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Influence of Non-Chemical Weed Management Practices on Grain Yield and Biochemical Parameters of Organic Rice

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ABSTRACT

Organic farming has played an important role in recent years in boosting the income of farmers without affecting health and environment. Scientific evidences around the world had showed the better quality of grain under organic farming. Hence, the field investigation was carried out at wetlands farm of Tamil Nadu Agricultural University, Coimbatore during rabi 2014 to find out the influence of non-chemical weed management practices on growth, yield and biochemical parameters of organic rice. 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 120 DAT. The study revealed that the higher growth, yield parameter, microbial population (viz., bacteria, fungi and actinomycetes) and biochemical parameters (Amylose content and Aroma) recorded under mulching using biodegradable polyethelene sheets and the lowest was observed in unweeded check. But taking into consideration of economics, among different non-chemical weed management practices benefit cost ratio was found to be highest in Hand weeding on 15 DAT followed by azolla inoculation.

Key words: *Organic rice, Yield parameters, Amylose content, Aroma.*

INTRODUCTION

Organic farming is gaining momentum in the recent past across the world and India. Growing awareness on health and environmental issues in agriculture has demanded production of organic foods, which are emerging as an attractive source of rural income generation[2]. In India, total area under certified organic cultivation is 4.72 million hectares (2013-14) including 3.99 million hectares under forest cover[7]. Area under organic rice is 11,292 ha and production is 22,674 million tonnes. In Tamil Nadu, organically rice cultivated in 5.8 ha and production is 14.77 million tonnes[16]. India has now become a leading supplier of basmati rice (3.70 million tonnes) to the world[5].

Weeds are the major biotic constraints and compete with rice for moisture, nutrients and light. Any delay in weeding leads to increased weed biomass and decrease in the yield.

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Apart from the yield, the kernel quality assumes significant from productivity considerations. The kernel quality is an integrated effect of the nutritional, physiological and biochemical factors. The amount of nutrients accumulating in the kernel is a genetic parameter. However, marginal changes in the quality do occur due to environmental changes. Hence, the present study was aimed at finding out the influence of non-chemical weed management practices on grain yield and biochemical parameters of organic rice.

MATERIALS AND METHODS

Field investigation was carried out 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}). CO (R) 50, medium duration (130 -135 days) rice variety was chosen for the study. 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}). All the package of practices for the treatments were carried out as per recommendation of CPG[4]. Observations were recorded for various yield and quality parameters. 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 upto 10^{-6} were made by transferring serially one ml of each dilution to nine ml sterilized water blanks. The population of bacteria (10^{-6}), fungi (10^{-4}) and actinomycetes (10^{-3}) were estimated by serial dilution and plate count technique by plating on appropriate media viz., Nutrient agar media[3], Martins rose Bengal agar media[14] and Kenknight's agar media[12], 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[9].

Biochemical characters

Amylose content

The simplified procedure of Julino[10] was used for the estimation of amylose content. Milled rice flour (50 mg) was weighed in duplicate in 50 ml volumetric flask. To this, 0.5 ml of 95 per cent was added to wash down the sample adhering to the flask followed by 5 ml of 1N NaOH. The material was left undisturbed overnight to gelatinize the starch. Sample extract of 2.5 ml was pipetted out into another 50 ml volumetric flask. To this, 20 ml of distilled water was added, followed by 3 drops of phenolphthalein to develop pink colour. 0.1 N HCL was added drop until the colour disappeared. The volume was made up to 50 ml after the addition of 1 ml of iodine reagent and the blue colour developed was read at 590 nm. Amylose concentration was obtained by plotting the absorbance in the standard curve. Amylose content of each genotype was expressed as percentage to total quantity of sample taken for analysis. Based on amylose content the rice was categorized as waxy (< 2 %), very low (2 - 6 %), low (9 - 16 %), intermediate (17 - 22 %) and high (> 23 %).

Aroma

Five grams milled rice was placed in a test tube. 20 ml distilled water was added to it and was covered with aluminium foil. The tube was placed in boiling water bath for 10 minutes. Tube was taken and cooled. The aroma of the sample was rated as follows IRRI[8].

Category	Scale
Very poor	1
Poor	2
Moderate	3
Good	4
Very good	5

Statistical analysis

The data on various parameters studied during the investigation was statistically analyzed as per the procedures suggested by Gomez and Gomez[6] for Randomized block design. Wherever statistical significance was observed, critical difference (CD) at 0.05 per cent level of probability was worked out for comparison.

RESULTS AND DISCUSSION

Growth and yield parameters

The variations in growth and yield parameters of organic rice production was due to different weed management practices and associated with change in environmental factors (Table 1 and 2).

Crop growth rate (CGR)

Crop growth rate of the crop was influenced by the weed management practices (Table 1). Significant improvement in CGR was observed among the different treatments employed. The crop growth rate was significantly higher (15.94 g m^{-2} day^{-1}) by mulching with biodegradable polyethelene sheet (T_5) between 60 – 90 DAT and it was comparable with application of rice bran at 2 t ha^{-1} fb hand weeding (T_8). It was followed by hand weeding on 15 DAT fb azolla inoculation (T_9) and hand weeding twice (T_3). Unweeded check (T_{10}) recorded significantly lower (11.00 g m^{-2} day^{-1}) CGR between 60 – 90 DAT.

The possible reason could be that the weed free situation at early stage favoured the vigorous growth of seedlings without crop weed competition due to prolonged suppression of weeds. This environment has increased the availability of nutrients to the crop and resulted in higher growth and yield of rice. The lower crop growth rate was recorded in unweeded check due to severe competition between crop and weed which resulted in poor growth.

Test weight

The thousand grain weight was not influenced significantly due to adoption of different weed management practices (Table 1). The thousand grain weight was not influenced by the treatments, since it is genetically governed factor.

Grain yield

The perusal of data revealed that grain yield of transplanted organic rice was very much influenced by weed control treatments over unweeded control (Table 1).

Mulching with biodegradable polyethelene sheet (T_5) recorded significantly higher grain yield of 5557 kg ha^{-1} and it was at par with application of rice bran at 2 t ha^{-1}fb hand weeding (T_8), hand weeding on 15 DAT fb azolla inoculation (T_9) and hand weeding twice (T_3). It was followed by application of paddy straw at 3 t ha^{-1}fb hand weeding (T_1), conoweeder incorporation thrice (T_4) which were comparable with each other. Drastically lower grain yield of 2774 kg ha^{-1} was obtained from the unweeded check (T_{10}). All other treatments recorded significantly higher yield than unweeded check (T_{10}).

Grain yield was significantly influenced by the weed management practices compared to control. Higher grain (5557 kg ha^{-1}) was observed in mulching with biodegradable polyethelene sheet 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 favoured the crop to produce more leaf area and plant dry matter production. The increase in number of productive tillers, panicle weight and fertility percentage resulted in the higher grain yield. The present findings are in close agreement with the results obtained by Liu *et al.*,[13] 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

Mulching with biodegradable polyethelene sheet (T_5) recorded higher fungal population (18.0 CFU x 10^4 g^{-1} of soil) and bacterial population (40.9 CFU x 10^6 g^{-1} of soil) which is at par with application of rice bran at 2 t ha^{-1}fb hand weeding (T_8) followed by hand weeding on 15 DAT fb azolla inoculation (T_9). For actinomycetes population (9.5 CFU x 10^3 g^{-1} of soil), the same treatment was found comparable with application of rice bran at 2 t ha^{-1}fb hand weeding (T_8) and hand weeding on 15 DAT fb azolla inoculation (T_9) at 120 DAT. The lowest number of microbial population was recorded in unweeded check (T_{10}) (12.0 CFU x 10^4 g^{-1} of soil, 12.7 CFU x 10^6 g^{-1} of soil and 3.6 CFU x 10^3 g^{-1} of soil at 120 DAT).

Among all the weed management practices, mulching with biodegradable polyethelene sheet had higher influence on the population of bacteria, fungal and actinomycetes at 120 DAT (Table 2). 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. The soil that was supplemented with organic matter supported larger and diverse population of micro-organisms[17]. 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.

Bio chemical characters

The biochemical parameters of organic weed management practices are discussed in terms of Amylose content and Aroma (Table 3).

Amylose content

Mulching with biodegradable polyethelene sheet (T_5) registered higher (24.00 per cent) amylose content and followed by application of rice bran at 2 t ha^{-1} on 3 DAT + HW on 35 DAT (T_8) and grouped under intermediate amylose content category. The lowest amylose content (17.04 per cent) was recorded with unweeded check (T_{10}) and grouped under intermediate amylose content category.

Amylose content can play a significant role in determining the overall cooking, eating and pasting properties of rice[1]. Rice having 20-25 per cent amylose gives soft and relatively sticky cooked rice. Juliano and Bachel[11] and Morris[15] reported that grains with higher surface area offers increased contact with water and amylose leach out during cooking and higher amylose content is liable to leach out more in to the cooking water.

Aroma

Aroma was no significantly influenced by the different weed management practices (Table 3). Aroma is important trait in rice and Aromatic rice has high demand in the market. All the weed management practices recorded aroma content of 3 and classified as moderate.

Table 1: Effect of different non-chemical weed management practices on Crop growth rate (g m^{-2} day^{-1}), 1000 grain weight Cooking parameter and Grain yield (kg ha^{-1}) in organic rice production

		Treatments	CGR 60-90 DAT	1000 grain weight	Grain yield (kg ha^{-1})
T_1	-	Application of paddy straw @ 3t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	15.22	19.57	4610
T_2	-	Azolla as dual crop with rice and incorporation on 35 DAT using power weeder	14.30	18.87	3898
T_3	-	Hand weeding twice on 15 DAT and 35 DAT	15.25	19.72	5020
T_4	-	Conoweeder 3 times on 20, 30, 40 DAT	15.09	19.32	4557
T_5	-	Mulching with biodegradable polyethelene sheet	15.94	21.20	5557
T_6	-	Intercropping mesta (Hibiscus cannabinus) with rice as paired row and harvesting as green	14.01	18.40	3642
T_7	-	Intercropping daincha (*Sesbania aculeata*) with rice as paired row cropping and incorporation on 35 DAT	14.56	19.02	4241
T_8	-	Application of rice bran @ 2t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	15.68	20.25	5377
T_9	-	Hand weeding on 15 DAT followed by azolla inoculation	15.42	20.01	5020
T_{10}	-	Unweeded check	11.00	18.16	2774
		SEd	**1.27**	**1.81**	**371.2**
		CD (P=0.05)	**2.67**	**NS**	**779.9**

Table 2: Effect of different non-chemical weed management practices on fungal population (x 10^4 CFU g^{-1} of soil), bacterial population (x 10^6 CFU g^{-1} of soil) and actinomycetes population (x 10^3 CFUg^{-1} of soil) in organic rice production

		Treatments	fungal population (x 10^4 CFU g^{-1} of soil)	bacterial population (x 10^6 CFU g^{-1} of soil)	actinomycetes population (x 10^3 CFUg^{-1} of soil)
T_1	-	Application of paddy straw @ 3t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	14.9	30.9	6.8
T_2	-	*Azolla* as dual crop with rice and incorporation on 35 DAT using power weeder	14.5	34.5	7.8
T_3	-	Hand weeding twice on 15 DAT and 35 DAT	12.3	28.1	8.3
T_4	-	Conoweeder 3 times on 20, 30, 40 DAT	13.8	28.6	7.0
T_5	-	Mulching with biodegradable polyethelene sheet	16.5	38.8	9.5
T_6	-	Intercropping mesta (*Hibiscus cannabinus*) with rice as paired row and harvested as greens	12.1	24.9	6.1
T_7	-	Intercropping daincha (*Sesbania aculeata*) with rice as paired row cropping and incorporation on 35 DAT	14.1	29.2	7.4
T_8	-	Application of rice bran @ 2t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	15.6	37.2	8.7
T_9	-	Hand weeding on 15 DAT followed by azolla inoculation	15.3	36.7	8.6
T_{10}	-	Unweeded check	12.0	12.7	3.6
		SEd	**1.3**	**2.9**	**0.7**
		CD (P=0.05)	**2.8**	**6.1**	**1.5**

Table 3: Effect of different non-chemical weed management practices on biochemical parameters in organic rice production

		Treatments	Amylose content (%)	Amylose character	Aroma
T_1	-	Application of paddy straw @ 3t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	22.2	Intermediate	3
T_2	-	Azolla as dual crop with rice and incorporation on 35 DAT using power weeder	21.7	Intermediate	3
T_3	-	Hand weeding twice on 15 DAT and 35 DAT	23.6	Intermediate	3
T_4	-	Conoweeder 3 times on 20, 30, 40 DAT	22.4	Intermediate	3
T_5	-	Mulching with biodegradable polyethelene sheet	24.00	Intermediate	3
T_6	-	Intercropping mesta (Hibiscus cannabinus) with rice as paired row and harvesting as green	19.8	Intermediate	3
T_7	-	Intercropping daincha (*Sesbania aculeata*) with rice as paired row cropping and incorporation on 35 DAT	21.1	Intermediate	3
T_8	-	Application of rice bran @ 2t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	23.9	Intermediate	3
T_9	-	Hand weeding on 15 DAT followed by azolla inoculation	20.5	Intermediate	3
T_{10}	-	Unweeded check	17.04	Intermediate	3
		SEd CD (P=0.05)	NA	-	NA

NA - Data statistically not analysed

CONCLUSION

On the basis of above findings, it may be concluded that maximum growth and yield parameters, higher number of microbial population in soil and biochemical parameters were recorded under mulching with biodegradable polyethelene sheet. Taking in to consideration of economics, B:C ratio was highest in hand weeding on 15 DAT followed by azolla inoculation.

REFERENCES

1. Adu-Kwarteng, E., Ellis, W. O., Oduro, I. and Manful, J. T., Rice grain quality: A comparsion of local varieties with new varieties under study in Ghana. *Food Control,* **14(7):** 507-514 (2003).
2. Bhattacharyya, P. and Chakraborty, G., Current status of organic farming in India and other countries. *India J. Fert.,* **1:** 111-23 (2005).
3. Collings, C.H. and Lyne, M.P., Microbiological methods. 5th Edition, Butter Worth, London. (1968).
4. CPG, Crop production guide. Published by Directorate of Agri., Chennai and TNAU, Coimbatore, India. (2012).
5. Directorate of Commerce. Commodity Profile for Rice-March 2015. pp.6 (2015).
6. Gomez, K.A. and Gomez, A.A., Statistical procedure for agricultural research. John Wiley and Sons, New York. pp. 680 (1984).
7. http://apeda.gov.in/apedawebsite/organic/ Organic_Products.htm
8. IRRI, Annual report. p. 199 (1970).
9. Jensen, V., The plate count method. *In:* the ecology of soil bacteria: An international symposium (Eds.) T.R.G. Gray and D. Parkinsons, Liverpool University Press, Liverpool: pp. 158-170 (1968).
10. Julino, B.O., *In:* Physicochemical properties of starch and protein in relation to grain quality and nutritional value of rice. IRRI, Publications: 389-405 (1972).
11. Juliano, B.O. and Bachel, D., The rice grain and its gross composition. In (Juliano B. ed.) Rice: Chemistry and Technology 2nd edition :17-58,USA (1985).
12. Kenknight, G. and Muncie, J.H., Isolation of phytopatho genic actinomycetes. *Phytopath.,* **29:** 1000-1001 (1939).
13. Liu, XJ., Wang, J.C., Lu, S.H., Zhang, F.S., Zeng, X.Z., Ai, Y.W., Peng, B.S. and Christie, P., Effects of non-flooded mulching cultivation on crop yield, nutrient uptake and nutrient balance in rice-wheat cropping systems. *Field Crops Res.,* **83:** 297-311 (2003).
14. Martin, J.P., Use of acid, rose Bengal and streptomycin in the plate method for estimating soil fungi. *Soil Sci.,* **69:** 215-233 (1950).

15. Morris V.J., Starch gelatinization and retrogradation. *Trends Food Sci Technol.*, **7:** 2-6 (1990).
16. NPOP (National Programme for Organic Production)., Organic Certification Area and Production Statistics (2012). hptt://www.npop.com.
17. Satyanarayana, A., System of rice intensification: An innovative method for sustainable rice production. *In:* Abstracts of National Symposium on System of Rice Intensification (SRI): Present status and future prospects, November 17-18. pp.18-20 (2006).