

OBSERVATIONS ON NODULATION AND NITROGEN FIXATION IN *TRIBULUS TERRESTRIS* LINN. UNDER FIELD CONDITIONS

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Tribulus terrestris (Zygophyllaceae) an annual herbaceous weed is commonly found in sandy soils of cultivated and fallow lands. Nodules on *T. terrestris* have been reported under natural conditions of plant growth (Athar & Mahmood, 1980) The present paper reports the evidence of nitrogen fixation by *T. terrestris* under field conditions.

Both nodulated and non-nodulated plants were collected and brought to laboratory for nitrogen estimation. Dry weight of nodules, nodulated and non-nodulated plants was determined after keeping them in an oven at 80°C for 48 hours and total nitrogen determined by conventional micro-kjeldahl method (McKenzie & Wallace, 1954). Enzymatic reduction of tetrazolium salt to form formazan was studied as described by Akkermans (1971).

Nodules, white-yellowish similar to the root colour, occurred singly as well as branched form and measured 1.3–2.0 mm in diameter (Fig. 1). Nodulated plants showed healthy growth possessing lustrous green to dark green turgid leaves as compared to non-nodulated plants showing morbid and stunted growth, with pale or yellowish green distorted leaves with signs of acute nitrogen deficiency (Table 1). The results show that nitrogen fixation is associated with nodulated plants. A significant relationship was obtained between the dry weight and nitrogen content of nodulated plant ($r = 0.708$, $P < 0.01$) which substantiates the effectiveness of *Tribulus* nodules. This relationship was non-significant in non-nodulated plants ($r = 0.295$, n.s).

A high percentage of nitrogen content of *Tribulus* nodules compared with the other plant parts is a characteristic feature of plants possessing effective nodules (Bond, 1967). This observation supports the view that the nodules in *Tribulus* are site of nitrogen fixation as in other non-legumes. Non-nodulated plants lacked this property.

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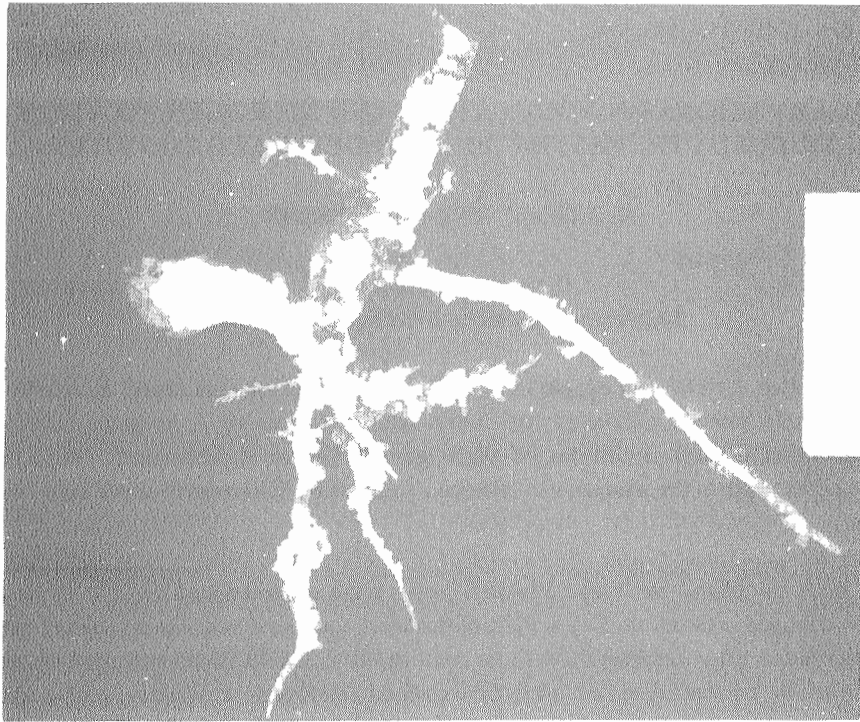


Fig. 1. Nodulated root system of *Tribulus terrestris*.

Large formazan crystals were located in the nodule sections when the nodules were treated with tetrazolium salt. Since nitrogen fixation is a strongly reducing process which requires a hydrogen donor, tetrazolium reduction can provide information about the localization of the reducing system which might be related to nitrogen fixation (Yakovlev, 1966). Thus the reduction of tetrazolium salt by *Tribulus* nodules renders some evidence about their involvement in the process of nitrogen fixation.

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Table 1. Mean harvest data per *Tribulus terrestris* plant growing under natural conditions. (Plant age 15 months).

Growth Parameters	Non-nodulated	Nodulated
No. of Plants	7	11
No. of Nodules	—	59
Dry weight:		
Nodules (g)	—	0.15
Root & Shoot (g)	0.97	5.92**
Total Nitrogen:		
Nodules (%)	—	3.66
Root & Shoot (%)	0.84	1.67
Whole Plant (mg)	6.83	70.79***

Means of nodulated plants are significantly different from the means of non-nodulated plants.

Level of significance ** = $P > 0.01$

*** = $P > 0.001$

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