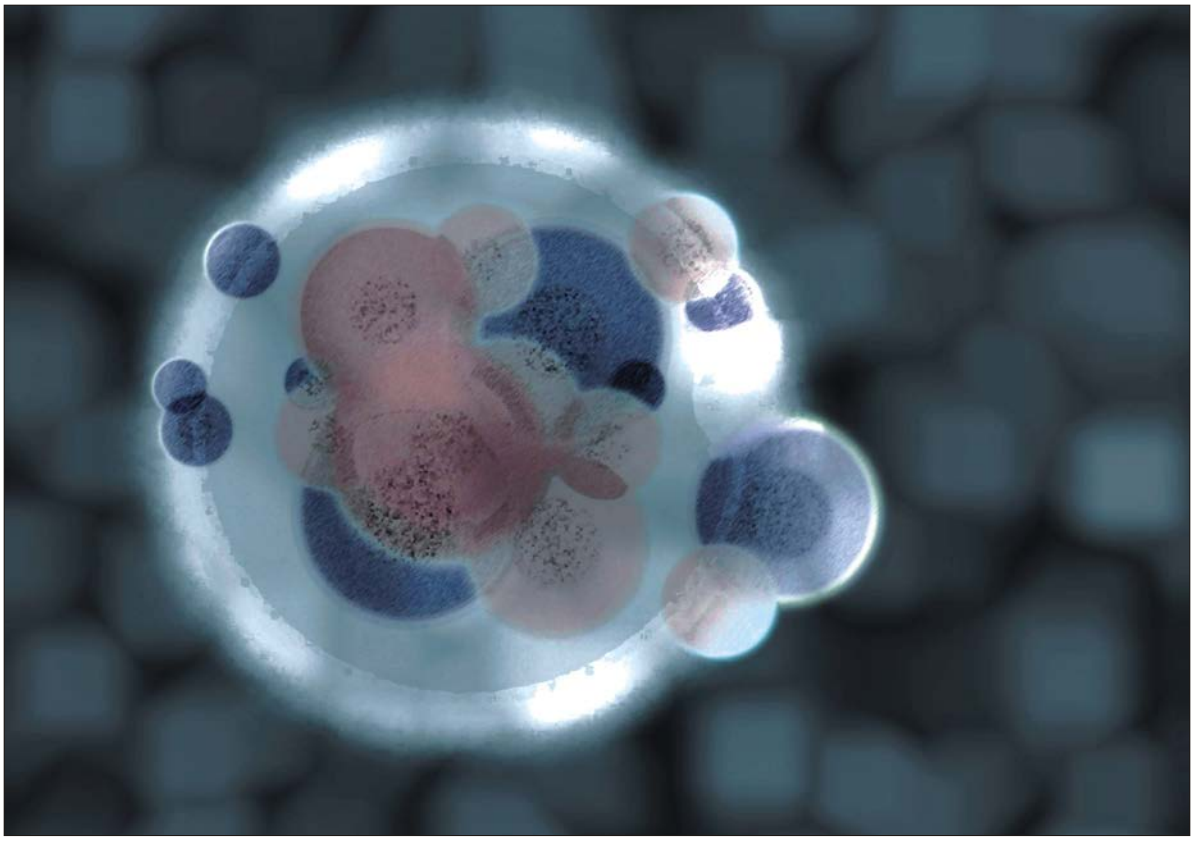

Journal of Biological Sciences

ISSN 1727-3048

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Journal of Biological Sciences, 6 (1): 76-81, 2006
ISSN 1727-3048

Nitrogen and Phosphorus Fertilization Effects on Yield Responses of Some Vetch Species

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Abstract: This study was carried out to determine major differences in yield (herbage yield, dry matter yield, biological yield and crude protein yield) response to some Nitrogen (0, 2, 4 and 6 kg da^{-1}) and Phosphorus doses (0, 4, 8 and 12 kg da^{-1}) between Hungarian and Hairy vetch species. The experiment was laid out in a randomized complete block design with three replications. Test results indicated significant differences between vetch species in terms of herbage yield, dry matter yield, biological yield and crude protein yield. The highest herbage and dry matter yield were obtained from Hungarian vetch in fertilized plots (6 kg da^{-1} nitrogen 4 kg da^{-1} phosphorus applications). The lowest herbage and dry matter yield were obtained from Hairy vetch in nonfertilizer plots. In terms of biological yield, the highest yield were obtained from Hungarian vetch with 2 kg da^{-1} nitrogen and 8 kg da^{-1} phosphorus applications and the lowest yield were obtained from Hairy vetch by control plots. Generally, herbage and dry matter yield responses of vetches were increased by Nitrogen and Phosphorus rates.

Key words: Hungarian vetch, Hairy vetch, herbage yield, dry matter yield, biological yield, crude protein yield

INTRODUCTION

Nitrogen and phosphorus are essential elements for plant growth. Nitrogen is very important for efficiency and quality in dry feed plants. Protein is also a vital element for plant growth and development as it is the keystone of amino and nucleic acids. Phosphorus is a necessary element for photosynthesis, energy synthesis and transfer, carbohydrate metabolism, nitrogen fixation and root development in seedling period[1].

In plants world, leguminous plants (leguminosae) are known by their lowest nitrogen requirement. Leguminous plants obtain some parts of the nitrogen they need from free nitrogen in air by Rhizobium bacterias that are in the soil. But until the bacterias become active, plants must receive nitrogen from the soil. Plants receive the highest portion of phosphorus from soil solution and the rest from the rigid phase of the soil[2]. The vetches in leguminosae feed plants are grown up in wide fields and preferred by the animal feeders[3]. As vetch is an annual plant that can grow in cold and mild climates[4], its weeds are high quality, delicious and nutritive and its grains possess high ratios of raw protein.

The vetch straw provided (obtained) after the harvest and blending (thresting) is delicious, nutritive and a good animal feed[5]. Because of different environment conditions and genetical structure, the vetches need different fertilizer doses for maximum growth and yield in different ecological areas. Among the vetch species, the Hungarian vetch and Hairy vetch can withstand to winter conditions and they are sowed widely in the world. It is reported that Common vetch, Hungarian vetch and Hairy vetch species must be fertilized with 8 kg da^{-1} P_2O_5 dose for high quality hay production and mineral components[6] and for increasing root and stem growth[7]. In Hungarian vetch, low levels of nitrogen fertilizer application to increase herbage and grain efficiency makes phosphorus fertilizers more effective. The highest herbage, dry herbage and grain yield were obtained with 8 kg da^{-1} N and 20 kg da^{-1} P_2O_5 doses[8]. In Persian clover that is an annual legume, the highest crude protein and dry herbage yield were found by 4 kg da^{-1} P_2O_5 doses[9].

This study was aimed to find out optimum Nitrogen (N) and Phosphorus (P) doses for the Hungarian and Hairy vetch in Isparta ecological conditions.

MATERIALS AND METHODS

This study was carried out at Süleyman Demirel University, Agricultural Faculty Research and Application Farm in Isparta in the winter of 1999-2000 and 2000-2001. Summers are hot and winters are cold with occasional

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frosts events in January. It rained 309.0 mm in the first year and 278.6 mm in the second year in the research area. The distribution of the rain by months has been differentiated during the vegetation period (between November and July)[10]. The texture of the land in the research area was silty-loam, its pH value was neutral and convenient phosphorus and potassium ratio contained high and medium organic material.

The experiment was laid out in a Randomized Complete Block Design with three replications. Vetch species were sown with 35 cm row to row distance by hand pulled drill in 4-5 cm depth as 6 rows with a seed rate of 230 plants in one square meter. Four nitrogen (0, 2, 4 and 6 kg N da^{-1}) and four phosphorus fertilizer levels (0, 4, 8, 12 kg P_2O_5 da^{-1}) were applied on Hungarian vetch and Hairy vetch. The trial was sowed on 04.11.1999 in the first year and on 01.11.2000 in the second year. Herbicide (pre-emergence Linurex 50 WP, 200 g da^{-1}) was applied against the herbs. No irrigation was applied throughout the study period. The plot area was 10.8 m^2 (6 x 0.3m x 6m) and the total trial area was 1036.8 m^2 (3x10.8 m^2 x 32). An area of 0.5 m^2 at the beginning and at the end of the plots and one row outside of the study area was excluded. Plots were harvested at the beginning of June for herbage production. Herbage yield was determined by measuring plants in the plots by reaping, weighing and converting the values into kg da^{-1}. Dry matter proportion was determined in three steps. Firstly, 100 g herbage sample, taken from each parcel randomly, were dried in air, then the samples were placed in an oven at 105°C until the weights were fixed. Finally, the samples were weighed and compared with wet samples. Dry matter yield (kg da^{-1}) calculated by multiplying herbage yield and dry matter proportion in each p arcel and then the results were converted into kg da^{-1}. The dried plant material was used for determination of crude protein content using Kjeldahl method. Crude protein values were obtained by multiplying crude protein proportions by dry matter values of the parcels[2] and by converting these values into kg da^{-1}. Biological yield was determined by harvesting and weighting plants in plots during the physiological maturity and converting the values into kg da^{-1}. Data were analyzed by MSTAT-C statistical program and the means were separated using Least Significant Difference (LSD) range test [11].

RESULTS AND DISCUSSION

Statistically significant differences were found between vetch species, between fertilizer doses and between interactions regarding vetch species and doses in terms of herbage yield (Table 1). While the two year average herbage yield was 2039.4 kg da^{-1} in Hairy vetch, Hungarian vetch showed higher performance with average herbage yield of 2260.0 kg da^{-1}. Herbage yield per decare has increased quickly between 0 and 4 kg da^{-1} phosphorus doses and this increase was not statistically significant. The effects of the phosphorus on herbage yield were different on vetch species. The herbage yield has increased by the dose of the 8 kg phosphorus application per decare in Hairy vetch. The highest herbage yield was obtained by 4 kg phosphorus per decare in Hungarian vetch. With the increase of the nitrogen doses, herbage yield between 0 and 6 kg da^{-1} doses has increased gradually. This increase was significant up to the 4 kg nitrogen dose per decare. However, the increase between the plots (applied between 4 and 6 kg nitrogen) was not statistically significant. The highest herbage yield were obtained in Hairy vetch with 6 kg da^{-1} N and 12 kg da^{-1} P_2O_5 doses and in Hungarian vetch with 6 kg da^{-1} N and 4 kg da^{-1} P_2O_5 doses. Results on herbage yield of Hungarian vetch and Hairy vetch are partially consistent with the results of previous researches[6,8]. This may be because of ecological factors and cultivars' genetic structure. The effect of the nitrogen on herbage yield has been evaluated between vetch species. Yield potentials of the species and their reactions to applied fertilizer rates can cause the differences in average herbage yield of the species and fertilizer rates.

The applied nitrogen and phosphorus rates and the effects of their interactions on dry matter yield were statistically significant between vetch species. The average dry matter yield of the species was increased proportionally with increase in nitrogen rates (Table 2). According to the nitrogen rates used for both species, the average dry matter yields for two years was between 362.4-619.3 kg da^{-1} in Hairy vetch and was between 419.3-628.6 kg da^{-1} in Hungarian vetch. The lowest dry matter yield was obtained from the plots where nitrogen was not applied. The highest dry matter yield in Hairy vetch obtained with 6 kg da^{-1} nitrogen and 12 kg da^{-1} phosphorus application. The lowest dry matter yield in Hungarian vetch was obtained with 0 kg da^{-1} nitrogen and 8 kg da^{-1} phosphorus application. Generally, dry matter yield increased when nitrogen and phosphorus rates were increased. The average dry matter yield of the plots was changed with species and fertilizer rates. Results on dry matter yield of Hungarian vetch and Hairy vetch were consistent with the results stated by some researchers[7-9].

Table 1: Herbage yield of two vetch species treated by different nitrogen and phosphoms doses (kg da^{-1})

		2000 Year Nitrogen doses (kg N da^{-1})				
Phosphorus doses (kg P_2O_5 da^{-1})		N_0	N_2	N_4	N_6	Average
Hairy vetch	P_0	1488.7	1614.0	1960.0	2208.3	1817.8
	P_4	1550.7	1993.7	2430.0	2190.0	2041.1
	P_8	2173.3	2306.7	2286.7	2353.3	2280.0
	P_{12}	2038.7	2039.0	2583.3	2644.3	2326.3
	Average	1812.8	1988.3	2315.0	2349.0	2116.3
Hungarian vetch	P_0	2066.7	2300.0	2431.7	2660.0	2364.6
	P_4	2066.7	2700.0	2463.3	2822.0	2513.0
	P_8	2100.3	2320.0	2420.7	2250.0	2272.8
	P_{12}	2120.0	2221.7	2426.0	2383.3	2287.8
	Average	2088.4	2385.4	2435.4	2528.8	2359.5
		2001 year				
Hairy vetch	P_0	1358.3	1537.0	1797.7	2092.0	1696.3
	P_4	1452.0	1880.0	2266.0	2074.0	1918.0
	P_8	2032.0	2160.0	2113.3	2142.7	2112.0
	P_{12}	1877.7	1849.3	2288.3	2479.0	2123.6
	Average	1680.0	1856.6	2116.3	2197.0	1962.5
Hungarian vetch	P_0	1853.3	1983.0	2253.3	2340.0	2107.4
	P_4	1860.0	2521.7	2317.0	2695.3	2348.5
	P_8	1925.3	2134.3	2175.7	2154.3	2097.4
	P_{12}	1878.3	2072.7	2232.7	2169.7	2088.3
	Average	1879.3	2177.9	2244.7	2339.8	2160.4
		Two years average				
Hairy vetch	P_0	1423.5q	1575.5p	1878.8o	2150.2i-k	1757.0
	P_4	1501.3pq	1936.8no	2348.0efg	2132.0j-m	1979.5
	P_8	2102.7k-m	2233.3g-jk	2200.0h-k	2248.0g-j	2196.0
	P_{12}	1958.2no	1944.2no	2435.8cde	2561.7bc	2225.0
	Average	1746.4	1922.5	2215.7	2273.0	2039.4
Hungarian vetch	P_0	1960.0no	2141.5jkl	2342.5efg	2500.0bcd	2236.0
	P_4	1963.3no	2610.8b	2390.2def	2758.7a	2430.8
	P_8	2012.8lmn	2227.2g-jk	2298.2fgh	2202.2h-k	2185.1
	P_{12}	1999.2mno	2147.2ijk	2329.3e-h	2276.5f-I	2188.0
	Average	1983.8	2281.7	2340.1	2434.4	2260.0

LSD %1 (Species x Phosphorus x Nitrogen): 133.7

Table 2: Dry matter yield of two vetch species treated by different nitrogen and phosphorus doses (kg da^{-1})

		2000 Year Nitrogen doses (kg N da^{-1})				
Phosphorus doses (kg P_2O_5 da^{-1})		N_0	N_2	N_4	N_6	Average
Hairy vetch	P_0	313.0z	446.0u-y	548.7i-o	640.0de	486.9
	P_4	326.3z	458.3t-x	648.3cde	518.3n-s	487.8
	P_8	427.0xyz	481.0r-v	517.3n-s	620.0d-g	511.3
	P_{12}	434.7v-z	510.0o-s	689.3bc	793.3a	606.8
	Average	375.3	473.8	600.9	642.9	523.2
Hungarian vetch	P_0	474.7s-w	574.0g-k	592.0f-i	691.7bc	583.1
	P_4	413.3xyz	620.7d-g	565.3h-m	762.0a	590.3
	P_8	413.0xyz	541.3j-p	588.7f-j	564.0h-n	526.8
	P_{12}	431.3w-z	518.3m-s	630.3df	627.0df	551.8
	Average	433.1	563.6	594.1	661.2	563.0
		2001 year				
Hairy vetch	P_0	293.3z	436.0v-z	539.3l-q	605.7e-h	468.6
	P_4	303.3z	404.3yz	604.0e-h	499.7p-t	452.8
	P_8	414.7xyz	454.7t-x	492.0q-u	566.3h-l	481.9
	P_{12}	386.7z	566.3h-l	644.3cde	711.0b	577.1
	Average	349.5	465.3	569.9	595.7	495.1
Hungarian vetch	P_0	434.7v-z	540.0k-p	575.0g-k	650.0cde	549.9
	P_4	392.7z	587.7f-j	539.0l-q	655.0cd	543.6
	P_8	370.3z	524.0l-r	550.3i-o	511.7o-s	489.1
	P_{12}	424.0xyz	477.0r-w	566.0h-l	567.3h-l	508.6
	Average	405.4	532.2	557.6	596.0	522.8

Table 2: Continue

Phosphorus doses (kg P_2O_5 da^{-1})		2000 year Nitrogen doses (kg N da^{-1}) N_0	N_2	N_4	N_6	Average
		Two years Average				
Hairy vetch	P_0	303.2	441.0	544.0	622.8	477.8
	P_4	314.8	431.3	626.2	509.0	470.3
	P_8	420.8	467.8	504.7	593.2	496.6
	P_{12}	410.7	538.2	666.8	752.2	592.0
	Average	362.4	469.6	585.4	619.3	509.2
Hungarian vetch	P_0	454.7	557.0	583.5	670.8	566.5
	P_4	403.0	604.2	552.2	708.5	567.0
	P_8	391.7	532.7	569.5	537.8	507.9
	P_{12}	427.7	497.7	598.2	597.2	530.2
	Average	419.3	547.9	575.8	628.6	542.9

LSD %1 (Year x Species x Phosphorus x Nitrogen): 47.55

Table 3: Biological yield of two vetch species treated by different nitrogen and phosphorus doses (kg da^{-1})

Phosphorus doses (kg P_2O_5 da^{-1})		2000 year Nitrogen doses (kg N da^{-1}) N_0	N_2	N_4	N_6	Average
Hairy vetch	P_0	216.3z	277.0z	337.7w-z	387.3r-v	304.6
	P_4	355.0u-x	470.7d-k	511.0a-e	515.0a-d	462.9
	P_8	481.0c-j	514.3a-d	537.0ab	488.3c-j	505.2
	P_{12}	401.7o-t	456.0h-n	499.7a-g	403.7o-t	440.3
	Average	363.5	429.5	471.3	448.6	428.3
Hungarian vetch	P_0	305.3yz	418.0m-s	436.0k-p	510.7a-e	417.5
	P_4	381.0s-w	489.7c-j	506.0a-f	509.7a-e	471.6
	P_8	461.0f-m	538.3a	496.0a-g	453.7i-n	487.3
	P_{12}	375.3s-x	435.7l-q	492.0b-i	524.0abc	456.8
	Average	380.7	470.4	482.5	499.5	458.3
		2001 year				
Hairy vetch	P_0	216.7z	257.0z	345.0v-y	367.0t-x	296.4
	P_4	335.0xyz	428.0l-r	502.3a-g	496.0a-g	440.3
	P_8	445.3j-o	485.0c-j	466.3e-l	411.7n-t	452.1
	P_{12}	375.3s-x	427.0l-r	483.3c-j	373.0s-x	414.7
	Average	343.1	399.3	449.3	411.9	400.9
Hungarian vetch	P_0	293.3z	395.3p-u	401.7o-t	455.7h-n	386.5
	P_4	346.3v-y	438.0k-p	459.3g-m	470.7d-k	428.6
	P_8	392.3q-u	495.3a-g	451.3i-n	516.0abc	463.8
	P_{12}	342.0wxy	392.7q-u	454.0i-n	487.3c-j	419.0
	Average	343.8	430.3	441.6	482.4	424.5
		Two years Average				
Hairy vetch	P_0	216.5	267.0	341.3	377.2	300.5
	P_4	345.0	449.3	506.7	505.5	451.6
	P_8	463.2	499.7	501.7	450.0	478.6
	P_{12}	388.5	441.5	491.5	388.3	427.5
	Average	353.3	414.4	460.3	430.3	414.6
Hungarian vetch	P_0	299.3	406.7	418.8	483.2	402.0
	P_4	363.7	463.8	482.7	490.2	450.1
	P_8	426.7	516.8	473.7	484.8	475.5
	P_{12}	358.7	414.2	473.0	505.7	437.9
	Average	362.1	450.4	462.0	491.0	441.4

LSD %1 (Year x Species x Phosphorus x Nitrogen): 45.27

The highest biological yield was obtained from the plot where 8 kg phosphorus was applied per decare (Table 3). In terms of biological yield, while the effects of phosphorus doses on Hairy vetch are much more clear than Hungarian vetch. The highest biological yield in Hairy vetch was obtained by 4 kg da^{-1} nitrogen rates. However, the biological yield in Hungarian vetch reached its maximum level when 6 kg da^{-1} nitrogen was applied. While the biological yield of phosphorus in Hairy vetch is much clearer, it was not observed in Hungarian vetch (Table 3). The lowest biological yield was obtained for both species when fertilizers were not used. Some researchers stated that use of nitrogen and phosphorus increases the biological yield[7,8]. The data collected in this study confirms their results.

Table 4: Crude protein yield of two vetch species treated by different nitrogen and phosphorus doses (kg da^{-1})

		2000 year Nitrogen Doses (kg N da^{-1})				
Phosphorus Doses (kg P_2O_5 da^{-1})		N_0	N_2	N_4	N_6	Average
Hairy vetch	P_0	51.3	70.0	89.5	105.9	79.2
	P_4	45.8	60.0	93.7	67.5	66.7
	P_8	56.5	66.8	78.2	120.5	80.5
	P_{12}	58.3	77.1	102.0	116.6	88.5
	Average	53.0	68.5	90.8	102.6	78.7
Hungarian vetch	P_0	85.2	98.3	100.0	106.0	97.5
	P_4	64.3	97.1	94.0	123.3	94.7
	P_8	53.5	89.4	107.1	92.4	85.6
	P_{12}	70.5	78.0	87.6	83.8	80.0
	Average	68.4	90.8	97.2	101.4	89.5
		2001 year				
Hairy vetch	P_0	49.6	66.4	77.2	99.0	73.1
	P_4	46.4	46.1	89.8	71.1	63.4
	P_8	50.8	63.6	71.9	106.0	73.1
	P_{12}	53.6	69.8	91.1	103.7	79.5
	Average	50.1	61.5	82.5	95.0	72.3
Hungarian vetch	P_0	79.3	95.6	87.9	96.3	89.8
	P_4	58.1	84.2	80.7	113.8	84.2
	P_8	48.6	80.6	95.5	84.1	77.2
	P_{12}	66.7	72.3	80.2	77.1	74.1
	Average	63.2	83.2	86.1	92.8	81.3
		Two years Average				
Hairy vetch	P_0	50.5pq	68.2lmn	83.4g-j	102.5bc	76.1
	P_4	46.1q	53.1opq	91.7d-g	69.2lmn	65.0
	P_8	53.6opq	65.2mn	75.0jkl	113.3a	76.8
	P_{12}	55.9op	73.4klru	96.6cde	110.2ab	84.0
	Average	51.5	65.0	86.7	98.8	75.5
Hungarian vetch	P_0	82.3hij	97.2cd	94.0c-f	101.2d	93.6
	P_4	61.2no	90.7d-h	87.5f-i	118.5a	89.5
	P_8	51.0pq	85.0ghi	101.3c	88.3e-i	81.4
	P_{12}	68.6lmn	75.2jkl	83.9ghi	80.5ijk	77.0
	Average	65.8	87.0	91.6	97.1	85.4

LSD %1 (Species x Phosphorus x Nitrogen): 8.528

In terms of crude protein yield, significant differences were found between the average values of the species. The nitrogen-phosphorus interaction was not statistically significant, but the effects of the other interactions related with the crude protein yield were significant. The average crude protein yield in Hairy vetch was 75.5 and 85.4 kg da^{-1} in Hungarian vetch (Table 4). Crude protein yield in Hairy vetch of the phosphorus doses and nitrogen doses was between 65.0-84.0 kg da^{-1} and 51.5-98.8 kg da^{-1} and in Hungarian vetch it was between 77.0-93.6 kg ha^{-1} and 65.8-97.1 kg da^{-1} rankingly (Table 4). The differences between crude protein yields can appear from the crude protein rates and dry matter yields related with the nitrogen and phosphorus rates.

It was found that the amount of nitrogen and Phosphorus doses applied significantly effected dry matter yield, biological yield and crude protein yields in Hairy vetch and Hungarian vetch species. The highest herbage and dry matter yield were obtained from Hungarian vetch with 6 kg da^{-1} nitrogen and 4 kg da^{-1} phosphorus applications. The lowest herbage and dry matter yield were obtained from Hairy vetch in nonfertilizer plots. The highest biological yield were obtained from Hungarian vetch with 2 kg da^{-1} nitrogen and 8 kg da^{-1} phosphorus applications and the lowest yield were obtained from Hairy vetch by control plots. The increase in nitrogen and phosphorus rates increases the herbage and dry matter yield responses of vetches. Results on green, dry matter, biological and crude protein yield of Hungarian vetch and Hairy vetch are partially consistent with the results stated by some researchers[6-8] This may be because of ecological factors and cultivars' genetic structure. Generally it is observed that yield values of Hungarian vetch was higher than Hairy vetch.

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