 20 years. Mistakes concerning to grazing of animals are effective on the basis of both gradual reduction of the current classes of existing vegetations and the lack of improvements in the rehabilitated ones. Attention should be paid to the grazing time and intensity, animal distribution and animal species in order to use the rangelands correctly. Failure to comply with any of these principles causes rangelands to tend to deteriorate. Generally, problems are not to be faced in terms of the selection of the species of animals will be grazed in the rangelands in Turkey. On the other hand, animal distribution would be a problem in the vicinity of the settlement and water resources; otherwise, there is not any major problem in other areas. Heavy grazing appears as an important problem in the rangelands of some settlement areas where the number of animals is high. However, this is not the main factor causing deterioration of the most rangelands. Because approximately 75% of the land is evaluated for grazing the animals in Turkey. In contrast, untimely grazing is one of the most destructive effects on rangelands vegetation. Untimely or yearlong grazing causes serious damage to plants that do not produce enough photosynthesis tissue. On the other hand, it disrupts the soil-water-air-nutrient element balance for a long time by causing deterioration of the soil structure. This causes destructive effects, especially, in good plants and the condition of the rangelands is gradually decreasing. Consequently, firstly, observing the grazing season will solve at least half of the issues related to the deterioration and sustainability in range management

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1. Introduction

Vegetation occur and develop under the influence of grazing along with the influence of prevailing climate and soil factors present already in the environment. Rangeland vegetation with small fluctuations persist, unless there is a significant change in these factors. However, if there is a significant change in any of these factors effective in the formation of vegetation, then the vegetation will react to this and follow the occurred changes. For instance, the dry matter production of the vegetation decreases in first, subsequently, a change towards more resistant species is observed if they have seen the period of droughts for few years. This impact increases or decreases due to the grazing pressure in the rangeland. Similarly, vegetation sparse as a result of improper grazing causes soil losses (Fig. 1). In this way, the fertility of the soil decreases and less rainwater is retained into the soil. The environment of vegetation and soil changes, shrinking root mass and plants take less benefit from soil water.

Generally, there are no extreme changes in environmental factors if putting aside the changes in the global climate for the last half century. That is why, it cannot be said that the effect of climate and soil factors in the change of vegetation is the main factor. On the other hand, improper grazing is the main reason for the deterioration of rangelands all over in the world (Altın et al., 2011). Improper grazing is a kind of grazing that has been done without following the principles of rangeland management. Principles of rangeland management; (a) grazing with the suitable number of animals for the amount of forage that produced in the rangeland, (b) complying with grazing and resting times, (c) steady distribution of animals in the rangeland and (d) grazing with those animal species that make sure the best usage of plant vegetation and land structure in the rangeland. Among these principles, untimely and heavy grazing are the most effective in the deterioration of rangelands. Irregularities in animal distribution are mostly observed in the collection of animals in those rangelands which are close to village. Generally, problem has also not been faced in the selection of animal species. As a matter of fact, the presence of sheep and cattle is mostly located in the Eastern Anatolia Region, the sheep in Central Anatolia and the goats in the Mediterranean belt of Turkey.

Therefore, approximately 85% of Turkish rangelands are either in fair or in poor conditions (Avağ et al., 2012), in other words, the main reason for the presence of good and excellence rangelands at only 15% which is the subject of this review paper.

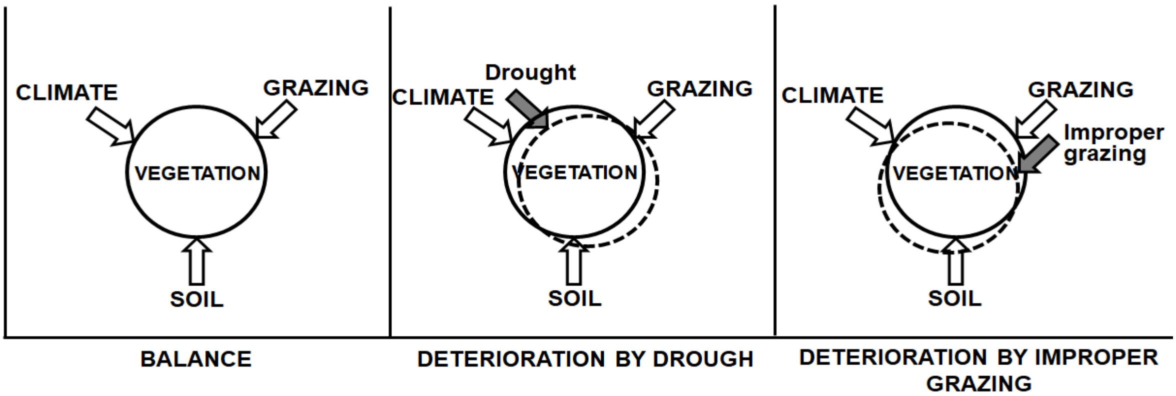

Fig 1. Vegetation balanced under climate, soil and grazing factors, and drought and deterioration caused by improper grazing.

Roughage Sources

Quality roughage sources of animals are the fodder crops sown in the fields along with the hays of rangelands and meadows. In addition, harvest and threshing as well as the factory residues are also offered to animals even if their feeding values are low. Also, in Turkey, a significant portion of the forage consumed by animals is constituted by crop residues (Gökkuş, 1994; Alçiçek et al., 2010). Since the relationship between production and consumption in rangeland livestock raising and its effects on the plants that are producers, and plant residues that can be used in livestock production and fodder crops are not considered in this review article.

Rangeland Presence

According to the data of the Turkish Statistical Institute, natural rangelands with a total area of 13.2 million hectares are concentrated in Eastern and Central Anatolian Regions in Turkey due to their climatic and soil properties. Apart from the Black Sea Region, the southern and western coastal belts are the regions with the least natural rangelands (Table 1).

Table 1. Distribution of rangeland areas by regions*

Regions	Total area (1000 ha)	Rangeland area (1000 ha)	Ratio (%)
Eastern Anatolia	16.355	4.861	29.7
Central Anatolia	19.802	4.704	23.8
Southeast Anatolia	6.175	749	12.1
Black Sea	11.642	1.269	10.9
Mediterranean	9.034	631	7.0
Aegean	7.496	435	6.3
Marmara	7.276	519	7.1
Total	**77.783**	**13.168**	**16.9**

* Calculated from the Turkish Statistical Institute (TÜİK)'s data in 2018.

Animal Presence

According to the livestock statistical data of Turkey for the year 2018, the total presence of animal heads are given as 63.6 million (TÜİK, 2018). Amongst, 46.1 million is composed of small ruminants (72.5%), 17.2 million of them are cattle (27.0%) and the remaining 0.3 million (0.4%) are equids. As a result of the calculation, the current animal presence totals 19.3 million AU. In the distribution of this by animal groups, it has been seen that the small ruminants have 4.4 million AU (23.0%), bovines have 14.6 million AU (75.6%) and the equids have 0.3 million AU (1.4%) shown in Table 2.

Eastern Anatolian Region occupies the first place with 14.4 million animal heads (3.7 million AU) in the distribution of animal presence by geographical regions. Central Anatolian Region ranks second in terms of number of animals (12.5 million head), especially because of the higher number of cultured cattle, but takes the first place in terms of its AU value i.e., 4.1 million AU. Southeast Anatolian Region is in the lower ranks as AU (2.2 million AU) despite of having the high number of animals (11.1 million head), especially, due to its high number of sheep population. The number of animals is less in coastal regions. However, Aegean Region has a significant number as AU due to the high amount of rearing the cultured cattle in large enterprises (Table 3.). But, almost all of these cultured cattle do not take benefit from rangelands.

Table 2. Livestock population of Turkey according to the statistical data of the year 2018.

	Number of animal		AU	
	Head	Percentage (%)	Head	Percentage (%)
Cultured cattle	8.419.204	13.24	8.419.204	43.52
Hybrid cattle	7.030.297	11.05	5.272.723	27.26
Domestic cattle	1.593.005	2.50	796.502	4.12
Buffalo	178.397	0.28	133.798	0.69
Camel	1.708	0.03	1.708	0.01
Total	*17.222.611*	*27.00*	*14.623.935*	*75.60*
Sheep	35.194.882	55.33	3.573.120	18.47
Goat	10.922.427	17.17	873.794	4.52
Total	*46.117.309*	*72.50*	*4.446.914*	*22.99*
Monogastric	273.029	0.43	273.486	1.41
Total	**63.612.949**		**19.344.335**	

Table 3. Distribution of livestock according to different geographical regions in Turkey (1000 head)

	Cattle				Small ruminant		Mono		
	Cultured	Hybrid	Domestic	Other	Sheep	Goat	gastric	Total	AU
Eastern A.	746,1	2.133,8	425,9	26,0	9.495,9	1.488,2	66,8	14.382,6	3.720,8
Central A.	2.080,1	1.326,6	186,2	23,5	7.597,5	1.243,7	39,9	12.497,5	4.109,0
Southeast	437,7	860,5	368,2	20,0	6.600,6	2.746,9	49,0	11.082,8	2.214,3
Blacksea	938,2	1.286,8	310,4	63,9	1.701,1	417,7	34,6	4.752,7	2.342,8
Mediterranean	843,3	469,1	74,8	3,1	2.800,2	2.984,9	19,4	7.194,9	1.776,0
Aegean	2.072,1	478,3	140,6	13,1	3.860,6	1.260,9	41,6	7.867,0	3.041,2
Marmara	1.301,8	475,3	87,0	30,5	3.138,9	780,2	21,8	5.835,6	2.140,2
Total	**8.419,2**	**7.030,3**	**1.593,0**	**156,6**	**35.194,9**	**10.922,4**	**273,0**	**63.612,9**	**19.344,3**

*Calculated from the data of the Turkish Statistical Institute (TÜİK) in 2018

Animal Presence Benefited from Rangeland

In large livestock enterprises, cultured cows are not left to natural rangelands but they are generally raised under a closed system of raising. Productive dairy animals reared by the small enterprises are also only allowed for very limited grazing into the rangelands. Therefore, cultured cattle have not been taken into consideration in calculating the amount of animals benefiting from the rangeland. In contrast, hybrid and domestic cattle are mostly grazed in the rangeland during the grazing season. On the other hand, since the number of equids is very small and not enough flocks can be formed in the rangeland, that is why, it is thought that these animals do not benefit in this extent that they affect the rangeland vegetation. Small ruminants (sheep and goats) are the animals which take most benefit from the rangeland. Even, mostly the grazing season is not taken into consideration when these animals are grazed. Small ruminants are grazed in the rangeland round the year as long as the weather conditions are suitable in winter. However, in regions where the continental climate prevails, snow cover and cold and humid weather in the coastal and passage zones make it difficult to graze in the rangeland. So, depending on the effective cold of winter and snow cover, small ruminants cannot take benefit from the rangelands in Eastern Anatolian Region for 4-5 months, 1-2 months from the rangelands in Central and Southeast Anatolian Regions, 0.5-1 month in Mediterranean and Aegean rangelands, 1 month in Marmara rangelands, 1-1.5 months in rangelands other than highlands in Black Sea Region, and up to 6 months only in the highlands.

In dry agricultural lands, fodder crops cannot be sown in summer since irrigation cannot be done. For this reason, the stubble remaining after the winter crops are harvested in early summer, are important feeding sources for animals. As a matter of fact, in a study conducted by Gökkuş et al., 2017, it has been reported that there was no significant difference between the live weights and body condition values of sheep grazing on wheat stubbles in sorghum-sudangrass pasture. In this regard, in the summer when the grass is decreasing and drying in the natural rangelands, the farm animals, especially the sheep are grazed in the stubble areas approximately for 2-3 months according to the regions. Small ruminants do not go to rangeland in winter, except for grazing season, as long as they graze in summer on stubbles. For this reason, it is accepted in the calculation that the small ruminants stay in the rangeland as long as the grazing season.

Considering the above mentioned issues, the results of the calculation and evaluation made in order to determine the presence of animals grazing in the rangeland are given in Table 4. According to this, it can be said that the areas accepted as rangeland are grazed with animals far above the amount they will carry (approximately more than 2.5 times). However, farm animals also make extensive use of areas (bushes, garbage disposals, roadsides, bumps in the field edges, etc.) outside of the rangeland. It is very difficult to estimate the extent of the contribution of grazing points other than the shrubby areas in animal feeding. Since the shrubby areas (rangelands) are in official records, it is possible to calculate the roughage that the animals can benefit from.

The shrublands, defined as degraded forests and included in the classification of forest, cover an area of 11.5 million hectares (OGM, 2012) and it is totally grazed by domestic small ruminants and partially by the hybrid cattle. Distribution, productions and carrying capacities of these areas according to regions are given in Table 5. In terms of climate characteristics, shrublands are concentrated especially in Aegean, Mediterranean and Black Sea Regions. As a result of the evaluation, the number of animals that could be carried by the shrublands has been calculated as 2.5 million AU. The supply-demand relationship between the number of animals and the actual rangelands, resulting from the grazing capacity, is explained in Fig. 2.

Table 4. Actual presence of animals benefiting from natural rangeland by region in Turkey.

	Grazing capacity (1000 AU)	Amount of animal utilized on rangelands (1000 AU)	Difference
Eastern Anatolia	2.187.5	2.901.3	+713.8
Central Anatolia	1.045.3	1996.7	+951.4
Southeast Anatolia	128.4	1.698.7	+1570.3
Black Sea	507.6	1.163.6	+656.0
Mediterranean	130.9	840.6	+709.7
Aegean	110.7	928.1	+817.4
Marmara	138.4	813.2	+674.8
Total	**4.248.8**	**10.342.2**	**+6.093.4**

Table 5. Amount of produced grazable feed and the number of fed animals in shrublands (degraded forest), (Gökkuş, 2019).

Regions	Area (1000 ha)	Yield* (ton ha^{-1})	Total production (1000 ton)	Grazing capacity (1000 AU)
Eastern Anatolia	1.173	0.8	938.4	205.7
Central Anatolia	1.453	0.8	1.162.4	254.8
Black Sea	1.726	1.2	2.071.2	454.0
Southeast Anatolia	966	0.8	772.8	169.4
Marmara	886	1.2	1.063.2	233.0
Mediterranean	2.049	1.0	2.049.0	449.1
Aegean	3.210	1.0	3.210.0	703.6
Total	11.463		11.267.0	2.469.5

*Amount of grazable dry hay.

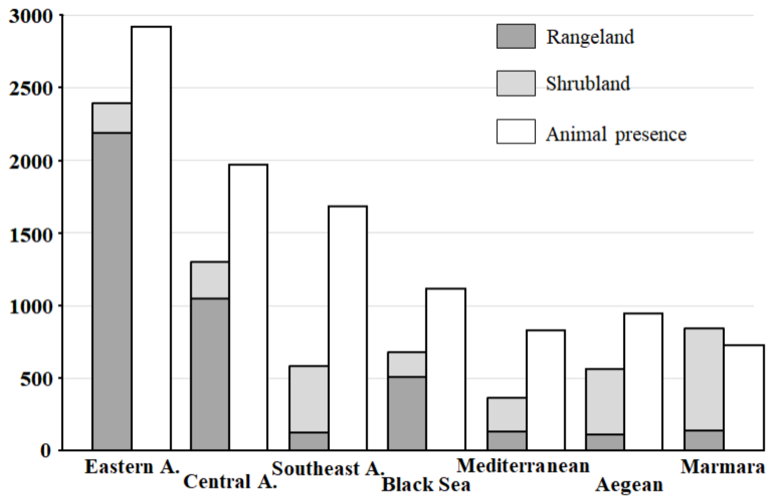

Fig 2. Grazing capacities of rangelands and shrublands and existing animal presence of the regions (1000 x AU). Dark columns indicate the supply and white columns indicate the demand of feed.

Based on this assessment, the obtained production from these natural feed producing areas in regions other than Marmara seems to be very far from meeting the need for roughage for the maintenance of animals in grazing season. Animal feed deficit is particularly high in the Southeast Anatolia Region. Decrease in rangeland yields and decline of shrublands in this region reveal this result. Widespread shrubs in coastal regions provide an important advantage to livestock raising of this region. It is possible to find green forage all around the year will be grazed, especially by small ruminants.

"Other land" represents those parts of the land which are not classified as productive lands (e.g., stony, steep, flooded, barren lands, etc.) having a share of the significant sources of animal roughage in our country. Such lands are among the places where farm animals mostly take benefit from. The area covered by these lands is consisted with 16.6 million hectares excluding agricultural lands, rangelands and forest areas. So, it has more space than rangelands. A part of these areas has already been covered as meadow- rangeland areas with 21.7 million hectares that is mentioned in the book titled ‘Land Use in Turkey’ (Anonymous, 1978) published in 1978 and also found in the statistical data issued in 1980 by the General Directorate of the Soil and Water. In other words, there is an area of approximately 7 million ha rangeland among other lands are already accepted as meadow- rangeland. It is very difficult to predict how much of the other land is grazed by the animals and what its production power is. However, it can still be said that the animals have been grazed in about half of these places. Livestock animals are grazed in an approximate of 75% of the land in Turkey by considering other lands, stubble and fallow fields, roadsides and forest areas are also used. For this reason, it can be stated that in regions other than the Southeast Anatolia Region, animals do not have any lack of roughage during the grazing season.

According to the statistical data of 2017, there is an acreage of 10.3 million hectares of cool season cereal fodder crops in Turkey. As a result of the calculation done by assuming that approximately ¾ of this area is used and the amount of grass stubbles that the animals can consume, is approximately 100 kg/ha, and an AU should consume 25 kg of stubble per day. Thus, it is concluded that the share of grass stubbles for the animals is equivalent to approximately 1.5 million AU.

Evaluation

By considering all of issues, it has been seen that the number of animals benefiting from the actual natural rangelands, therefore, the grazing pressure on the rangeland is not in a size that will lead to the degradation of vegetation. In that case, what could be the main reason for the existence of the risk of erosion (Koç et. al., 1994), and often being in poor or fair condition of the majority of rangelands in Turkey?

The main factor causing the deterioration of rangeland is the untimely grazing. By means of untimely grazing that the grazing has been carried out without paying attention to the critical periods of spring, summer and autumn, as well as grazing throughout the winter means grazing all around the year. Rangeland plants do not have unlimited power of production. They have sufficient photosynthesis and continue their biomass production when the environmental factors are not restrictive. In this respect, the factors that affect or even threaten the production of plants are grazing and unfavorable environmental factors. Plants should have enough photosynthesis tissues to reproduce after grazing. It is tried to be covered with already reserve nutrients in case the nutrients required for growth cannot be produced by the plant. In this case, plants grow less and use a lot of reserve nutrients. Also, a long period of time is required for the plant to recover itself after grazing since the growth is slow due to reserve nutrients (Altın et al., 2011). If grazing is repeated, there would be a proportional decreasing amount of reserve nutrients each time, and even, it becomes no longer able to fulfil the plant's need at a stage. The death of the plant occurs at this stage. Moreover, reserve nutrients ensure that the plants are physiologically strong, thus resisting against the negative use and environmental factors. Plants face these conditions more frequently in spring caused by untimely grazing. This heavy pressure forces particularly the desirable plants to withdraw from vegetation. Similar conditions are also be faced to the growth of some plants in the regions (coastal belts) where the winter season is cool. The development period, where the plants have small and green leaves, is the period when it is sensitive to grazing. Plants are found in this position in late autumn, cool winters and early spring; and very sensitive to grazing. During these sensitive periods, plants, especially the desirable plants in rangeland are seriously damaged by the implementation of yearlong grazing. Their powers of production fall dawn and they withdraw from the rangeland vegetation over time. As a result, rangeland condition gradually decreases and first, it becomes "fair" and then in "poor" condition. If this pressure continues, the rangeland completely loses its quality and becomes a land that does not produce crops. These periods when plants are sensitive to grazing also coincide with the cool and rainy season. Therefore, the soil is generally saturated with water and there is an excess of water at the bottom, too. Grazing such rangelands seriously disrupts the soil structure as well as the damage to the plants. Soil becomes compacted, its aeration is reduced, surface runoff and associated erosion increase and infiltration of rainy water becomes difficult. Root development weakens, the amount of organic matter in the soil declines, and the productivity decreases. These negative conditions, besides the direct effect of grazing, decrease the production power of plants and invader species that are resistant to these conditions and mostly have noxious plants, that is, hay yield and low quality are adjusted in the environment. As a result, rangeland deteriorates and goes away from reaching the needs for roughage for animals.

2. Results

As a result of the above mentioned evaluations, in Turkey, the main factor involves in the deterioration of rangelands, contrary to popular belief, has been seen that come forward from the untimely grazing but not from the heavy grazing. The solution for this depends on the proper and correct management of the rangeland, especially the times of grazing and resting. If this can be done in addition, the expected improvement in rangelands can be achieved with the application of a proper and timely rangelands improvement program. Furthermore, in this way, the sustainability problem can be solved, which is still seen as the most important handicap in rangelands improvement and management projects carried out by the Turkish Ministry of Agriculture and Forestry. This is a well-known fact that the proper rangelands management is also an improvement method and that the desired results cannot be obtained if rangelands improvement practices are carried out on rangelands that are not managed properly. Here, besides proper management in the rangelands of Southeast Anatolia Region, focusing on improvement practices and supplement feeds to grazing animals is an important requirement for improving rangelands.

References

Alçiçek, A., A. Kılıç, V. Ayhan, ve M. Özdoğan, 2010. Türkiye'de kaba yem üretimi ve sorunları. Türkiye Ziraat Mühendisliği VII. Teknik Kongresi. 11-15 Ocak, Ankara, Bildiriler (II): 1071-1080.

Altın, M., A. Gökkuş ve A. Koç, 2011. Çayır Mera Yönetimi (1. Cilt). TKB, TÜGEM, Çayır Mera ve Havza Amenajmanı Daire Başk., Ankara, 376s.

Anonim, 1978. Türkiye Arazi Varlığı. Köyişleri ve Koop. Bak., Toprak Etüd ve Har. Daire Bşk. Yay., Ankara.

Avağ, A., A. Koç and H. Kendir, 2012. National Rangeland Management Project Final Report. TÜBİTAK Project No: 106G017, 483p.

Gökkuş, A., 1994. Türkiye'nin kaba yem üretiminde çayır-mera ve yem bitkilerinin yeri ve önemi. Atatürk Üni. Ziraat Fak. Derg. 25, 250-261.

Gökkuş, A., 2019. Forage sources of the organic animal husbandry: Meadows, rangelands and shrublands. 6. Organic Agricultural Symposium, 15-17 May 2019, Fuar İzmir (Gaziemir), 13p.

Gökkuş, A., C. Tölü, H. Hanoğlu Oral and F. Alatürk, 2017. Effects on Animal Production and Planning of Annual Fodder Production in Sheep Grazing Pastures. TÜBİTAK Project No: 214O233, Final Report, 258p.

Koç, A., A. Gökkuş ve Y. Serin, 1994. Türkiye'de çayır-meraların durumu ve erozyon yönünden önemi. Ekoloji Çevre Derg. 13, 36-41.

OGM, 2012. Türkiye Orman Varlığı – 2012. Orman ve Su İşleri Bakanlığı, Orman Genel Müd., Orman İdaresi ve Planlama Dairesi Başk., Ankara, 26s.

TÜİK, 2018. Agricultural Statistics. Ankara.