Original Research Article

Response of Nitrogen and Gibberellic acid 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 Agricultural, Technology And Sciences, Prayagraj (U.P.) to study the "Response of nitrogen and gibberellic acid on growth and yield of fodder maize (*Zea mays* L.)". The results showed that treatment 9 [Nitrogen (100 kg/ha) + Gibberellic acid (75ppm)] recorded significantly higher plant height (188.83 cm), maximum number of leaves/plant (15.00), higher plant dry weight (71.29 g), maximum stem thickness (2.40 cm), higher green forage yield (43.55 t/ha) and maximum moisture content (83.45 %) compare to all other treatments. The maximum gross return (108875.00 INR/ha), net return **(**71914.35 INR/ha) and highest B:C ratio (1.94) was recorded in treatment 9 application of [Nitrogen (100 kg/ha) + Gibberellic acid (75ppm)] as compared to all other treatments.

Keywords: Fodder Maize, Nitrogen, Gibberellic acid, Growth, Yield and Economics.

Introduction

India has the largest livestock population of 520 million heard which is about 15 per cent of the world's livestock. Whereas, India has only 2 per cent of the world's geographical area under fodder crops (Solanki *et al*. 2022).Uttar Pradesh has about 67.8 million of livestock population which needs about 203.4 million tonnes dry fodder. However, only 70 million tonnes of dry fodder is available from all the resources. The unavailability of sufficient quality green fodder throughout the year in the state is the major constraint in the development of animal husbandry. To alter such situation, forage maize (*Zea mays* L.) can play an important role, because agro-climatic condition of the state is well suited for growing maize as an ideal fodder crop. Maize has the best nutritive value and the milk production increases when it is fed to milch animals. This crop can be grown throughout year and on account giving green fodder within short period, it is very good fodder crop for lean period of the year. Its fodder can be used for

silage making when the other succulent fodder crops are available as green fodder. Maize is also preferred over other crops due to quick growing nature, being free from toxicants and better forage qualities.

Agriculture is the back bone of Indian economy and livestock sector is an integral part of agriculture. At present, the country is facing a net deficit of 61.1 per cent green fodder, 21.9 per cent dry crop residue and 64 per cent concentrated feeds (Nepalia *et al*. 2020). At current level of growth in forage resources, there will be 64 per cent deficit in green fodder and 25 per cent deficit in dry fodder. This situation indicates that green forage supply has to grow at 3.2 per cent to meet the deficit (Anon. 2013).

Maize is one of most important crop in the world agricultural economy both as food for man and feed for animals. It has very high yield potential; there is no cereal on earth with so immense potentially and that is why it is called “Queen of cereals". Maize is an annual plant which belongs to family Gramineae and Genus *Zea*.

Maize is grown in almost all states of India. Fodder maize is one of the most important forage crop next to sorghum in India and it occupies 0.9 million hectares area (Ram *et al*. 2019).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 is having the highest state productivity followed by Punjab (ICAR 2020).

Among various essential plant nutrients, nitrogen is the key element in crop growth and is the most limiting nutrient in Indian soils. The paramount importance of nitrogen for luxuriant vegetative growth, early bulking of crop and quick growing has been widely accepted. The major portion of the nitrogen taken up by the plants is used in synthesizing protein. Maize being exhaustive crop requires heavy dose of nitrogen for producing succulent high quality herbage. Nitrogen application enhances forage yield and gross returns of maize. The forage quality of maize is improved with proper dose of nitrogen application. This may be due to acceleration of meristamatic activity and encouragement of vegetative growth with nitrogen application.

Nowadays, phytohormones have been found to play a major role in plants development. Plant growth hormones have plentiful applications in agriculture i.e. delaying/accelerating maturity, stimulation, flowering, abscission, controlling weeds and so on (Neupane *et al*. 2011). Dwarfing depends upon gibberellin deficiency and dwarfing gene effects on gibberellin

biosynthesis. So, by applying gibberellic acid on dwarf maize mutant, they showed normal growth after hormone treatment. In addition, long stems have more bioactive gibberellin than short stems (Naghashzadeha *et al.* 2009). Plant growth hormones so far have been emerged as "magic chemicals" that could increase agricultural production at an unprecedented rate and help in removing and circumventing many of the barriers imposed by genetics and environment. Therefore, the present study was conducted to investigate the suitable doses of gibberellic acid for increasing the growth and yield attributes of fodder maize. Keeping in view the above fact, the experiment was conducted to find out "Response of different levels of nitrogen and gibberellic acid on growth and yield 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 gangetic 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 Gibberellic acid (25, 50 and 75 ppm). The experiment was laid out in RBD with 10 treatment each replicated thrice. The treatment combination are T_1 – [Nitrogen (60 kg/ha) + Gibberellic acid (25ppm)], T_2 – [Nitrogen (60 kg/ha) + Gibberellic acid (50ppm)], T_3 – [Nitrogen (60 kg/ha) + Gibberellic acid (75ppm)], T_4 – [Nitrogen (80 kg/ha) + Gibberellic acid (25ppm)], T_5 – [Nitrogen (80 kg/ha) + Gibberellic acid (50ppm)], T_6 – [Nitrogen (80 kg/ha) + Gibberellic acid (75ppm)], T_7 – [Nitrogen (100 kg/ha) + Gibberellic acid (25ppm)], T_8 – [Nitrogen (100 kg/ha) + Gibberellic acid 50ppm)], T_9 – [Nitrogen 100 kg/ha) + Gibberellic acid (75ppm)] and T_{10} – [Control]. 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)**.

RESULT AND DISCUSSION:

Growth parameters Plant height (cm)

The data revealed that significantly higher plant height (188.83 cm) was recorded in treatment 9 (Nitrogen 100 kg/ha + Gibberellic acid 75ppm) as compared to all treatments. This results might be due to positive effect of nitrogen (100 kg/ha). 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 was also reported by **Kuldeep *et al.*, (2022)**. Further, significant and higher plant height was with application of gibberellic acid (75ppm) gibberellic acid promotes cell elongation through releasing DELLA mediated inhibition of BZR1 transcription factors which increase plant height and development. Similar results was also reported by **Rasheed *et al.*, (2021).**

Number of leaves/ plant

The data revealed that significantly maximum number of leaves/plant (15.00) was recorded in treatment 9 (Nitrogen 100 kg/ha + Gibberellic acid 75ppm) as compared to all treatments. The 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 internodes, which may have results in production of more leaves /plant. Similar results was also reported by **Amin, (2011).** Further, significant and maximum number of leave/plant was with application of gibberellic acid (75ppm) Gibberellic acid are extensively involved in all phase of plant growth and development, increase the strength of physiological source by increasing chlorophyll and effective age of leaves. They promote leaf expansion, number of leaves and development. Similar results was also reported by **Rahim *et al.*, (2018).**

Plant dry weight

The data revealed that significantly higher plant dry weight (71.29 g) was recorded in treatment 9 (Nitrogen 100 kg/ha + Gibberellic acid 75ppm) as compared to rest of the treatments. However, the treatment 8 (Nitrogen 100 kg/ha + Gibberellic acid 50ppm), treatment 7 (Nitrogen 100 kg/ha + Gibberellic acid 25ppm), treatment 6 (Nitrogen 80 kg/ha + Gibberellic acid 75ppm), treatment 5 (Nitrogen 80 kg/ha + Gibberellic acid 50ppm) and treatment 4 (Nitrogen 80 kg/ha + Gibberellic acid 25ppm) was found to be statistically at par with treatment-9 (Nitrogen 100 kg/ha + Gibberellic acid 75ppm).This 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).** Gibberellic acid promotes cell proliferation in plant development stages due to their own metabolism regulation and promotes the development of cells by increasing turgor pressure and it also activates different enzymes and has a positive effect on plant growth and dry matter accumulation, similar result was also reported by **Guguloth *et al*.**

(2022).

Yield attributes

Stem thickness (cm)

The data revealed that Significant and maximum stem thickness (2.40 cm) was recorded with treatment 9 (Nitrogen 100 kg/ha + Gibberellic acid 75ppm) which was superior over all other treatments. Significant and maximum stem girth was recorded with application of nitrogen (100 kg/ha) might be due to increased supply of nitrogen concentration which trigger cell division, cell elongation resulted in expansion of stem diameter. Similar results were also reported by **Ali *et al.* (2017)**.

Green forage yield (t/ha)

The data revealed that Significant and higher green forage yield (43.55 t/ha) was recorded with treatment 9 (Nitrogen 100 kg/ha + Gibberellic acid 75ppm) which was superior over all other treatments. Significant and higher green forage yield was recorded with application of nitrogen (100kg/ha) might be due to important role of nitrogen in the synthesis of proteins, carbohydrates, which lead to increased plant height, leaves/plant, stem diameter, dry matter production resulted higher forge yield. Similar results was also reported by **Ali *et al.* (2012)**. Further, application of gibberellic acid (75ppm) the plant growth regulators also increases metabolization of reserved food materials to the developing sink through increases in hydrolyzing and oxidizing enzyme activities and lead to yield increases in plant, similar results was also reported by **Singh *et al.* (2018)**.

Moisture content (%)

The data revealed Significant and maximum moisture content (83.45 %) was recorded with treatment 9 (Nitrogen 100 kg/ha + Gibberellic acid 75ppm) which was superior over all other treatment. Significant and maximum moisture content was recorded with application of nitrogen (100 kg/ha) might be due to increasing level of nitrogen increased moisture content in fodder maize. Where less carbohydrate are 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 increased moisture content in fodder maize. Similar results was also reported by

Karla *et al.* (2015).

Economics

The result showed that, maximum Gross return (108875.00 INR/ha), maximum net return **(**71914.35 INR/ha) and highest B:C ratio (1.94) was recorded maximum in treatment 9 [Nitrogen (100 kg/ha) + Gibberellic acid (75ppm)] 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).**

CONCLUSION:

It can be concluded that in fodder maize application of Nitrogen 100 kg/ha along with Gibberellic acid 75ppm (treatment 9) recorded higher fodder yield and benefit cost ratio.

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Table 1: Response of different levels of nitrogen and gibberellic acid 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 + Gibberellic acid 25ppm	159.97	12.22	61.83	68.28	0.0543
2.	Nitrogen 60 kg/ha + Gibberellic acid 50ppm	162.31	12.44	63.06	69.87	0.0546
3.	Nitrogen 60 kg/ha + Gibberellic acid 75ppm	164.98	12.78	60.63	66.74	0.0539
4.	Nitrogen 80 kg/ha + Gibberellic acid 25ppm	169.20	13.00	65.13	72.77	0.0556
5.	Nitrogen 80 kg/ha + Gibberellic acid 50ppm	171.97	13.22	66.74	72.22	0.0523
6.	Nitrogen 80 kg/ha + Gibberellic acid 75ppm	175.00	13.33	67.64	71.50	0.0502
7.	Nitrogen 100 kg/ha + Gibberellic acid 25ppm	179.40	14.11	69.17	71.88	0.0491
8.	Nitrogen 100 kg/ha + Gibberellic acid 50ppm	184.30	14.22	69.75	73.23	0.0498
9.	Nitrogen 100 kg/ha + Gibberellic acid 75ppm	188.83	15.00	71.29	73.03	0.0477
10.	80-40-40 kg NPK/ha (Control)	165.60	12.67	62.44	66.43	0.0509
	F test	S	S	S	NS	NS
	SEm(±)	0.75	0.13	2.29	4.09	0.002
	CD (p=0.05)	2.24	0.41	6.8	-	-

Table 2: Response of different levels of nitrogen and gibberellic acid on yield attributes and yield of Fodder maize.

S. No.	Treatment combinations	Yield attributes and yield		
		Stem thickness (cm)	Green forage yield (t/ha)	Moisture content (%)
1.	Nitrogen 60 kg/ha + Gibberellic acid 25ppm	1.67	29.96	70.21
2.	Nitrogen 60 kg/ha + Gibberellic acid 50ppm	1.69	31.24	71.35
3.	Nitrogen 60 kg/ha + Gibberellic acid 75ppm	1.73	32.51	73.21
4.	Nitrogen 80 kg/ha + Gibberellic acid 25ppm	1.84	34.13	74.36
5.	Nitrogen 80 kg/ha + Gibberellic acid 50ppm	1.88	36.09	75.95
6.	Nitrogen 80 kg/ha + Gibberellic acid 75ppm	1.97	37.71	77.32
7.	Nitrogen 100 kg/ha + Gibberellic acid 25ppm	2.08	39.42	79.19
8.	Nitrogen 100 kg/ha + Gibberellic acid 50ppm	2.30	40.96	81.36
9.	Nitrogen 100 kg/ha + Gibberellic acid 75ppm	2.40	43.55	83.45
10.	80-40-40 kg NPK/ha (Control)	1.74	33.14	72.49

F test		S	
	S 0.03		S 0.55
SEm (±)		0.32	
CD (P=0.05)	0.09	0.96	1.66

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 + Gibberellic acid 25ppm	35151.65	74900.00	39748.35	1.13
2.	Nitrogen 60 kg/ha + Gibberellic acid 50ppm	35751.65	78100.00	42348.35	1.18
3.	Nitrogen 60 kg/ha + Gibberellic acid 75ppm	36351.65	81275.00	44923.35	1.23
4.	Nitrogen 80 kg/ha + Gibberellic acid 25ppm	35459.65	85325.00	49865.35	1.40
5.	Nitrogen 80 kg/ha + Gibberellic acid 50ppm	36059.65	90225.00	54165.35	1.50
6.	Nitrogen 80 kg/ha + Gibberellic acid 75ppm	36659.65	94275.00	57615.35	1.57
7.	Nitrogen 100 kg/ha + Gibberellic acid 25ppm	35760.65	98550.00	62789.35	1.75
8.	Nitrogen 100 kg/ha + Gibberellic acid 50ppm	36360.65	102400.0	66039.35	1.81
9.	Nitrogen 100 kg/ha + Gibberellic acid 75ppm	36960.65	108875.00	71914.35	1.94
10.	80-40-40 kg NPK/ha (Control)	33879.65	82850.00	48970.35	1.44