with 5 t ha^{-1} organic manures (FYM or GLM)/ 10 kg ha^{-1} bio-fertilizer (BGA) proved superior to other treatments for wet season rice. On the residual soil fertility to mustard crop, the result was not encouraging and this indicated that for higher mustard yield in this system, additional nutrients have to be applied to the succeding crop mustard.

References

Berasteskii, O.A., Andreeva, N.A. and Patyak, V.K. (1986). Nitrogen fixing cyanobacteria in the rhizosphere of rice grown continuously and in crop rotation. *Soviet Agriculture Biology* 1, *Plant Biology*, No.3, pp.120-124.

Chakraborty, P.K., Mondal, L.N. and Majumdar, A. (1988). Organic and chemical sources of nitrogen, its effect on nitrogen transformation and rice productivity under submerged conditions. *J.Agric.Sci.* UK II: 91-94.

Jackson, M.L. (1973). Soil chemical analysis. Prentice Hall of India, New Delhi.

Kanwar, J.S. (1981). Soil fertility: Theory and practices, ICAR, New Delhi, pp.156-201.

Mohapatra, A.K. and Pradhan, D.C. (1990). *Sesba* green leaf manuring doubles the prof *Agriculture Extension Review*, Septemb October 1990, pp.7-8.

Piper, C.S. (1950). Soil and plant analys Interscience Pub.New York.

Rathore, A.L., Chipde, S.J. and Pal, A.R. (199 Direct and residual effects of bio-orgar and inorganic fertilizers in rice-whe cropping system. *Indian J. Agron.* 40: 1 19.

Sharma, A.R. and Mittra, B.N. (1990). In rice bas cropping systems in eastern India orgar manures should be combined with chemic fertilizers. *Indian Fmg*, 40: 40-42.

Singh, A.L. and Singh, P.K. (1987). Nitrogen fixati and balance studies on rice soil. *Biol. Fer Soils*, 4: 15-19.

Singh, Surendra, Prasad, R. and Sharma, S.N. (19 Effect of blue green algae, nitrogen lev and modified urea materials on yield attribu and yield of wet land rice. *Indian J. Agr.* 40: 594-597.

(Received : March 2002; Revised : September 200

Madras Agric. J. 90 (4-6) : 344-347 April-June 2003

Research Notes

Effect of foliar nutrition of major and chelated micronutrients an rhizobium seed treatment on rice-fallow blackgram

V. MANIVANNAN AND K. THANUNATHAN

Dept. of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar-608 002, Tamil Na

Blackgram is the predominant pulse crop of Tamil Nadu and it is the main source of food protein to the vegetarians. The crop is mainly raised in rice-fallow after harvest of samba rice crop. Foliar application of macro and micronutrients and seed treatment with *Rhizobium* biofertilizer were reported to be efficient in increasing the grain yield, haulm yield, NPK uptake and protein content of pulse grains (Gopal Singh and Sudhakar, 1991). In order to find out the effect of *Rhizobium* seed treatment and foliar application of macro and chelated micronutrients on grain yield, haulm yield, nutrient uptake and protein content rice-fallow blackgram, the present investigati was undertaken.

Field experiments were conducted duri the year 1999-2000 (Rice-fallow condition) Vertisols of Annamalai University Experiment Farm, Annamalai University, Tamil Nadu. Tl blackgram cv.ADT 3 was grown as test cro The experimental soil was found to be neutr in reaction (pH 7.2) with EC of 0.5 dSm^{-1}. The available N,P and K were 23 21.8 and 285 kg ha^{-1}, respectively.

ble 1. Effect of foliar application of macro and micro-nutrients (Microsol) and Rhizobium seed incoulation on grain yield and haulm yield or rice - fallow blackgram

eatments	Grain yield (kg ha^{-1})		Haulm yield (kg ha^{-1})	
	Crop I	Crop II	Crop I	Crop II
Control (No foliar spray)	660.6	582.3	957.0	930.3
Rhizobium seed treatment	789.6	693.9	1470.3	1196.6
DAP spray 30 and 45 DAS	924.6	810.3	1635.0	1485.0
Microsol spray 15 DAS	1048.3	962.0	1814.6	1746.9
Microsol spray 30 DAS	1178.6	976.9	2075.0	2093.6
Microsol spray 45 DAS	919.0	822.6	1520.6	1451.0
Rhizobium + DAP spray 30 and 45 DAS	1320.0	1093.3	2480.6	2359.0
Rhizobium + Microsol spray 15 DAS	1443.6	1212.6	2815.6	2610.3
Rhizobium + Microsol spray 30 DAS	1570.6	1323.0	3109.6	2896.0
Rhizobium + Microsol spray 45 DAS	1303.6	1097.3	2451.0	2367.6
Rhizobium + Microsol spray 15 and 30 DAS	1818.3	1577.3	3654.6	3409.9
Rhizobium + Microsol spray 30 and 45 DAS	1692.0	1450.9	3383.0	3147.3
Rhizobium + Microsol spray 15, 30 and 45 DAS	1948.3	1693.6	3916.0	3697.3
D (P=0.05)	120.7	108.4	244.3	236.9

Table 2. Effect of foliar application of macro and micro-nutrients (Microsol) and Rhizobium seed incoulation on nutrient uptake of rice - fallow blackgram

Treatments		Nutrient uptake (kg ha^{-1}) at harvest					
		Nitrogen		Phosphorus		Potassium	
		Crop I	Crop II	Crop I	Crop II	Crop I	Crop II
T_1	Control (No foliar spray)	64.2	62.1	13.16	12.07	54.2	58.2
T_2	*Rhizobium* seed treatment	70.0	68.4	14.55	15.89	66.3	66.4
T_3	DAP spray 30 and 45 DAS	75.5	72.0	18.27	17.70	70.2	68.5
T_4	Microsol spray 15 DAS	76.9	76.5	18.09	17.55	75.1	72.1
T_5	Microsol spray 30 DAS	81.1	82.1	18.31	18.27	75.1	73.5
T_6	Microsol spray 45 DAS	74.4	72.0	17.28	17.11	72.8	70.7
T_7	*Rhizobium* + DAP spray 30 and 45 DAS	92.6	89.1	18.72	18.80	80.5	77.1
T_8	*Rhizobium* + Microsol spray 15 DAS	92.9	93.5	20.11	20.06	85.2	77.0
T_9	*Rhizobium* + Microsol spray 30 DAS	103.0	94.5	20.88	20.17	85.5	78.3
T_{10}	*Rhizobium* + Microsol spray 45 DAS	85.16	90.0	18.76	18.95	84.0	74.7
T_{11}	*Rhizobium* + Microsol spray 15 and 30 DAS	107.4	105.0	24.14	20.85	92.3	85.4
T_{12}	*Rhizobium* + Microsol spray 30 and 45 DAS	104.5	101.9	22.08	20.63	92.0	83.8
T_{13}	*Rhizobium* + Microsol spray 15, 30 and 45 DAS	110.5	105.4	24.65	21.30	93.5	85.6
CD (P=0.05)		2.10	1.96	0.33	0.30	1.19	1.20

Table 3. Effect of foliar application of macro and chelated micronutrients (Microsol) and Rhizobium se inoculation on protein content (%) of rice - fallow blackgram grain

Treatments		Protein content (%)	
		Crop I	Crop II
T_1	Control (No foliar spray)	21.59 (27.68)	20.26 (26.75)
T_2	*Rhizobium* seed treatment	22.00 (27.97)	20.73 (27.08)
T_3	DAP spray 30 and 45 DAS	22.40 (28.24)	21.01 (27.28)
T_4	Microsol spray 15 DAS	22.08 (28.02)	21.59 (27.68)
T_5	Microsol spray 30 DAS	22.66 (23.38)	21.65 (27.73)
T_6	Microsol spray 45 DAS	22.10 (28.04)	21.28 (27.47)
T_7	*Rhizobium* + DAP spray 30 and 45 DAS	23.00 (28.66)	22.00 (27.79)
T_8	*Rhizobium* + Microsol spray 15 DAS	23.53 (29.02)	22.62 (28.4(
T_9	*Rhizobium* + Microsol spray 30 DAS	23.28 (28.85)	23.43 (28.9
T_{10}	*Rhizobium* + Microsol spray 45 DAS	23.11 (28.73)	23.20 (28.7
T_{11}	*Rhizobium* + Microsol spray 15 and 30 DAS	24.20 (29.46)	24.20 (29.47
T_{12}	*Rhizobium* + Microsol spray 30 and 45 DAS	23.90 (29.26)	23.75 (29.16
T_{13}	*Rhizobium* + Microsol spray 15, 30 and 45 DAS	24.52 (29.68)	24.33 (29.55
CD (P=0.05)		0.16	0.18

Figures in parenthesis are arc - sine transformed values

The nutrient content of the macro and chelated micronutrients mixture was as follows [Microsol = Hileaf (14:42:14% NPK) + Microsol-B (Sodium borate - 2.50% B; FeEDTA - 4.75% Fe; MnEDTA - 2.37% Mn; ZnEDTA - 0.95% Zn; CuEDTA - 2.37% Cu; Ammonium molybdate - 0.035% Mo)]. The treatments consisted of foliar application of DAP on 30 and 45 DAS (Days after sowing), Microsol on 15,30 and 45 DAS with and without *Rhizobium* seed treatment and a control without foliar spray and *Rhizobium* seed treatment. As per the treatment schedule, spray solution of 200,300 and 400 litres ha^{-1} was followed for different growth stages *viz.* 15,30 and 45 DAS, respectively. The spray solution was prepared by dissolving the required quantity of NPK (Hileaf) readymade mixture @ 3,4 and 5 g $litre^{-1}$ at 15,30 and 45 DAS respectively and Microsol-B @ 0.5 g $litre^{-1}$ at 15,30 and 45 DAS in required quantity of water. Seeds were treated with *Rhizobium* before sowing as per the treatment. There were altogether 13 treatments and were replicated thrice in randomised block design (RBD). Proper plant protection measures were taken up. The plant samples drawn at harvest stage were analysed for the N,P and K contents by adopting standard analytical methods and uptake were computed. Protein content of grain was calculated by multiplying the N content (Humphries, 1956) of grain with the factor 6.25.

Grain and haulm yield

Rhizobium seed treatment with foliar application of NPK and chelated micronutrients (Microsol) thrice at 15,30 and 45 DAS had significant influence on rice-fallow blackgram grain and haulm yield (Table 1). The highest grain yield of 1943.3 and 1693.7 kg ha^{-1} in the first and second crop, respectively were recorded in treatment T_{13} (*Rhizobium* seed treatment + Microsol spray 15,30 and 45 DAS). The minimum values were observed in control plots in both the crops. Periodical spray of NPK and chelated micronutrients mixture containing B,Fe,Mn,Cu and MO helps in increasing the yield of rice-fallow blackgram. The results are inline with the findings of Revathy *et al.* (1997).

Nutrient uptake

Nutrient uptake was significantly influenced by *Rhizobium* seed inoculation and foliar application of N,P,K and chelated micronutrients (Microsol)

able 2). *Rhizobium* seed treatment + Microsol pray 15,30 and 45 DAS (T_{13}) recorded significantly igher N (110.5 and 105.4 kg ha^{-1}), P (24.65 nd 21.30 kg ha^{-1}) and K (93.5 and 85.6 kg a^{-1}) uptake in the first and second crop, spectively. Nutrients applied through foliage ould have easily absorbed and translocated the plant without any loss. This was in greement with the earlier findings of Rajendran 1991) in greengram.

rotein content

Rhizobium seed treatment and foliar pplication of macro and chelated micronutrients howed significant influence on protein content Table 3). Maximum protein content of 24.52 nd 24.33 per cent in grain during the first nd second crop, respectively were recorded nder the treatment of *Rhizobium* + Microsol pray at 15,30 and 45 DAS (T_{13}). *Rhizobium* ould have helped the plants by fixing atmospheric itrogen and as a result, the nitrogen content turn the protein in grain was increased. The esult was inline with the findings of Bhalu *t al.* (1995). Foliar application of macro and micronutrients enhanced the protein content of grain. This might be due to increase in the efficiency of fixing of nitrogen and nitrate reductase activity by molybdenum. Similar view was expressed by Sharma and Minhas (1990) in soybean.

Thus, it is concluded that *Rhizobium* seed inoculation and foliar application of N,P,K and chelated micronutrient mixture (Microsol) thrice at 15,30 and 45 DAS increased the grain yield, haulm yield, NPK uptake and protein content in the grain of rice-fallow blackgram.

Acknowledgements

The financial assistance given by the Varadaman Fertilizer and Seeds Ltd. Pune.

References

Bhalu, V.B., Sadaria, S.G., Kaneria, B.B. and Khanpara, V.D. (1995). Effect of nitrogen phosphorus and *Rhizobium* inoculation on yield and quality, N and P uptake and economics of blackgram (*Phaseolus mungo*). *Indian J. Agron.* **40**: 316-318.

Gopal Singh, B. and Sudhakar, P. (1991). Effect of inoculation and phosphorus fertilization on DMP, N and P composition and yield in blackgram. *Indian J. Plant Physiol.* **34**: 297-301.

Humphries, E.C. (1956). Mineral components and ash analysis. Modern methods of plant analysis. Springer-Verlag. Berlin 1, pp.468-502.

Rajendran, R. (1991). Response of greengram (CO 4) to soil and foliar nutrition. *Madras Agric. J.* **78**: 453-455.

Revathy, M., Krishnasamy, R. and Chitdeswari, T. (1997). Chelated micronutrients on the yield and nutrient uptake by groundnut. *Madras Agric. J.* **84**: 659-662.

Sharma, C.M. and Minhas, R.S. (1990). Effect of molybdenum application on nitrogen and protein content of soybean (*Glycine max*). *Madras Agric. J.* **77**: 243-244.

(Received: November 2001; Revised: September 2002)

Madras Agric. J. 90 (4-6) : 347-350 April-June 2003

Research Notes

Nutrient management on growth and yield of Deli. Ekona oil palm plantation

S. JEYARAMAN AND S. ALAGUDURAI

Sugarcane Research Station, Sirugamani-639 115, Tamil Nadu

Oil palm, a relatively new oil yielding crop, is cultivated in about 5,000 acres in Tamil Nadu. A range of soil nutrient content and fertility exist in the oilpalm growing soils of Tamil Nadu. An oil palm plantation producing 25 tonnes of fresh fruit bunches per hectare per year remove about 93.5, 91.0, 92.7, 19.3 and 20.3 kg per ha of N,P,K,Mg and Ca respectively