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# DOSE RESPONSE EFFECT OF NITROGEN AND PHOSPHORUS ON FORAGE QUALITY, YIELD AND ECONOMIC RETURN OF RANGELANDS

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**Abstract**

A two-year experiment was conducted in Karacadağ rangeland, Şanlıurfa, Turkey to evaluate Nitrogen (N) and Phosphorus (P) fertilization on forage quality and plant species composition and to determine their economic impact on animal production. Treatments were 0, 50, 100, 150 and 200 kg ha$^{-1}$ of N and 0, 50, 100, and 150 kg ha$^{-1}$ of P fertilizer doses. Nitrogen and Phosphorus fertilization significantly influenced the composition of plants. Botanical composition of experimental fields was recorded as 25 legume, 22 grass and 27 species from other families. The results show large interaction between P and N due largely to the fact that legume species are relatively abundant fertilization reduced legume proportion; however, P fertilizer increased the proportion of legume in vegetation. Adverse effect of N on growth of legume resulted in significantly crude protein decrease in forage. In both years, overall mean dry matter yield increased with increase in N and P applications. Highest dry matter yield production was 3407 kg ha$^{-1}$ in 150 kg ha$^{-1}$ of P and 200 kg ha$^{-1}$ of N as compared to control treatment which had a 1152 kg ha$^{-1}$. Average mean crude protein concentration was 110 g kg$^{-1}$ for control plots, while it decreased to 106, 102, 104 and 103 g kg$^{-1}$ in 50, 100, 150 and 200 kg ha$^{-1}$ of N applications, respectively. Crude protein concentrations were significantly enhanced with increasing P fertilizer amounts. Maximum crude protein concentration was 140 g kg$^{-1}$ obtained from $P_{150}$+$N_0$ treatments. The average crude protein yield was 126.7 kg ha$^{-1}$ in control plots and maximum crude protein yield was from $P_{150}$+$N_{200}$ treatment as 464.1 kg ha$^{-1}$. Overall results indicated that, the most profitable treatment was $P_{150}$+$N_{200}$ and average calculated benefit was 644 € per hectare.

## Introduction

Rangelands in Turkey consist 16% of the area (Aydin & Uzun, 2005). Animals are mainly grazed on the rangelands in Turkey and the dry matter production of these rangelands is rather low. Improvement in rangelands is vital in order to meet animal forage needs.

The most practical and effective measures to increase dry matter production in rangelands is application of appropriate doses of fertilizers (Frame, 1992; Aydin & Uzun, 2005). Many researchers reported that fertilization increases the forage quality and yield (Wight & Black, 1979; Feyter *et al.*, 1985; Pamo & Yonkeu, 1993; Keane & Allen, 1999). Fertilization levels up to 120 kg ha$^{-1}$ $P_2O_5$ and 70 kg ha$^{-1}$ of N application has increased rangelands yield in Canada (Hubbart & Mason, 1967). Carene *et al.,* (1984) applied 50 and 100 kg ha$^{-1}$ of N and found that with N applications root density of legumes increased, but, higher doses decreased legumes densities. Several studies indicated that the application N and P has increased the yield of rangelands in different countries (Pamo & Yonkeu, 1993; Keane & Allen, 1999). Dry forage yields of rangelands increased between 0.6-2 ton ha$^{-1}$ with 80 kg ha$^{-1}$ N and 80 kg ha$^{-1}$ $P_2O_5$ applications and also increased plant species and carrying capacity (Tükel *et al.,* 1997).

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To provide better feed quality for the pasture-grazed animal production, the composition of plant and the species are important. Soil fertilizer level of N is a main factor determining production intensity of pasture and grazing lands (Keane & Allen, 1999).

Fertilization affects botanical composition, the dry matter productivity of forage, and quality (Keane & Allen, 1999; Sengul, 2003; Aydin & Uzun, 2005). There are reports of close relationship between plant composition and forage quality in rangelands (Samuel & Hart, 1998; Keane & Allen, 1999; Sengul, 2003; Aydin & Uzun, 2005). The quality of forage can be expressed in conversation of consumed forage to animal production. One of the main criteria of forage quality is the crude protein concentration (Gillen & Berg, 1998; Sengul, 2003; Aydin & Uzun, 2005). Legumes generally increase the crude protein concentration of forages (Sengul, 2003). At same harvest maturity, legumes contain higher crude protein compared to grass (Aydin & Uzun, 2005). Crude protein concentration increases the digestibility of hay (Van Soest, 1973).

Use of N fertilizer decreases an average crude protein concentration slightly, but no significant increase was recorded in mixtures with leguminous species (Sengul, 2003). Fertilization with nitrogen stimulates grass growth; while adversely affect the legume growth (Aydin & Uzun, 2005). This adverse effect on growth of legume resulted in significantly crude protein decrease in forage. The objectives of the study were to; (i) determine the right doses of P at which the negative effect of wide range of N on forage yield and quality can be minimized. (ii) To determine economic optimum benefit of N and P applications.

## Materials and Methods

**Site description:** This study was conducted between September 2001 and 2003 on a natural high rangeland in Karacadağ, Şanlıurfa, located on the Eastern Anatolian region of Turkey 39°35N′ and 39°38E′ at an altitude of 801. Data were collected in 2002 and 2003. The annual precipitations in the region were 327.8 and 513.9 in 2002 and 2003, respectively (Table 1).

Soil in the experimental site has 3% organic mater content, 13.4 kg $ha^{-1}$ $K_2O$ and 0.1 $P_2O_5$ with pH 7.8.

**Sampling:** In both years, samples were taken from the respective site in the middle of May. To assess the plant composition, one meter square wooden measure quadrate was placed in plots for four times per plot and plant species included were counted and recorded each year. A botanical list of all the species found on the square meter was classified by botanical family, type and proportion of species calculated as per square meter.

**Experimental design:** Treatments consisted of 20 plots with 3 blocks of 5m x 10m with one meter distance between plots. Treatments were repeated for two years. Nitrogen was applied as urea (46% N) with 0, 50, 100, 150 and 200 kg $ha^{-1}$rates. Phosphorus was applied as triple super phosphate (42-44% P) @ 0, 50, 100 and 150 kg $ha^{-1}$. Fertilizers were broadcast by hand. Half of N and all of the P were applied in October and remaining N was applied in early spring (April). To prevent grazing, experimental areas were fenced.

**Table 1. Average monthly precipitation and temperature during the experimental year in 2002 and 2003.**

| | Precipitation (mm) | | Temperature ºC | |
|---|---|---|---|---|
| **Month** | **2002** | **2003** | **2002** | **2003** |
| January | 25.7 | 84.6 | 4.9 | 7.4 |
| February | 42.7 | 176.9 | 9.8 | 4.9 |
| March | 97.4 | 90.9 | 12.6 | 9.0 |
| April | 47.3 | 21.6 | 14.7 | 15.9 |
| May | 7.4 | 11.0 | 21.4 | 24.2 |
| June | 0.3 | 5.2 | 28.7 | 28.6 |
| July | 4.6 | 0.0 | 32.0 | 32.6 |
| August | 0.0 | 0.0 | 30.5 | 32.7 |
| September | 0.7 | 0.1 | 26.9 | 26.4 |
| October | 6.6 | 23.1 | 21.8 | 21.5 |
| November | 35.9 | 36.1 | 14.4 | 12.7 |
| December | 59.2 | 64.4 | 5.0 | 7.2 |
| **Total** | **327.8** | **513.9** | - | - |

**Economic analysis:** In order to determine the effect of N and P fertilization on forage quality of rangelands for the benefit of animal production, crude protein of plants was determined. Converted consumable crude protein to meat was calculated as 1.8 kg of consumable crude protein per one kg of meat for the hoof in cow-calf as referred by Aydin & Uzun (2005) and NRC (Anon., 1996). The economic impact of fertilizers was also assessed by over all economic analyses using the price of fertilizer and expenditures.

**Herbage yield assessment:** To determine herbage yield of treatments for each plots, plants were cutted at soil surface within 30 $m^2$ areas in the middle of plots. Remaining area was used for the border effect. Before harvest of herbage plants, one $m^2$ quadrate were randomly placed in each plots and included plants were classified as legumes, grasses and others in order to determine the dry ratio of each group for every year. Then those samples were oven-dried at 70ºC for 72 hours, thus dry weight ratio of each samples were calculated. Dry matter production was determined by the green forage production and dry-weight percentage for each plant family.

In order to determine crude protein content of harvested herbage samples and crude protein concentrations of each plant families in each plot were analyzed by micro-kjeldahl.

**Statistical analysis:** Data analysis was performed by using PROC GLM procedure in SAS (Anon., 1999). Experiment was designed as both randomized complete block and split plot design for the analysis of two years mean. Separating of means was accomplished by using LSD multiple range test at P 5% level. The effects of N and P fertilizers on dry matter production were best fitted with polynomial relation (Fig. 1), and linear relation was fitted for the crude protein yield except for $P_{100}$ and $P_{150}$. Due to sharp increases in crude protein production with increasing N and P doses these were best shown with polynomial relation (Fig. 2).

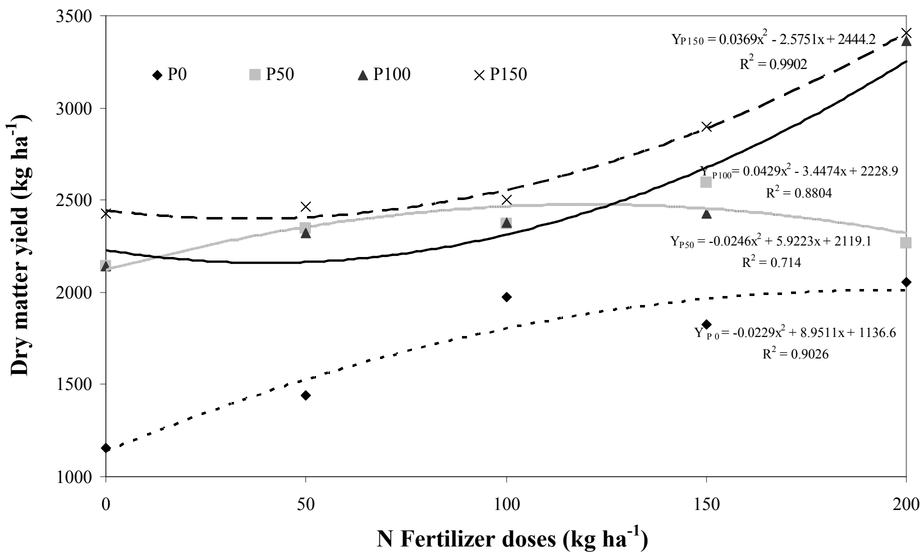


Fig. 1. The effects of different N and P fertilizer doses on dry matter yield production of forage on a rangeland (data are average of two years).

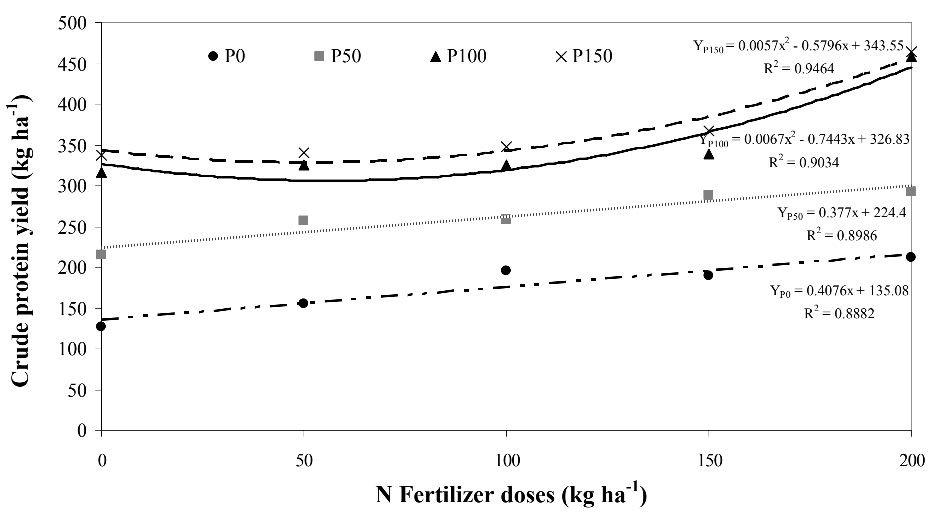


Fig. 2. The effects of different N and P fertilizer doses on crude protein yield production of forage on a rangeland (data are average of two years).

## Results

Botanical composition of experimental area was recorded as 25 legume, 22 grass and 27 species from the other families. The most common legume species were *Astragalus* sp., *Coronilla parviflora* Willd., *C. scorpioides* (L.) Koch., *C. varia* L., *Hippocrepis unisiliquosa* L., *Hymenocarpos circinnatus* (L.) Savi*, Lathyrus cicera* L*., Madicago* *coronata* (L.) Bart., *M. truncatula* Gartn., *M. minima* (L.) Bartal., *Scorpirus muricatus* L., *Trifolium campestre* Schreb., *T. lappaceum* L., *T. stellatum* L., *T. globosum* L., *T. scabrum* L., *T. tomentosum* L., *T. fragiferum* L., *Trigonella kotschyi* Fenzl., *Torilis leptophylla* (L.) Reichb. and *Vicia hybrida* L.

The most common grasses were *Aegilops ovata* L. Sensu Willd., *A. triuncialis* L., *Alopecurus myosuroides* Huds., *Avena sterilis* L., *Bromus erectus Huds., B. inermis* Leysser, *Cynodon dactylon* (L.) Pers., *Dactylis glomerata* L., *Echinaria capitata* (L.) Desf., *Hordeum bulbosum* L., *Hordeum spontaneum* C. Koch, *Festuca sp., Poa bulbosa* L., *Lolium perenne* L.

The most common plant species of other families were *Achillea milefolium* L., *Cirsium arvense* (L.) Scop., *C. acarne* (L.) Moench., *Euphorbia macroclada* Boiss., *Geranium molle* L., *Matricaria chamommilla* L., *Papaver rhoeas* L., *Poterium sanguisorba* L., *Ranunculus arvensis* L., *Salvia* spp., *Scandix pecten-veneris* L., *Senecio vernalis* Waldst and Kit.

Legumes dry weight ranged between 2.1 and 5.7%, over two years and it decreased to 1.9% in 2002 while it increased to 7.7% in 2003 where 150 kg $ha^{-1}$ P and 200 kg $ha^{-1}$ N were applied. In contrast, as the N doses increased, the grass dry weight ratio sharply enhanced. The grass dry weight ratio was 68.0 and 70.2% in 2002 and 2003, respectively which increased to 88.4 and 83.3% in 2002 and 2003, respectively (Table 2). The dry weight ratio of other plant families decreased with increasing N doses in all treatments. The average dry weight ratio of two years was 27% in control plots, while it decreased to 9.5% where 150 kg $ha^{-1}$ P and 200 kg $ha^{-1}$ N were applied (Table 2).

Dry matter weight ratio of the botanical composition families were significantly different between years (***$p<0.0001$). Legume dry weight ratio was 2.3% in 2002, while it increased to 14.5% in 2003. However, the proportion of grasses decreased by 80.9 to 78.5% in 2003 (Table 2). The dry weight ratio of botanical families of others increased from 9.2 to 14.7% in 2002 and 2003, respectively.

Overall, average dry matter yield of both years increased with increased N and P fertilizers (Fig. 1). Dry matter yield production of control treatment was 1152 kg $ha^{-1}$ and, 150 kg $ha^{-1}$ of P and 200 kg $ha^{-1}$ of N applied plots; it increased to 3407 kg $ha^{-1}$.

Plant community does not respond to more than 100 kg N $ha^{-1}$. Strong interaction between N and P application were obtained (Fig. 1). At $P_0$, N application rate of 100 increased dry matter yield from 1152 kg $ha^{-1}$ up to about 2000 kg $ha^{-1}$ and higher application rates did not provide any response. Another important finding is that at $P_{50}$, there was no response to N. At $P_{100}$ and $P_{150}$. there was no response from $N_0$ to $N_{100}$ but showed a response from $N_{100}$ to $N_{200}$. Also at $N_0$ there was a large response from $P_o$ to $P_{50}$ with no response from $P_{50}$ to $P_{150}$. The N application of $N_{100}$ decreased the response of P, however the rate of $P_{50}$ and $P_{150}$ showed a high response (Fig.1).

Phosphorus and Nitrogen fertilizer might also affect crude protein concentration of the legume, grasses and other plant botanical families. As the N fertilization doses increased, the crude protein concentration of legumes slightly decreased in $P_0$ and $P_{50}$ treatments (Table 3). However, crude protein concentration of legumes increased with increasing N rate in $P_{100}$ and $P_{150}$ treatments. The results of experiment also showed that, enhanced N and P doses increased crude protein ratio of both grasses and other plant families. The averaged crude protein concentration decreased compared to the control plots as the N doses increased. The mean crude protein concentration in both years was 110 g $kg^{-1}$ for control plots while it decreased to 106, 102, 104 and 103 g $kg^{-1}$ in 50, 100, 150 and 200 kg N $ha^{-1}$ applications, respectively, for $P_0$ treatments (Table 3). Crude protein concentrations significantly increased with increasing P fertilizer doses. The maximum crude protein concentration was obtained from $P_{150}$+$N_0$ as 140 g $kg^{-1}$ (Table 3).

**Table 2. Dry weight ratio of legumes, grasses and other plant families related with different fertilizer doses**

| Fertilizer treatments P-N | Legumes 2002 | Legumes 2003 | Legumes Average | Grasses 2002 | Grasses 2003 | Grasses Average | Others 2002 | Others 2003 | Others Average |
|---|---|---|---|---|---|---|---|---|---|
| 0-0 | 3.0 d | 4.0 hi | 3.5 hij | 70.0 efg | 68.6 ef | 69.3 hi | 27.0 a | 27.4 a | 27.2 a |
| 0-50 | 1.4 efg | 6.2 hi | 3.8 hi | 78.6 bcd | 74.0 de | 76.3 efg | 20.0 bc | 19.8 bcd | 19.9 cd |
| 0-100 | 0.6 g | 3.2 i | 1.9 ij | 83.0 abcd | 81.8 bc | 82.4 bcd | 16.4 cd | 15.0 fgh | 15.7 ef |
| 0-150 | 0.4 g | 3.0 i | 1.7 ij | 85.6 ab | 82.0 bc | 83.8 bc | 14.0 de | 15.0 fgh | 14.5 fg |
| 0-200 | 0.2 g | 2.5 i | 1.3 j | 86.8 ab | 85.5 b | 86.2 ab | 13.0 def | 12.0 hij | 12.5 ghij |
| 50-0 | 2.3 def | 26.4 cd | 14.3 d | 88.0 a | 62.0 f | 75.0 def | 9.7 fgh | 11.6 ij | 10.7 jk |
| 50-50 | 2.4 de | 27.0 cd | 14.7 d | 89.0 a | 57.0 i | 73.0 fgh | 8.6 fgh | 16.0 fg | 12.3 ghij |
| 50-100 | 2.5 de | 25.6 d | 14.1 d | 89.0 a | 58.0 cd | 72.0 bc | 8.5 efgh | 16.4 efg | 12.5 fghi |
| 50-150 | 2.2 def | 19.8 e | 11.0 e | 85.0 ab | 59.0 hi | 81.5 gh | 12.8 defgh | 21.2 j | 17.0 ghij |
| 50-200 | 1.2 efg | 14.0 f | 7.6 f | 88.0 a | 75.0 a | 58.5 a | 10.8 h | 11.0 j | 10.9 k |
| 100-0 | 5.4 bc | 30.6 c | 18.0 c | 67.0 g | 50.0 j | 67.0 jk | 27.6 a | 19.4 cde | 23.5 b |
| 100-50 | 3.2 d | 24.6 d | 13.9 d | 76.0 def | 58.0 i | 77.5 i | 20.8 gh | 17.4 def | 19.1 ghi |
| 100-100 | 2.1 def | 15.2 f | 8.6 f | 85.1 ab | 70.0 c | 80.9 bcd | 12.9 def | 14.8 fghi | 13.9 fgh |
| 100-150 | 2.2 def | 12.0 fg | 7.1 f | 85.0 ab | 76.8 cd | 84.4 cde | 12.8 efgh | 11.2 j | 12.0 ijk |
| 100-200 | 1.0 fg | 8.2 gh | 4.6 gh | 90.8 a | 78.0 cd | 55.0 bc | 8.2 gh | 13.8 ghij | 11.0 ijk |
| 150-0 | 7.8 a | 41.6 a | 24.7 a | 68.0 fg | 42.0 k | 59.1 k | 24.2 ab | 16.4 efg | 20.3 c |
| 150-50 | 6.7 ab | 37.0 b | 21.9 b | 71.8 cde | 46.4 jk | 68.5 j | 21.5 b | 16.6 defg | 19.1 cd |
| 150-100 | 5.2 c | 24.0 de | 14.6 d | 75.0 def | 62.0 ghi | 74.2 hi | 19.8 fgh | 14.0 ghij | 16.9 hij |
| 150-150 | 2.8 d | 14.0 f | 8.4 f | 84.5 abc | 64.0 fgh | 76.0 fg | 12.7 defg | 22.0 bc | 17.4 de |
| 150-200 | 2.1 def | 11.2 fg | 6.7 fg | 86.0 ab | 66.0 fg | 73.7 fg | 11.9 defg | 22.8 b | 17.4 de |
| **Average** | **2.7 B** | **17.5 A** | | **81.6 A** | **65.8 B** | | **15.7 B** | **16.7 A** | |

Values within columns with same letter are not statistically significantly ($p<0.05$) different. Values within rows for within each family with same letter are not statistically significantly (***$p<0.05$) different.

**Table 3. Average crude protein concentration of legumes, grasses and other plant families related with different fertilizer doses over two years and average crude protein concentration of forage (g $kg^{-1}$) with ± S.D.**

| Fertilizer treatments P-N | Legumes | Grasses | Others | Average crude protein concentration |
|---|---|---|---|---|
| 0-0 | 160 ± 8.0 | 83 ± 1.9 | 115 ± 2.4 | 110 ±4.2 |
| 0-50 | 160 ± 1.0 | 85 ± 1.6 | 130 ± 2.1 | 105 ± 3.1 |
| 0-100 | 158 ± 1.0 | 87 ± 0.7 | 125 ± 2.9 | 102 ± 5.3 |
| 0-150 | 158 ± 3.0 | 89 ± 2.0 | 119 ± 3.0 | 104 ± 2.7 |
| 0-200 | 159 ± 2.0 | 86 ± 1.7 | 120 ± 2.3 | 103 ± 2.4 |
| 50-0 | 164 ± 4.2 | 81 ± 3.2 | 120 ± 2.8 | 130 ± 3.5 |
| 50-50 | 165 ± 3.8 | 88 ± 1.6 | 130 ± 3.1 | 132 ± 2.9 |
| 50-100 | 163 ± 4.3 | 90 ± 1.4 | 135 ± 2.6 | 128 ± 3.1 |
| 50-150 | 160 ± 3.2 | 93 ± 0.7 | 137 ± 2.2 | 127 ± 6.0 |
| 50-200 | 163 ± 5.1 | 112 ± 1.2 | 140 ± 3.1 | 128 ± 4.2 |
| 100-0 | 165 ± 3.3 | 90 ± 1.3 | 115 ± 3.3 | 138 ± 3.4 |
| 100-50 | 164 ± 2.7 | 89 ± 1.7 | 138 ± 2.7 | 130 ± 3.1 |
| 100-100 | 165 ± 2.6 | 101 ± 1.4 | 140± 3.2 | 135 ± 3.7 |
| 100-150 | 167 ± 4.4 | 104 ± 2.4 | 139 ± 2.4 | 137 ± 2.9 |
| 100-200 | 168 ± 3.7 | 108 ± 2.7 | 145 ± 2.7 | 136 ± 3.2 |
| 150-0 | 166 ± 2.9 | 99 ± 2.6 | 120 ± 3.5 | 140 ± 5.3 |
| 150-50 | 169 ± 3.4 | 102 ± 1.4 | 150 ± 3.2 | 139 ± 4.7 |
| 150-100 | 171 ± 5.3 | 110 ± 2.3 | 165 ± 2.3 | 138 ± 3.4 |
| 150-150 | 180 ± 4.7 | 111 ± 1.7 | 169 ± 2.7 | 137 ± 3.8 |
| 150-200 | 184 ± 3.3 | 113 ± 1.3 | 167 ± 3.4 | 135 ± 2.9 |

Enhanced P and N fertilization doses significantly increased crude protein production (Fig. 2). However at $P_{150}$ the crude protein yield was increased. The average crude protein yield was 126.7 kg $ha^{-1}$ in control plots and maximum crude protein yield was obtained from $P_{150}$+$N_{200}$ treatments as 464.1 kg $ha^{-1}$ (Fig. 2).

Economical analysis of two years results showed that fertilization with N and P is profitable. The net profit obtained from the treatments can depend on fertilizer doses and net return obtained from the crude protein that converts to meat on the hoof in cow-calf. The $P_{150}$+$N_{200}$ treatment was most profitable treatment and provide average of 644 € $ha^{-1}$ benefit (Fig. 3).

## Discussion

Phosphorus and Nitrogen fertilization significantly affected composition of plants. N fertilization reduced legume proportion, however, P increases the proportion of legume in vegetation and similar results were reported by Sengul, (2003); Keane & Allen, (1999); Aydin & Uzun, (2005). Carene *et al.*, (1984) reported that while the application of 50 and 100 kg $ha^{-1}$ N increased the root density of legumes, but high doses of N decreased densities of legumes. P fertilizers can increase the proportion of legumes with lower than (50 kg $ha^{-1}$) doses of N.

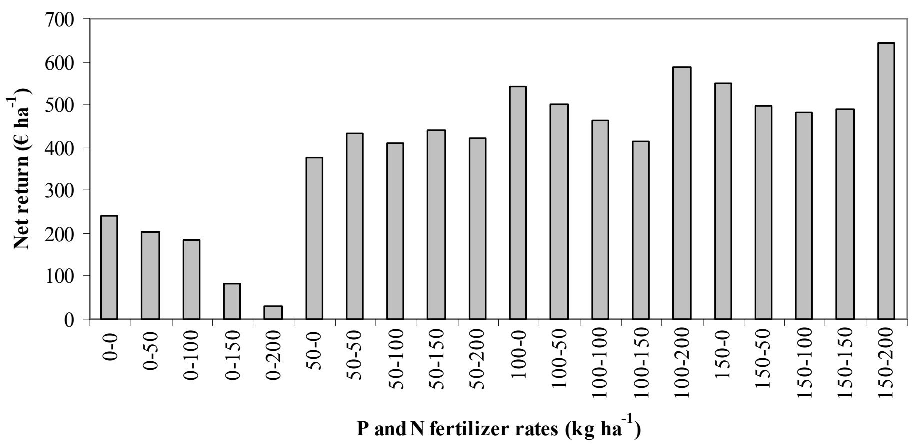


Fig. 3. Net return obtained from different fertilization rate for rangeland.

Based on the results, the reduction in legume proportion related with increased N could hardly be prevented with 50 kg ha$^{-1}$ or higher P application (Table 2). It was assumed that the decreased legume dry weight ratio in relation with N applications was due to higher utilization of N by the grasses. The ability of a certain species to utilize the available resources in prevailing environmental conditions depends on their high and efficient use of environmental conditions. Those species could grow faster. Hence the species with high coverage must have physiological advantage over other species (Bukun, 2004; Bukun & Guler, 2005). Nitrogen fertilizers have positive effect on the growth of grasses. Thus, it can be more competitive than legumes. Legumes are preferentially for forage compared to grasses (Dove, 1996; Wright *et al*., 2004). These findings agree with the results of previous studies (Carene *et al*., 1984; Sengul, 2003; Aydin & Uzun, 2004; Wright *et al*., 2004). Aydin & Uzun (2005) who proposed that the decrease of legume proportion due to N application can not be prevented with 52 kg ha$^{-1}$ P. However, results of our study showed that 50 kg ha$^{-1}$ P would be enough to prevent the reduction in legume proportion. This difference may be related with ecological differences and plant composition. There were considerable differences between years in herbage composition and their dry weight ratio (***$p<0.0001$).

Dry weight ratios of legumes in 2003 were higher than 2002. Those differences mainly resulted from lower precipitation in first year (Table 1) and especially the effect of fertilization appeared on plant growth in the second year. Legumes were better in utilizing P fertilizer and as a result it increased their growth. Density of weeds occupying a certain area depends upon many factors and varies according to season of year such as precipitation, temperature etc., type of crops, climatic conditions, soil type, fertilizer level (Nasir & Sultan, 2004).

The dry weight ratio of legumes was 2.1 and 5.7% in control plots in 2002 and 2003, respectively. These ratios increased with 150 kg ha$^{-1}$ P fertilizer application to 7.8 and 41.6% in 2002 and 2003, respectively (Table 2). As the P fertilizer doses increased, the legume dry weight proportion also increased, while the dry weight proportion of other plant families decreased (Table 2). These findings are in agreement with the results of Keane & Allen (1999); Sengul (2003), and Aydin & Uzun (2005). The reasons for lower legume dry weight ratio in our study compared to pervious studies might be due to low precipitation (Table 1). In general the growths of legumes are related with available precipitation rate.

Mean crude protein concentration in the forage dry matter of two years was 110 g $kg^{-1}$ in control plots close to 120 g $kg^{-1}$ reported by Aydin & Uzun (2005). This difference was probably related to lower legume dry weight ratio in the study. Legumes are greatly increased in crude protein concentration of forages (Sengul, 2003). When P fertilization was applied alone, crude protein concentration increased because of increased legume proportion which has high crude protein content. However, as the N rate increased, crude protein concentration of grass and other plant families as well increased (Table 3). Despite, this increase did not increase the crude protein concentration of forage. Moreover, crude protein ratio decreases with increasing N doses. The maximum crude protein concentration was obtained from 150 kg $ha^{-1}$ P fertilizer application alone and it was continued to decrease with increasing N rate.

Forage that contains 125 g $kg^{-1}$ crude protein classified high quality for the animal feeding (Yıldız, 2001). This is the key finding of this study, because previous studies did not perform so wide range doses of both N and P fertilizers. The forage obtained from this study for the rate of 150 kg $ha^{-1}$ P application was more valuable for the animal production.

Crude protein production and dry matter yield increase with increasing both N and P fertilization. The fertilization with N and P effect the botanical composition of rangeland, thus dry matter yield was affected by change of the plant composition which influences the crude protein yield. The results of treatments of $P_0$ and $P_{50}$ showed that the increased doses of N for 100 kg $ha^{-1}$ or more reduced the dry matter yield. However, sharply increases were determined for treatments of $P_0$ and $P_{50}$ at the 100 kg $ha^{-1}$ and higher doses of N applications. These result supports the conclusion of compensate effect of P as 50 kg $ha^{-1}$ or more doses to tolerate adverse effect of N fertilization on forage yield (Fig. 1).

Crude protein yield of forage on rangeland was linearly increased with increasing N doses for $P_0$ and $P_{50}$ treatments. But these increases did not reach a level that supply sufficient crude protein content. In contrast, the doses of 100 and 150 kg $ha^{-1}$ P have sharply increased the crude protein content for 150 and 200 kg $ha^{-1}$ N applied treatments. The doses of 100 and 150 kg $ha^{-1}$ P fertilizer positively effect the legume growth and their proportion as a result the protein yield was increased. It can be concluded that high crude protein yield was obtained from increased doses of fertilizer that effects dry matter yield. Higher crude protein yield and dry matter were obtained from $P_{150}$+$N_{200}$ treatment as 464.1kg $ha^{-1}$ protein yield and 3407 kg $ha^{-1}$ dry matter yield. Additive phosphorus fertilizer application doses of 50 kg $ha^{-1}$ or more can tolerate the adverse effect of nitrogen fertilization on forage quality in respect of protein concentration of forage dry matter.

In economic perspective, N applications decrease the benefit of forage while N and P application together increase the net return. The maximum benefit was obtained from $P_{150}$+$N_{200}$ treatment. The most profitable treatment was $P_{150}$+$N_{200}$ and average of 644 € $ha^{-1}$ benefit was obtained from this rate of fertilizer doses.

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