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ENSHOT OF DIFFERENT NUTRIENT SOURCES ON FODDER YIELD, QUALITY AND SOIL FERTILITY STATUS OF MULTICUT FODDER SORGHUM GROWN SOIL

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SUMMARY

An experiment was carried out during 2009-12 to study the impact of different nutrient sources on yield and quality of multicut fodder sorghum CO(FS)29. The mean of three years' data of the experiment conducted to identify suitable organic source showed that poultry manure (PM) applied @18.8 t/ha+2 kg Azospirillum+2 kg Phospho bacteria recorded 167.6 t green fodder yield/ha/year. The crude protein content got increased in the FYM applied treatment. The higher organic carbon content of 1.12 per cent recorded in FYM applied plot followed by poultry manure applied treatment (0.99%) from the initial carbon status of 0.62 per cent. The poultry manure applied plot recorded higher available N content of 185 kg/ha. The PM applied plot observed higher net returns of Rs.1,16,500 with B/C ratio of 4.7.

Key words : Multicut fodder sorghum, crude protein, FYM, poultry manure, fodder yield, soil nutrient balance, net returns

Sorghum as a green foliage in most parts of India and nearly 2.5 million ha area is planted during **kharif**. In summer, under irrigated conditions, multicut sorghum is very popular. Forage sorghum is characterized by quick growth, high biomass accumulation, dry matter content and wide adaptability besides drought withstanding ability. It is also suitable for silage and hay making. There are improved varieties and hybrids capable of yielding on an average 50 t/ha in single cut varieties and up to 70 t/ha in multicut varieties. The increasing feed requirements of the expanding livestock population necessitate the introduction of sorghum hybrid into the irrigated areas. Among the **kharif** forage crops, multicut hybrid sorghum is an important one that possesses a wide range of ecological adaptability because of its xerophytic characteristics. The use of forage sorghum hybrids for pasture and silage has been increasing in recent years (Iptas *et al*., 1997). Cured sorghum fodder, with a little protein supplement, maintains cattle in good condition. Sorghum fodder contains 70 per cent carbohydrates, minerals, crude fat and nitrogen free extract (Chaudhry, 1994). A promising multicut sorghum variety released by the Tamil Nadu Agricultural University, CO (FS 29) is the leading one in Tamil Nadu and other states.

Multicut sorghum should be fertilized more like an intensively managed perennial grass than a corn crop with N fertilizer being applied before planting and after each cut in a multicut system (Ketterings *et al.*, 2004). In irrigated areas, N fertilizer is very important and is the main factor affecting the DM yield of sorghum cultivars; proper N application increases both fodder yield and herbage quality (Buxton, 1996; Corlett *et al.*, 1992; Davorat *et al.*, 1993). Nitrogen should be applied to a crop at times that avoids periods of significant loss and provides adequate N when needed (Khosla *et al.*, 2000).

Nitrogen is highly volatile in soil but mainly advantageous to vegetative development of plant. Balanced N supply to crop not only increases biomass but also improves forage quality. N fertilizers are easily soluble and leachable in most of the soils, and increase the forage yield of sorghum varieties (Rahman *et al.*, 2001). Studies of the yield response of forage multicut sorghum hybrids developed for areas with shorter growing seasons to additions of fertilizer N have not been previously reported. In India, a little information is available on the organic sources of nitrogen on the quality and fodder yield of multicut sorghum. The present study was therefore planned with the objective to identify the suitable organic N sources for obtaining maximum fodder yield of sorghum under multicut irrigated condition of Tamil Nadu, India.

MATERIALS AND METHODS

An experiment was carried out during 2009-12 to study the impact of different nutrient sources on yield and quality of multicut fodder sorghum CO (FS 29). The nutrient sources viz., farm yard manure (FYM), poultry manure (PM), INM and inorganics alone were tried in this experiment. The FYM and poultry manure applied on N equivalent basis and for INM and inorganics treatments, followed as per crop production guide. The soil analysis report before the commencement of experiment revealed that the soil was slightly alkaline 8.01 and free from excessive salts (0.13 dS/m). It was medium in organic carbon (0.65%) and low in available N (165 kg/ha), medium in available P (15 kg/ha) and high in available K (510 kg/ha). Similarly, microbial populations viz., bacteria (42.1 CFU×10^6/g soil), fungal (13.2 CFU×10^3 /g soil) and actinomycetes also recorded (5.3 CFU×10^4 /g soil). The green fodder yield was recorded as such in the field. The dry fodder yield was recorded by keeping the samples in electric oven at 65ºC. The available N, P, K, S and micronutrients were analysed as per the standard procedures. The data were analysed statistically by using simple RBD.

RESULTS AND DISCUSSION

Fodder Yield

The first year data of this experiment showed that among the different sources of nutrients tried to improve the green fodder yield, the fodder sorghum was highly responded to poultry manure application. In this treatment, green fodder yield recorded was 175.6 t/ha/year and followed by FYM application (155.1 t/ha/year) and INM (147.4 t/ha/year). During second year also it was highly responded to poultry manure application (147.6 t/ha/year) followed by FYM application (131.4 t/ha/year). The INM recorded 105.4 t/ha/year green fodder which is on par with inorganics alone 95.9 t/ha/year. During third year also fodder sorghum was highly responded to poultry manure application. The pooled analysis of three-year data (Table 1) showed that the application of poultry manure @18.8 t/ha/year in multicut fodder sorghum recorded 168 t/ha/year which was 29 per cent increase over inorganics alone. Suksri and Phosen (2000) reported that application of inorganic with organics recorded higher growth parameters than that of chemical fertilizer alone. The results showed that sorghum plants required a large amount of nitrogen and organic amendments for growth. The higher dry fodder yield was recorded in poultry manure applied plot (38.28 t/ha/year) followed by FYM (33.81 t/ha/year) and INM (32.13 t/ha/year). Same trend of results was observed during second and third year also. Afzal (2013) reported that the multicut fodder sorghum showed high response to increasing level of N.

Quality Parameters

Crude protein yield and content, crude fibre and crude fat content

The data on the crude protein yield in multicut fodder sorghum reveal that highest crude protein yield was observed in the PM applied plot (3.12 t/ha) which was followed by FYM (2.71 t/ha). The same trend of results was observed in second and third year also.

The important fodder quality parameters viz., crude protein, crude fibre and crude fat content were analysed for the application of different nutrient sources (Table 1). Among the treatments, the poultry manure applied treatment recorded higher crude protein content (8.7%). The favourable influence of nitrogen in poultry manure on cell division and cell elongation could have produced more functional leaves for a longer period of time (Gardner *et al.*, 1988). Crude protein content increased significantly with poultry manure application in all the cuttings. This increase in crude protein content may be due to increased availability of nitrogen thereby more uptake and corresponding increase in protein content of herbage. The crude protein yield increased significantly due to increased crude protein content associated with enhanced dry matter yield.

TABLE 1
Effect of source of nutrients on yield attributes of multicut fodder sorghum CO (FS 29)

Treatment	Green fodder yield (t/ha/year)				Dry fodder yield (t/ha/year)				Fodder quality (%)		
	I year	II year	III year	Mean	I year	II year	III year	Mean	Crude protein	Crude fibre	Crude fat
S_1–FYM	131.4	155.1	164.2	150.2	33.81	35.80	34.2	33.81	8.4	25.1	3.1
S_2–PM	147.6	175.6	179.5	167.6	38.28	39.13	38.1	38.28	8.7	24.3	3.0
S_3–INM	105.4	147.4	151.2	134.7	32.13	32.96	30.5	32.13	7.9	24.2	2.9
S_4–Inorganics	95.9	126.8	135.2	119.3	27.64	29.47	27.1	27.64	7.8	24.0	2.8
C. D. (P=0.05)	6.9	18.8	14.1						0.3	NS	NS

NS–Not Significant.

In the crude fibre and crude fat analytical data, there was no significant difference observed among the treatments. The crude fibre content decreased significantly with poultry manure application at all the cuttings. This could be attributed to increase in crude protein content due to higher nitrogen content in the poultry manure. The significant decrease in crude fibre content with increase in nitrogen level might be due to higher nitrogen supply. The more rapidly synthesized carbohydrates are converted into proteins and to protoplasm and only smaller portions are available for cell wall material. Cells thus produced tend to contain more protoplasm than cell wall material. The leaves of a plant rich in nitrogen contain a relatively high proportion of water, low proportion of dry matter, more succulent and low in crude fibre content (Kothari and Saraf, 1987). The ether extract content and yield increased significantly with increased nitrogen levels. These findings are in agreement with those of Vasanthi and Kumarswamy (1998) and Bhilare *et al.* (2002). Among the different nitrogen levels 300 kg N/ha recorded higher crude protein content compared to lower levels of nitrogen treatment in all the cuttings (Manjunath *et al.*, 2013)

Nutrient Uptake

In the multicut fodder sorghum (Table 2), highest N uptake was observed in the PM applied plot (515 kg/ha) which was followed by FYM (444 kg/ha). Highest P uptake was recorded in the PM applied plot of 159 kg/ha which was followed by FYM applied plot (135 kg/ha). The INM (106 kg/ha) and inorganics applied plot (97 kg/ha) recorded statistically comparable values. Highest K uptake was observed in the PM applied plot (648 kg/ha) which was followed by FYM (561 kg/ ha). The INM (429 kg/ha) and inorganics alone plot (398 kg/ha) recorded comparable values.

Highest Ca uptake was recorded in the PM applied plot of 152 kg/ha which was followed by FYM applied plot (135 kg/ha).The INM (109 kg/ha) and

TABLE 2
Effect of source of nutrients on nutrient uptake (kg/ha) of multicut fodder sorghum

Treatment	Nutrient uptake (kg/ha)									
	N	P	K	Ca	Mg	S	Fe	Zn	Mn	Cu
S_1–FYM	444	135	561	135	102	29	26.5	3.56	8.0	3.30
S_2–PM	515	159	648	152	115	33	29.7	4.00	9.0	3.70
S_3–INM	335	106	429	109	82	23	21.3	2.86	6.4	2.65
S_4–Inorganics	301	97	398	101	75	21	19.3	2.60	5.8	2.41
C. D. (P=0.05)	42	16	58	14	10	3	3.2	NS	0.8	NS

NS–Not Significant.

inorganics applied plot (101 kg/ha) recorded statistically comparable values. Highest Mg uptake was observed in the PM applied plot (115 kg/ha) which was followed by FYM (102 kg/ha), INM (82 kg/ha) and inorganics (75 kg/ha). Highest S uptake was observed in the PM applied plot (33 kg/ha) which was followed by FYM (29 kg/ ha). The INM (23 kg/ha) and inorganics alone plot (21 kg/ha) recorded comparable values.

Highest Fe uptake was recorded in the PM applied plot of 29.7 kg/ha which was followed by FYM applied plot (26.5 kg/ha). The INM (21.3 kg/ha) and inorganics applied plot (19.3 kg/ha) recorded statistically comparable values. Highest Mn uptake was observed in the PM applied plot (9.0 kg/ha) which was followed by FYM (8.0 kg/ha) and then INM (6.4 kg/ha) and inorganics (5.8 kg/ha). The same trend of results was observed in second and third year also. Non-significant response was observed for zinc and copper uptake.

Soil Fertility

The FYM applied on N equivalent basis recorded higher organic carbon content of 1.12 per cent followed by poultry manure applied treatment (0.99%) and INM (0.79%) (Table 3). Application of FYM was better in terms of carbon build-up and sustained release of nitrogen to the crops.The analytical data of the available nitrogen status of the soil showed that the poultry manure applied plot recorded higher available N content of 185 kg/ha followed by FYM applied treatment of 182 kg/ha from the initial soil available N content of 165 kg/ha. The same trend of results was observed in the available P status. The higher available K content of 565 kg/ha was recorded in the FYM applied treatment. The FYM recorded higher Ca of 16.5 cmol (p+)/kg which is on par with PM plot (15.7 cmol (p+)/kg). Higher exchangeable Mg was recorded in FYM plot (7.8 cmol (p+)/kg) which is followed by 7.0 cmol (p+)/kg. The INM (6.5 cmol (p+)/ kg) and inorganics (5.7 cmol (p+)/kg) recorded comparable values.

The DTPA extractable micro-nutrients in soil indicated that the FYM applied plot recorded higher DTPA Fe content of 9.6 ppm from the initial value of 7.8 ppm followed by PM applied treatment of 8.4 ppm. The same trend of results was observed in DTPA Mn, Zn and Cu content. Applying manure annually is not always possible. The studies that have been done to date indicate that applications made to meet a two year nutrient requirement result in a good response.

The organic carbon application improved the

TABLE 3

Effect of source of nutrients on soil nutrient status of fodder sorghum grown soil

Treatment	SOC (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)	E x Ca (cmol p(+)/kg)	E x Mg (cmol p(+)/kg)	DTPA Fe (ppm)	DTPA Zn (ppm)	DTPA Mn (ppm)	DTPA Cu (ppm)
S_1	1.12	182	20.2	565	16.5	7.8	9.6	6.5	7.8	7.8
S_2	0.99	185	20.4	548	15.7	7.0	8.4	5.7	7.0	7.0
S_3	0.79	170	18.5	538	14.3	6.5	8.1	4.3	6.5	6.5
S_4	0.67	161	17.2	525	13.5	5.7	7.6	3.5	5.7	5.7
C. D. (P=0.05)	0.11	14	0.5	14	1.9	0.9	0.7	0.9	0.5	0.9

TABLE 4

Soil nutrient balance sheet for multicut fodder sorghum

Treatment	Nitrogen			Phosphorus			Potassium		
	Applied	Uptake	Balance	Applied	Uptake	Balance	Applied	Uptake	Balance
S_1	225	460	-235	90	140	-50	225	581	-356
S_2	225	531	-306	75.2	164	-88	75.2	667	-591
S_3	225	386	-161	40	122	-82	40.0	495	-455
S_4	225	338	-113	40	109	-69	40.0	447	-407

TABLE 5

Effect of source of nutrients on monetary benefits

Treatment	Fodder sorghum			
	CC	GR	NR	B/C
S_1–FYM	60900	131400	70500	2.1
S_2–PM	31100	147600	116500	4.7
S_3–INM	40900	105400	64500	2.5
S_4	20200	95900	75700	4.7

CC–Cost of cultivation (Rs.)
GR–Gross return (Rs.)
NR–Net return (Rs.)
B/C–Benefit-cost ratio

Zn and Fe concentration but it reduced Cu and Mn content in plants (Sidhu and Narval, 2007). In order to maximize the economic benefit, manure should be applied when forage prices are high in an effort to maximize yields and get the greatest return. The nutrient carryover, particularly in the case of solid manure applications, will increase forage production in subsequent years thereby improving profitability over a longer period of time. Forages, relative to some field crops, have high nutrient requirements. Applications should be calculated to meet the forage nutrient demand based on potential yield. If the manure is in short supply, it may be better to apply appropriate rates to one field, correcting nutrient deficiencies, rather than lower rates to several. The application of excess nutrients may result in losses from runoff or leaching, and so it is important to consider the site specific nature of soils and the opportunity for runoff.

Soil Nutrient Balance Sheet for Multicut Fodder Sorghum

The nutrient uptake pattern of multicut fodder sorghum (Table 4) reveals that N and K also P were heavily removed from the soil. The K and N recommendation was not sufficient to meet out the crop requirement.

Effect of Source of Nutrients on Economics of Fodder Cultivation

Nutrients from manure can replace commercial fertilizer inputs so there is an economic value to manure application. A fertilizer equivalent value for manure can be calculated based on current prices for nutrients from inorganic fertilizer sources and the nutrient concentrations in the manure. Data pertaining to influence of inorganic and organic source of nutrients on economics of fodder cultivation are presented in Table 5. The results showed that in the sorghum crop, the PM applied plot observed higher net return of Rs. 1,16,500 with B/C ratio of 4.7. There is also a value to the micronutrients in manure and to the improved soil water-holding capacity and tilth that manure provides. These values are highly dependent upon soil conditions prior to manure application (e. g. are the micronutrients really needed?) and are extremely difficult to generalize and assign a dollar value.

CONCLUSION

The mean of three year data of the experiment conducted to identify suitable nutrient source showed that PM application @18.8 t/ha+2 kg Azospirillum+2 kg Phosphobacteria recorded 167.6 t green fodder yield/ha/year. The important quality parameter crude protein content got increased in the FYM applied treatment irrespective of the crops. The major nutrients available in the soil after completing three-year period indicated that there was a drastic depletion of almost all nutrients. If cereal forage crops are recommended for cultivation the fertilizer schedule has to be researched. Especially the potassium was heavily mined from the soil. Hence, the K study related to pools of K, sources and doses of K have to be taken care.

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