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Changes in Soil Nitrogen Due to Cultivation of Grain Legumes Fertilized With Phosphate in an Arid Loamy Sand Soil

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The soils of western Rajasthan in general are quite low in organic matter and soil N. Legumes have been universally accepted as restorative crops for build up of soil N. The Application of phosphates to legumes for enhancing their performance and nitrogen fixation has been reported by a number of workers. However, the beneficial effect of legume to succeeding cereal crop does not commensurate with the amount of nitrogen added by legumes (Narwal *et al.* 1983) but due to the variations in the different organic-N fractions added. The information on the changes in soil-N-fractions due to cultivation of legumes viz., clusterbean, mungbean and mothbean with P application is rather meagre in desert sandy soil. The present investigation is an attempt in this direction.

Surface soil samples (0-30 cm depth) were collected from field experiments where three grain legumes viz. clusterbean (*Cyamopsis tetragonoloba* cv FS 277), mungbean (*Vigna radiata* cv S-8) and mothbean (*Vigna aconitifolia*, cv. local) were grown successively for three years 1988-90 during *kharif* (June-September) with P levels of 0 and 40 kg P_2O_5 ha^{-1} in randomised block design at the Central Farm of CAZRI, Jodhpur. The soil of experimental site belonged to Pal series, a Typic Camborthid and initial available N, P and K contents were 80, 12 and 120 kg ha^{-1} respectively with pH of 8.1.

The processed field soil samples were analysed for OC, total N, NO_3-N and NH_4-N as per the methods described by Bremner (1965). Acid hydrolysable-N and its fractions were determined as per the flow sheet given by Keeney and Bremner (1964). Unidentified hydrolysable-N was worked out as difference between total hydrolysable-N and sum of hydrolysable NH_4-N, amino acid and hexosamine-N fractions. The results are reported as the mean values on oven dry basis.

The results indicate that P application to legumes not only enhanced the per cent N in nodules, but also increased the weight of nodules. The per cent N in nodules increased from 6.1 to 7.9 in mungbean, 6.7 to 7.4 in clusterbean and 6.8 to 15.0 in mothbean with 40 kg P_2O_5 ha^{-1} over control. The respective increases in weight of nodules for the three legumes were found to be from 28.0 to 48.6, 8.8 to 18.7 and 11.0 to 15.7 mg $plant^{-1}$. These observations indicate that P application promotes nodulation in legumes (Ahlawat & Saraf 1982) which has intimate link with N fixation.

Effect on organic carbon, total-N and mineral-N status

The results presented in Table 1 indicate that cultivation of legumes for three seasons, have increased the OC by 12.5 to 15.0% over the initial level and with P application, this level further increased from 21.2 to 28.7%. The beneficial effect of P application seems primarily due to more root biomass production and nodule formation which ultimately add to the soil organic matter at maturity.

There was about 4.3 to 9.6% increase in total-N content in soil due to the growth of different legumes over initial level and P application enhanced this level by 19.3 to 33.9%. The variations observed amongst the three grain legumes may be due to the variations in their root-N content and the amount and rate of N minieralization (Nnadi & Balasubramanian 1978). The variation in the N additions amongst cultivars of mungbean has also been observed by Aggarwal and Prasad (1981). The soil mineralized-N content also increased from 15.7 ppm (initial level) to 47.0 ppm due to growth of legumes. The P application had little effect on this parameter. Amongst the different legumes, maximum amount of mineralized-N was observed under clusterbean which may possibly be due to higher mineralization rate of its root residues left in soil (Nnadi & Balasubramanian 1978).

Effect on organic forms of soil-N

The results reported in Table 1 show an increase in the hydrolysable organic-N fractions with the cultivation of legumes and P application, however, the magnitude of increase varied amongst different fractions and also with the type of legume.

Amongst different fractions of total hydrolysable -N, a substantial increase in hydrolysable NH_4-N and hexosamine-N was observed with the legumes. The application of P further enhanced

Table 1 *Organic carbon and N-forms in soil as affected by cultivation of legumes fertilized with phosphorus for three years*

Treatments	Organic carbon%	Total–N	Mineralized–N ($NH_4 + NO_3$)	Total hydrolysable–N	Hydrolysable NH_4–N	Amino acid–N	Hexosamine-N	Unidentified-N
Mungbean								
P_0	0.180	252.0	33.6	175.0	17.5	49.0	41.1	94.5
	(12.5)*	(9.6)*		(69.5)**	(6.9)**	(19.5)**	(5.6)**	(54.0)**
P_{40}	0.206	308.0	35.8	224.0	38.3	98.0	47.2	31.5
	(28.7)	(33.9)		(72.7)	(12.4)	(31.8)	(13.3)	(14.1)
Mothbean								
P_0	0.184	240.8	35.8	168.0	19.2	52.5	15.8	80.5
	(15.0)	(4.3)		(69.7)	(8.0)	(21.8)	(6.5)	(47.9)
P_{40}	0.194	308.0	39.2	210.0	42.8	112.0	31.5	19.2
	(21.2)	(33.9)		(68.2)	(14.8)	(36.4)	(10.3)	(9.1)
Clusterbean								
P_0	0.184	249.2	47.0	175.1	27.4	42.0	17.5	73.5
	(15.0)	(8.3)		(70.3)	(11.0)	(16.9)	(5.0)	(41.9)
P_{40}	0.194	274.4	48.2	209.8	42.2	101.5	29.7	31.3
	(21.2)	(19.3)		(76.5)	(17.2)	(37.0)	(10.8)	14.9)
Fallow								
(without crop)								
Initial	0.160	230.0	15.7	112.0	5.3	35.0	3.5	68.3
				(48.6)	(2.3)	(15.0)	(1.5)	(61.0)
Final	0.157	235.0	16.8	108.0	5.6	30.2	3.0	69.2
				(41.2)	(2.4)	(12.8)	(1.3)	(64.0)

Figures in parenthesis indicate * as percent increase over initial level, ** as percent of total –N.
N–forms expressed as ppm.

this amount by nearly two fold. This increase in organic hydrolysable-N fraction seems to be favoured by build up of organic matter in soils. Amongst different legumes, maximum build up of hydrolysable NH_4-N (11.0%) and hexosamine-N (7.0%) was observed under clusterbean over the initial levels of 2.3 and 1.5% of total N respectively. The differential behaviour amongst legumes may be due to the differences in organic-N fractions in the root residues (Aggarwal & Ramamoorthy 1977).

The results further showed that the cultivation of legumes decreased the level of unidentified hydrolysable-N, and P application still further decreased this level. Thus, the legumes seem to favour mobilisation of N in different hydrolysable-N fractions particularly hydrolysable-NH_4, amino acid and hexosamine-N and also improved the level of organic-N and C; and phosphate application has an additive effect.

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