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Nodulation and N-fixation by legumes grown as inter-crops of sugarcane and their effect on sugarcane Production[1]

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To study the nodulation pattern of legumes grown as inter-crops of sugarcane and their effect on cane yield, two field experiments were conducted at the Indian Institute of sugarcane Research, Lucknow, over a period of 4 years (1977-80), Number and weight of nodules increased upto 30 days after sowing and declines thereafter in green gram (*vigna radiata* (L) wilczek Cv. *Pusa baisakhi*) and black gram (*vigna mungo* (L) Happer Cv. Type 9). Increasing trend in both these two characters was observed upto 60 days in pigeonpea (*cajanus cajan* (L) Milsp. Cv. Type 21). The rate of decrease in nodulation of green gram and black gram was faster in inter-cropping system due to shading caused by lateral spread of sugarcane. N application to pigeonpea. and to sugarcane proved deleterious for nodule development of green gram and black gram. Inter-cropping of black gram decreased the cane yield compared to pure sugarcane supplied with P. Autumn sugarcane planted in between standing crop of pigeonpea yielded highest at 40 Kg N/ha applied to pigeonpea and 150 Kg N/ha applied to sugarcane.

Much of the inter-row space in sugarcane remains unutillized for a period of about 100 days as the initial rate of horizontal spread of sugarcane is slow (Singh and Kumar, 1977) Instead of allowing weeds to grow and offer severe competetion to main crop, growing short duration legumes in between 2 rows of sugarcane has become a practice in subtropical India (Yadav and Srivastava, 1978) In this study, efforts are being made to find out the differences in growth pattern of green gram and black gram and nitrogen fixation by them when grown as pure and intercrop of sugarcane, and also of pigeonpea at different levels of N with their residual effect on sugarcane.

MATERIAL AND METHODS

Two field experiments were condcuted at Lucknow in a sandy loam soil of neutral reaction and medium fertility status. The treatments of first experiment consisted of 4 rates of N (0, 20, 40 and 60 kg N/ha) to pigeonpea (*cajanus cajan* (L) Milsp C. V. Type 25) and 3 rates of N (75, 150 and 225 kg N/ha) to sugarcane *Saccharum officinarum* Linn. Cv/Co 1148. All these treatments were replicated thrice in a split-plot design having N-rates to pigeonpea in main and N-rates to sugarcane in subplots. For second experiment, treatments as listed in table 4 were replicated 4 times in a randomised block design. For studies. concerning nodulation and grain yield of green gram (Vigna radiata Cv. Pusa baisakhi) and black gram (*Vigna mungo* (L) Happer CV. Type 9] 6 treatments as listed in table-3 were subjected to statistical analysis. In intercropping system, one row of each *mung* and *urd* was sown in between two rows of

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sugarcane. Pure legumes received 25 kg N/ha through urea (46% N) before sowing. Sugarcane received 100 kg N/ha with the combination of O and 60 kg P_2O_5/ha, which was applied through single-superphosphate (16% P_2O_5) before planting beneath the sugarcane setts. Balance of N in soil after legume harvesting studied only in experiment No.2, was calculated using the following formula :

N balance = Y—(x—a) —N

where Y = Crop removal of N
x = Initial soil N
a = Soil N at the time of legume harvesting
N = N applied through fertilizers

RESULTS AND DISCUSSION

Nodulation :

In both the experiments, the nodule formation in legumes commenced 15 days after sowing and reached to peak at 60 days stage in pigeonpea (Table 1) and 30 days stage in green gram and black gram (Table 3). Thereafter the number declined in green and black gram probably on account of decay of the early formed nodules following flowering and early pod development. Number of nodules in inter-cropped legumes was less than their pure stand at all the stages.

The weight of pigeonpea nodules, in experiment 1, was higher at lower N rates (Table 1). Favourable effect of lower doses of N on nodulation has also been reported by Brar (1967) and Yadava and Singh (1978). In second experiment there was a shrap rise in nodules weight from 15 to 30 days but further increase from 30 to 45 days was slow (Table 3). The weight declined thereafter with faster rate (40 g to 3 g) in intercropped legume-s than pure ones (50 g to 10 g) because after 50 days of legume growth, the main crop of sugarcane entered into a tillering phase which caused more lateral spread and thus shading. Reddy and Chatterjee (1973) also observed reduced nodulation in soybean due to shading caused by tall growing companion crops of maize and sorghum. N content in the nodules of pure legumes was higher than the intercropped legumes (Table 3). This was because of the fact that the legumes grown in association with sugarcane received higher quantity of N which reduced the efficiency of nodules for higher N fixation.

Grain yields of legumes :

Grain yield of pigeonpea increased upto 20 kg N/ha in 1977 and 60 kg N/ha in 1978 (Table 2). In second experiment green gram yielded significantly higher dry matter and grains than black gram, in pure as well as in intercropping systems (Table 5). Comparing the yields of pure and intercropping systems green gram and black gram yielded 54 and 51% less respectively in intercropping system than pure culture. This showed that the reduction in yield due to intercropping was less by black gram.

N fixation :

N fixation indicated that uptake of N by legumes was higher when grown pure than when intercropped in sugar-

cane. Considering the total uptake of N by crops (legumes + sugarcane), at the time of legume harvesting, and its fixation in soil, it was more in inter-cropping system that too where P was applied (Table 4). This was because more production of grains and straw as observed with P application. N content of the soil also increased were P was added because P has increased the matabolic activities of nodules to fix more nitrogen (Yadava & Singh 1978).

Yield of Sugarcane

Application of N upto 40 Kg./ha in pigeonpea significantly increased the yield of subsequent autumn planted sugarcane (Table 2). Further increase in the dose of N to pigeonpea did not bring significant changes in cane yield might be because higher application of N to pigeonpea proved harmful in its nodule development (Table I) Direct application of N to sugarcane increased the yield significantly upto 150 kg N/ha. There was no difference in the cane yield at 150 and 225 kg N/ha.

In Second experiment, where legumes were intercropped in spring planted sugarcane, black gram decreased the can yield significantly compared to pure cane supplied with P and inter-cropping green gram in sugarcane supplied with P (Table 3).

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TABLE 1. Nodulation and grain yield of pigeonpea as influenced by N-rates

N-rates (kg/ha)	Days after sowing									Grain yield (q/ha)
	No. Nodules/Plant			Fresh weight of nodules/plant (g)			N-content in nodules (mg/plant)			
	15	30	60	15	30	60	15	30	60	
					1977					
0	5.0	18.3	60.2	0.30	1.02	2.10	0.675	1.115	2.367	9.6
20	3.6	15.4	55.0	0.19	0.92	2.02	0.612	0.923	2.313	13.6
40	2.0	10.0	40.7	0.12	0.81	1.75	0.429	0.867	1.928	13.1
60	1.6	0.2	38.9	0.09	0.80	1.63	0.326	0.816	1.739	10.3
CD 5%										1.2
					1978					
0	3.4	16.3	54.2	0.26	0.97	1.95	0.478	0.967	1.698	6.4
20	2.5	12.6	48.7	0.13	0.97	1.90	0.392	0.823	1.547	6.7
40	1.9	8.7	32.4	0.06	0.80	1.68	0.265	0.686	1.386	7.6
60	1.3	6.9	29.3	0.06	0.68	1.52	0.232	0.600	1.333	9.1
CD 5%										1.5

TABLE 2. Yield of sugarcane as influeced by different N-rates to pigeonpea and sugarcane

N to Pigeonpea (kg/ha)	N to sugarcane (kg/ha)							
	1977-79				1978-80			
	75	150	225	Mean	75	159	225	Mean
				Cane Yield (t/ha)				
0	65.0	75.0	81.4	73.8	61.6	66.8	69.4	65.9
20	65.8	78.9	83.2	76.0	62.2	67.9	68.8	66.9
40	70.3	84.2	80.0	78.2	65.9	72.8	70.0	69.7
60	70.5	82.1	80.2	77.6	65.0	71.9	70.5	61.3
Mean	67.9	80.1	81.2		63.7	69.9	69.7	
C.D. 5% for N to pigeonpea				4.2				NS
for N to sugarcane				10.1				6·5

TABLE 3. Number and weight of nodules and their N-content as influenced by different treatments.

Treatments	Days after sowing of inter-crops				
	15	30	45	60	75
	No. of nodules/plant				
Green gram pure	5.1	35.6	27.2	10.4	8.4
Black gram pure	4.2	30.3	22.4	8.2	5.2
Cane P_0 + Green gram	4.8	33.7	20.0	5.3	1.8
Cane P_{60} + Green gram	5.0	35.0	22.2	6.4	2.0
Cane P_0 + Black gram	3.2	27.4	18.3	4.2	1.5
Cane P_{60} + Black gram	3.6	29.6	19.2	5.6	1.7
C D. 5%	1.2	4.3	3.7	2.0	1.5
	Nodule Weight (mg/plant)				
Green gram pure	0.25	46.7	55.9	38.4	15.2
Black gram pure	0.22	38.2	46.4	32.2	10.4
Cane P_0 + Green gram	0.24	34 0	40.8	20.3	4.3
Cane P_{60} + Green gram	0 23	38.6	45.7	22.4	5.7
Cane P_0 + Black gram	0.20	30.4	39.2	18 0	3.3
Cane P_{60} + Black gram	0.20	32.8	41.3	20.4	4.0
C.D. 5%	NS	4 3	5 9	8.0	3.2
	N-content in nodules (mg/plant)				
Green gram pure		0.926	2.116	1.232	0.594
Black gram pure		0.817	2.001	1.093	0.500
Cane P_0 + Green gram		0.918	2.200	1.171	0.555
Cade P_{60} + Green gram		0.921	2.108	1.175	0 567
Cane P_0 + Black gram		0.809	2.000	0.958	0.467
Cane P_{60} + Black gram		0.812	1.980	0.918	0,474

TABLE 4. N uptake of crops and its balance into the soil at the time of legume harvest

Treatments	Total initial N of soil (kg/ha)	N uptake of crop (kg/ha)		Final N of soil (kg/ha)	Balance of N (kg/ha)
		Mung/Urd	Sugarcane		
Mung alone	690	78.2	–	712	+ 75.2
Urd alone	690	43.4	–	708	+ 36.4
Cane $N_{100}P_0$ + Mung	690	29.3	43.0	780	+ 62.3
Cane $N_{100}P_{60}$ + Mung	690	31.2	46.9	790	+ 78.1
Cane $N_{100}P_0$ + Urd	690	14.2	41.3	780	+ 45.5
Cane $N_{100}P_{60}$ + Urd	690	15.3	43.7	796	+ 65.0
Cane alone $N_{100}P_0$	690	–	48.6	750	+ 8.6
Cane alone $N_{100}P_{60}$	690	–	50.2	758	+ 18.2
C.D. 5%				45	12.1

TABLE. 5. Yield of different crops under various treatments

	Dry matter yield of legumes (kg/ha)		Grain yield of legumes (kg/ha)	Cane yield (t/ha)
	Roots	above ground parts.		
Green gram pure	245	4018	523	
Black gram pure	156	2376	315	
Cane P_0 + Green gram	75	1630	240	63.5
Cane P_{60} + Green gram	80	1665	245	68.5
Cane P_0 + Black gram	48	810	153	60.1
Cane P_{60} + Black gram	53	828	154	62.8
Cane P_0 Pure				61.6
Cane P_{60} Pure				68.7
C.D. 5%	12	63	51	2.3