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Effect of Organic Rice to Weed Management Practices on Yield Parameters and Microbial Population Grown under Lowland Condition

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A B S T R A C T

A Field experiment was carried out at wetlands farm of Tamil Nadu Agricultural University, Coimbatore during *rabi* 2014 to evaluate the effect of organic rice to weed management practices on yield parameters and microbial population grown under lowland condition. The experiment was laid out in randomized block design with three replication and ten treatments. Microbial counts were recorded in the soil samples taken at 30, 60 and 90 DAT. The study revealed that the higher yield parameter and soil microbial population *viz.*, bacteria, fungi and actinomycetes recorded under mulching using biodegradable polyethelene sheets which was statistically at par with application of rice bran at 2 t ha^{-1} on 3 DAT fb hand weeding on 35 DAT and the lowest was observed in unweeded check.

Introduction

Rice is the world's staple food crop and accounting for 90% of the world's production and consumption of rice. In recent years, the area under rice crop is decreasing year by year due to negative impact of modern agriculture leading to less profitability and there are limited possibilities of increasing additional area under cultivation. Farmers around the world realized the adverse effects of modern agriculture and started their own efforts to develop a sustainable system which is now recognized as Organic Farming. There is an emerging awareness among public on the use of high quality food materials which are free from chemical toxicants.

Weeds are the most severe constrains in organic rice and timely weed management is crucial to increase the rice productivity. Weed incorporation in soil also helped to boost microbial population in soil. The different organic matter increases the soil micro organisms which include both micro flora and fauna. They play a very important role in soil fertility not only because of their ability to carry out biochemical transformation but also due to their importance as a source and sink of mineral nutrients (Jenkinson and Ladd, 1981). The soil microbial community is involved in numerous ecosystem functions, such as nutrient cycling and organic matter

decomposition, and plays a crucial role in the terrestrial carbon cycle (Schimel, 1995). The organic matter upon decomposition releases nutrients into soil which is utilized by the crop for its growth, improves physico-chemical properties of soil and increasing soil microbial population. So, the present study was undertaken to understand the effect of organic rice to weed management practices on yield parameters and microbial population under low land condition.

Materials and Methods

Field experiment was conducted during *rabi* 2014 at O_4 block wetland farm of Tamil Nadu Agricultural University, Coimbatore. The soil of the experimental field was clay loam with pH (8.3) and EC (0.45 dSm^{-1}). The experiment was laid out in Randomized Block Design with ten treatments replicated thrice.

The treatments comprised of different weed management practices *viz.*, Application of paddy straw @ 3 t ha^{-1} on 3 DAT + Hand weeding on 35 DAT (T_1), *Azolla* as dual crop with rice and incorporation on 35 DAT using power weeder (T_2), Hand weeding on 15 DAT and 35 DAT (T_3), Conoweeder 3 times on 20, 30, 40 DAT (T_4), Mulching with biodegradable polyethelene sheet (T_5), Intercropping mesta (*Hibiscus cannabinus*) with rice as paired row and harvested greens (T_6), Intercropping daincha (*Sesbania aculeata*) with rice as paired row cropping and incorporation on 35 DAT (T_7), Application of rice bran @ 2 t ha^{-1} on 3 DAT + Hand weeding on 35 DAT (T_8), Hand weeding on 15 DAT followed by azolla inoculation (T_9) and Unweeded check (T_{10}). Enumeration of serial dilution plate count method and agar plate count method. The initial microbial composition of soil bacteria was 15.0 CFU x 10^6 g^{-1} of soil, actinomycetes 4.0 CFU x 10^3 g^{-1} of soil and fungi 9.0 CFU x 10^4 g^{-1} of soil.

Assessment of microbial population

The microbial population in the soil at different stages of the crop was determined by serial dilution plate count method. Soil samples from different treatments were collected replication wise.

Ten gram of soil (treatment wise) was mixed in 90 ml sterilized water blank to give 10^{-1} dilutions. Subsequent dilutions up to 10^{-6} were made by transferring serially one ml of each dilution to nine ml sterilized water blanks. The population of bacteria, fungi and actinomycetes were estimated by serial dilution and plate count technique by plating on appropriate media viz., Nutrient agar, Martins rose Bengal agar media and Kenknight's agar media, respectively. The inoculated plates were kept for incubation at $30^oC \pm 1^oC$ and emerged colonies were counted. The incubation time was varied based on the microorganisms. Microbial population was expressed as colony forming units (CFU) g^{-1} of soil. This method was suggested by Jensen (1968).

Total bacteria

Total bacteria were estimated in the 10^{-6} dilution by the plate count method using nutrient agar medium (Collings and Lyne, 1968).

Total fungi

Total Fungi were estimated in the 10^{-4} dilution by plate count method using Martin's Rose Bengal medium (Martin, 1950).

Total actinomycetes

Total actinomycetes were estimated in the 10^{-3} dilution by plate count method using Kenknight's agar medium (Kenknight and Muncie, 1939).

Results and Discussion

The different weed management practices showed a significant effect on yield attribute and microbial population under low land condition. The results obtained from the study have been discussed below.

Yield Attributes

All the weed control practices significantly influenced the yield attributes of rice compared to control. Mulching with biodegradable polyethelene sheet recorded consistently higher value of yield components (Table 1) *viz.,* panicle length (19.91 cm), fertility percentage (85.70) and least sterility percentage (14.30), the panicle length was not influenced by the adoption of different weed management practices. This might be due to decreasing the germination and nourishment of weeds and keeping the weeds suppressed during the critical growth stages. These finding are in accordance with Ali Mohtisham *et al.,* (2013) who reported that more yield under polythene shee*t al*ong with mulch due to improvement in panicle length, 1000 kernel weight, biological yield and harvest index. Distinctly lower yield attributes were recorded in unweeded check.

Grain yield

Grain yield was significantly influenced by the weed management practices compared to control. Higher grain (5557 kg ha^{-1}) observed in mulching with biodegradable polyethelene sheet (Table 1) and at par with application of rice bran at 2 t ha^{-1} on 3 DAT followed by hand weeding on 35 DAT (5377 kg ha^{-1}) due to timely and effective control of weeds the competition for light, space and nutrient were reduced and resulted in better availability and uptake of the required nutrients by the crop. This favourable environment resulted in higher production of growth and yield parameters like panicle length, fertility percentage and sterility percentage. All these improved the performance of the crop under the favorable weed free condition leading to higher grain yield. The present findings are in close agreement with the results obtained by Liu *et al.,* (2003) who reported that there was an increase of 12% in average rice yield by the usage of plastic sheet mulching, while there was a reduction in rice yield (14%) where wheat straw was used as mulch compared with conventional rice flooding.

Microbial population

The highest bacterial count (40.9 CFU x 10^6 g^{-1} of soil) was observed in mulching with biodegradable polyethelene sheet (T_5) which was at par with application of rice bran at 2 t ha^{-1}fb hand weeding (40.6 CFU x 10^6 g^{-1} of soil), hand weeding on 15 DAT fb *Azolla* inoculation (38.2 CFU x 10^6 g^{-1} of soil) and *Azolla* as dual crop with rice and power weeder incorporation on 35 DAT (37.7 CFU x 10^6 g^{-1} of soil). The fungal counts recorded the highest ($18.0X10^4$ g^{-1} of soil) and the lowest ($14.4X10^4$ CFU g^{-1}) in mulching with biodegradable polyethelene sheet and unweeded check. At 90 DAT, the fungal population was not influenced due to adoption of different weed management practices. The actinomycetes recorded highest count in mulching with biodegradable polyethelene sheet (10.8 CFU x 10^3 g^{-1} of soil) was found comparable with application of rice bran at 2 t ha^{-1}fb hand weeding (9.6 CFU x 10^3 g^{-1} of soil) and lowest in unweeded check (2.7 CFU x 10^3 g^{-1} of soil). Among all the weed management practices, mulching with biodegradable polyethelene sheet had higher influence on the population of bacteria, fungal and actinomycetes (Table 2, 3 and 4) which is at par with application of rice bran at 2 t ha^{-1}fb hand weeding at 30, 60 and 90 DAT.

Table.1 Effect of different weed management practices on panicle length (cm), fertility percentage, sterility percentage and grain yield (kg ha^{-1}) in organic rice grown under lowland condition

		Treatments	Panicle length (cm)	Fertility percentage	Sterility percentage	Grain yield (kg ha^{-1})
T_1	-	Application of paddy straw @ 3t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	19.54	78.77	21.23	4610
T_2	-	*Azolla* as dual crop with rice and incorporation on 35 DAT using power weeder	19.43	74.02	25.93	3898
T_3	-	Hand weeding twice on 15 DAT and 35 DAT	19.29	78.81	21.19	5020
T_4	-	Conoweeder 3 times on 20, 30, 40 DAT	19.10	78.40	21.60	4557
T_5	-	Mulching with biodegradable polyethelene sheet	19.91	85.70	14.30	5557
T_6	-	Intercropping mesta (*Hibiscus cannabinus*) with rice as paired row and harvested as greens	18.91	71.14	28.86	3642
T_7	-	Intercropping daincha (*Sesbania aculeata*) with rice as paired row cropping and incorporation on 35 DAT	19.02	79.55	20.45	4241
T_8	-	Application of rice bran @ 2t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	19.85	83.81	16.19	5377
T_9	-	Hand weeding on 15 DAT followed by azolla inoculation	19.74	82.61	17.39	5020
T_{10}	-	Unweeded check	17.90	56.72	43.28	2774
		SEd	**1.80**	**7.09**	**2.50**	**371.2**
		CD (P=0.05)	**NS**	**14.90**	**5.25**	**779.9**

Table.2 Effect of different non-chemical weed management practices on fungal population (x 10^4 CFU g^{-1} of soil) in organic rice grown under lowland condition

Treatments			Fungal population (x 10^4 CFU g^{-1} of soil)		
			30 DAT	**60 DAT**	**90 DAT**
T_1	-	Application of paddy straw @ 3t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	9.8	13.7	16.7
T_2	-	*Azolla* as dual crop with rice and incorporation on 35 DAT using power weeder	9.2	14.5	17.0
T_3	-	Hand weeding twice on 15 DAT and 35 DAT	8.4	12.7	15.7
T_4	-	Conoweeder 3 times on 20, 30, 40 DAT	9.5	14.3	16.5
T_5	-	Mulching with biodegradable polyethelene sheet	10.9	14.9	18.0
T_6	-	Intercropping mesta (*Hibiscus cannabinus*) with rice as paired row and harvested as greens	8.2	12.4	15.2
T_7	-	Intercropping daincha (*Sesbania aculeata*) with rice as paired row cropping and incorporation on 35 DAT	8.9	13.4	16.3
T_8	-	Application of rice bran @ 2t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	10.6	14.7	17.6
T_9	-	Hand weeding on 15 DAT followed by azolla inoculation	8.7	13.2	17.4
T_{10}	-	Unweeded check	7.2	10.1	14.4
		SEd	**0.9**	**1.2**	**1.6**
		CD (P=0.05)	**1.8**	**2.5**	**NS**

Table.3 Effect of different non-chemical weed management practices on bacterial population (x 10^6 CFU g^{-1} of soil) in organic rice grown under lowland condition

Treatments			Bacterial population (x 10^6 CFU g^{-1} of soil)		
			30 DAT	**60 DAT**	**90 DAT**
T_1	-	Application of paddy straw @ 3t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	17.4	29.7	37.1
T_2	-	*Azolla* as dual crop with rice and incorporation on 35 DAT using power weeder	16.2	29.8	37.7
T_3	-	Hand weeding twice on 15 DAT and 35 DAT	15.2	26.9	30.5
T_4	-	Conoweeder 3 times on 20, 30, 40 DAT	17.2	28.0	35.6
T_5	-	Mulching with biodegradable polyethelene sheet	18.3	31.2	40.9
T_6	-	Intercropping mesta (*Hibiscus cannabinus*) with rice as paired row and harvested as greens	14.0	23.1	29.8
T_7	-	Intercropping daincha (*Sesbania aculeata*) with rice as paired row cropping and incorporation on 35 DAT	15.3	27.2	37.4
T_8	-	Application of rice bran @ 2t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	18.2	31.0	40.6
T_9	-	Hand weeding on 15 DAT followed by azolla inoculation	17.1	29.4	38.2
T_{10}	-	Unweeded check	7.3	12.9	16.6
		SEd	**1.5**	**2.5**	**3.3**
		CD (P=0.05)	**3.1**	**5.3**	**6.9**

Table.4 Effect of different weed management practices on actinomycetes population (x 10^3 $CFUg^{-1}$ of soil) in organic rice grown under lowland condition

Treatments			Actinomycetes population (x 10^3 $CFUg^{-1}$ of soil)		
			30 DAT	**60 DAT**	**90 DAT**
T_1	-	Application of paddy straw @ 3t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	6.2	7.9	7.5
T_2	-	*Azolla* as dual crop with rice and incorporation on 35 DAT using power weeder	6.0	8.7	8.6
T_3	-	Hand weeding twice on 15 DAT and 35 DAT	4.6	8.0	9.3
T_4	-	Conoweeder 3 times on 20, 30, 40 DAT	4.8	7.0	8.0
T_5	-	Mulching with biodegradable polyethelene sheet	6.3	9.6	10.8
T_6	-	Intercropping mesta (*Hibiscus cannabinus*) with rice as paired row and harvested as greens	4.5	6.1	7.1
T_7	-	Intercropping daincha (*Sesbania aculeata*) with rice as paired row cropping and incorporation on 35 DAT	4.7	7.4	8.3
T_8	-	Application of rice bran @ 2t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	6.9	8.9	9.6
T_9	-	Hand weeding on 15 DAT followed by azolla inoculation	5.1	7.0	9.4
T_{10}	-	Unweeded check	2.7	3.6	4.7
		SEd	**0.5**	**0.7**	**0.8**
		CD (P=0.05)	**1.0**	**1.5**	**1.7**

This is due to the organic nutrients availability below the mulch significantly energized the soil microbial population during the crop growth period. Weed suppressed in the soil also boost microbial population. These findings are supported by Bhardwaj (2013) who reported that mulching stimulates soil micro-organisms such as algae, mosses, fungi, bacteria, actinomycetes and other organisms owing to loose, well aerated soil conditions, uniform moisture and temperatures thus resulting in a more rapid breakdown of organic matter in the soil and release of plant nutrients for crop growth.

The data presented in the Table 2, 3 and 4 resulted in increase in count of bacteria, fungi and actinomycetes was observed at all the stages when compared with other treatments. Weed incorporation in soil also helped to boost microbial population in soil. The soil that was supplemented with organic matter supported larger and diverse population of micro-organisms (Satyanarayana, 2006). The organic mulch also adds organic matter (3-5 t ha^{-1}), stimulates soil microflora and takes part in nutrient cycle as well as increases the biological activity of soil (Bhardwaj, 2013). The lower microbial load was found in unweeded check which might be due to non availability of nutrients and organic matter resulted in unfavourable conditions for the microbial growth.

On the basis of above findings, it may be concluded that maximum yield attributes, grain yield and higher number of microbial population in soil were recorded under mulching with biodegradable polyethelene sheet and this was at par with application of rice bran at 2 t ha^{-1} on 3 DAT fb hand weeding at 35 DAT.

Taking in to consideration of economics, it is suggested to go for economically viable weed management practices in organic rice. Among all the treatments, the net return and B:C ratio was highest from hand weeding on 15 DAT followed by *Azolla* inoculation.

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