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GROWTH AND YIELD OF SUGARCANE AS INFLUENCED BY NITROGEN LEVELS AND GREEN MANURING

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SUMMARY

Dhaincha (*Sesbania aculeata*) was sown, as an intercrop (one and two rows) between two rows of sugarcane, 30 days after spring planted sugarcane and green manured (*in situ*) at 45 and 60 days after sowing (DAS). Variations in shoot and root biomass (kg/ha), fresh weight of root nodules (kg/ha) and nitrogen accumulation (kg/ha) in dhaincha were observed. The highest shoot and root biomass and nitrogen accumulation was observed at 60 DAS with 2 rows of dhaincha. Nitrogen application to plant crop of sugarcane produced higher shoot biomass of dhaincha at 225 kg N/ha. Plant crop yield in sugarcane was significantly reduced when two rows of dhaincha intercrop were incorporated (green matured, *in situ*) at 60 DAS. This was largely due to reduction in biomass and leaf area. Ratoon yield, on the other hand, was significantly increased (5-8%) with dhaincha green manuring in plant crop. Highest ratoon yield was observed with 2 rows of dhaincha intercrop incorporated at 60 DAS. The present study highlights that integrated nutrient management in sugarcane can be practiced by green manuring with dhaincha intercrop and fertilizer N application for sustaining the yield of sugarcane-ratoon system.

Key words **: Biomass, cane yield, intercrop, nitrogen accumulation, ratoon, *Sesbania aculeata*, sugarcane.**

INTRODUCTION

Sugarcane, being an exhaustive crop leaves nutrient depleted soil for raising successive ratoon crop. Therefore, twenty five per cent higher dose of nitrogen is recommended for the ratoon crop compared to plant crop (Singh *et al.* 1973). Inadequate available fertilizer resource with the farmers limits the productivity of ratoon crop in this country. Legume intercropping in sugarcane for green manuring has been reported to economise the use of nitrogen to an extent of 25-50 per cent in sugarcane (Singh 1992, Singh and Yadav 1992, Yadav 1995). The initial germination and growth of sugarcane needs about 40 days, which could be very well utilized for raising green manure crop. Therefore, an attempt was made in the present study to introduce dhaincha (*Sesbania aculeata*) as green manuring intercrop in plant crop of sugarcane with a view to enhance the soil fertility and yield of sugarcane.

MATERIALS AND METHODS

The experiment was conducted at the main research farm of the Project Directorate for Cropping Systems Research, Modipuram, Meerut during 1995-97 on sugarcane cv CoS 767 in split plot design with 3 replications. The main crop of sugarcane was planted on February 4, 1995 at a row spacing of 90 cm. One and two rows of dhaincha were grown as intercrop between 2 rows of sugarcane after one month of planting and green

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manured (*in situ*) in the soil at 45 and 60 DAS. The treatments consisted of five green manure treatments of dhaincha (*Sesbania aculeata*), viz. control (no dhaincha), 1 row of dhaincha incorporated at 45 days after sowing (DAS), 1 row of dhaincha incorporated at 60 DAS, 2 rows of dhaincha incorporated at 45 DAS, 2 rows of dhaincha incorporated at 60 DAS, as main plots and 4 levels of N (0, 75, 150 and 225 kg/ha) as sub plots. After harvest of plant crop, the sugarcane crop was ratooned with N application at the rate of 180 kg/ha. Samples for biomass accumulation (dry weight) and nodulation (fresh weight of nodules) in *Sesbania aculeata* were taken from 0.5 m row length at 45 and 60 DAS. Biomass and leaf area of sugarcane were recorded at 225 days after planting (DAP) in plant crop and at maturity in ratoon crop from 0.5 m running row length. Leaf area was measured by an automatic leaf area meter (LI-3100). The observations on tiller numbers in plant and ratoon crop were recorded at maximum tillering stage (170 days of crop growth). The plant and the ratoon crop of sugarcane were harvested on 28th February 1996 and 23rd February 1997, respectively.

RESULTS AND DISCUSSION

Shoot and root biomass, N accumulation and fresh weight of nodules (kg/ha) in dhaincha were significantly higher at 45 and 60 DAS with 2 rows of dhaincha intercrop as compared to 1 row. Application of N (75, 150 and 225 kg/ha) substantially increased shoot and root biomass and N accumulation in dhaincha at 45 and 60 DAS. Significant increase in these parameters was, however, observed with 150 and 225 kg N/ha over control (Table 1).

Root nodulation (fresh weight of nodules, kg/ha) in dhaincha substantially increased from 45 to 60 DAS under both the treatments, the highest in 2 rows at 60 DAS (974 kg/ha). Nodulation in roots at 45 DAS was adversely affected with the application of nitrogen. The variations in fresh weight of nodules due to N application were not significant at 45 and 60 DAS. However, highest fresh weight of nodules was observed at 60 DAS (795 kg/ha) with the application of N @ 150 kg/ha in sugarcane (Table 1). Khurana *et al*. (1995) also reported variation in nodulation and nitrogen fixation ability of dhaincha (*Sesbania aculeata*) genotypes at different dates of sowing.

Nitrogen accumulation in shoots and roots of dhaincha increased from 45 to 60 DAS, the highest being at 60 DAS (Table 1). This could be attributed to higher biomass production and nodulation at this stage. Nitrogen accumulation, both in shoot and root, was more with 2

Table 1. Biomass and nitrogen accumulation (kg/ha) at 45 and 60 DAS in shoots and roots of *Sesbania aculeata* intercropped with sugarcane.

Treatments	Biomass (kg/ha)				N accumulation (kg/ha)				Nodule fresh weight (kg/ha)	
	Shoot		Root		Shoot		Root			
	45 DAS	60 DAS	45 DAS	60 DAS	45 DAS	60 DAS	45 DAS	60 DAS	45 DAS	60 DAS
1 row of *Sesbania*	362	1365	80	414	5.61	12.56	4.25	8.89	98.96	403.23
2 rows of *Sebania*	767	3320	175	813	11.7	29.22	8.42	11.79	192.58	974.28
CD (P=0.05)	87	115	55	23	2.42	6.43	1.52	2.76	70.62	414.8
N levels in plant crop										
0 kg N/ha	479	1258	107	610	6.09	11.32	2.55	9.58	162.42	607.9
75 kg N/ha	514	1746	114	620	7.86	15.54	3.43	8.31	135.53	609.5
150 kg N/ha	574	2075	139	711	8.67	18.68	4.00	9.53	159.32	794.9
225 kg N/ha	591	3293	131	712	8.98	30.0	4.27	11.53	125.81	743.4
CD (P=0.05)	49	69	NS	14	1.89	1.89	1.26	2.02	NS	NS

DAS : days after sowing

rows of dhaincha. Bergersen *et al*. (1989) observed that nodulation was associated with the N_2 fixation in field grown legumes. Becker *et al*. (1995) reported nitrogen accumulation in green manuring crops ranging from 7 to 200 kg N/ha at 45-60 DAS.

Variations is biomass accumulation in sugarcane with 1 and 2 rows of dhaincha and the stage of its incorporation were not significant (Table 2). Dhaincha intercropping, for *in situ* green manuring, however, reduced the biomass accumulation of sugarcane by 3-10%. On the other hand, N application in plant crop of sugarcane (75 and 150 kg/ha) significantly increased the biomass of sugarcane. Higher dose of N (225 kg/ha) did not increase the sugarcane biomass significantly (Table 2). There was, however, higher growth (biomass) of dhaincha at 225 kg N/ha (Table 1). Dhaincha intercrop reduced the growth of sugarcane during the early phase of growth, especially when 2 rows were *in situ* green manured at 60 DAS. This reduction in sugarcane biomass was largely due to the reduction in leaf area index (13-17%) and the number of tillers per ha (6-12%) at the active growth phase (Table 3 and 4). Highest reduction in tiller number was observed with 2 rows of dhaincha incorporated at 60 DAS (Table 4). This led to reduction in cane yield by 5-15% of plant crop (Table 5). This could be attributed to inter-row competition of *Sesbania aculeata* with main sugarcane crop for light, moisture and nutrients. Singh *et al*. (1993) also observed similar reduction in tillers in sugarcane by *Sesbania aculeata* inter-cropping. Yield of sugarcane ratoon, on the other hand, increased (5-8%) with *in situ* green manuring of dhaincha in plant crop of sugarcane (Table 5). This could be due to the increase in biomass (25-49%) and leaf area index (8-21%). Kathiresan *et al*. (1996) also reported such increase in yield with dhaincha green manure in sugarcane.

Table 2. Biomass accumulation (t/ha) in sugarcane (plant crop at 225 days after planting and ratoon at maturity) as influenced by *Sesbania aculeata* intercrop and nitrogen levels.

***Sesbania aculeata* intercrop**	**Nitrogen levels (kg N/ha)**									
	0		**75**		**150**		**225**		**Mean**	
	Plant	**Ratoon**	**Plant**	**Ratoon**	**Plant**	**Ratoon**	**Plant**	**Ratoon**	**Plant**	**Ratoon**
Sugarcane alone (no *Sesbania*)	32.5	12.8	36.4	13.8	41.5	15.1	29.8	16.7	35.1	14.6
Sugarcane + *Sesbania* 1 row at 45 DAS	29.0	17.0	38.3	17.7	31.8	18.7	31.3	20.3	32.6	18.4
Sugarcane + *Sesbania* 1 row at 60 DAS	30.4	15.2	31.0	18.5	35.1	21.0	39.0	22.9	33.9	19.4
Sugarcane + *Sesbania* 2 rows at 45 DAS	28.4	20.0	39.2	21.0	34.6	23.3	33.6	23.0	33.9	21.8
Sugarcane + *Sesbania* 2 rows at 60 DAS	32.4	16.9	31.7	19.0	31.7	18.0	30.3	19.4	31.5	18.3
Mean	30.5	16.4	35.3	18.0	35.0	19.2	32.8	20.4		
		Plant crop					Ratoon			
	Intercrop	Nlevels	Interaction		Intercrop	Nlevels	Interaction			
CD(P = 0.05)	NS	3.28	7.34		1.79	0.96	2.15			

Table 3. Leaf area index of sugarcane (Plant crop at 225 days after planting and ratoon at maturity) as influenced by *Sesbania aculeata* intercrop and nitrogen levels.

***Sesbania aculeata* intercrop**	**Nitrogen levels (kg N/ha)**									
	0		**75**		**150**		**225**		**Mean**	
	Plant	**Ratoon**	**Plant**	**Ratoon**	**Plant**	**Ratoon**	**Plant**	**Ratoon**	**Plant**	**Ratoon**
Sugarcane alone (no *Sesbania*)	5.50	1.83	6.10	2.07	6.80	2.16	5.70	2.16	6.00	2.06
Sugarcane + *Sesbania* l row at 45 DAS	5.10	1.72	5.40	2.13	5.70	2.15	4.70	2.16	5.20	2.04
Sugarcane + *Sesbania* 1 row at 60 DAS	4.80	1.69	5.10	2.20	5.40	2.20	5.00	2.82	5.10	2.23
Sugarcane + *Sesbania* 2 rows at 45 DAS	4.50	2.32	5.30	2.35	5.80	2.70	5.00	2.66	5.10	2.50
Sugarcane + *Sesbania* 2 rows at 60 DAS	4.50	1.64	5.00	2.09	5.50	1.83	5.00	2.18	5.00	1.94
Mean	4.90	1.84	5.40	2.17	5.80	2.21	5.10	2.40		
		Plant crop					Ratoon			
	Intercrop	Nlevels	Interaction		Intercrop	Nlevels	Interaction			
CD (P = 0.05)	NS	0.70	NS		NS	0.22	NS			

Table 4. Effect of *Sesbania aculeata* intercrop and nitrogen levels on number of tillers (000 ha^{-1}) in plant and ratoon crop of sugarcane at 170 days of crop growth.

***Sesbania aculeata* intercrop**	**Nitrogen levels (kg N/ha)**									
	0		**75**		**150**		**225**		**Mean**	
	Plant	**Ratoon**	**Plant**	**Ratoon**	**Plant**	**Ratoon**	**Plant**	**Ratoon**	**Plant**	**Ratoon**
Sugarcane alone (no *Sesbania*)	97.8	238.7	109.6	254.1	94.2	192.6	112.8	194.9	103.6	220.1
Sugarcane + *Sesbania* l row at 45 DAS	87.1	178.5	104.3	183.4	96.8	253.9	103.3	263.8	97.9	219.9
Sugarcane + *Sesbania* 1 row at 60 DAS	85.6	167.5	89.9	173.9	87.3	198.9	111.0	207.1	93.4	186.9
Sugarcane + *Sesbania* 2 rows at 45 DAS	77.5	211.9	92.6	192.4	97.4	186.2	101.3	185.9	92.2	194.1
Sugarcane + *Sesbania* 2 rows at 60 DAS	75.6	195.6	91.6	192.0	91.4	183.4	108.0	195.1	91.7	191.5
Mean	84.8	198.4	97.6	199.2	93.4	203.0	107.3	209.4		
		Plant crop					Ratoon			
	Intercrop	Nlevels	Interaction		Intercrop	Nlevles	Interaction			
CD(P = 0.05)	NS	9.94	NS		NS	NS	37.21			

Table 5. Effect of *Sesbania aculeata* intercrop and nitrogen levels on cane yield (t/ha) of plant and ratoon crop of sugarcane.

Sesbania aculeata intercrop	Nitrogen levels (kg N/ha)									
	0		75		150		225		Mean	
	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
Sugarcane alone (no *Sesbania*)	40.9	45.5	45.6	53.7	46.8	56.3	53.6	62.7	46.7	54.6
Sugarcane + *Sesbania* l row at 45 DAS	37.7	48.8	43.7	55.6	48.8	60.1	53.8	64.4	46.0	57.2
Sugarcane + *Sesbania* 1 row at 60 DAS	37.4	53.0	43.2	56.8	46.8	60.5	52.1	64.9	44.9	58.8
Sugarcane + *Sesbania* 2 rows at 45 DAS	36.6	48.5	44.6	52.3	47.7	61.2	52.5	66.4	45.3	57.1
Sugarcane + *Sesbania* 2 rows at 60 DAS	36.2	45.7	38.3	50.8	39.5	58.3	45.6	61.5	39.9	54.1
Mean	37.8	48.3	43.1	53.8	45.9	59.3	51.5	64.0		
		Plant crop					Ratoon			
	Intercrop	Nlevels	Interaction		Intercrop	Nlevels		Interaction		
CD(P = 0.05)	NS	2.57	NS		2.50	2.74		NS		

Application of nitrogen significantly increased the number of tillers (15-26 per cent) the highest being with 225 kg N/ha (Table 4). Addition of nitrogen to plant crop of sugarcane increased biomass and yields of both plant (7-16 and 14-36%, respectively) as well as ratoon crop (10-24 and 12-32%, respectively). This increase was the highest with 225 kg N/ha (Table 2 and 5). Verma (1995) observed similar increase in yield of sugarcane with N application. Biomass accumulation in ratoon, on the other hand, increased with dhaincha green manuring in plant crop of sugarcane (Table 2). This was largely due to increase (8-21%) in leaf area index (Table 3). Increase in biomass was reflected in the cane yield of ratoon, which was significantly increased (5-8 %) due to dhaincha green manuring in plant crop of sugarcane. Further, interaction of *Sesbania aculeata* with nitrogen application was more useful in enhancing the yield of ratoon crop. Various workers have observed similar increase in yield of ratoon with balanced and integrated use of fertilizer in sugarcane (Singh *et al*. 1993, 1995, Verma and Dang 1995) and other crops (Sharma and Das 1994, Hegde 1998). The present study highlights that integrated nutrient management in sugarcane can be practiced by *in situ* green manuring with dhaincha intercrop and fertilizer N application. Green manuring with dhaincha intercrop in plant crop of sugarcane did not enhance the cane yield of plant crop. However, long-term effect of green manuring treatment was observed in the increase of ratoon growth (biomass and leaf area) and yield. It shows that the integrated nutrient management gives long-term benefit in sustaining the yield of sugarcane-ratoon system.

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