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Abbas Ali
University of Mississippi

Muhammad Asif
University of Sargodha

Tasneem Khaliq
University of Agriculture Faisalabad

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GROWTH AND YIELD OF MAIZE (*Zea mays* L.) CULTIVARS AFFECTED BY NPK APPLICATION IN DIFFERENT PROPORTION

A. Asghar, A. Ali*, W. H.Syed*, M. Asif*, T. Khaliq and A. A. Abid

University of Agriculture, Faisalabad. *University College of Agriculture, University of Sargodha, Sargodha.
Corresponding author Email: amjedalich@gmail.com

ABSTRACT: This study was conducted to investigate the effect of different NPK rates on growth and yield of maize cultivars; Golden and Sultan. Application of increasing rate of NPK, delayed number of days taken to tasseling, silking and maturity of the crop. The plant height was significantly affected by different rates of NPK. Treatment F_3 (250-110-85) of NPK produced tallest plants than two other treatments in both the varieties. Too low or high NPK levels reduced the yield and yield parameters of maize crop. Treatment F_2 (175-80-60) seems to be the most appropriate level to obtain maximum grain yield under the prevailing conditions. Application of NPK beyond treatment F2 (175-85-60) seems to be an un-economical and wasteful practice. Varieties (Golden& Sultan) seem to have similar production potential under uniform and similar growing condition.

Key words: Maize, cultivars, nitrogen, phosphorus, potassium.

INTRODUCTION

Maize *(Zea mays* L.) ranks third after wheat and rice in the world food grain production. It is grown extensively with equal success in temperate, sub-tropical and tropical regions of the world. In Pakistan, area under this crop is 950 thousands hectares with an annual production of 3487 thousands tones. (Anonymous. 2009-10).In addition to meeting the food requirement of human and livestock, maize is put to many industrial uses. It is a well known fact that the yield potential of a crop is mainly dependent upon its genetic make up as well as the environment in which it is grown. The genetic potential however, can be exploited to the maximum by providing favorable growth environments. The climatic conditions and existing varieties in our country are highly favorable for increasing production of maize. Fertilizer play an important role in increasing the maize yield and their contribution is 40-45 percent. Balanced and optimum use of nitrogen, phosphorus and potassium fertilizers play a pivotal role in increasing the yields of cereals. Though the yield potential of our present varieties is high enough, but it has not been explored fully due to some production constraints. Among the limiting factors; proper level and ratio of nitrogen, phosphorus and potassium are of prime importance. Moreover the nutritional requirements of approved varieties must also be investigated.

Keeping in view the above facts the present study was undertaken to determine the effect of nitrogen, phosphorus and potassium on growth and yield parameters of maize grown under central Punjab conditions.

MATERIALS AND METHODS

The experiment was conducted during autumn season at the Research area of University of Agriculture, Faisalabad. The experiment was laid out in a randomized complete block design (factorial) with three blocks. The net plot size was 3x5 m^2. The following treatments were included in the experiment:

A) Varieties

V1 Golden

V2: Sultan

B) Fertilizer levels (NPK kg ha^{-1})

	N	P	K
F_0:	0	0	0
F_1:	100	50	35
F_2:	175	80	60
F_3:	250	110	85

The crop was sown with the help of a single row hand drill, using a seed rate of 30 $kgha^{-1}$. The plant to plant distance was maintained approximately at 20 cm by thinning out the excess plants. The whole dose of phosphorus and potash along with half of nitrogen fertilizer in the form of single super phosphate, sulphate of potash and urea, respectively, were applied at sowing by broadcasting and subsequent amount of nitrogen fertilizer was applied at tasseling stage of the crop.

All other agronomic practices and plant protection measures were applied to all treatments uniformly during the course of study.

Ten plants were selected at random from each plot to record individual plant observations like plant height (cm), number of cobs plant^{-1}, number of grains cob^{-1}, grain weight cob^{-1} (g) and 1000- grains weight (g) by using standard procedure. The height of randomly selected ten plants was measured (cm) and then averaged. Number of cobs was counted from ten plants selected at random from each plot and average was calculated. Total grains of the ten cobs were counted and grain weight of all the cobs selected from each plot was taken by using triple beam balance and averaged and thousand grain weights (gm) were done. 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}.Biological yield was calculated in kilograms by deducting seed yield from the total biomass of each plot and converted into tonnes per hectare. Harvest index was calculated on percentage basis by using the following formula.

Harvest index = Economic yield/ Biological yield (S.S. Singh 2001).

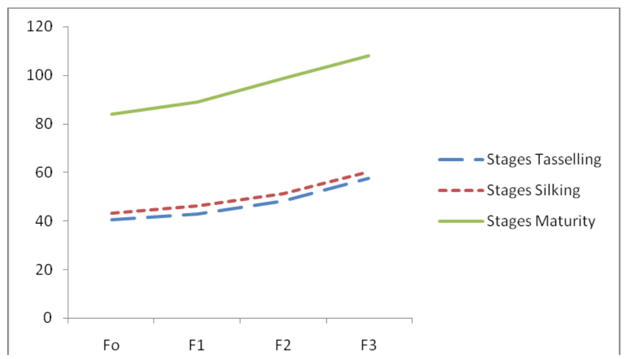
The data collected were analyzed statistically by using analysis of variance technique and treatment means were compared using LSD test at 5 % level of probability (Steel et al., 1997).

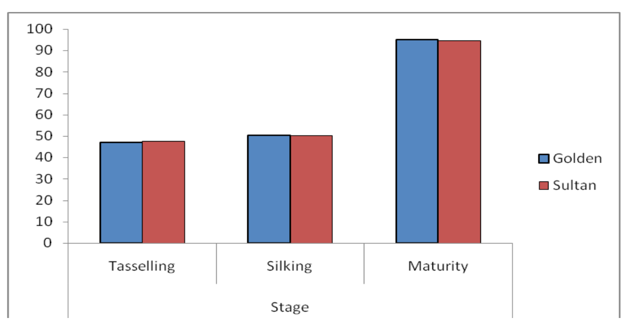
RESULTS AND DISCUSSION

Days taken to tasselling: Within NPK levels, treatment F_3 (250-110-85) (57.46) was followed by treatment F_2 (175-8—60), (48.13), F_1 (100-50-35), (42.98), and control plots (40.57) in a descending order. The number of days taken to tasselling was increased in linear fashion with the increase in NPK levels. Taking more days for the plant to tassel in treatment F_3 (250-110-85) may partly be due to the bumper growth of plant on account of more nitrogen availability and other nutrients in this treatment. The higher level of NPK prolonged the vegetative growth stage of the plant rather longer period of time resulting in more days taken to tasselling. Both varieties used in trial again did not show any difference in number of days taken to tasselling. These results are in accordance with those of Toor (1990), who reported that the number of days taken to tasselling was increased in linear fashion with the increase in NPK levels.

Days taken to silking: As regards the individual comparison of treatments, treatment F_3 (250-110-85) took more days to maturity as compared to rest of the treatments i.e. treatment F_2 (175-80-60) F_1 (100-50-35) and F_0 (0-0-0) in a descending order. The number of days taken to silking was increased in linear fashion with increase in NPK levels. It can be concluded from the data that higher levels of NPK took more days to silking as compared with the lower level. The more days taken to silking may be due to the more succulent vegetative growth of the plant. This may be due to the adequate nitrogen in combination with P and K which greatly influenced vegetative growth of plant. The varieties however, did not affect the number of days taken to silking. These results are supported by those of Toor (1990).

Days taken to maturity: Among the treatments, treatment F_3 took more days (107.98 days) to maturity as compared to rest of the treatments i.e., treatment F_2 (98.52 days) F_1 (89.07 days) and F_0 (83.90 days) in a descending order. The number of days taken to maturity was increased in a linear fashion with the increase NPK levels. Taking more days for the plant to mature in treatment F_3 (107.98) may be explained in terms of more vegetative growth due to more nitrogen availability in combination with P &K in this treatment. The lesser days taken to maturity in lower levels of NPK may be attributable to the fact that the vegetative growth stopped earlier in these treatments. Both varieties used in trial again did not show any difference in number of days taken to maturity. These results are partly in agreement with Toor (1990).





Plant height at maturity (cm): Plant height of maize cultivars varied from 143.60 to 198.55 cm (Table1).Plant height increased linearly with NPK application. Among different treatments, F_3 (250-110-85) gave maximum plant height (198.55 cm) against the minimum recorded (143.60) in F_0 (control). Next treatment to follow was F_2 (175-80-60) with plant height of (184.67 cm) which was found better than treatment F_1 (100-50-35) value (173.63 cm). Treatment F_0 was dragging behind. Since nitrogen in combination with P and K greatly influenced the vegetative growth and plant height. So plant height was increased with respect to increase in NPK levels. The varieties (V_1&V_2) however did not differ significantly. Similar results that plant height increases with increasing levels of fertilizers were reported by Maqsood *et al.,* (2001), Ayub *et al*., (2002) and Sharar *et al*. (2003).

Number of Cobs plant^{-1}: It is revealed from the data in Table 1 that the number of cobs per plant was not significantly affected by different NPK rates. Among the NPK Levels, treatment F_3 (250-110-85) gave maximum number of cobs (1.53) per plant. The reason for having statistically similar number of cobs per plant might have been that this character was mainly genetically controlled and was less influenced by environmental than other factors. The varieties (V_1 and V_2) used did not show any difference in producing cobs per plant. Non significant effects of fertilizer application on cobs per plant had also been reported by Maqsood *et al.,* (2001) and Sharar *et al*. (2003).Where as these results are contradictory to findings of Khan *et al*. (1999).They reported significant effect of NP applications on number of cobs per plant.

Number of grain rows cob $^{-1}$: Different levels of NPK significantly affected the number of grain rows per cob (Table 1).The number of grain rows per cob ranged between 13.53 and 15.30 in maize plants. The maximum number of grain rows per cob (15.30) was produced by NPK application at the rate of 250-110-85kg, however, did not differ statistically when compared with treatment 175-80-60 kg which gave 15.03 number of grain rows per cob. The treatment F_1 (100-50-35) results 14.30 and seemed to be better than the control 13.53.The varieties (V_1&V_2) used did not show any difference on producing number of grain rows per cob. It can be suggested from the data that most appropriate level of NPK to produce optimum grain rows per cob seems to be the treatment F_2.This might be due to adequate availability of nitrogen in combination with P & K and maximum N use efficiency in this treatment. Going beyond this treatment F_2 (175-80-60) seems to be an uneconomical and wasteful practice. These results are in agreement with those of Ali *et al*., (2002) and Younas, (2002) who reported that number of grains rows per cob was increased with application of fertilizers.

Number of grains per cob $^{-1}$: Number of grains cob$^-$1 is an important yield determining component of maize. The data regarding number of grains cob$^-$1 showed that various NPK applications significantly affected number of grains cob^{-1} (Table2). Treatment F_3 (250-110-85) produced more number of grains (425.13) per cob. Treatment F_3 was followed by treatment F_2 (175-80-60), F_1 (100-50-35) and F_0 (0-0-0).The varieties (V_I & V_2) used did not show any difference in producing number of grains per cob. It can be concluded from the data that rather higher levels of NPK will help to increase the size of cob and number of grains per cob. The decreased number of grains per cob in treatment F_0 (0-0-0) may be due to want of nitrogen at different growth stages. The results are partly in agreement with those of Maqsood *et al*., (2001); Sharar *et al*., (2003), Rasheed *et al*., (2004) and Oktem *et al*., (2005) who reported that number of grains per cob were increased at certain levels of fertilizer application.

Grain weight per cob (g): Among the NPK levels, treatment F_3 (250-110-85) gave more grain weight (104.99) per cob. Next to follow were treatment F_2 (175-80-60) and F_1 (100-50-35) where 101.53 and 95.63 grain weight per cob was recorded. Treatment F_0 (0-0-0) produced the minimum grain weight (90.00) per cob. The varieties (V_1 & V_2) used did not show any difference in producing grain weight per cob. It can be concluded from the data given in table 2 that higher levels of nitrogen increased the rain weight producing well developed and bold grains. A decrease in grain weight obtained in treatment F_0 (0-0-0) may be explained in terms of lesser availability of nutrients. Depending upon the soil and climatic conditions the NPK levels can be adjusted creating a best appropriation between the source and sink on the basis of further experimentation. The results are supported by Hussain (1999) who reported that grain weight per cob increased with increasing levels of NPK fertilizers.

1000-grain weight (g): It is evident that 1000-grain weight was affected significantly by NPK applications (Table2).The NPK application @ 250-110-85 kg ha^{-1} produced highest 1000-grain weight (255.92g). Next to follow were treatment F_2 (175-80-60) and F_1 (100-50-35) resulted in 253.18g and 245.13g, respectively. The minimum 1000-grain weight was recorded in treatment from plots receiving no fertilizer. The varieties (V_1 & V_2) used did not show any difference in producing 1000-grain weight. It can be concluded from the data that higher levels of NPK increased 1000-grain weight producing well developed and bold grains. A decrease in 1000-grains weight in treatment F_0 (control) may be explained in terms of low availability of nitrogen and other nutrients. The results are partly in agreement with the findings of Maqsood *et al*., (2001), Mahmood *et al*., (2001) and Sharar *et al*., (2003) who reported that number of grains per cob were increased at certain levels of fertilizer application.

Grain yield (t ha^{-1}): It is revealed from the data in table 3 that the grain yield was greatly affected by different levels of NPK. Among different treatment, treatment F_3 (250-110-85) produced maximum grain yield 6.03 t ha^{-1}. However, yield of plots of treatment F_3 did not differ statistically when compared with the yield of treatment F_2 (175-80-60) which was 5.90 t ha^{-1}. Next to follow was treatment F_1 (100-50-35) yield (4.53) and the plots without NPK application produced significantly the lowest grain yield (3.25 t ha^{-1}).The varieties (V_1&V_2) used did not show any difference in producing grain yield. It is again confirmed that rather higher NPK levels will help to increase grain yield (t ha^{-1}) on account of increased number of grain rows per cob, number of grains per cob and grain weight per cob etc.Too high or too low levels will lower the grain yield under the prevailing conditions. Treatment F_2 seems to be the best level and going beyond this level will not bring any economical benefits .This may partly be due to increased nitrogen use efficiency and adequate nutrients supply. Similar results that grain yield was increased with application of NPK fertilizers were reported by Sharma and Gupta, (1998), Maqsood *et al*., (2001); Ali *et al*., (2002); Kogbe *et al*., 2003 and Sharar *et al*., (2003)

Biological yield (t ha^{-1}): Data given in table 3 show that among different NPK levels treatment F_3 gave more biological yield (16.83tha^{-1}) as compared to rest of the treatments. Treatment F_3 was however, statistically at par with treatment F_2 (16.23) Next to follow was the treatment F_1 (13.69) and minimum biological yield was produced in treatment F_0 (10.81).The varieties however, did not show any difference in producing biological yield. It is again confirmed that too low or too high levels or NPK will not help to increase the biological yield of the maize plant. Treatment F_2 seems to be optimum level and going beyond this level will be an uneconomic and wasteful practices. This may again be explained in terms of appropriation between the NPK supply and plant requirement for nutrients during the growth period of the plant. These findings are supported by those of Hanif, (1990).

Table 1. Plant height at maturity, number of cobs plant^{-1} and number of grain rows cob^{-1} as influenced by varying NPK levels.

NPK kg ha^{-1}	Plant height (cm)			Cobs plant^{-1}			Grain rows cob^{-1}		
	Golden	Sultan	Mean	Golden	Sultan	Mean	Golden	Sultan	Mean
0-0-0	144.60	144.60	143.60d	1.50	1.50	1.50 NS	13.83	13.23	13.53c
100-50-35	172.77	172.77	173.63c	1.52	1.49	1.50	14.50	14.10	14.30b
175-80-60	186.23	186.23	184.67b	1.53	1.48	1.50	15.07	15.00	15.03a
250-110-85	197.60	197.60	198.55a	1.57	1.50	1.53	15.40	15.20	15.30a
Mean	175.30	174.93		1.53	1.49		14.70	14.38	
LSD(0.05)	NS		11.1866	NS		0.204905	NS		1.01423

Means not sharing a letter common in column differ significantly with each other at 0.05 level of probability. NS = Non-significant

Table 2. No, of grains cob^{-1}, grain weight cob^{-1} and 1000-grain weight as influenced by varying NPK levels.

NPK kg ha^{-1}	No. of grains cob^{-1}			Grain weight cob^{-1} (g)			1000-grain weight (g)		
	Golden	**Sultan**	**Mean**	**Golden**	**Sultan**	**Mean**	**Golden**	**Sultan**	**Mean**
0-0-0	395.07	387.07	391.29d	91.28	88.75	90.01d	238.37	235.43	236.90d
100-50-35	415.50	413.47	414.48c	96.79	94.47	95.63c	246.13	244.13	245.13c
175-80-60	423.20	419.37	421.28b	101.58	101.49	101.53b	254.16	252.20	253.18b
250-110-85	426.10	422.87	425.13a	105.57	104.41	104.99a	256.63	255.20	255.92a
Mean	415.29	410.69		98.81	97.28		248.83	246.74	
LSD(0.05)	NS		10.86386	NS		15.50188	NS		2.709095

Means not sharing a letter common in column differ significantly with each other at 0.05 level of probability. NS = Non-significant

Table 3. Grains yield (t ha^{-1}), biological yield (t ha^{-1}) and Harvest index (%) as influenced by varying NPK levels.

NPK kg ha^{-1}	Grain yield (t ha^{-1})			Biological yield (t ha^{-1})			Harvest index (%)		
	Golden	Sultan	Mean	Golden	Sultan	Mean	Golden	Sultan	Mean
0-0-0	3.30	3.20	10.81c	10.77	10.84	3.25c	30.83	29.68	30.25c
100-50-35	4.60	4.47	13.69b	13.57	13.82	4.53b	33.94	32.45	33.19bc
175-80-60	5.93	5.87	16.23a	16.40	16.07	5.90a	36.34	36.61	36.47a
250-110-85	6.07	6.00	16.83a	17.09	16.57	6.03a	35.65	36.28	35.96ab
Mean	4.97	4.88		14.46	14.33		34.19	33.75	
LSD(0.05)	NS		0.14489	NS		1.561858	NS		4.524655

Means not sharing a letter common in column differ significantly with each other at 0.05 level of probability. NS = Non-significant

Harvest index (%): It is revealed from the data (Table 3) that the harvest index was markedly influenced by NPK application in different proportions. Among different treatments, treatment F_2(175-80-60) resulted in more harvest index (36.47) but this treatment is statistically at a par with treatment F_3(250-110-85) harvest index (35.96), treatment F_3 is also statistically similar to treatment F_1(100-50-35) harvest index (33.19). Similarly, treatment F_1 is statistically at par with treatment F_0 results (30.25).Too low nitrogen levels will result in decreased harvest index due to subnormal growth and development of the other yield parameters due to shortage of N. Going beyond treatment F_2 would be an un-economical and wasteful practice under the prevailing conditions. These findings are quite in line with those of Sharar *et al*., (2003) who reported that harvest index was markedly influenced by NPK application in different proportions.

Conclusion. It is concluded that treatment F2 (175-80-60) is appropriate and economical rate of NPK for obtaining maximum grain yield of maize under agro-ecological conditions of Faisalabad.

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