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Effect of spacing and nitrogen levels on quality parameters and nitrogen uptake of fodder maize (*Zea mays* L.)

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Abstract

The field experiment was carried out during rabi season of 2017-18 on calcareous clayey soil at Junagadh to study the effect of spacing and nitrogen levels on quality parameters and nitrogen uptake of fodder maize. The experiment was laid out comprising twelve treatments in split plot design with four replications. The experiment results revealed that sowing of the fodder maize at wider row spacing of 40 cm recorded significantly higher values of crude protein, crude fiber and nitrogen content. Row spacing of 30 cm produced maximum crude protein yield, crude fiber yield and removed significantly highest nitrogen. Crude protein content, crude fiber content, nitrogen content and uptake were found significantly higher when crop was fertilised with 120 kg N ha⁻¹ followed by 100 kg N ha⁻¹. Interaction effect between spacing and nitrogen levels were also observed significant for crude protein yield, crude fiber yield and nitrogen uptake by the fodder.

Keywords: Fodder maize, rabi, spacing, nitrogen levels

Introduction

Maize (*Zea mays* L.) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions and successful cultivation in diverse seasons and ecologies for various purposes. Globally, maize is known as "Queen" of cereals because it has the highest genetic yield potential among the cereals. It is cultivated on nearly 150 million hectares in about 160 countries having wider diversity of soil, climate, biodiversity and management practices. In modern maize production systems, enhanced plant-to-plant variability often results from increased competition among individual plants at progressively higher plant densities for limiting resources. There are two major approaches to increase fodder production i.e. horizontal and vertical improvement. Firstly, the production of fodder can be increased by increasing the area under fodder crops, which is not feasible, as the country is already facing hardship in feeding its human population which is increasing at the rate of more than 1% per annum. Thus, the only way left out is vertical enhancement of fodder production by increasing the yield of fodder per unit area per unit time. In Saurashtra, most of the small and marginal farmers' keep one or two milch cows or buffaloes for selling milk. To provide good quality green and dry fodder for the milch animals round the year, it is become inevitable to find out suitable row spacing and proper nitrogen dose for rabi fodder maize under Saurashtra region.

Materials and Methods

The field experiment was carried out during rabi season of 2017-18 at Junagadh to study the effect of spacing and nitrogen levels on quality parameters and nitrogen uptake of fodder maize. The soil of experimental field was medium black in texture, medium in available nitrogen, phosphorus and potassium with alkaline in reaction (pH of 7.67). Twelve treatment combinations consisted of three spacing viz., S1:20cm, S2:30cm, S3:40cm and four levels of nitrogen viz., N1:00 kg N ha⁻¹, N2:80 kg N ha⁻¹, N3: 100 kg N ha⁻¹ and N4: 120 kg N ha⁻¹ were tested under split plot design with four replications. Furrows at 20 cm, 30 cm and 40 cm distance were opened by bullock drawn cultivar in the whole experimental field. The full dose of phosphorus in the form of DAP and half quantity of nitrogen in the form of urea were applied in opened furrows as basal application at the time of sowing and remaining half quantity of nitrogen was applied as top dressing at knee height crop stage (30 DAS) in the

form of urea. Herbicide Pendimethalin 30 EC @ 0.9 kg ha⁻¹ was applied as pre-emergence with irrigation water. Two manual weeding was done in between the rows at 20 and 35 DAS of crop. The first common irrigation was applied immediately after sowing. Second common irrigation was given 7 DAS for proper germination and establishment of the seedlings. Total seven irrigations were given to fodder maize crop.

Result and Discussion

Effect of spacing

Quality and nitrogen uptake

Fodder maize sown at wider row spacing of 40 cm noted significantly higher crude protein (6.98%) and crude fiber content (25.11%) and it was remained at par with row spacing of 30 cm. Higher crude protein content in wider row spacing may be due to less plant population, resulting in availability of more nitrogen per plant. In case of crude protein and crude fiber yields significantly maximum yields were recorded under row spacing of 30 cm (800 and 2905 kg ha⁻¹ respectively). These results are in accordance with the finding of Emine *et al.* (2010) [7] and Dar *et al.* (2014) [6]. Different row spacing exerts their significant influence on nitrogen content and uptake by fodder. Significantly maximum nitrogen content (1.10%) and uptake (126.1 kg ha⁻¹) by fodder were observed when crop was sown at wider row spacing of 40 cm and 30 cm, respectively. Higher nitrogen content and uptake under wider spacing could be due to optimum plant population resulted in lower competition and higher N uptake by the crop. The results obtained in present study are in close agreement with those reported by Mercy *et al.* (2012) [9], Dar *et al.* (2014) [6] and Santgam *et al.* (2017).

Available NPK in soil after harvest

Soil fertility status after harvest of fodder maize was not significantly influenced due to different row spacing except, available soil nitrogen where in wider row spaced fodder maize noted maximum available nitrogen (256.1 kg ha⁻¹) and it was closely followed by row spacing of 30 cm. After

harvest of crop available soil nutrients viz., nitrogen, phosphorus and potash were slightly increased by litter fall and root exudates but cannot reach the levels of significant due to the losses of decomposed materials and immobilization with wider C: N ratio. Similar results were also reported by Srikanth *et al.* (2009) [13] and Santgam *et al.* (2017).

Effect of nitrogen

On quality and nitrogen uptake

Data presented in Table 1 showed that application of 120 kg N ha⁻¹ to fodder maize recorded significantly higher values of crude protein content (7.04%) and crude protein yield (866 kgha⁻¹). Per cent increase in protein content and crude protein yield with the application of nitrogen @ 120 kg ha⁻¹ over control were to the tune of 33.3 and 80.8%, respectively. Different nitrogen levels produced their significant effect on crude fiber content and crude fiber yield. Results showed that fertilizing the fodder maize with 120 kg N ha⁻¹ observed significantly maximum crude fiber content of 25.21% and crude fiber yield of 3142 kg ha⁻¹. Higher dose of nitrogen @ 120 kg ha⁻¹ increased crude fiber content and crude fiber yield to the tune of 9.5 and 48.4%, accordingly over control. These results are in accordance with the findings of Bilal *et al.* (2005) [4], Budakli *et al.* (2010) [5], Emine *et al.* (2010) [7], Aslam *et al.* (2011), Dar *et al.* (2014) [6] and Ali and Muhammad (2017) [1]. Various nitrogen levels produced their significant effect on nitrogen content and uptake by fodder. Fodder maize fertilized with 120 kg N ha⁻¹ appreciably improved nitrogen content (1.17%) and nitrogen uptake (145.3 kg ha⁻¹) As stated in earlier paragraph that application of nitrogen might have improve nutritional environment in rhizosphere as well as plant system leading to absorption, uptake and translocation of nutrient in reproductive structure which leads to higher content and uptake. Higher green and dry fodder yields with supply of nutrients might have increase nitrogen content in fodder which reflected higher uptake of nitrogen by fodder maize. Similar findings were also reported by Reddy and Bhanumurthy (2010) [11], Patil (2013) [10], Dar *et al.* (2014) [6], Khan *et al.* (2014) and Vyas *et al.* (2015) [15].

Table 1: Effect of spacing and nitrogen levels on crude protein content, crude fiber content, crude protein yield (CPY), crude fiber yield (CFY), nitrogen content and nitrogen uptake and available NPK on fodder maize

Treatments	CP content (%)	CF content (%)	CPY (kg ha ⁻¹)	CFY (kg ha ⁻¹)	N content (%)	N uptake (kg ha ⁻¹)	Available N	Available P2O5	Available K2O
Spacing (cm)									
S1: 20	5.24	23.10	645	2822	0.96	119.0	235.0	24.7	248.1
S2: 30 cm	6.65	24.40	800	2905	1.05	126.0	245.0	25.6	245.1
S3: 40 cm	6.98	25.11	655	2341	1.10	102.5	256.1	26.5	246.1
S.Em.±	0.14	0.32	36.63	84.92	0.02	4.17	3.58	0.77	4.48
C.D. at 5 %	0.49	1.10	126.77	293.85	0.07	14.45	12.39	NS	NS
C.V. %	8.99	5.23	20.94	12.63	8.25	14.41	5.84	12.08	7.27
Nitrogen levels (kg ha⁻¹)									
N1- 00 kg N ha ⁻¹	5.28	23.02	479	2117	0.88	80.6	223.7	24.8	240.5
N2- 80 kg N ha ⁻¹	6.12	23.87	654	2563	1.00	107.5	239.2	25.4	242.0
N3- 100 kg N ha ⁻¹	6.72	24.72	800	2935	1.09	130.1	256.3	26.0	247.6
N4- 120 kg N ha ⁻¹	7.04	25.21	866	3143	1.17	145.3	262.3	26.2	255.8
S.Em.±	0.11	0.33	20.04	89.98	0.02	3.76	3.24	0.82	4.43
C.D. at 5 %	0.33	0.95	58.14	261.10	0.05	10.92	9.41	NS	NS
C.V. %	6.20	4.69	9.92	11.59	5.31	11.25	4.58	11.16	6.22
Interaction S x N									
S.Em.±	0.20	0.57	34.70	155.85	0.03	6.52	5.62	1.43	7.67
C.D. at 5 %	NS	NS	100.70	452.24	NS	18.91	NS	NS	NS

Table 2: Interaction effect of spacing and nitrogen levels on crude protein yield, crude fiber yield and nitrogen uptake of fodder maize.

Interaction S x N (cm x kg ha-1)	CPY (kg ha-1)	CFY (kg ha-1)	N uptake (kg ha-1)
20 x 00	464	2386	89.2
20 x 80	572	2539	104.2
20 x 100	676	2815	120.6
20 x 120	869	3548	162.0
30 x 00	513	2109	79.1
30 x 80	733	2785	113.4
30 x 100	1026	3513	159.1
30 x 120	928	3212	152.6
40 x 00	460	1856	73.5
40 x 80	657	2363	104.9
40 x 100	699	2476	110.4
40 x 120	802	2668	121.3
S.Em.±	34.70	155.85	6.52
CD at 5 %	100.70	452.24	5419

Available NPK in soil after harvest

Results on soil fertility status after harvest of fodder maize as influenced by different nitrogen levels presented in Table 4.18 showed that available nitrogen was significantly influenced by different nitrogen levels and maximum available nitrogen of 262.3 kg ha⁻¹ was observed when crop was fertilized with 120 kg N ha⁻¹. Results confirms the findings of Patil (2013)^[10] and Sangtam *et al.* (2017)^[12].

Interaction effect

Interaction effect between row spacing and nitrogen levels was found significant for crude protein yield, crude fiber yield and nitrogen uptake by fodder. Significantly maximum protein yield of 1026 kg ha⁻¹ was observed when crop was sown at row spacing of 30 cm and fertilized the fodder maize with 100 kg N ha⁻¹ (S2N3) which was remained on par with treatment combination S2N4. Maximum crude fiber yield of 3548 kg ha⁻¹ and nitrogen uptake (162.0 kg ha⁻¹) were recorded when fodder maize was sown at closer row spacing of 20 cm and fertilized the crop with 120 kg N ha⁻¹ (S1N4) which was closely followed by treatment combinations S2N3 and S2N4. While, fodder maize Fodder maize sown at closer row spacing of 20 cm and fertilizing the crop with 120 kg N ha⁻¹ (S1N4) recorded significantly higher nitrogen uptake (162.0 kg ha⁻¹) and which was comparable with treatment combination S2N3 and S2N4. The results more or less collaborates the findings of Emine *et al.* (2010)^[7], Bhatt *et al.* (2012)^[3] and Verma and Tomar (2014)^[14].

Conclusion

On the basis of one year field experimentation, it seems quite logical to conclude that under medium black calcareous soil of South Saurashtra Agro-climatic zone for getting good quality fodder, fodder maize should be sown at row spacing of 40 cm with the application of 120 kg N ha⁻¹ along with other recommended package of practices.

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