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Effect of Different Rates of Nitrogen and Phosphorus on Growth and Grain Yield of Maize (*Zea mays* L.)

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Abstract: In a field experiment, growth and grain yield of maize cultivar golden as influenced by different NP combinations were studied. The different NP combinations significantly affected the plant height, cob bearing plant m^{-2}, number of grains cob^{-1}, 1000-grains weight, grain yield and harvest index. The number of cobs $plant^{-1}$ was not influenced significantly by NP application. The NP application @ 180-130 kg ha^{-1} produced significantly higher grain yield (4.62 t ha^{-1}) than all other NP combinations. The increase in yield was mainly due to higher 1000-grains weight, number of grains per cob and number of cobs bearing plant per plot. The results indicated that NP fertilizers should be applied @ 180-130 Kg ha^{-1} to obtain higher grain yield of maize cultivar golden under Faisalabad (Pakistan) conditions.

Key words: Maize (*Zea mays* L.), nitrogen, phosphorus, growth, grain yield

Introduction

Maize is grown both for fodder and grain purposes in Pakistan. it is not only consumed by human beings in the form of food grain but it also provides feed for livestock and poultry. In Pakistan it is third most important cereal after wheat and rice. Maize grain has much nutritive value. It contains about 72% starch, 10% protein, 4.8% fibre, 3% sugar and 1% ash (Chaudhary, 1983). In spite of all efforts made in the past, the average grain yield of maize (1364 kg ha^{-1}) is still much lower than yields obtained in many other countries of the world like Italy, USA, China and Argentina having average yield of 9699, 8398, 7974, 4880, 5254 kg ha^{-1}, respectively (Anonymous, 1999). The use of suitable fertilizers in appropriate doses is considered one of the most important factor which could increase maize yield on per unit area basis (Shrivestra *et al.,* 1971). The use of correct fertilizer can increase yield up to 50% (Zia *et al.,* 1991). Growth and grain yield of different maize varieties was increased with increase in N and P levels (Arnold *et al.,* 1974). Similarly, Khan *et al.* (1999) observed significant effects of NPK application on plant height, number of cobs $plant^{-1}$, number of grains cob^{-1}, 1000-grains weight, grain and biological yield. Ali *et al.* (2002) reported significant effect of NP application on grain yield, nitrogen uptake at tasseling and in grain, while non-significant effect of N and P was recorded on harvest index. Ayub *et al.* (2002) observed significant effects of NP application on dry matter yield and individual plant characteristics such as height, diameter, number of leaves and leaf area $plant^{-1}$. This study aimed to find out the appropriate NP level for getting higher grain yield of maize cultivar golden under Faisalabad conditions.

Materials and Methods

A field experiment to study the effect of different combinations of nitrogen and phosphorus on growth and grain yield of maize was carried out at the Agronomic Research Area, University of Agriculture, Faisalabad, during the year 2000. The experiment was laid out in randomized complete block design (RCBD) with three replications measuring a net plot size of 3.6 x $7m^2$. Maize variety golden was sown in 60 cm apart rows on 1st August 2000 with a single row hand drill, using a seed rate of 30 Kg ha^{-1}. The nitrogen and phosphorus fertilizers were applied @ 0-0, 60-50, 90-70, 120-90, 150-110 and 180-130 kg ha^{-1}. Nitrogen and phosphorus were applied in the form of urea and triple super phosphate, respectively. Potassium was applied in the form of potassium sulphate @ 50 Kg ha^{-1} to all the treatments. Half dose of nitrogen, full dose of phosphorus and potassium were applied at the time of sowing by side dressing with the help of a hand drill. While, remaining half N was applied before tassling stage. Ten plants were selected at random from each plot to record individual plant observations like plant height, number of cobs $plant^{-1}$, number of grains cob^{-1} and 1000-grains weight. For grain yield, cobs of each plot after removing were shelled with the help of an electric-sheller and were weighed to have grain yield $plot^{-1}$. Then yield was converted from kg $plot^{-1}$ into t ha^{-1}. All other agronomic practices and plant protection measures were applied to all treatments uniformly during the course of study. The data collected were analyzed statistically by using Fisher's analysis of variance technique and differences among treatment means were compared by using least significant difference test (LSD) at 5% level of probability (Steel and Torrie, 1984).

Results and Discussion

Plant height at maturity (cm): The data revealed significant effects of NP application on plant height. The NP application @ 180-130 kg ha^{-1} did not differ significantly from NP rates of 150-110 and 120-90 kg ha^{-1} but produced significantly taller plants than other treatments (Table 1). The smallest plant height was observed from plots receiving no fertilizer. Significant effects of NP application on plant height has also been reported by Ahmad (1989), Khan *et al.* (1999), Maqsood *et al.* (2001) and Ayub *et al.* (2002).

Number of cob bearing plants m^{-2}: The effect of NP application on number of cob bearing plants m^{-2} was significant (Table 1). There has been an increasing trend in number of cob bearing plants m^{-2} with increased rate of NP application. The control produced the lowest cob bearing plants m^{-2} but it was statistically similar to NP levels of 60-50, 90-70 and 120-90 kg ha^{-1}. The NP levels of 180-130 Kg ha^{-1} produced the highest number of cob bearing plants m^{-2} but it was not significantly different from NP levels of 150-110 kg ha^{+} .
The differences between the levels of 150-110 and 120-90 kg ha^{-1} were also not significant. The better nutrient supply might have increased the number of cob bearing plants m^{-2}. Shahzad (1987) had also reported an increase in cob bearing plants m^{-2} with NP application.

Number of cobs $plant^{-1}$: The number of cobs $plant^{-1}$ was not significantly affected by different NP rates. The maximum number of cobs $plant^{-1}$ (1.26) were produced by NP rates of 150-110 Kg ha^{-1}. The reason for having statistically similar number of cobs $plant^{-1}$ might have been that this character was mainly genetically controlled and was less influenced by environmental and other factors. Non-significant effects of NP application on cobs $plant^{-1}$ had also been reported by Saqib (1996) Maqsood *et al.* (2001). But these results are contradictory to those of Khan *et al.* (1999). They reported significant effect of NP applications on number of cobs $plant^{-1}$.

Number of grains cob^{-1}: Number of grains cob^{-1} in an important yield determining component of maize. The data regarding number of grains cob^{-1} showed that various NP applications significantly affected the number of grains cob^{-1}(Table 1). The application of NP fertilizer @ 180-130 Kg ha^{-1} did not differ significantly from NP rates of 150-110 kg ha^{-1} but produced significantly higher number of grains cob^{-1} than all other treatments. The NP levels of 90-70 Kg ha^{-1} did not differ significantly from NP rates of 60-50 and 120-90 Kg ha^{-1}. Increased number of grains cob^{-1} with increased NP rates might have been due to better nutrition. Duggal (1990) and Maqsood *et al.* (2001) had also reported that number of grains cob^{-1} were influenced significantly with NP application.

1000-grains weight (g): It is evident that 1000-grains weight was affected significantly by nitrogen and phosphorus applications (Table 1). The NP application @ 180-130 Kg ha^{-1} produced highest 1000-grain weight but statistically similar to NP rates of 150-110 Kg ha^{-1}. The differences between control and NP rates of 60-50 Kg ha^{-1} were not significant. The NP rates of 120-90 Kg ha^{-1} did not differ significantly from 90-70 and 150-110 kg ha^{-1}. The minimum 1000-grains weight was recorded in control. The differences in 1000-grains weight could be attributed to variation in nutrition due to varied NP application. The results are in accordance with those of Fareed (1996) and Maqsod *et al.* (2001). They had also observed an increase in 1000-grain weight with increase in NP application.

Grain yield: Grain yield was influenced significantly by different levels of nitrogen and phosphorus. The trend of yield components due to NP applications had been reflected in the grain yield almost in the same order. The NP application @ 180-130 kg ha^{-1} produced significantly higher grain yield (4.62 t ha^{-1}) than all other NP combinations. The NP levels of 150-110 and 120-90 kg ha^{-1} produced statistically similar grain yield. The plots without NP application produced significantly the lowest grain yield (2.11 t ha^{-1}). The increase in grain had been

Table 1: Growth and grain yield of maize as influenced by different NP combinations.

Treatment	NP kg ha^{-1}	Plant height (cm)	No. of cobs bearing plants (m^{-2})	No. of cobs $plant^{-1}$	No. of grains cob^{-1}	1000-grains wt (g)	Grain yield (t ha^{-1})	Harvest Index (%)
T_0	0-0	178.65d	3.92c	1.13NS	357.4d	204.36d	2.11c	28.37d
T_1	60-50	184.37cd	4.21c	1.13	429.4c	209.54d	2.87d	32.87c
T_2	90-70	195.62b-d	4.13c	1.16	437.4bc	232.19c	2.98c	32.96c
T_3	120-90	201.48a-c	4.37bc	1.23	456.3b	247.39bc	3.23b	34.47c
T_4	150-110	205.51ab	4.83ab	1.26	504.9a	259.54ab	3.32b	36.57b
T_5	180-130	219.45a	4.92a	1.23	512.5a	265.54a	4.62a	39.33a

Means followed by the same letter within columns are not statistically different (P=0.05).
NS = Non-significant

mainly due to increase in number of cob bearing plants m^{-2}, number of grains cob^{-1} and 1000-grains weight. Increase in grain yield due to NP application had also been reported by Arnold *et al.* (1974), Khan *et al.* (1999), Maqsood *et al.* (2001) and Ali *et al.* (2002).

Harvest index: The physiological efficiency of a crop in converting the photosynthates in to grain yield is measured in the form of harvest index. Higher the harvest index, the greater is the physiological efficiency of a crop. Harvest index was influenced significantly by the application of NP fertilizer (Table 1). Significantly higher harvest index value was obtained by NP levels of 180-130 kg ha^{-1} and it was followed by NP levels of 150-110 and 120-90 kg ha^{-1}, having a harvest index value of 36.57 and 34.47%, respectively. The differences between NP levels of 60-50, 90-70 and 120-90 kg ha^{-1} could not reach to a significant level. The minimum harvest index value (28.37%) was observed in control. The increase in grain yield due to NP levels might have resulted in an increase in harvest index value. The results are contradictory to those of Ali *et al.* (2002). These contradictory results might have been due to variation in genetic make up of the cultivars or climatic factors.

It is indicated that for obtaining higher grain yield of maize cultivar golden NP fertilizers should be applied @ 180-130 Kg ha^{-1} under Faisalabad (Pakistan) conditions.

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