NARDI FUNDULEA, ROMANIA
www.incda-fundulea.ro

ROMANIAN AGRICULTURAL RESEARCH, NO. 29, 2012
Print ISSN 1222-4227; Online ISSN 2067-5720

FORAGE YIELD AND SOME QUALITY PROPERTIES OF SAFFLOWER (*CARTHAMUS TINCTORIUS* L.) - FODDER PEA (*PISUM ARVENSE* L.) MIXTURES, AS AFFECTED BY SOWING RATES IN THRACE REGION, TURKEY

Burhan Arslan[1], Ertan Ates[1*], and Levent Coskuntuna[2]

[1]University of Namik Kemal, Faculty of Agriculture, Department of Field Crops, Tekirdag, Turkey
[2]University of Namik Kemal, Faculty of Agriculture, Department of Animal Science, Tekirdag, Turkey
*Corresponding author. E-mail: ertan_ates@hotmail.com

ABSTRACT

The aim of this study was to determine the effect of sowing ratios on forage yield and quality (amino acid, fibre and mineral contents) in fodder pea-safflower mixtures. Three field experiments were conducted at Namik Kemal University, Tekirdag, Turkey between 2006 and 2009 in a randomised complete block design with 3 replications. The pea was sown with safflower as follow: fodder pea 25% + safflower 75%, fodder pea 50% + safflower 50%, fodder pea 75% + safflower 25%. Besides, pure safflower and fodder pea were sown. The green fodder yield, dry matter yield, botanical composition, crude fibre, crude fibre, neutral detergent fibre, acid detergent fibre, potassium, calcium, magnesium, phosphorus, total amino acid and amino acid contents were determined. The highest green fodder yield (56.40 t ha^{-1}) was obtained from pure fodder pea plots. The dry matter yield ranged from 7.88 t ha^{-1} to 15.11 t ha^{-1}, the maximum dry matter yields being determined in pure fodder pea (15.11 t ha^{-1}) and 75% fodder pea+25% safflower mixture (13.74 t ha^{-1}). There were no significant differences between P ratios (0.32 to 0.35 %). The pure safflower hay had highest CF (27.80%), ADF (36.44%), K (2.22%) and Mg (0.72%) contents, whereas, the highest NDF contents (44.72 to 45.14%) were determined from pure safflower and 75% safflower+ 25% fodder pea mixture. The maximum Ca ratios were found in 75% fodder pea + 25% safflower mixture (1.71%) and pure safflower (1.82%) hays. The highest total contents of AA (128.4 g kg^{-1}), CP (153.1 g kg^{-1}), lysine (8.9 g kg^{-1}), histidine (3.6 g kg^{-1}), arginine (6.1 g kg^{-1}), aspartic acid (15.4 g kg^{-1}), threonine (6.4 g kg^{-1}), glutamic acid (15.4 g kg^{-1}), proline (17.9 g kg^{-1}), glycine (5.6 g kg^{-1}), serine (7.0 g kg^{-1}), alanine (8.4 g kg^{-1}), phenylalanine (6.1 g kg^{-1}), leucine (10.7 g kg^{-1}) and tyrosine (3.9 g kg^{-1}) were determined in the pure fodder pea.

Key words: *Carthamus tinctorius* L., forage yield, forage quality, mixture, *Pisum arvense* L.

INTRODUCTION

The forage used to feed animals in Turkey and other countries is provided by grassland, forage crops, forage crops-other than cultivated plants mixtures and the secondary products of other cultivated plants (Tekeli and Ates, 2011). The acreage of fodder pea (*Pisum arvense* L.) and other forage legumes continues to increase in the Thrace region, Turkey and the world. The new fodder pea cultivars (cv. Ates, cv. Tore etc.) are widely adapted in Thrace region as high-quality annual forages. Fodder pea-cereal and forage crops-other than cultivated plants mixtures are popular annual hay mixtures; the combined protein and energy level of these forages is superior to many other crops (Cash et al., 2001). Fodder pea has many advantages as forage or grain in crop rotations, however until recently, lack of seed varieties, seed cost and other concerns have limited it use in Turkey and the many countries. The current increase in acreage and availability of fodder pea will likely improve its acceptance by livestock producers of Thrace region.

Establishing seeded forage mixtures is one of the quickest ways to increase the quality of forage production (Arslan et al., 2008). Interspecific mixtures are used throughout the world for forage and grain production, often because of an assumed advantage over monocrops (Uher et al., 2008). Growing annual legumes such as Persian clover (*Trifolium resupinatum* L.), vetch (*Vicia* spp.) and lupine species (*Lupinus* spp.)

Received 03 October 2011; accepted 28 March 2012

in monoculture, and fodder pea in mixture with cereals and other species, provides many benefits to forage grasses (*Poaceae* family)-based cropping systems: legumes biologically fix atmospheric nitrogen through symbiosis with *Rhizobium* bacteria, making it available to both the legumes and subsequent non-legumes, thus reducing the need for inorganic nitrogen fertilizer inputs (Ates and Tekeli, 2005; Maćešic et al., 2007; Uher et al., 2008), decrease potential diseases, weeds and pest cycles established in continuous forage grasses and plant species of other families.

Total forage yield, quality and seasonal distribution of forage production may be of greater importance to the livestock producer. Forage quality can be considered satisfactory when animals consuming the forage perform as desired. Three factors, which effect animal performance, are: a) Intake - forage must be palatable if it is to be consumed in adequate quantities to produce the desired performance; b) Digestibility - nutrient content once the forage is eaten; it must be digested and converted to animal products; c) Toxic factors - the forage must be free of components, which are harmful to the animals. Many factors affect forage quality for animals, so that no single characteristic can serve to predict animal production. Some of the important factors that determine forage quality for animals are: growth stages, chemical composition, legume-grass ratio, physical form, foreign material (particularly weeds and dust), damage or deterioration during harvest and storage, and the presence of anti-quality substances such as estrogens, thyrotoxic factors, and toxic amines and their condensation products (Tekeli and Ates, 2003). The objective of this investigation was to determine the effect of sowing rates on forage yield and quality in fodder pea-safflower (*Carthamus tinctorius* L.) mixtures.

MATERIAL AND METHODS

The experimental area was located in the coastal zone of northwest Turkey (41.0° 59′ N, 27.5° 34′ E), 5 m above the sea level. According to State Meteorology Department, total annual precipitation is 482 mm per year, annual mean temperature is 10.5°C and average relative humidity is 78%. The soil was clay, classified as alfisol typic xeralf, low in organic matter (1.09%), moderate in phosphorus (P) content (64.2 kg ha^{-1}), but rich in potassium (K) content (602.7 kg ha^{-1}) and with pH 7.1. The soil test recommendation showed that it did not require fertilization and lime.

The three field experiments were conducted at Namik Kemal University, Tekirdag, Turkey between 2006 and 2009 in a randomised complete block design with 3 replications. Plot size was 2.5 m x 5 m = 12.5 m^{-2}, consisting of ten rows spaced 25 cm. Certified seed of the safflower variety Dinçer and the fodder pea variety Töre were used. The pea was sown with safflower as follow:

1. Fodder pea 25% + safflower 75%;
2. Fodder pea 50% + safflower 50%;
3. Fodder pea 75% + safflower 25%.

The seed rates for each species in the mixtures were calculated using the following formulas (Avcioglu, 1997):

Utilization Value (UV) = Seed Purity (%) x Germination Ratio (%)/100.

Seed Rate in Mixture = Ratio of Plants in Mixture (%) x Sowing Rate (kg ha-1)/UV.

Besides, pure safflower and fodder pea were sown. Sowing rates of 120 kg ha^{-1} (fodder pea) and of 48 kg ha^{-1} (safflower) were used. The seeds were sown on November 4th, 9th and 11th in 2006, 2007 and 2008 respectively. The mixtures, the fodder pea and the safflower were harvested at the full-bloom stage of the fodder pea. The samples (2 m^{-2}) were taken by hand. One cut was made each year at the full-bloom stage of fodder pea. The green fodder yield (t ha^{-1}) was determined on 2 m^{-2} and later it was calculated per hectare. Approximately 500 g herbage samples were dried at 55°C for 48 h and stored one day at room temperature (Ates and Tekeli, 2007). Then, the dry matter yield (t ha^{-1}) was calculated. The botanical composition (safflower, fodder pea and forbs) of the samples was determined on a dry matter basis after hand separation.

All dried samples were ground to small (<2 mm) pieces and used for the analyses. Forage samples were analysed for nitrogen

(N) using procedures of the Association of Official Analytical Chemists (AOAC, 2007). Crude protein (CP) contents (%) of the samples were determined by multiplying N contents by a coefficient of 6.25. Crude fibre (CF) contents were determined by the Weende methods. The samples were wet-fired with nitric-perchloric acid, and P was determined spectrophotometrically. K, calcium (Ca) and magnesium (Mg) ratios were found using an atomic adsorption spectrophotometer. The neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents were determined following Romero et al. (2000). The amino acid (AA) content (in dry matter (DM), g kg^{-1}) was determined by automatic aminoalyzer AAA-881 after hydrochloric acid hydrolysis. All samples were analysed in triplicate. Analysis of variance was performed on all data (means of three years) using TARIST program.

RESULTS AND DISCUSSION

The results of the analyses for the traits studied are given tables 1, 2 and 3. Green fodder yield, dry matter yield, CP ratio, fibre and mineral contents are very important traits for the production and quality of forage (Ates et al., 2010). The highest green fodder yield (56.40 t ha^{-1}) was obtained from pure fodder pea plots ($P \leq 0.01$). The dry matter yield ranged from 7.88 t ha^{-1} to 15.11 t ha^{-1}, the maximum dry matter yield being determined in pure fodder pea (15.11 t ha^{-1}) and 75% fodder pea + 25% safflower mixture (13.74 t ha^{-1}), followed by the 50% fodder pea + 50% safflower mixture (12.33 t ha^{-1}), 25% fodder pea+75% safflower mixture (12.00 t ha^{-1}) and pure safflower (7.88 t ha^{-1}) ($P \leq 0.01$, Table 1). According to Janata et al. (1973) pea with sunflower (*Helianthus annuus* L.) mixture sowed early in the spring are able to give 18-25 t ha^{-1} green fodder yields. Wichman et al. (2001) assessed the forage production potential of safflower in the Northern Great Plains and Inter-Mountain regions; they reported that the safflower dry matter yield ranged from 2.46 to 11.55 Mg ha^{-1}. Servet and Ates (2004) and Hoffmann et al. (2008) stated that the fodder pea provides 2.18 to 7.24 t ha^{-1} of dry matter yields. Rapčan et al. (2006) reported 57.04 t ha^{-1} of green fodder yield and 9.8 t ha^{-1} of dry matter yield in fodder pea. The lowest green fodder yield (32.18 to 37.34 t ha^{-1}) and dry matter yield (9.87 to 11.23 t ha^{-1}) for safflower-fodder pea mixtures were found by Arslan et al. (2008). The results of these researchers are similar to the findings in our investigation.

Table 1. Botanical composition, green fodder and dry matter yield of fodder pea-safflower mixtures, pure pea and safflower (means of three years)

Treatments	Yields		Botanical Composition, g kg^{-1}		
	Green fodder yield, t ha^{-1}	Dry matter yield, t ha^{-1}	Fodder pea	Safflower	Forbs[1]
Fodder pea 75% + safflower 25%	50.75b	13.74a	751.11b	229.79d	19.10b
Fodder pea 50% + safflower 50%	43.45c	12.33b	502.78c	483.60c	13.62c
Fodder pea 25% + safflower 75%	41.31c	12.00b	251.12d	737.58b	11.30d
Safflower 100%	28.47d	7.88c	-	973.14a	26.86a
Fodder pea 100%	56.40a	15.11a	988.73a	-	11.27d
LSD	4.11*	2.07*	44.11*	37.23*	2.33**

*$P \leq 0.05$; **$P \leq 0.01$,
[1]*Adonis* spp., *Poa annua* L., *Papaver rhoeas* L., *Hordeum murinum* L., *Brassica nigra* L., *Lolium multiflorum* Lam., *Galium aparine* L., *Ranunculus* spp., *Taraxacum officinale* F.H. Wigg.
Values in the same column, followed by different letters, are significantly different at the probabilities indicated by stars in the LSD row.

When the safflower rates increased in the mixture, the CF content, ADF and NDF contents increased and CP ratio of hay decreased, as expected. Differences in CF, NDF, ADF, Ca, K and Mg contents of mixtures and species were significant (P≤0.01). There were no significant differences between P ratios (0.32 to 0.35%) (Table 2). The pure safflower hay had highest CF (27.80%), ADF (36.44%), K (2.22%) and Mg (0.72%) contents, whereas, the highest NDF contents (44.72 to 45.14%) were determined from pure safflower and 75% safflower + 25% fodder pea mixture. The maximum Ca ratios were found in 75% fodder pea + 25% safflower mixture (1.71%) and pure safflower (1.82%) hays. Kilic et al. (1991) suggested that CF content over 20% of dry matter is required for successful feeding. The CF has been widely used to classify fodder, and this use has made it possible to formulate better diets. Roughages have been defined, with some exceptions, as those fodders having more than 18% CF in the dry matter, as opposed to concentrates, which are defined as having less than 18% CF (Fisher et al., 1995).

The NDF approximates the total cell wall constituents including hemicelluloses; however, ADF primarily represents cellulose, lignin and ash. In general, forages that contain less than 70% NDF and more than 8% CP will contain enough digestible protein and energy, vitamins, and minerals to maintain older animals. Thus, even many low quality forages and crop residues can meet the maintenance needs of some classes of animals, if protein and minerals are adequate (Ball et al., 2001). Tuna et al. (2004) reported CF, ADF and NDF ratios of fodder pea of 27.03%, 34.69% and 40.35%, respectively.

Landau et al. (2005) emphasized that NDF ratio may vary from 41 to 49 % in safflower hay. McKenzie and Jacobs (2002) reported 0.13% Mg, 0.48% P and 0.8% K ratios in white clover (*Trifolium repens* L.)-grass mixtures. Arslan et al. (2008) obtained CF, ADF, NDF, Ca, K and Mg ratios ranging from 22.34 to 27.56%, 29.45-35.76%, 37.98-44.56%, 1.26-1.72%, 1.78-2.07% and 0.45-0.67% respectively, in safflower-fodder pea, safflower and fodder pea. Anonymous (2011) reported 25.0 % CF, 1.10% Ca and 0.38% P ratios from dry matter of safflower. Blackwood (2011) stated that the Ca, P, Mg and K amounts ranged from 3-4 g kg-1, 8-14 g kg^{-1}, 3.3-3.9 g kg^{-1} and 8-13.3 g kg^{-1}, respectively, in safflower meal. The results of these researchers are similar to the findings in our study.

Table 2. Crude fibre, ADF, NDF and mineral ratios of mixtures, pure fodder pea and safflower (means of three years)

Treatments	Ca, %	P, %	K, %	Mg, %	CF, %	ADF,%	NDF, %
Fodder pea 75% + safflower 25%	1.71a	0.34	1.65b	0.48c	23.00c	31.12b	39.73c
Fodder pea 50% + safflower 50 %	1.60b	0.33	1.55b	0.53c	24.20c	31.74b	42.68b
Fodder pea 25% + safflower 75%	1.48b	0.32	1.48b	0.61b	25.60b	32.22b	44.72a
Safflower 100%	1.82a	0.35	2.22a	0.72a	27.80a	36.44a	45.14a
Fodder pea 100%	1.55b	0.33	1.68b	0.43d	23.10c	29.10c	36.11d
LSD	0.12**	0.04	0.22**	0.06**	1.23**	1.27**	1.68**

**P≤0.01, Values in the same column, followed by different letters, are significantly different at the probability indicated by stars in the LSD row.

The results of the analyses for the total AA, CP and AA contents studied are given in table 3. There were no significant differences between the cystine contents (0.2 to 0.4 g kg^{-1}) (P≥0.05). The highest total contents of AA (128.4 g kg^{-1}), CP (153.1 g kg^{-1}), lysine (8.9 g kg^{-1}), histidine (3.6 g kg^{-1}), arginine (6.1 g kg^{-1}), aspartic acid (15.4 g kg^{-1}), threonine (6.4 g kg^{-1}), glutamic acid (15.4 g kg^{-1}), proline (17.9 g kg^{-1}), glycine (5.6 g kg^{-1}), serine (7.0 g kg^{-1}), alanine (8.4 g kg^{-1}), phenylalanine (6.1 g kg^{-1}), leucine (10.7 g kg^{-1}) and tyrosine (3.9 g kg^{-1}) were determined in the pure fodder pea, in comparison with the

means of the other observed mixtures and pure safflower (P≤0.01). The maximum methionine contents were obtained in pure fodder pea (0.6 g kg^{-1}), 75% fodder pea + 25% safflower mixture (0.5 g kg^{-1}) and 50% fodder pea + 50% safflower mixture (0.5), respectively. The pure safflower exhibited lower contents than the other species and mixtures for the valine content (3.9 g kg^{-1}) and isoleucine content (1.8 g kg^{-1}). The AA and not protein per se are the required nutrients. Absorbed AA, used principally as building blocks for the synthesis of proteins, are vital to the maintenance, growth, reproduction, lactation, and other physiological processes in animals.

Ates et al. (2010) reported 127.1 g kg^{-1} total AA, 151.3 g kg^{-1} CP, 8.7 g kg^{-1} lysine, 3.7 g kg^{-1} histidine, 5.7 g kg^{-1} arginine, 15.7 g kg^{-1} aspartic acid, 6.7 g kg^{-1} threonine, 15.2 g kg^{-1} glutamic acid, 18.4 g kg^{-1} proline, 5.7 g kg^{-1} glycine, 7.1 g kg^{-1} serine, 8.1 g kg^{-1} alanine, 5.8 g kg^{-1} phenylalanine, 10.1 g kg^{-1} leucine, 4.0 g kg^{-1} tyrosine, 0.5 g kg^{-1} methionine, 0.5 g kg^{-1} cystine, 6.7 g kg^{-1} valine and 4.5 g kg^{-1} isoleucine contents in DM from fodder pea, similar to the present findings.

Table 3. Total amino acid, crude protein (CP) and amino acid (AA) contents of mixtures, pure fodder pea and safflower in dry matter (DM), g kg^{-1} (means of three years)

Amino acids	Mixtures					
	Fodder pea 100%	Safflower 100%	Fodder pea 75% + safflower 25%	Fodder pea 50% + safflower 50%	Fodder pea 25% + safflower 75%	LSD
Lysine	8.9a	6.2e	7.9b	7.2c	6.7d	0.32**
Histidine	3.6a	2.1e	3.0b	2.7c	2.3d	0.11**
Arginine	6.1a	3.7e	5.2b	4.6c	4.1d	0.14**
Aspartic acid	16.0a	10.1e	15.1b	13.8c	11.0d	0.23**
Threonine	6.4a	4.1e	5.7b	5.1c	4.6d	0.33**
Glutamic acid	15.4a	8.0e	13.1b	11.7c	9.2d	0.17**
Proline	17.9a	8.8e	15.6b	13.4c	10.7d	0.87**
Glycine	5.6a	3.6b	4.9a	4.4b	3.8b	0.74**
Serine	7.0a	4.4e	6.1b	5.4c	4.9d	0.34**
Alanine	8.4a	4.9e	7.5b	6.3c	5.5d	0.43**
Phenylalanine	6.1a	3.7e	5.7b	5.2c	4.8d	0.22**
Cystine	0.4	0.2	0.4	0.3	0.3	0.21
Valine	6.5a	3.9d	6.1a	5.7b	4.6c	0.45**
Methionine	0.6a	0.2b	0.5a	0.5a	0.3b	0.11**
Isoleucine	4.3a	1.8c	3.9a	3.2b	2.7b	0.61**
Leucine	10.7a	6.5e	9.3b	8.7c	7.7d	0.21**
Tyrosine	3.9a	1.8d	3.1b	2.9b	2.0c	0.55**
Total AA content	128.4a	74.0e	113.1b	101.1c	85.2d	10.33**
Crude protein content	153.1a	81.4d	132.4b	128.9b	99.7c	9.33**

**P≤0.01, Values in the same row, followed by different letters, are significantly different at the probability indicated by stars in the LSD column.

CONCLUSIONS

The forage yield, mineral composition, total amino acid, fibre, protein and amino acid contents of mixtures were affected by seeding rates of fodder pea and safflower well below those typically used in the Thrace region of Turkey and probably in same climatic conditions. High forage quality of the mixtures would require a very low seeding proportion of safflower to increase fodder pea contribution to forage yield. According to

yield, fibre, protein and amino acid contents, pure fodder pea and 75% fodder pea + 25% safflower mixture are more suitable and could be suggested for utilization as fresh and dried feed in livestock.

REFERENCES

Anonymous, 2011. *Carthamus tinctorius, Safflower, False Saffron*. http://www.fao.org/AG/aGa/agap/FRG/afris/DATA/368.HTM. [Accessed 05 October 2011].

AOAC. 2007. *Official Methods of Analysis of AOAC International*. 18th Ed., Revision 2. Association of Official Analytical chemists. USA.

Arslan, B., Ates, E., Tekeli, A.S., Esendal, E., 2008. *Feeding and agronomic value of field pea (Pisum arvense L.) - safflower (Carthamus tinctorius L.) mixtures*. Proceedings of the 7th International Safflower Conference, Wagga Wagga, Australia, November 3-6:18.

Ates, E., Coskuntuna, L., Tekeli, A.S., 2010. *Plant growth stage effects on the yield, feeding value and some morphological characters of the fiddleneck (Phacelia tanacetifolia Benth.)*. Cuban J. Agric. Sci., 44: 425-428.

Ates, E., Tekeli, A.S., 2005. *Forage quality and tetany potential of orchardgrass (Dactylis glomerata L.) and white clover (Trifolium repens L.) mixtures*. Cuban J. Agric. Sci., 39: 97-102.

Ates, E., Tekeli, A.S., 2007. *Salinity tolerance of Persian clover (Trifolium resupinatum var. majus Boiss.) lines at germination and seedling stage.* World J. Agric. Sci., 3: 71-79.

Avcioglu, R., 1997. *Turfgrass Techniques: Sowing, Planting and Maintenance of Grasslands*. Ege University Press, Turkey, p. 128.

Ball, D.M., Collins, M., Lacefield, G.D., Martin, N.P., Mertens, D.A., Olson, K.E., Putnam, D.H., Undersander, D.J., Wolf, M.W., 2001. *Understanding Forage Quality.* American Farm Bureau Federation Publication 1-01, Park Ridge, IL, USA, p. 2.

Blackwood, I., 2011. *Mineral Content of Common Ruminant Stock Feeds, Crops and Pastures*. http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0018/180621/mineral-content-ofcommon-ruminant-stockfeeds-crops-and-pastures.pdf. [Accessed 01 October 2011]

Cash, D., Wichman, D., Neill, K., 2001. *Seeding Rates for Pea and Pea-cereal Mixtures for Hay*. Montana State University Extension, USA.

Fisher, D.S., Burns, J.C., Moore, J.E., 1995. *The Nutritive Evaluation of Forage*. In: Barnes, R.F., Miller, D.A., Nelson, C.J. (eds.), Forages, Vol. I. An Introduction to Grassland Agriculture, Iowa State University Press, Iowa, USA: 108.

Hoffmann, R., Fábián, T., Dér, F., 2008. *Comparison of yield and nutritive value of different spring green forage mixtures*. Acta Agriculturae Slovenica, Supplement 2: 143-148.

Janata, V., Kanizsai, E., Udvari, L., 1973. *Az Egynyári Szálastakarmányok Termesztésének Technológiája.* Mezőgazdasági Kiadó, Budapest: 1-97.

Kilic, A., Ogretmen, T., Ayhan, V., 1991. *The effects of feed quality on animal feed economy*. Proceedings of the 2nd Rangeland and Forage Crops Congress, Izmir, Turkey, May 28-31: 460.

Landau, S., Molle, G., Fois, N., Friedman, S., Barkai, D., Decandia, M., Cabiddu, A., Dvash, L., Sitzia, M., 2005. *Safflower (Carthamus tinctorius L.) as a novel pasture species for dairy sheep in the Mediterranean conditions of Sardinia and Israel*. Small Ruminant Res., 59: 239-249.

Maćešic, D., Uher, D., Sikora, S., Blažinkov, M., Štafa, Z., 2007. *Yield and height of alfalfa (Medicago sativa L.) effected by Rhizobial inoculation*. Cereal Research Communications, 35: 737-740.

McKenzie F.R., Jacobs, J.L., 2002. *Effects of application of nitrogen fertilizer on concentrations of P, K, S, Ca, Mg, Na, Cl, Mn, Fe, Cu and Zn in perennial ryegrass/white clover pastures in south-western Victoria, Australia.* Grass Forage Sci., 57: 48.

Rapčan, I., Bukvić, G., Grljušic, S., Teklić, T., Jurišić, M, 2006. *Field pea (Pisum satium L.) biomass production depended on seed age and agroecological growth conditions*. Agriculture, 12: 29-35.

Romero, M.J., Madrid, J., Hernández, F., Cerón, J.J., 2000. *Digestibility and voluntary intake of vine leaves (Vitis vinifera L.) by sheep*. Small Ruminant Res., 38: 191-195.

Servet, A., Ates, E., 2004. *Determinación de algunas características agrícolas en variedades de chícharo (Pisum arvense L.) en Tekirdag (Turquía). Condiciones ecológicas*. Revista Cubana de Ciencia Agrícola, 38: 323-326.

Tekeli, A.S., Ates, E., 2003. *Yield and its components in field pea (Pisum arvense L.) lines*. J. Cent. Eur. Agric., 4: 313-318.

Tekeli, A.S., Ates, E., 2011. *Forage Legumes* (Revised 2nd Ed.). Sevil Grafik Tasarim ve Ciltevi Press, ISBN:978-605-62007-0-0, Tekirdag, Turkey.

Tuna, C., Coskuntuna, L., Koc, F., 2004. *Determination of nutritional value of some legume and grasses*. Pakistan J. Biol. Sci., 7: 1750-1753.

Wichman, D.M., Welty, L.E., Strang, L.M., Bergman, J.W., Westcott, M.P., Stallknecht, G.F., Riveland, N.R., Ditterline, R.L., 2001. *Assessing the forage production potential of safflower in the Northern Great Plains and Inter-Mountain regions.* Proceedings of the 5th International Safflower Conference, Williston, N.D., USA, July 23-27: 269-273.

Uher, D., Štafa, Z., Sikora, S., Blažinkov, M., 2008. *Yield and quality of forage type pea lines and wheat mixtures*. VII. Alps-Adria Scientific Workshop, Stara Lesna, Slovakia: 523.