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SUZAN ALTINOK

AZİZ KARAKAYA

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## Forage Yield of Different Alfalfa Cultivars under Ankara Conditions

Suzan ALTINOK

Ankara Üniversitesi Ziraat Fakültesi Tarla Bitkileri Bölümü Dışkapı 06110 Ankara - TURKEY

Aziz KARAKAYA

Ankara Üniversitesi Ziraat Fakültesi Bitki Koruma Bölümü Dışkapı 06110 Ankara - TURKEY

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**Abstract:** This research was carried out in the experimental field of Ankara University, Faculty of Agriculture, Department of Field Crops during the years 1997, 1998, and 1999. Alfalfa cultivars Elçi, Kayseri, Mesa Sirsa, Fortress, Bilensoy-80, 5638/Miral, Peru, and Bitlis were used as materials. Plant heights of alfalfa cultivars during three years were highest before first cuts, and the highest forage yields were obtained from these cuts. According to the results, total green yields and dry matter yields were 1869 and 651 kg/da in first year, 4071 and 1297 kg/da in the second year, and 3839 and 1226 kg/da in the third year. After a period of three years, no significant yield differences were detectable among the cultivars. Total green and dry matter yields were 9779 and 3214 kg/da, respectively. The crude protein contents of the cultivars found after the first cut were similar in the first and third year (21-25% and 17-22%); however, they were lower in the second year (15-17%). The total dry matter yield of local cultivar Bilensoy-80 was higher than the other cultivars over the three years (3615 kg/da). After a period of three years, local and introduced cultivars were compared for their dry matter yields. It was found that, although statistically not significant, the yield of the local cultivars was slightly higher (2.6%) than that of the introduced cultivars under Ankara conditions.

**Key Words:** Alfalfa, plant height, forage yields

### Bazı Yonca Çeşitlerinin Ankara Koşullarında Yem Verimleri

**Özet:** Bu araştırma Ankara Üniversitesi Ziraat Fakültesi Tarla Bitkileri deneme tarlasında 1997, 1998 ve 1999 yıllarında yürütülmüştür. Elçi, Kayseri, Mesa Sirsa, Fortress, Bilensoy-80, 5638/Miral, Peru ve Bitlis yonca çeşitleri materyal olarak kullanılmıştır. Her üç yılda da, yonca çeşitlerinde bitki boyları birinci biçim öncesi en yüksek olarak belirlenmiş, bu da en fazla yem verimlerinin bu biçimden elde edilmesi şeklinde sonuçlanmıştır. Yeşil ot ve kuru madde verimleri, birinci yıl 1869 ve 651 kg/da, ikinci yıl 4071 ve 1297 kg/da, üçüncü yıl ise 3839 and 1226 kg/da olmuştur. Üç yılın sonunda toplam yem verimlerinde yonca çeşitleri arasında önemli bir farklılık olmamış ve tüm çeşitlerin ortalaması olarak 9779 kg/da toplam yeşil ot verimi, 3214 kg/da toplam kuru madde verimi elde edilmiştir. Birinci biçim sonrası saptanan ham protein oranları ise birinci ve üçüncü yıl benzer sonuçlar verirken (% 21-25 ve % 17-22), ikinci yıl biraz daha düşük olmuştur (% 15-17). Ülkemizin yerli bir çeşidi olan Bilensoy-80 üç yılın sonunda en fazla toplam kuru madde verimi göstermiştir (3615 kg/da). Üç yıllık araştırma sonucunda yerli ve yabancı yonca çeşitlerinin kuru madde verimleri karşılaştırılmıştır. Sonuçta istatistiki olarak önemli bir farklılık elde edilmemesine karşın, Ankara koşullarında yerli çeşitlerin kuru madde verimleri yabancı çeşitlerden çok az bir farkla daha fazla bulunmuştur (% 2.6).

**Anahtar Sözcükler:** Yonca, bitki boyu, yem verimleri.

### Introduction

In Turkey, alfalfa is grown over 230,000 ha and hay production from these area reaches 1,500,000 tons (Anonymous, 1998). Asia minor, Caucasia, Iran and Turkmenistan are known as the gene centers for *Medicago sativa* L. In Turkey, alfalfa can be grown successfully in all regions. Alfalfa production seems to be on the increase in all areas from the Aegean, Mediterranean and Black Sea coasts to the high plateaus of eastern Turkey (Manga et al., 1995). In the coastal

regions, non-dormant alfalfa cultivars suitable for warm, humid climates are common. However, in the cool and high plateaus of eastern Turkey dormant and cold-tolerant cultivars can be grown successfully. Alfalfa is a very important forage crop throughout the world. It has superior forage qualities and high yields that can be consumed by livestock readily. Alfalfa has a high protein content and it is also rich in minerals and vitamins. Despite all these advantages, the alfalfa planting area in Turkey is limited and far from meets the need for quality

forage. Therefore, it is important to find the alfalfa varieties suitable for different ecological regions, while the enlargement of alfalfa planting areas is necessary. The aim of this study was to test the forage yield of alfalfa cultivars under Ankara conditions. For this reason, different introduced and local alfalfa cultivars were evaluated under Ankara conditions over a period of three years.

**Materials and Methods**

This study was carried out in the experimental field of Ankara University, Faculty of Agriculture, Department of Field Crops during the years 1997, 1998, and 1999. The soil texture was a clay loam with a slight alkaline condition. The amount of organic matter was approximately 1%. The monthly precipitation, temperature and relative humidity of the experimental area are presented in Table 1. The total amounts of precipitation during the years 1997, 1998, and 1999 were 548 mm, 442 mm, and 435 mm, respectively. These values were higher than the mean of the long years precipitation, which was 343 mm. The means of the temperature and relative humidity during the experimental period were close to the mean of long years.

In this study, local alfalfa cultivars Elçi, Kayseri, Bitlis and Bilensoy-80 and introduced alfalfa cultivars Mesa

Sirsa, Peru, Fortress and 5638/Miral were used as the research materials.

The experiment was established in April of 1997. The experimental design was a randomized complete block with three replications. Each plot consisted of 20 rows of 4 m length. Plant spacing between the rows was 17.5 cm. Seeding rate was 1 kg/da for all cultivars. Weeds were removed by hoeing as needed. Plant heights were measured before the harvests. Harvesting was accomplished when approximately 10-20% of the plants were at the flowering stage. Plots were flood irrigated after each cut. There were two cuts in the first year (1997) and four cuts during the years 1998 and 1999. Green yield was determined and samples were dried in ovens at 70°C to a constant weight for dry matter content (Martin et al., 1990). Dried samples were ground and the amount of N was determined using the Kjehldal method. The amount of N from each sample was multiplied by 6.25 and crude protein content was calculated. Green yield obtained from each plot, dry matter and crude protein contents were calculated as green, dry matter and crude protein yields per decare.

Data were analyzed by analysis of variance (Anonymous, 1989). P≤0.05 and 0.01 levels of significance and means were compared using Duncan’s multiple range test at the P≤0.05 level.

Table1. Monthly precipitation, mean temperature and relative humidity in the experimental area.

Months	Precipitation (mm)				Temperature (°C)				Relative humidity (%)			
	Long Years	1997	1998	1999	Long Years	1997	1998	1999	Long Years	1997	1998	1999
January	33	37	11	28	1	2	2	3	77	76	73	72
February	38	17	53	86	1	1	3	3	73	68	69	72
March	25	15	46	55	6	3	4	7	63	59	68	63
April	40	91	71	14	13	8	14	12	58	67	67	60
May	48	71	64	7	16	17	16	17	57	58	70	52
June	21	122	48	35	20	20	20	20	51	55	65	60
July	9	2	18	45	24	23	25	25	46	50	53	51
August	6	30	0	31	23	21	25	24	47	58	46	52
September	7	0	8	21	20	16	19	19	46	55	54	55
October	29	60	31	43	15	13	15	14	59	67	57	64
November	50	40	38	31	6	7	9	7	72	74	75	68
December	33	66	55	39	1	4	5	5	78	77	77	73
Total	343	548	442	435	-	-	-	-	-	-	-	-
Mean	-	-	-	-	12	11	13	13	60	64	64	62

## Results and Discussion

According to first year's results, there were statistically significant ( $P \leq 0.01$ ) differences among the alfalfa cultivars regarding plant height measurements, which were performed before each cut (Table 2). However, there were no statistically significant differences among the cultivars regarding green and dry matter yields as well as crude protein content and yields. In the first year, the plant height values of the cultivar Mesa Sirsa were the highest in both cuttings (60 and 47 cm). After the first cut, green and dry matter yields of the cultivar Fortress were the highest. However, Peru was

the highest crude protein yielding cultivar. The crude protein content of the cultivars varied between 21 and 25%. After the second cut, the green and dry matter yields of the cultivar Elçi were found to be the highest.

Second year results showed that there were no significant differences among the plant heights obtained before the first cut (Table 3). However, there were statistically significant ( $P \leq 0.05$  and  $P \leq 0.01$ ) differences among the other variables for all cutting periods. Cultivars started to show their actual performances beginning with the second year. Under Ankara conditions, following winter, the cultivar Bitlis, which is adapted to

Table 2. Plant height and forage yields of alfalfa cultivars after the first year (1997 planting) under Ankara conditions.

Cultivars	First Cut					Second Cut		
	PH*	GY	DMY	CPC	CPY	PH	GY	DMY
Elçi	51ab**	1501	469	24	111	44ab	558	205
Kayseri	59a	1527	487	25	120	40abc	456	167
Mesa-sirsa	60a	1574	487	21	103	47a	518	187
Fortress	56a	1644	579	21	121	33cd	331	130
Bilensoy-80	52ab	1562	552	22	123	34bc	375	141
5638/Miral	54ab	1288	467	23	104	33cd	348	131
Peru	52ab	1441	580	22	129	31cd	319	111
Bitlis	46b	1242	420	23	100	23d	270	98
Mean	54	1472	505	23	114	36	397	146
C.V. (%)		8.3	25.2	30.8	8.5	35.1	15.4	35.535.7

\* PH= Plant height (cm), GY=Green yield (kg/da), DMY= Dry matter yield (kg/da), CPC= Crude protein content (%), CPY= Crude protein yield (kg/da).

\*\* Means followed by the same letters are not statistically significant according to Duncan's Multiple Range Test.

Table 3. Plant height and forage yields of alfalfa cultivars after the second year (1998 results) under Ankara conditions

Cultivars	First cut					Second cut		Third cut			Fourth cut		
	PH*	GY	DMY	CPC	CPY	GY	DMY	PH	GY	DMY	PH	GY	DMY
Elçi	93	1719bc**	487bc	15b	72cd	1021a	367a	57a	1066b	305bcd	48ab	600ab	226ab
Kayseri	96	1505c	423c	17a	71d	1063a	391a	65a	1025b	327abc	37abc	632a	248a
Mesa-sirsa	88	1624bc	466bc	16ab	73cd	1105a	382a	66a	1541a	455a	54a	693a	237ab
Fortress	99	2124ab	608ab	16ab	97ab	612bc	236bc	38b	657bc	203cd	17d	175c	93c
Bilensoy-80	94	1867bc	543abc	15b	79bcd	1010a	356a	56a	1093b	347ab	30bcd	506abc	173abc
5638/Miral	92	1919bc	567abc	17a	94abc	791ab	296ab	35b	797bc	245bcd	27d	396abc	140abc
Peru	87	1514c	453c	15ab	70d	819ab	290ab	58a	804bc	255bcd	31bcd	459abc	168abc
Bitlis	106	2414a	669a	17a	111a	348c	139c	35b	527c	171d	15d	231bc	107bc
Mean	94	1836	527	16	83	846	307	51	939	289	32	461	174
C.V. (%)	9.4	14.3	14.7	4.7	13.8	24.8	20.2	17.4	25.1	25.4	32	43	39.0

\* PH= Plant height (cm), GY=Green yield (kg/da), DMY= Dry matter yield (kg/da), CPC= Crude protein content (%), CPY= Crude protein yield (kg/da).

\*\* Means followed by the same letters are not statistically significant according to Duncan's Multiple Range Test.

cold winter conditions, was the fastest growing cultivar. After the first cut, the plant height and yield values of the cultivar Bitlis were found to be the highest. The crude protein content of the cultivars after first cutting ranged between 15 and 17%. After the second cut, the green and dry matter yields of the cultivars Mesa Sirsa and Kayseri were the highest. During this year, the green yield of the cultivar Mesa Sirsa was the highest following the second, third and fourth cuts. The dry matter yield of the cultivar Mesa Sirsa was also the highest following the second and third cuts.

According to third year results, there were statistically significant ( $P \leq 0.05$ ) differences among the cultivars regarding crude protein content after the first cut and green and dry matter yields after the second and third cuts (Table 4). After the first cut, plant height, dry matter and crude protein yields of the cultivar Bilensoy-80 were the highest. However, the highest green matter yield was obtained from the cultivar Bitlis, which was also the case in the previous year. The crude protein content of the cultivars ranged between 17 and 22%. The highest green and dry matter yields were obtained from the cultivar Kayseri following the second cut, with the cultivars Kayseri and Peru following the third cut, and with the cultivar Elçi following the fourth cut.

Total forage green and dry matter yields for each year and the totals for the three years are presented in Table 5. First year total forage yield (first and second cut) results showed no statistically significant differences among the alfalfa cultivars (Table 5). Also, no significant differences were observed among the forage cultivars in the third year regarding green and dry matter yields after four cuts. However, second year results showed statistically significant ( $P=0.05$ ) differences among the yield of forage cultivars. The green and dry matter yields for the three years also showed no significant cultivar differences (Table 5). After the first year, the total dry matter yield of the cultivar Fortress was the highest (709 kg/da). The total dry matter yield of the cultivar Mesa Sirsa was the highest following the second year (1541 kg/da). The total dry matter yield of the cultivar Bilensoy-80 in third year was the highest (1502 kg/da). After three years, the total dry matter yield of the cultivar Bilensoy-80 was the highest (3615 kg/da).

According to Sheaffer et al., (1998) alfalfa cultivars are available that produce high quality forage; however, information is lacking on the consistency of cultivar forage quality over environments. Eğinlioğlu et al., (1996), under Menemen conditions, evaluated the yield of 20 introduced and local alfalfa cultivars over three years. The cultivars Sundor, Elçi, California 50, Maxidor,

Table 4. Plant height and forage yields of alfalfa cultivars after the third year (1999 results) under Ankara conditions.

Cultivars	First cut					Second cut		Third cut		Fourth cut	
	PH*	GY	DMY	CPC	CPY	GY	DMY	GY	DMY	GY	DMY
Elçi	82	1295	405	20abc**	79	1331abc	425ab	1032a	328a	634	238
Kayseri	80	1490	470	20abc	95	1645a	504a	1053a	333a	422	152
Mesa-sirsa	77	1088	326	22a	71	1517ab	494a	1039a	316a	442	162
Fortress	78	1205	442	19bc	81	623bc	231b	254b	94b	372	131
Bilensoy-80	87	1646	540	20abc	106	1502ab	489a	1040a	325a	380	148
5638/Miral	67	1434	454	19bc	87	1000abc	373ab	672ab	237ab	381	136
Peru	83	1360	475	20abc	92	1370abc	440ab	1013a	336a	310	107
Bitlis	78	1729	532	17c	90	712bc	231b	379b	130b	342	120
Mean	79	1406	456	19	88	1213	399	810	262	410	149
C.V. (%)	12.1	23.5	19.1	7.7	24.3	34.4	32.0	39.1	35.2	34.9	38.0

\* PH= Plant height (cm), GY=Green yield (kg/da), DMY= Dry matter yield (kg/da), CPC= Crude protein content (%), CPY= Crude protein yield (kg/da).

\*\* Means followed by the same letters are not statistically significant according to Duncan's Multiple Range Test.

Table 5. Total green and dry matter yields of alfalfa cultivars after a period of three years under Ankara conditions.

Cultivars	First year (1st and 2nd cuts)		Second year (1st, 2nd, 3rd and 4th cuts)		Third year (1st, 2nd, 3rd and 4th cuts)		TOTAL (Year 1, 2 and 3)	
	GY*	DMY	GY	DMY	GY	DMY	GY	DMY
Elçi	2060	674	4406ab**	1388ab	4292	1397	10758	3458
Kayseri	1983	654	4224ab	1389ab	4611	1459	10817	3502
Mesa-sirsa	2092	674	4962a	1541a	4085	1299	11140	3513
Fortress	1975	709	3478b	1140bc	2454	898	7907	2746
Bilensoy-80	1937	693	4475ab	1420ab	4568	1502	10980	3615
5638/Miral	1636	597	3903b	1247bc	3487	1201	9025	3046
Peru	1760	691	3597b	1168bc	4052	1357	9409	3216
Bitlis	1512	519	3520b	1086c	3162	1014	8194	2619
Mean	1869	651	4071	1297	3839	1226	9779	3214
C.V. (%)	23.6	27.0	12.6	11.7	27.3	23.8	16.0	14.6

\* GY=Green yield (kg/da), DMY= Dry matter yield (kg/da).

\*\* Means followed by the same letters are not statistically significant according to Duncan's Multiple Range Test.

Condor, Pierce, California 60, and Aumara outyielded the standard cultivar Mesa Sirsa in terms of green yield. Cultivar Elçi had the highest total dry matter yield. The highest yield was obtained with the first cut. Elçi is a Turkish cultivar developed by the Faculty of Agriculture of Ankara University and it is primarily recommended for growing in south eastern Turkey (Manga et al., 1995). This cultivar was also very productive under Menemen conditions. However, in our study, according to the three year results, the dry matter yield of Elçi was less than the dry matter yield of the cultivars Bilensoy-80, Mesa Sirsa and Kayseri. It appears that different cultivars should be recommended for different regions. Also in our study, the highest green and dry matter yields were obtained with the first cut in all cultivars during the three year period.

In a study performed at the Eastern Anatolian Agricultural Research Institute (EAARI), 19 alfalfa cultivars and lines were evaluated (Anonymous, 1992). In this study, the dry hay yields of the cultivars Şark, Arrow, Kayseri, and Ladak were 1780, 1738, 1696, and 1683 kg/da, respectively. In another study, Şengül and Tahtacıoğlu (1996) evaluated different alfalfa cultivars and lines, including Bilensoy-80, over a three year period. In this study, average green yields ranged between 3050-2524 kg/da and dry hay yields ranged between 1797-982 kg/da. The mean over three years of crude protein yield was found to be 208 kg/da. After three years, the

highest yields were obtained with the alfalfa lines x-1312 and x-1313. These lines are recommended for Erzurum conditions. In our study, after a three year period, average green and dry matter yields ranged between 3713-2731 kg/da and 1205-873 kg/da (data not shown in tables), respectively. In our study, green yields were higher than the yields obtained in the above mentioned studies of EAARI. However, dry matter yields were lower than EAARI's yields. On the other hand, in our study evaluations were made using dry matter yield, not the hay yield as was the case in their studies. In another study, Aydın et al. (1994) evaluated 39 alfalfa cultivars under Samsun conditions without irrigation. Their three year average hay yields ranged between 205 and 292 kg/da. The crude protein contents of the cultivars ranged between 12.56-21.14%.

Haby et al. (1999) reported that acid soils and wet conditions limit alfalfa production. Their results showed that the yield of alfalfa with a 23 cm row spacing in 1991 was 8.8 t/ha and declined to 6.7 t/ha with a 69 cm row spacing. In 1992, alfalfa yield increased an additional 2.2 t/ha at each row spacing. Alfalfa yielded 11 t/ha in all four different row spacings (between 23 and 92 cm) in 1993, despite a midseason drought. In our study, which was carried out in similar ecological regions, row spacing was 17.5 cm and dry matter yields were higher. In another study, Sleugh et al. (2000) found that the total dry



matter yields of monoculture alfalfa, alfalfa intermediate wheatgrass, and alfalfa smooth brome grass were 13400, 12700 and 12600 kg/ha, respectively. In 1996, the same yields were 7500, 6800, and 6700 kg/ha, respectively. In our study, total dry matter yields of alfalfa cultivars were 1297 kg/da and 1226 kg/da in the second and third years, respectively. Our results are similar to or higher than the results of Sleugh et al. (2000).

As can be seen in Table 3, yields of the local cultivars were slightly higher (2.6%) than the yields of the introduced cultivars. In a study conducted in the Aegean region, Mugañlı (1965) obtained higher (25-30%) yields from the introduced alfalfa cultivars compared to local cultivars. Yılmaz (1975), under Konya conditions, evaluated Kayseri and nine American alfalfa cultivars. Caliverdi-65 and Washoe cultivars yielded 35% more green forage yield. Tosun et al. (1978) evaluated 81 introduced cultivars and Erzurum, Ağrı and Kayseri ecotypes during a seven year study. They found that some introductions yielded 30% more than the native ecotypes. However, in our study, after a period of three years, it has been found that local cultivars were more productive,

although these differences were not statistically significant. Of course, an important factor to obtain higher yields from the cultivars is to grow them in suitable ecological regions.

## Conclusion

According to the results, after a period of three years no significant yield differences were detectable among the eight alfalfa cultivars. Total green and dry matter yields were 9779 and 3214 kg/da, respectively. However, the total dry matter yield of local cultivar Bilensoy-80 was higher than that of the other cultivars over the three years (3615 kg/da). Bilensoy-80 was developed by the Field Crops Central Research Institute in 1984 for the Central Anatolia region. This study confirms the high yielding capacity and adaptability of this cultivar. After a period of three years, local and introduced cultivars were compared for their dry matter yield. It was found that, although statistically not significant, the yields of the local cultivars were slightly higher (2.6%) than introduced cultivars under Ankara conditions.

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