Response of Nitrogen and Phosphorus on Growth, Yield and Economics of Fodder Maize (Zea mays L.)

ABSTRACT

The field experiment was conducted during *rabi* season, 2022 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P) to study the "Response of Nitrogen and Phosphorus on Growth, Yield and Economics of Fodder Maize (Zea mays L.)". The results showed that treatment 9 [Nitrogen (100 kg/ha) + Phosphorus (50 kg/ha)] recorded significantly higher plant height (164.67 cm), maximum number of leaves/plant (15.24), higher plant dry weight (75.81 g), maximum stem girth (3.33 cm), higher green forage yield (47.90 t/ha), maximum moisture content (84.02 %) and maximum crude protein content (7.57 %) compare to other treatment. The maximum gross return (119750.00 INR/ha), maximum net return (83883.77 INR/ha) and highest B:C ratio (2.33) was also recorded in treatment 9 [Nitrogen (100 kg/ha) + Phosphorus (50 kg/ha)] as compared to other treatments.

Keywords: Fodder Maize, Nitrogen, Phosphorus, Growth, Yield and Economics.

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1. Introduction

Maize (Zea mays L.) is one of the most important fodder crops in the world. It is fondly called as "King of fodder" due to its great importance in animal diet. "It is the ideal fodder crop having quick growing habit, high yielding ability, palatability, nutritive value and acceptable to the cattle at any stage of growth. The maize is also most useful crop for making silage. It can be grown within still wider limits and tolerate minimum temperature of about 10 ^{0}C and maximum of 45 ^{0}C” (**Patel and Thanki, 2020).** “Maize is cultivated in diverse production environments ranging from temperate hill zone to the semi - arid region. In terms of world acreage, among the maize growing countries, India rank 4th in area and 7th in production, Maize is an important crop for billions of people as food, feed, and industrial raw material. The global consumption pattern of maize is feed-61%, food-17% and industry-22%. Currently, nearly 1147.7 million MT of maize is being produced together by over 170 countries from an area of 193.7 million ha with average productivity of 5.75 t/ha” (**FAOSTAT 2020**).

“In India, maize is principally grown in two seasons, kharif and rabi. Kharif maize represents around 83% of maize area in India, while rabi maize correspond to 17% maize area. Among Indian states Madhya Pradesh and Karnataka has highest area under maize (15% each) followed by Maharashtra (10%), Rajasthan (9%), Uttar Pradesh (8%) and others, After Karnataka and Madhya Pradesh Bihar is the highest maize producer. Andhra Pradesh is having the highest state productivity” **(ICAR 2020).**

Livestock is backbone of Indian economy and its importance in India cannot be over emphasized. India has the largest livestock population of 520 million in the world. It is about 15 % of world's livestock population with only two per cent of world’s geographical area. With such a huge population of livestock, the country should have been over flooding with milk. The availability of nutritious feed and fodder are the major limiting factors for increasing livestock products like milk, meat, egg and wool. The supply of nutritious feed and fodder through proper scientific methods are essential for the vast livestock population (**Meena *et al.* 2022).**

“Thus fulfilling the demand for feed and fodder will be major challenge for the livestock sector of the country. Maize is most ideal and suitable crop for fodder as well as silage because of its high yielding ability, excellent nutritional profile, its quick growing nature, succulence, palatability and excellent quality without any anti-nutritional factor, when harvested at any stage of crop growth” (**Panwar *et al.* 2020).** It may not be possible to increase the area under fodder crop because of ever increasing pressure on arable land for grain and commercial crops. So, the only alternative to meet the fodder requirement is to increase the yield of fodder per unit area per unit time. This can be achieved by growing of high yielding varieties and hybrids of cereal fodders.

“Fertilizer application is one of the principle factors that directly influence the fodder yield and quality. An adequate supply of nutrients at each growth stage is highly essential for good yield and quality of fodder maize. The essential nutrients such as nitrogen and phosphorus are important for plant growth, yield and quality. Fertilization is most important agronomic practices and therefore there are several studies conducted with different fertilizer levels suggests that optimum rate of fertilizer for forage maize cultivation depends on many variable factors such as environmental factors, management systems, soil fertility and, management factors including plant density. Higher plant density may require more fertilizer. Nitrogen and Phosphorus fertilization of maize influences dry matter yield by influencing leaf area index, leaf area duration and photosynthetic efficiency. Some other researchers also reported that there were positive effects of nitrogen on dry matter yield and forage yield” (**Subrahmanya *et al*. 2019).**

“Among different nutrients, nitrogen is the most commonly deficient nutrient in the soil and gives considerable response in forage maize crop. It has the quickest and most pronounced effect on plant growth and development, and ultimately on forage yields. The adequate supply of this element is associated with vigorous vegetative growth and deep green color of the foliage. Nitrogen and phosphorus application increases the green fodder yield of maize. Phosphorus application enhances the crop to reach 50% tasseling and silking earlier. It also enhances the leaves protein content of forage maize. Crude fiber content of maize is also significantly influenced by the application of nitrogen and phosphorus” (**Ayub *et al.* 2002).**

“In plants, phosphorus is common component of organic compounds. Phosphorus deficiency, however, significantly reduces plant growth. Phosphorus application increased green forage and dry matter yield of the crop. It also effects on plant height, stem thickness and leaf: stem ratio of fodder maize and quality characters like crude protein content” (**Eltelib *et al.* 2006)**. Keeping in view the above fact, the experiment was conducted to find out “Response of Nitrogen and Phosphorus on Growth, Yield and Economics of Fodder Maize (Zea mays L.)”.

2. MATERIALS AND METHODS

This experiment was laid out during the *rabi* season of 2022 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The soil of the field constituting a part of central gang etic alluvium is neutral and deep. The soil of the experimental field was sandy loam in texture, nearly neutral in soil reaction (pH 8.0), low level of organic carbon (0.62%), available N (225 kg/ha), P (38.2 kg/ha) and K (240.7 kg/ha). The treatment consist of 3 different levels of Nitrogen (60, 80 and 100 kg/ha) with combination of 3 different levels of Phosphorus (30, 40 and 50 kg/ha). "The experiment was laid out in RBD with 9 treatment each replicated thrice. The treatment combination are T_1 – [Nitrogen (60 kg/ha) + Phosphorus (30 kg/ha0], T_2 – [Nitrogen (60 kg/ha) + Phosphorus (40 kg/ha)], T_3 – [Nitrogen (60 kg/ha) + Phosphorus (50 kg/ha)], T_4 – [Nitrogen (80 kg/ha) + Phosphorus (30 kg/ha)], T_5 – [Nitrogen (80 kg/ha) + Phosphorus (40 kg/ha)], T_6 – [Nitrogen (80 kg/ha) + Phosphorus (50 kg/ha)], T_7 – [Nitrogen (100 kg/ha) + Phosphorus (30 kg/ha)], T_8 – [Nitrogen (100 kg/ha) + Phosphorus (40 kg/ha)], T_9 – [Nitrogen (100 kg/ha) + Phosphorus (50 kg/ha)]. The Data recorded on different aspects of crop, *viz.*, growth parameters, yield attributes were subjected to statistically analysis by analysis of variance method". (**Gomez and Gomez, 1976)**

3. RESULT AND DISCUSSION:

3.1 Growth parameters

3.1.1 Plant height (cm)

The data revealed that a significantly higher plant height (164.67 cm) was recorded in treatment 9 (Nitrogen 100 kg/ha + phosphorus 50 kg/ha) as compared to rest of the treatments. However, the treatment-4 (Nitrogen 80 kg/ha + phosphorus 30 kg/ha) treatment-5 (Nitrogen 80 kg/ha + phosphorus 40 kg/ha), treatment -6 (Nitrogen 80 kg/ha + phosphorus 50 kg/ha), treatment-7 (Nitrogen 100 kg/ha + phosphorus 30 kg/ha) and treatment -8 (Nitrogen 100 kg/ha + phosphorus 40 kg/ha) was found to be statistically at par with treatment 9 (Nitrogen 100 kg/ha + phosphorus 50 kg/ha) in (Table 1). Significant and higher plant height was recorded with application of nitrogen (100 kg/ha) might be due to supply of proper amount of nitrogen at different stages of maize. The nitrogen promotes plant growth, increased number of internodes, increased cell division, cell elongation, nucleus formation as well as green foliage, which may have direct impacts on growth and development of plants. Similar results were also reported by **Kuldeep *et al.* (2022).** "Further, significant and higher plant height was with application of phosphorus (50 kg/ha) fertilizer may be due to appropriate nutrient availability, which in turn helps in robust vegetative growth of plants and subsequently increases the plant through cell elongation, cell division, photosynthesis and turbidity of plant cell which leads to vegetative growth of crop, particularly plant height". [21] Similar results was also reported by **(Kumar *et al*. 2021).**

3.1.2 Number of leaves/ plant

The data revealed that significantly maximum number of leaves/plant (15.24) was recorded in treatment-9 (Nitrogen 100 kg/ha + phosphorus 50 kg/ha) as compared to rest of the treatments. However, the treatment-4 (Nitrogen 80 kg/ha + phosphorus 30 kg/ha), treatment-5 (Nitrogen 80 kg/ha + phosphorus 40 kg/ha), treatment-6 (Nitrogen 80 kg/ha + phosphorus 50 kg/ha), treatment-7 (Nitrogen 100 kg/ha + phosphorus 30 kg/ha) and treatment-8 (Nitrogen 100 kg/ha + phosphorus 40 kg/ha) was found to be statistically at par with treatment-9 (Nitrogen 100 kg/ha + phosphorus 50 kg/ha) in (Table 1). Significant and maximum number of leaves/plant was recorded with application of nitrogen (100kg/ha) might be due to nitrogen application increased plant growth and development, particularly more nodes and inter nodes, which may have results in production of more leaves /plant. Similar results were also reported by **(Amin, 2011).** "Further, Significant and maximum number of leaves/plants was recorded with application of phosphorus (60 kg/ha) might be due to formation of new cells, promote plant vigorously and fastens leaf development, which help in harvesting more solar energy and better utilization of nitrogen, which help toward higher growth attributes". **(Sankadiya *et al*. 2021).**

3.1.3 Plant dry weight

The data revealed that significantly higher plant dry weight (75.81 g) was recorded in treatment-9 (Nitrogen 100 kg/ha + phosphorus 50 kg/ha) as compared to rest of the treatments. However, the treatment-4 (Nitrogen 80 kg/ha + phosphorus 30 kg/ha), treatment-5 (Nitrogen 80 kg/ha + phosphorus 40 kg/ha), treatment-6 (Nitrogen 80 kg/ha + phosphorus 50 kg/ha), treatment-7 (Nitrogen 100 kg/ha + phosphorus 30 kg/ha) and treatment-8 (Nitrogen 100 kg/ha + phosphorus 40 kg/ha) was found to be statistically at par with treatment-9 (Nitrogen 100 kg/ha + phosphorus 50 kg/ha) in (Table 1). Significant and higher plant dry weight was recorded with application of nitrogen (100kg/ha) might be due to adequate availability of nitrogen leads to better nutritional environment at root zone and also increases auxins supply to plants, which results in better vegetative growth and more dry matter accumulation in plants. Similar result was also reported by **(Pal *et al*. 2017).** "Further, significant and higher plant dry weight was recorded with application of phosphorus (60 kg/ha) might be due to phosphorus increases plant height, no. of leaves/plant and vegetative growth which results in more dry matter accumulation" **(Khan *et al*. 2014).**

3.1.4 Crop growth rate (g/m^2/day)

The data revealed that significantly higher crop growth rare (86.74 g/m^2/day) was recorded in treatment-9 (Nitrogen 100 kg/ha + phosphorus 50 kg/ha) as compared to rest of the treatments. However, the treatment-1 (Nitrogen 60 kg/ha + phosphorus 30 kg/ha), treatment-2 (Nitrogen 60 kg/ha + phosphorus 40 kg/ha), treatment-3 (Nitrogen 60 kg/ha + phosphorus 50 kg/ha), treatment-4 (Nitrogen 80 kg/ha + phosphorus 30 kg/ha), treatment-5 (Nitrogen 80 kg/ha + phosphorus 40 kg/ha), treatment-6 (Nitrogen 80 kg/ha + phosphorus 50 kg/ha), treatment-7 (Nitrogen 100 kg/ha + phosphorus 30 kg/ha) and treatment-8 (Nitrogen 100 kg/ha + phosphorus 40 kg/ha) was found to be statistically at par with treatment-9 (Nitrogen 100 kg/ha + phosphorus 50 kg/ha) in (Table 1). "Significant and higher crop growth rate was recorded with application of nitrogen (100kg/ha) with phosphorus (50kg/ha) might be due to supply of nutrient with higher availability of nitrogen and phosphorus which might have promoted development of morphological structure by virtue of multiplication of cell division which is well reflected through increased crop growth rate". **(Khan *et al.* 2017).**

3.2 Yield attributes

3.2.1 Stem girth (cm)

The data revealed that Significant and maximum stem girth (3.33 cm) was recorded with Treatment-9 (Nitrogen 100 kg/ha + Phosphorus 50 kg/ha) which was superior over all other treatment. However, the treatment -8(Nitrogen 100 kg/ha + Phosphorus 40 kg/ha) was found to be statistically at par with treatment-9 (Nitrogen 100 kg/ha + Phosphorus 50 kg/ha) in (Table 2). Significant and maximum stem girth was recorded with application of nitrogen (100 kg/ha) might be due to increasing supply of nitrogen concentration might trigger cell division, cell elongation which attributed to expansion of stem diameter. Similar results were also reported by **Ali *et al.* (2017).**

3.2.2 Green forage yield (t/ha)

The data revealed that Significant and higher green forage yield (47.90 t/ha) was recorded with Treatment-9 (Nitrogen 100 kg/ha + Phosphorus 50 kg/ha) which was superior over all other treatment .However, the treatment -7 (Nitrogen 100 kg/ha + Phosphorus 30 kg/ha), treatment -8(Nitrogen 100 kg/ha + Phosphorus 40 kg/ha) was found to be statistically at par with treatment-9 (Nitrogen 100 kg/ha + Phosphorus 50 kg/ha) in (Table 2). Significant and higher green forage yield was recorded with application of nitrogen (100kg/ha) might be due to nitrogen plays an important role in the synthesis of proteins, carbohydrates, which increased in yield with increased in nitrogen level was mainly due to associated with increased plant height, leaves/plant, stem diameter, dry matter production resulted higher forge yield. Similar results were also reported by **Ali *et al.* (2012)**. Further, significant and higher forage yield was with application of phosphorus (50 kg/ha) might be due to phosphorus enhances nutrient uptake by the crop, better translocation of photosynthesis form source to sink, which results in increased plant growth and forage yield. Similar results were also reported by **Jena *et al.* (2014)**.

3.2.3 Moisture content (%)

The data revealed Significant and maximum moisture content (84.02 %) was recorded with Treatment-9 (Nitrogen 100 kg/ha + Phosphorus 50 kg/ha) which was superior over all other treatment. However, the treatment-4 (Nitrogen 80 kg/ha + phosphorus 30 kg/ha), treatment-5 (Nitrogen 80 kg/ha + phosphorus 40 kg/ha), treatment-6 (Nitrogen 80 kg/ha + phosphorus 50 kg/ha), treatment-7 (Nitrogen 100 kg/ha + phosphorus 30 kg/ha),treatment -8(Nitrogen 100 kg/ha + Phosphorus 40 kg/ha) was found to be statistically at par with treatment-9 (Nitrogen 100 kg/ha + Phosphorus 50 kg/ha) in (Table 2). Significant and maximum moisture content was recorded with application of nitrogen (100kg/ha) might be due to increases the protein formation from manufactured carbohydrates. "Where, less carbohydrate is deposited in vegetative cell and more the protoplasm will be formed. As protoplasm is highly hydrated which lead to more succulence in the plant, which results in increasing level of nitrogen increased moisture content in fodder maize". **Karla *et al.* (2015).**

3.2.4 Crude protein content (%)

The data revealed Significant and maximum crude protein content (7.52 %) was recorded with Treatment-9 (Nitrogen 100 kg/ha + Phosphorus 50 kg/ha) which was superior over all other treatment. However, the treatment -8(Nitrogen 100 kg/ha + Phosphorus 40 kg/ha) was found to be statistically at par with treatment-9 (Nitrogen 100 kg/ha + Phosphorus 50 kg/ha) in (Table 2). "Significant and maximum crude protein was recorded with application of nitrogen (100kg/ha) might be due to nitrogen is an active ingredient of protein molecule and a building block of amino acid results in linear increase in crude protein with increased nitrogen levels". **Sewhag *et al.* (2021)**

3.2.5 Economic

The result showed that, maximum Gross return (119750.00 INR/ha), maximum net return **(**83883.77 INR/ha) and highest B:C ratio (2.33) was recorded maximum in treatment 9 [Nitrogen

(100 kg/ha) + Phosphorus (50 kg/ha)] in (Table 3). Maximum economic was recorded with application of Nitrogen (100 kg/ha) might be due to sufficient availability and split application of nitrogen minimize nitrogen utilization which helps to get better vegetative growth that leads to higher fodder yield. Similar result was also reported by **Meena *et al.* (2022).**

4. CONCLUSION:

On the basis of the findings given, it is determined that fodder maize with the application of Nitrogen (100kg/ha) along with Phosphorus (50 kg/ha) was observed higher green yield and benefit- cost ratio.

ACKNOWLEDGEMENT

The authors are thankful to Department of Agronomy, Naini Agricultural Institute, Prayagraj, Sam Higginbottom University of Agriculture Technology And sciences, (U.P) India for providing necessary facilities to undertaken the studies.

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Table 1: Response of different levels of nitrogen and phosphorus on growth attributes of Fodder maize

S. No.	Treatment combinations	At 80 DAS				
		Plant height (cm)	**Number of leaves/plant**	**Dry weight (g/plant)**	**CGR (60-80) DAS**	**RGR (60-80) DAS**
1.	Nitrogen 60 kg/ha + Phosphorus 30 kg/ha.	143.20	12.15	64.12	78.57	0.066
2.	Nitrogen 60 kg/ha + Phosphorus 40 kg/ha.	144.13	12.98	67.31	82.92	0.067
3.	Nitrogen 60 kg/ha + Phosphorus 50 kg/ha.	146.13	13.15	65.92	80.38	0.066
4.	Nitrogen 80 kg/ha + Phosphorus30 kg/ha.	151.97	13.48	68.90	83.88	0.066
5.	Nitrogen 80 kg/ha + Phosphorus 40 kg/ha.	154.63	13.89	70.52	84.25	0.063
6.	Nitrogen 80 kg/ha + Phosphorus 50 kg/ha.	158.17	14.37	71.96	83.54	0.060
7.	Nitrogen 100 kg/ha + Phosphorus 30 kg/ha.	164.10	14.51	72.72	82.83	0.058
8.	Nitrogen 100 kg/ha + Phosphorus 40 kg/ha.	163.23	14.83	74.96	86.29	0.059
9.	Nitrogen 100 kg/ha + Phosphorus 50 kg/ha.	164.67	15.24	75.81	86.74	0.058
	F test	S	S	S	S	NS
	SEm(±)	4.71	0.61	2.49	4.36	0.003
	CD (p=0.05)	14.11	1.83	7.47	13.06	-

Table 2: Response of different levels of nitrogen and phosphorus on yield attributes and yield of Fodder maize

S. No.	Treatment combination	Yield attributes and yield			
		Stem girth (cm)	**Green forage yield(t/ha)**	**Moisture content (%)**	**Crude protein content (%)**
1.	Nitrogen 60 kg/ha + Phosphorus 30 kg/ha.	1.34	36.97	73.99	5.04
2.	Nitrogen 60 kg/ha + Phosphorus 40 kg/ha.	1.57	38.07	77.66	5.47
3.	Nitrogen 60 kg/ha + Phosphorus 50 kg/ha.	1.92	38.87	78.74	5.82
4.	Nitrogen 80 kg/ha + Phosphorus30 kg/ha.	2.07	39.80	80.74	5.97
5.	Nitrogen 80 kg/ha + Phosphorus 40 kg/ha.	2.22	41.37	82.23	6.12
6.	Nitrogen 80 kg/ha + Phosphorus 50 kg/ha.	2.44	42.87	82.83	6.34
7.	Nitrogen 100 kg/ha + Phosphorus 30 kg/ha.	2.77	45.27	83.10	6.67
8.	Nitrogen 100 kg/ha + Phosphorus 40 kg/ha.	3.10	46.50	83.54	7.00
9.	Nitrogen 100 kg/ha + Phosphorus 50 kg/ha.	3.33	47.90	84.02	7.57
	F-test	S	S	S	S
	S Em (±)	0.11	15.55	1.98	0.21
	CD (p=0.05)	0.33	46.62	5.92	0.62

Table 3. Response of different levels of nitrogen and phosphorus application on economics in Fodder maize

S. No.	Treatment combination	Economics			
		Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C
1.	Nitrogen 60 kg/ha + Phosphorus 30 kg/ha.	34132.51	92425.00	58292.49	1.70
2.	Nitrogen 60 kg/ha + Phosphorus 40 kg/ha.	34395.01	95175.00	60779.99	1.76
3.	Nitrogen 60 kg/ha + Phosphorus 50 kg/ha.	35257.51	97175.00	61917.49	1.75
4.	Nitrogen 80 kg/ha + Phosphorus30 kg/ha.	34436.87	99500.00	65063.13	1.88
5.	Nitrogen 80 kg/ha + Phosphorus 40 kg/ha.	34999.37	103425.00	68425.63	1.95
6.	Nitrogen 80 kg/ha + Phosphorus 50 kg/ha.	35561.87	107175.00	71613.13	2.01
7.	Nitrogen 100 kg/ha + Phosphorus 30 kg/ha.	34741.23	113175.00	78433.77	2.25
8.	Nitrogen 100 kg/ha + Phosphorus 40 kg/ha.	35303.73	116250.00	80946.27	2.29
9.	Nitrogen 100 kg/ha + Phosphorus 50 kg/ha.	35866.23	119750.00	83883.77	2.33