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The Effects of Different Level of Nitrogenous and Phosphorus Doses on Herbage Yield and Yield Components of Silage Maize as the Second Crop under the Ecological Conditions of Tokat

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ABSTRACT

Nitrogen and phosphorus play a pivotal role in the crop growth and yield. This research was conducted to determine the effects of different nitrogenous (0, 60, 120, 180, 240 kg N ha^{-1}) and phosphorus doses (0, 60, 120 kg P_2O_5 ha^{-1}) on a plant length, leaf number, herbage yield, dry matter yield, harvest index, leaf nitrogen content, stalk nitrogen content, cob nitrogen content, leaf phosphorus content, stalk phosphorus content, cob phosphorus content, leaf crude protein content, stalk crude protein content, cob crude protein content in silage maize cultivar (MF-714 FAO 500) as the second crop in the experimental field of the Agricultural Faculty of Gaziosmanpaşa University in Tokat Conditions during the years of 2003-04. It was shown that nitrogen dose of 240 kg ha^{-1} and phosphorus dose of 120 kg ha^{-1} were a suitable combination for maximum herbage yield according to regression analysis.

Key Words: nitrogenous, phosphorus, silage maize.

INTRODUCTION

Maize is one of the alternative plants decreased excessive pasture in meadow pasture areas. Maize silage is important a crop provided roughage to ruminants. Nitrogen is an important nutrient that affects the yield and quality traits of this crop. (Russel and Balko, 1980). Maize, grows more rapidly in first growth stage and completes more early vegetatif growth if there was nitrogen in soil (Ülger, 1998; Uslu, 1999). Thus maize, is produce a high-quantity of dry matter, leaves and grain (Ülger et al., 1987). The reaction of silage maize to different nitrogen doses was studied by some researchers (Cox et al., 1993; Kara et al., 1999; Saruhan, 2002; Yılmaz, 2005). Yılmaz (2005) reported that the nitrogen dose had a significant effect on most of the yield component of silage maize and that the highest herbage yield, dry matter yield and harvest index was obtained at the nitrogen dose (200 kg N ha^{-1}). Phosphorus is another important nutrients that affects the yield and quality traits of silage maize (Kogbe and Adediran, 2003). Phosphorus has increased growth and development of cereals when uptake early stage in plants (Matarn and Brown, 1989). Maize that is grown on soils adequate in phosphorus is arrived earlier tasselling and silking stages and reached earlier harvest (Hofner and Krantz, 1951). The existence of sufficient phosphorus in soils in early growth stage of plant plays a pivotal role in forming of reproduction members (Güzel ve ark., 2002). Phosphorus taken in early stage by maize increase to harvest index and yield (Barry and Miller, 1989). Many researchers (Lönharn-Bary and Nemeth, 1989; Barriere and Traineau, 1986) have reported that leaf number increase with phosphorus application therefore that herbage yield increased. Öktem and Ülger (1998), evaluated the effects of 4 phosphorus doses (ranging from 40 to 160 kg P_2O_5 ha^{-1}) on the use efficiency of phosphorus in maize reporting that optimum crop growth appeared at phosphorus dose 80 kg P_2O_5 ha^{-1}. Kogbe and Adediran (2003), reported that increasing available phosphorus dose in soil decrease the use efficiency of phosphorus in maize. Selection of the most appropriate dose of N and P fertilization is a major two factor affecting the yield of corn (Cerrato and Blackmer, 1990).

The objective of this study was to evaluate the effects of nitrogen and phosphorus doses on yield and yield components of silage maize growing as a second crop under Tokat conditions.

MATERIAL and METHODS

This study was conducted in the experimental area Faculty of Agriculture, University of Gaziosmanpaşa, Tokat, (40^0 18' N, 36^0 34'E, altitude 608 m) Turkey during the 2003-2004 cultivation seasons. Weather conditions of the experimental area during the cultivation seasons are given in Table 1 (Anonymous, 2006). The soil of experimental area was a clay loam; pH: 7.49; available P: 6.7 kg P_2O_5 da^{-1}; organic matter: 0.75%, lime: 12.66%. The experimental design was a randomized complete block in a split plot arrangement with 4 replications. N rates (0, 60, 120, 180, 240 kg ha^{-1}) were the main plots, P rates (0, 60, 120 kg ha^{-1}) were the split- plots in the experiment. Phosphorus (as triple superphosphate) and half of the N (as ammonium nitrate) was added as a band at planting, and the other half of the N was added when the plants were about 50-60 cm high. All plots consisted of 5 rows that were 4 m long, with 60cm between row spacing. Sowing dates were July 9, 2003 in the first year; July 20, 2004 in the second year. Plants were collected by randomly selecting ten whole plants within the plot area at R3-R4 stage (Ritchie and Hanway, 1984) and were split into leaf, stalk and ear fractions. The samples were washed with deionized water, dried at 60 ^{0}C for 48 h, and ground using a silica grinder to pass a 0.5-mm sieve (Cox et al., 1993). The samples were dry-ashed and extracted with 0.3 N HCl solution to determine selected nutrients (Walsh and Beaton, 1973). Data were analyzed using the standard analysis of variance (ANOVA) technique and means were seperated using the comparisons based upon the least significant difference (LSD) using the MSTAT-C statistical analysis package. Also, regression equations were fitted for herbage yield, as a function of N dose and P dose by the General Linear Models (GLM) produce of Minitab.

Table 1. Monthly mean temperature accumulated precipitation and mean relative humidity in each site year in the maize growing seasons (May through October)

Month	Temperature (^{o}C)		Precipitation (mm)		Relative humidity (%)	
	2003	2004	2003	2004	2003	2004
May	17.0	14.9	11.8	48.0	64.6	74.2
June	18.2	18.7	11.4	27.2	66.8	78.6
July	21.7	20.6	1.4	0.4	64.6	68.0
August	21.2	21.9	0.2	4.8	66.5	73.6
September	16.9	16.8	37.8	0	77.6	72.8
October	13.9	13.2	72	0.4	79.4	76.4
Average	18.2	17.7	134.6	80.8	69.9	73.9

RESULTS and DISCUSSION

The nitrogen application significantly increased the plant height in terms of the average of the two years (Table 2). The lowest plant height was obtained from the control (187.8 cm) while the highest plant height was obtained from application of 180 kg N ha^{-1} (231.7 cm). Some researchers have reported that the plant height increased with N application in silage maize (Flesch and Viera, 2000; Turgut, 2000; Kara, 2006). Phosphorus doses were also effect plant height. The values for plant height ranged from 214.2 to 221.4 cm. The highest plant height (221.4 cm) was obtained at application of 60 kg P_2O_5 ha^{-1}.

The leaf number values increased from the 0 (12.4 number $plant^{-1}$) to 180 kg N ha^{-1} (12.9 number $plant^{-1}$) nitrogen doses. The highest leaf number was obtained with of application 180 kg N ha^{-1} (12.9 number $plant^{-1}$, Table 2). Our findings are confirmed by Yılmaz (2005) , who concluded that increased N rates increased leaf number in silage maize. Phosphorus doses were not affected on leaf number.

Dry matter yield results are presented in Table 2. Considerable difference existed among N doses with respect to dry matter yield. The highest dry matter yield was obtained at nitrogen dose of 240 kg N ha^{-1} (1601.3 kg da^{-1}). The findings here support the data published by Cox et. al. (1993); Cox and Cherney (2001) who reported that rising nitrogen doses increase the dry matter yield. O'Leary and Rehm (1990) explained that there has been linear relation between dry matter yield and nitrogen doses. No differences occured among the phosphorus doses in dry matter yield (Table 2). The mean dry matter yield varied between ranged from 1291.1 to 1323.2 kg da^{-1}.

Table 2. The average values of two years results of plant height, leaf number and dry matter yield due to different nitrogen and phosphorus doses

N dose, kg ha^{-1}	P dose, kg ha^{-1}											
	Plant height(cm)				Leaf number (number/plant)				DM yield (kg da^{-1})			
	0	60	120	Aver.	0	60	120	Aver.	0	60	120	Aver.
0	188.7	190.3	184.5	187.8 B**	12.3	12.4	12.4	12.4 B**	821.6	730.5	716.7	756.3C *
60	210.4	218.4	217.4	215.4 A	12.5	12.7	12.8	12.6AB	1185.1	1111.1	1133.9	1143.4 B
120	219.3	231.0	223.4	224.6 A	13.0	12.7	12.8	12.8A	1340.5	1398.5	1441.5	1393.5 A
180	224.1	234.7	236.2	231.7 A	12.7	13.0	12.9	12.9A	1496.1	1498.3	1738.3	157.5A
240	228.5	232.3	233.5	231.4 A	12.8	12.8	12.8	12.8A	1612.1	1606.2	1585.6	1601.3 A
Aver.	214.2 B*	221.4 A	219.0 AB	218.2	12.7	12.7	12.7	12.7	1291.1	1268.9	1323.2	1294.4

* , **, indicates significance at 0.05 and 0.01, respectively.

Plant height (N LSD:19.0**; P LSD: 5.3*); Leaf number (N LSD: 0.4**); DM yield (N LSD:216**)

Increasing nitrogen doses would be caused by decreasing harvest index (HI) values (Table 3). The lowest harvest index was obtained from the application of 180 kg N ha^{-1} (% 8.1) while the highest harvest index was obtained from control (% 10.4). The phosphorus application significantly increased harvest index in terms of mean over two years. Harvest index tended to increase as the phosphorus dose increased. The control plots not receiving P fertilizer had the lowest value. The greatest harvest index was obtained from 120 kg P_2O_5 ha^{-1} (Table 3). Barry and Miller (1989) reported that uptake phosphorus by plant during the early stage increased harvest index and yield.

There was a significant difference in herbage yield with different N doses in terms of the average of the two years (Tablo 3). The application of nitrogen increased herbage yield when compared with the control (Table 3). Some researchers have reported that the herbage yield increased with N application in silage maize (Kara ve ark., 1999 ; Ülger ve ark, 1996). The lowest value (4198.1 kg da^{-1}) was obtained from control plots while the highest value (8386.2 kg da^{-1}) was at the 240 kg N ha^{-1}. When the mean results were taken into consideration, no significant difference was observed among phosphorus doses in terms of mean over two years. The values for herbage yield ranged from 6849.6 to 7045.2 kg da^{-1}.

The effect of nitrogen doses on herbage yield was founded 2 nd quadratic. According to results of this analysis the equation explaining this relationships $y = -9.015x^2 + 390.3x + 4211.2$ (Figure 1).

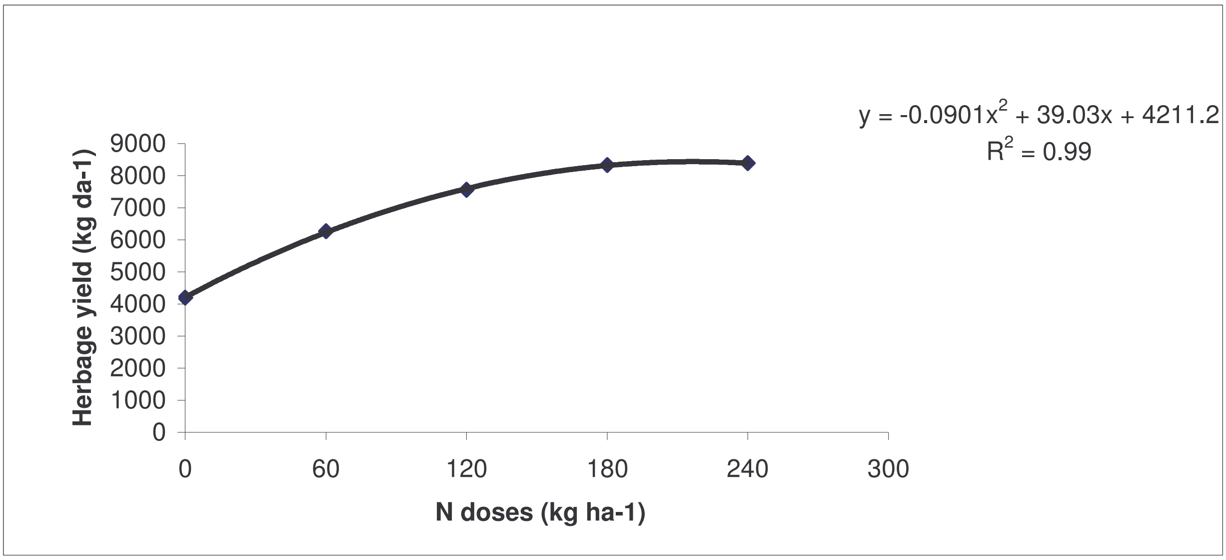

Figure 1. The relationship between nitrogen doses and herbage yield

The effect of phosphorus doses on herbage yield was founded significant at 2 nd quadratic (Figure 2). The equation was given below:

$y = 0.0408x^2 - 4.0878x + 6947.9$

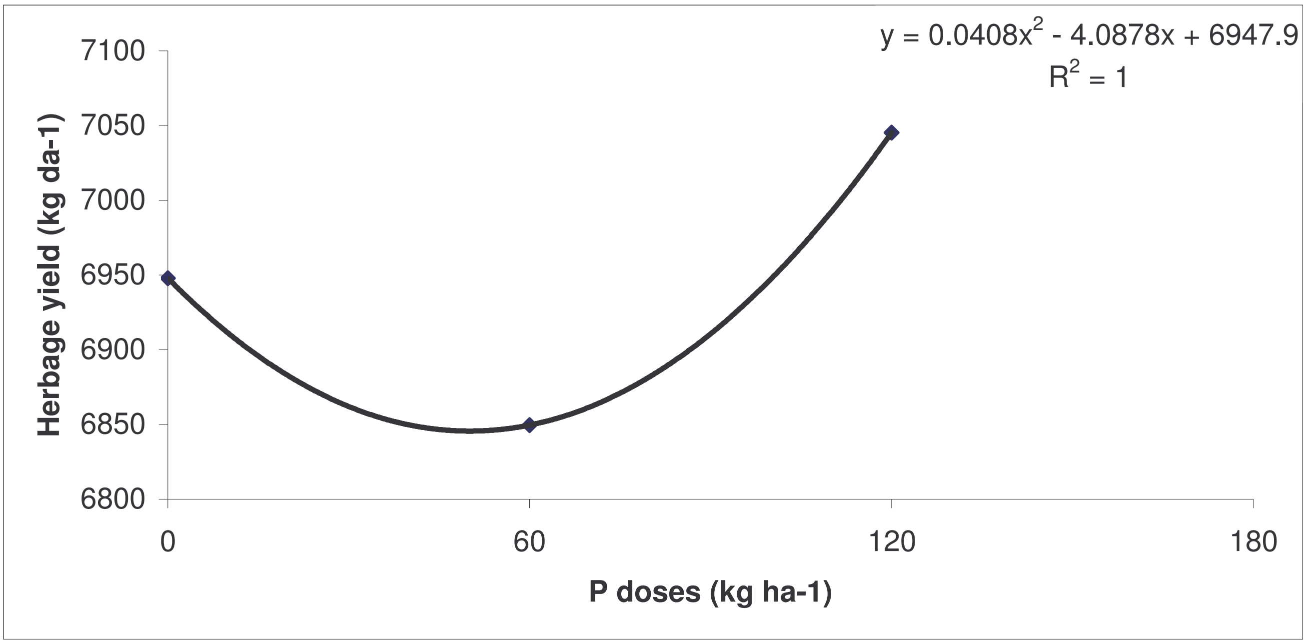

Figure 2. The relationship between phosphorus doses and herbage yield

Table 3. The average values of two years results of harvest index, herbage yield due to different nitrogen and phosphorus rates.

N dose, kg ha^{-1}	P dose, kg ha^{-1}							
	Harvest index (%)				Herbage yield (kg ha^{-1})			
	0	60	120	Aver.	0	60	120	Aver.
0	10.1	10.6	10.5	10.4	4456.9	4258.6	3878.7	4198.1 C**
60	7.8	8.6	10.1	8.8	6225.6	6216.8	6360.3	6267.6 B
120	7.0	8.4	9.8	8.4	7343.4	7695.4	7636.5	7558.4A
180	6.8	8.1	9.4	8.1	8213. 8	7978.5	8790.8	8327.7 A
240	8.2	9..3	10.1	9.2	8500.1	8098.7	8559.9	8386.2 A
Aver.	7.9 C**	8.9 B	9.9 A	8.9	6947.9	6849.6	7045.2	6947.6

**, indicates significance at 0.01

Harvest index (P LSD: 0.9**); Herbage yield (N LSD:1022**)

Leaf nitrogen content were not affected with both phosphorus and nitrogen doses (Table 4). The lowest leaf nitrogen content was obtained from the control (% 1.3) while the highest leaf nitrogen content was obtained from application of 180 kg N ha^{-1} (% 1.6). As phosphorus doses increased, leaf nitrogen content decreased.

A combined analysis over both years for stalk nitrogen content indicated that the stalk nitrogen content was affected neither by nitrogen nor by phosphorus doses (Table 4). The values for stalk nitrogen content ranged from % 0.5 to % 0.7 in the nitrogen doses. The highest stalk nitrogen content (% 0.6) was obtained at application of 120 kg P_2O_5 ha^{-1}.

Cob nitrogen content results are shown in Table 4. The lowest cob nitrogen content was obtained from the control (%1.4) while the highest cob nitrogen content was obtained from application of 180 kg

N ha^{-1} (% 1.6). Kaplan and Aktaş (1993) also reported that grain nitrogen content was effected positively with application of nitrogen dose. Phosphorus doses were not affected on cob nitrogen content.

Table 4. The average values of two years results of leaf nitrogen content, stalk nitrogen content, cob nitrogen content due to different nitrogen and phosphorus doses.

N dose, kg ha^{-1}	P dose, kg ha^{-1}											
	Leaf nitrogen content (%)				Stalk nitrogen content (%)				Cob nitrogen content (%)			
	0	60	120	Aver.	0	60	120	Aver.	0	60	120	Aver.
0	1.3	1.3	1.3	1.3	0.5	0.5	0.5	0.5	1.3	1.4	1.3	1.4
60	1.5	1.6	1.4	1.5	0.5	0.7	0.8	0.7	1.5	1.5	1.4	1.5
120	1.6	1.4	1.4	1.5	0.6	0.6	0.5	0.6	1.5	1.5	1.5	1.5
180	1.7	1.6	1.5	1.6	0.6	0.6	0.6	0.6	1.6	1.5	1.6	1.6
240	1.6	1.5	1.5	1.5	0.5	0.5	0.6	0.5	1.7	1.4	1.5	1.5
Aver.	1.5	1.5	1.4	1.5	0.6	0.6	0.6	0.6	1.5	1.4	1.5	1.5

Neither nitrogen application nor phosphorus application appeared to affect leaf crude protein ratio in terms of the average of the two years. The highest leaf crude protein was obtained with of application 180 kg N ha^{-1} (Table 5). These results are in agreement with those of many other workers (Cox et. al., 1993; Yılmaz, 1994; Yılmaz, 2005). As phosphorus doses increased, leaf crude protein ratio decreased.

No differences occured among the nitrogen doses in stalk crude protein ratio (Table 5). The lowest stalk crude protein ratio (% 3.5) was obtained from the control while the highest stalk crude protein ratio(% 4.4) was obtained from application of 60 kg N ha^{-1}. The increase of phosphorus dose up to 120 kg P_2O_5 ha^{-1} was observed.

Cob crude protein ratio increased with increase of nitrogen dose (Table 5). The lowest cob crude protein ratio (% 8.9) was obtained from the control while the highest cob crude protein ratio (% 10.2). was obtained from application of 180 kg N ha^{-1}. Rising nitrogen doses increase grain nitrogen and protein content (Lambert et. al., 1998). Phosphorus doses didn't affect on cob crude protein ratio. Cob crude protein ratio results are shown in Table 5.

Table 5. The average values of two years results of leaf crude protein ratio, stalk crude protein ratio, cob crude protein ratio due to different nitrogen and phosphorus doses.

N dose, kg ha^{-1}	P dose, kg ha^{-1}											
	Leaf crude protein ratio (%)				Stalk crude protein ratio (%)				Cob crude protein ratio (%)			
	0	60	120	Aver.	0	60	120	Aver.	0	60	120	Aver.
0	8.7	8.4	8.8	8.6	3.6	3.4	3.5	3.5	8.8	9.1	8.8	8.9
60	9.6	10.3	9.1	9.7	3.6	4.3	5.4	4.4	10.1	9.9	9.8	9.9
120	10.3	9.4	9.0	9.6	4.3	4.1	3.3	3.9	9.8	10.1	10.1	9.9
180	10.9	10.8	10.1	10.6	4.1	4.0	4.5	4.2	10.3	9.8	10.4	10.2
240	10.7	9.7	9.7	10.0	3.5	3.4	3.9	3.6	10.9	9.7	9.7	10.1
Aver.	10.0	9.7	9.3	9.7	3.8	3.8	4.2	3.9	9.9	9.7	9.8	9.8

Nitrogen doses didn't affect on leaf phosphorus contents (Table 6). The highest leaf phosphorus content was obtained from the control (Table 6). No differences occured among the phosphorus doses in leaf phosphorus content. The lowest leaf phosphorus content (% 0.17) was obtained from interaction 60 kg N ha^{-1}x 60 kg P_2O_5 ha^{-1} while the highest leaf phosphorus content (% 0.3) was obtained from interaction 0 kg N ha^{-1} x 60 kg P_2O_5 ha^{-1}

Table 6. The average values of two years results of leaf phosphorus content, stalk phosphorus content, cob phosphorus content due to different nitrogen and phosphorus doses.

N dose, kg ha^{-1}	P dose, kg ha^{-1}											
	Leaf phosphorus content (%)				Stalk phosphorus content (%)				Cob phosphorus content (%)			
	0	60	120	Aver.	0	60	120	Aver.	0	60	120	Aver.
0	0.21 bcd	0.31a **	0.26 ab	0.26 a*	0.23	0.28	0.28	0.26a**	0.35	0.41	0.43	0.40 **
60	0.19 bcd	0.17d	0.18cd	0.18 b	0.15	0.16	0.17	0.16 b	0.30	0.28	0.31	0.30 b
120	0.18 cd	0.21bcd	0.19 bcd	0.19 b	0.11	0.14	0.14	0.13 b	0.30	0.31	0.33	0.31 b
180	0.20 bcd	0.20bcd	0.18 cd	0.19 b	0.14	0.14	0.16	0.15 b	0.29	0.34	0.28	0.30 b
240	0.17 cd	0.19 cd	0.25 abc	0.20 ab	0.13	0.16	0.17	0.15 b	0.31	0.28	0.32	0.30 b
Aver.	0.19	0.21	0.21	0.20	0.15 b**	0.18 ab	0.19 a	0.17	0.31	0.32	0.33	0.32

**, indicates significance at 0.05 and 0.01

Leaf phosphorus content(N LSD: 0.06*; N x P int.LSD: 0.1**); Stalk phosphorus content (N LSD: 0.06**; P LSD: 0.03**); Cob phosphorus content (N LSD : 0.06**)

Both nitrogen application and phosphorus application appeared to affect stalk phosphorus content in terms of mean over two years (Table 6). The highest stalk phosphorus content was obtained from the control (% 0.3 Table 6). Stalk phosphorus content tended to increase as the phosphorus dose increased. Hajabbasi and Schumacher (1994) reported that phosphorus stimulated growth in maize. Nitrogen doses were effective on cob phosphorus content. The values for cob phosphorus content ranged from % 0.4 to % 0.3 (Table 6). The highest cob phosphorus content (% 0.4) was obtained from the control. No differences occured among the phosphorus doses in cob phosphorus content (Table 6).

Our results showed that 240 kg N ha^{-1} and 60 kg P_2O_5 ha^{-1} should be applied in the case of silage maize growing as a second crop under Tokat conditions.

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