Indian Journal of Agronomy **51** (4) : 310–313 (December 2006)

Response of fodder sorghum *(Sorghum bicolor)* to different weed-management techniques and nitrogen levels

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Received : February, 2006

ABSTRACT

A field experiment was conducted during rainy *(kharif)* seasons of 2000-02 at Jhansi to know the response of fodder sorghum *[Sorghum bicolor* (L.) Moench] to nitrogen levels and weed-control techniques. Significant increase in green-fodder, dry-matter and crude-protein yields was recorded with successive increase in nitrogen up to 60 kg/ha. N at 60 kg/ha gave significantly higher green-fodder (45.2 t/ha), dry-matter (8.26 t/ha) and crude-protein yields (646.7 kg/ha) as well as nitrogen uptake (104.2 kg/ha), but at higher level showed no significant differences. However, 90 kg N/ha gave the highest net profit (Rs 15,850/ha) and benefit : cost (B:C) ratio (1.55) compared with the remaining levels. Among weed-control techniques, broadcast sowing of cowpea (*Vigna unguiculata* (L.) Walp.) and application of atrazine @ 0.5 kg/ha were at par and gave significantly higher green-fodder (52.1 and 49.1 t/ha) and dry-matter (8.9 and 9.06 t/ha) yields than other techniques. Broadcast sowing of cowpea gave higher net profit (Rs 13,800/ha), B:C ratio (1.45) and significantly higher crude-protein yield (800 kg/ha) as well as nitrogen uptake (126.2 kg/ha) than others methods. Atrazine 0.5 kg/ha gave significantly lower weed density (25.6/m^2), dry weight of weeds (0.30 t/ha) and nitrogen uptake by weeds (4.0 kg/ha) than other techniques. This was closely followed by broadcast sowing of cowpea, registering 104.5/m^2, 1.93 t/ha and 16.3 kg/ha respectively. Interaction effects of nitrogen levels and weed-control techniques for green-fodder, dry-matter, crude-protein yields and nitrogen uptake of sorghum were also significant.

Key words : Forage sorghum, Green fodder, Crude protein, Nitrogen uptake, Weed-control techniques

Forage sorghum *[Sorghum bicolor* (L.) Moench] occupies 2.93 million ha area in semi-arid regions of India. Judicious use of nutrients, especially nitrogen, in forage sorghum may improve the yield and quality of fodder and optimize its production cost (Shiva Dhar *et al.*, 2005). Being a rainy season crop, it faces the problem of heavy infestation of weeds. Therefore weed management in forage sorghum is an important aspect to check the nutrient, water loss and to increase the fodder yield. Chemical control of weeds advocated for grain and forage sorghum may be hazardous to the environment. Alternatively, cultural control of weeds may be suitable for controlling them without affecting the environment. Inclusion of legumes like cowpea, greengram and blackgram has proved effective for reducing the weeds due to their smothering effect (Solaimalai and Shivakumar, 2000). Fast-growing legumes cover the ground very quickly and give less chance for weeds to grow, Besides, legumes enrich the soil by environmental nitrogen fixation, and thus improve the nitrogen economy. Legume crops are also beneficial to improve forage quality due to their high crude-protein content. Keeping in view these points an experiment was carried out to find out the response of nitrogen levels and weed-management techniques in efficient control of weeds, for improving the productivity of forage sorghum.

MATERIALS AND METHODS

The field experiment was conducted during rainy *(kharif)* seasons of 2000-02 at Central Research Farm of the institute, at Jhansi. The soil was sandy clay-loam, low in organic carbon (0.30%) and available nitrogen (202 kg/ha), medium in available phosphorus (23 kg P/ha) and high in available potassium (322 kg/ha) with pH 7.4. The crop received 464, 726 and 477 mm precipitation in 24, 31 and 20 rainy days respectively during the crop period of 2000, 2001 and 2002.

The experiment was laid out in split-plot design and replicated thrice. The treatments comprised five levels of nitrogen (0, 30, 60, 90 and 120 kg N/ha) in main plots and five weed-control techniques (WCT), viz. weedy check, weeder-cum-mulcher at crop age of 3 weeks, pre-emergence application of atrazine @ 0.5 kg/ha, broadcast sowing of cowpea ('Bundel 2') @ 25 kg seed/ha and broadcast sowing of blackgram '(T 9)' @ 20 kg seeds/ha, in subplots. Seeds of cowpea and blackgram were broadcast during sowing of sorghum.

Forage sorghum variety 'HD 15' was sown in lines 25 cm apart, using 40 kg seed/ha. Basal fertilizer dose consisting of 17.5 kg P and 24.9 kg K/ha was applied uniformly to all the plots through single superphosphate and muriate of potash. The doses of nitrogen were applied through urea as per treatment. Two-third amount of nitrogen was applied basal before sowing and the remaining one-third of the respective doses was applied 3 weeks after sowing. The crop was harvested on attaining 50% flowering. It was sown in the first week of July and harvested in the second week of September during the experimental years. The weed population, dry weight of weeds and nitrogen content of weeds were recorded at the crop age of 6 week. The data on sorghum were recorded at the time of harvest. Dry-matter content and dry-matter yield of weeds and sorghum were estimated by drying the samples in hot-air oven at 70°C. Nitrogen uptake and crude-protein yield were calculated by multiplying the dry-matter yield with the content. The data for individual years were pooled and statistically analysed.

RESULTS AND DISCUSSION

Effect on weeds

Weed density : During the 3 years of experimentation, the field was infested with grassy weeds like *Echinochloa colonum* (L.) Link, *Dactyloctenium aegypticum* (L.) Willd. and *Digitaria sanguinalis* (L.) Scop; and broad-leaf weeds like *Commelina benghalensis* L., *Digera arvensis* Forsk., *Celosia argentia* L., *Phyllanthus niruri* L. and *Trianthema monogyna* (L.). Pooled analysis of the data revealed that weed-control techniques significantly influenced the density; however, variations due to nitrogen levels were found non-significant (Table 1). Significantly lower weed density was recorded with the application of atrazine @ 0.5 kg/ha compared with the remaining treatments, followed by broadcast sowing of cowpea. Application of atrazine and broadcast sowing of cowpea reduced the weed density by 98.2 and 66.7% respectively compared with the weedy check. Broadcast sowing of blackgram was also found significantly better than weeding-cum-mulching, recording lower weed density. Velayutham and Sanbagavalli (2002) and Mukherjee *et al.* (2000) also observed reduced weed density due to cowpea intercropping and atrazine application.

Table 1. Effect of nirogen level and weed-control technique on weeds associated with forage sorghum

Treatment	Weed density (weeds/m^2)	Dry matter of weeds (t/ha)	N uptake (kg/ha)	Weed-control efficiency (%)
N level (kg/ha)				
0	140.1	2.46	19.9	
30	142.9	2.34	20.3	
60	416.1	2.67	20.2	
90	150.2	2.53	20.8	
120	149.3	2.60	21.0	
CD (P=0.05)	NS	NS	NS	
Weed-control technique				
Weedy check	313.6	4.76	37.3	
WCM at 3 weeks	151.1	3.00	24.6	37.0
Atrazine @ 0.5 kg a.i/ha	25.6	0.30	4.0	93.7
Broadcast sowing of cowpea	104.5	1.93	16.3	59.5
Broadcast sowing of blackgram	135.0	2.73	20.3	42.6
CD (P=0.5)	5.8	0.30	5.1	

WCM=Weeding cum-mulching

Dry matter of weeds : Dry-matter production of weeds was significantly affected by different weed-control practices (Table 1). Atrazine 0.5 kg/ha recorded significantly lower dry matter of weeds than other practices. Among the remaining treatments, broadcast sowing of cowpea gave the lowest dry matter of weeds. Mukherjee *et al.* (2000) also reported the superiority of atrazine in forage sorghum for reducing the dry matter of weeds. The reduction in dry matter of weeds under broadcast sowing of cowpea might be due to its fast growth and ground coverage, which exert smothering effect on weeds (Rana *et al.*, 2004).

Weed control efficiency : The highest weed-control efficiency (93.7%) was recorded with the application of atrazine (Table 1), followed by broadcast sowing of cowpea (59.5%) for controlling the weeds. Broadcasting of blackgram was also closely followed by broadcast sowing of cowpea, but it was superior to weeding-cum-mulching Solaimalai and Shivakumar (2000) also recorded higher smothering efficiency of cowpea intercropped with sorghum.

N uptake by weeds : Nitrogen uptake of weeds was unaffected by nitrogen levels, but different weed-control practices did significantly influence it (Table 1). Atrazine application gave the significantly lowest nitrogen uptake by weeds. Broadcast sowing of cowpea was on a par with that of blackgram but it was significantly lower than weeding-cum-mulching and weedy check treatments. The amount of dry matter in weeds was found directly related to nitrogen uptake in weeds. Therefore the nitrogen uptake followed the same trend as dry matter of weeds.

Effect on sorghum

Green-fodder and dry-matter yields : Nitrogen levels, different weed-control measures and their interaction significantly influenced the green-forage and dry-matter yields of sorghum (Table 2). These yields increased sig-

Table 4. Effect of nitrogen level and weed-control technique on net profit and B:C ratio of sorghum (mean data of 3 years)

Treatment	Net profit (Rs/ha)	B:C ratio
N (kg/ha)		
0	4,550	0.49
30	6,750	0.70
60	14,650	1.48
90	15,850	1.55
120	11,100	1.06
Weed-control technique		
Weedy check	6,700	0.72
WCM at 3 weeks	7,100	0.70
Atrazine 0.5 kg ai/ha	12,950	1.34
Broadcast sowing of cowpea	13,800	1.45
Broadcast sowing of blackgram	13,750	1.43

nificantly with successive increase in N levels from 0 to 60 kg/ha, but not beyond it. However, Rathod *et al.* (2002) recorded increase in yields up to 80 kg N/ha. Solaimalai and Shivakumar (2000) reported increase in forage sorghum yield when intercropped with cowpea, and Mukherjee *et al.* (2000) reported beneficial effect of atrazine in controlling the weeds and increasing the yields. We observed that atrazine @ 0.5 kg/ha and broadcast sowing of cowpea produced significantly higher green-fodder and dry-matter yields than other weed-control treatments, which is turn were on a par with each other. Atrazine @ 0.5 kg/ha and N @ 90 kg/ha gave the highest green-fodder and dry-matter yields. However, this treatment was on a par with that of 120 kg N/ha and broadcast sowing of cowpea with 60, 90 or 120 kg kg/ha. Application of atrazine with 60, 90 or 120 kg/ha and broadcasting of cowpea with 60 or 90 kg resulted in better green-fodder and dry-matter yields. These yields of sorghum were statistically on a par with those of atrazine @ 0.5 kg/ha along with 90 kg N/ha and broadcast sowing of cowpea with 60 kg N/ha. This indicates a net saving of 30 kg N/ha by broadcast sowing of cowpea without affecting yields.

Crude-protein yield : Nitrogen levels, weed-control measures and their interactions significantly influenced the crude-protein yield of sorghum (Table 3). Crude-protein yield increased significantly with increase in N level from 0 to 60 kg N/ha, which was on a par with that of 90 kg but significantly less than of 120 kg N/ha. Among weed-control measures broadcast sowing of cowpea gave significantly higher crude-protein yield than the remaining treatments. Higher crude-protein content of cowpea, being a leguminous fodder, might have contributed to the crude protein yield of fodder. Broadcast sowing of cowpea also gave significantly higher crude-protein yield at 60 kg/ha than other measures. Ram and Singh (2001) also observed increase in crude-protein yield of sorghum with N up to 80 kg N/ha and on intercropping with cowpea.

N uptake : Nitrogen levels, weed-control measures and their interactions significantly affected the uptake of nitrogen in fodder (Table 3). Nitrogen uptake significantly increased with successive increase in nitrogen levels from 0 to 60 kg N/ha, but showed no increase thereafter up to 120 kg N/ha. Higher nitrogen uptake in fodder might be

Table 2. Effect of nitrogen level and weed-control technique on green-fodder and dry-matter yields of sorghum

Weed-control technique	N (kg/ha)					
	0	30	60	90	120	Mean
Green-fodder yield (t/ha)						
Weedy check	18.4	23.6	27.9	30.7	37.9	27.7
WCM at 3 weeks	25.5	29.8	35.4	36.5	36.4	32.7
Atrazine 0.5 kg a.i./ha	35.8	38.3	54.4	59.6	57.5	49.1
Broadcast sowing of cowpea	43.1	42.6	58.4	58.9	57.5	52.1
Broadcast sowing of blackgram	37.1	37.6	50.1	47.2	44.0	43.2
Mean	32.0	34.4	45.2	46.6	46.7	
CD (P=0.05)	N level		Weed-control techniques		Interaction	
	1.6		3.1		4.5	
Dry-matter yield (t/ha)						
Weedy check	3.31	4.37	5.08	5.58	5.75	4.82
WC at 3 weeks	4.67	5.55	6.54	6.57	6.55	5.98
Atrazine 0.5 kg ai/ha	6.44	6.91	10.80	10.81	10.35	9.06
Broadcast sowing of cowpea	7.08	7.38	10.03	10.12	9.86	8.90
Broadcast sowing of blackgram	6.34	6.31	8.86	7.99	7.82	7.46
Mean	5.57	6.10	8.26	8.21	8.06	
CD (P=0.05)	N levels		Weed-control techniques		Interaction	
	0.30		0.36		0.80	

WCM=Weeding-cum-mulching

Table 3. Effect of nitrogen level and weed-conrol technique on crude-protein yield and nitrogen uptake of sorghum

Weed-conrol technique	N (kg/ha)					
	0	30	60	90	120	Mean
Crude-protein yield (kg/ha)						
Weedy check	233.3	305.6	366.7	388.9	411.1	341.1
WCM at 3 weeks	333.3	400.0	455.6	461.1	461.1	422.2
Atrazine 0.5 kg ai/ha	455.6	500.0	772.2	766.7	727.8	644.5
Broadcast sowing of cowpea	672.2	738.9	894.5	855.6	838.9	800.0
Broadcast sowing of blackgram	538.9	533.3	744.5	694.5	638.9	630.0
Mean	446.7	495.6	646.7	633.4	615.6	
CD (P=0.05)	N levels		Weed-control techniques		Interaction	
	24.3		12.3		27.5	
N uptake (kg/ha)						
Weedy check	37.3	48.9	62.2	62.2	65.8	55.3
WCM at 3 weeks	53.3	64.0	73.8	73.8	73.8	67.7
Atrazine 0.5 kg ai/ha	72.9	80.0	122.7	122.7	116.4	120.9
Broadcast sowing of cowpea	107.6	109.3	143.1	136.9	134.2	126.2
Broadcast sowing of blackgram	86.2	85.3	119.1	111.1	102.2	100.8
Mean	71.5	77.5	104.2	101.3	98.5	
CD (P=0.05)	N levels		Weed-control techniques		Interaction	
	5.7		4.3		9.6	

WCM=Weeding-cum-mulching

due to higher proportion of dry-matter yield obtained from these treatments. However, uptake values of fodder obtained from broadcast sowing of cowpea were higher due to the higher nitrogen content of cowpea, leading to higher nitrogen content in the fodder, which is mixture of cowpea and sorghum. Duraisami *et al.* (2001) reported that cowpea and sorghum association significantly improved the N uptake by sorghum, which might be the reason behind higher uptake from broadcast sowing of cowpea compared with other treatments. No significant differences were observed in nitrogen uptake between applications of atrazine and broadcast sowing of cowpea. Among combinations of nitrogen levels and weed-control measures, broadcast sowing of cowpea with 60 kg N/ha gave significantly high N uptake, which was on a par with that at 90 kg or 180 kg N/ha.

Economics : The highest net profit and B:C ratio were obtained from 90 kg N/ha among all the levels (Table 4). Among weed-control measures, broadcast sowing of cowpea @ 25 kg seeds/ha gave the highest net profit and B:C ratio, closely followed by broadcast sowing of blackgram @ 20 kg seed/ha. Ram and Singh (2001) also reported similar finding.

It was concluded that for achieving higher quality fodder yield, economic gain and effective weed control in forage sorghum, 60 kg nitrogen/ha should be applied with broadcast sowing of cowpea @ 25 kg seed/ha.

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