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YIELD, NITROGEN UPTAKE, AVAILABLE SOIL NUTRIENTS AND ECONOMICS OF MULTICUT FODDER SORGHUM (*SORGHUM SUDANENSE* L.) TO DIFFERENT SEED RATES AND NITROGEN LEVELS

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SUMMARY

A field experiment was conducted at Zonal Agricultural Research Station, Visweswaraiah Canal Farm, Mandya (Karnataka) during **kharif** season of 2011 to study the yield, nitrogen uptake, available soil nutrients and economics of multicut fodder sorghum (*Sorghum sudanense* L.) to different seed rates and nitrogen levels under protective irrigated condition. The experiment consisted of 12 treatments which were tested in randomized complete block design with factorial concept replicated three times. The mean of four cuts data indicated that seed rate of 7.5 kg/ha with the application of 30 kg N/ha recorded significantly higher green fodder yield (79.88 and 76.46 t/ha, respectively), dry matter yield (18.51 and 17.04 t/ha, respectively), nitrogen uptake (243.83 and 220.11 kg/ha, respectively), net returns (Rs. 35018 and 31285/ha, respectively) and B : C ratio (2.40 and 2.20, respectively).

Key words : Fodder sorghum, green forage yield, dry matter yield, available nutrients

Karnataka state is a home for 28.6 million heads of livestock with only 3.5 per cent of the cultivated area under fodder crops. The annual fodder requirement of the state is 122 million tonnes of green fodder and 24 million tonnes of dry fodder, where the present production is 85 and 15 million tonnes of green and dry fodder, respectively, with a deficit of 46 million tonnes of total fodder requirement (Anonymous, 1999). Although, India stands first in milk production (90 mt) in the world, the productivity per animal is far below compared to the developed countries, which is mainly due to inadequate supply of quality fodder. In India, due to increased population pressure and competing demand for food crops, it is not possible to increase the area under fodder crops. The only way to bridge the large gap between supply and demand of fodder is to maximize the fodder production per unit area and unit time within the existing farming systems and utilizing marginal, sub-marginal dry lands and problematic soils for developing feed and fodder resources. Simultaneously, efforts should be made in the genetic improvement of the livestock as well as fodder resources with the identification and introduction of new high yielding nutritious fodder crops with suitable agronomic practices. Among numerous species of grasses available for forage utility, sorghum is very important world fodder crop. It is drought and heat tolerant and is an important proposition in arid regions. Varieties of *Sorghum bicolor* are used for both grain and fodder purposes. There are varieties which can be used as either single cut or multicut (2-3) (Surendran *et al*., 1988). But, for regular year round supply of quality green fodder, perennial varieties are desired. These kinds of varieties can give constant normal green fodder yield in six cuts in a year and save seed cost. To fulfil this demand, multicut fodder sorghum CoFS-29 was developed from TNAU, Coimbatore and released during 2001 for general cultivation in Tamil Nadu. This variety was identified and introduced to Karnataka state during the year 2011-12. However, information on location-specific agronomic

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requirements for higher green fodder yield and quality is meagre for this variety. Among the various agronomic practices, optimum plant population and proper crop nutrition are the prime importance in getting higher forage yield of better quality. Among the major nutrient elements, nitrogen has special significance in increasing green biomass yield and its quality. Nitrogen fertilization has been reported to improve not only the yield but also the crude protein content of multicut fodder sorghum. Keeping these things in view, the present investigation was carried out for achieving good quality and maximum production.

MATERIALS AND METHODS

A field experiment was conducted during **kharif** season of 2011 at Zonal Agricultural Research Station, Vishweswaraiah Canal Farm, Mandya (Karnataka) to assess the yield, uptake and economics of multicut fodder sorghum (CoFS-29) as influenced by different seed rates and nitrogen levels. The soil of experimental field is red sandy loam with neutral soil pH (6.86), medium in available nitrogen (297.5 kg/ha), phosphorus (34.20 kg/ha) and potassium (34.20 kg/ha). The experiment was laid out in randomized complete block design with factorial concept with three replications. The experiment consisted of 12 treatment combinations viz., three levels of seed rates (5, 7.5 and 10 kg/ha) and four levels of nitrogen (15, 30, 45 and 60 kg N/ha for each cut). Equal quantity of farm yard manure at the rate of 10 t/ha was applied to each plot three weeks prior to sowing**.** A common dose of 40 kg of nitrogen, 50 kg of P_2O_5 and 40 kg of K_2O/ha was applied as basal dose at the time of sowing in the form of urea, single super phosphate and muriate of potash, respectively. The remaining 45 kg of nitrogen was applied in two equal splits each at 30 and 45 DAS in the form of urea for establishment of the crop. After first cut the nitrogen was applied as per treatment for each cut. Fodder sorghum variety CoFS-29 was sown in line 30 cm apart. The crop was sown during last week of July and harvested when crop attained full flowering which is considered to be ideal stage for quality fodder. Five plants were randomly selected in each net plot area for taking observations on growth and yield attributing parameters. The crop in each net plot was harvested separately as per treatment and the values were converted into hectare basis and expressed in tonnes. The samples were first dried under shade and then in electric oven at a temperature of 60^0 C till attaining constant weight on the basis of weight of these samples, the green fodder yield was converted into dry matter yield (t/ha). The data of all four cuts were pooled and statistically analyzed for interpretation of results.

RESULTS AND DISCUSSION

Green Fodder Yield

Green fodder yield was significantly influenced by seed rates and nitrogen levels. Pooled data (Table 1) indicated that seed rate of 7.5 kg/ha recorded significantly higher green fodder yield (79.88 t/ha) as compared to that with seed rate of 5 kg/ha (67.99 t/ha) and was on par with seed rate of 10 kg/ha (76.51 t/ha). The higher green fodder yield in seed rate of 7.5 kg/ha was mainly due to higher plant height, number of tillers per metre row length and leaf : stem ratio. Apart from this, the over burden of the plant population which might compete for light and nutrients which leads to lanky growth and grassy shoot appearance resulted in lower green fodder yield in seed rate of 10 kg/ha. These results are in conformity with the findings of Mishra *et al*. (1994), Gaurkar and Bharad (1998) and Naganagouda (2002). Among nitrogen levels, application of 30 kg N/ha recorded significantly higher green fodder yield (76.46 t/ha) as compared to that with 15 kg N/ha (65.19 t/ha) and was on par with 45 and 60 kg N/ha (77.27 and 80.26 t/ha) on pooled data basis. This may be mainly attributed to improved growth and yield parameters viz., plant height, number of tillers/m row, leaf : stem ratio and the beneficial effects of nitrogen on cell division and elongation, formation of nucleotides and co-enzymes which resulted in increased meristematic activity and photosynthetic area and hence more production and accumulation of photosynthates, yielding higher green fodder and dry matter. These results are in conformity with the findings of Dudhat *et al*. (2004), Sharma and Verma (2005) and Sheoran and Rana (2006).

Dry Matter Yield

Dry matter yield was significantly influenced by seed rates and nitrogen levels. Pooled data indicated that seed rate of 7.5 kg/ha recorded significantly higher total dry matter yield (18.51 t/ha) as compared to that with seed rate of 5 kg/ha (14.09 t/ha) and was on par with seed rate of 10 kg/ha (17.40 t/ha). Among nitrogen levels, application of 60 kg N/ha recorded significantly

TABLE 1
Green fodder yield, dry matter yield, total nitrogen uptake, net returns and B : C ratio of multicut fodder sorghum as influenced by different seed rates and nitrogen levels

Treatment	Green fodder yield (t/ha)	Dry matter yield (t/ha)	Total nitrogen uptake (kg/ha)	Net returns (Rs./ha)	B : C ratio
Seed rates (kg/ha)					
S_1–5	67.99	14.09	170.33	26600	2.09
S_2–7.5	79.88	18.51	243.83	35018	2.40
S_3–10	76.51	17.40	221.83	31987	2.25
S. Em±	1.17	0.39	6.17	880	0.03
C. D. (P=0.05)	3.44	1.15	18.11	2582	0.10
Nitrogen levels (kg/ha)					
N_{15}–15	65.19	13.80	157.78	23415	1.91
N_{30}–30	76.46	17.04	220.11	31285	2.20
N_{45}–45	77.27	17.60	227.67	30896	2.15
N_{60}–60	80.26	18.23	242.44	32550	2.18
S. Em±	1.36	0.45	7.13	1017	0.04
C. D. (P=0.05)	3.98	1.33	20.91	2983	0.11
Treatment combinations (S x N)					
S_1N_{15}	56.83	11.40	116.67	17643	1.70
S_1N_{30}	69.98	14.37	182.33	26918	2.05
S_1N_{45}	71.11	15.03	184.00	26781	1.96
S_1N_{60}	74.05	15.58	198.33	28347	2.04
S_2N_{15}	71.65	15.12	172.67	28258	2.10
S_2N_{30}	80.98	19.01	255.33	34665	2.32
S_2N_{45}	82.03	19.37	262.67	34471	2.28
S_2N_{60}	84.87	20.52	284.67	36010	2.31
S_3N_{15}	67.10	14.87	184.00	24343	1.93
S_3N_{30}	78.45	17.75	222.67	32270	2.21
S_3N_{45}	78.64	18.39	236.33	31428	2.14
S_3N_{60}	81.84	18.59	244.33	33237	2.18
S. Em±	2.35	0.79	12.35	1761	0.07
C. D. (P=0.05)	NS	NS	NS	NS	NS

NS–Not Significant.

higher dry matter yield (18.23 t/ha) as compared to that with 15 kg N/ha (13.80 t/ha) and was on par with 45 and 30 kg N/ha (17.60 and 17.04 t/ha, respectively) on pooled data basis.

Nitrogen Uptake (kg/ha)

Nitrogen uptake was significantly influenced by seed rates and nitrogen levels. Pooled data indicated that seed rate of 7.5 kg/ha recorded significantly higher total nitrogen uptake (243.83 kg/ha) over seed rate of 10 and 5 kg/ha (221.83 and 170.33 kg/ha). Among nitrogen levels, application of 60 kg N/ha recorded significantly higher total nitrogen uptake (242.44 kg/ha) which was on par with 45 kg N/ha (227.67 kg/ha) but significantly superior over 30 and 15 kg N/ha (220.11 and 157.78 kg/ha, respectively). This was mainly due to increased nitrogen application which increased the total nitrogen content in plant resulting in more dry matter production and uptake. These results are in conformity with the findings of Purohit (1960).

Available Soil Nutrients

Available nitrogen content in soil (kg/ha) : Available nitrogen content in soil after each cut differed significantly due to seed rates and nitrogen levels (Table 2). In first cut, seed rate of 5 kg/ha recorded significantly higher available nitrogen content in soil (226.41 kg/ha) as compared to that with seed rate of 10 kg/ha (201.95 kg/

TABLE 2
Available soil nutrients (kg/ha) as influenced by different seed rates and nitrogen levels

Treatment	Soil available nutrients (kg/ha)				Available P after final harvest	Available K after final harvest
	Nitrogen after each harvest					
	I	II	III	IV		
Seed rates (kg/ha)						
S_1–5	226.41	188.87	170.54	161.20	23.75	108.73
S_2–7.5	218.17	183.21	164.16	154.82	25.46	115.13
S_3–10	201.95	164.51	149.76	140.51	25.12	113.48
S. Em±	5.49	6.12	4.18	4.11	0.44	1.50
C. D. (P=0.05)	16.10	17.96	12.26	12.04	1.29	4.39
Nitrogen levels (kg/ha)						
N_{15}–15	210.34	156.81	142.65	133.31	21.87	101.31
N_{30}–30	213.11	177.95	161.86	152.63	24.97	114.01
N_{45}–45	217.70	184.15	168.85	159.52	25.93	115.77
N_{60}–60	220.89	196.54	172.59	163.25	26.34	118.68
S. Em±	6.34	7.07	4.83	4.74	0.51	1.73
C. D. (P=0.05)	NS	20.74	14.15	13.90	1.49	5.07
Treatment combinations (S x N)						
S_1N_{15}	223.81	168.44	145.65	136.32	20.79	100.14
S_1N_{30}	224.00	183.41	172.53	163.19	23.84	109.06
S_1N_{45}	226.93	192.05	181.24	171.91	24.85	112.26
S_1N_{60}	230.89	211.56	182.73	173.39	25.53	113.46
S_2N_{15}	214.35	163.23	142.98	133.64	22.54	102.03
S_2N_{30}	215.59	179.78	163.46	154.13	25.85	117.30
S_2N_{45}	221.17	186.75	172.53	163.19	26.51	117.94
S_2N_{60}	221.56	203.08	177.67	168.33	26.94	123.25
S_3N_{15}	192.85	138.75	139.31	129.88	22.29	101.77
S_3N_{30}	199.74	170.65	149.58	140.58	25.20	115.69
S_3N_{45}	204.99	173.65	152.78	143.45	26.43	117.11
S_3N_{60}	210.22	174.99	157.37	148.04	26.54	119.34
S. Em±	10.98	12.25	8.36	8.21	0.88	2.99
C. D. (P=0.05)	NS	NS	NS	NS	NS	NS

NS–Not Significant.

ha) and was on par with seed rate of 7.5 kg/ha (218.17 kg/ha). The same trend was found similar in all the cuts. In second cut, application of 60 kg N/ha for each cut recorded higher available nitrogen content in soil (196.54 kg/ha) than 15 kg N/ha for each cut (156.81 kg/ha) and was on par with 45 and 30 kg N/ha for each cut (184.15 and 177.95 kg/ha, respectively). The same trend was found similar in third and fourth cuts except first cut. In first cut, available soil nitrogen was not significant among nitrogen levels (210.34 to 217.70 kg/ha). The interactions between seed rates and nitrogen levels were not significant.

Available phosphorus content in soil after final harvest (kg/ha) : Available phosphorus content in soil differed significantly due to seed rates and nitrogen levels. Seed rate of 7.5 kg/ha recorded significantly higher available phosphorus content in soil (25.46 kg/ha) than seed rate of 5 kg/ha (23.75 kg/ha) and was on par with seed rate of 10 kg/ha (25.12 kg/ha) after final harvest. Among nitrogen levels, application of 60 kg N/ha recorded significantly higher available phosphorus content in soil (26.34 kg/ha) as compared to that with 15 kg N/ha (21.87 kg/ha) and was on par with 45 and 30 kg P_2O_5/ha for each cut (25.93 and 24.97 kg/ha, respectively). The interactions between seed rates and nitrogen levels were not significant.

Available potassium content in soil after final harvest (kg/ha) : Significant influence on available

potassium content in soil was exhibited by different seed rates and nitrogen levels. Seed rate of 7.5 kg/ha recorded significantly higher available potassium content in soil (115.13 kg/ha) than seed rate of 5 kg/ha (108.73 kg/ha) and was on par with seed rate of 10 kg/ha (113.48 kg/ha). Among nitrogen levels, application of 60 kg N/ha for each cut recorded significantly higher available potassium content in soil (118.68 kg/ha) as compared to that with 15 kg N/ha for each cut (101.31 kg/ha) and was on par with 45 and 30 kg K_2O/ha for each cut (115.77 and 114.01 kg/ha, respectively). The interactions between seed rates and nitrogen levels were not significant.

Economics

Higher gross returns (Rs. 59911/ha), net returns (Rs. 35018/ha) and B : C ratio (2.40) were obtained with the seed rate of 7.5 kg/ha as compared to that with seed rate of 10 and 5 kg/ha. This was mainly due to higher green forage yield and less cost of production as compared to 5 and 10 kg seeds/ha. Among nitrogen levels, significantly higher gross returns (Rs. 59987/ha) and net returns (Rs. 32550/ha) were obtained with 60 kg N/ha which was on par with application of 30 kg N/ha for each cut (Rs. 57350 and 31285/ha, respectively). However, significantly higher B : C ratio was obtained with 30 kg N/ha for each cut (2.20). This was due to higher green fodder yield with minimum incremental nitrogen level and lower cost of cultivation.

CONCLUSION

Based on the results it can be inferred that seed rate of 7.5 kg/ha with 30 kg N/ha for each cut was found optimum and economical which recorded higher green forage, dry matter yield, total nitrogen uptake, available soil nutrients, net returns and B : C ratio.

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