Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi, 2012, 21 (1): 32-38
Araştırma Makalesi (Research Article)

A study on Some Phenologic, Morphologic and Agronomic Characters of Hungarian Alfalfa (*Medicago sativa* L.) Entries in The Central Anatolian Highlands of Turkey

*Sabahaddin ÜNAL[1] Ziya MUTLU[1] Hüseyin Kansur FIRINCIOĞLU[2]

[1]The Central Research Institute for the Field Crops, Ankara
[2]Retired in 16.10.2007
Corresponding author; e-mail:sabaunal@hotmail.com

Received: 11.04.2012 Accepted: 01.06.2012

Abstract
This study was conducted to determine the adaptation ability and the yield potentials of alfalfa entries under the irrigated condition in Haymana location of the Central Research Institute for the Field Crops in the years of 2006, 2007, and 2008. The five alfalfa materials, the three entries originated from Hungary (L-1734, L-1735, and L-1736) and two local check varieties (Bilensoy-80 and Sazova), were investigated for the some phenological, morphological, and agronomical characters. The averages of the main stem lenght, thickness, and the number were 63.1 cm, 2.86 mm, and 2.79, respectively. Alfalfa stand score ranged from 71.3 to 77.5 % , and averaged as 74.0 % in 2008. The green herbage yield averages were found as 4454.5 kg/da, and 2591.7 kg/da in 2007, and 2008, respectively. Average yield over the two years was 3523.1 kg/da. The hay yield averages of first and second year were obtained as 1472.6 kg/da, and 815.6 kg/da, respectively. The two- year hay yield averaged to 1141.1 kg/da. They ranked from 1044.4 kg/da to 1228.2 kg/da. Trial results indicated that all three entries, especially L-1736, had good adaptability, and yield performance for the Central Anatolia Region.
Key words: Alfalfa entries, stand score, green herbage, hay

Türkiye'nin Orta Anadolu Yüksek Alanlarında Macaristan Kökenli Yonca Materyallerinin Bazı Fenolojik, Morfolojik ve Tarımsal Özellikleri Üzerine Bir Çalışma

Öz
Bu çalışma, Tarla Bitkileri Merkez Araştırma Enstitüsünün Haymana alt istasyonunda sulu şartlarda yonca materyallerinin verim potansiyelini ve adaptasyon kabiliyetini belirlemek için 2006-2008 yıllarında yürütülmüştür. Macaristan kökenli üç materyal (L-1734, L-1735 ve L-1736) ile iki standart çeşit (Bilensoy-80 ve Sazova) olmak üzere beş yonca, bazı fenolojik, morfolojik ve tarımsal özellikler açısından incelenmiştir. Ana dal uzunluğu, kalınlığı ve sayısı ortalamaları sırayla 63.1 cm., 2.86 mm ve 2.79 adet olmuştur. Yonca parsellerinde 2008 yılındaki bitki örtüsü % 71.3-77.5 arasında değişirken, ortalama % 74.0 olarak tespit edilmiştir. Yeşil ot ortalama verimleri 2007 ve 2008 yıllarında sırayla 4454.5 kg/da, 2591.7 kg/da olurken, iki yıllık ortalama verim ise 3523.1 kg/da olarak belirlenmiştir. Kuru ot ortalama verimi ilk yıl ve ikinci yıl sırayla 1472.6 kg/da ve 815.6 kg/da iken, iki yıllık ortalama verim 1141.1 kg/da olarak saptanmıştır. İki yıllık ortalama kuru ot verimleri 1044.4 kg/da ile 1228.2 kg/da arasında değişmiştir. Deneme sonuçlarına göre, Orta Anadolu Bölgesi için üç yeni materyal, özellikle L-1736, adaptasyon kabiliyeti açısından iyi ve verim potansiyeli olarak yeterli bulunmuştur.
Anahtar kelimeler: Yonca materyalleri, bitki örtüsü değeri, yeşil ot, kuru ot

Introduction

Turkey has totally 1.18 million hectares of forage crop acreage (Anonymous, 2010). Annual forage requirement of livestock section in Turkey is estimated as 50 million tons of good quality forage. Actual national forage production is about 6.87 million tones. This amount meets only 13.74 % of total requirement (Anonymous, 2010). Alfalfa sown area is 5.69 million hectares, which takes the first rank among the grown areas of forages crops. These figures show that there is a high rate of forage shortage in country level. Alfalfa, often called Queen of the Forages, is almost grown throughout Turkey (Açıkgöz, 2001). Alfalfa is generally sown under the irrigated condition so that it is a promising potential for the production of annual hay need of Turkey. Alfalfa is high adaptation ability being winter-hardy and highly drought tolerant (Barnes and Sheaffer, 1995). It has high herbage yields with tiny plentiful and palatable leaves. It is a good quality hay with

high crude protein (16.0-18.0 %). It can be easily grown alone or in mixtures with grasses (wheatgrass, smooth brome, orchard grass etc.) (Barnes and Sheaffer, 1995; Açıkgöz, 2001; Albayrak and Ekiz, 2005).

Alfalfa can also be produced under the semi-arid conditions without irrigation (Açıkgöz, 2001) and on marginal cropland where cereals have generally low yield potential.

There are many studies on alfalfa in the literature. Some researchers have worked on its morphology (Alınoğlu et al 1972; Volenec et al, 1987; Chamble and Warren, 1990; Rosellini et al. 1991; Prosperi et al. 1996), agronomy (Şengül, 1996 ; Koç and Tan, 1996; Altınok and Karakaya, 2002), quality (Şengül, 1996; Nursoy, 2000), breeding (Hatipoğlu, et al. 1996), livestock feeding (Nursoy, 2000), disease, (Eken and Demirci, 2001), biotechnology (Bilgen and Çelen, 1991).

The objective of this study is to determine the yield potentials of alfalfa and the adaptation ability of new materials in the Central Anatolian Highlands of Turkey.

Materials and Methods

The field trial was carried out at Haymana location of the Central Research Institute for the Field Crops in the years of 2006, 2007, and 2008. Yield trials with three alfalfa accessions (L-1734, L-1735, L-1736), and check varieties (Bilensoy-80 and Sazova) were sown in a randomized complete block design with 4 replications. Seeds were sown by hand. The plot size was 1.6 m x 5.0 m = 8.0 m^2, consisting of 8 rows spaced at 20 cm for green herbage. The experiments were established in a fallow field. After seeding (18 May 2006), 36 kg ha^{-1} N, and 96 kg ha^{-1} P_2O_5 fertilizer were applied into the soil and the upper layer of soil was pressed with plowing roller. Weeds were controlled by hand hoeing when necessary.

Four cuttings were performed in the dates of May 28 to 30 and September 5 in year 2007; May30 to June 4, and August 20 to 27 in year 2008. The beginning time of plant growth is considered as 15th February (15.02.2007 and 15.02.2008) for the Central Anatolia Region.

When plants reached 10 percent of their flowering stages in each accession, they were cut. Ten plants were sampled and measured from each plot for the plant characters at the second cutting time during the vegetation period under the irrigated condition. Trial plots were irrigated twice at each cutting. After that, a 4.8 m^2 of 8.0 m^2 of each plots was harvested as green herbage and samples (each 500g) were dried at 70 ^{o} C for 48 h. The soil of Haymana location was clay textured, slightly alkaline, poor in organic matter, but high in lime content (Anonymous, 2007). During the experimental years of 2006, 2007, and 2008, total precipitation, average temperatures and average relative humidity were 333.0 mm, 303.0 mm and 247.2 mm; 11.2^{o}C, 11.8 ^{o}C and 12,9 ^{o}C; 69.7 %, 61.6 %, and 62.2 % at Haymana, respectively (Table 1) (Anonymous, 2009). Long term (1990-2005) average rainfall, temperatures, and relative humidity are 394.5 mm and 10.1 ^{o}C, and 73.7 %, respectively (Table 1). The climatic data of trial years were compared with that of long term. The total precipitation, and average relative humidity of experimental years were lower than that long term average. On the other hand, average temperatures of experimental years were higher than that long term average.

Analysis of variance were performed for all data measured. The significance of the main effects was estimated by F test. Differences among treatment means were presented by LSD test ($P < 0.05$) (Düzgüneş vd 1983).

The plant characters measured are as follows;

Stand score (%)

It based on a scale from 1 to 100. A 100 is considered to be a perfect stand.

Phenological characters

Days to flowering: it is the number of days from 15 February to 10 % flowering date

Morphological characters

Main stem length: The longest stem of a plant was considered as a main stem, and it is measured from ground level to the stem tip.

Main stem diameter: It was measured between the second and third nodes of bottom of main stem.

Main stem numbers: It was counted as the number of main stems in a plant (Ünal, 2000, and Anonymous, 2001).

Table 1. The climatic data of trial years and long term in Haymana location*

		Months												Total	Av.
		1	2	3	4	5	6	7	8	9	10	11	12		
2006 season	[1]Prec.(mm)	15.8	44.4	33.2	**53.2**	**37**	**51.2**	**1.6**	**0.2**	**51**	37	7.4	1.0	**333.0**	
	[2]A.tem.(°C)	-4.7	-1.96	5.7	114	12.5	19.1	20.8	25.4	16.5	12.3	3.7	-2.5		11.2
	[3]Rl.hum.(%)	85.9	93	74.1	**60**	**73.5**	**57**	**48.6**	**37.9**	**62.1**	79.6	84.2	80		69.7
2007 season	[1]Prec.(mm)	11.2	6.8	41.2	**10.4**	**6.6**	**30.8**	**2.2**	**14.9**	**0**	14	64.6	100.6	**303.3**	
	[2]A.tem.(°C)	0	0.2	5.2	7.3	18.1	20	24.3	24.4	17.6	12.3	5.4	-4.8		11.8
	[3]Rl.hum.(%)	77.9	84	73	**64.6**	**48.7**	**55.3**	**33.9**	**39.5**	**41.4**	59.9	77.3	83.5		61.6
2008 season	[1]Prec.(mm)	4	5.4	50	**21.4**	**39**	**15.8**	**1.8**	**0**	**40**	16.4	33.8	23.6	**247.2**	
	[2]A.tem.(°C)	-5.7	-2.4	7.9	11.3	12.7	19.5	22.2	24.3	17.4	10.5	6.3	-0.9		12.9
	[3]Rl.hum.(%)	84	77	56	**54.2**	**42.4**	**47.8**	**42**	**41.2**	**59**	67	83	93		62.2
Long term (1990-2005)	[1]Prec.(mm)	31.1	32.6	43.5	**54.7**	**48.3**	**22.4**	**17.8**	**16.0**	**18.4**	24.4	34.7	50.5	**394.5**	
	[2]A.tem.(°C)	-1.4	-0.4	3.9	9.1	13.9	18.1	21.7	21.3	16.9	12.4	5.5	0.8		10.1
	[3]Rl.hum.(%)	78.2	77.7	77.7	**77.0**	**73.3**	**69.9**	**64.3**	**64.8**	**67.9**	73.3	78.7	81.6		73.7

(*)The climatic data of Haymana location. The General Director of State Meteorological, Annual Climatic Observation Table (Anonymous, 2009).
[1]Precipitation (mm)
[2]Average temperature (°C)
[3]Relative humidity (%)

Agronomical characters

The plots harvested for green herbage were weighted, recorded, and calculated as yields for decare.

First each 500 g sample was dried, and weighted. This figure was used for the determination of hay yield.

Results and Discussions

Alfalfa stand (%)

Alfalfa stand was detected at the end of growth season in 2008. There wasn't significantly difference among the trial materials (Table 2). Average of material stand scores was 74.0 %. Sazova variety was the highest stand score with 77.5 %.

Table 2. Alfalfa stand score

Materials	Stand score (%)
L-1734	75.0
L-1735	72.5
L-1736	73.8
Bilensoy-80	71.3
Sazova	77.5
Average	**74.0**
F (0.05)	**1.48**
LSD (0.05)	**6.089**
CV (%)	**5,34**

Phenological characters

Flowering dates (Cutting times)

The period between cutting 1 and cutting 4 was 97 days in the first year, and 82 days in the second year, respectively (Table 3). The first year period was 15 days longer than the second year period. Although the trial was conducted under irrigated condition, year differences on cutting dates can be explained by changes in climatic data. Higher precipitation and lower temperatures caused growth season be longer.

Morphological characters

There is no statistically significant difference on the morphological features over the trial materials (Table 4). But the year effects were found statistically significant. The averages of main stem lenght, thickness, and numbers were 63.1 cm, 2.86, mm and 2.79, respectively.

Main stem length is considered as plant length because of being erect types of all trial entries.

The averages of main stem length were 75.4 cm and 50.9 cm in 2007 and 2008, respectively. Second year value was 32.5 % lower than first year data.

Plant lengths of the other studies vary as the following the plant length of Kayseri alfalfa was 86.2 cm (Alınoğlu et al 1972); alfalfa plant length ranked from 61.0 to 68.0 cm Volenec et al (1987); the plant lenght of alfalfa populations in 1977 and 1978 ranged from 45 to 60 cm and 29 to 54 cm, respectively (Chamble and Warren, 1990); the plant lengths and their coefficient of variation of alfalfa populations in two groups were 80.5 cm and 18.0 %, and 82.5 cm and 60 %, respectively (Rosellini et al, 1991); plant

lengths were 63.0 cm to 67.0 cm in spring, and 37.0 to 46.0 cm in summer (Prosperi et al. 1996). The values in the literature found higher (86.2 cm) (Alınoğlu et al 1972); less (37.0 to 46.0 cm) (Prosperi et al. 1996), and similar (61.0 to 68.0 cm (Volenec et al. 1987). Plant lengths show a large variation within and among years. For instance, Prosperi et al. (1996), measured that 63 to 67 cm in spring and 37-46 cm in summer season. In another study, plant lengths were 45 to 60 cm in 1977 and 29 to 54 cm in 1978 (Chamble and Warren 1990).

The averages of main stem thickness were 3.26 mm and 2.46 mm in 2007 and 2008, respectively. The value for 2008 was 24.53 % lower than first year data.

The averages of main stem numbers were 2.25 in 2007 and 3.34 in 2008. Second year stem number was 48.44 % higher than that of first year.

Green herbage yields (kg/da)

There weren't statistically significant differences for the green herbage yields of trial materials (Table 5). The entry of L-1736 gave the highest yield with 4937.5 kg/da in 2007. In 2008, and Sazova variety had the highest yield as 3082.8 kg/da, and two- year average was 3770.0 kg/da. Material yields change in association with year impact. Annual averages were 4454.5 kg/da , 2591.7 kg/da, and 3523.1 kg/da in 2007, 2008, and two-year average, respectively (Table 4).

Second year yield sharply declined. This reduction can be explained by variation in climatic data especially by temperature and relative humidity values, although this trial was conducted under irrigated condition. The green herbage values in some previous studies was found higher (5769,4 kg/da (Şengül, 1996), and less (2945,9 kg/da (Şengül and Tahtacıoğlu, 1996).

Table 3. Days to flowering and cutting times of trial materials over the two- year

Materials		**2007 year**				**2008 year**			
		Cutting 1	Cutting 2	Cutting 3	Cutting 4	Cutting 1	Cutting 2	Cutting 3	Cutting 4
L-1734	FD*	28.05.07	13.07.07	29.07.07	06.09.07	03.06.08	24.06.08	21.07.08	20.08.08
	CT**	103	132	164	201	108	129	156	185
L-1735	FD	27.05.07	13.07.07	04.08.07	06.09.07	30.05.08	26.06.08	21.07.08	25.08.08
	CT	102	132	169	201	105	131	156	190
L-1736	FD	28.05.07	13.07.07	30.07.07	05.09.07	02.06.08	26.06.08	21.07.08	27.08.08
	CT	103	132	165	200	107	131	156	192
Bilensoy 80	FD	30.05.07	13.07.07	21.08.07	-	04.06.08	30.06.08	24.07.08	-
	CT	105	132	186	-	109	135	159	-
Sazova	FD	30.05.07	13.07.07	01.08.07	06.09.07	02.06.08	27.06.08	22.07.08	23.08.08
	CT	105	132	167	201	107	132	157	188
Averages	**CT**	**104**	**132**	**170**	**201**	**107**	**132**	**157**	**189**
Period (1 to 4)		97				82			

Not: At the beginning time of plant growth of 15.02.2007 and 15.02.2008
*FD: 10 % flowering dates
* *CT: Cutting times (days)

Table 4. The results of variance analysis of length, thickness, and numbers of main stem

Materials	MSL* (cm)			MST (mm)			MSN (number)		
	2007	2008	Averages	2007	2008	Averages	2007	2008	Averages
L-1734	75.8	50.7	63.2	3.20	2.43	2.82	2.33	3.30	2.82
L-1735	71.3	47.3	59.3	3.38	2.44	2.91	2.00	3.23	2.61
L-1736	76.7	50.0	63.4	3.57	2.42	3.00	2.33	3.33	2.83
Bilensoy 80	75.5	52.6	64.0	3.11	2.62	2.86	2.50	3.05	2.78
Sazova	77.9	53.9	65.9	3.03	2.37	2.70	2.07	3.80	2.93
Mean	**75.4**	**50.9**	**63.1**	**3.26**	**2.46**	**2.86**	**2.25**	**3.34**	**2.79**
F year $_{(0.05)}$			**226.91 ****			**67.54 ****			**92.55 ****
F variety$_{(0.05)}$	**2.65**	**0.6**	**1.75**	**2.13**	**0.35**	**0.98**	**2.6**	**1.6**	**0.84**
LSD$_{(0.05)}$	**4.72**	**10.2**	**5.31**	**0.45**	**0.49**	**0.31**	**0.4**	**0.7**	**0.37**
CV (%)	**4.06**	**12.98**	**8.2**	**9.14**	**13.03**	**10.82**	**11.5**	**13.1**	**12.86**

MSH : **Main stem length** MST: **Main stem thickness** MNS: **Main stem number**

Table 5. The green herbage yields (kg/da) of years and average for alfalfa materials

Materials	2007	2008	Averages
L-1734	4146.7	2516.7	3331.7
L-1735	4562.4	1920.8	3241.6
L-1736	4937.5	2524.5	3731.0
Bilensoy-80	4168.6	2913.6	3541.1
Sazova	4457.2	3082.8	3770.0
Averages	**4454.5**	**2591.7**	**3523.1**
F var. (0.05)	**2.46**	**0.89**	**0.51**
F year (0.05)			**
F int. (var. x year)			
CV (%)	**9.27**		**26.23**

Table 6. The hay yields (kg/da) of years and average for alfalfa materials

Materials	2007	2008	Averages
L-1734	1329.0	814.1	1071.5
L-1735	1486.2	602.6	1044.4
L-1736	1695.6	760.8	1228.2
Bilensoy-80	1372.0	936.6	1154.3
Sazova	1480.1	964.2	1222.2
Averages	**1472.6**	**815.6**	**1144.1**
F var. (0.05)	**3.47 ***	**1.05**	**0.78**
LSD (0.05)	**234.73**	**-**	**-**
CV (%)	**10.34**		**23.49**
F year (0.05)			**59.71****

Table 7. The hay yields (kg/da) and averages of four cutting dates of alfalfa materials

Materials	2007 year			
	Cutting 1	Cutting 2	Cutting 3	Cutting 4
L-1734	423.6	483.0	303.4	119.0
L-1735	484.5	530.7	299.8	171.2
L-1736	519.2	638.5	349.5	188.4
Bilensoy-80	587.2	600.7	184.1	-
Sazova	485.2	516.5	302.9	175.5
Averages	**500.0**	**553.9**	**287.9**	**163.5**
Materials	2008 year			
	Cutting 1	Cutting 2	Cutting 3	Cutting 4
L-1734	402.0	133.0	175.7	103.4
L-1735	311.5	107.7	127.6	55.8
L-1736	353.4	152.6	173.5	81.3
Bilensoy-80	669.2	224.6	42.9	-
Sazova	404.1	188.2	201.0	170.9
Averages	**428.0**	**161.2**	**144.1**	**102.9**

Hay yields (kg/da)

There were statistically significant (P<0.05) differences among hay yields of the materials in 2007 (Table 6). The L-1736 had the highest yield (1695.6 kg/da) in first year. The yearly yield average was 1472.6 kg/da. In the second year, there weren't statistically significant differences among material yields. The two checks had higher yields than the entries yields at the same year. The material yields averaged over the two years appeared no statistically significant differences. The average yield of all materials was 1144.1 kg/da. There was statistically significant difference (P<0.01) between the two years. The averages of hay yields were 1472.6 and 815.6 kg/da in 2007 and 2008, respectively. These results were the similar with the trial's data (982,4-1796,8 kg/da) of Şengül and Tahtacıoğlu (1996) but the value in this study

was less than the experiment yields (1512,0 - 1612,6 kg/da) of Şengül, (1996).

Cutting 1 and cutting 2 in the year of 2007 had similar yields with 500.0 kg/da, and 553.9 kg/da, respectively (Table 7). The second year results indicated that cutting 1 gave the highest yield of 428.0 kg/da in the all cuttings. The two- year results showed that cutting 1 and sometimes cutting 2 had more yields than other following cuttings in the highland condition of Central Anatolia. Consequently, first two cuttings' yields accounted for the significant proportion of total yields.

Conclusions

Alfalfa stand score (average, 74.0 %) plays significant role on the yields of green herbage and hay.

Two-year average of green herbage, and hay yields in 2007 and 2008 were 3523.1 kg/da, and 1141.1 kg/da, respectively.

Trial results indicated that all three entries, especially L-1736, had good adaptability, and yield performance for the Central Anatolia Region. Moreover, the yield performance of two check varieties was found satisfactory.

Acknowledgements

Authors would like to thank to Dr. Ali Mermer and Dr. Ediz Ünal for their comments and helps on article.

Literatures

Açıkgöz, E., 2001. Forages. Uludağ University, Agriculture Faculty, Publication no: 7-025- 0210, Bursa.

Albayrak, S and H. Ekiz. 2005. A Study for the establishment of pasture under Ankara ecological condition. Turk. J. Agric. For. 29: 69-74.

Alınoğlu, N., H. Merttürk, and A.T. Özmen, 1972. The investigations on some morphological and phenological characters of Kayseri alfalfa (*Medicago sativa* var. Kayseri N. A.), Grassland and Animal Husbandry Research Institute, Ankara, publication no: 19.

Altınok S. and A. Karakaya, 2002. Herbage yields of some Alfalfa varieties in Ankara conditions. Turk. J. Agric. For. 26: 11-15.

Anonymous, 2001. Baklagil Yem Bitkileri. Tarımsal Değerleri Ölçme Denemeleri Teknik Talimatı. T.C. Tarım ve Köyişleri Bakanlığı, Tohumluk Tescil ve Sertifikasyon Merkezi Müdürlüğü.

Anonymous, 2007. Soil analysis results of trails in Haymana. Central Soil, Fertilizer and Water Resources Research Institute, Ankara.

Anonymous, 2009. The climatic data of Haymana. The General Director of State Meteorological, Annual Climatic Observation Table.

Anonymous, 2010. The summary agricultural statistics. Turkish Statistical Institute, Prime Ministry Republic of Turkey.

Barnes, D. B. and C.C. Sheaffer, 1995. Alfalfa. Edi: Barnes,R. F., D.A. Miller, and C.J. Nelson. Forages, An introduction to grassland agriculture, pg: 205-216.

Bilgen G. and A. E. Çelen, 1991. The using possibilities of isoenzymes electrophoresis technique on alfalfa breeding. Turkey 2nd Meadow-rangeland and forage crops congress 28-31 May 1991. pg. 532-539. Aegean University İzmir.

Chamblee, D.S. and Warren Jr. R.D. 1990. Movement of *Rhizobia* alfalfa plants. Agronomy J. 82: 283-286.

Düzgüneş, O., Kesici, T. ve Gürbüz, F. 1983. İstatistik metodları I. Ankara Üniversitesi Ziraat Fakültesi Yayınları: 861, Ders Kitabı: 229, Ankara.

Eken, C. ve E. Demirci. 2001. Erzurum ilinde yonca bitkilerinde saptanan fungal etmenlerin yayılışları ve patojeniteleri. Atatürk Üni. Zir. Fak. Dergisi 32(2): 143-150.

Koç, A. ve M. Tan. 1996. Some traits of the hybrid alfalfa (*Medicago varia* L.) grown in the natural pastures of the Erzurum province. In the proceedings of the third national grassland congress, pg:621-626, Erzurum.

Nursoy, H. 2000. The effects of the milling with different thresher on nutrient content, feed consumption, and digestibility of forage. The Journal of the University of Yuzuncu Yıl, Faculty of Veterinary Medicine 11(2):82-86.

Hatipoğlu, R., N. Çeliktaş and E. Can. 1996. The possibilities to benefit from gene transfer techniques on forages breeding. Turkey 3th Meadow-rangeland and forage crops congress 17-19 June 1996. pg. 232-238. Atatürk University Agricutural Faculty Erzurum.

Prosperi, J.M., Angevain, M., Bonnin, I., Chaulet, E., Genier, G., Jenczewski, E., Olivieri, I., and Ronfort, J. 1996. Genetic diversity, preservation and use of genetic resources of Mediterranean legumes: Alfalfa and Medics. The Genus *Medicago* in the Mediterranean Region: Current Situation and Prospects in Research, Vol:18. Cahiers Options Mediterranean, CIHEAM.

Rosellini, D., Veronesi, F., Falcinelli, M. and Lorenzetti, F., 1991. The possibility of using gametophytic selection in breeding Lucerne (*Medicago sativa* L.). Fodder crops breeding: Achievements, novel strategies and biotechnology, Proceedings of the 16th meeting of the fodder crops section of Eucarpia Wageningen, Netherlands. Pg. 203-204.

Şengül, S. 1996. The determination of hay and crude protein yield of Şark alfalfa (*Medicago sativa* L.). Turkey 3th Meadow- rangeland and forage crops congress 17-19 June 1996. pg. 615-620. Atatürk University Agricultural Faculty Erzurum.

Şengül, S. and L. Tahtacıoğlu. 1996. The determination of hay and crude protein yield of different alfalfa varieties and lines under Erzurum ecological condition. Turkey 3th Meadow-rangeland and forage crops congress 17-19 June 1996. pg. 608-614. Atatürk University Agricultural Faculty Erzurum.

Ünal, S. 2000. Nohut geveni (*Astragalus cicer* L.) Ayrık (*Agropyron* GAERTN.) Ekimi Karışım Oranlarının Yem Verimi ve Botanik Kompozisyona Etkileri Üzerinde Araştırmalar. Ankara Üniversitesi Fen Bilimleri Enstitüsü, Tarla Bitkileri Anabilim Dalı (Doktora tezi).

Volenec, J. J., Cherney, J. H. and Johnson, K. D., 1987. Yield component, plant morphology, and forage quality of alfalfa as influenced by plant population. Crop Sci. 27: 321-326.