Fodder, Grain Yield, Nitrogen uptake and Crude Protein of Forage Maize as Influenced by Different Nitrogen Management Practices

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Abstract

A field study was conducted during three consecutive *rabi* seasons at Dairy Experimental Station, Livestock Research Institute, Rajendranagar to evaluate forage maize grown for green fodder, dry fodder and grain (GDG maize) with three nitrogen levels (120, 180 and 240 kg N ha^{-1}) and four times of nitrogen application, i.e. 0, 30 days after sowing (DAS); 0, 30, 70 DAS; 0, 30, 95 DAS and 0, 30, 70, 95 DAS. Zero denotes application of the nutrient at the time of sowing. The above combination of twelve treatments was compared with three checks, viz. normal grain maize (60x25 cm^2 spacing), double density grain maize (30x25 cm^2 spacing) and maize sown at 30x25 cm^2 for green fodder at recommended dose of nitrogen (120 kg N ha^{-1}) following a randomized block design (RBD). A uniform dose of 60 kg P_2O_5 ha^{-1} and 40 kg K_2O ha^{-1} was applied as basal dose. It was found that GDG maize grown by applying 240 kg N ha^{-1} in three splits (0, 30 and 70 DAS) gave significantly higher grain ((3.9 t ha^{-1}) and stover (8.3 t ha^{-1}) yield, N uptake (273.4 kg ha^{-1}), crude protein yield (1695 kg ha^{-1}) and net returns (INR 24,509 ha^{-1}). However, it was comparable with that of normal grain maize in terms of grain and stover yield and was comparable with GDG maize at 240 kg N ha^{-1} in two splits (0, 30 DAS) in respect of N uptake and crude protein yield. Total dry matter production was significantly higher with double density grain maize. The study revealed that GDG maize system can be practiced for simultaneous harvest of green fodder and dry fodder economically.

1. Introduction

Present livestock population in India is around 480 million heads. The animal productivity in terms of draft, milk, meat and other products depend directly on the availability of good quality green fodder. Against the projected need of 1130 mt of green fodder and 950 mt of dry fodder in the country the present availability is to the tune of 420 mt of green fodder and dry fodder, respectively. The present gap between the requirement and demand is around 50% (Hazra, 1998). Since the availability of quality green fodder to the livestock especially during winter and summer months is scarce it has to depend on crop residues such as paddy straw, *jowar*/maize stover, groundnut/pulses haulms, etc. Under such circumstances, maize which ranks first in terms of quality of fodder can be conveniently grown for sustaining the productivity of livestock both in terms of milk and draft power.

In Andhra Pradesh state of India, maize as a grain crop is grown in 8.56 lakh ha area with an average grain productivity of 4930 kg ha^{-1} (Acharya N.G. Ranga Agricultural University Research and Extension highlights 2008-09, 2009). The area under green fodder is negligible. In such situation, cultivation of maize for grain as well as green fodder would be a real boost to the livestock as well as human needs. Begum (1994) and Sharma et al. (1997) found that half of the population of maize harvested for green fodder at tasseling stage does not have detrimental effect on grain production of the left over maize crop. Hence it is desirable to investigate the nitrogen requirement of forage maize when grown simultaneously for green fodder, dry fodder and grain (GDG maize). It is also necessary to find out the economic viability of the GDG system in comparison to grain maize sown at 60x25 cm^2, double density grain maize at 30x25 cm^2 and green fodder maize at 30x25 cm^2.

2. Materials and Methods

Experiments were conducted at Dairy Experimental Station, Livestock Research Institute, Rajendranagar during three consecutive *rabi* seasons (2001-02, 2002-03 and 2003-04). The soil was alfisol with sandy loam textural class containing 245 kg ha^{-1} available N, 43.5 kg ha^{-1} available P_2O_5 and 275 kg ha^{-1} available K_2O. The soil pH was 7.6 with organic carbon of 0.4%. The experiment was laid out in a randomized block design (RBD) with fifteen treatments in three replications. A medium duration fodder maize cultivar of 110 days APFM-8 was taken for experimentation. Maize for green fodder, dry fodder and grain (GDG maize) was sown at 30x25 cm^2. Green fodder was harvested from alternate rows at 70 days after sowing (DAS) and topping of maize for fodder from the left over rows was taken up at 95 DAS. Finally stover and grain was harvested at physiological maturity.

The experiment was laid out in a RBD with 15 treatments, viz. T_1: GDG maize, 120 kg N ha^{-1}, 0-30 DAS; T_2: GDG maize, 120 kg N ha^{-1}, 0-30-70 DAS; T_3: GDG maize, 120 kg N ha^{-1}, 0-30-95 DAS; T_4: GDG maize, 120 kg Nha^{-1}, 0-30-70-95 DAS; T_5:

GDG maize, 180 kg N ha^{-1}, 0-30 DAS; T_6: GDG maize, 180 kg N ha^{-1}, 0-30-70 DAS; T_7: GDG maize, 180 kg N ha^{-1}, 0-30-95 DAS; T_8: GDG maize, 180 kg N ha^{-1}, 0-30-70-95 DAS; T_9: GDG maize, 240 kg N ha^{-1}, 0-30 DAS; T_{10}: GDG maize, 240 kg N ha^{-1}, 0-30-70 DAS; T_{11}: GDG maize, 240 kg N ha^{-1}, 0-30-95 DAS; T_{12}: GDG maize, 240 kg N ha^{-1}, 0-30-70-95 DAS; T_{13}: Grain maize (60x25 cm^2), 120 kg N ha^{-1} ,0-30-70 DAS; T_{14}: Grain maize (30x25 cm^2), 120 kg N ha^{-1}, 0-30-70 DAS; T_{15}: Fodder maize (30x25 cm^2), 120 kg N ha^{-1}, 0-30 DAS. Green fodder, dry fodder, grain, total dry matter production, nitrogen uptake and crude protein yield were recorded. N content (%) of the maize plant samples was estimated using Micro Kjeldahl method (Piper, 1966). Nitrogen uptake (kg N ha^{-1}) was estimated by multiplying the N content (%) of maize samples with total dry matter. Crude protein yield was obtained by multiplying N content (%) with dry matter and the factor 6.25. Nitrogen uptake of fodder maize was found to increase with increase in nitrogen application up to 120 kg N ha^{-1} as per Verma et al. (1999). Singh et al. (2000) and Kumar and Singh (2003) observed the increase in uptake of nitrogen in maize up to 150 kg N ha^{-1}.

3. Results and Discussion

3.1. Total green fodder yield

Green fodder yield of maize was significantly higher from the check, i.e. maize grown invariably for green fodder with a mean green yield of 36.4 t ha^{-1} over that obtained from different treatments of GDG maize (Table 1). This is mainly due to the fact that above ground biomass of maize with double the population was harvested for green fodder at 70 DAS as compared to harvest of alternate rows of maize in case of GDG maize which constitute half the population and fodder obtained from topping of remaining rows of GDG maize at 95 DAS. For GDG maize 180 kg N ha^{-1} was sufficient to obtain 24.5 t ha^{-1} of green fodder when applied in two equal splits (0, 30 DAS) which was significantly higher over most of the other GDG maize treatments and at par with that of 240 kg N ha^{-1} (Table 1). The results conform to the studies conducted by Soloman and Bhanumurthy (1997-98). With regard to harvest of green fodder by application of 180 kg N ha^{-1} in two equal splits as basal and at 35 DAS which was ideal for harvest of alternate rows for green fodder from double the population (1,33,333 ha^{-1}) leaving the remaining crop for grain.

3.2. Maize stover yield

Mean stover yield data as given in Table 1 show that double density grain maize with 9.7 t ha^{-1} gave significantly higher stover yield over that of normal grain maize and most of the GDG maize treatments. However, stover yield of GDG maize grown with 120 kg N ha^{-1} applied in two equal splits (0, 30 DAS) was enough to obtain stover yield at par that of double the density maize suggesting recommended dose for better stover yield to be 120 kg ha^{-1}. Reddy et al. (1987) and Shivay et al. (2002) noticed response in respect of obtaining higher stover yield up to 120 kg N ha^{-1}.

3.3. Grain yield

Based on the mean of three years normal grain maize sown at 60x25 cm^2 and applied with 120 kg ha^{-1} in three equal splits (0, 30, 70 DAS) was found to give significantly higher grain yield of 4.7 t ha^{-1} (Table 1). Similar results were obtained by Kumar and Singh (1999). The next best treatment was GDG maize grown with 240 kg N ha^{-1} applied in three equal splits (0, 30, 70 DAS) with a grain yield of 3.9 t ha^{-1}. This is due to the fact that favorable condition was created in normal grain maize in terms of spacing and nutrient availability to the crop.

Table 1: Green fodder, maize stover, grain yield and economics of GDG maize as compared to grain maize and fodder maize (pool of 3 years)

Sl. No.	Treatment	Total green fodder yield (t ha^{-1})	Maize stover yield (t ha^{-1})	Grain yield (t ha^{-1})	Gross returns (INR ha^{-1})	Cost of cultivation (INR ha^{-1})	Benefit-cost ratio
1	T_1	22.6	8.5	2.0	30,634	14,878	2.06
2	T_2	20.4	7.0	2.4	29,294	15,015	1.95
3	T_3	21.4	7.6	2.4	31,175	15,015	2.08
4	T_4	19.3	7.3	2.0	27,564	15,152	1.82
5	T_5	24.5	7.9	2.5	33,486	19,972	2.11
6	T_6	22.4	8.4	2.9	35,182	15,848	2.20
7	T_7	21.2	7.4	2.8	33,046	15,985	2.07
8	T_8	21.3	8.2	2.3	31,072	16,122	1.93
9	T_9	24.9	9.0	3.4	39,259	16,453	2.38
10	T_{10}	24.9	8.3	3.9	41,099	16,590	2.48
11	T_{11}	22.6	7.5	3.4	36,625	16,590	2.21
12	T_{12}	21.2	7.7	3.0	33,927	16,727	2.04
13	T_{13}	-	8.0	.7	31,273	11,515	2.71
14	T_{14}	-	9.7	3.3	27,244	12,404	2.20
15	T_{15}	36.4	-	-	18,648	14,128	1.74
SEm+		0.65	0.43	0.09	474	-	0.03
CD (p=0.05)		1.91	1.27	0.26	1,315	-	0.09

3.4. Benefit-cost ratio

Normal grain maize can be considered as the best practice with a benefit-cost ratio of 2.71 which was significantly higher over the remaining two checks and treatments of GDG maize. The next better treatment was GDG maize at 240 kg N ha^{-1} applied in three equal splits (0, 30, 70 DAS) with a benefit-cost ratio of 2.48 which is almost comparable with that of normal grain maize. Paradkar et al. (1993) reported that inter-cropping of grain maize with fodder maize was significantly superior to that obtained from sole grain maize in terms of net returns. This clearly shows that forage maize could be cultivated more profitably as GDG maize under better nitrogen management practice and have a scope to harvest good quality green fodder in *rabi* and summer months in addition to grain and stover which is in conformity with results of Soloman and Bhanumurthy (1997-98).

3.5. Total dry matter production

Total dry matter production was significantly higher (23.43 t ha^{-1}) with grain maize grown at double the density at a spacing of 30x25 cm^2 at 120 kg N ha^{-1} compared to GDG maize or normal grain maize (Table 2). However, next best treatments for total dry matter production were GDG maize grown at 240 kg N ha^{-1} applied in two splits (0, 30 DAS) with 22.32 t ha^{-1} or three splits (0, 30, 70 DAS) with 22.52 t ha^{-1}. Tripathi and Singh (1982), Raju et al. (1986) and Singh et al. (1993) reported that 120 kg N ha^{-1} to be beneficial for higher dry matter production in grain maize.

3.6. Total uptake of N and crude protein yield

Total uptake of N was significantly low (124.9 kg ha^{-1}) with maize grown for sole green fodder (Table 2). Among the combination of N and time of application with GDG maize, 240 kg N ha^{-1} in three splits (0, 30, 70 DAS) recorded significantly higher total N uptake of 273.4 kg ha^{-1} which was comparable with the same dose of N in two splits. Similar observations were made in respect of crude protein yield suggesting that improving the quality of maize by practicing the GDG system with 240 kg N ha^{-1} either in two splits (0, 30 DAS) or in three splits (0, 30, 70 DAS) (Table 2).

Table 2: Total dry matter, N uptake and crude protein yield of maize as influenced by different treatments

Sl. No.	Treatment	Total dry matter (t ha^{-1})	Total N uptake (kg ha^{-1})	Crude protein yield (kg ha^{-1})
1	T_1	17.67	182.9	1230
2	T_2	18.22	202.0	1294
3	T_3	17.16	190.1	1213
4	T_4	15.59	177.2	1085
5	T_5	20.14	221.1	1448
6	T_6	21.20	239.9	1543
7	T_7	20.40	235.1	1469
8	T_8	18.14	210.7	1265
9	T_9	22.32	253.0	1679
10	T_{10}	22.52	273.4	1695
11	T_{11}	21.79	261.2	1612
12	T_{12}	21.79	232.7	1426
13	T_{13}	18.12	200.1	1258
14	T_{14}	23.43	227.3	1424
15	T_{15}	10.73	124.9	781
SEm+		0.22	5.2	20
CD (p=0.05)		0.56	15.0	55.7

4. Conclusion

GDG maize sown at 30x25 cm^2 spacing supplemented with 240 kg N ha^{-1} in three split applications (0, 30, 70 DAS) was judged as the better practice for realizing higher benefit-cost ratio (2.48) which also provided good quality fodder for the livestock during the winter and summer months.

5. Further Research

It is imperative to know the response of GDG maize system to other sources of nutrients such as phosphorus and potassium.

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