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Research Article

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Effect of Weed Management Practices on Productivity and Economics of Rice-Rice Crop sequence under Organic Production System

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Abstract

The present field investigation was carried out during *kharif* and *rabi,* 2017-18 in deltaic alluvial soils of Regional Agricultural Research Station, Maruteru, Andhra Pradesh (534 122), India to evaluate the impact of different weed management practices on weed index and productivity of rice-rice cropping sequence under organic production system in Godavari delta region. The results revealed that incorporation of green leaf manure *Sesbania* sp. (3680 and 3587 kg ha^{-1}) being at par with incorporation of locally available aquatic weed (*Eichhornia* sp.)+one manual hand weeding (3613 and 3407 kg ha^{-1}), has significantly out yield all other treatments in terms of grain yield of rice-rice cropping system. Though, the practice of one mechanical weeding at 20-25 DAT+one manual hand weeding at 45-50 DAT has recorded lowest weed index values (1.0 and 0.3), the average grain yield was less by 323 kg ha^{-1} as compared to that of green leaf manure incorporation. The highest net returns (₹ 15250 and 14083 ha^{-1}) and B:C ratio (1.50 and 1.46) were accrued with the practice of incorporation of green leaf manure (*Sesbania*) at 5 t ha^{-1}. The incidence of leaf folder and brown plant hopper was below economic thresh hold level with the treatment incorporation of green leaf mulch (*Sesbania* sp.) and was closely followed by neem cake incorporation at 15 days before planting.

Keywords: Rice, green leaf manure, aquatic weed, weed management

1. Introduction

Rice (*Oryza sativa* L.) is the most important staple food crop for more than half of the world's population. It is grown in more than 100 countries across the globe. In India, it is cultivated over 43.79 mha area with a production of 112.91 mt of milled rice and an average productivity of 2578 kg ha^{-1} (DES, 2018). In Andhra Pradesh, rice is grown in an area of 2.1 m ha with an annual production of 12.0 mt and a productivity of 5.70 t ha^{-1} (Anonymous, 2017). Godavari delta with alluvial soils is the rice bowl of Andhra Pradesh, is one of the major contributors of rice production in India. Rice-rice is the predominant cropping system in this deltaic region under canal irrigated conditions. Furthermore, continuous cultivation of rice for longer periods and often with poor agronomic management especially improper or inadequate weed management practices, results in substantial yield loss (Tripathi, 1992; Dwivedi et al., 2001) and decline in factor productivity (Yadav, 1998). On the other hand, organic farming

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or traditional farming is gaining importance across the world and more particularly in India. It is one of the better options to improve the nutrient availability in deltaic alluvial soil by way of improving the microbial activity in the soil (Ramanjaneyulu et al., 2013). Available literature shows that, higher number of tillers m^{-2} were produced in organically enriched soils (Kumar et al., 2014). Of many problems in organic farming, weed management is the major challenge as weeds have to be effectively controlled through non-chemical methods in organic production system. Traditionally, hand weeding has been in vogue in rice ecosystem. Of late, demand and usage of herbicides for timely and effective weed control has gained importance. However, neither chemicals can be used nor only one weed management method can be adopted as weed menace is the main problem in organic farming. The total annual loss in agriculture due to different pests is about 6000 crores in India. More than one third of the total loss (33–45%) is attributed by weeds alone (Mukherjee, 2006 and Manhas et al., 2012). This loss may be still more which is not quantified in case of organic production system. Furthermore, controlling weeds in rice-rice sequence is a difficult task due to poor land preparation following less turnaround time and monocropping, in low lying areas under uncontrolled canal irrigated conditions in Godavari deltaic regions (Satyanarayana, 2017). Hence, the present study is intended to study various options by adopting either a single method or combinations of methods through non-chemical practices, for effective and timely control of weeds in organic rice production system on deltaic alluvial soils.

2. Materials and Methods

The field experiment was conducted during *kharif*, 2017 and *rabi,* 2017–18 seasons under coastal irrigated ecosystem in deltaic alluvial soils at Regional Agricultural Research Station, Maruteru, West Godavari district, Andhra Pradesh, India. The experimental site is located at 16.38^0 N latitude, 18.44^0 E longitude with an average elevation of 5 m mean sea level altitude. It was laid out with seven treatments in a randomized block design (RBD) with three replications. The most common weed species existing in this Godavari delta alluvial soils are *Echinochloa colona, Echinochloa crusgalli, Dactyloctenium aegyptium, Cyperus rotundus, Cyperus difformis, Cynodon dactylon, Commelina benghalensis, Ipomoea auatica, Monochoria vaginalis, Marsilea quadrifolia, Ludwigia parviflora, Ammania baccifera, Alternanthera echinata* and *Bergia capensis*. The treatments are mainly comprised of combination of cultural and mechanical weed management practices *viz*., T_1: Hand weeding twice at 20-25 DAT and 45-50 DAT, T_2: One mechanical weeding at 20-25 DAT along with one manual hand weeding at 45-50 DAT, T_3: Location specific green leaf manure (*Sesbania* Sp.) incorporation @ 5 t ha^{-1}, T_4: Reduced spacing (20×12 cm^2 during *kharif* and 12×12 cm^2 during *rabi*) and incorporation of previous crop residue (paddy straw) @ 2 t ha^{-1} along with one manual hand weeding, T_5: Locally available aquatic weed (*Eichhornia* sp.) incorporation @ 2 t ha^{-1} and one manual hand weeding, T_6: Incorporation of neem cake 15 days before planting @ 5 t ha^{-1} and one manual hand weeding and T_7: ITK treatment on weed control practiced by farmers (incorporation of mango leaf @ 2 t ha^{-1}). The experimental soil was clay loam in texture, slightly alkaline in reaction, low in organic carbon (0.43%) and available nitrogen (188 kg ha^{-1}), medium in available phosphorus (34.4 kg ha^{-1}) and high in available potassium (225.4 kg ha^{-1}). A medium duration rice variety MTU 1075 was planted at a spacing of 25×15 cm^2 during *kharif* season and a short duration rice variety MTU 1010 at 15×15 cm^2 during *rabi* season. All other standard agronomic and plant protection operations recommended for organic production systems for Godavari Agro-climatic zone of Andhra Pradesh were performed (Anonymous, 2016). The data were subjected to RBD analysis by using OPSTAT software and values were compared by using f-test and CD (Gomez and Gomez., 1984).

3. Results and Discussion

The results of experiments furnished in Table 1 revealed that, highest grain yield of 3680 kg ha^{-1} was recorded with incorporation of green leaf manure (*Sesbania* sp.) (T3). It was at par with incorporation of locally available aquatic weed (*Eichhornia* sp.)+one manual hand weeding treatment (3613 kg ha^{-1}), but, significantly superior to rest of the treatments, during *kharif* season. Similar trend was observed in *rabi* season during which incorporation of green leaf manure (*Sesbania* sp.) treatment recorded highest grain yield of 3587 kg ha^{-1}. But, it was found to be on par with that of T5 (locally available aquatic weed (*Eichhornia* sp.) incorporation @ 2 t ha^{-1}+one manual hand weeding 3407 kg ha^{-1}), T_1 (hand weeding twice at 20-25 DAT and 45-50 DAT recorded 3367 kg ha^{-1}) but, significantly outyielded remaining weed management options. The superior performance of T3 treatment in both the seasons of experimentation was owing to considerably more no. of tillers m^{-2} (392 during *kharif* and 373 during *rabi*) and panicles m^{-2} (271) during *rabi*. Similar results are in confirm with Sarkar et al. (2015). Further, different weed management practices failed to show significant effect on plant height of rice in both the seasons, number of panicles m^{-2} and straw yield during *kharif* season and panicle weight during *rabi* season which means all treatments were equal in their performance (Table 1). Though, reduced spacing (20×12 cm^2 during *kharif* and 12×12 cm^2 during *rabi*)+incorporation of previous crop residue (paddy straw) @ 2 t ha^{-1} along with one manual hand weeding resulted in considerably less number of tillers and panicles, it has produced nearly 500 kg ha^{-1} (16%) less grain yield as compared to that of T_3. The yield reduction is due to high density population might have hindered the tillering ability which in turn resulted in less no. of effective tillers. This result could be supported by the findings of Mubshar et al. (2012). Though, straw yield was insignificant during *kharif* season, significantly higher straw yield was registered during

Table 1: Effect of non-chemical weed management practices on growth, yield attributes, yield and weed index in rice-rice cropping system (*Kharif*, 2017 and *rabi*, 2017-18)

Treatments	Plant height (cm)		No. of tillers m^{-2}		No. of panicles m^{-2}		Panicle weight (g)		Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Weed index (%)	
	Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*
T_1	98.5	73.7	380	341	264	240	2.21	2.08	3240	3367	5260	5273	0	0
T_2	95.2	76.4	376	359	268	244	2.38	2.10	3267	3353	5200	5193	1.0	0.3
T_3	99.9	73.5	392	373	260	271	2.14	2.02	3680	3587	5187	5327	13.8	6.8
T_4	89.9	77.8	376	310	280	238	2.23	2.06	3140	3107	5327	5373	-3.0	-7.7
T_5	94.3	76.1	383	345	265	254	2.40	2.12	3613	3407	5613	5160	11.6	1.2
T_6	93.9	81.5	373	325	260	246	2.00	2.02	3160	3147	5213	5147	-2.3	-6.4
T_7	91.1	71.9	425	311	249	217	1.97	2.00	3407	2957	5820	4333	5.2	-12.1
SEm±	3.3	3.8	8	11	12	5	0.09	0.10	75	73	215	145	2.6	2.0
CD (*p*=0.05)	N.S.	N.S.	25	33	N.S.	15	0.28	N.S.	232	228	N.S.	453	7.2	7.0

T_1: Hand weeding twice at 20-25 DAT and 45-50 DAT; T_2: One mechanical weeding at 20-25 DAT along with one manual hand weeding at 45-50 DAT; T_3: Location specific green leaf manure (*Sesbania* Sp.) incorporation @ 5 t ha^{-1}; T_4: Reduced spacing (20×12 cm^2 during kharif and 12×12 cm^2 during *rabi*) and incorporation of previous crop residue (paddy straw) @ 2 t ha^{-1} along with one manual hand weeding; T_5: Locally available aquatic weed (*Eichhornia* sp.) incorporation @ 2 t ha^{-1} and one manual hand weeding, T_6: Incorporation of neem cake 15 days before planting @ 5 t ha^{-1} and one manual hand weeding and T_7: ITK treatment on weed control practiced by farmers (incorporation of mango leaf @ 2 t ha^{-1})

rabi season with the treatment i.e. incorporation of locally available aquatic weed (*Eichhornia* sp.) along with one manual hand weeding (5327 kg ha^{-1}) and next best treatment was reduced spacing and incorporation of previous crop residue (paddy straw) along with one manual hand weeding treatment (5373 kg ha^{-1}). This might be due to more plant population leading to more of vegetative growth rather than economic yields. These findings are in accordance with Al-Mamun et al. (2013). The grain yield of transplanted organic rice was very much influenced by weed control treatments with mulching with biodegradable produces compared to other practices of weed control. These results were in confirmation with research findings of Rathod and Somasundaram (2017). Less is the weed index better is the weed control. In the current experiment, lowest values of weed index (1.0 and 0.3) were recorded with T_2 (One mechanical weeding at 20-25 DAT along with one manual hand weeding at 45-50 DAT). It means, this operation has effectively controlled the weeds better than other treatments. While, the highest weed index was recorded with location specific green leaf incorporation (*Sesbania* sp.) (13.8%, 6.8% and 20.6%) which is on par with locally available aquatic weed incorporation (*Eichhornia* sp.)+one hand weeding (11.6%, 1.2% and 12.8%) during *kharif and rabi*, respectively (Table 2). The T_4, T_6 and T_7 treatments registered negative weed index values due to limited weed control in these treatments which means these practices are ineffective in controlling the weeds in rice ecosystem under organic production system (Table 1).

Though incidence of leaf folder and brown plant hopper and also diseases like sheath blight and leaf blast, was below economic threshold level in all the treatments, however, the treatment *viz.,* green leaf manure incorporation treatment and neem cake incorporation at 15 days before planting treatments fared well with very low incidence than others (data not shown).

The data on economics in Table 2 showed that net returns (₹ 15250 and 14083 ha^{-1}) and B:C ratio (1.50 and 1.46) were highest with green leaf manure (*Sesbania* sp.) incorporation. It was closely followed by locally available aquatic weed (*Eichhornia* sp.) incorporation+one manual hand weeding (₹ 12917 and 10333 ha^{-1} of net returns and 1.40 and 1.33 B:C ratio during *kharif and rabi*, respectively.

Table 2: Effect of non-chemical weed management practices on the economics of rice-rice cropping system (*kharif*, 2017 and *rabi*, 2017-18)

Treatments	Gross returns (₹ ha^{-1})		Net returns (₹ ha^{-1})		B:C ratio	
	Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*
T_1	40500	42083	6000	7583	1.17	1.22
T_2	40833	41917	8333	9417	1.26	1.29
T_3	46000	44833	15250	14083	1.50	1.46
T_4	39250	38833	7000	6583	1.22	1.20
T_5	45167	42583	12917	10333	1.40	1.32
T_6	39500	39333	7000	6833	1.22	1.21
T_7	42583	36958	11833	6208	1.38	1.20

4. Conclusion

Organic farming especially under monocropping of rice-rice system under uncontrolled canal irrigation faces severe weed management problems. The experimental results clearly indicated incorporation of locally available green leaf manure (*Sesbania* sp.) is the best way to maximize the crop productivity (average grain yield of two seasons: 3633 kg ha^{-1}) besides controlling the weeds to some extent. Further, research has to be continued to find out effective, low cost and yield maximizing weed management modules under organic production systems in different rice growing ecologies across the country.

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6. References

Al-Mamun, M.A., Biswas, P.K., Karim, M.F., Hasanuzzaman, M., Rahman, A., 2013. Influence of rice straw and water hyacinth incorporation on the performance of Boro rice. International Journal of Bio-Resource and Stress Management. 4(2), 209–213.

Anonymous, 2018. Agricultural Statistics at a Glance: Andhra Pradesh: 2016–17, Govt. of Andhra Pradesh, Ministry of Agriculture, Department of Agriculture and Cooperation, Directorate of Economics and Statistics, Amaravathi.

Anonymous, 2018. Vyavasaya Panchangam: 2018-19. Publication from Acharya N.G. Ranga Agricultural University, Lam, Guntur, Andhra Pradesh.

DES (Directorate of Economics and Statistics), 2018. Pocket Book of Agricultural Statistics 2018. Department of Agriculture, Cooperation and Farmers welfare, Ministry of Agriculture & Farmers Welfare, Govt. of India. Available at http://eands.dacnet.nic.in/

Dwivedi, B.S., Shukla, A.K., Singh, V.K., Yadav, R.L., 2001. Results of participatory diagnosis of constraints and opportunities (PDCO) based trials from the state of Uttar Pradesh. In: Subba Rao, A., Srivastava, S. (Eds.), Development of Farmers' Resource-Based Integrated Plant Nutrient Supply Systems: Experience of a FAO–ICAR–IFFCO Collaborative Project and AICRP on Soil Test Crop Response Correlation. IISS, Bhopal, India, 50–75.

Gomez, A.K., Gomez, A.A., 1984. Statistical procedures for Agricultural Research. International Rice Research Institute Book. International Science Publication, John Wiley and Sons, Singapore.

Kamalam, J., Bridgit, T.K., 1993. Effect of Chemical and integrated weed management in upland rice. Journal of Tropical Agriculture 31(1), 77–80.

Kumar, P., Singh, F., Singh, A.P., Singh, M., 2014. Integrated nutrient management in rice-pea cropping system for sustainable productivity. International Journal of Engineering Research and Technology 3(4), 1093–1095.

Manhas, S.S., Singh, G., Singh, D., Khajuria, V., 2012. Effect of tank-mixed herbicides on weeds and transplanted rice (*Oryza sativa* L.). Annuals of Agricultural Research. New series 33(1-2), 25–31.

Mubshar, H., Farooq S., Ali, S., 2012. Plastic mulching improves the water use efficiency and productivity of direct seeded and transplanted fine rice. Proceedings of third International Conference 'Frontiers in Agriculture' held at Dankook International Cooperation on Agriculture, Dankook University, Cheonansi, Republic of Korea during October 3–5, 2012.

Mukherjee, M., 2006. "Weed management strategy in Rice – A review 27(4), 247–257.

Ramanjaneyulu, A.V., Sarkar, N.C., Thakur, K.A., Maiti, R.K., 2013. Organic farming – A perspective. International Journal of Bio-Resource and Stress Management 4(1), i–ii.

Rathod, B.G.S., Somasundaram, E., 2017. Nutrient uptake by weeds and rice under different organic weed management practices. International Journal of Chemical Studies. 5(4), 2050–2052.

Sarkar, S., Santra, G.H., Mandal, M., 2015. Effect of green manure and bio-fertilizers on the availability of zinc and copper and their uptake by rice (Oryza sativa L.). International Journal of Bio-Resource and Stress Management 6(4), 534–538.

Satyanarayana, V., Latchanna, L., Varaprasad, P.V., 1997. Weed management in direct seeded upland paddy. Annals of Agricultural Research 18(3), 385–387.

Satyanarayana, P.V., 2017. Rice varietal development in ANGRAU. The Andhra Agricultural Journal. 64(4), 736–740.

Singh, A.K., Kumar, P., 2009. Nutrient management in rainfed dryland agro ecosystem in the impending climate change scenario. Agricultural Situation in India 66(5), 265–270.

Tripathi, R.P., 1992. Physical properties and tillage of rice soils in rice–wheat system. In: Pandey, R.K., Dwivedi, B.S., Sharma, A.K. (Eds.), Rice–wheat Cropping System. PDCSR, Modipuram, India, 53–67.

Yadav, R.L., 1998. Factor productivity trends in a rice–wheat cropping system under long-term use of chemical fertilizers. Experimental Agriculture 34, 1–18.

Yadav, M.K., Aravindan, S., Mukherjee, A.K., Bag, M.K., Lenka, S. 2015. Sheath rot: emerging threat to rice production. Everyman's Science 1, 286.