YYÜ TAR BİL DERG
(YYU J AGR SCI)
2015, 25(2): 134-139

Geliş Tarihi (Received): 12.12.2014
Kabul Tarihi (Accepted): 18.02.2015

Araştırma Makalesi/*Research Article (Original Paper)*

Effects of Phosphorus Fertilization on Forage Yield and Quality of Common Vetch (*Vicia sativa* Roth.)

Fatma YILDIZ, Mevlüt TÜRK*

Süleyman Demirel University, Faculty of Agriculture, Department of Field Crops, Isparta- TURKEY
*e-mail: mevlutturk@sdu.edu.tr phone +90 246 211 8552, fax +90 246 237 16 93

Abstract: This research was conducted to determine the effects of five phosphorus rates (0, 30, 60, 90 and 120 kg ha^{-1}) on forage yield and quality of common vetch (*Vicia sativa* Roth.). Dry matter (DM) yield, crude protein (CP), acid detergent fibre (ADF), neutral detergent fibre (NDF), total digestible nutrient (TDN) and relative feed value (RFV) were determined. Phosphorus rates significantly affected all components determined in common vetch. Phosphorus applications increased DM yield, TDN, RFV, CP contents, but decreased ADF and NDF contents.

Key words: Acid detergent fibre, Dry matter, Common vetch, Neutral detergent fibre, *Vicia sativa.*

Fosforlu Gübrelemenin Yaygın Fiğin (*Vicia sativa* L.) Ot Verimi ve Kalitesi Üzerine Etkileri

Özet: Bu araştırma beş farklı fosfor dozunun (0, 3, 6, 9 ve 12 kg/da P_2O_5) yaygın fiğin (*Vicia sativa* L.) ot verimi ve kalitesi üzerine etkilerini belirlemek amacıyla yürütülmüştür. Araştırmada kuru madde verimi, ham protein oranı, ADF, NDF, toplam sindirilebilir besin maddesi (TDN) ve nispi besleme değeri (RFV) gibi özellikler incelenmiştir. Fosfor dozları, belirlenen bütün komponentler üzerine istatistikî olarak önemli düzeyde etki yapmıştır. Araştırma sonucuna göre fosfor dozları arttıkça kuru madde verimi, TDN, RFV ve ham protein oranları artarken, ADF ve NDF oranları azalmıştır.

Anahtar kelimeler: ADF, NDF, Kuru madde, Yaygın fiğ, *Vicia sativa*.

Introduction

Common vetch is commonly grown to provide a seed and hay crop in many different farming systems in Turkey (Albayrak et al. 2004). Several researchers found that dry matter yield varied from 1.50 to 8.65 t ha^{-1} in common vetch grown in the different regions of Turkey (Gokkus et al. 1996; Anlarsal et al. 1999; Avcıoğlu et al. 1999; Albayrak et al. 2006). Vetches can be used for the grazing of livestock, green manure, forage or silage, or the grain fed to livestock (Caballero 1993; Chowdhury et al. 2001; Egan and Crouch 2006). Phosphorus fertilisation affects dry matter yield and chemical composition of vetch (Bell et al. 2001; Turk 2001). Turk et al. (2007) reported that P fertilisation increased dry matter (DM) yield and CP, but it decreased acid detergent fibre (ADF) and neutral detergent fibre (NDF).

The nutrient contents of the forage have an important role in animal feeding. The factors influencing the nutritive value of forage are many and the degree to which they are interrelated may vary considerably from one area to another. These factors may include, alone or in combination, plant type, climate, season, weather, soil type and fertility, soil moisture, leaf to stem ratio, physiological and morphological characteristics and others, and may change depending on whether the plants are annuals perennials, grasses or legumes. Nutrient composition levels are not necessarily the only criterion in evaluating the nutritive value of plants (Stobbs 1975; Cook and Harris 1979). The aim of the present research was to determine the effects of P on dry matter yield, forage quality and nutritional value of common vetch.

Materials and Methods

The study was conducted at Usak (38°39′N, 29°39′E, altitude 910 m) located in the Aegean region of Turkey. Total precipitation was 378 mm in 2014 (March–June). The long-term average is 280 mm. Average temperature was 15.1 ^{o}C in 2014. The long- term average is 14.9 ^{o}C.

The experiments were established in a randomized complete block design with three replications in March in 2014. 'Albayrak' cultivar was used in this research. Five different phosphorus rates (0, 30, 60, 90 and 120 kg P ha^{-1}) were applied in this study. Seeding rate was 80 kg ha^{-1}. Individual plot size was 1.8 × 6 m = 10.8 m^2. Phosphorus was broadcast as triple superphosphate (46% P_2O_5) during sowing in March.

Dry matter (DM) yield, CP, acid detergent fibre (ADF), neutral detergent fibre (NDF), total digestible nutrient (TDN) and relative feed value (RFV) were investigated in samples were taken from quadrats (1 m^2). Samples taken from each plot were dried at room temperature then dried in an oven at 65°C till they reached constant weight. After cooling and weighing, the samples were ground for mineral contents analyses. Nitrogen content was calculated by Kjeldahl method (Kacar 1972). The ANKOM Fibre Analyser was used for NDF and ADF analysis. ANKOM F57 filter bags were used for ADF and NDF analysis in this study.

Total digestible nutrients (TDN), dry matter intake (DMI), digestible dry matter (DDM) and relative feed value (RFV) were estimated according to the following equations adapted from (Horrocs and Vallentine 1999):
TDN = (-1.291 x ADF) + 101.35
DMI = 120% NDF % dry matter basis
DDM = 88.9-(0.779 x ADF % dry matter basis)
RFV = DDM% x DMI% x 0.775

The data were analysed together using the Proc GLM (SAS 1998). Means were separated by LSD at the 5 % level of significance.

Results and Discussion

The results of ANOVA summarized in Table 1. The results of variance analysis showed that DM yield, CP, ADF, NDF, TDN contents and RFV value in common vetch were influenced significantly by phosphorus treatments (Table 1). The highest DM yield was obtained from 90 and 120 kg ha^{-1} P rate (2.98 and 2.99 t ha^{-1}), while the lowest DM yield (2.37 t ha^{-1}) was obtained from control plot (Figure 1). Increase in DM yield due to P application was well documented by many authors (Bell et al. 2001; Türk et al. 2007; Albayrak et al. 2009; Sürmen et al. 2011).

Table 1. Results of Analysis of Variance Traits Determined

	df	DMY	CP	ADF	NDF	TDN	RFV
Block	2	9.58	0.15	0.04	0.08	0.07	4.06
Phosphorus	4	2379**	1.71**	7.65**	13.60**	12.75**	760**
Error	8	3.16	0.15	0.03	0.04	0.04	2.28

df: degrees of freedom, *P<0.05 and **P<0.01.

Phosphorus fertilizer increased forage quality of common vetch. The highest CP content (20.21%) was obtained from 90 kg ha^{-1} P rate, while the lowest CP content (18.25%) was obtained from the control treatment (Figure 2). Similar results were reported by Sürmen et al. (2011) and Turk et al. (2007).

The effects of phosphorus fertilization on ADF and NDF contents of common vetch were found statistically significant. In present study, increasing P fertilization decreased ADF and NDF concentration. The highest ADF (27.09%) and NDF contents (36.08%) were obtained from the control treatment rate, while the lowest ADF (23.08%) and NDF contents (30.74%) were obtained from the 120 kg ha^{-1} P (Figure 3 and 4). Our results confirm the finding of Albayrak et al. (2009), Sürmen et al. (2011) and Türk et al. (2007). The trends in ADF and NDF contents with increasing maturity are normally the

reverse of protein (Oelberg 1956; Rebole et al. 2004). Young plant cells has the primary cell wall, but also the secondary cell wall occurs with maturing. This causes being the more fibrous of mature plants (Arzani et al. 2004).

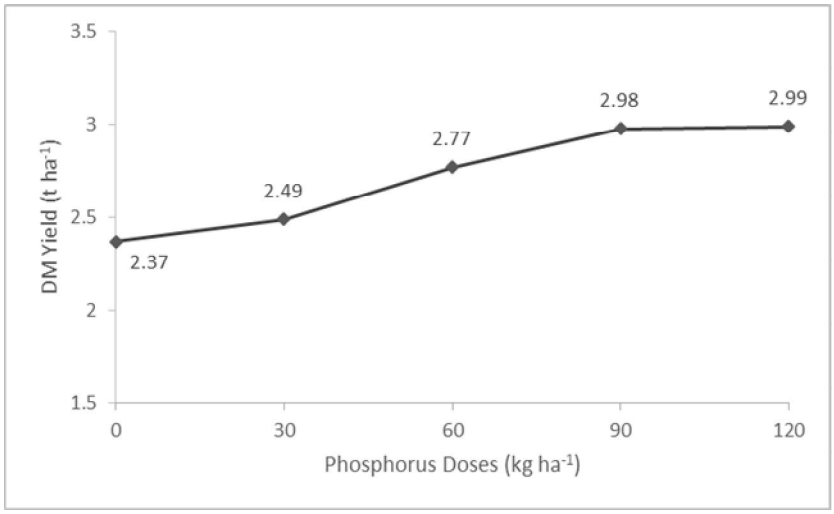

Figure 1. The DM yield of common vetch at different phosphorus doses.

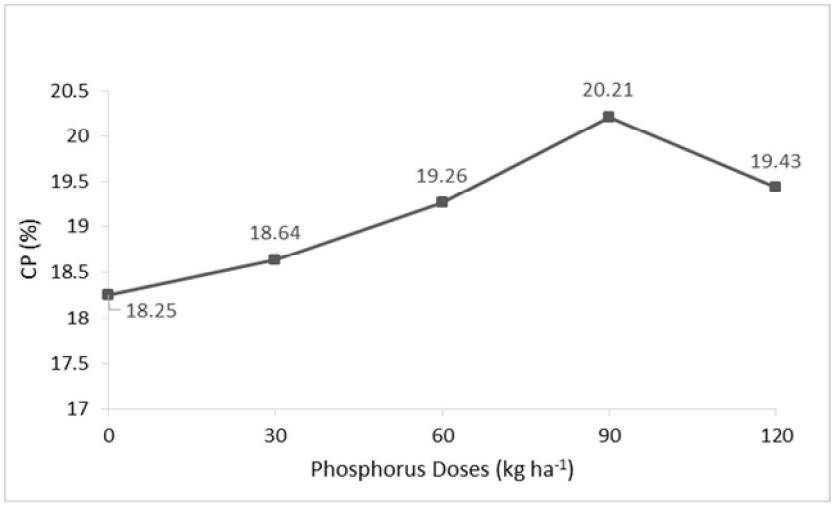

Figure 2. The CP contents of common vetch at different phosphorus doses.

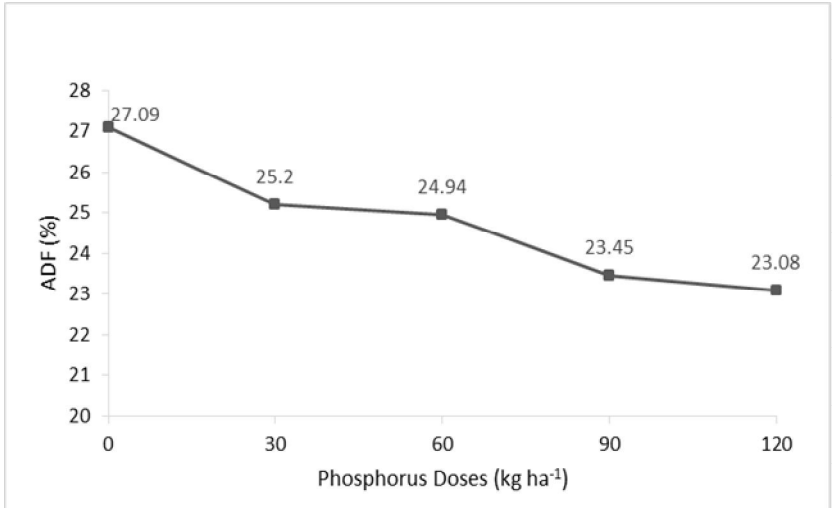

Figure 3. The ADF contents of common vetch at different phosphorus doses.

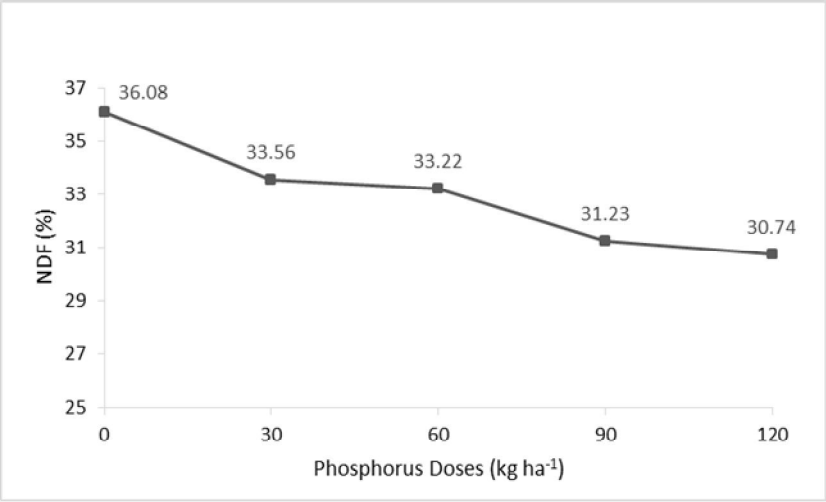

Figure 4. The NDF contents of common vetch at different phosphorus doses.

The TDN refers to the nutrients that are available for livestock and are related to the ADF concentration of the forage (Sürmen et al. 2011). As ADF increases there is a decline in TDN which means that animals are not able to utilize the nutrients that are present in the forage (Aydın et al. 2010). The highest TDN values (71.08 and 71.55) were obtained from 90 and 120 kg ha^{-1} P rate, while the lowest TDN values (66.37) was obtained from the control treatment (Figure 5). Similar results were reported by Sürmen et al. (2011).

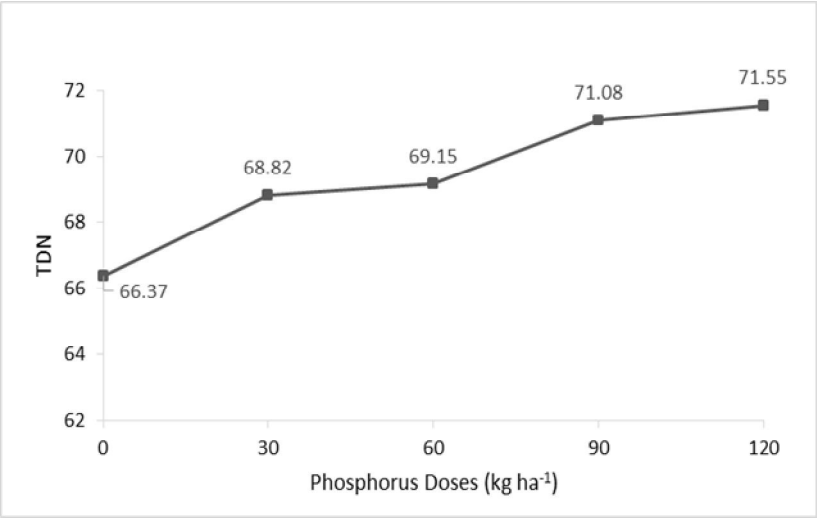

Figure 5. The TDN values of common vetch at different phosphorus doses.

The RFV is an index that is used to predict the intake and energy value of the forages and it is derived from the DDM and dry matter intake (DMI). Forages with an RFV value over 151, between 150-125, 124-103, 102-87 and 86-75, and less than 75 are considered as prime, premium, good, fair, poor and reject, respectively (Lithourgidis et al. 2006). The highest RFV value (214.5) was obtained from 120 kg ha^{-1} P rate, while the lowest RFV values (174.7) was obtained from the control treatment (Figure 6). Similar results were reported by Sürmen et al. (2011).

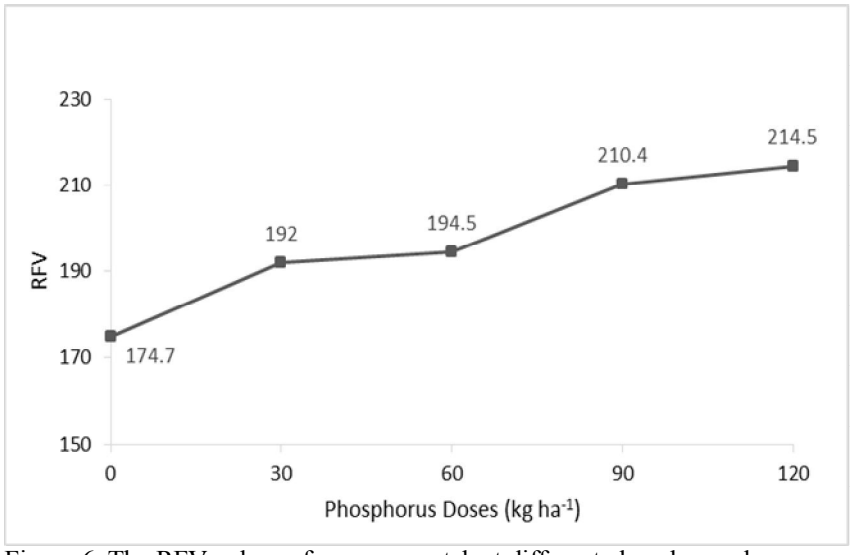

Figure 6. The RFV values of common vetch at different phosphorus doses.

Conclusions

Common vetch has adequate mineral content for ruminant animal requirements for production in the Agean conditions of Turkey. Increasing P rates resulted in increased forage yield and quality. The highest DM yields were obtained from 90 and 120 kg ha^{-1} P rates. The content of CP increased while increasing P fertilization rates. As P rate increased from 0 to 120 kg ha^{-1}, ADF and NDF contents decreased, TDN and RFV values increased. At the end of this research conducted in Agean conditions of Turkey, 90 kg ha^{-1} phosphorous fertilizer is recommended for high herbage yield and quality in common vetch.

Acknowledgements

This research was supported by the Unit of Scientific Research Projects, Suleyman Demirel University (SDU-BAP:4014-YL1-14). Present manuscript was a part of the master thesis.

References

Albayrak S, Sevimay CS, Töngel Ö (2004). The effects of inoculation with Rhizobium on forage yield and yield components of common vetch (Vicia sativa L.). Turkish Journal of Agriculture and Forestry, 28: 405-411.

Albayrak S, Sevimay CS, Çöçü S (2006). Effect of rhizobium inoculation on forage and seed yield and yield componets of common vetch (*Vicia sativa* L.) under rainfed conditions. Acta Agriculturae Scandinavica Section B - Soil and Plant Science 56(3):235-240.

Albayrak S, Türk M, Yüksel O (2009). Effects of phosphorus fertilization and harvesting stages on forage yield and quality of woolypod vetch. Turkish Journal of Field Crops 14(1):30-40.

Anlarsal AE, Yücel C, Özveren, D (1999). Researches on adaptation of some vetch lines (*Vicia sativa* L.) to Çukurova Conditions. Turkey 3rd Field Crops Congress, Adana, pp. 86-92.

Avcıoğlu R, Soya H, Geren H, Demircioğlu G, Salman A (1999). The researches on the effects of harvest time to yield and quality of the some valuable forage. Turkish 3rd Field Crops Congress, Adana, 3:29-34.

Arzani H, Zohdi M, Fish E, Zahedi Amiri GH, Nikkhah A, Wester D (2004). Phenological effects on forage quality of five grass species. J Range Manage 57:624 –629.

Aydın N, Mut Z, Mut H, Ayan İ (2010). Effect of autumn and spring sowing dates on hay yield and quality of oat (*Avena sativa* L.) genotypes. Journal of Animal and Veterinary Advances 9(10):1539-1545.

Bell CA, Korte CJ, Heazlewood C, Castleman GH, Matassa VJ (2001). Narbon bean response to fertilizer nutrients in the Victorian Mallee. 10th Australian Agronomy Conference, "Science and Technology: Delivering Results for Agriculture?" Hobart January 2001.

Caballero R (1993). An experts' survey on the role of legumes in arable cropping systems of the Mediterranean area. Journal of Sustainable Agriculture, 3: 133 - 154

Chowdhury D, Tate ME, McDonald GK, Hughes R (2001). Progress towards reducing seed toxin levels in common vetch (*Vicia sativa* L.). Proceedings of the Australian Agronomy Conference, Australian Society of Agronomy. The regional institute Ltd. Online community publishing. Australia.

Cook CW, Harris LE (1979). Nutritive value of seasonal ranges. Utah Agricultural Experiment Station Bulletin. 472, 55 p.

Egan J, Crouch J (2006). Bean variety sowing guide for 2006. SARDI, Port Lincoln, and Wayne Hawthorne, Pulse Australia, Naracoorte, FS 16/00/06.

Gökkuş A, Bakoğlu A, Koç A (1996). A research on the adaptation of some vetch lines and cultivars in irrigation areas in Erzurum. Turkish 3rd Grass and Forage Congress, Erzurum, pp. 674-678.

Horrocks RD, Vallentine JF (1999). Harvested Forages. Academic Press, London, UK.

Lithourgidis AS, Vasilakoglou IB, Dhima KV, Dordas CA, Yiakoulaki MD (2006). Forage yield and quality of common vetch mixtures with oat and triticale in two seeding ratios. Field Crops Research 99:106-113.

Oelberg K (1956). Factors affecting the nutritive value of range forage. Journal of Range Management. 9:220-225.

Rebole A, Alzueta C, Ortiz LT, Barro C, Rodriguez ML, Caballero R (2004). Yields and chemical composition of different parts of the common vetch at flowering and at two seed filling stages. Spanish Journal of Agricultural Research. 2(4), 550-557.

SAS Institute (1998). INC SAS/STAT users' guide release 7.0, Cary, NC, USA.

Stobbs TH (1975). Factors limiting the nutritional value of grazed tropical pastures for beef and milk production. Tropical Grassland. 9:141-150.

Sürmen M, Yavuz T, Çankaya N (2011). Effects of Phosphorus Fertilization and Harvesting Stages on Forage Yield and Quality of Common Vetch, International Journal of Food, Agriculture & Environment – JFAE 9. (1). 353-355.

Turk MA (2001). Effects of phosphorus on narbon vetch and barley under open and controlled conditions. Agriculture Mediterranean. 131: 112-117.

Türk M, Albayrak S, Yüksel O (2007). Effects of phosphorus fertilization and harvesting stages on forage yield and quality of narbon vetch. New Zealand Journal of Agricultural Research, 50:457-462.