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Influence of different tillage systems and herbicides on soil microflora of rice rhizosphere

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ABSTRACT

A field study was conducted in an inceptisol with rainy season rice to evaluate the effect of different tillage systems *vis-à-vis* different weed control measures on the survival and growth of total bacteria, actinomycetes, fungi, *Rhizobium* and *Azotobacter* in rhizosphere soil. Four types of tillage system were evaluated *viz.* (i) conventional-conventional (ii) conventional-zero (iii) zero-conventional and (iv) zero-zero tillage systems. Among weed control measures comparative effect of hand weeding and recommended herbicidal application (butachlor as pre emergence and fenoxaprop ethyl + ethoxysulfuron as post emergence) were tested along with a weedy check. The results of the investigation revealed that maximum growth of different microorganisms was observed in conventional-conventional tillage system, whereas minimum was in zero-zero tillage system. Pre emergence herbicide suppressed the microbial population between 0 to 10 days after emergence of plant (DAE), whereas post emergence herbicide inhibited the microbial population for a period of 10 days between 20 to 30 DAE. In weedy check, the microbial population was found significantly higher over other weed management practices in most of the cases.

Keywords: Rice, Tillage, Zero tillage, Rhizobium, Azotobacter.

Weeds are one of the major constraints for increasing rice production and considered as a major pest (Larbrada, 1966). Hence it is essential to eradicate weeds which are the main competitors of plants for nutrients, sunlight, moisture and space. Besides above, the weeds are also sink of different pest and disease causing organisms and may induce allelopathic effect on crops. Weed control technology integrates preventive, cultural, mechanical, chemical and biological practices in which the use of chemical herbicides is probably the most important component of weed management system for most of the major crops. The ultimate destination of herbicidal chemicals is the soil system where they come in contact with different microflora which are responsible for different biochemical transformations related to mineral nutrition to plants. Generally herbicides are not harmful when it is applied in recommended levels in soil (Selvamani and Sankaran, 1993) but reports are there which envisaged that herbicidal application has adverse effect on bacterial (Rajendran and Lourduraj 1999), fungal (Shukla, 1997) and actinomycetes population (Rajendran and Lourduraj, 1999). Different cultural techniques affect soil productivity, contrasting tillage practices have been shown to alter the chemical and microbiological properties of soils which is supposed to create a great impact on agricultural production (Ferreira *et al.* 2000). Hence a field experiment was framed to assess the influence of different tillage systems and herbicides on different rhizosphere microflora of rice.

MATERIALS AND METHODS

Rice-wheat cropping system was rotated for three consecutive years (2005-07) at research farm of Indira Gandhi Agricultural University and in the third year a study was conducted to find out the effect of different tillage systems *vis-à-vis* different weed control practices on the population of bacteria, fungi, actinomycetes, *Rhizobium* and *Azotobacter* in rhizosphere soil. The experiment was conducted in *kharif* rice with test variety MTU-1010. The soil was Inceptisol (pH : 6.7, EC : 0.26 mmhos/cm, organic carbon : 0.57%, available N: 198.20 kg/ha, available P: 13.72 kg/ha and available K : 340.00 kg/ha). Four types of tillage system were evaluated and put in main plots viz (1) conventional-conventional (ii) conventional –zero (iii) zero-conventional and (iv) zero-zero tillage system. Among weed control measures performance of hand weeding and recommended herbicidal application was tested compared with a weedy check and put in sub plots. As per recommendation for *kharif* rice butachlor was sprayed in pre emergence and fenoxaprop ethyl and ethoxysulfuron as post emergence herbicides on rice field @ 1.5 kg/ha, 56.25 g/ha and 15.00 g/ha, respectively. The treatments were replicated thrice under split plot design. Soil from rhizosphere was collected from 7.5-15.0 cm. The soil samples from six rhizosphere zones were pooled together for the purpose of analysis. Soil sampling was done at 0, 5, 10, 20, 30, 50 days after emergence of plant (DAE) and at harvest stage of the crops. The pooled soil samples were subjected to analysis to estimate total bacteria, fungi, actinomycetes, *Rhizobium* and *Azotobacter* by serial dilution technique and pour plate method (Pramer and Schmidt 1965).

Enumeration of bacteria was done on nutrient Agar, fungi on Rose-Bengal agar (Martin 1950), actinomycetes on Kenknight and Munaier's medium, *Rhizobium* on YEMA and *Azotobacter spp.* on Jensen's nitrogen free medium (Jensen 1951).

RESULTS AND DISCUSSION

(a) Effect of tillage system: From the results it is apparent that different types of tillage operations influenced profoundly on soil micro flora. In this study, different tillage systems quantitatively altered the soil micro flora (Table 1, 2 and Fig. 1). Maximum microbial population in rice rhizosphere was noticed in conventional-conventional tillage system whereas, minimum was in zero-zero tillage system. However, in conventional-zero and zero-conventional system the microbial population was found intermediate type. In conventional-zero system, the population of rhizosphere micro flora was observed more than zero-conventional system but in some time intervals (10, 20, 50 DAE and at harvest) the actinomycetes population was found at par among them. Singh *et al.* (2007) also found higher microbial counts under conventional tillage system at lower soil depth (7.5 to 15 cm). They also reported that at lower layer, *Azotobacter* spp. counts were significantly higher under conventional tillage as compare to minimum tillage. Ferreira *et al.* (2000) also reported similar observations with regard to *Bradyrhizobium* spp. population in soybean rhizosphere cultivated under zero tillage system. They found reduced soil microflora in lower layer (7.5 to 15 cm) under minimum tillage. Relatively high availability of soil organic matter at soil lower soil profile under conventional tillage may due to even distribution of crop residues and other nutrients throughout the plough zone. This may possibly be accounted for observed higher counts of soil microflora at rice rhizosphere under conventional-conventional tillage than the zero-zero tillage system. At harvest stage of the crop different tillage systems found statistically similar with respect to fungal, bacterial and actinomycetes population.

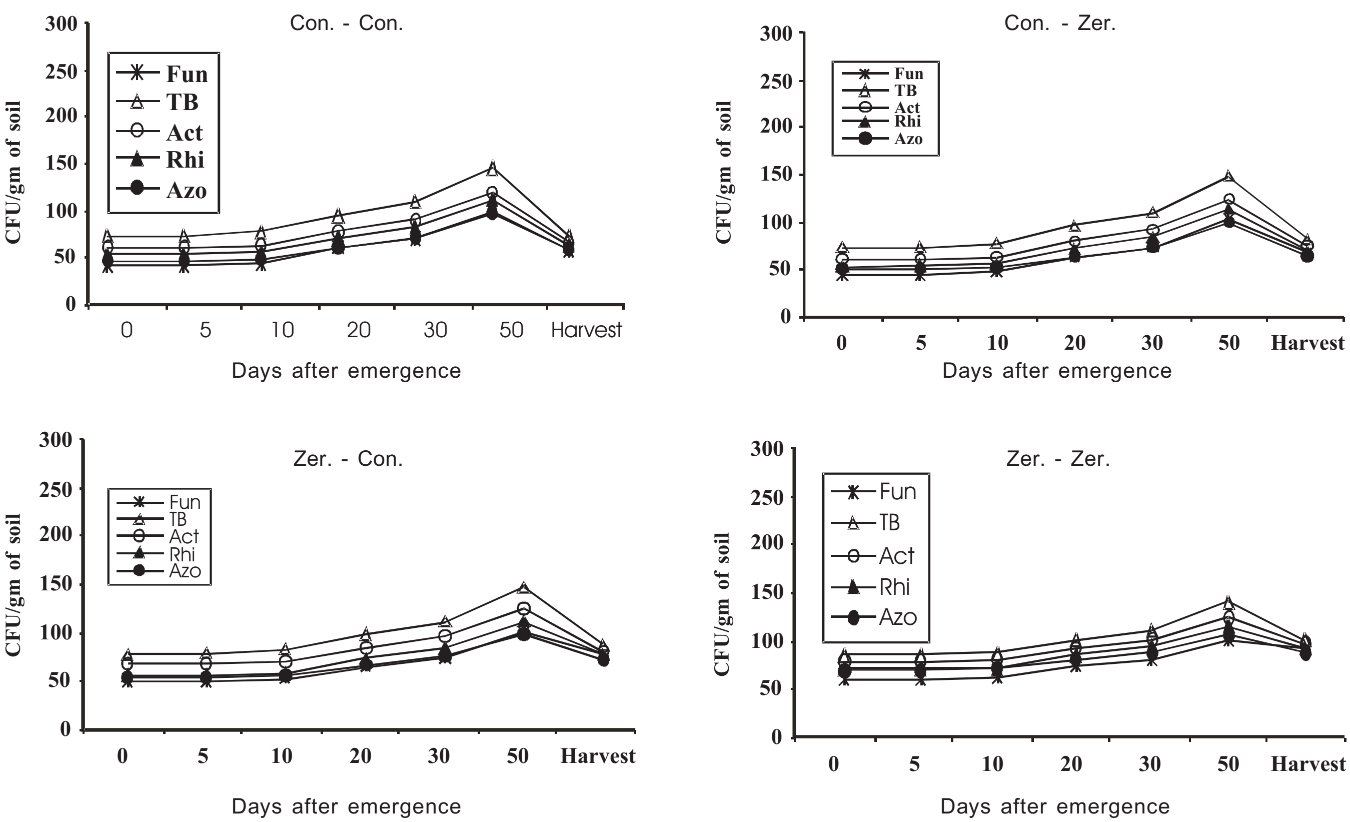

Fig.1: Effect of tillage practices on microflora of rice rhizosphere

Table 1. Effect of tillage practices and herbicides on the pr oliferation of fungi (CFU x 10^3), total bacteria (CFU x 10^5), actonomycetes (CFU x 10^5), *Rhizobium* (CFU x 10^4) and *Azotobacter* (CFU x 10^3) in rhizosphere soil (per gram dry soil) of rice.

Treatment	Days after emergence																			
	0					5					10					20				
	Fun	TB	Act	Rhi	Azo	Fun	TB	Act	Rhi	Azo	Fun	TB	Act	Rhi	Azo	Fun	TB	Act	Rhi	Azo
Tillage																				
Con.-Con.	51.0	86.0	72.7	63.0	55.8	49.9	86.5	71.7	63.4	56.6	53.9	90.8	74.0	65.6	58.5	71.4	112.5	92.0	83.6	73.4
Con.-Zer.	43.8	72.4	61.9	52.6	50.3	43.0	73.2	61.1	53.3	50.9	47.0	77.0	63.2	55.2	52.5	62.5	95.6	79.5	72.1	63.0
Zer.-Zer.	29.6	60.0	52.3	41.4	40.2	29.0	60.4	51.1	41.7	40.6	32.4	63.0	52.8	43.1	42.0	44.8	79.3	67.3	58.8	54.5
Zer.-Con.	38.4	69.7	59.8	45.7	44.5	37.7	70.3	59.1	46.2	44.6	41.4	74.1	61.1	47.9	46.0	55.6	91.6	77.0	64.3	57.7
LSD (P=0.05)	1.2	1.8	1.9	0.6	1.9	0.8	1.8	1.2	1.0	1.5	1.6	2.1	2.2	1.6	1.5	7.2	1.7	3.7	1.6	2.2
Weed management																				
Hand weeding	37.0	68.0	57.5	46.3	43.6	38.1	72.5	59.5	50.5	47.8	45.7	80.5	64.5	55.2	51.6	62.4	101.2	82.6	73.8	66.3
Re. Herb. Appl.	45.2	75.7	65.0	54.5	51.6	40.0	68.1	58.1	47.2	44.7	35.7	63.5	54.1	43.1	41.7	46.3	76.8	66.6	55.6	49.0
Weedy check	40.0	72.5	62.6	51.2	47.9	41.6	77.3	64.8	55.7	52.1	49.6	84.7	69.8	60.6	55.9	67.0	106.3	87.7	79.7	71.2
LSD (P=0.05)	1.2	1.2	1.5	1.5	1.0	1.4	1.2	0.9	1.4	1.2	0.9	0.9	0.6	1.2	0.9	5.9	1.2	2.5	1.2	1.2

Con.-Con. till = Conventional-Conventional tillage system
Con.-Zer. till. = Conventional-Zero tillage system
Zer..-Zer. till = Zero-Zero tillage system
Zer.-Con. till. = Zero-Conventional tillage system
Re. Herb. Appl.=Recommended Herbicide Application

Fun = Fungi
TB = Total Bacteria
Act = Actinomycetes
Rhi = *Rhizobium*
Azo = *Azotobacter*

(b) Effect of weed control practices: The results of weed management study (Table 1, 2 and Fig. 2) envisaged that application of pre emergence herbicide (butachlor) sprayed at 3 days after sowing {0 day after emergence (DAE) of crop suppressed the fungal population from 45.2x 10^3 (0 DAE) to 35.7 x 10^3 (10 DAE) which further increased to 46.3 x 10^3 at 20 days after emergence. Similarly the bacterial growth also inhibited from 0 DAE to 10 DAE which was reflected by the population data of total bacteria recorded at 0 DAE (75.7 x 10^5) and 10 DAE (63.5 x 10^5). The actinomycetes and crop beneficial bacterial population (*Rhizobium and Azotobacter*) also showed the similar trend. Similarly the application of post emergence herbicides (fenoxaprop-p-ethyl and ethoxy sulfuron) which were sprayed at 20 days after crop emergence suppressed the fungal population from 46.3 x 10^3 (20 DAE) to 34.7 x 10^3 (30 DAE) which again increased to 53.8 x 10^3 at 50 DAE. The bacteria and actinomycetes also followed the similar trend. The findings revealed that the persistence of butachlor, fenoxaprop-p-ethyl and ethoxy sulfuron in paddy field exists at least 10 days after application. These findings are in accordance with that of Samanta *et al.* (2005) where application of post emergence herbicides (carfentrazone ethyl, 2,4-D and pyrazosulfuron ethyl) inhibited the microbial growth in rice soil up to 10 days of its application which in later stage significantly augmented the population of total bacteria, actinomycetes and fungi over that of control in the rhizosphere soil of rainy season rice. Stimulation in the bacterial population could be attributed to the increment of resistant organisms which utilize the herbicides as a nutrient source (Wardle and Parkinson, 1990). Stimulation in fungal propagates showed that major part of the population could tolerate the herbicides and most possibly utilize the herbicides (Shukla, 1999). Rajendran and Lourduraj (1999) also reported that population of bacteria, fungi and actinomycetes were affected with butachlor application in rice and these adverse effects gradually reduced with passage of time. Reasons for the faster degradation in tropical rice fields include reducing conditions, favourable temperature, pH and the presence of flood water (Roger *et al.* 1994). Among different kind of microorganism, the reduction of bacterial population is higher in comparison to actinomycetes and fungi in case of pre emergence herbicidal application. Nalayini and Sankaran (1992) also revealed that fungi showed resistance to the herbicides. Similarly, rhizobial population affected more than *Azotobacter* by pre emergence herbicide application. In this study maximum microbial population was observed at 50 DAE and thereafter declination of the population was noticed up to harvest of the crop. In weedy check, the microbial population was found significantly higher over other weed management practices in most of the cases. This might be attributed to more rhizosphere area under weedy check conditions in comparison to hand weeding conditions. The rihzosphere region in weedy check is comparatively more than hand weeding because number of weedy plants per unit area is more under weedy check which increase the total area of rhizosphere region, ultimately enhance microbial population. Subba Rao (2005) also reported that one of the most important factors responsible for

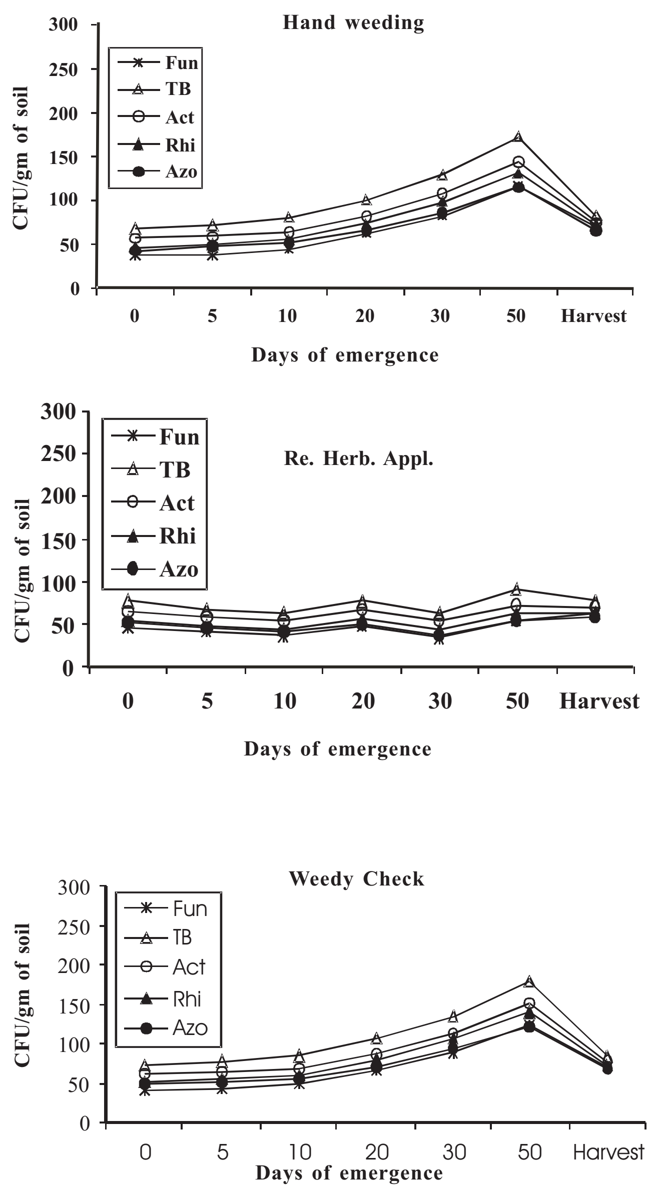

Fig. 2. Effect of herbicidal application on microflora of rice rhizosphere

Table 2. Effect of tillage practices and herbicides on the proliferation of fungi (CFU x 10^3), total bacteria (CFU x 10^5), actonomycetes (CFU x 10^5), *Rhizobium* (CFU x 10^4) and *Azotobacter* (CFU x 10^3) in rhizosphere soil (per gram dry soil) of rice.

Treatment	Days after emergence														
	30					50					At harvest				
	Fun	TB	Act	Rhi	Azo	Fun	TB	Act	Rhi	Azo	Fun	TB	Act	Rhi	Azo
Tillage															
Con. -Con.	84.1	128.7	106.7	97.9	84.5	115.8	170.6	138.5	130.1	112.9	70.5	87.1	77.6	73.8	69.1
Con. -Zer.	72.9	109.7	92.6	84.4	72.9	102.3	148.8	124.0	113.1	98.6	68.0	81.2	74.3	69.3	64.3
Zer.-Zer.	53.2	91.6	79.3	70.3	62.5	79.5	127.3	106.9	95.2	84.9	66.8	77.9	72.3	66.9	61.4
Zer.-Con.	65.8	105.5	89.8	76.7	67.5	94.5	144.1	120.0	104.4	92.3	68.0	80.1	73.4	68.6	63.0
LSD (P=0.05)	4.4	10.8	1.3	2.9	3.0	2.3	3.4	4.9	3.4	2.4	NS	NS	NS	3.1	2.6
Weed management															
Hand weeding	83.5	129.2	108.3	98.7	86.1	116.1	172.1	143.1	130.5	114.5	70.7	83.2	75.7	72.0	66.3
Re. herb. appl.	34.7	62.1	53.7	42.6	37.0	53.8	90.4	73.2	62.4	55.0	62.3	76.2	69.9	62.9	58.9
Weedy check	88.9	135.3	114.4	105.7	92.4	124.3	180.5	150.8	139.2	122.0	72.1	85.3	77.7	74.1	68.2
LSD (P=0.05)	2.4	8.9	0.9	2.4	1.8	2.0	2.5	1.5	1.9	1.9	2.4	2.1	2.9	3.1	2.2

rhizosphere effect is the availability of many organic substances at the root region by way of exudates from roots which directly or indirectly influence the quality and quantity of microorganisms in the root region. The substances exuded by plant roots include amino acids, sugars, organic acids, vitamins, nucleotides and many other unidentified substances. The nature and amount of substances exuded are dependent on the species of plants, age of plant and environmental conditions under which they grow.

REFERENCES

Ferreira C, Andrade DS, Chueire LM, Takemura SM and IIungria M. 2000. Tillage method and crop rotation effects on the population sizes and diversity of bradyrhizobia nodulating soybean. *Soil Biology and Bio Chemistry.* **32** : 627-637.

Jensen HL. 1951. Notes on the biology of Azotobacter. *Proceedings of Society of Applied Bacteriology* **14** : 89.

Larbrada R. 1996. Weed control in rice. In: *Weed management in rice* (Eds. BA Auld and KV Kim). FAO Plant Production and protection Paper, 139 Food Agricultural Organization of the United Nations. Oxford & IBH Pub. Co. Pvt. Ltd., pp. 3-5.

Martin JP. 1950. Use of acid, rose bengal and streptomycin in the plate method for estimating soil fungi. *Soil Science* **69** : 215.

Nalayini P and Sankaran S. 1992. Effect of pre emergence herbicides on soil microorganisms. *Indian Journal of Agronomy* **37** : 625-626.

Pramer D and Schmidt ED. 1965. *Experimental Soil Microbiology*. Burges Publishing Co. Minneapolis.

Rajendran K and Lourduraj AC. 1999. Residual effect of herbicides in rice ecosystem a review. *Agrilculture Review* Karnal. **20** : 48-52.

Roger PA. 1994. In: Rice pest science and management. IRRI Publication. pp. 225-276.

Samanta A, Ghosh S, Haldar M, Mukherjee D and Ghosh RK. 2005. Influence of herbicides on microorganisms and transformation of iron in rice rhizosphere soil. *Journal Interacad emisia* **9** (4) : 528-532.

Selvamani S and Sankaran S. 1993. Soil microbial population as affected by herbicides. *Madras Journal Agriculture* **80** : 397-399.

Shukla AK. 1997. Effect of herbicides butachlor, fluchloralin, 2, 4-D and oxyfluorfen on microbial population and enzyme activities of rice field soil. *Indian Journal Ecology* **24** : 189-192.

Singh Geeta, Singh AK, Marwaha TS and Kaushik BD. 2007. Effect of tillage on soil microbiological parameter in maize-wheat cropping system. *SAARC Journal of Agriculture* **5** (1) : 71-78.