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Determination of Some Plant and Agricultural Characteristics in Persian Clover (*Trifolium resupinatum* L.)*

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Abstract: Forage legumes have been important livestock feed for centuries as pasture, soilage and conserved forage. Because of the large number of species, their wide adaptation to soil and climatic conditions, and their general ability to reseed readily, *Trifolium* is one of the two most important legume genera in livestock agriculture. Persian clover (*Trifolium resupinatum* L.), one of the important species of genus Trifolium, has agronomic potential to be grown in Central Anatolia. This study was carried out to investigate some plant and agronomic characteristics of Persian clover lines. A number of lines of this valuable pasture and hay plant were tested for forage yield potential in Ankara conditions. According to the results, the highest natural plant height was measured in Line 5475 as 51.267 cm, the highest plant height was in Line 5475 as 58.987 cm, biggest leaf number was in Line 5453 as 9.6, the widest leaf was in Line 5475 as 22.3 mm, the longest leaf was in Line 5475 as 33.5 mm, the widest stem diameter was in Line 5475 as 55 mm. The highest fresh and dried hay yield obtained from Line 5475 as 1962 kg/da and 331.37 kg/da while Line 5461 gave biggest dried hay ratio as %19.1. Persian clover could be used as a forage crop in Ankara conditions because of it's high fresh and dry herbage yield. And it can be recommended that Line 5475 is a suitable genotype in the production of fresh and dried hay in Ankara conditions.

Key Words: Persian clover, plant characteristics, plant height, herbage yield,

İran Üçgülünde (*Trifolium resupinatum* L.) Bazı Bitkisel ve Tarımsal Özelliklerinin Belirlenmesi

Öz: Baklagil yem bitkileri yüzyıllardan beri çayır ve meralarda, tarla topraklarında kuru ot ve silaj amaçlı yetiştirilmektedir. Üçgüller, tür sayısının fazlalığı, değişik iklim ve toprak koşullarına uyumu ve kendi kendilerini tohumlama özelliklerinden dolayı hayvan besleme açısından en önemeli iki cinsten biridir. Üçgül cinsinin en önemli türlerinden biri olan İran üçgülü (*Trifolium resupinatum* L.) Orta Anadolu Bölgesi'nde yetişme potansiyeline sahiptir. Bu çalışma, İran üçgülü hatlarının, değişik bitkisel ve tarımsal özelliklerinin incelenmesi amacıyla yürütülmüştür. Bu değerli yem bitkisi türünün değişik hatları Ankara iklim koşullarında yem üretimi potansiyelinin belirlenmesi amacıyla denenmiştir. Araştırmadan elde edilen verilere göre, bitkisel ve tarımsal özellikleri incelendiğinde en uzun doğal bitki boyu 5475 numaralı hatta (51,267 cm), en uzun bitki boyu 5475 numaralı hatta (58,987 cm), en yüksek yaprak sayısı 5453 numaralı hatta (9.6 adet), en geniş yaprakçık eni 5475 numaralı hatta (22,3 mm), en uzun yaprakçık boyu 5475 numaralı hatta (33,5 mm), en geniş sap çapı 5475 numaralı hatta (5.5 mm), en yüksek yeşil ot verimi 5475 numaralı hatta (1962 kg/da), en yüksek kuru ot verimi 5475 numaralı hatta (331,37 kg/da), en yüksek kuru ot oranı 5461 numaralı hatta (%19,1) elde edilmiştir. Araştırma sonucuna göre İran üçgülü yüksek yeşil ve kuru ot veriminden dolayı Ankara koşullarında yem bitkisi olarak kullanılabilir. Bunun yanında 5475 numaralı hat Ankara koşullarıda yeşil ve kuru ot üretimi için uygun bir genotip olarak kullanılabilir.

Anahtar Kelimeler: İran üçgülü, bitkisel özellikler, bitki boyu, yem verimi

Introduction

There is a big shortage in animal feeding in Turkey (Anonymous 2000). Having various ecological conditions, Anatolia has the potential for many forage crops used in animal feeding to be grown successfully. Nevertheless these forage crops which occupies 25-30% of area sown in agriculturally developed countries share only 4-5% of the area sown in Turkey.

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Zohary and Heller (1984) reports *Trifolium* L. as one of the most important genus in legume family (Fabaceae=Leguminosae) for its agricultural value as much as its species number which exceeds 237. According to them, Mediterranean region and its neighbor countries are one of the main gene centers of the genus. They also inform that Turkey is the richest Mediterranean country for clovers species with over 100 species in its natural flora.

Clovers (*Trifolium* L.) are a very big group having annual and perennial species. The members of this genus that distribute in the humid and cool belt of the temperate regions are accepted as nutritive forages. Mostly they have thin stem and ample foliage. They have also high digestive value. They are used more widely for grazing than for harvested forage, but are also important as hay, silage and green-chop. Although they are annuals or short-lived perennials, stands can be maintained for long periods of time because they can generally be re-established or allowed to reseed naturally (Van Keuren and Hoveland 1985)

Zohary (1970) investigated the clovers in the flora of Turkey and the east Aegean islands and describes Persian clover as an prostrate annual legume, 20-60 cm tall, having 1-2.5 cm leaves, occurring in road sides, barren areas. He divided the species into three varieties and named the group with the big leaflets and a height up to 80 cm as var.majus. Zohary claims that var.majus could naturally be found in flora of Turkey. Generally it is grown for agricultural purposes in autumn-spring period. In the irrigated conditions, it can be sown in early times of spring season. It's fresh or dried palatable herbage is consumed eagerly by livestock. Persian clover is used to improve the grazing lands as a self seeding species in the regions where Mediterranean type climates prevails. In addition, it is sown with other annual legumes in a mixture because of its high palatable and nutritive forage. To enlarge the production period, it can be mixed with other sub-species. It regenerates successfully after cut or grazing by animals. It also plays an important role in improving fallow lands.

Gençkan (1983), claims that origin centre of Persian clover is Turkey and Iran and it might be a cultured plant in Anatolia in ancient times where animal growing was advanced. He describes Persian clover as fast growing, having many branches and a winter type plant species. Stem of Persian clover may reaches up to 1 m long and never turns into a woody structure with maturity. Its yield is low on light soils and produces a yield of 11 t/ha after 4 cuts in Portugal originated Persian clover types (Gençkan 1983).

Knight (1985) describes Persian clover as an excellent grazing plant and nutritious if properly cured. He also adds that silage from Persian clover is excellent feed for beef and dairy cows, and it grows best on alkaline soils though it can be grown on soils of medium acidity. According to him hay yields of Persian clover are generally in the range of 1 to 2 ton/ha.

Ateş and Tekeli (2001) compared some wild Persian clover forms collected from Tekirdağ and its surroundings with cultural varieties for yield components. They reported significant differences among the traits such as plant height, stem length, lateral branch number, main stem diameter, leaf number on main stem, leaf length, leaflet height, leaflet wide, green herbage yield, dried herbage yield.

Persian clover can be used as either a special purpose forage crop or a self-regenerating pasture. Regrowth after grazing or cutting is excellent, and it has a high nutritive value as pasture or hay. There are two main subspecies of *Trifolium resupinatum*: majus and resupinatum. *Trifolium resupinatum* var. *majus* has an erect habit, thick hollow stems and large leaflets. Hard seed level is very low at one to two per cent. *Trifolium resupinatum* var. *resupinatum* has a more prostrate habit, thinner stems and smaller leaflets. Hard seed and seed yields are higher than majus. Flowering and maturity are mostly earlier than majus. The cultivars Kyambro, Nitro and Prolific belong to this subspecies (Lacy et al. (2003).

Tekeli et al. (2003) investigated changes in some morphological and chemical traits of Persian clover in relation to time and above ground biomass. All the parameters were regressed against time and aboveground biomass. They reported plant height as 45 cm, leaves number on main stem as 32.4, leaf7stem raio as 1.40 ans dry matter ratio as 11.8%.

The aim of this research was to investigate some plant and agricultural characteristics of Persian clover lines in Ankara conditions.

Material and Method

The study was carried out on the experimental fields of Department of Field Crops, Faculty of Agriculture of Ankara University in 2002. The experimental area has an altitude of 860 m from sea level. The soil of the study area was clay-loam and slightly alkaline with a 1.47% of organic matter. It has also 7.89 % lime and 0.192 Milimhos/cm soluble salts. The climatic conditions of the study year were almost same with long term values (Table 1).

Table 1. Some climatic data of the experimental area in 2002 and long term

Months	Long term			2002		
	Temperature (^{0}C)	Precipitation (mm)	Relative Humidity (%)	Temperature (^{0}C)	Precipitation (mm)	Relative Humidity (%)
January	-0.1	40.5	78	-3.8	29.8	77
February	1.3	34.9	74	5.0	11.8	60
March	5.4	35.6	65	8.6	23.0	58
April	11.2	40.3	59	10.4	101.1	66
May	15.9	51.6	57	16.7	38.7	50
June	19.8	32.6	51	20.8	29.0	53
July	23.1	13.5	44	24.8	35.3	56
August	23.0	10.3	42	22.5	6.6	59
September	18.4	17.4	47	18.3	54.7	64
October	12.8	24.4	58	13.3	22.7	66
November	7.3	30.9	70	8.0	19.0	72
December	2.3	45.6	78	-0.8	16.2	74
Mean	11.7	-	60.2	11.9	-	62.9
Total	-	377.6	-	-	387.9	

The seed material of the experiment was 8 Persian clover (*Trifolium resupinatum* var. *majus*) lines obtained from Osman Tosun Plant Gene Bank of Ankara University and one variety (var. resupinatum) obtained from Maro Seed Company (Table 2).

The field study of the research was carried out at the fields of Department of Field Crops, Faculty of Agriculture of Ankara University. The experiment was designed as randomised complete block with 3 replicates and seeded in spring. Seed samples were sown to the 3.6 m2 plots (3m x 1.2m) consisted of 4 rows 30 cm apart from each others. Seeds were placed in rows with hand. Seeding rate was 2 kg/da. No fertiliser was applied and plants were grown in rainfed conditions without irrigation.

Relatively good stands were obtained after seeding and weeds between the rows were eliminated by labour. At harvesting time, one of the cultivars (5117) was put out of the experiment since it did not produce necessary plant material in plots to measure herbage yields. The rest of the experiment was carried out with 8 lines.

Table 2. Origin of the seeds used in the experiment

Lines	Obtained from
5400(var.majus)	Osman Tosun Gene Bank
5453(var.majus)	Osman Tosun Gene Bank
5456(var.majus)	Osman Tosun Gene Bank
5461(var.majus)	Osman Tosun Gene Bank
5464(var.majus)	Osman Tosun Gene Bank
5475(var.majus)	Osman Tosun Gene Bank
5480(var.majus)	Osman Tosun Gene Bank
5313(var.majus)	Osman Tosun Gene Bank
5117(var.resupinatum)	MARO Seed Company

When plants reached 50% blooming, 5 individual Persian clover plants from each plot were labelled to observe and determine various morphological characters. At this stage, number of days to flowering (Ünlü 1986), plant height (Ekiz 1983), stem diameter (Eraç 1973), leaf number on main stem (Tokluoğlu 1979) leaflet length and width (Kılıç 1991) were counted or measured. All the plants in plots were cut for green herbage yield (Manga 1978, Eraç 1982) and 500 g of plant material was dried in oven for 48 hours for moisture content and dried herbage yields were calculated (Tekeli 1977). Data obtained in field and laboratories were analyzed in computer with MSTAT-C software for analysis of variance and the differences were grouped for Duncan test (Düzgüneş et al. 1987).

Results and Discussion

Number of days to flowering: Persian clover lines had different number of days to flowering ($P<0.01$). The average number of days to flowering and Duncan test results were shown in Table 3.

Table 3 shows that the period necessary for flowering for Persian clover lines varied between 75.0 and 91.7 days. Among the lines, Line 5313 produced

Table 3. Some plant characteristics and hay yields of Persian clover lines

Line	Number of days to flowering	Plant height (cm)	Stem diameter (mm)	Number of leaves	Leaflet width (mm)	Leaflet height (mm)	Fresh herbage yield(kg/da)	Dried herbage ratio (%)	Dried herbage yield (kg/da)
5400	91.333 b	48 a	3.99 bc	9.5	15.4 b	23.1 b	1160.0abc	18.3	207.7 bc
5453	91.667 b	56 a	4.32 bc	9.6	17.8 ab	26.1 b	1866.0 ab	17.0	317.7 ab
5456	91.000 b	45 a	3.84 bc	5.7	16.3 b	24.4 b	1390.0abc	18.1	246.4abc
5461	91.000 b	52 a	4.42 bc	8.7	17.3 ab	25.1 b	1712.3abc	19.1	324.4 ab
5464	91.333 b	46 a	4.12 bc	8.5	16.4 b	23.9 b	976.3 bc	17.8	170.8 c
5475	91.667 b	59 a	5.51 a	8.9	22.3 a	33.5 a	1962.0 a	16.9	331.4 ab
5480	90.333 b	54 a	4.83 ab	5.9	18.5 ab	27.3 b	1819.3 ab	17.7	320.9 a
5313	75.000 a	32 b	3.54 c	6.2	13.8 bc	23.2 b	875.0 c	17.9	157.7 c
5117	90.667 b	26 b	2.20 d	5.5	9.6 c	17.3 c			

*Letters sign different groups at P<0.01 level

flowers just after 75 days from the sowing of the seeds so it flowered 16 days before than the other lines. Flowering time for Persian clover lines except Line 5313 changed between 90.3 days and 91.7 days. But the differences between these lines were not significant. Sağlamtimur (1986) reports the period necessary to 50% flowering for Persian clover in Çukurova conditions as 101 days. Namlı and İnce (1987), claims that altitude and soil reaction are effective in flowering time for Persian clover. Ateş and Tekeli (2001) found out significant differences among Persian clover varieties and forms for flowering period.

Plant height: Significant differences for plant height among the lines have been found. Plant heights of Persian clover lines varied between 26 cm and 59 cm. The highest plant height was obtained from Line 5475 as 59 cm while the lowest plant height was line 5117 as 26 cm. Lines 5400, 5453, 5456, 5461, 5464, 5475 and 5480 were in higher plant height group and Lines 5313 and 5117 were in lower plant height group. Zohary (1970), Gençkan (1983), Namlı et al. (1994), Lacy et al. (2003) and Tekeli et al. (2003) report same plant height values for Persian clover.

Stem diameter: Persian clover lines had different stem diameters (P<0.01). Stem diameters changed between 2.20 mm and 5.51 mm among the lines. The widest stem diameter for the lines was obtained from Line 5475 as 5.51 mm and the narrowest diameter was 2.20 mm in Line 5117. Line 5475 and Line 5480 composed of the highest stem diameter group statistically while Line 5117 was alone in the lowest group (Table 3). Ateş and Tekeli (2001) reports stem diameter 3.7 mm for wild types of Persian clover and 10.84 mm for cultural varieties of the species.

Leaf number on main stem: There were no significant differences among the lines for leaf number on main stem. Leaf number on main stem varied between 5.5 and 9.6 in 9 Persian clover lines. The highest leaf number on main stem was 9.6 in Line 5453 and the lowest number was 5.5 in Line 5117. This results show that leaf numbers on main stem were similar in lines and no significant difference was not obtained. Zohary (1970) Tekeli and Ateş (2002) had similar leaf numbers for Persian clover in their studies. The results of Tekeli et al. (2003) show a big difference for leaf number in Persian clover. They reports 32.4 leaves in Persian clovers. The reason of this difference might be location, time and genotypes.

Leaflet width: Significant differences (P<0.01) were obtained from Persian clover lines for leaflet width (Table 3). Persian clover lines had leaflet widths between 9.6 mm and 22.3 mm.The highest leaflet width was recorded in Line 5475 as 22.3 mm and shortest leaflet was 9.6 mm in Line 5117. Lines 5453, 5461 5475 and 5480 were in higher leaflet width group while Line 5313 and Line 5117 were in lower leaflet group. Zohary (1970) reports leaflet width as 10-25 mm, Gençkan (1983) as 10 mm, and Lee et al. (1999) as 15-25 mm. The 20-45 mm leaflet width reported by Tekeli and Ateş (2002) might be measured in plants of a distinct ecology or genotype.

Leaflet length: Persian clover lines had different leaflet length (P<0.01) (Table 3). Leaflet lengths were measured between 17.3 mm and 33.5 mm. The highest leaflet length was 33.5 mm in Line 5475 and lowest leaflet length was in Line 5117 as 17.3 mm. Namlı et al. (1994) reports leaflet length as 7.5mm and18.0 mm for the Persian clover plants grown in nature. Leaflet length for cultural varieties of Persian clovers has been reported as 10-25 mm by Suttie (1999) 10-25 mm, 16.0-28.7 mm by Tekeli and Ateş (2002).

Fresh herbage yield: There were significant differences (P<0.01) among the lines for fresh herbage yields. Fresh herbage yields of Persian clover lines measured 1962 kg/da in Line 5475 as highest and

875 kg/da in Line 5313 as the lowest fresh herbage yield. Lines 5400, 5453, 5456, 5461, 5475 and 5489 were in the higher yielding group while Lines 5400, 5456, 5461, 5464, 5313 were in lower yielding group. The fresh herbage yields of Persian clover were similar to what Gençkan (1983), Knight (1985), Sağlamtimur et al. (1986) and Açıkgöz (2001) reports about the yield of the species. Higher yields reported by Sabancı and Ürem (1993), Sabancı and Ürem (1994), Çelen et al. (1997) and Özpınar and Sabancı (1999) were obtained in Aegean region where ecological conditions were more suitable for a better growth of Persian clover.

Dried hay ratio: All lines of Persian clover had the same dried hay ratio statistically ($P<0.01$). They showed a dried hay ratio between 17.0% and 19.1%. The highest dried hay ratio was obtained from the Line 5461 as 19.1% while Line 5453 had the lowest dried hay ratio as 17.0%. Dried hay ratios were similar in Persian clover lines. Sabancı and Ürem (1993) found dry matter ratio in Persian clover as 14%. On the other hand Tekeli et al. (2003) report 11.8% dry matter ratio in Persian clover. Dried hay includes some moisture (10-12%) while dry matter contains 0% moisture. In addition dry matter content might be high in plants grown in semi-arid regions.

Dried hay yield: Persian clover lines used in this experiment produced different dried hay yields ($P<0.01$) (Table 3). The highest dried hay yield obtained from Line 5475. Dried hay yield of this line was 331.4 kg/da. Line 5313 gave the lowest dried hay yield as 157.3 kg/da. Lines 5453, 5456, 5461, 5475 and 5480 were grouped as high yielding group while Lines 5400, 5456, 5464 and 5313 were in lower dried hay yielding group. Gençkan (1983), Knight (1985), Sağlamtimur et al. (1986) and Açıkgöz (2001) reports similar dried hay yields for Persian clover. Higher dried hay yields of Sabancı and Ürem (1993), Sabancı and Ürem (1994), Çelen et al. (1997) and Özpınar and Sabancı (1999) were obtained in Aegean region where better ecological conditions for Persian clover prevail.

Conclusion

When the results were evaluated in the study that aimed to determine some plant and agricultural characteristics of Persian clover lines, there were significant differences between lines for number of days to flowering, plant height, leaflet width and length, stem diameter, fresh herbage yield and dried herbage yield. On the other hand lines tested in this experiment had no difference in number of leaves and dried hay ratios. According to the results of one year study, Lines 5400, 5453, 5456, 5461, 5475 and 5489 could be recommended in the fresh herbage production of Persian clover. Lines 5453, 5456, 5461, 5475 and 5480 could be used in dried herbage production in the region. Line 5475 that has the highest values almost for all traits tested in the experiment is recommended for production both fresh and dried herbage.

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