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Effect of Nitrogen and Phosphorus levels on productivity and profitability of Fodder Maize (*Zea mays* L.)

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ABSTRACT

A field experiment entitled "Effect of Nitrogen and Phosphorus Levels on productivity and profitability of Fodder Maize (*Zea mays* L.)" was conducted at the Crop research centre-1, School of Agriculture, ITM University Gwalior (M.P.) during the *Kharif* season 2022. The experiment was laid out in a Factorial randomized block design with 9 treatment combinations, which includes three Nitrogen Levels (viz., N_1-30 kg N/ha, N_2-60 kg N/ha and N_3-90 kg N/ha), three phosphorous levels (viz., P_1-20 kg P_2O_5/ha, P_2-40 kg P_2O_5/ha and P_3-60 kg P_2O_5/ha) and one absolute control, and each treatment were replicated thrice. The result of the experiment revealed that an increase in the application of Nitrogen and Phosphorous had significantly increased the growth, yield nutrient uptake, quality and economics of fodder maize viz., plant height (cm), No. of leaves per plant, leaf area index, Stem diameter (cm), Leaf stem ratio, green fodder yield, dry matter content, dry fodder yield, nutrient uptake (kg ha^{-1}), quality studies and economics of fodder Maize, the application of 90 kg N/ha and 60 kg $P_2O_5ha^{-1}$ were significantly superior over the application of 30 kg N/ha and 20 kg P_2O_5/ha and application of 60 kg N/ha and 40 kg P_2O_5 ha^{-1} were found significant with this treatment.

Key words: *Nitrogen, Phosphorus, Yield, Nutrient uptake, Quality, Fodder maize.*

Introduction

Maize is one of the most important crops in the world's agricultural economy both as food for man and feed for animals. It is a miracle crop. It has very high yield potential (Bhagat *et al*., 2017); there is no cereal on earth with so immense potential and that is why it is called the "Queen of cereals" (Kumar *et al*., 2022). Maize is grown in almost all states of India (Kumar *et al*., 2014). It occupies an area of about 6 million hectares which accounts for about 23 per cent of the total area in the continent. It is next to rice, wheat, and sorghum in the area and production in India. Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh and Punjab are leading states growing maize on large scale. Though the maximum production of maize in Uttar Pradesh but Andhra Pradesh gives the highest average yield per hectare (3182 kg) followed by Punjab (2574 kg). It is a tall annual plant that is usually grown to the height of one to three meters or more in some cases. The root system of maize is fibrous and deep. It is usually well-developed. It consists of seminal roots, crown or coronal roots and brace and aerial roots. The seed rate for hybrid maize is 20-25 kg ha^{-1}, a composite of about 18-20 kg ha^{-1} for grain and 70-75 kg ha^{-1} for fodder. Agriculture is the backbone of the Indian economy and the livestock sector is an integral part of agriculture. The livestock sector contributes 24.72 per cent of the agricultural GDP and 4.36 per cent of the to-

tal GDP. This contribution is derived from a livestock population of about 202.3 million cattle, 102.4 million buffaloes, 4.4 million sheep, 11.8 million goats, 16 million pigs, 1.1 million camels, and 427 million others including livestock. Using these resources, India ranked first with 112.5 million tones of milk production (ICAR, 2021).

Nitrogen is a primary nutrient which is required by crop plants for their growth and development. It plays a key role in vegetative growth of maize plants. The application of nitrogen not only affects the forage yield of maize, but also improves its quality, mostly its protein content (Haque *et al*., 2001). Application of nitrogen to maize increased growth characters, yield characters and quality characters as well as nutrient uptake by increasing nitrogen levels (Aziz Khan *et al*., 2014). It is reported that application of nitrogen to maize increase fodder nutritive value by increasing crude protein,ash and by reducing fiber contents. (Baran 1987) Plant height, stem diameter, green fodder yield, protein, fiber, and total ash content were increased by increasing nitrogen levels.

Phosphorus is also considered an essential nutrient to plant growth and development. It is an integral part of nucleic acid and is essential for cellular respiration and for metabolic activity. Therefore, the use of phosphorus along with nitrogen will help increase yield of maize. Previous studies suggested that phosphorus influenced both maize's forage yield and quality (Patil *et al*,. 1997). Phosphorus application increased fodder yield and quality by increasing plant height, and the number of leaves plant^{-1} (Masood *et al*., 2011). The objective of this study was to determine the effectiveness of different phosphorus and nitrogen fertilizer on the fodder yield.

Materials and Methods

A field experiment entitled "Standardization of Nitrogen and Phosphorus Levels on Growth, Yield, Nutrient uptake, Quality and Economics of Fodder Maize (*Zea Mays* L.)"was conducted at the Crop research centre-1, School of Agriculture, ITM University Gwalior (M.P.) during the *Kharif* season of 2022. The research field is situated in the subtropics at an elevation of 196 m above sea level with coordinates at 26º 21' N latitude and 78º 17' E longitude which represents the Indo-Gangetic plains region. Gwalior is characterized by very hot summers and cold winters. Gwalior has a semiarid, subtropical climate with moderate to severe cold during the winter, hot and dry days with desiccating hot winds during summer, and humid warm in the monsoon season. The annual rainfall of Gwalior region ranges from 600 to 700 mm with uneven variations in its distributions.Gwalior receives an about 80 to 90% of the total rainfall between July to September from the southwest monsoon and the region's regular climate ranges from a max of 48°C in the summer with hot desiccating winds to a minimum of 0 °C lower in the winter with frost. But before preparing the layout, 5 samples were collected randomly from 0-15 cm depth of soil profile for chemical analysis of experiment area soil in the field. The soil of the experimental field was sandy loam in texture with a medium in available nitrogen (177.89), low in available phosphorous of 24.38 and high in available potassium of 381.73 and low in organic carbon (0.40) and having a pH of 7.4. The geographical location of the experiment field was 26.22 N and 78.18 E and situated at an altitude of 228 meters above the mean sea level. The Research Center falls under the grid zone of agro-ecological zones of Madhya Pradesh. The experiment was laid out in a Factorial randomized block design with 9 treatment combinations, which includes three Nitrogen Levels (viz., N_1-30 kg N/ha, N_2-60 kg N/ha and N_3-90 kg N/ha), three phosphorous levels (viz., P_1-20 kg P_2O_5/ha, P_2-40 kg P_2O_5/ha and P_3-60 kg P_2O_5/ha) and one absolute control, and each treatment were replicated thrice. Maize variety "African tall" was sown by line sowing (seed drills) method. And the recommended dose of fertilizer is 60:40:20 kg/ha NPK. Observations are taken while carrying the experiment, growth parameters like, Plant height (cm), No. of leaves, Stem diameter (cm), Leaf area index (LAI) and Leaf stem ratio. Yield attributing characters like, Green fodder yield, Dry matter content and Dry fodder yield. Uptake studies are Nitrogen uptake, Phosphorus uptake and Potassium uptake. In quality studies Protein content, crude fibre content and ash content and in economics, gross return, net return and B: C ratio.

Results and Discussion

The present investigation of experiment revealed that an increase in the application of nitrogen levels and phosphorus levels gradually impacted on growth parameters like plant height (cm), no. of leaves, stem diameter (cm), leaf area index (LAI)

and leaf stem ratio at 90 kg/ha, where as it is at par with 60 kg/ha but it is statistically higher over 30 kg/ha. In all the growth parameter aspect maximum nitrogen levels shows maximum growth. With a plant height (265.24 cm), no. of leaves (14.28), stem diameter (3.06 cm), leaf area index (8.55) and leaf stem ratio (0.43) with 90 kg N/ha nitrogen and plant height (250.20 cm), no. of leaves (13.08), stem diameter (2.83 cm), leaf area index (7.73) and leaf stem ratio (0.42) with 60 kg N/ha. 30kg N/ha growth was statistically less compared to 90 kg N/ha and 60kg N/ha. Nitrogen increased chlorophyll content accompanied with more functional leaves and leaf area under the application of 90 kg N ha^{-1} might have increased interception, absorption and utilization of radiant energy which in turn increased photosynthesis and thereby plant height, stem diameter and finally results in better growth (Kumar *et al.* (2018) and Sharma *et al.* (2020). In phosphorus levels also same as nitrogen, Plant height (260.50), no. of leaves (13.09), stem diameter (2.62 cm), leaf area index (8.24) and leaf stem ratio (0.39) with 60kg P_2O_5/ha and at par with 40 kg P_2O_5/ha, It is statistically superior over 20 kg P_2O_5/ha. Phosphorus fertilization improves the various metabolic and physiological processes and thus known as "energy currency" which is subsequently used for vegetative and reproductive growth through photo-phosphorylation Tadesse (2018) and Sankadiya and Sanodiya (2021) in fodder maize.

The yield attributing characters like green fodder yield (t /ha), dry matter content and dry fodder yield (t/ha). Application of 90kg N/ha recorded significantly the highest green fodder yield (39.13 t/ha), dry matter content (22.15) and dry fodder yield (8.67 t/ha), is at par with 60 kg N/ha and significantly superior over 30 kg N/ha. As significant increase in green forage yield under these fertility levels appears to be on account of their influence on dry matter production and indirectly via increase in plant height, number of leaves, leaf area index and stem diameter. The present findings are in close agreement with the results obtained by Zubair *et al.* (2015), Mandic *et al.* (2021) and Liimatainen *et al.* (2022) in fodder maize. In phosphorus levels also same as nitrogen increase in the levels green fodder yield (39.13 t/ha), dry matter content (22.15), and dry fodder yield (8.17 t/ha) in 60 kg P_2O_5/ha, it is at par with 40 kg P_2O_5/ha and is significant over 20 kg P_2O_5/ha and absolute control. As significant increase in green fodder yield under higher dose of phosphorus appears to be on account of their influence on dry matter production.

The highest,nutrient uptake was observed in parameters like,nitrogen (94.09 kg/ha), phosphorus (11.70 kg/ha) and potassium (143.34 kg/ha) uptake with 90 kg N/ha, is superior over rest of the treatment, i.e. 60, 30 kg N/ha and absolute control. As the levels of nitrogen increases concentration in leaves and associated with green forage yield both

Table 1. Growth and yield of fodder maize as influenced by nitrogen and phosphorus levels.

Treatments	Plant height (cm)	No. of leaves	Stem diameter (cm)	Leaf area index	Leaf: stem ratio	Green fodder yield (t ha^{-1})	Dry matter content (%)	Dry fodder yield (t ha^{-1})
Absolute control	196.86	8.50	1.74	5.96	0.25	26.46	17.00	4.50
Nitrogen levels (kg ha^{-1})								
N_1 – 30	223.31	10.78	2.23	6.68	0.40	31.89	18.02	5.78
N_2 – 60	250.20	13.08	2.83	7.73	0.42	36.06	20.67	7.46
N_3 – 90	265.24	14.28	3.06	8.55	0.43	39.13	22.15	8.67
S.Em ±	6.72	0.41	0.08	0.28	0.01	1.19	0.54	0.27
C.D at 5%	19.98	1.23	0.23	0.84	NS	3.53	1.59	0.80
Phosphorus levels (kg ha^{-1})								
P_1 – 20	219.01	11.86	2.10	6.47	0.36	33.41	19.09	6.42
P_2 – 40	252.24	12.83	2.40	7.48	0.38	35.35	20.74	7.38
P_3 – 60	267.50	13.44	2.62	8.24	0.39	38.31	21.01	8.11
S.Em ±	6.72	0.41	0.08	0.28	0.01	1.19	0.54	0.27
C.D at 5%	19.98	1.23	0.23	0.84	NS	3.53	1.59	0.80
Interaction								
S.Em ±	11.65	0.72	0.14	0.49	0.02	2.06	0.93	0.47
C.D at 5%	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Nutrient uptake and quality parameters of fodder maize as influenced by nitrogen and phosphorus levels.

Treatments	N-Uptake (kg ha^{-1})	P-Uptake (kgha^{-1})	K-Uptake (kg ha^{-1})	Crude protein (%)	Crude fiber (%)	Ash (%)	Gross return (ha^{-1})	Net return (ha^{-1})	B: C Ratio
Absolute control	38.98	4.39	56.99	5.44	21.72	6.05	39690.31	15620	1.65
Nitrogen levels (kg ha^{-1})									
N_1 – 30	54.46	7.29	77.84	5.88	21.26	6.21	47840	20330	1.74
N_2 – 60	82.08	10.11	119.02	6.86	20.47	7.96	54085	26140	1.93
N_3 – 90	94.09	11.70	143.34	7.25	19.06	8.13	58700	30320	2.07
S.Em ±	3.07	0.47	4.66	0.23	0.59	0.24	1781.99	1781.99	0.06
C.D at 5%	9.11	1.40	13.85	0.67	NS	0.72	5294.57	5294.57	0.19
Phosphorus levels (kg ha^{-1})									
P_1 – 20	64.77	7.22	97.31	6.47	20.59	6.90	50110	23670	1.89
P_2 – 40	77.73	10.10	114.51	6.65	20.23	7.59	53050	25110	1.90
P_3 – 60	88.13	11.77	128.38	6.86	19.97	7.80	57460	28010	1.95
S.Em ±	3.07	0.47	4.66	0.23	0.59	0.24	1781.99	1781.99	0.06
C.D at 5%	9.11	1.40	13.85	NS	NS	0.72	5294.57	NS	NS
Interaction									
S.Em ±	5.31	0.82	8.07	0.39	1.02	0.42	3086.50	3086.50	0.11
C.D at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

are increases Reddy *et al.* (2014). In phosphorus levels also nutrient uptake increases like nitrogen (88.13 kg N/ha), phosphorus (11.77 kg P_2O_5/ha) and potassium (128.38 kg P_2O_5/ha) but it is highly superior over all the treatments, i.e. 40, 20 kg P_2O_5/ha and absolute control. Significant improvement in uptake of P might be attributed due to the low level of available phosphorus already present in the soil under these treatments Khanzada *et al.* (2022)

The highest crude protein content (7.25), ash content (8.13) with 90 kg N/ha and is at par with 60 kg N/ha and it is statistically superior over 30kg N/ha. Protein and ash contents were dependent on nitrogen content. The highest crude fibre content (21.26) was observed in 30 kg P_2O_5/ha and it is at par with, 60 kg N/ha but superior over 90 kg N/ha. The highest crude protein content (6.86), ash content (7.80) with 60 kg P_2O_5/ha, it is at par with 40 kg P_2O_5/ha, where as it is superior over 20 kg P_2O_5/ha. But in crude fibre content it was reverse highest crude fibrecontent (20.59) was observed in 20 kg P_2O_5/ha, it is at par with 40 kg P_2O_5/ha, where as it is significant over 60 kg P_2O_5.

The highest gross returns (58700/ha), net return (30320/ha)and B: C ratio (1.07) was recorded with application of 90 kg N/ha, closely followed by that of 60 kg N/ha and lowest was observed in 30 kg N/ha. The highest gross return (39690/ha), net return (28010ha) and B: C ratio (0.95) was observed with the application of 60 kg P_2O_5/ha. It is followed by 40 kg P_2O_5/ha and lowest was recorded in 20 kg P_2O_5/ha.

Conclusion

From the results of the experiment it is concluded that application of 90 kg N/ha nitrogen and 60 kg P_2O_5/ hashowed better results in growth, yield, nutrient uptake, quality studies and economics of fodder maize, followed by 60 kg N/ha and 40 kg P_2O_5/ ha and significantly lower results were recorded in 30 kg N/ha and 20 kg P_2O_5/ha and lowest results were observed in absolute control among the treatment levels.

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