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GENOTYPIC RESPONSE OF FODDER MAIZE TO DIFFERENT NITROGEN LEVELS

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SUMMARY

A field experiment was conducted to assess the impact of four graded levels of nitrogen (40, 80, 120 and 160 kg/ha) on yield, quality and economics of four fodder maize (*Zea mays* L.) genotypes (J-1006, African Tall, COHM-8 and PFM-12) at Hisar (Haryana), India during *kharif* (rainy) season of 2021 using factorial RBD design with three replications. Results revealed that check entry 'J-1006' and test entry 'PFM-12' with identical green and dry fodder yields *i.e.* 397.68 and 106.49 t/ha (mean) have excelled other two checks African Tall and COHM-8 by 8 & 14 and 11 & 11 per cent, respectively and are promising from crude protein, digestible dry matter yield and net income wise also. Check cultivar "African Tall' that fared good for fodder yield but better from quality point of view; however, was most efficient from dry fodder yields/ kg N-P-K uptake. High fodder producing genotypes (J-1006 and PFM-12) are more depletive of soil nutrients. Among N levels, significant improvement was seen in leaf to stem ratio values from 40 kg N to 80 kg N and further 80 kg N to 120 kg N/ha but no significant increase was observed from 120 to 160 kg N/ha. It is concluded that fodder maize genotypes J-1006 and PFM-12 are promising and application of 120 kg N/ha was recommended for higher fodder yield, quality and income.

Key Words: Fodder maize, genotypes, nitrogen levels, fodder yield, crude protein and IVDMD

Maize (*Zea mays* L.) is known as queen of cereals because it has the highest genetic yield potential among the cereals. At worldwide, it was cultivated on an area of 205.87 mha and recorded the production of 1210 mha of grain with an average grain yield of 58.7 q/ha. In India, acreage under maize is 9.9 mha for grain with an average productivity of 31.3 q/ha (FAO, 2021) and 0.9 mha for fodder with an average green fodder productivity of 350.5 q/ha. In Haryana, area under grain maize in *kharif* season is only about 6200 ha with average productivity of 27.4 q/ha (Anonymous 2020). Maize needs less water than other cereals. Being a C_4 plant, it has a competitive edge over C_3 plants. The C_4 plants use less water, allowing them to grow in conditions of drought, high temperature and CO_2 limitation. Maize gives higher fodder productivity even in a shorter period than any other cereal fodder crop. Besides this, being a day-neutral crop, it can be grown in any season. It is also, one of the popular dual purpose crop, grown widely in *kharif* season for grain as well as for fodder in India. Production potential of fodder maize can be altered with changes in agronomic practices *viz*., improved genotype, plant density and nutrient management. The selection of location specific cultivar of maize is prime requisite for higher fodder production. Besides this, fertilizer management is one of the principle factors that directly influence the fodder yield and quality. Further, an optimum supply of nutrients at each critical growth stage is highly essential for realizing the potential of fodder maize in terms yield and quality.

Under All India Coordinated Research Project on Forage Crops & Utilization (AICRP FCU), continuous efforts are being made to improve not only the fodder productivity but also its quality. For this, new promising genotypes of breeding program (AVT-II) are tested for agronomic performance also against the check cultivars (J-1006, African Tall and COHM-8). High productivity of fodder maize results in removal of huge quantity of primary nutrients (NPK) that is evident from the fact that a fodder maize crop was estimated to remove 16.3-5.6-34.2 kg N-P_2O_5-K_2O per tonne of dry matter produced (Janjal *et al.,* 2021). Such a high nutrient removal by fodder maize calls for adequate supply both through native soil fertility and fertilizer and manure application. Indian soils are already deficit in primary nutrients. Perusal of the soil test data of 500 districts (Muralidharudu *et al.,* 2011) indicated that 51 & 40% and 9 & 42% district are low & medium for available P and K, respectively. This fertility is further declining under intensive cultivation. These declines in macronutrient availability coupled with declines in soil organic matter content and degradation in physical soil structure in the Indo-Gangetic Plains is leading to crop yield declines (Bhandari *et al.,* 2002). The situation is worrisome in Haryana also, as 99, 24.8 and 10% of the 1.4 million soil samples analyzed for soil health card purpose, were very low for available N, P and K while 31.7 and 19.0% of samples were low for available P and K. Thus 99-56.5-29% samples are deficit for soil fertility and can't support high levels of production without fertilizers. Among the nutrients essential for plant growth, N plays a dominant role in plant growth as it is required for chlorophyll production, as a constituent of enzymes, proteins, nucleic acids and cell walls (Marschner, 1986; Schrader, 1984). N is also constituent of low molecular weight plant compounds including nucleotides, amides and amines. Consequently, sufficient N is a prerequisite. Moreover, maize is also a nitro-positive crop which needs heavy doses of nitrogenous fertilizer to achieve optimal production (Khan *et al*., 2011). To evaluate the response of potentially high yielding cultivars of fodder maize to differing levels of nitrogen fertilizer. For achieving good crop yields, there is need to revise nitrogen dose to various crops keeping in view the increasing crop requirements and depleting soil supplies and reduced fertilizer use. It is in this context, the present study was made to assess the response of new fodder maize genotypes (including the checks) to varying nitrogen levels.

MATERIALS AND METHODS

A field experiment was conducted during rainy (*kharif*) season of 2021 at Forage Section Research Area, Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar (29°10' N of 75°46' E, at an average elevation of 215.2 m above mean sea level) having semi-arid and sub-tropical climate with hot dry summer and severe cold winters and receives 450 mm precipitation per annum. A rainfall of 517.6 mm was received during crop duration. Weekly weather parameters *i.e.* temperature (^{o}C), relative humidity (%) and rainfall (mm) during the crop duration are given Fig 1. Just before the start

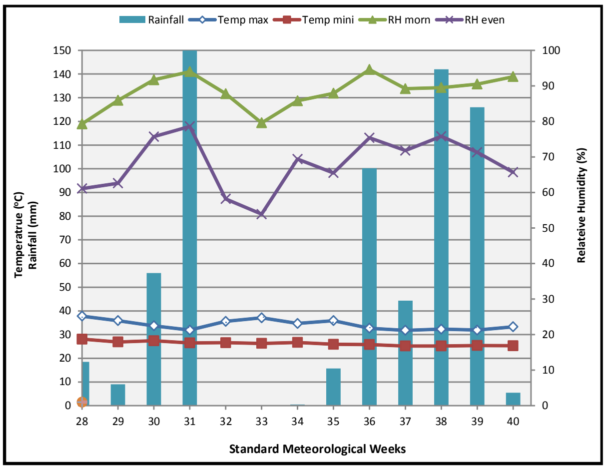

Fig. 1. Weekly weather data during the study period.

of the study, the soil samples were drawn from the plough layer of the experimental site; and as per test report, the sandy-loam soil with pH 7.8 was rated as low for organic carbon (0.46%), available N (112.0 kg/ha), and medium for available P and K (12.2 and 232.0 kg/ha). 16 treatments formed by combination of four fodder maize genotypes (J-1006, African Tall, COHM-8 and PFM-12) and four Nitrogen levels (40, 80, 120 and 160 kg N/ha) were evaluated in Factorial randomized block design with three replications. Entire recommended dose of P and K along with $^{1}/_{2}$ N dose of the treatment was applied basal at the time of sowing in last ploughing and remaining $^{1}/_{2}$ N was top dressed at 30 days after sowing (DAS). Crop was sown manually on July 18, 2021 in soiled rows at 30 cm apart and were harvested at 65 DAS. Nitrogen content (AOAC, 1995) and *in-vitro* dry matter digestibility (IVDMD) (Barnes *et al.*, 1971) were estimated for dried and grinded samples (2 mm sieve size) collected at 50 per cent flowering stage. Crude protein content (CPC) was calculated by multiplying the nitrogen content (%) with 6.25. Crude protein and digestible dry matter yield (t/ha) were calculated by multiplication of CPC and IVDMD with dry matter yield (t/ha), respectively. Data were analyzed by using OPSTAT software available at CCS Haryana Agricultural University website (Sheoran *et al*., 1998). The results are presented at five per cent level of significance (p=0.05) for making comparison between treatments.

RESULTS AND DISCUSSION

Genotypes

Data (Table 1) reveals that among genotypes, maximum plant height was recorded with J-1006 which was on a par with PFM-12. Maximum leaf to

TABLE 1
Response of promising entries of fodder maize to different nitrogen levels

Treatment	Plant stand/ mrl at harvest	Plant height at harvest (cm)	L:S Ratio at harvest	Green fodder yield (q/ha)	Dry fodder yield (q/ha)
Genotypes (G)					
J-1006	10.00	228.61	0.38	405.97	108.18
African Tall	9.00	213.06	0.35	367.78	93.82
COHM-8	9.67	208.22	0.36	358.33	95.58
PFM-12	9.72	224.11	0.38	389.38	104.80
SEm±	0.25	2.53	0.01	5.94	1.98
CD (P=0.05)	NS	7.34	0.02	17.24	5.73
N Levels (N) kg/ha					
40	9.56	192.28	0.32	304.93	83.31
80	9.47	217.08	0.36	372.78	98.42
120	9.80	230.20	0.39	416.88	109.10
160	9.56	234.44	0.39	426.88	111.55
SEm±	0.25	2.53	0.01	5.94	1.98
CD (P=0.05)	NS	7.34	0.02	17.24	5.73
G X N					
SEm±	0.50	5.06	0.012	11.88	3.95
CD (P=0.05)	NS	NS	NS	NS	NS
CV %	9.08	4.01	-	5.41	6.80

stem ratio (0.38) was recorded with J-1006 and PFM-12. However, the plant stand per m row length was not affected significantly among genotypes. Maximum green fodder and dry matter yield (406.97 and 108.18 q/ha, respectively) were recorded with J-1006 which was on a par with PFM-12. The differential values of the genotypes could be ascribed to their genetic makeup (Meena *et al*., 2012).

Quality parameters data was presented in Table 2. Genotypes differed for crude protein contents and it ranged from 9.77 to 10.48%. Maximum CPC (10.48 per cent) was estimated in African tall which was on a par with J-1006 and PFM-12. However, maximum CPY (11.23 q/ha) recorded with J-1006 was on a par with PFM-12. Maximum *in-vitro* dry matter digestibility (IVDMD, 53.85%) was estimated in African tall which was on a par with J-1006 and PFM-12. However, maximum DDMY (58.04 q/ha) recorded with J-1006 which was on a par with PFM-12. Maximum nitrogen content (1.68 per cent) was estimated in African tall which was on a par with J-1006 and PFM-12. Maximum nitrogen uptake (179.61 kg/ha) was estimated by J-1006 which was on a par with PFM-12.

Nitrogen levels

Perusal of the data of nitrogen levels (Table 1) shows that maximum plant height was reported with the application of 160 kg N/ha but it was on a par with 120 kg N/ha. The plant stand per meter row length was not affected significantly among nitrogen levels. Highest and same leaf to stem ratio (0.38) was recorded with 160 kg N/ha and 120 kg N/ha. Except leaf to stem ratio and plant height, no other growth parameter improved significantly due to enhanced nitrogen levels and thus production improved significantly due to enhanced nitrogen levels over lower nitrogen doses. On the contrary, reduction in RDN to 40 kg N/ha proved detrimental to crop growth and yields as well. Maximum green fodder and dry matter yields (426.88 and 111.55 q/ha, respectively) were recorded with the application of 160 kg N/ha which

TABLE 2
Quality parameters and N uptake of fodder maize promising entries as influenced by nitrogen levels

Treatment	Crude protein content (%)	Crude protein yield (q/ha)	IVDMD (%)	Digestible dry matter yield (q/ha)	N content (%)	N Uptake (kg/ha)
Genotypes (G)						
J-1006	10.26	11.23	53.20	58.04	1.64	179.61
African Tall	10.48	9.92	53.85	50.81	1.68	158.71
COHM-8	9.77	9.52	51.01	49.64	1.56	152.31
PFM-12	10.22	10.72	53.08	55.31	1.64	171.53
SEm±	0.09	0.24	0.30	0.98	0.02	3.86
CD (P=0.05)	0.27	0.70	0.86	2.84	0.04	11.22
N Levels (N) kg/ha						
40	8.89	7.50	48.20	40.68	1.42	119.98
80	9.99	9.78	52.63	51.51	1.60	156.43
120	10.85	11.84	54.98	59.85	1.74	189.40
160	10.99	12.27	55.34	61.75	1.76	196.36
SEm±	0.09	0.24	0.30	0.98	0.02	3.86
CD (P=0.05)	0.27	0.70	0.86	2.84	0.04	11.22
G X N						
SEm±	0.19	0.48	0.59	1.96	0.03	7.73
CD (P=0.05)	NS	NS	NS	NS	NS	NS
CV %	3.21	8.08	1.96	6.34	3.36	8.09

TABLE 3
Economics of promising entries of fodder maize as influenced by nitrogen levels

Treatment	Cost of cultivation (Rs./ha)	Goss returns (Rs./ha)	Net Returns (Rs./ha)	B : C ratio
Genotypes (G)				
J-1006	40756	81195	40438	1.99
African Tall	40756	73556	32799	1.80
COHM-8	40756	71667	30910	1.76
PFM-12	40756	77875	37119	1.91
SEm±		1188	1188	0.03
CD (P=0.05)		3448	3448	0.08
Nitrogen Levels (N)				
40	39767	60986	21219	1.53
80	40605	74556	33950	1.84
120	41088	83375	42287	2.03
160	41566	85375	43809	2.05
SEm±		1188	1188	0.03
CD (P=0.05)		3448	3448	0.08

was on a par with 120 kg N/ha. It was obvious that crude protein content was increased with increase in level of nitrogen application. Highest crude protein and IVDMD contents (10.99 and 55.34%, respectively) were estimated with the application of 160 kg N/ha which were on a par with the application of 120 kg N/ha. Similar results were reported by Souza *et al.* (2019) and Guo *et al.* (2021).

ECONOMICS

Perusal of the data (Table 3) of net returns and BC ratio shows that J-1006 and PFM-12 are equally promising while COHM-8 is least promising. Among nitrogen levels, 120 kg/ha nitrogen dose (Net returns Rs. 42,287/ha and benefit cost ratio 2.03) is at par with 160 kg/ha (Net returns Rs. 43,809/ha and benefit cost ratio 2.05).

CONCLUSION

It is concluded from the study that for fodder maize genotype J-1006 recorded highest green fodder and dry matter yields which were on a par with PFM-12. Among nitrogen levels, maximum green fodder (426.88 q/ha) and dry matter (111.55 q/ha) yield were recorded with 160 kg N/ha which were on a par with 120 kg N/ha but significantly superior to lower levels.

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