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Effect of Different Levels of NPK Fertilizers and Delayed Sowing on Growth, Yield of Maize (*Zea mays* L.) Varieties

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ABSTRACT

The present study was conducted in research farm of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology & Sciences, Allahabad (U.P) during Kharif 2017 to investigate the effectiveness various levels of NPK fertilizers, their combinations (T_1) 26g Urea: 42g DAP :20g MOP / 2 m^2 (T_2), 52g Urea: 84g DAP :40 g MOP/ 2 m^2 (T_3), 78g Urea: 126 g DAP :60g MOP / 2 m^2 and delayed sowing on growth and yield characters of three varieties of maize. The three varieties (Kaveri 3110 (V_1), Deluxe (V_2), Ganga-2 (V_3). each were treated with different levels of fertilizers (Urea - 26 g,52g and 78 g) which supplies nitrogen, (DAP- 42g,84g,124g) which supplies nitrogen and phosphorous, (MOP- 20g,40g,60g) which supplies potassium. The experimental design was factorial Randomized Block Design (Factorial RBD) with four replications. The results showed that the treatment combinations V_2T_2 yielded maximum in all the characters followed by (V_1T_2) treatment in leaf width, cob length, no of rows/cob, no of grains /row, no of seeds/cob (V_3T_1) in plant height, no of cobs per plant (V_3T_2) in tassel length and leaf length (V_2T_3) in cob diameter and minimum is recorded in control (T_0)

Key words: *Urea, Kharif, Seeds, Grains, Leaf*

INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal crop native to Mexico. Maize or corn is a plant belonging to the family of grasses (Poaceae) having chromosome number 2n =20. It is one of the most versatile emerging crop having wider adaptability under varied agro-climatic conditions. Globally maize is known as "Queen of Cereals". In India, it is cultivated in 9.43 M ha and Production and productivity is 23.67 MT and 2557 kg/ha respectively[10]

Growth and yield, of a plant species differ with soil types, soil nutrient status, and fertilizer management; and a plant species requires suitable soil for higher yield[4,8,13]. Different plant species respond differently to fertilizer rates and combination and a plant species requires balanced fertilizers to maximize growth, yield.

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Potassium plays catalytic roles and regulates functions of various minerals in plants and promotes N uptake efficiency of plants. Insufficient K causes shoot yellowing, poor growth, and low resistance to cold and drought of plant. Phosphorus promotes absorption of other nutrients and plant growth[4]. Fertilization is a widely used practice to correct nutritional deficiencies in plants caused by improper supply of nutrients to roots. The efficiency of different forms of nitrogen–phosphorus–potassium (NPK) fertilizers applied to maize (*Zea mays* L.), either to the soil or to the leaves. For profitable production, corn requires adequate fertilizer management. Applying the right fertilizers at right rate and the right time is crucial for a successful crop.

The three main factors for best fertilizer plan for corn the potential yield of the variety you grow. Fertility of the soil fertilizing according to the corn growth stages and growing degree days (GDD). We need to pay more and more attention to the reaction to maize hybrids to fertilizers and to biological bases, because maize hybrids can utilize nutrients in a different way. It means hybrids can reach their potential level and at different rate of nutrients. The three primary nutrients required for healthy plant growth. The agriculture industry relies heavily on the use of NPK fertilizer to meet global food supply and ensure healthy crops.

Maize requires application of fertilizer such as:

Nitrogen which is the most important nutrient and role player in the growth, yield and quality of maize crops. Nitrogen fertilizer is essential to promote good leaf growth. Smaller leaves result in reduced photosynthesis, a process required for starch storage in the grain. A Nitrogen deficiency thus results in poorer quality grains and a decrease in total yield.

Nitrogen is important to securing high maize yields. It fuels crop growth and development and needs to be readily available. Low and high nitrogen dose have adverse effect on quality of maize. Phosphorus which is essential for root development and growth of the maize plant, as it directly affects the growth tips of the plant. If a Phosphorus deficiency occurs at an early stage, it can affect plant growth throughout the plant life, resulting in smaller plants and less crop yield. Concentration of phosphorus in corn plants plays a critical role in intake of these nutrients by animal. Several studies have been done looking for the concentration of P in corn seed. The P concentration in corn hybrids depends on its genetics and environments where it is grown.

Potassium: like nitrogen, potassium also boosts crop development, and large amounts of K are taken up by the growing plant. Supplies need to be balanced alongside those of nitrogen. Potassium also help minimizing the effects of frost damage and reduces lodging. Potassium is most important for stomatal closure and low supplies result in loss of water from the plant.

Maize plants require great amounts of potassium, especially during maximum periods of growth. It is thus essential that the soil contain adequate levels of potassium as required, for optimal growth of the maize plants. Potassium fulfils a number of roles in maize plants including regulating the water content (beneficial in periods of drought), the transportation of sugar from the leaves and maintaining the plant rigidity.

MATERIAL AND METHODS

The present experiment was carried out in the experimental field of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology & Sciences, Allahabad (U.P) during Kharif 2017. All types of facilities necessary for cultivation of successful crop including field preparation, inputs, irrigation facilities and laborers were provided from Department of Genetics and Plant Breeding.

The test was in factorial Randomized Block Design. Three levels of fertilizers were applied to the plot

Instrument used

Measuring scale, Measuring Tape, Petri plate Volumetric flasks.

Equipment used

Weighing Machine

The various parameters recorded during developmental and growth at distinct phases of crop were Plant height, Tassel length, Leaf length, Leaf width, Cob length, Cob diameter, No of cobs per plant, No of rows per cob, No of grains per row, No of seeds per cob, 100 seed weight, seed weight per plot.

A) Varieties

V1 (Kaveri-3110)

V2 (Deluxe)

V3 (Ganga – 2)

B) Fertilizers (Treatments)

T_0 - Control

T_1 - 26g Urea: 42g DAP :20g MOP / 2 m^2

T_2 - 52g Urea: 84g DAP :40 g MOP/ 2 m^2

T_3 - 78g Urea: 126 g DAP :60g MOP / 2 m^2

STATISTICAL ANALYSIS

The data recorded was analyzed using formula of 3 x 4 Randomized Block Design(Factorial). Comparisons of means were done by utilizing Least Significance Difference (LSD) test at 5 % level.

RESULTS AND DISCUSSION

All the growth and yield characters which are analyzed through RBD factorial showed that the treatment combinations V_2T_2, yielded maximum all the characters and followed by V_3T_2, $V_{21}T_2$. i.e., in all the varietal combinations with fertilizers it showed better results in varieties which 52g urea, 48g DAP, 40 g SSP /2 m^2 is applied.

Effect of NPK on growth and yield components

Plant height (cm)

Among different levels of NPK fertilizers, Plant height of maize cultivars it is varied from 157.92 cm to 214.68 cm found to be statistically more over all other doses of NPK whereas, V_2T_2 gave maximum plant height (214.68 cm). Next treatment to follow was V_3T_1 with plant height of (211.33 cm) and minimum was recorded from Control (V_2) is 157.05

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.

Similar results that plant height increases with increasing levels of fertilizers were reported by Asghar *et al.*[5], Maqsood *et al.*[19].

These consequences are similar with the findings of Karasu *et al.,* Nadeem *et al.*, Onasanya *et al.*[25], Aslam *et al.*[6] who noticed that plant height was enhanced due to increased rates of nitrogen.

These results are also resemblance with, Masood *et al.*[19], Rashid and Iqbal[27] who found that phosphorus affected plant height in a significant manner.

Tassel length

Tassel length of maize cultivars varied from 40.87 cm to 45.98 cm (Table2). Tassel length increased linearly with NPK application. Among different treatments, V_2T_2 gave maximum (45.28 cm). Next treatment to follow was V_3T_2 with tassel length of (45.03 cm) and minimum was recorded from Control (V_2T_0) is 40.87

Tassel length increased linearly with NPK application. Longest tassel is due to highest amount of NP & K levels. This might be due to increased photosynthetic activity and better vegetative growth obtained under higher dose of nitrogen, which leads to production of better size and quality of inflorescence as compared to other doses. These consequences are similar with the findings of Jerry *et al*, Mofunanya *et al*[22].

More potassium was absorbed after the flowers were opened because potassium ion stimulates petal cell expansion and observed maximum length of tassel. These consequences are similar with the findings of Agrawal *et al.*

Leaf width

The maximum leaf width (5.89 cm), followed by (5.57 cm) and (5.55 cm) was noticed in interaction V_2T_2, V_1T_2 and V_3T_2 respectively (Table 3) and minimum was recorded from control (V_2) is 4.28 cm.

Increases leaf width of maize as progressed for high amounts of phosphorous treatments. High amounts of phosphorous which enhances the growth in maize crop. These consequences are similar with the findings of Olowoboko *et al.*[24], Abdul Ghaffoor *et al*.

Leaf length

Maximum leaf length (83.14 cm), followed by (81.52 cm) and (80.90 cm) was noticed in interaction V_2T_2, V_3T_2 and V_2T_3 respectively (Table 3) and minimum was recorded from control (V_3) is 68.80 cm.

Increases in leaf length of maize as progressed for high amounts of phosphorous treatments. High amounts of phosphorous which enhances the growth in maize crop. These consequences are similar with the findings of Olowoboko *et al.*[24], Abdul Ghaffoor *et al*.

Cob length

Among the NPK Levels, V_2T_2 gave maximum (25.17 cm), Next treatment to follow was V_3T_2 with cob diameter (25.13 cm) (Table 3) and minimum was recorded from control (V_1) is 20.21 cm.

Cob length increased linearly with NPK application. Longest cob is due to highest amount of NP & K levels. This might be due to increased photosynthetic activity and better vegetative growth obtained under higher dose of nitrogen, which leads to production of better size and quality of cob as compared to other doses. These consequences are similar with the findings of Jerry *et al.*, Mofunanya *et al.*[22], Shamim *et al*[30].

Cob diameter

Among the NPK Levels, V_2T_2 gave maximum (15.11 cm). Next treatment to follow was V_2T_3 with cob diameter (14.79 cm) and minimum was recorded from control (V_3) is 12.39 cm.

Cob diameter increased linearly with NPK application. Longest cob is due to highest amount of NP & K levels. This might be due to increased photosynthetic activity and better vegetative growth obtained under higher dose of nitrogen, which leads to production of better size and quality of cob as compared to other doses. These consequences are similar with the findings of Mofunanya *et al.*[22], Shamim *et al*[30].

No of cobs per plant

No of cobs per plant of maize varied from 1.00 to 2.40 (Table2). It is revealed from the data in Table 3 that the number of cobs per plant was significantly affected by different NPK rates. Among the NPK Levels, V_2T_2 gave maximum (2.40). Next treatment to follow was V_3T_2 with no of cobs per plant of (2.25) and minimum was recorded from all Controls (T_0) is 1.00.

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. These consequences are similar with the findings of Asghar *et al*[5].

No of rows per cob

Different levels of NPK are not significantly affected the number of grain rows per cob (Table 3). No of rows per cob of maize varied from 11.70 to 13.20 (Table 3). Among the NPK Levels, V_2T_2 gave maximum (13.20). Next treatment to follow was V_3T_2 with no of grains for row of (13.10) and minimum was recorded from Control (V_3T_0) is 11.70.

Table 1: ANOVA for different growth and yield characters in maize varieties

S. No.	Characters	Mean squares				
		Replication	Varieties	Fertilizer	Interaction effect b/w varieties &fertilizer	Error
		(df= 3)	(df= 2)	(df= 3)	(df= 6)	(df= 33)
1.	Plant Height	2.45	25.11**	1904.48**	105.87**	2.60
2.	Tassel length	3.52	6.65**	39.78**	1.98**	1.11
3.	Leaf width	0.02	0.83**	3.61**	0.11	0.049
4.	Leaf length	26.63	51.48**	356.28**	5.91**	17.42
5.	Cob length	0.60	17.78**	33.54**	2.80**	0.65
6.	Cob diameter	0.08	0.35**	13.79**	0.19*	0.25
7.	**No of cobs / plant**	0.12	0.16**	4.02**	0.08*	0.03
8.	No of rows / cob	0.31	0.01	4.72**	0.04	0.18
9.	No of grains / row	0.51	3.03**	26.71**	0.48	1.14
10.	**No of seeds / cob**	83.58	753.78**	16417**	172.52**	348.25
11.	**100 seed weight**	1.14	0.65*	49.25**	6.15**	3.78

**** Significant at 5 % and 1% level of significance, respectively**

Table 2: Effect of different varieties and treatments on growth and yield characters of Maize field during *Kharif* - 2017

S. No	Characters / Factors		Plant Height	Tassel length	Leaf width	Leaf length	Cob length	Cob diameter	No of cobs / plant	No of rows / cob	No of grains / row	No of seeds / cob	100 seed weight
1	V_1		195.21	43.48	4.79	75.04	22.76	13.85	**1.78**	12.77	30.50	389.36	20.94
2.	V_2		194.25	44.33	5.32	78.51	23.85	14.12	1.97	12.79	30.84	395.25	20.57
3.	V_3		196.74	43.03	5.19	77.59	21.74	14.07	1.80	12.72	29.98	381.56	20.63
4.	**Mean**		**195.40**	**43.61**	**5.10**	**77.04**	**22.78**	**14.01**	**1.85**	**12.76**	**30.44**	**388.72**	**20.71**
5.	Range	Min	194.25	43.03	4.79	75.04	21.74	13.85	1.78	12.72	29.98	381.56	20.57
		Max	196.74	44.33	5.32	78.51	23.85	14.12	1.97	12.79	30.84	395.25	20.94
6.	**SE.(d)**		2.28	**1.51**	**0.31**	**5.90**	**1.14**	**0.70**	**0.24**	**0.60**	**1.51**	**26.39**	**2.73**
7.	**SEM**		**1.62**	**1.07**	**0.22**	**4.17**	**0.81**	**0.49**	**0.17**	**0.43**	**1.07**	**18.66**	**1.93**
8.	C.D.5%		**1.16**	**0.76**	**0.15**	**3.00**	**0.59**	**0.36**	**0.11**	**0.32**	**0.76**	**13.43**	**1.40**
9.	T_1		160.72	40.94	4.31	68.95	20.31	12.41	1.00	11.82	28.20	333.27	17.83
10.	T_2		207.45	44.94	5.38	79.15	23.46	14.41	1.97	13.05	31.12	406.17	22.00
11.	T_3		206.42	44.20	5.51	80.77	23.96	14.76	2.23	13.10	31.30	409.21	22.25
12.	T_4		207.90	44.43	5.29	79.31	23.41	14.44	2.20	13.07	31.13	406.23	20.75
13.	**Mean**		**195.62**	**43.63**	**5.12**	**77.04**	**22.78**	**14.01**	**1.85**	**12.76**	**30.44**	**388.72**	**20.71**
14.	Range	Min	160.72	40.94	4.31	68.95	20.31	12.41	1.00	11.82	28.20	333.27	17.83
		Max	207.90	44.94	5.51	80.77	23.96	14.76	2.23	13.10	31.30	409.21	22.25
15.	**SE.(d)**		**1.98**	**1.29**	**0.27**	**5.11**	**0.99**	**0.60**	**0.20**	**0.52**	**1.30**	**22.86**	**2.38**
16.	**SME**		**1.40**	**0.91**	**0.19**	**3.61**	**1.40**	**0.86**	**0.14**	**0.74**	**0.92**	**16.16**	**1.68**
17.	C.D.5%		**1.33**	**0.88**	**0.18**	**3.47**	**0.68**	**0.42**	**0.12**	**0.36**	**0.89**	**15.51**	**1.61**

Table 3: Effect of Interaction b/w different varieties and treatments on growth and yield characters of Maize during *Kharif* - 2017

S. No	Characters / Factors		Plant Height	Tassel length	Leaf width	Leaf length	Cob length	Cob diameter	No of cobs / plant	No of rows / cob	No of grains / row	No of seeds / cob	100 seed weight
1	V1T0		157.915	40.90	4.29	68.69	20.21	12.47	1.00	12.00	28.37	340.39	18.75
2	V1T1		207.165	44.76	5.10	76.64	23.24	14.22	1.70	13.00	31.40	408.29	22.75
3	V1T2		204.395	45.28	5.57	80.01	25.13	14.34	2.20	13.10	31.50	412.50	21.75
4	V1T3		211.325	44.78	5.47	80.81	21.99	14.71	2.00	13.05	30.45	397.73	21.50
5	V2T0		157.335	41.04	4.28	69.34	20.23	12.40	1.00	11.75	28.25	331.90	16.00
6	V2T1		203.735	43.50	5.19	78.28	23.90	14.39	2.20	13.00	31.05	403.08	21.75
7	V2T2		**214.330**	**45.98**	**5.89**	**83.14**	**25.17**	**15.11**	**2.40**	**13.20**	**32.20**	**425.07**	**23.75**
11	V2T3		201.615	43.14	5.48	80.90	22.84	14.79	2.10	13.08	30.65	399.47	21.25
9	V3T0		164.435	40.87	4.39	68.80	20.48	12.39	1.00	11.70	28.00	327.55	18.75
10	V3T1		211.675	44.75	4.94	76.56	23.70	14.30	2.25	13.05	31.20	405.66	20.50
8	V3T2		208.545	45.04	5.55	81.52	24.86	14.64	2.25	13.10	31.40	411.51	20.75
12	V3T3		202.295	43.50	5.41	79.84	21.66	14.38	2.10	13.05	30.80	401.50	21.00
13	Mean		195.40	43.62	5.13	77.04	22.78	14.01	1.85	12.76	30.44	388.72	20.71
14	Range	MIN	157.92	40.87	4.28	68.69	20.21	12.39	1.00	11.70	28.00	327.55	16.00
		MAX	214.33	45.98	5.89	83.14	25.17	15.11	2.40	13.20	32.20	425.07	23.75
15	C.V.		0.83	2.41	4.18	5.42	3.55	3.53	8.35	3.41	3.50	4.81	9.39
16	**SE.(d)**		3.95	2.61	0.54	10.22	1.98	1.21	0.41	1.05	2.63	45.72	4.76
17	C.D.5%		2.32	1.52	0.30	6.01	1.17	0.72	0.22	0.63	1.53	26.85	2.80

No of grains per row

Different levels of NPK are not significantly affected the number of grains per row (Table 3). No of grains per row of maize varied from 28 to 37.20 (Table 3). Among the NPK Levels, V_2T_2 gave maximum (37.20). Next treatment to follow was V_1T_2 with no of grains per row

of (31.50) and minimum was recorded from Control (V_3T_0) is 28.0.

This might be due to adequate availability of nitrogen in combination with P & K and maximum N use efficiency in this treatment.

Similar results that no of rows per cob increases with increasing levels of fertilizers were reported by Asghar *et al*[5], Maqsood *et al.*[18], by Mansouri and Shokoohfar that maximum number of seeds per pod in cow pea with the application of highest dose of potassium Surendra *et al*.[31] that maximum number of seeds with the application of highest dose of potassium in sunflower.

No of grains per cob

Number of grains per cob is an important yield determining component of maize. The data regarding number of grains per cob showed that various NPK application significantly affected no of grains per cob (Table 3)

No of grains per cob of maize varied from 327.55 to 425.07 (Table2). The number of grains per cob was significantly affected by different NPK rates. Among the NPK Levels, V_2T_2 gave maximum (425.07). Next treatment to follow was V_1T_2 with no of grains per cob of (412.50) and minimum was recorded from Control (V_3T_0) is 327.55

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.

Similar results were also reported by Sahoo and Mahapatra[29].

It is ***100 seed weight***

evident that 100-grain weight was affected significantly by NPK applications (Table2).100 seed weight varied from 16 to 23.75 (Table2). Among the NPK Levels, V_2T_2 gave maximum (16.00). Next treatment to follow was V_1T_1 with (22.7) The minimum 100-grain weight was recorded in treatment from plots receiving no fertilizer.

It can be concluded from the data that higher levels of NPK increased 1000-grain weight producing well developed and bold grains. Similar results were also reported by Asghar *et al.*[5], Sahoo and Mahapatra[29].

Number of seeds per row were produced in greater number with application of higher doses of potassium as it had role in increasing carbohydrates production and their quick translocation to the developing cobs Syed *et al*[32].

CONCLUSION

From the results of present investigation, it can be concluded that

The combination of T_2 (52g Urea/$2m^2$ + 84 g DAP/$2m^2$ + 40 g MOP/$2m^2$)with V_2 (deluxe variety) shows higher growth, yield of all the parameters.

Followed by (V_1T_2) treatment in leaf width, cob length, no of rows/cob, no of grains /row, no of seeds/cob (V_3T_1) in plant height, no of cobs per plant (V_3T_2) in tassel length and leaf length (V_2T_3) in cob diameter and minimum is recorded in control (T_0)

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