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IMPROVING SYMBIOTIC NITROGEN FIXATION AND PRODUCTIVITY IN BLACK GRAM (*VIGNA MUNGO* L.)

P. C. PARICHA AND M. KAR
Department of Plant Physiology,
Orissa University of Agriculture and Technology,
Bhubaneshwar 751003, India.

RESPONSES to nitrogen fertilization in tropical and other legumes have been confirmed in several studies[1-3]. With the escalation in the cost of fertilizers such a finding has very little relevance to practical farming. The alternative approach is to increase the efficiency of nitrogen fixation and assimilation in legumes. It is well known that iron and molybdenum are constituents of the enzyme nitrogenase[4] whereas the availability of iron is plentiful, molybdenum is limited to acid soils[5]. Liming and molybdenum fertilization in such soils are practiced to ameliorate the soil conditions.

The present study was undertaken as a field experiment in 1980-1981 using acid laterite soils of pH 5.4 to know the response of Mo seed treatment and to relate the benefits in terms of applied nitrogen to the soils. The plots were 16 m^2 replicated four times in an experimental design of randomized block.

The soil was sterilized with formaldehyde (40% w/v) in the proportion of 1:50 parts of irrigation water and seeds of blackgram were inoculated with appropriate *Rhizobium* culture. Molybdenum was applied at the rate of 3 g/kg of seed. Nitrogen was added to the soil in the form of urea at rates of 0, 15, 30, 45 kg/ha with *P* and *K* uniformly applied at rates of 80 and 50 kg/ha respectively.

Total nitrogen was estimated following the standard Kjeldahl method[6] and total chlorophyll according to the method of Arnon[7]. Control plants were less vigorous and exhibited premature yellowing of the lower leaves, typical as those of nitrogen deficiency. The plants attained lush green colour due to *N* fertilization or Mo seed treatment which is evident from the chlorophyll contents of the leaves (table 1).

The nodulation decreased considerably in the uninoculated series but could not be completely eliminated as is evident from sparse nodulation in the control plants. Evidences in literature indicate both promotion[8] and inhibition[9] of nodulation due to starter dose of *N* fertilization. In the present study, low levels of nitrogen fertilization consistently resulted in an increase in the nodule number, possibly, because of low *N* status (0.06%) of the soils. The nodule number increased significantly due to Mo seed treatment. Similar increases in nodulation due to Mo were also reported in pea[10].

Apart from nodule number, the dry weight of the nodules was higher in the inoculated series (62.0 mg) as compared to the uninoculated plants (13.2 mg) Mo seed treatment resulted in further increases in dry weight of the nodules[11]. The inhibitory effects of applied *N* were observed at or above 30 kg/ha on both nodule number and dry weight of nodules.

The inoculated plants contained higher concentration of *N* as compared to the uninoculated plants. Nitrogen concentrations increased progressively as a response to added nitrogen. Stimulation in *N* concentration due to Mo alone was equivalent to the highest

TABLE 1

Effect of Rhizobium, N and Mo on chlorophyll content, nodulation, N concentration (%) and seed yield (q/ha) of black gram.*

Treatments		Total chlorophyll (mg plant^{-1})	Nodule number	Nodule dry wt. (mg plant^{-1})	N concentration of leaf (%)	Seed yield (q ha^{-1})
Uninoculated						
N_0	− Mo	9.44 (cont.)	8.0	12.1	2.48	6.75 (cont.)
	+ Mo	13.9	19.0	32.1	4.64	7.35
N_{15}	− Mo	10.9	10.3	13.2	2.75	8.30
	+ Mo	10.7	20.3	35.0	4.68	8.49
N_{30}	− Mo	10.8	6.6	11.0	3.65	8.62
	+ Mo	13.3	14.0	29.0	4.96	8.90
N_{45}	− Mo	9.5	6.6	11.0	4.65	8.30
	+ Mo	14.4	12.0	24.1	5.12	8.95
Inoculated						
N_0	− Mo	13.6	27.0	56.8	3.81	7.65
	+ Mo	10.7	28.0	63.0	5.11	8.54
N_{15}	− Mo	14.5	30.0	62.0	4.42	8.40
	+ Mo	14.1	39.5	76.0	5.2	11.20
N_{30}	− Mo	13.3	27.0	54.1	4.64	8.70
	+ Mo	14.8	31.4	56.1	5.21	12.55
N_{45}	− Mo	10.1	25.2	54.2	4.91	8.88
	+ Mo	14.6	24.5	48.0	5.96	12.18
C.D. at 5%						
N		N.D†	3.8	N.S.‡	N.D	0.41
Rhizobium			3.5	9.5		0.60
Mo			2.8	6.0		0.25
Mo × *Rhizobium*			2.6	N.S.		0.50

* Determined at 30 days of growth † Not determined. ‡ Not significant.

level of nitrogen fertilisation. The nitrogen concentrations in the stems and roots were nearly 35–40% of the leaf *N* concentration. Albeit, the principal source of nitrogen for mobilisation appears to be the leaves, the stems as well as the roots constituting as secondary organs of *N* for redistribution at the time of grain formation.

Seed yield increased significantly in all the treatments. Response to *N* was observed upto fertilization of N_{30} (table 1) and thereafter the yields were stabilised or increased marginally with higher dose of fertilization. The maximum increase due to *N* fertilization was 27% in the uninoculated plants, 32% in the inoculated plants in the absence of Mo and the corresponding values were 34% and 86% respectively with Mo seed treatment. Similar increases have also been reported in other crops[12] indicating the need for Mo towards improved symbiosis in legumes.

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OCCURRENCE OF *CRUCIGENIA MITRII* TIWARI *et* PANDEY, FROM POONA

M. S. BALAKRISHNAN AND LEELA T. DEORE*
Department of Botany, University of Poona,
Pune 411 007, India.

*Department of Botany, JaiHind College of Arts, Science & Commerce, Dhule 424 002, India.

CRUCIGENIA mitrii Tiwari *et* Pandey, a member of Chloroccocales occurred in a small puddle in Aundh, Pune. Observations of the alga were made both in field material and in culture. It appeared as mucilaginous coenobia of 3–8 cells; multiple coenobia of 16 cells or even more not uncommon. The coenobia were of various sizes and shapes. The cells are not compact, but rather free from each other and may form a small rectangular or triangular space at the centre. The cells are oval-cordate to almost triangular with rounded corners; the shape appears due to mutual compression. Cells measure 8–20 μ in breadth and 8–15 μ in length. The chloroplast is parietal and almost entirely fills up the cell; embedded in it is a single pyrenoid.

Reproduction is by autocolonies formed by simultaneous divisions of the protoplast into four daughter cells which become arranged to form a cruciate coenobium with a central space. Very often, formation of two autocolonies from a single mother cell was also observed (figure 8). The two daughter coenobia lie one above the other or side by side, while still enclosed in the parent cellwall. The daughter coenobia are liberated by rupture of the parent cellwall, remaining attached to the new coenobia (figures. 7, 9–11). Liberation is usually delayed until the daughter coenobia mature. Though four-celled coenobia (figures 3–6) are usual, two-celled, coenobia as also the solitary state (figures 1,2) have been observed (for figure please see Page No. 1146).

Our form agrees closely in all respects with the type described from Allahabad by Tiwari and Pandey[1]. It may be pointed out here that, *C. mitrii* comes very near to *Suxenella* Srivastava *et* Nizam[2] differing from it only in the absence of mucilage and also in the cells being all in one plane. Tiwari and Pandey have discussed this point in detail and suggested that a critical reinvestigation of *Suxenella* is necessary to decide whether *Suxenella* is distinct from *Crucigenia mitrii*. We are inclined to agree.

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STUDIES OF AREOLES IN ASCLEPIADACEAE AND PERIPLOCACEAE

T. M. RAMAKRISHNA AND D. A. GOVINDAPPA*
Department of Botany, Maharani's Science College, Mysore 570 005, India.
*Department of Botany, Bangalore University, Jnana Bharathi, Bangalore 560 056, India.

THE leaf architecture and venation pattern have attracted the attention of several botanists in recent years. Hickey[1] exploited the features for identifying the foliage of living and fossil dicotyledons. The architectural pattern and venation of leaves of Bignoniaceae have been examined by Jain[2]. The comparative venation studies of Apocynaceae have been presented by few workers[3–7]. The venation pattern is certainly helpful in the diagnostic and taxonomic consideration of plants[8,9]. Further, these characters have been of great value in identifying plant materials used in drugs.

The present work deals with the areole pattern of 35 species and 4 varieties of the Asclepiadaceae and Periplocaceae. An attempt has been made to find out the taxonomic significance of areoles and free vien endings.

The taxa investigated are listed in the text, The leaf bits, between the margin and the midrib and in the midway between the tip and the base of the lamina, were cut and treated in 10% KOH solution and cleared. But in *Genianthus*, *Hoya*, *Decalepis* and *Hemidesmus* the leaves were treated with Stock Well's bleach solution for 1–2 hours. This was followed by a treatment with saturated chlorolhydrate solution until the tissue