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EFFECT OF DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS ON GROWTH OF FODDER MAIZE (*ZEA MAYS* L.)

KULWINDER SINGH[1] AND KARAN VERMA[2,*]

University College of Agriculture, Guru Kashi University Talwandi Sabo
Bathinda-151 302 (Punjab), India
(e-mail : karanverma@gku.ac.in)

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SUMMARY

A field experiment entitled "Fodder maize production under different levels of nitrogen and phosphorus in Punjab" was carried out at the research farm of Guru Kashi University, Talwandi Sabo (Bathinda) during *kharif* season 2021. The experiment comprising total 16 treatments combinations *viz.,* four levels of nitrogen control, (Control, nitrogen @ 60, 80 and 100 kg/ha) allotted in main plots and four level of phosphorus (Control, P_2O_5 @ 30, 40 and 50 kg/ha) in sub plot treatments. Experiment was carried out in split plot design with three replications. Results revealed that growth, yield and economics of maize influenced significantly due to application of nitrogen and phosphorus levels. Results showed that application nitrogen @ 100 kg/ha at par with nitrogen @ 80 kg/ha recorded significantly higher plant height, dry weight, leaf area index, number of leaves/plant, number of internodes/plant, inter-node length and leaf: stem ration as compared to control and nitrogen @ 60 kg/ha. Further results indicated that application of P_2O_5 @ 50 kg/ha at par with P_2O_5 @ 40 kg/ha recorded significantly higher plant height, dry weight, leaf area index, number of leaves/plant, number of internodes/plant, inter-node length and leaf: stem at 40 and 60 DAS, as compared to control and P_2O_5 @ 30 kg/ha, respectively.

Keywords: Maize, nitrogen, phosphorus, growth and yield attributes and yield

Maize in India, contributes nearly 9 percent in the national basket and more than Rs.100 billion to the agricultural GDP. In India, maize is cultivated on 9.84 million hectares with a production of 23.85 million tonnes and productivity 25.83 q/ha (Anonymous., 2020) mainly during kharif season, which covers 80 per cent area. Karnataka (16.5 per cent), Rajasthan (9.9 per cent), Maharashtra (9.1 per cent), Bihar (8.9 per cent), U.P (6.1 per cent), Madhya Pradesh (5.7 per cent) and Himachal Pradesh (4.4 per cent).

The maize production in Punjab was 4071 lakh metric tonnes, and the total area under the crop was 1.29 lakh hectares with an average productivity of 3,650 kg/ha, farmers. cultivating maize made substantial profits that year.

The leaf area and canopy structures are important growth parameters for fodder production. The optimum leaf area index for grain production is considerably less than that for maximum dry matter production. Goldsworthy *et al*., (1974) demonstrated that when leaf area index was larger than five the additional dry matter produced accumulated mainly on the stem and therefore, leaf production can be increased by increasing leaf area per plant. All growth attributes that directly or indirectly affected fodder yield and quality are affected by cultural practices as well as agricultural inputs.

Forge yield in maize increases and quality decreases rapidly as plant matures (Jung and Barkjer 1973), indicating that harvesting at early heading stage is generally the right time to produce high fodder yield with high quality. When maize is grown for silage, it is harvested 2-3 weeks earlier than maize harvested for grain. Pain (1978) reported that when maize is the most suitable crop to be grown for silage in temperate countries, fodder maize become one of the most important feed stuffs for ruminants specially cattle (Rouanet, 1987). Fodder maize compared to other grasses has a relatively high content of non-structural carbohydrates. In case of silage maize, sugars with in the cell and the water-soluble carbohydrates are more important in the preservation of the silage material (Pain, 1978). Other carbohydrate sugars are often added to the crop for silage making.

Nitrogen fertilization increased number of leaves per plant and leaf area (Gasim, 2001). John

[1]M. Sc. Agronomy Scholar, [2]Assistant Professor (Agronomy)

and Warren (1967) noted that the addition of nitrogen increased stem diameter. Koul (1997) recorded that nitrogen application resulted in greater values of plant height, leaf area, number of leaves and stem diameter of fodder maize, fresh and dry forage yield were also increased due to addition of nitrogen. Leaf to stem ratio was found also to be increased by nitrogen (Duncan, 1980). These findings are in full agreement with that of Gasim (2001) who reported that the increase in leaf to stem ratio with nitrogen application is probably due to the increase in number of leaves and leaf area under nitrogen treatments, producing more and heavy leaves.

Nitrogen is a primary nutrient required by crop plants for their growth and development. Nitrogen plays a key role in vegetative growth and grain production of maize plant. The application of nitrogen not only affects the fodder yield of maize, but also improves its quality especially its protein contents. It is reported that application of nitrogen to maize increase fodder nutritive value by increasing crude protein and by reducing ash and fiber contents. 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.

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. The studies suggested that phosphorus influenced both maize's fodder yield and quality. Phosphorus application increased fodder yield and quality by increasing plant height, and the number of leaves per plant.

MATERIALS AND METHODS

The field experiment was conducted at Research Farm of Guru Kashi University, Talwandi Sabo (Bathinda), Punjab, India ($29^0 57'$N latitude and $75^0 7'$E longitude and altitude of 213 m average elevation from above mean sea level) in 2021. At the start of the experiment, the soil in the experimental field was sandy loam, slightly alkaline in reaction (pH 7.6), with low available nitrogen (Alkaline permanganate method, Subbiah and Asija, 1956) 127 kg/ha, medium available phosphorus of 13.8 kg/ha, (Olsen's method, Olsen *et al.,* 1954), and medium available potassium of 245.4 kg/ha, (Flame photometric method (Jackson (1973) in 0-15 cm soil depth. The experiment was laid out in factorial randomized block design with three replications. There were experiment comprises viz. four nitrogen levels (0, 60, 80 and 100 kg/ha) and four levels of phosphorus (0, 30, 40 and 50 kg/ha). Maize variety 'J-1006' was sown on July 7, 2021 with using seed rate of 70.0 kg per hectare at the row spacing of 30 cm. All the recommended package of practices was followed to raise the crop. Growth and yield parameters were recorded as per standard practice. The plant population at 15 DAS and at harvest, plant height at 40 and 60 DAS, dry matter accumulation at 40 and 60 DAS, number of leaves/plant at 40 and 60 DAS, number of internodes/plant at 40 and 60 DAS, stem thickness at 40 and 60 DAS, length of internodes at 40 and 60 DAS, LAI, Leaf: Stem ratio were measured from randomly selected five plants from each plot. Experimental data recorded in various observations were statistically analyzed with the help of Fisher's analysis of variance technique (Fisher, 1950). The analysis of data of the various treatments was compared together using CD at 5% significant levels.

RESULTS AND DISCUSSION

Effect of nitrogen levels

Results revealed that plant height at 40 and 60 DAS, dry matter accumulation at 40 and 60 DAS, number of leaves/plant at 40 and 60 DAS, number of internodes/plant at 40 and 60 DAS, stem thickness at 40 and 60 DAS, length of internodes at 40 and 60 DAS, LAI, Leaf: stem ratio of fodder maize was influenced significantly by different levels of nitrogen (Table 1 and 2). Plant population of maize did not differ with the application of nitrogen. Application of nitrogen 100 kg/ha recorded maximum plant height (117.40 cm and 173.89 cm), dry weight (156.1 and 246.9 g/plant), number of leaves/plant (11.9 and 15.7), number of internodes/plant (10.82 and 14.88), length of internode (10.61 and 10.42 cm) and leaf area index (11.98 and 16.17), leaf- stem ratio at 40 and 60 DAS and stem thickness as compared to control and nitrogen 60 kg/ha, respectively, but it was at par with the application of nitrogen 80 kg/ha.

The growth parameters increased with increasing in successive levels of nitrogen might be due to more supply of nitrogen to crop resulting in rapid synthesis of carbohydrates and consequently

TABLE 1
Effect of nitrogen and phosphorus levels on plant population, plant height, dry weight and number of leaves of fodder maize

Treatments	Plant population		Plant height (cm)		Dry weight (g/plant)		Number of leaves/plant	
	Initial	Final	40 DAS	60 DAS	40 DAS	60 DAS	40 DAS	60 DAS
Nitrogen levels (N kg/ha)								
Control	65583	64108	82.65	118.24	109.00	174.11	8.0	11.0
60	65542	64142	99.34	144.56	132.91	210.47	9.9	13.2
80	66667	66350	111.80	164.22	149.66	235.88	11.2	14.9
100	66083	64683	117.40	173.89	156.09	246.91	11.9	15.7
S.Em.±	1407	1571	2.60	4.17	2.92	4.36	0.3	0.4
CD at 5 %	NA	NA	7.51	12.05	8.44	12.61	0.8	1.0
Phosphorus levels (P_2O_5 kg/ha)								
Control	65417	64825	91.98	132.95	122.28	194.46	9.0	12.3
30	66542	65117	100.17	145.87	133.36	210.64	9.9	13.4
40	66333	65158	106.97	157.43	143.33	225.80	10.7	14.6
50	65583	64183	112.08	164.66	148.70	236.47	11.3	15.0
S.Em.±	1407	1571	2.60	4.17	2.92	4.36	0.3	0.4
CD at 5 %	NA	NA	7.51	12.05	8.44	12.61	0.8	1.0

DAS-Days after sowing, N-Nitrogen, P_2O_5 - Phosphorus

converted into protoplasm and thereby smaller portion available for cell wall formation. This has served consequences one of them is increase in size of cell which is expressed morphologically through increase in dry matter accumulation, number of leaves/plant at, number of internodes/plant, stem thickness, length of internodes. The results are in conformity with the findings of Singh and Agarwal (2004) and Chotiya and Singh (2005). Satpal *et al*. (2022) also reported that yield attributes of fodder maize improved with application of nitrogen from 0 to 160 kg N/ha. They further added that Leaf to stem ratio and plant height improved significantly due to increased nitrogen levels over lower nitrogen doses. The higher leaf: stem ratio with increasing level of nitrogen might be due to more supply of nitrogen, leading to more protein synthesis. The extra protein, might have allowed the leaves to grow larger and ultimately larger surface area.

Effect of phosphorus levels

Data presented in Table 1 and 2 indicated that

TABLE 2
Effect of nitrogen and phosphorus levels on number of internodes, stem thickness, length of internodes, LAI and Leaf: stem ratio of fodder maize

Treatments	Number of internodes/ plant		Stem thickness (cm)		Length of internodes (cm)		Leaf area index		Leaf-stem ratio	
	Initial	Final	40 DAS	60 DAS	40 DAS	60 DAS	40 DAS	60 DAS	40 DAS	60 DAS
Nitrogen levels (N kg/ha)										
Control	7.27	10.65	0.73	1.04	5.64	7.26	8.47	11.52	0.776	0.938
60	9.03	12.62	0.84	1.17	7.05	8.76	9.71	13.18	0.795	0.962
80	10.15	13.88	0.90	1.26	8.11	9.89	11.15	15.08	0.803	0.971
100	10.82	14.88	0.96	1.34	8.61	10.42	11.98	16.17	0.831	1.005
S.Em.±	0.26	0.40	0.03	0.03	0.23	0.23	0.30	0.41	0.015	0.014
CD at 5 %	0.75	1.14	0.07	0.10	0.66	0.67	0.86	1.17	0.043	0.042
Phosphorus levels (P_2O_5 kg/ha)										
Control	7.16	10.59	0.72	1.03	6.43	8.06	8.37	11.26	0.779	0.943
30	9.17	12.84	0.83	1.17	7.14	8.82	9.88	13.46	0.794	0.960
40	10.13	13.92	0.91	1.27	7.74	9.46	11.25	15.16	0.802	0.970
50	10.81	14.70	0.96	1.34	8.13	9.98	11.80	16.07	0.830	1.004
S.Em.±	0.26	0.40	0.03	0.03	0.23	0.23	0.30	0.41	0.015	0.014
CD at 5 %	0.75	1.14	0.07	0.10	0.66	0.67	0.86	1.17	0.043	0.042

plant height at 40 and 60 DAS, dry matter accumulation at 40 and 60 DAS, number of leaves/plant at 40 and 60 DAS, number of internodes/plant at 40 and 60 DAS, stem thickness at 40 and 60 DAS, length of internodes at 40 and 60 DAS, LAI, Leaf: stem ratio of fodder maize was influenced significantly due to different levels of phosphorus. Plant population of maize did not differ with the application of different doses of phosphorus. Significantly higher values of plant height (112.08 cm and 164.88 cm), dry weight (148.70 and 236.47g/plant), number of leaves/plant (11.3 and 15.0), number of internodes/plant (10.81 and 14.70), length of internodes (8.13 and 9.98 cm) and leaf area index (11.98 and 16.17), leaf- stem ratio at 40 and 60 DAS and stem thickness (0.96 and 1.34 cm) were observed with the application of phosphorus @ 50 kg/ha, but it was at par with phosphorus @40 kg/ha and proved superior over control and phosphorus @ 30 kg/ha, respectively.

The increase in increase in dry matter accumulation, number of leaves/plant at, number of internodes/plant, stem thickness, length of internodes of fodder maize with successive doses of phosphorus might be owing to the role of phosphorus in cytokine synthesis, which increases cell division and elongation, thereby resulting in higher growth parameters. These results were in agreement with Midha *et al.* (2015), Meena and Jain (2013). Increase in number of leaves with increasing in phosphorus rates has been reported by Patil (2012).

CONCLUSION

On the basis of results obtained in this study, it can be concluded that application of nitrogen @ 80 kg/ha and phosphorus @ 40 kg/ha is needed to realize the higher values of growth attributes of fodder maize.

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