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Feeding and agronomic value of field pea (*Pisum arvense* L.)-safflower (*Carthamus tinctorius* L.) mixtures

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Abstract

This research was conducted in the experimental fields of the Agriculture Faculty of Namik Kemal University in Turkey, for one year, 2006-2007. The objective of this work was to determine the feeding and agronomic values of field pea-safflower mixtures. The experimental design was a randomized complete block with three replicates. The following seed mixtures were sown: 25 % field pea + 75 % safflower, 50 % field pea + 50 % safflower, 75 % field pea + 25 % safflower, 100 % field pea and 100 % safflower. The fresh herbage yield, dry matter yield, crude protein content, crude fiber content, Ca, Mg, P, K, acid detergent fiber and neutral detergent fiber contents were determined. There were statistically significant differences among mixtures, field pea and safflower for fresh herbage yield, dry matter yield, crude protein content, crude fiber content, Ca, Mg, K, neutral detergent fiber and acid detergent fiber contents. The highest fresh herbage yield (40.15 t ha^{-1}), dry matter yield (12.50 t ha^{-1}), and crude protein content (19.77 %) were obtained from the pure field pea plots. The maximum crude fiber content (27.56%), Ca (1.72%), Mg (0.67), K (2.07), neutral detergent fiber (44.56%) and acid detergent fiber (35.76%) were found in pure safflower. According to yield and agronomic components, the 75 % field pea + 25 % safflower mixture and 100% field pea can be sown in Turkey as well as in subtropical climate conditions.

Key words: *Carthamus tinctorius* L., feed, mixture, *Pisum arvense* L.

Introduction

Proteins are vital for proper nourishment. The 70-80 g of protein required daily to maintain good human health should be in the form of both plant (45%) and animal (55%) proteins (Ates and Tekeli, 2001). However, in less-developed and developing countries, the demand for animal protein is often lower than that for plant protein, perhaps because of preference, but partly because people with modest incomes cannot afford to buy animal products. Certainly in Turkey the production of animal products is insufficient, which increases their cost: the country's animal population therefore needs to be increased. The forage used to feed animals in Turkey and other less-developed countries is provided by grassland, forage crops, forage crops-other than cultivated plants mixtures and the supernumerary materials of other cultivated plants (Tekeli and Ates, 2006; Kok et al. 2007).

Forage mixtures usually result in better forage production and animal performance than a single species grown alone. Besides, all legumes and forage mixtures will build up the humus content of the soil. Microbial activity is also encouraged because the soil is protected from tillage and exposure and earthworm populations increase because the plant roots provide a good food supply. The choice of what species to grow on a particular site should be based on: (a) species adaptation to the site, (b) species response to the grazing system, (c) potential forage yield and seasonal distribution, (d) palatability and nutritional value, and (e) persistence (Ates and Tekeli, 2005). Total yield, quality and seasonal distribution of forage mixtures may be greater importance to the livestock producer. The most important aspect of forage quality is the amount of usable or metabolic energy consumed by the animal. Energy is required for practically all animal life processes- for the action of the heart, maintenance of blood pressure and muscle tone, transmission of nerve impulses, ion transport across membranes, re-absorption in the kidneys, protein and fat synthesis, the secretion of milk, and the production of eggs, wool, and energy. A deficiency of energy is manifested by slow or stunted growth, body tissue losses, and/or lowered production of meat, milk, eggs, fiber, or energy, rather than by specific signs such as those which characterize many mineral and vitamin deficiencies. It is common knowledge that forage must contain dry matter (carbohydrates = cellulose + gums +sugars + starch, and ash), proteins, minerals, and fats (Ensminger et al. 1990). These important traits are used to estimate forage quality (Tekeli and Ates, 2003).

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 animal so that no one characteristic can serve to predict animal production.

Some of the important factors that determine forage quality for animal are stage of maturity, 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). Establishing seeded forage mixtures is one of the quickest ways to increase the quality of forage production. The objective of this work was to determine the feeding and agronomic values of field pea-safflower mixtures.

Materials and Methods

This research was conducted in the experimental fields of the Agriculture Faculty of Namik Kemal University in Turkey, for one year, 2006-2007. The experimental area (41.0 °N, 27.5 °E) had an altitude of 5 m, with a total precipitation of 482 mm on average and an annual overall temperature of 10.5 °C. The soil of the experimental area was xeralf, low in organic matter (0.97%), moderate in phosphorus (P) content (60.3 kg ha^{-1}), but rich in potassium (K) content (588.1 kg ha^{-1}) and with pH 7.1. Certified seed of the safflower variety Dinçer and the field pea variety 16-DY (Töre) were used. The pea was sown with safflower as follow:

1. Field pea 25 % + safflower 75 %
2. Field pea 50 % + safflower 50 %
3. Field 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 field pea were sown. Row distances of 25 cm, sowing rates of 120 kg ha^{-1} (field pea) and of 48 kg ha^{-1} (safflower) were used. The plots were of 2.5 x 5.0 m, arranged in a randomized block design with three replicates. The seeds were sown on November 4th, 2006. The mixtures, the field pea and the safflower were harvested at the full-bloom of the field pea. The samples (2 m^2) were taken by hand. One cut was made in year at the full-bloom stage of field pea. The plots were not irrigated and fertilized after sown. Approximately 500 g herbage samples were dried at 55 °C for 48 h and stored one day at room temperature. Then, the dry matter yield (t ha^{-1}) was calculated. The botanical composition (safflower, pea and forbs) of the samples was determined on a dry matter basis after hand separation. Crude protein (CP) and crude fiber (CF) contents were determined by the micro-Kjeldahl and Weende methods. The samples were wet-fired with nitric-perchloric acid, 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 results were analyzed using the TARIST statistical program.

Results and Discussion

The results of the analyses for the traits studied are given in table 1 and 2.

Table 1. Fresh herbage yield, dry matter yield, and botanical compositions of field pea-safflower mixtures, pure pea and safflower (TARIST statistical program was used for comparison test of the means).

Treatments	Yields		Botanical Composition, g kg $^{-1}$		
	Fresh herbage yield, t ha $^{-1}$	Dry matter yield, t ha $^{-1}$	Safflower	Pea	Forbs[1]
75 % Pea + 25 % Safflower	37.34b	11.23b	244.00	728.13	27.87
50 % Pea + 50 % Safflower	34.28c	10.77c	467.37	513.77	16.86
25 % Pea + 75 % Safflower	32.18d	9.87d	735.23	245.80	18.97
100% Field Pea	40.15a	12.50a	-	955.00	45.00
100% Safflower	30.11e	8.78e	942.00	-	58.00
SE±	0.175**	0.039**	9.811**	10.872**	0.178**

[1]Forbs, *Galium aparine* L., *Sinapsis* sp., *Cirsium* sp., *Xanthium* sp., **: P< 0.01

There were no significant differences between the mixtures, pure field pea and safflower for P ratio (P>0.01 and 0.05). The interactions of these traits were not significant. The P ratio changed from 0.31 to 0.34 in mixtures. When the grass and other cultivated plants increased in the mixtures, the CP content decreased and CF content of hay increased as expected (Table 1 and 2). The pure field pea showed higher values (P<0.01) than the other mixtures for fresh herbage yield (40.15 t ha^{-1}), dry matter yield (12.50 t ha^{-1}) and crude protein ratio (19.77%). The forage production potential of safflower in the Northern Great Plains and Inter-Mountain regions was assessed by Wichman et al. (2001); they reported that the dry matter yield and CP content ranged from 2.46 to 11.55 Mg ha^{-1} and 7.2 to 20.5 % respectively, in the safflower. Acikgoz et al. (2001) and Tekeli and Ates (2007) stated that the pure field pea provides 3.2-14.10 t ha^{-1} of dry matter yields, similar to the present findings.

The pure safflower exhibited higher values than the other mixtures for the CF (27.56%), Ca (1.72%), Mg (0.67%), K (2.07%), ADF (35.76%) and NDF (44.56%) (Table 2). NRC (2001) reported that the requirement for major mineral nutrients for gestating beef cows or lactating beef cows is 0.60-0.80 % (w/w) for K, 0.18-0.44 % for Ca, 0.18-0.39 % for P, and 0.04-0.10 % for Mg. Vonghia et al. (1992) for safflower containing 21 % of CP and 20 % of NDF. Landau et al. (2005) emphasized that NDF ratio may vary from 41 and 49 % in safflower hay. Tekeli and Ates (2007) reported 21.6 % crude fiber, 0.31 % P, 1.74 % K, 0.43 % Mg and 1.20 % Ca from field pea, similar to the present findings. Anonymous (2008) reported 25.0 % CF, 1.10% Ca and 0.38% P ratios from dry matter of safflower. Blackwood (2008) 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.

Conclusion

The highest herbage yield (40.15 t ha^{-1}), dry matter yield (12.50 t ha^{-1}) and crude protein content (19.77%) were determined for pure field pea, followed by 75 % field pea + 25 % safflower mixture. According to yield and quality components, pure field pea and 75 % field pea + 25 % safflower mixture can be sown in Turkey as well as in subtropical climate conditions.

Table 2. The CP, CF, Ca, Mg, P, K, ADF and NDF ratios of mixtures, pure field pea and safflower (TARIST statistical program was used for comparison test of the means)

Treatments	Crude protein,%	Crude fiber, %	Ca, %	Mg, %	P, %	K, %	ADF, %	NDF,%
75 % Pea + 25 % Safflower	16.41b	22.91d	1.26e	0.51c	0.32	1.82d	30.76b	39.09cd
50 % Pea + 50 % Safflower	15.93c	23.10c	1.40d	0.61b	0.33	1.88c	32.11c	40.32c
25 % Pea + 75 % Safflower	12.17d	25.67b	1.54c	0.63b	0.32	1.94b	33.42c	42.44b
100 % Field pea	19.77a	22.34e	1.66 b	0.45d	0.31	1.78e	29.45b	37.98d
100 % Safflower	7.30e	27.56a	1.72a	0.67a	0.34	2.07a	35.76a	44.56a
SE ±	0.041**	0.015**	0.0052**	0.0019**	NS	0.0044*	0.116**	0.109**

**: P<0.01, NS: P>0.01 and 0.05, *: P<0.05

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