SUBSTRATE-DEPENDENT MICROBIAL fllODUCTION OF AUXINS AND THEIR INFLUENCE ON THE GROWTH AND NODULATION OF LENTIL

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Lentil seeds inoculated with *Rhizobium* and those without inoculation were sown in pots and 15 days after germination, different concentrations of L-tryptophan (L-TRP) were applied to the inoculated plants. Results showed that nodulation (number and weight) was substantially increased due to *Rhizobium* inoculation and L-TRP application. *Rhizobium* inoculation alone increased the grain yield by 20.9% over uninoculated control and application of 1.7 mg L-TRP kg" soil along with *Rhizobium* inoculation increased it further by 30.6%. Indole-acetic acid production by *Rhizobium leguminosarum* increased with increasing L-TRP levels and incubation period.

INTRODUCTION

For optimum symbiotic Nrfixation, the roots should be densely nodulated with effective nodules. Many agronomic, environmental and nutritional factors are known to affect the nodulation process. In addition to these factors, involvement of plant growth regulators (PGRs) in nodule organogenesis has been speculated by many workers. Plant growth regulators influence almost all the phases of plant growth and development (Davies, 1987). Recent studies have unequivocally demonstrated the ability of microsymbiont *(Rhizobium)* as well as other soil indigenous microflora, to produce PGRs particularly in the presence of physiological precursors (Arshad and Frankenberger, 1992). Exogenous application of these precursors stimulated microbial biosynthesis of PGRs in the rhizosphere which causes alterations in plant growth and development (Arshad and Frankenberger, 1990, 1991, 1992). This substrate-dependent microbial production provides the most economical and continuous source of PGRs in the rhizosphere. So it is most likely that PGRs released as a result of precursor-inoculum interaction may help in better nodulation and Nrfixation which ultimately may lead to improved growth and yield of grain legumes.

MATERIALS AND METHODS

a) **Biosynthesis of IAA**

Biosynthesis of indole-acetic acid from L-tryptophan (L-TRP) by *Rhizobium leguminosarum* was studied in sterile and non-sterile soil by taking three L-TRP levels (10,3, 10'2 and 10ı M) and two incubation periods (24 and 48 hours). The procedure followed was as described by Sarwar *et al: (1992).*

b) **Pot experiment**

Experiment was conducted on a loam soil having organic matter 0.85 and total N 0.05%. NPK @ of 25. 25 and 40 kg ha' were thoroughly mixed in soil before filling the pots. Inoculated (with *R. leguminosarum*) and uninoculated seeds of lentil var.: masoor-85 were sown in pots. Fifteen days after

germination L-TRP concentrations 0.0, 1.7 x 10-6, 1.7 x 10-4, 1.7 IO-Z, 1.7x 10 1, 1.7 and 17 mg kg' soil were applied as solutions to the inoculated plants. Control was without inoculation and with out L-TRP. Nodulation was checked at flowering and grain yield was recorded at maturity.

RESULTS AND DISCUSSION

RESULTS:

Biosynthesis of IAA from L-TRP by R. *leguminosarum* (figure 1) was studied and it was observed that IAA production was increased by *Rhizobium* inoculation and L-TRP application. Maximum IAA production by R. *leguminosarum* without L-TRP (13.4 mg Kg-I) was observed in sterile soil followed by non-sterile soil. With increasing levels of L-TRP, IAA production was further increased. Highest L-TRP level (10-IM) resulted in maximum IAA (16.4 mg L) and was followed by 1O-Zand 10-3 M. Similarly, with increasing incubation period from 24 to 48 hours, IAA production was increased from 9.4 to 12.5 mg Kg^{-1}.

Rhizobium inoculation and L-TRP application showed a substantial increase in nodulation (number and weight) of lentil (figure 2). There was no nodulation in uninoculated control and all the levels of L-TRP increased nodulation over inoculation alone. Maximum number (29.3) and weight (55.2 mg) of nodules plant" were recorded with 1.7xlO-4 mg L-TRP kg' soil along with *Rhizobium* inoculation, and these were 148.9 and 253.8%, respectively, higher than inoculation alone. The percent increase in nodulation was lower at higher concentrations ofL-TRP.

Orain yield increased significantly with *Rhizobium* inoculation and L-TRP application (figure 3). *Rhizobium* inoculation alone increased the grain yield by 20.9% over uninoculated control and application of 1.7 mg L-TRP kg' soil along with *Rhizobium* inoculation increased it further by 30.6%. At higher concentrations of L-TRP, grain yield was decreased compared to that with 1.7 mg L-TRP kg' soil.

DISCUSSION:

The effect of soil applied L-TRP (precursor of auxins) on nodulation and yield of lentil was studied. It is obvious from the results that nodulation and grain yield of lentil were substantially increased due to *Rhizobium* inoculation and L-TRP application. No nodulation was observed in uninoculated plants (control). This might be due to the absence of effective infecting *Rhizobia* in soil indicating that inoculation of seeds with effective *Rhizobium* is indispensible for obtaining successful nodulation. Increases in the yield of grain legumes with *Rhizobium* inoculation have been reported by many workers (Hussain and Clark, 1969 and Rao et ai, 1979). This increase in lentil yield due to *Rhizobium* inoculation could be attributed to symbiotic Nz-fixation and also there is sufficient evidence about the synthesis of plant growth regulators which may also be involved in increasing crop yields (Philips and Torrey, 1972). Nodulated roots often contain substantially greater auxin concentration than non nodulated roots (Dullaart, 1967).

Recent studies have unequivocally demonstrated the ability of rnicrosyrnbiont as well as other soil indigenous microflora, to produce PORs, particularly in the presence of physiological precursors (Arshad and Frankenberger, 1992). Exogenous application of these precursors stimulated microbial biosynthesis of PORs in the rhizosphere which caused alterations in plant growth and development (Arshad and Frankenberger, 1990, 1991, 1992). In our study, it was also observed that IAA production was increased with the addition of L-TRP in the soil inoculated with *Rhizobium.* This substrate-

Figure 1: Biosynthesis of IAA (mg L-1) from L-TRP by Rhizobium leguminosarum

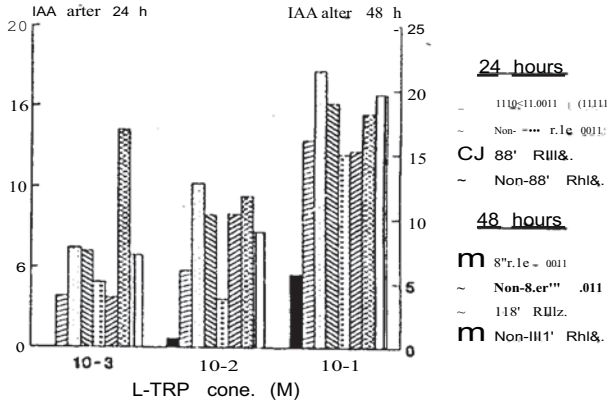


Figure 2: Effect of Rhizobium inoculation and L-TRP on No. and weight of nodules

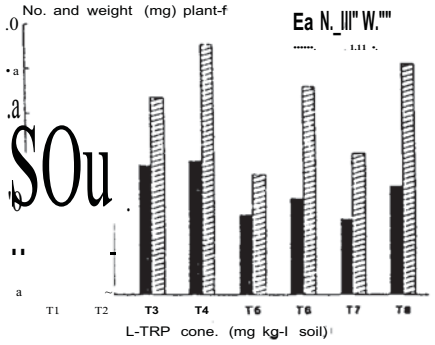
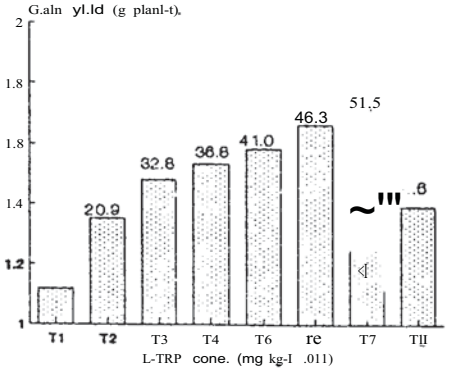


Figure 3: Effect of Rhizobium inoculation and soli applied L-TRP on grain yield



dependent microbial production provides the most economical and continuous source of PORs in the rhizosphere, so it is most likely that PORs released as a result of precursor-inoculum interaction may help in better nodulation and N_2-fixation which ultimately may lead to improved growth and yield of grain legumes.

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