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Nitrogen Balance in Soil and Nutrients Status of Green Gram in Relation to Plant Population and Fertility Levels*

B. S. YADAVA[1] and CHOKHEY SINGH[2]

The effect of two plant populations and six fertility levels on the nodulation, nitrogen content and its uptake by three varieties of green gram (*Phaseolus aureus* Roxb.) and nitrogen balance in soil was studied. The number of nodules increased till 30 days after sowing and thereafter their number declined. Thirty and 60 kg P_2O_5/ha significantly increased the number of nodules over control. Application of 20 kg N/ha reduced the nodule formation that was not affected by 10 kg N/ha. Variety 'Cott.70' had some what poor nodulation as compared to 'H-70-16' (Varsha). The total uptake of nitrogen and its fixation was more with high plant population than the lower one. Application of nitrogen and phosphate increased the uptake of nitrogen by the crop and the fixation of nitrogen in soil over control. The nitrogen content in root, shoot, its totol uptake and protein content was the highest in 'Pusa Baisakhi' but the highest nitrogen fixation (62.44 kg/ha) in soil was obtained with 'H-70-16' and lowest with 'Cott. 70' (13.56 kg/ha).

Pulses, on account of high protein content and their soil enriching capabilities by fixing atmospheric nitrogen, play a key role in the agriculture production. Phosphate fertilization has been reported to stimulate the process of N fixation and the growth of the pulses. Among all the pulses, green gram, being of wider adaptability, is extensively grown in the country, but the growth, yield and nitrogen balance in plant and soil due to different varieties, with varying plant population and fertility levels may not be similar under diverse climatic and soil conditions. Therefore, a trail to study the effect of nitrogen and phosphate fertilization and plant population of different varieties of Green gram on the N-balance in crop and soil was conducted during 1973 at Haryana Agricultural University, Hissar.

MATERIALS AND METHODS

The experiment included three varieties of green gram (*Phaseolus aureus* Roxb.) *viz.* 'H. 70-16' (V_1); 'Pusa Baisakhi' (V_2) and 'Cott. 70' (V_3); two plant populations i.e., 3 lakh/ha (P_1) and 4.5 lakh/ha (P_2) and six fertility levels i.e., No fertilizer (F_0); 30 kg P_2O_5 (F_1); 10 kg N + 30 kg

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1-2 Haryana Agricultural University, Hissar.

P_2O_5 (F_2); 60 kg P_2O_5 (F_3); 10 kg N + 60 kg P_2O_5 (F_4) and 20 kg N + 60 kg P_2O_5/ha (F_5). It was laid out in split plot design with 4 replications. The crop was sown on 22nd July, 1973 by drilling 6 kg seed/ha in rows 30 cm apart. The two plant populations were maintained by thinning the excess seedlings 10 days after germination. As per assignments of the treatments, nitrogen through CAN and P_2O_5 through superphosphate was drilled before planting in rows where the seed was sown. The sap before planting contained 1360 kg/ha as the total nitrogen. The available N, P_2O_5 and K_2O were 196, 17 and 386 kg/ha respectively and pH was 8.5. At the harvest stage the nitrogen content in plant and total nitrogen in soil were estimated. Nitrogen uptake by the crop and its balance in soil were studied by the formula :

$$N \text{ Balance} = Y - (x-a) - N$$

where,

Y = Total nitrogen in crop (Root + Shoot)

x = Total nitrogen in soil just before sowing of the crop.

a = Total nitrogen in soil just after harvesting of the crop.

N = Nitrogen applied through fertilizers after taking soil samples for x.

RESULTS AND DISCUSSION

The data on the number of nodules per plant at fortnightly interval and nitrogen content in plant at harvest are presented in Table I.

In all the treatments, the nodule formation commenced 15 days after sowing and their maximum number reached almost at 30 days stage, thereafter the number declined probably on account of decay of the early formed nodules. The two plant populations did not affect the number of nodules per plant at any stage. The increased number of nodules with 60 kg P_2O_5/ha over 30 kg P_2O_5 might be on account of greater quantity of phosphorus being available for their metabolic activities. This view has also bean reported by Burkhart and Collins (1941), Roberts and Olson (1944), and Vyas and Desai (1953) who considered degree of nodulation to be directly related to the utilization of phosphorus. Despande and Bathkal (1965), Tiwari (1965), Brar (1967), Kurup and Kalippan (1969) and Kaushik and Singh (1969) reported increased number of nodules with increasing levels of P_2O_5. Ten kg N with 30 or 60 kg P_2O_5/ha did not affect the number of nodules per plant, but 20 kg N with 60 kg P_2O_5/ha slightly reduced the nodule formation. The favourable effect of lower dose of nitrogen on nodulation has been supported by Fedorov and Kozlov (1954), Bjalive (1960) and Brar (1967).

The highest and lowest number of nodules were formed in 'H.70-16' (V_1) and 'Cott. 70' (V_3) respectively at all the stages of growth. The differential behaviour of the varieties might be due to the survival of *Rhizobia* with different host species.

TABLE 1. Number of nodules per plant, per cent of nitrogen in roots and protein content in grain of green gram

Treatment	Number of nodules per plant Days after sowing					% Nitrogen		Protein in grain
	15	30	45	60	76	Root	Shoot	(%)
Plant population								
P_1	4.9	43.3	20.4	7.0	2.5	0.7	1.8	20.6
P_2	5.1	42.9	21.8	7.0	2.4	0.7	1.8	20.8
S.Em.±	0.32	0.72	0.71	0.47	0.22	0.01	0.05	0.34
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Fertility levels								
F_0	4.0	40.3	17.6	6.10	1.5	0.7	1.8	19.7
F_1	4.4	43.1	18.8	9.7	2.6	0.7	1.9	20.6
F_2	4.9	42.6	21.1	5.2	2.1	0.6	1.8	20.5
F_3	5.2	47.8	24.3	9.3	3.3	0.7	1.8	20.2
F_4	6.2	45.0	24.4	5.8	2.9	0.6	1.9	22.1
F_5	5.4	40.0	20.3	6.0	2.8	0.6	1.7	21.0
S.Em.±	0.56	1.26	1.23	0.82	0.38	0.03	0.08	0.59
C.D. at 5%	N.S.	3.7	3.6	2.4	1.1	0.08	N.S.	N.S.
Varieties								
V_1	4.8	47.6	22.4	7.5	3.6	0.7	1.8	20.3
V_2	5.2	43.1	20.8	7.3	2.3	0.7	1.9	21.2
V_3	5.0	38.6	20.1	6.3	1.5	0.7	1.8	20.6
S.Em.±	0.27	1.02	0.55	0.41	0.25	0.017	0.04	0.35
C.D. at 5%	N.S.	2.8	1.5	N.S.	0.6	N.S.	0.1	N.S.

The application of phosphorus in combination with nitrogen resulted in higher N content in shoot and protein content in grain. The higher number of nodules due to phosphorus might have increased the nitrogen fixation and thus, making nitrogen available in greater quantity to the plants that resulted in higher protein content in grain as repoted by Tondon and Singh (1962), Kurup and Kalippan (1969) and Yadav (1973). There was no consistant effect of nitrogen application on N-content in shoot and protein content in the grain.

N content in root and shoot and protein content in grain were the highest in 'Pusa Baisakhi' and lowest in 'Cott. 70'. This might be due to poor

nodulation in latter varieties compared to the other two.

The data on the nitrogen balance in soil and plant are pesented in Table II.

TABLE II. Uptake of nitrogen and its balance in crop and soil

Original soil nitrogen (total) = 1360 kg/ha

Treatments	Uptake of nitrogen (kg/ha)			Total N in soil at harvest (kg/ha)	Grain or loss over original N status
	Root	Shoot	Total		
Plant population					
P_1	1.6	80.8	82.4	1310.2	+26.0
P_2	1.9	100.9	102.8	1318.8	+54.9
Fertility levles					
F_0	1.4	64.2	65.6	1265.6	−28.8
F_1	1.9	89.6	91.4	1315.8	+47.2
F_2	1.8	101.3	103.0	1311.9	+45.0
F_3	2.0	86.0	88.0	1339.5	+67.5
F_4	1.7	107.8	109.6	1327.3	+66.9
F_5	1.8	96.0	97.9	1327.0	+44.8
Varieties					
V_1	1.9	86.1	87.9	1341.2	+62.4
V_2	2.0	97.7	09.7	1312.3	+44.3
V_3	1.5	88.7	90.2	1290.1	+13.6

Uptake of nitrogen in plants and its fixation in soil was more with higher plant population (P_2) than with lower one (P_1). This might have been brought about by larger number of nodules as well as the total dry matter of the plants per unit area being more with P_2 than with P_1.

Ten kg N in combination with 30 or 60 kg P_2O_5/ha increased the total uptake of nitrogen. This might be due to more-production of grain and straw as compared to phosphorus alone.

The treatments 60 kg P_2O_5 with and without 10 kg N/ha resulted in greater N fixation than 30 kg P_2O_5 and 20 kg N + 60 kg P_2O_5/ha. Lower dose of N resulted in better nodulation and higher nitrogen fixation than higher nitrogen dose which might have some determental effect on the nodulation. These results are in conformity with the findings of Robert and Olson (1944), Acharya *et al*. (1952) and Sen and Rao (1953).

The highest N uptake was in 'Pusa Baisakhi' (V_2) and the lowest in 'H. 70 -16'. This might have been due to higher total dry matter production in 'Pusa Baisakhi' (V_2) and more content of nitrogen in shoot and grain than the others. N fixation was the highest in 'H. 70-16' (V_1) and the lowest in 'Cott. 70' (V_3) probably on account of better nodulation in 'H.70-16' (V_1) as compared to 'Cott. 70' (V_3).

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