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in

Acar Z. (ed.), López-Francos A. (ed.), Porqueddu C. (ed.).
New approaches for grassland research in a context of climate and socio-economic changes

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 102

2012
pages 333-336

Effects of nitrogen and phosphorus fertilization on dry matter yield and quality of an abandoned rangeland

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Abstract. The object of this study was to determine the effects of nitrogen and phosphorus fertilization on dry matter yield, crude protein content, ADF, NDF and total digestible nutrient of an abandoned rangeland in Bursa-Turkey in 2008 and 2009 years. Nitrogen was applied as urea (46 % N) at 0, 50, 100, 150, 200 and 250 kg ha^{-1}rates. Phosphorus was applied as triple super phosphate (42-44 % P_2O_5) at 0, 50, 100 and 150 kg ha^{-1} rates. Fertilizers were broadcasted by hand. All of nitrogen rates increased dry matter yield and the yield reached the peak value at 200 kg ha^{-1} rate, followed by 150 and 250 kg Nha^{-1}rates, but the differences among rates were not so great. All but 50 kg ha^{-1} nitrogen level increased crude protein content, but no differences among their effects. The effects of nitrogen rates on NDF values were the same and positive when compared with the NDF value of unfertilized range. All phosphorus rates did affect only the crude protein content of hay, indicating similar effects as a result; to produce higher and quality forage from abandoned rangelands like in the experimental region the 150 kg N ha^{-1}rate can be recommended with economical considerations.

Keywords. Nitrogen – Phosphorus – Dry matter yield – Crude protein – ADF – NDF.

Titre. Effets de la fertilisation azotée et phosphorée sur le rendement en matière sèche et la qualité d'un parcours abandonné

Résumé. *Résumé. L'objet de cette étude était de déterminer les effets de la fertilisation azotée et phosphorée sur le rendement en matière sèche, la teneur en protéine brute, ADF, NDF et nutriments digestibles totaux d'un parcours abandonné situé à Bursa, Turquie, en 2008 et 2009. L'azote a été appliqué sous forme d'urée (46 % N) à raison de 0, 50, 100, 150, 200 et 250 kg/ha-1. Le phosphore a été appliqué sous forme de triple super phosphate (42-44 % P2O5) à raison de 0, 50, 100 et 150 kg/ha. Les fertilisants étaient épandus à la main. Tous les niveaux d'azote ont augmenté le rendement en matière sèche, qui a atteint une valeur maximale au taux de 200 kg ha-1, suivi de 150 et 250 kg N/ha, mais les différences entre taux n'étaient pas très élevées. Tous les niveaux d'azote sauf celui de 50 kg ha-1 ont accru la teneur en protéine brute, mais sans différences entre leurs effets. Les effets des taux d'azote sur les valeurs NDF, positifs, étaient les mêmes lorsque comparés à la valeur NDF du parcours non fertilisé. Tous les taux de phosphore ont affecté seulement la teneur en protéine brute du foin, indiquant des effets semblables comme résultat; pour produire plus de fourrage et de meilleure qualité à partir des parcours abandonnés tels que ceux de la région d'expérimentation, le taux de 150 kg N ha-1 peut être recommandé d'après les considérations économiques.*

Mots-clés. *Azote – Phosphore – Rendement en matière sèche – Protéine brute – ADF – NDF.*

I – Introduction

The growing medium in rangelands must have appropriate conditions in order that the plants should indicate their yielding power in present conditions. One of the most important factors that limits the plant production in the world is the insufficiency or inbalance of plant nutrients. Fertilization of range lands is necessary and useful when the nutrients required by plants are deficient in soil (Altın *et al.*, 2005). Generally, the response of rangelands to fertilization is

positive and quite high. For this reason, the fertilization is a common practice on rangelands in order to enrich plant cover or increase hay yield. Indeed, fertilizing rangelands has a lot of useful effects such as; (i) to increase hay yield and quality, (ii) to distribute hay production evenly throughout the grazing season, (iii) to ease the seedlings and (iv) to increase the palatability of hay (Altın, 1992; Heady and Child, 1994). Therefore, most practical and effective method to increase dry matter yield and quality and to improve botanical composition in rangelands is to fertilize these areas with appropriate and adequate fertilizers (Frame 1992). Fertilization, especially with N and P can increase dry matter production upto two- to three-fold from rangelands depending on the annual rainfall and moisture in the region(Aydın and Uzun, 2005). Increased N application generally increases hay production and crude protein content (Gokkus and Koc, 1995; Aydın and Uzun, 2005; Polat *et al*., 2007; Turk *et al*., 2007a; Turk *et a*l., 2007b; Balabanlı *et al*., 2010; Celebi *et a*l., 2011; Dascı and Comaklı, 2011). However, inconsistent results have been reported on the effects of fertilization on crude protein, NDF and ADF contents. Some researchers reported that there were positive effects of nitrogen on crude protein content of rangelands (Turk *et al*., 2007b; Balabanlı *et al*., 2010; Dascı and Comaklı, 2011). Balabanlı *et al*. (2010) reported that NDF peaked at the low fertilizer rates and then decreased with increasing fertilizer rates. On the other hand, Balabanlı *et al.* (2010) reported that phosphorus rate had no effect on crude protein content and ADF of rangeland. Dascı and Comaklı (2011) found that effects of phosphorus fertilization on NDF were no significant.

The objective of this study was to evaluate the responses of dry matter yield, crude protein content, ADF, NDF and TDN of an abandoned rangeland to different rates of nitrogen and phosphorus fertilization.

II – Materials and methods

This study was conducted for two years (2008 and 2009) on an abandoned rangeland in Bursa (40° 11´ N, 29° 04´ E), located on the Southern Marmara Region of Turkey. Data evaluated in this article include the results of 2008 and 2009. Total precipitation and average temperature were found as 577.9 mm and 9.9°C in 2007-2008; 579.7 mm and 7.8°C in 2008-2009; while long years average (1975-2008) were 499.6 mm and 9.7°C respectively. Soil test values indicated a pH of 7, none saline, low values in lime and organic matter and rich in potassium.

Nitrogen was applied as urea (46% N) with 0, 50, 100, 150, 200 and 250 kg ha^{-1}rates. Phosphorus was applied as triple super phosphate (42-44% P_2O_5) with 0, 50, 100 and 150 kg ha^{-1} rates. Fertilizers were broadcast by hand. Half of N and the entire of P_2O_5 were applied at the beginning of November. The rest half of N was applied at the beginning of rapid growth period of vegetation (mid-March). Fertilizer treatments were applied randomly in complete block experiment design with three replications. The dimensions of each plot were 2 m x 1 m (width and length). The distance between adjacent plots was 1 m. Harvest of plots were made at mid-May in each year when the dominant grass species reached about 50% flowering stage. After harvest, green forage samples were taken randomly from harvested green forages of each plot and put in cloth bags. They were oven-dried at 78 ºC for 48 hours and weighed, then dry weight percentages were calculated. Dry matter yield of each plot was calculated by multiplying the fresh weight of plot with its dry weight percentages. Then, oven-dried samples were ground and 1 g ground sample was used for the total nitrogen determination and 0.5 g for ADF and NDF. ADF and NDF were analyzed by sequential detergent analysis method (Van Soest *et al*., 1991) and total nitrogen by Kjedahl method. Crude protein content was calculated by multiplying total nitrogen with 6.25 constant. Total digestible nutrient (TDN) was determined by equation of TDN% = 88.9-(0.779xADF%) (Linn and Martin 1999).

Variance analysis was evaluated over two-year data. Variance analysis of components such as of dry matter yield, crude protein content, ADF, NDF and TDN were made by using MINITAB

and MSTAT-C programs. The LSD was used to group the means of nitrogen, phosphorus and their interactions for each component determined when the F-test was significant.

III – Results and discussion

The response of range to nitrogen fertilizer was more evident than that of phosphorus fertilizer in respect of all components determined in the experiment. The effects of nitrogen rates on dry matter yield was found significant and the highest yield (10431 kg ha^{-1}) was produced at 200 kg N ha^{-1} level. On the other hand, the lowest dry matter yield (7725 kg ha^{-1}) was produced at plots without nitrogen (Table 1). Numerous workers have determined different nitrogen rates for maximum dry matter yield (Aydın and Uzun, 2005; Polat *et al*., 2007; Balabanlı *et al*., 2010; Celebi *et al*., 2011; Dascı and Comaklı, 2011). These are natural results due to the different ecologies and range vegetations. Response of crude protein content to nitrogen fertilization was statistically significant. Crude protein content increased up to 100 kg N ha^{-1} and then stayed stable at 150, 200 and 250 kg N ha^{-1}. These results coincide with the findings of most workers (Turk *et al*., 2007a; Balabanlı *et al*., 2010; Dascı and Comaklı, 2011). Nitrogen rates had no effects on ADF that ranged from 34.14 to 37.39 (Table 1). Nitrogen application affected also NDF content of forage. The lowest NDF value was determined at untreated plots, and the plots treated with any rates of nitrogen produced the highest NDF values, but no differences among themselves. Nitrogen rates had no effects on TDN ranging from 59.77 to 62.31 (Table 1). There were reverse results reported by other workers (Dascı and Comaklı, 2011).

Table 1. Effects of nitrogen and phosphorus rates on dry matter yield (kg ha^{-1}) and the contents of crude protein (%), ADF (%), NDF (%) and TDN (%) in an abandoned rangeland (average of two years)

	Dry matter yield (kg ha^{-1})	Crude protein (%)	ADF (%)	NDF (%)	TDN (%)
Nitrogen rate (kg ha^{-1})					
0	7725c	12.17b	37.39	49.48b	59.77
50	9004b	12.29b	36.81	50.58a	60.23
100	9030b	13.44a	36.29	52.82a	60.63
150	9448ab	13.41a	36.45	51.56a	60.51
200	10431a	13.58a	35.88	53.31a	60.95
250	9723ab	13.67a	34.14	53.37a	62.31
Phosphorus rate (kg ha^{-1})					
0	8600	12.89b	36.12	52.51	60.77
50	9213	13.48a	36.15	52.33	60.74
100	9809	13.76a	36.10	51.57	60.78
150	9551	13.59a	36.27	50.99	60.65
Years (Y)	ns	ns	**	*	**
Nitrogen (N)	**	*	ns	*	ns
Phosphorus (P)	ns	*	ns	ns	ns
Y x N	ns	ns	ns	*	ns
Y x P	ns	ns	ns	ns	ns
N x P	ns	ns	ns	*	ns
Y x N x P	ns	ns	ns	*	ns

Means of the same column followed by the same letter were not significantly different at the 0.05 level using LSD test.
*, **: F-test significant at $p \leq 0.05$, and $p \leq 0.01$, respectively. ns: not significant.

The effects of phosphorus rates on dry matter yield were insignificant (Table 1). Similar results for phosphorus fertilization were reported by Dascı and Comaklı (2011). However, some workers reported reverse results (Aydın and Uzun, 2005; Balabanlı *et al*., 2010). Crude protein content of forages was affected by phosphorus fertilization and all rates of phosphorus increased crude protein content, but there were no differences among themselves (Table 1). Polat *et al*. (2007) reported similar results for phosphorus fertilizing however, Balabanlı *et al*. (2010) reported results indicating no effects of phosphorus fertilizer on crude protein content of rangeland. The effects of phosphorus rates on ADF, NDF and TDN were found insignificant (Table 1). Dascı and Comaklı (2011) found that effects of phosphorus fertilization on NDF were no significant; which is consistent with our results. Balabanlı *et al*. (2010) reported that ADF contetnt of rangeland did not vary significantly with the phosphorus rates. All of these results, consistent or inconsistent with each other, indicated that many factors may interfere in the effects of phosphorus to occur.

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