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Evaluation of forage yield and quality of forage turnip x legume mixtures

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Abstract. Forage turnip (*Brassica rapa* L. var. r*apa)* was sown with common vetch (*Vicia sativa* L.), Hungarian vetch (*Vicia pannonica* Crantz) and pea (*Pisum sativum* L.) as binary mixtures with two seeding ratios (25:75, 50:50) for forage production. Each species was also sown as pure crop. The experiment was established in autumn 2012. The mixtures and pure forage turnip were harvested when forage turnip was at full flowering stage. Pure legume plots were harvested when they were at full flowering stage. Forage yield and quality (crude protein, ADF, NDF, Ca, Mg, P and K contents) were measured. Results revealed that all the mixtures, especially the mixture of 75% Hungarian vetch + 25% forage turnip, had higher forage yield than pure stands of forage turnip and legumes and satisfactory crude protein content.

Keywords. Forage turnip – Vetch – Pea – Mixture.

Evaluation de la production et de la qualité de mélanges navet fourrager x légumineuses

Résumé. *Du navet fourrager (*Brassica rapa *L. var.* rapa*) a été semé en mélange binaire avec de la vesce commune (*Vicia sativa *L.), de la vesce de Hongrie (*Vicia pannonica *Crantz) et du pois (*Pisum sativum *L.) avec deux proportions dans le semis (25:75, 50:50) pour la production fourragère. Chaque espèce a également été semée en pur. L'expérimentation a été implantée à l'automne 2012. Les mélanges et les espèces pures ont été récoltés lorsque le navet fourrager était en pleine floraison. La production et la qualité du fourrage (teneurs en matières azotées totales, ADF, NDF, Ca, Mg, P et K) ont été mesurées. Les résultats montrent que tous les mélanges, en particulier le mélange semé avec 75% de vesce de Hongrie + 25% de navet fourrager, avaient une production supérieure à celle des espèces pures de navet fourrager et de légumineuses et des teneurs en matières azotées totales satisfaisantes.*

Mots-clés. *Navet fourrager – Vesce – Pois – Mélange.*

I – Introduction

Livestock play a key role in the Turkish agricultural economy. However, quantity of animal products still remains below the country's needs mainly due to insufficient forage and feed production. The strategies performed for bridging the gaps in demand and supply of feeds and fodder include increasing forage yield and improving pastures. Considering that it takes a long time for perennial pasture improvement and there are economic limitations to increase forage area, the best way is seen to increase yield of annual forage crops. One way to increase forage yield should be to include forage legumes in mixed cropping systems (Ross *et al*., 2004).

Mixing forage pea and vetches with cereals to improve quality and yield is a common practice in the forage stands. These mixtures of legume and non-legume species also provide weed control, easy harvest, and reduce forage loss resulted from trait on the ground (Tan and Serin, 1996; Anlarsal *et al*., 1996). Besides cereals, other erect grown crops such as brassicas can be seeded with wrapping-growth (bed in plants) legumes. Rankin (1989) reported that positive results for forage turnip – legume mixtures in forage production regarding yield and quality.

Forage turnip is a popular crop especially in cold regions of the world. It has a broad-leafed, plenty habits and a high digestibility. Dry matter yield of forage turnip is close to legumes with slightly lower values. However, anti-nutritional compounds (erucic acid, glycosides, and nitrate sinapine) can cause damage to animals, in case it is used for animal feeding. Thus legume x turnip mixtures, in addition, eliminates or decrease the anti-nutritional effects of forage turnip (Hertrampf and Pascual, 2000). Maturation-dependent decrease in nutrient content in turnip is faster than in legumes and, best stages of turnip for quality are vegetative and flowering stages (Canbolat, 2013).

In the present study, forage turnip – legume mixtures established at different seed rates were evaluated for yield and quality.

II – Materials and methods

This study was conducted in the experimental fields of Agriculture and Natural Sciences Faculty, Bozok University in 2012-2013 growing season. The experiment was arranged in randomized block design with three replications. The soil taken from 30 cm depth is classified as clay loam with pH: 7.62, 2.17% DM, 7.7% $CaCO_3$, 11.57 kg da^{-1} P_2O_5 and 222,85 kg da^{-1} K_2O.

As plat material, Lenox variety of forage turnip (*Brassica rapa* L. *var. rapa*), Seymen variety of common vetch (*Vicia sativa* L.), Altınova-2002 variety of Hungarian vetch (*Vicia pannonica* Crantz) and Ozkaynak variety of pea (*Pisum sativum* L.) were used. Four different mixture rates (%100 legume, %75 legume + %25 forage turnip, %50 legume + %50 forage turnip, %100 forage turnip) were tested. Sowing was done manually in September 26, 2012. Four lines 5 m long and 30 cm apart were sown for each plot. The seed in pure stands were amounted 1 kg da^{-1} for forage turnip, 12 kg da^{-1} for legumes as reported by (Avcioglu *et al*., 2009).

The experiment was fertilized with 4 kg da^{-1} N and 12 kg da^{-1} P_2O_5 and irrigated for ensuring germination of plants (same N fertilisation for all plots, with or without legume). The mixtures and pure forage turnip were harvested when forage turnip was at full flowering stage. Pure legume plots were harvested when they were at full flowering stage.

After harvest, species were hand separated in samples of mixtures. Each species dried at 60ºC for 48 hours and was weighed. By using species dry weight, the rates of species in hay mixtures and total forage yield were determined. The dried samples were milled with a herb grinder. Crude protein, ADF (Acid detergent fiber), NDF (Neutral detergent fiber), Ca, Mg, P and K (g kg^{-1}) were determined by IC – 0904FE package program and device Near Infrared Reflectance Spectroscopy (NIRS) (Foss 6500). NIRS analyses were performed separately for legumes and forage turnip and results were multiplied by species yield percentage to calculate mixture quality. According to randomized blocks design, the data were evaluated by statistical package program SPSS10.0.

III – Results and discussion

The effects of the treatments on the investigated traits except K and Ca contents, in analysis of variance, were significant (Table 1, 2). Forage yield was the highest in Hungarian vetch (HV) x turnip (T) mixture with the 75% HV + 25% T and the lowest in pure turnip. The highest crude protein content was found in the mixture of 50% Common vetch (CV) + 50% T. However, 75% HV + 25% T mixture produced the highest protein yield owing to its high yield. Same authors, who have done similar research reported that legume x cereal mixtures produced higher forage yield compared to its pure stands (Suzer and Demirhan, 2005; Gummadov and Acar, 2007), and increase ratio of legumes in mixtures caused higher protein content in forage (Buyukburc *et al*., l989; Ross *et al*., 2004). Pure turnip had the highest ADF and NDF content while pure legumes especially pea had the lowest. There is no significant difference among mixtures for ADF and NDF contents.

Sowing treatments did not show significant effects on Ca and K content, statistically (Table 2). However, the effect of the treatments was significant for Mg ($p<0.05$) and P ($p<0.01$). The pure seeded common vetch had the highest Mg content while the highest P content was obtained from the mixture of 50% CV + 50% T. All these results indicate that forage turnip x legume mixtures investigated generally advantageous for forage yield and quality than their pure seeding.

Table 1. Average values of forage yield, crude protein content, crude protein yield, ADF and NDF in forage turnip x legume mixtures and pure crops

Treatments	Forage yield (t ha^{-1})†	Crude protein (g kg^{-1})†	Crude protein yield (t ha^{-1})†	ADF (g kg^{-1})†	NDF (g kg^{-1})†
Pure turnip	4.47 f	126.7 c	0.56 e	477.7 a	632.7 a
Pure Hungarian vetch	10.32 c	208.7 ab	2.15 bc	344.0 cd	445.3 c
Pure common vetch	7.54 e	206.3 ab	1.55 d	338.3 d	503.7 bc
Pure field pea	7.29 e	216.0 ab	1.56 d	293.0 e	457.7 c
50% HV + 50% T	8.77 de	199.7 ab	1.75 cd	388.0 bc	523.7 b
75% HV + 25% T	17.40 a	195.3 ab	3.40 a	400.7 b	553.0 b
50% CV + 50% T	8.57 e	228.7a	1.95 cd	380.7 bcd	562.7 b
75% CV + 25% T	12.85 b	201.0 b	2.59 b	383.0 bcd	533.3 b
50% FP + 50% T	10.05 cd	181.7 b	1.82 cd	386.7 bcd	554.7 b
75% FP + 25% T	8.54 e	220.0 ab	1.86 cd	357.3 bcd	551.3 b

†: $p<0.01$.

Table 2. Average values of Ca, Mg, P and K content in mixtures with forage turnip, common vetch, Hungarian vetch and pea and pure crops

Treatments	Ca (g kg^{-1})	Mg (g kg^{-1})†	P (g kg^{-1})††	K (g kg^{-1})
Pure turnip	11.00	1.67 d	3.00 d	25.00
Pure Hungarian vetch	13.33	2.00 bc	4.00 cd	30.33
Pure common vetch	12.67	3.00 a	4.00 cd	32.33
Pure field pea	12.67	2.67 ab	4.00 cd	30.00
50% HV + 50% T	13.67	2.00 bc	6.33 ab	32.00
75% HV + 25% T	12.67	2.33 abc	5.67 ab	31.33
50% CV + 50% T	13.00	2.33 abc	7.00 a	35.00
75% CV + 25% T	13.33	2.00 bc	5.33 bc	31.33
50% FP + 50% T	12.67	2.00 bc	5.33 bc	27.33
75% FP + 25% T	13.00	1.67 d	6.67 ab	33.33

††: $p<0.01$, †: $p<0.05$.

IV – Conclusions

The present study demonstrated that forage turnip can be seeded with legumes such as vetches and field pea and produce higher yield compared to pure seeding in the autumn sowing conditions. However, selected legume and its seed rate in the mixture are also significant. With these preliminary data collected in a single trial, Hungarian vetch – turnip mixture with the 75% x 25% seeding rate was the most suitable treatment for forage and protein yield.

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