

The present discovery of *Solenopora-Amphiroa* association in the Trichinopoly Cretaceous rocks confirms the author's earlier conclusion³ that the stratigraphic distribution of fossil algae in the Trichinopoly Cretaceous is not of so much value in fixing the age as much as in interpreting the paleoecology of those sediments. It is of interest to recall here that the genus *Corallina* which is known to be restricted to Tertiary everywhere else is found⁶ in the Callapaudy limestone band which occurs, like Varagapaudy band, at the base of the Utatur Group. This occurrence of *Corallina* also corroborates the conclusion referred to earlier in regard to the stratigraphic range of fossil algae in the Trichinopoly Cretaceous succession.

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RESPONSE OF RHIZOBIUM CULTURE INOCULATION, ZINC AND MOLYBDENUM APPLICATION ON RHIZOSPHERE AND PHYLLOSHERE MICROBIAL POPULATION OF SOYABEAN (*GLYCINE MAX* MERILL)

CLARK AND PAUL⁴ have summarised various factors like plant species, growth stages and soil or plant treatments that affect rhizosphere or phyllosphere microbial populations. Several workers (Lochhead and Rouatt⁹; Sundararao and Venkatraman¹²; Rangaswami¹¹; Emmimath and Rangaswami⁶; Bagyaraj and Rangaswami¹³; and Egeratt⁷) have reported that fertilizers, herbicides, insecticides, fungicides and antibiotics influence the quality and quantity of the rhizosphere microbial populations. In view of this a trial in randomized block design with eight treatments including zinc and molybdenum application separately and combined, and with and without *Rhizobium* culture as seed inoculant was conducted with Soyabean var, to note the influence of the treatments on total bacteria, *Azotobacter* and *Rhizobium* in the rhizosphere and phyllosphere at Allahabad Agricultural Institute. Soil was applied with zinc in the form of zinc sulphate and molybdenum in the form of ammonium molybdate. *Rhizobium* sp. was applied as seed inoculant.

Field was managed as described in our earlier paper (Tripathi and Edward¹⁴).

Phyllosphere and rhizosphere study was done at flowering stage according to the methods adopted by Prasad and Edward¹⁰, and Agnihothrudu², respectively. The former is a modified method of Dickenson⁵. Total bacteria, *Rhizobium* and *Azotobacter* were enumerated in Thornton's agar (Allen¹) and yeast extract mannitol agar (Allen¹) and Base medium 77 (Allen¹), respectively. *Rhizobium* was identified as per the method described by Vincent¹⁵.

Rhizosphere.—Soyabean inoculated with *Rhizobium* registered higher population of total bacteria as compared to uninoculated control irrespective of trace element treatment. Similar findings have also been reported by Tripathi¹³ with *Azotobacter* inoculated wheat. Application of trace elements (zinc and molybdenum) separately or combined decreased total bacterial population, irrespective of whether culture was inoculated or not. Molybdenum when applied along with *Rhizobium* culture had the most depressing effect on total bacterial population whereas zinc had the most depressing effect on total bacterial populations among the uninoculated series. Under culture inoculated condition, molybdenum treatment antagonized the stimulatory effect of zinc on total bacterial population of zinc and molybdenum treated culture plants. Under uninoculated treatments, on the other hand, application of zinc antagonised the stimulatory effect of molybdenum on total bacterial population under zinc and molybdenum combined treatment (Table I). Rangaswami¹¹ stated that the trace elements suppressed the growth of pathogenic or parasitic forms of microorganisms in the rhizosphere.

Contrary to the findings on total bacteria in rhizosphere, *Azotobacter* and *Rhizobium* recorded an increased population with culture inoculation treatment over uninoculated control. The application of zinc or molybdenum separately or combined recorded increased population of *Rhizobium* and *Azotobacter* in both culture inoculated or uninoculated series over their respective controls without trace-element application. That the nitrogen fixing microorganisms require higher amounts of zinc and molybdenum has been recognized by Waksman¹⁶.

Phyllosphere.—Phyllosphere, in general, recorded reduced population of total bacteria and *Azotobacter* and increased population of *Rhizobium* in culture inoculated soyabeans over uninoculated controls, irrespective of trace-element treatments. Application of trace-elements remarkably reduced the population of total bacteria and *Azotobacter* whereas significantly increased the population of *Rhizobium* in both inoculated and uninoculated series over treatments without trace-element controls. Amongst the trace element treatments, application of molybdenum whether or

TABLE I

Rhizosphere microbial population of soyabean as influenced by Rhizobium inoculation, Zn or Mo application

Treatment	Total bacteria (10 ⁶ /g dry soil)		<i>Azotobacter</i> (10 ³ /g dry soil)		<i>Rhizobium</i> (10 ³ /g dry soil)	
	UI	I	UI	I	UI	I
Control	729.1	891.0	66.6	127.2	3.0	16.1
Zn @ 1.0 kg/ha	224.0	431.3	230.0	268.0	19.0	69.0
Mo @ 1.0 kg/ha	298.8	208.7	206.0	236.3	27.0	132.8
Zn + Mo @ 1.0 kg/ha each	292.2	289.0	219.0	237.0	28.0	124.0
Average	386.03	455.0	180.4	217.1	19.3	85.5
F. test	sig.		sig.		sig.	
C.D. @ 5% L.S.	209.4		103.7		29.1	

UI = Uninoculated. I = Inoculated with *Rhizobium* culture.

TABLE II

Phyllosphere microbial population of soyabean as influenced by Rhizobium inoculation, Zn or Mo application

Treatment	Total bacteria (10 ³ /cm ² leaf)		<i>Azotobacter</i> (10 ⁷ /cm ² leaf)		<i>Rhizobium</i> (10 ² /cm ² leaf)	
	UI	I	UI	I	UI	I
Control	917.0	684.2	318.0	275.5	28.0	64.3
Zn @ 1.0 kg/ha	776.0	804.2	276.3	280.0	34.7	144.3
Mo @ 1.0 kg/ha	432.2	218.0	228.0	126.4	36.8	803.4
Zn + Mo @ 1.0 kg/ha each	866.0	882.8	301.7	294.0	31.0	242.2
Average	747.8	638.8	281.0	244.0	32.6	313.9
F. test	sig.		sig.		sig.	
C.D. @ 5% L.S.	188.1		112.0		29.4	

UI = Uninoculated. I = Inoculated with *Rhizobium* culture.

not inoculated with culture had most depressing effect on population of total bacteria and *Azotobacter* and highly stimulating influence on *Rhizobium* (Table II). Clark and Paul⁴ reviewed various factors like, plant species, plant treatment and environment that would affect the phyllosphere population.

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