Forage Res., **46** (4) : pp. 363-367 (2021) **http://forageresearch.in**

RESPONSE OF SPRING PLANTED FODDER MAIZE TO NITROGEN AND PHOSPHORUS LEVELS

MEENA SEWHAG[1], SHWETA[1], SURESH KUMAR[1], ROHTAS KUMAR[2], J. TOKAS[3], NEELAM[1], UMA DEVI[1] AND SATPAL[1]

[1]Department of Agronomy, [2]Department of Soil Science, [3]Department of Biochemistry,
CCS Haryana Agricultural University, Hisar-125004 (Haryana), India
**(e-mail : meenasewhag@gmail.com)*

(Received : 16 December 2020; Accepted : 27 March 2021)

SUMMARY

Nitrogen and phosphorus are the nutrient that most frequently limits yield and plays an important role in quality of forage crops. To investigate the effect of varying nitrogen and phosphorus levels on growth, yield and quality of spring fodder maize (*Zea mays* L.), a field study was conducted during spring 2019 at Agronomy Research Farm, CCS Haryana Agricultural University, Hisar located at 29°16'N latitude and 75°7'E longitude at an elevation of 215.2 m above the mean sea level in north-west part of India. The soil of the experimental field was sandy loam in texture, neutral in reaction, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potassium. The experiment was laid out in FRBD design with four nitrogen levels (0, 50, 75 and 100 kg N/ha) and four phosphorus levels (0, 15, 30 and 45 kg P_2O_5/ha) replicated thrice. Overall results depicted that growth parameters, yield attributes and yield of fodder maize in spring season increased with the increase in nitrogen and phosphorus levels upto 100 kg N/ha and 45 kg P_2O_5/ha, respectively. With the application of nitrogen @ 50, 75 and 100 kg N/ha there was 27.86, 49.50 and 64.50 per cent increase, respectively, in green fodder yield over the control (no nitrogen). Application of increasing level of nitrogen and phosphorus increased the soil available nitrogen and phosphorus status over control. Application of 100 kg N ha^{-1} and 45 kg P_2O_5/ha recorded highest crude protein (%) and crude protein yield of fodder maize, however, the crude protein recorded at 50, 75 and 100 kg N/ha was statistically at par with each other. Synergistic effect of N and P was observed on green fodder and dry matter yield.

Key words : Fodder maize, green fodder yield, nitrogen, phosphorus and spring season

The demand for maize will double in the developing world by the year 2050 and it is predicted to become the crop with the greatest production globally and in the developing world. Under current scenario, forage based economical feeding strategies are needed to cut down the cost of livestock product as the feed alone constitutes 60-70% of the total milk production cost. However, there is tremendous pressure of livestock on available total feed, fodder, as land available for fodder production has been decreasing and there is hardly any scope of expansion due to increasing pressure on agricultural land for food and cash crops. Thus, any attempt towards enhancing feed availability and economizing the feed cost would result in increased margin of profits to livestock owners. The solution, therefore, lies in increasing quality fodder production on limited space and time as green fodder is considered as the rich and cheapest source of protein, vitamins, carbohydrates and minerals for livestock (Kumar *et al*., 2020). Maize being a C_4 plant is considered as an important crop, which is cultivated for food, feed and fodder. It is quick growing high yielding crop and supplies essential nutrients (Arya *et al.,* 2020). It can be fed at any stage of growth without any risk to animals as it is free from anti-metabolites. It is one of the most adaptable emerging crops having wider adaptability under varied agro-climatic conditions (Arya *et al.,* 2015). It can be grown almost throughout the year in our country and can be fed as green or dry and is most favourable for silage making. Maize, being a fast growing crop, is highly exhaustive in nature requires efficient nitrogen and phosphorus management as they are of the most important and complex nutrients needed by the crop plants in particular for yield and quality. Ayub *et al*. (2002) reported that nitrogen and phosphorus application increased the green fodder yield of maize. An increase in the leaves protein content of maize is

reported in response to phosphorus application. Most of the research work in fodder maize has been carried out in rainy season, but limited studies have been carried out to in the spring planted fodder maize. The main objective of this study was to investigate the influence of different levels of nitrogen and phosphorus on growth, yield and quality of spring planted fodder maize.

MATERIALS AND METHODS

To analyze the influence of varying nitrogen and phosphorus levels on performance of fodder maize in spring season a field experiment was carried out during *spring* season of 2019 at Agronomy Research Area of Chaudhary Charan Singh Haryana Agricultural University, Hisar located at 29°16'N latitude and 75°7'E longitude at an elevation of 215.2 m above the mean sea level in north-west part of India with an objective to evaluate the effect of four different levels of nitrogen and phosphorus on growth, yield and quality parameters of fodder maize planted in spring season. The experiment was laid out in FRBD design with four nitrogen levels (0, 50, 75 and 100 kg N/ha) and four phosphorus levels (0, 15, 30 and 45 kg P_2O_5 /ha) replicated thrice. The climate of Hisar is sub-tropical, semi-arid with an average annual rainfall of around 450 mm of which, 70-80 per cent is received during monsoon period *i.e.*, July to September and the rest is received in showers of cyclic rains during the winter and spring seasons. The weekly weather data during the crop season has been depicted in figure 1. The Soil nitrogen and phosphorus status before sowing was 128.38 kg N/ha and 17.64 kg P_2O_5/ha, respectively, while organic carbon, pH and available K_2O were 0.44, 7.8 and 375 kg/ha, respectively.

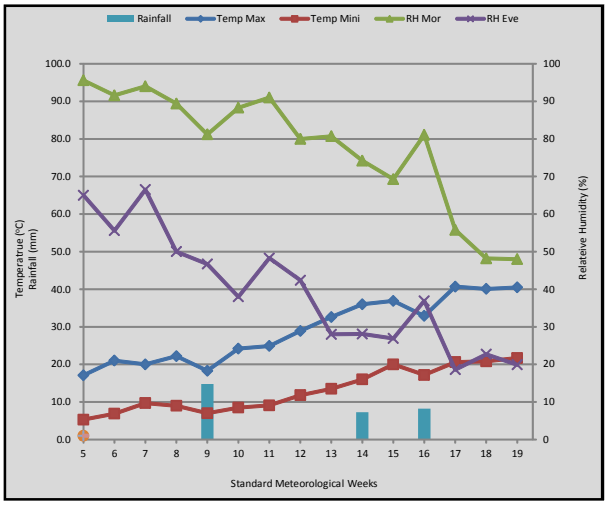

Fig. 1. Weekly weather parameters during the crop season (2019).

Fodder maize variety 'African tall' was sown on February 8, 2019 after pre-sowing irrigation and harvested at 50 percent flowering stage. As per the treatment full dose of phosphorus and half dose of nitrogen were applied as basal dose at the time of sowing and remaining half dose of nitrogen was top dressed at crop knee high stage. The other agronomic practices like irrigation, insect-pests control and weed control measures were done as per recommended package of practices of CCS HAU, Hisar. All growth parameters and yield attributes of fodder maize were recorded periodically on randomly selected and tagged plants. The plant samples were collected at crop harvest and analyzed for quality parameters following by standard procedure.

RESULTS AND DISCUSSION

Effect on growth parameters

Plant height

Increasing levels of nitrogen upto 100 kg/ha resulted in significantly taller plant of spring planted fodder maize at all the stages of crop growth. The magnitude of plant height at harvest recorded under various treatments varied from 133.7 cm under control to 164.3 cm under 100 kg N/ha (Table 1). Improved plant height with increased dose of nitrogen, may be due to fact that nitrogen being an important constituent of chlorophyll, nucleotides, proteins and enzymes involves in various metabolic process which has a direct impact on vegetative and reproductive phase of plants. The increment in plant height with the increase in nitrogen levels indicated that plants used nitrogen during active cell division to form building blocks (protein) for cell elongation. Similar results were reported by Ullah *et al.*, (2015). The critical analysis of periodic data on plant height of spring planted fodder maize revealed that application of 45 and 30 kg P ha^{-1} results in significantly taller plant than control and 15 kg P ha^{-1} at harvest (Table 1). At 30 and 60 DAS application of 15, 30 and 45 kg P/ha results in significantly taller plats than control. Maximum plant height of maize was recorded at harvest with application of 45 kg P/ha Higher phosphorus levels are reported to increase plant height of maize by Cheema *et.al.* (2010).

Number of leaves/plant

The leaf area was positively influenced by

different levels of nitrogen and phosphorus at 60 DAS and at harvest (Table 1). However, at 30 DAS there was no significant effect of varying nitrogen and phosphorus levels on number of leaves/plant of spring planted fodder maize. From 60 DAS onwards, application of 50, 75 and 100 kg N ha^{-1} results in significantly higher number of leaves/plant than control (Table 1). Similarly, at 60 DAS and harvest, application of higher doses of phosphorus results in significantly higher number of leaves/plant of maize. Khan *et al.* (2014) also reported increase in number of leaves/ plant with increased levels of nitrogen and phosphorus.

Leaf length

Leaf length of fodder maize at 30, 60 DAS and at harvest were influenced significantly by the application of nitrogen and phosphorus fertilizers in spring season (Table 1). Among the N levels, it was found highest with the application of 100 kg N/ha and lowest in control treatment, however, the differences were not significant with the application of 50, 75 and 100 kg N/ha at all the three stages of crop growth. Application of 45 kg P/ha recorded highest leaf length in spring planted fodder maize; however, values with application of 15, 30 and 45 kg P/ha were statistically at par with each other at 60 DAS and at harvest.

Leaf area index (LAI)

The application of 75 and 100 kg N ha^{-1} results in significantly higher value of LAI than control at 30, 60 DAS and at harvest (Table 1) and the highest value of LAI (5.83) was recorded at harvest with application of 100 kg N/ha. Increase in LAI with increased N levels was due to more number of leaves produced per plant. Increase in LAI with increase in N level was also reported by Ullah *et al*., (2015). The LAI of fodder maize was also positively influenced by different levels of phosphorus, the maximum LAI (5.88) being recorded at harvest with application of 45 kg P_2O_5/ha which was at par with 15 and 30 kg P_2O_5/ha.

Effect on green fodder yield

With the application of nitrogen @ 50, 75 and 100 kg N ha^{-1} there was 27.86, 49.50 and 64.50 per cent increase, respectively, in green fodder yield over the control (Table 2). Application of 100 kg N ha^{-1} produced 33.7 and 10.7 per cent higher dry matter yield (DMY) as compared to 50 and 75 kg N ha^{-1} (Table 2). Similar trend was observed in green fodder yield which indicated that nitrogen played an important role in the production of assimilates. Increase in nitrogen might have resulted in more active plants growth, which consecutively resulted in more dry matter partitioning. Similar results were reported by Ayub *et al.* (2002). Similarly, increase in phosphorus levels upto 45 kg P_2O_5/ha significantly increase the green fodder and dry matter yield of fodder maize in spring season (Table 2). The probable reason might be that phosphorus increase number of leaves, plant height, leaf area, and vegetative growth due to which fodder yield also increased. Our results are in confirmation with those of the previous studies by Masood *et al.* (2011) who reported that dry fodder yield increased with increase

TABLE 1
Effect of varying N and P levels on growth of spring planted fodder maize

Treatment	Plant height (cm)			No of Leaves /plant			Leaf length (cm)			LAI		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
Nitrogen levels (kg/N/ha)												
Control (No N)	25.99	126.5	133.7	5.35	10.58	11.17	16.67	62.83	78.87	1.96	2.98	4.98
50	28.81	140.4	148.2	5.42	11.95	12.83	20.75	65.09	81.09	2.18	3.26	5.13
75	32.62	146.9	155.5	5.46	12.73	13.67	21.17	67.91	84.07	2.38	3.41	5.69
100	37.12	154.9	164.3	5.53	12.92	13.92	22.25	68.66	85.67	2.51	3.57	5.83
C. D. (P=0.05)	1.13	2.82	2.84	N.S.	0.42	0.55	1.31	3.75	5.98	0.37	0.42	0.69
Phosphorus levels (kg P_2O_5/ha)												
Control (No P)	29.57	138.55	146.7	5.25	11.74	12.42	18.33	62.41	78.82	1.88	2.82	4.92
15	31.27	142.83	150.1	5.41	12.01	12.75	19.55	66.28	82.72	2.25	3.31	5.25
30	31.84	143.19	151.8	5.49	12.17	13.17	20.94	67.13	83.18	2.41	3.4	5.57
45	31.86	144.13	153	5.61	12.25	13.25	22.04	68.69	84.96	2.49	3.68	5.88
C. D. (P=0.05)	1.13	2.82	2.84	N.S.	0.42	0.55	1.31	3.75	5.98	0.37	0.42	0.69

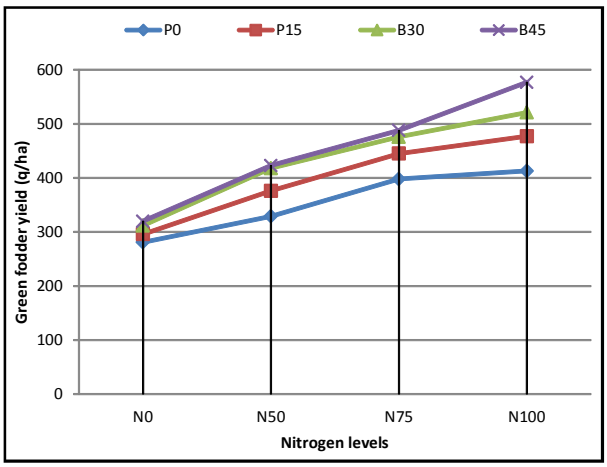

Fig. 2. Interactive effect of N and P levels on green fodder yield of spring maize.

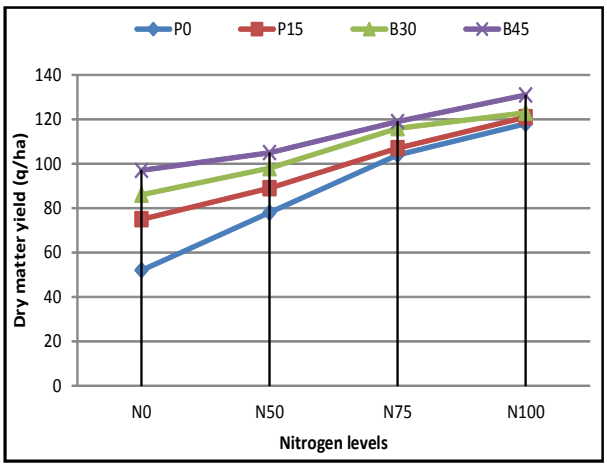

Fig. 3. Interactive effect of N and P levels on dry matter yield of spring maize.

in phosphorus levels. Synergistic effect was observed on green fodder yield in respect of N and P interaction (Fig. 2).

Dry matter yield

Among the varying nitrogen levels plants received 100 kg N/ha produced maximum dry matter yield at all the stages of crop growth (1737, 4635 and 7278 kg/ha at 30, 60 and 90 DAS) followed by 75 kg N/ha. However, minimum dry matter yield was recorded in control treatment followed by 50 kg N/ha (Table 2). Increase in dry matter accumulation with increased nitrogen was mainly associated with greater plant height and number of leaves/plant. At 30 and 60 DAS application of 45 kg P/ha being at par with 30 kg P/ha recorded significantly higher value of dry matter accumulation of spring planted fodder maize as compared to lower doses of phosphorus (Control and 15 kg P/ha). However at harvest increasing levels of phosphorus upto 45 kg P/ha resulted in significantly higher value of dry matter accumulation of spring planted fodder maize. Khan *et al.* (2014) also reported increase in dry matter of maize with higher doses of nitrogen and phosphorus. There was a synergistic effect was on d fry matter yield in respect of N and P interaction, however, the relative increase in dry matter yield decreased after 75 kg N/ha and 30 kg P/ha (Fig. 3).

Effect on fodder quality

The crude protein (%) and crude protein yield were significantly affected by varying N and P

TABLE 2

Effect of N and P levels on dry matter accumulation fodder yield and crude protein of spring fodder maize and their residual effect on soil N and P

Treatment	Dry matter accumulation (kg/ha)			GFY (q/ha)	DMY (q/ha)	Crude protein (%)	Crude protein (q/ha)	Available N (kg/ha)	Available P_2O_5 (kg/ha)
	30 DAS	60 DAS	90 DAS						
Nitrogen levels									
Control (No N)	1018	2619	4224	302.2	77.5	9.37	7.62	120.81	16.31
50 kg N/ha	1130	3114	5266	386.4	92.6	9.71	9.35	131.84	18.36
75 kg N/ha	1395	3708	6098	451.9	111.8	9.83	12.12	133.62	19.82
100 kg N/ha	1737	4635	7278	497.2	123.8	9.92	13.19	134.84	20.65
C. D. (P=0.05)	247	623	998	10.8	5.8	0.24	0.28	1.27	1.67
Phosphorus levels									
Control (No P)	1021	2648	4312	355.2	88.6	9.49	8.32	122.84	15.18
15 kg P_2O_5/ha	1228	3116	4895	398.5	98.2	9.67	9.98	130.65	18.27
30 kg P_2O_5/ha	1421	3878	6128	431.7	105.1	9.81	11.27	133.44	20.59
45 kg P_2O_5/ha	1610	4434	7531	452.3	113.8	9.86	12.71	134.17	21.09
C. D. (P=0.05)	247	623	998	10.8	5.8	0.24	0.28	1.27	1.67

levels (Table 2). Application of 100 kg N/ha and 45 kg P_2O_5 /ha recorded highest crude protein (%) in spring planted fodder maize; however, the crude protein recorded at 50, 75 and 100 kg N/ha was statistically at par with each other. Similarly, the crude protein (%) recorded at 30 and 45 kg P_2O_5/ha was statistically at par with each other. Crude protein yield of spring planted fodder maize also increased significantly with increase in nitrogen and phosphorus levels upto 100 kg N/ha and 45 kg P_2O_5/ha. A linear increase in crude protein with increased N levels might be due to the fact that nitrogen is an active ingredient of protein molecule and a building block of amino acid. The highest crude protein content at higher level of nitrogen was also reported by Ullah *et al*., (2015).

Effect on residual N and P in soil

Application of increasing level of nitrogen and phosphorus increased the soil available nitrogen and phosphorus status over control (Table 2). Maximum soil available nitrogen was recorded with 100 kg N/ ha application, which was significantly at par with 75 kg N/ha. Similarly, maximum value of soil available phosphorus was recorded with 45 kg P_2O_5/ha application, which was statistically at par with 30 kg P_2O_5/ha application.

CONCLUSION

The increasing nitrogen and phosphorus levels significantly improved growth, green fodder yield, dry matter yield and fodder quality of spring maize upto 100 kg N/ha and 45 kg P_2O_5/ha. Thus, it can be concluded that spring maize may be fertilized with 100 kg N/ha and 45 kg P_2O_5/ha for higher green fodder yield, dry matter yield and fodder quality of spring season maize under semi-arid conditions. Synergistic effect of N and P was observed on green fodder and dry matter yield.

REFERENCES

Arya, R.K., M.C. Kamboj and S. Kumar, 2020 : Evaluation of new extra-early maturing hybrids of maize (*Zea mays* L.) for grain yield and its contributing traits under humid and semi-arid conditions of Haryana. *Ekin J.,* **6**(2): 23-27.

Arya, R.K., M.C. Kamboj and S. Kumar, 2015 : Performance of medium maturing maize hybrids under Haryana agro-climatic conditions. *Forage Res.,* **41**: 130-34.

Ayub, M. A. Nadeem, M. S. Sharar and N. Mahmood, 2002 : Response of Maize (*Zea mays* L.) Fodder to Different Levels of Nitrogen and Phosphorus. *Asian Journal of Plant Sciences,* **1**: 352-354.

Cheema, M.A., W. Farhad, M.F. Saleem, H.Z. Khan, A. Munir, M.A. Wahid, F. Rasul and H.M. Hammad, 2010 : Nitrogen management strategies for sustainable maize production. *Crop Environ*., **1**: 49-52.

Khan, A., F. Munsif, K. Akhtar, M.Z. Afridi, Zahoor, Z. Ahmad, S. Fahad, R. Ullah, F.A. Khan and M. Din, 2014 : Response of Fodder Maize to Various Levels of Nitrogen and Phosphorus. *American J. Plant Sciences*, **5** : 2323-2329.

Kumar, N., Satpal, S. Kumar, U. Devi, J. M. Sutaliya and Shweta. 2020 : Maize fodder production under changing climatic scenario for nutritional security of livestock– A review. *Forage Res.,* **46** (1): 10-21.

Masood, T., R. Gul, F. Munsif, F. Jalal, Z. Hussain, N. Noreen, H. Khan, N. Din and H. Khan, 2011 : Effect of Different Phosphorus Levels on the Yield and Yield Components of Maize. *Sarhad J. Agric*. **27** : 167-170.

Ullah, M. I., A. A. Khakwani, M. Sadiq, I. Awan, M. Munir and Ghazanfarullah, 2015 : Effects of nitrogen fertilization rates on growth, quality and economic return of fodder maize (*Zea mays* L.). *Sarhad Journal of Agriculture*, **31**(1): 45-52.