# GRASS PEA (*Lathyrus sativus* L.) AS A FEED CROP IN MIXED FARMING SYSTEMS IN TURKEY

**Hüseyin K. FIRINCIOĞLU[(1)], Sabahaddin ÜNAL[(1)] and Hüseyin ÖZPINAR[(2)]**

[(1)] The Central Research Institute for Field Crops, Ankara, Turkey,
[(2)] The Aegean Agricultural Research Institute, Menemen-İzmir, Turkey

**SUMMARY:** In Turkey the main feed resources are obtained from natural pastures, forage crops and crop residues. The grass pea (*Lathyrus sativus* L) has a limited sown area with a few provinces. The farmers' preference for the grass pea can be outlined as follows; *(1)* its better adaptation to drought and less fertile soil, *(2)* lower input requirements to grow, and *(3)* more productive compared to common vetch. The research studies have mainly focused on the comparison of grass pea with feed legumes, in trying to understand how the grass pea is substitutable to others, and what its superiority is, if any. The grass pea studies have mostly generated positive results; such as its usefulness in crop rotations, herbage yield in mixtures and its superior seed and straw yields, and or it might be useful as a green manure crop. Grass pea may be regarded as a marginal crop in Turkey; however, its cultivation can be improved through enlarging of its growing area, better yielding varieties and suitable growing techniques. The objectives of this paper are to examine the current research and development potentials of the grass pea cultivation in Turkey, and to suggest the necessary future work for The enhancement of its production.

**Key Words:** Grass pea, *Lathyrus sativus* L., cultivation, research, development, cultivar

## TÜRKİYE'DE ÇEŞİTLİ ÇİFTLİK SİSTEMLERİ İÇİNDE BİR YEM BİTKİSİ OLARAK MÜRDÜMÜK (*Lathyrus sativus* L.)

**ÖZET:** Türkiye'de ana yem kaynakları doğal meralar, yem bitkileri ve bitki artıklarından sağlanmaktadır. Mürdümük, ülkemizin muhtelif yerlerine dağılmış az sayıda ili kapsayan sınırlı bir ekiliş alanına sahiptir. Çiftçilerin Mürdümük'ü tercih etme sebepleri şu şekilde sıralanabilir; *(1)* kıraç topraklara ve kuraklığa karşı dayanıklılığı, *(2)* yetiştirilmesinde daha az girdiye ihtiyaç göstermesi ve *(3)* yaygın fiğ ile mukayese edildiğinde daha verimli olmasıdır. Araştırma çalışmaları, özellikle mürdümüğün diğer bitkilerin nasıl yerine kullanılabileceği ve varsa üstün özelliklerinin ortaya konulması üzerine yoğunlaşmıştır. Mürdümük çalışmaları genelde ekim nöbetindeki faydaları, karışımdaki ot verimi ve tohum ve kes verimindeki üstünlükleri ve/veya yeşil gübre bitkisi olarak yararları gibi pozitif sonuçlar üretmiştir. Mürdümük, Türkiye'de marjinal bitki olarak dikkate alınabilir, ancak onun kültürü yetiştirme alanının genişletilmesi, daha iyi verim veren çeşitlerin ve yetiştirme tekniklerinin geliştirilmesi ile iyileştirilebilir. Bu makalenin amacı, Türkiye'de Mürdümük tarımının mevcut araştırma ve üretim potansiyelini incelemek ve onun üretimini iyileştirmek için yapılması gereken çalışmaları önermektir.

**Anahtar Kelimeler:** Mürdümük, *Lathyrus sativus* L., kültürü, araştırma, geliştirme, çeşit

## 1. INTRODUCTION

Turkey has the total area of 776000 km$^2$, which is positioned between 36$^0$ to 42$^0$ N longitudes and 26$^0$ to 45$^0$ E latitudes. The climate and topography show a wide discrepancy from west to east and from hinterland towards coastal areas. Most of the country is located in arid and semi-arid regions; annual rainfall varies from an average of 350 mm in the central plateau to 2300 mm in Eastern Black Sea Region. The dry areas, which cover Central, Eastern and South-eastern Regions of the country,

receive less than 500 mm annual precipitation where about 70% of annual rainfall occurs between December and May, and its year to year variation is erratic. The arable and fallow lands and natural pastures occupy 23.5 and 4.5, and 13.1 million hectares, respectively (SSI, 2002).

Roughly, Turkey can be divided into two cropping areas; *(1)* dry inland (rainfed farming), and *(2)* coastal areas with sufficient rainfall. In dry inland, the traditional cereal-fallow cropping system is implemented in large areas. First year a cereal, mainly wheat and barley, is grown and in subsequent year the field is left empty to accumulate soil water as possible. Several research studies revealed that annual forage legumes could be successfully grown in place of the fallow, and produced high quality of the forage. In coastal areas, the cropping sequence of cereal and industrial crops is practiced in rotations. Two major crop groups are grown as cereals in winter, and as industrial crops in summer, which are maize, sunflower, cotton, potato, tobacco, sugar beet and soybean. In this cropping system, the annual forage legumes can only be cultivated as an intercrop in winter.

The most popular annual forage legumes are common vetch (*Vicia sativa* L.) and bitter vetch (*V. ervillia*). The common vetch cultivation area varied from 265 000 ha to 320 000 respectively, whereas bitter vetch cultivation area decreased dramatically from 96000 ha to 2900 ha in the same order (SSI, 2004). In much less extent grass pea (*Lathyrus sativus* L), is grown in limited areas, but its cultivation area is not recorded in the statistics, probably included in that of common vetch.

The objective of this paper is to outline and elaborate on the production potentials and research studies, and suggest necessary future work to improve the grass pea production.

## 2. GRASS PEA CULTIVATION

The grass pea cultivation is reported by the Agriculture Provincial Directorates of Denizli, Nevşehir and Elazığ. According to the Provincial Directorates in 2004, a total of 1045 farmers in 160 villages has grown grass pea, covering 1540 ha area. In these three provinces grass pea is grown for herbage, and straw and grain production. Its hay, straw and grinding seed are used to feed small and large ruminants.

Nevşehir Agriculture Directorate notifies that sowing method is broadcasting over a prepared seed bed, and it is harvested with hand, and grown in a rotation with cereals as spring crop. Farmers save their own seeds from harvested crop, or get from neighbors or purchase from local traders. They suggested that the certified seed in sufficient quantities should be made available to the farmers. They also explained that the preferential reasons for grass pea over other forages were that; *(1)* grass pea is well adapted to drought and unfertile soils, *(2)* input for its production is relatively low, *(3)* it is more nutritive and productive than common vetch.

The extension people in Denizli Agriculture Directorate reports that if it is harvested for seed grass pea hay was given to the livestock in winter-indoor time, but first it is roughly grinded. Moreover, they states that in irrigated land it is grown as an intercrop in winter, and after its harvest , the maize or cotton is planted. In dry areas, first year grass pea is grown as a winter crop, and following year a cereal is sown. They also point out that for hay, it is mown at 50% flowering stage, and the foliage is air-dried, bailed and stored for winter feeding, and its great ability of drought resistance is the main reason to grow grass pea. And, the farmers mainly grow it for its grain, grind and mix it with maize or barley; hay is also mixed with the cereal straw.

Elazığ Agriculture Directorate informs that grass pea is grown in place of fallow as spring crop and sown by broadcasting. The agronomic practices such as irrigation, fertilization, and weed control are not common. The major constraints of its cultivation are lack of seed supply in the market and labor intensity due to hand harvesting.

## 3. RESEARCH EFFORTS ON GRASS PEA

Several research studies on grass pea have been conducted to determine its adaptation, agronomy, variety development and nutritive value. These works have mainly focused on the comparisons of the grass pea with the currently used feed legumes, in trying to understand how the grass pea is substitutable to others, and what its superiority is, if any. With these purposes a number of experiments have been carried out in different ecological zones of Turkey, and they have mostly generated the positive results such as greater straw and seed yield over that of vetch or others. Some agronomic studies revealed that it was beneficial crop in rotations for the herbage production mixtures, or it might be useful as a green manure crop. And also, some selections were made to develop the varieties. The various studies were conducted on its nutritive value in the poultry and sheep diets.

### *3.1. Growing Grass Pea in Crop Rotations*

Grass pea is more suitable to grow for herbage production in coastal areas and to be best to produce for seed and straw in the arid hinterlands of Turkey. In fact, its adaptation and production purposes are exactly the same as common vetch. Because it is cold sensitive, it can only be grown as a summer crop in inland areas. There are several crop rotations in which grass pea can be successfully fitted in. In the dry regions, where cereal-fallow cropping is the main pattern, then it may replace the fallow. In the coastal areas with mild climate, it may be put in rotation with the cereals and industrial crops as an intercrop in winter.

In the Mediterranean Region of the country cotton, peanut and sesame are cultivated as the main crops from April to October, after their harvest the annual forages can be successfully grown as winter crops. Çakmakçı and Çecen (1999) studied on potentials of some annual forage legumes in the crop rotations in the Mediterranean coast of the Antalya province. The crop species of common vetch (*Vicia sativa* L) narbon vetch (*V. narbonensis* L.), hairy vetch (*V. villosa* Roth.), bitter vetch (*V. ervillia* L. Wild), grass pea (*Lathyrus sativus* L.), field pea *(Pisum sativum ssp. arvense* L. Poir), fenugreek (*Trigonella foecum-graecum* L), berseem clover (*Trifolium alexandrinum*) and Persian clover (*Trifolium resupinatum*) were grown to compare the herbage yield and number of days from planting to cutting for hay. The two-year results revealed that grass pea produced the greatest herbage yield, followed by narbon vetch, time span to cutting was the shortest in the field pea with 141 days and the longest in the Persian clover with 182 days, whereas for grass pea it was at near middle.

In this region, the cash crops such as the cotton, peanut, sesame and wheat are grown as the main crops, but the forage legumes are regarded as the marginal crops. The main crop rotation is a combination of the cropping sequences as wheat in winter- cotton, peanut and sesame in summer – annual forages in winter. In such a rotation the forage crop, which would be adopted by the farmers, must have the properties; first its harvesting time for hay should be short enough to plant the following main crop in spring, and second it should produce satisfactory dry-matter yield. In light of these priorities, Çakmakçi and Çeçen (1999) suggested that most of the species, studied on, allowed enough time to plant for the next crop, and especially field pea, narbon vetch, fregreek, common vetch and grass pea were the most suitable species for harvesting time. Moreover, grass pea with its greatest dry-matter yield and relatively short growth period was the most important forage species and primarily recommendable to the farmers in that region.

As it is known, if the aim is to produce herbage, annual forage legumes yield better in quality and quantity when they are grown with a companion cereal in mixtures. These mixtures provide well-balanced diet of protein and energy. Karadağ and Büyükburç (2003) studied on the effects of seed sowing rates of the annual forage legumes-cereal mixtures on the dry-matter and crude protein yields. The lowest dry-matter yield (1.51 ton/ha) was obtained from pure vetch, and the highest (10.71

ton./ha) was produced by the common vetch (25%) + barley (75%) mixture, whereas grass pea + barley mixture formed the greatest crude protein yield. And, they concluded that by considering hay yield and the source of high protein concentration, the mixtures of 25% either vetch or grass pea with 75% barley outyielded other mixture types and pure stands. Karadağ and Büyükburç (2003) recommended 50% grass pea and 50% barley mixture for their highest crude protein yield.

Başbağ *et al*. (2001) investigated adaptation of some annual forage legumes in the Diyarbakır province of the South Eastern Region of Turkey. The dry-matter yield varied from 4817,9 kg/ha in narbon vetch to 1948,6 kg/ha in grass pea, whereas narbon vetch produced the highest seed yield with 2531,2 kg/ha and Hungarian vetch had the lowest with 440,7 kg/ha, but grass pea possessed only 809,3 kg/ha seed yield. In crop rotations Başbağ et al. (2001) concluded that for winter growing, the emphasis should be given to narbon vetch, common vetch and bitter vetch.

Sabancı *et al*. (1996) studied on adaptation of grass pea (*Lathyrus sativus* L.) lines in the Aegean Region. All of the traits did not differ significantly, the mean biologic and seed yields were 1370 and 1018 kg/ha, respectively. The authors concluded that grass pea was well adapted to the Aegean Region climatic and soil conditions and the breeding efforts should be directed especially towards its seed production.

Andiç *et al*. (1996) studied on the dry-matter yield of some grass pea and dwarf chichkling (*Lathyrus cicera*) lines in the Van province of East Anatolia Region in Turkey. The mean dry-matter yield of the grass pea lines (1574 kg/ha) was greater than that of the dwarf chickling lines (1229 kg/ha). And, they suggested that the lines 311, 463 and 459 were promising for herbage production in that region.

### *3.2. Grass pea as a green manure plant:*

The green manuring is a common practice to ameliorate the soil properties. The purposes of the green manuring are *(1)* to increase the soil organic matter, *(2)* to improve the soil structure, *(3)* to enrich the soil nutritive elements and *(4)* to prevent the soil erosion. But the main objective is to rehabilitate the physical structure of the soil. For green manuring, the annual and perennial forages can be utilized, in some regions the green manure plant is first grazed and then residuals are ploughed down. If the hay is robustly needed the standing crop is mown and the crop residuals are buried. However, in both methods the organic matter is left less than that of the entire burial of the green crop stand (Açıkgöz, 2001). In the Black Sea Region of Turkey, the cropping patterns such as wheat-maize, maize-maize, maize-sunflower and sunflower-sunflower are widely implemented. But, repeatedly the same cropping causes the degradation of soil properties, and results in the yield losses, and naturally so as to compensate that the greater amount of fertilizer has to be applied. In order to overcome this problem, the annual forage legumes can be grown as an intercrop in winter for forage or green manure crop. Özyazıcı and Manga (2000) investigated the effects of some forage legume crops used as the green manure on yield and quality characteristics of subsequent maize and sunflower on the Black Sea coast of Samsun province. The forage legumes as the green manure crop were narbon vetch (*Vicia narbonensis* L.), common vetch (*V. sativa* L.), Persian clover (*Trifolium resipinatum* L.), grass pea (*Lathyrus sativus* L.), field pea (*Pisum arvense* L.) and lupin (*Lupinus albus* L.). The research results revealed that the burial treatment of both narbon and common vetch produced highest seed yield in both maize (9742 and 9633 kg/ha) and sunflower (4938 and 4925 kg/ha), respectively, in other words the green manure treatments of these species increased seed yield in order of 51.7 % and 50% in maize, and 36.8 % and 36.4 % in sunflower. Grass pea burials significantly produced less grain yields of maize and sunflower. They concluded that narbon and common vetch were useable as green manuring in winter part of the crop rotation, and in case of forage demand these crops could be mown

for hay and crop residues stubble and roots could be mixed to the soil. Therefore, this study indicated that grass pea is less favorable to use as the green manuring plant for the subsequent maize and sunflower in humid regions like Black Sea Region.

### *3.3. Germplasm enhancement*

To be successful in any cultivar development, there should be *(1)* an adequate amount of variation in plant material to select, *(2)* a solid method suited to vegetative and generative characteristics of the interested plant species and *(3)* the clear objectives to follow. However, the variability out of the trio is the most important factor, if it is not sufficient, response to selection is unachievable. The simple selection is surely the oldest method, which is mainly to pick up the superior(s) from the base population(s). Fırıncıoğlu *et al*. (1996) studied on the agronomic traits of some vetch (*Vicia* sp.) and chichkling (*Lathyrus sp.*) lines, which were obtained from ICARDA and tested in 1993 to 1995 in Ankara, Haymana Research Farm of Central Research Institute for the Field Crops.

The certain number of lines of common vetch (*Vicia sativa* L.), bitter vetch (*V. ervillia*), narbon vetch (*V. narbonensis*), grass pea (*Lathyrus sativus*) and dwarf chichkling (*L. cicer*) were compared for biologic, seed and straw yields, number of days to mature and grain crude protein (Table 1). The lines of common and narbon vetch did differ significantly for all aspects, and bitter vetch lines were significantly different for all attributes except the seed yield. But, neither grass pea nor dwarfchickling lines did significantly differ for the biologic, seed and straw yields, excluding days to maturity (Table 1). The grass pea produced the greatest biological (2850 kg/ha), seed (1190 kg/ha) and straw (1660 kg/ha) yields, followed by the dwarf chichkling with 2490, 1080 and 1410 kg/ha yields in the same order (Table 1).

When the species was put in order, the grass pea was superior over other species in terms of the biologic, seed and straw yields. This makes it an alternative crop to common vetch, which is widely cultivated in the region. After the yield trials were completed, the registration trials of the selected lines of grass pea were conducted in the region, in both yield and registration trials, lines were compared with a local population, and the results did not display the significant difference between any of the lines and local population.

Therefore, one of the lines was registered with its relative superiority with the homogeneous maturity over the local population, and it was named as Gürbüz-2001. Its seed multiplication continues, and there is a demand for the certified seed.

Table 1. The biologic, seed and straw yields and number of days to maturity as overall means in the trials conducted in 1993 to 1995, the seed crude proteins only a year result (source: Fırıncıoğlu *et al*. 1996)

| Species | Number of accession | Biologic yield (kg/ha) | Seed yield (kg/ha) | Straw yield (kg/ha) | Days to maturity | Seed crude protein (%) |
|---|---|---|---|---|---|---|
| Common vetch | 11 | 2030 ** | 770 ** | 1270 * | 85 ** | 25,6 |
| Bitter vetch | 10 | 1810 * | 800 ns | 1010 ** | 79 ** | 19,22 |
| Narbon vetch | 5 | 2150 ** | 800 ** | 1360 * | 90 ** | 22,6 |
| Grass pea | 10 | 2850 ns | 1190 ns | 1660 ns | 95 ** | 25,4 |
| Dwarfchichkling | 7 | 2490 ns | 1080 ns | 1410 ns | 89 ** | 25.5 |

(**) the lines of that species do differ significantly at 1% level and (*) at 5% level; (ns) the lines do not differ significantly

Once more, our selection study proved that simply selection from the base material, which displayed invariability of the agronomic traits under concern, did not produce a variety with the greater yield potential. Forage species have been recently domesticated and retained many characteristics of wild species, and most of the varieties were simple selections from the wild populations. The simple selection may be a perfectly good improvement technique, but improved selections look the same as unimproved form, and indeed since the populations are variable, it may be difficult to identify and describe them as varieties (Turner, 1998). This may be true for our grass pea variety Gürbüz-2001, but it is the first registered cultivar, and we believe that it is reasonably acceptable for an initial step.

### *3.4. Grass pea as a feed crop*

In Turkey, the grass pea is mainly used for livestock feeding, but not for human consumption. Although its utilization pattern varies from region to region, mostly its seed, straw and herbage are exploited for feeding. It may be used for other purposes, but there is not any evidence in the recorded literature. However, some studies have been conducted on feeding of poultry so as to substitute the grass pea seed with an expensive soybean cake.

Çetin and Bolat (1992) investigated the effects on the use of grass pea seed in the increasing ratios as 0, 5, 10, 15, 20 and 25% plus 0,17 % of the DL methyonin for each level added into to the broiler diets as a substitute to the soybean cake. The diets consisting of grass pea seed up to 15% level increased the feed intake, and there was no sign of any effect of the DL methyonin on the feed intake. Çetin (1996) reported that grass pea as a grain feed with its high energy value and protein content, when its grain without any treatment was used at ratios of up to 30%, the chicken egg production was greater than other groups, but the live weight gain and feed intake were affected negatively. Demirkuş et al (1999) studied the utilization possibilities of grass pea seed in the broiler rations. In this study, the live weight gain, the feed benefit ratios, the carcass, liver and hearth weights were positively affected, but with increasing level of grass pea seed in diet, its effect turned out to be negative. Çerçi and Özer (1993) studied on use of the rations with 0, 40, and 80 % grass pea grain content as a concentrate feed for the sheep in relation with the digestibility attributes. In this study the dry matter digestibility was 75.2%, 76.83% and 76.54% respectively, the crude protein digestibility was 80.24%, 80.33% and 81.96% in the same order. They recommended that grass pea seed could be efficiently used in the ruminant diets. As it is proved in results the above, the use of grass pea seeds in poultry feeding may not be satisfactory, but it is suitable as a protein supplementary feed for the ruminants.

## 4. CONCLUSION AND FUTURE RESEARCH NEEDS

Most of the research studies produced the positive results. In fact grass pea is a multi-purposes crop. It has been shown that grass pea is suitable to grow for herbage, straw and seed production and use for ruminant feeding. Additionally, it can be also grown in mixtures with cereals and produce a well-balanced diet of protein and energy. It may also be utilized for the green manuring. Since it is a quite drought resistant crop and its straw and seed production are superior over other annual feed legumes, it is reasonably recommendable in dry areas to replace fallow or some acreages of common vetch. The studies on the variety development of grass pea are limited exclusively with the simple selections. But, as a preliminary study they are worth for the future improvement studies. In fact the success of crop production is mainly dependent on the resistance to the abiotic-stress in the arid environments. Because of year to year variations in rainfall, the yield stability of a single crop species should not be expected. The grass pea with much greater yield should be regarded as an alternative crop to widely grown common vetch in dry areas.

Since the research results proved its superiority over common vetch in the dry areas, several actions that can be made to improve the grass pea cultivation are as follows:

*(1)* Expansion of its growing area; as it is mentioned earlier the grass pea cultivation area is limited to few provinces. Because of its superior yield potential and its appropriateness for the fallow replacement, its production area should be expanded through strong extension action. In dry areas, the farmers are usually not familiar with grass pea. Some demonstration trials can prove its importance.

*(2)* Seed production; seed is regarded as a key element in crop production, and it is the material used to establish a new crop each year, and the quality of the seed determines how effectively that is succeeded. Currently, grass pea's seed is produced as in informal seed sector, in which the farmers obtain seed by saving a part of the crop directly sowing the following season or buying from neighbors or local traders. The seed quality may not be satisfactory. A sufficient amount of the grass pea seed should be multiplied and distributed to the farmers, while the extension action is put in place.

*(3)* Research action; although several studies on grass pea have generated good results, there is a need to study further on its agronomy and breeding. Its place in crop rotations should be comprehensively investigated, and the seeding rate and fertilization ought to be studied. The breeding efforts should be focused on greater yield and nutritive value. And, after identification of the suitable parental lines, the relevant crosses may be made in order to incorporate the desirable plant characteristics. In Turkey, there is a wide range of bio-diversity of the genus *Lathyrus* sp., the basic plant material may be collected, classified and characterized, and be made available for the breeding purposes.

Last but not least, at present grass pea may be regarded as a marginal feed crop in Turkey, and its production with low input is realized in a traditional way. However, there appears to be a great potential to expand its cultivation area and improve its production.

a

**REFERENCES**

Açıkgöz, E. 2001 Forage Crops. Field Crops Department, Agriculture Faculty, Uludağ University, Third edition, p: 419-420, Bursa, Turkey.

Andiç, C., Ö. Terzioğlu, B. Keskin, İ. Yılmaz, M. Deveci, H. Akdeniz, Ö. Arvas. 1996. A sudy on the herbage yield of some grass pea (*Lathyrus sativus* L.) lines in the arid conditions of Van province. In the proceedings of the third Turkish Grassland and Forage Crops Congress, p: 704-709, Agriculture Faculty of Atatürk University, Erzurum, Turkey.

Başbağ, M., V. Saruhan, İ. .Gül. 2001. A study on the adaptations of some annual forage legumes under conditions of the Diyarbakır Province. In the proceedings of the Fourth Turkish Field Crops Congress, p. 169-173, 17-21 September, 2001, Agriculture Faculty, Trakya University, Tekirdağ, Turkey.

Cakmakci, S. and S. Cecen. 1999. A study on the investigation of the utilization possibilities of the annual forage legumes in crop rotations in the Antalya province. Turkish Journal of Agriculture and Forestry, 23 (1999), p. 119-123.

Çerçi, I.H. and Özer H., 1993. The effects of the different ratios of grass pea (*Lathyrus sativus* L.) in the sheep diets on the digestibility of the nutritive elements, used in place of the soybean cake. Journal of Livestock Research, 3(1): 16-19.

Çetin, M., Bolat, D., 1992. The effects of grass pea (*Lathyrus sativus* L.) at different ratios as protein resources in diets on the fattening performance of the broiler chicken in place of soybean cake. Science Institute of the Hundredth Year University, (Master Thesis), Van, Turkey.

Çetin, M. 1996. The effects of grass pea seed used in the rations as protein and energy resources on the live weight gain, feed intake, egg production and quality of the egg type chicken. Science Institute of the Hundredth Year University, (Doctora Thesis), Van, Turkey.

Demirkus, T., Çetin, M., Eratak, S., Aydin. A. 1999. The utilization possibilities of grass pea (*Lathyrus sativus* L.) in the broiler chicken diets. GAP I. Agriculture Congress, 26-28 May, 1097-1106, Şanlıurfa, Turkey.

Fırıncıoğlu, H.K., D. Uncuer, S. Unal and Fatma Aydın. 1996. A study on some agronomic traits of vetch (Vicia sp.) and grass pea (Lathyrus sp.) species. In the proceedings of the third Turkish Grassland and Forage Crops Congress, p.685-691, Agriculture Faculty of Atatürk University, Erzurum, Turkey.

Karadağ, Y., U. Büyükburç 2003. Effects of seed rates on forage production, seed yield and hay quality of annual legume-barley mixtures. Turkish Journal of Agriculture and Forestry, 27, p. 169-174

Özyazıcı, M.A, İ. Manga. 2000. The effects of some annual forage legumes used as the green manure crop on the yield and quality of the subsequent maize and sunflower crops under the irrigated conditions Bafra basin. Turkish Journal of Agriculture and Forestry, 24 (2000), p. 95-103.

Sabancı, C., G. Eğinlioğlu, H. Özpınar. 1996. A study on the adaptation of the narbon vetch (*Vicia narbonensis* L.) and grass pea (*Lathyrus sativus* L.) in the Menemen county conditions. In the proceedings of the third Turkish Grassland and Forage Crops Congress, Agriculture Faculty of Atatürk University, p: 287-292, Erzurum, Turkey.

SSI 2002, Statistic Yearbook of the Turkish State Statistic Institute, Ankara

SSI 2004, Statistic Yearbook of the Turkish State Statistic Institute, Ankara

Turner, M.R., 1998. Current status of seed program development and implications for forage seed supply. In Proceedings of the Pasture and Forage Seed Production Workshop Eds. L. Grass and MR Turner, Addis Ababa, Ethiopia 27-31 October 1997.