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EVALUATION OF WEED MANAGEMENT PRACTICES ON WEED DYNAMICS IN DIFFERENT RICE (*Oryza sativa*) FARMING SYSTEMS

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ABSTRACT

An experiment was undertaken in a farmer's field in Chidambaram Sathamangalam, Cuddalore district of Tamil Nadu, during *Samba* 2020 (August 2020 – January 2021) to determine the weed management in different rice farming systems on weed dynamics. The experiment was conducted in split plot design with four replications, two main treatments with different rice farming systems *viz,* M_1- Monocropping and M_2- Annamalai rice + fish + poultry farming system and three sub treatments with weed management practices *viz.,* S_1– unweeded control, S_2 – twice hand weeding on 20 and 40 DAT, S_3 – pre emergence (PE) application through tank mix of butachlor (50 % EC) @ 1.25 kg a.i. ha^{-1}+ 2,4-DEE (38 % EC) @ 0.6 kg a.i. ha^{-1}. The results indicated that, among the farming systems, Annamalai rice + fish + poultry farming system (M_2) recorded the lowest weed population, weed DMP and highest weed control index (WCI) at 30 and 60 DAT. Whereas, rice monocropping (M_1) recorded the highest weed population, weed dry matter production and the lowest weed control index (WCI) at all the stages of crop growth. In weed management practices, twice hand weeding in on 20 and 40 DAT (S_2) recorded the lowest weed parameters and higher weed control index. It was followed by PE application through tank mix of butachlor (50 % EC) @ 1.25 kg a.i. ha^{-1}+ 2,4-DEE (38 % EC) @ 0.6 kg a.i. ha^{-1} (S_3). The highest weed population, weed dry weight and lower weed control index registered in unweeded control (S_1). Among interactions, Annamalai rice + fish + poultry farming system along with twice hand weeding on 20 and 40 DAT (M_2S_2) recorded significantly the lowest weed population, weed dry weight with higher weed control index during *Samba* 2020. This was followed by Annamalai rice + fish + poultry farming system along with PE application through tank mix of butachlor (50 % EC) @ 1.25 kg a.i. ha^{-1}+ 2,4-DEE (38 % EC) @ 0.6 kg a.i. ha^{-1} (M_2S_3). Hence it is concluded that Annamalai rice + fish + poultry farming system performs significantly better than rice mono cropping by recording lowest weed population, weed dry weight and the highest weed control efficiency.

Keywords: IFS, Annamalai rice + fish + poultry farming system, Rice monocropping, Weed management, Twice hand weeding, Butachlor + 2,4-DEE.

INTRODUCTION

Rice (*Oryza sativa* L.) is consumed as a staple food by more than 60 per cent of the current world population. (Maharajan *et. al.,* 2014). Globally rice is cultivated in 167.13 million hectares of land with production and productivity of 782 Mt and 4.67 t ha^{-1}, respectively

(FAO,2018). India is one of the leading producers of rice in the world and more than 100 million metric tons of rice was produced in 2019–2020 (Economic Survey, 2020–2021) with a rice growing area of 43.7 million hectares. In Tamil Nadu, rice is cultivated in an area of 2.7 million hectares with production of 7.98 billion kg (Department of Agriculture, Cooperation and Farmers Welfare, 2019). The Cauvery delta region (popularly known as the "Granary of Tamil Nadu") contributes a major share of rice production, with a total rice growing area of 0.74 million ha and rice production of 1.67 billion kg, contributing 47.02 per cent of the rice production in Tamil Nadu (Department of Economics and Statistics, 2017). However, considering the current population growth rate of 1.5 per cent, the projected demand for rice for the exploding population of the total rice requirement by 2025 would be around 125 million tonnes (Dey *et al.,*2020).

In the view of farming community, the Indian government has formulated several programs training programmes to bring livelihood security of small and marginal farmers and to aide agriculture, and livestock production (Behera *et al.,*2013; Mahapatra and Behera, 2011). Monoculture and continuous cropping of rice has resulted in various disadvantages like degradation of natural resources, build up of diseases and pests, and decline in factor of productivity. This rice monoculture model with higher applications of fertilizers and pesticides negatively affects the environment of the agriculture system, such as non-point source pollution, soil fertility decline, and rice quality reduction (Zheng *et al.,* 2017). The integrated farming system (IFS) offers various benefits, they guarantee high production with nutritional security, diversifying the farmer's income and, preserving the natural resources, and provides climatic and economic resilience of the agricultural production system (Paramesh *et al.* 2019).

IFS in terms of mixed farming systems has drawn attention to these contemporary, specialised, intensive farming methods that have an impact on the variety of weed flora and fauna and farmers with limited resources are more vulnerable to weather and market variations as a result of their dependence on fewer agricultural products an farmers with limited resources are more vulnerable to weather and market variations as a result of their dependence on fewer agricultural products (Manjunath *et al.,*2018; Paramesh *et al.,*2019; Paramesh *et al.,* 2018). This integrated farming system approach assumes greater significance especially with small farm holders as additionally, it improves the food standards of resource-poor farmers and creates meaningful work while minimising pesticide usage and environmental damage and additionally, it improves the food standards of resource-poor farmers and creates productive work while minimising pesticide usage and environmental damage and maintenance of sustainability (Kathiresan *et al.,*2001; Gunasekaran and Kathiresan, 2003). A combination of one or more operations with crops offers better returns than a single enterprise when carefully chosen, planned, and implemented, especially for small and marginal farmers. Rice + fish + poultry integration not only helps to compensate the economic loss in rice production brought about by natural calamities but also enhances the land and water productivity without bringing about environmental degradation.

During its life cycle rice crop suffers from various abiotic and biotic stresses of which weed competition a biotic constraint, considerably declines the grain production. Hand weeding is the most effective traditional method of eradication of weeds which could be

conveniently adopted at any stage of crop growth. However, the prevailing labour unavailability and the escalated labour costs make this operation uneconomical. Under this juncture, chemical method of weed control would be the effective, economical and time saving strategy in combating of weeds. Although there are a number of ready-to-use pre- and post-emergence new herbicide molecules with significant phytotoxicity against weed species, it is important to determine their actual efficacy against weeds before recommending them in order. Due to the advantages of using combination herbicides, whether tank or ready mix, to manage complex weed flora, their use has recently increased. Emphasis should be placed on using herbicide mixtures in order to increase herbicide use efficiency and prevent problems related to herbicide use.

MATERIALS AND METHODS

The present study was carried out during *Samba* 2020 (August 2020 – January 2021) in Chidambaram Sathamamgalam, Cuddalore district of Tamil Nadu on effect of weed management rice farming systems on weed dynamics. The experiment was done in split plot design. The design of experiments comprises of two rice farming systems *viz.,* Rice monocropping (M_1) and Annamalai rice + fish + poultry (M_2) as main plots. In sub plot three weed management strategies comprising unwedded control (S_1), twice hand weeding on 20 and 40 DAT (S_2) and pre emergence (PE) application through tank mix of butachlor 50 % EC @ 1.25 kg a.i. ha^{-1} and 2,4-DEE 38 % EC @ 0.6 kg a.i. ha^{-1} (S_3). The long duration rice cultivar BPT 5204 was used as test variety. The field was levelled and laid out into plots with irrigation and drainage channels. In the Annamalai rice + fish + poultry farming system, field trenches of 20 x 1 x 1m dimensions in an area of 20 m^2 were dug for fish shelter in respective treatments. Poultry cages of dimension 6 x 4 x 2 ft were installed in respective plots, supported by concrete poles of 8 ft length of which 4 ft was buried into the soil. The total number of weeds were recorded on 30 DAT and 60 DAT from four quadrants of size 0.5 x 0.5 m area placed at random in each of the net plot area and expressed as total weeds m^{-2}. The weeds after removing the roots were dried in the hot air oven at 85°C ± 5°C for 48 hours and the weed dry matter production of each group of weeds were computed and expressed as kg ha^{-1}. Weed control index of each weed management practice were calculated by using the formula suggested by Misra and Tosh (1979).

RESULTS AND DISCUSSION

Weed flora of the experiment site

Observations on the total weed count on 30 and 60 DAT, floristic composition of weeds in individual treatments, weed density, weed dry matter and weed control index (WCI) in the component enterprises *viz.,* fish culture and poultry do contribute the management of weeds. The weed flora of the experimental field was mentioned in Table 1.

Table 1. Weed flora in paddy field

S.No.	Botanical Name	Common Name	Family
1.	*Leptochloa chinensis*	Chinese sprangle top	Poaceae
2.	*Cyperus iria*	Rice flats edge	Cyperaceae
3.	*Marsilea quadrifolia*	European water-clover	Marsileaceae
4.	*Echinochloa colonum*	Jungle rice	Poaceae

5.	*Echinochloa crusgalli*	Common barnyard grass	Poaceae
6.	*Cyperus difformis*	Small-flowered nutsedge	Cyperaceae
7.	*Bergia capensis*	White water fire	Elatinaceae
8.	*Eclipta alba*	False daisy	Asteraceae
9.	*Sphenoclea zeylanica*	Wedge wort	Sphenocleaceae

Effect on total weed population and weed control index

The findings in **Table 2.** revealed that among the different farming systems evaluated, Annamalai rice + fish + poultry (M_2) recorded the lowest total weed population 50.47 no. m^{-2}, 68.12 no. m^{-2}, weed DMP 109.07 kg ha^{-1}, 225.70 kg ha^{-1} and highest weed control index 65.63, 66.73 at 30 and 60 DAT respectively. The highest total weed population of 82.04 no. m^{-2}, 98.35 no. m^{-2}, weed DMP 146.22 kg ha^{-1}, 302.49 kg $ha^{-1}$and highest weed control index 53.93, 55.41 at 30 and 60 DAT respectively were recorded under rice monocropping system (M_1). Due to herbivores fishes *viz*., common carp and grass carp presence in the field lead to control the weeds in field supported by Kathiresan *et al.,* (2001). The acidic nature of the organic manure may influence the weed seed germination (Kathiresan, 2007).

Regarding the weed management practices, twice hand weeding on 20 and 40 DAT (S_2) recorded the lowest total weed population and weed DMP of 39.08 no. m^{-2}, 48.60 kg ha^{-1} and highest weed control index 84.69 at 30 DAT. However, this was on par with PE application through tank mix of butachlor (50 % EC) @ 1.25 kg a.i. ha^{-1}+ 2,4-DEE (38 % EC) @ 0.6 kg a.i. ha^{-1} (S_3). At 60 DAT the lowest total weed population and weed DMP 32.69 no. m^{-2}, 76.79 kg ha^{-1} and highest weed control index 92.79 were resulted with twice hand weeding on 20 and 40 DAT (S_2). This was followed by PE application through tank mix of butachlor (50 % EC) @ 1.25 kg a.i. ha^{-1} + 2,4-DEE (38 % EC) @ 0.6 kg a.i. ha^{-1} (S_3). Regardless of stages of crop the highest total weed population and weed and lowest weed control index recorded under unweeded control (S_1). In spite of this, similarity can be shown in the variation between weed control practise and day of observation. (Mishra and Singh, 2007).

Even if herbicides and their efficacy, practicality is greater, hand weeding is still the primary method used in Asian nations (Rao *et al.,* 2007) and in West Africa (Rodenburg *et al.,* 2011). Because of weed resistance, environmental degradation, and health risks (Singh *et al.,* 2007: Rao *et al.,* 2007).

With respect to the interactions, lowest total weed population and weed DMP 21.63 no. m^{-2}, 37.85 kg $ha^{-1}$and highest weed control index 86.28 at 30 DAT recorded respectively with Annamalai rice+ fish + poultry farming system with twice hand weeding on 20 and 40 DAT (M_2S_2) and it was comparable with Annamalai rice+ fish + poultry farming system with PE application through tank mix of butachlor (50 % EC) @ 1.25 kg a.i. ha^{-1}+ 2,4-DEE (38 % EC) @ 0.6 kg a.i. ha^{-1} (M_2S_3). Annamalai rice+ fish + poultry farming system combined with twice hand weeding on 20 and 40 DAT (M_2S_2) significantly recorded the lowest total weed population and weed DMP 11.70 no. m^{-2}, 48.89 kg $ha^{-1}$and highest weed control index 92.79 at 60 DAT. This was followed by Annamalai rice+ fish + poultry farming system along with PE application through

tank mix of butachlor (50 % EC) @ 1.25 kg a.i. ha^{-1}+ 2,4-DEE (38 % EC) @ 0.6 kg a.i. ha^{-1} (M_2S_3). Regardless of the cropping season and crop growth stage the highest total weed population were documented with rice monocropping under unweeded control (M_1S_1). The reduction of weed biomass resulted in increase in weed control efficiency. This finding is in conformity with the result obtained by Pandey *et al.,*1996, Ramachandran *et al.,*2012 and Dadsena *et al.,*2014.

Practice of continuous hand weeding and the complimentary impact of fish and poultry components results in 26 to 24 per cent weed control, respectively, and approximately 30 per cent weed control when combined (Kathiresan, 2007). In lowland rice culture, integration of fish suppressed the weeds effectively and minimized the incidence of pests and diseases (Nursandi, 2022).

Table 2. Weed parameters

Treatment	Weed population (no. m^{-2})		Weed dry matter (kg ha^{-1})		WCI (%)	
	30DAT	60DAT	30DAT	60DAT	30DAT	60DAT
Main treatment						
M_1	9.09 (82.04)	9.94 (98.35)	146.22	302.49	53.93	55.41
M_2	7.14 (50.47)	8.28 (68.12)	109.07	225.70	65.63	66.73
S.Ed	0.06	0.05	1.71	3.18	0.70	0.69
CD (p=0.05)	0.18	0.15	5.43	10.13	2.21	2.19
Sub treatment						
S_1	10.96 (119.55)	12.94 (167.02)	281.58	611.33	11.27	13.20
S_2	6.29 (39.08)	5.92 (34.49)	48.60	76.79	75.55	70.65
S_3	40.14 (40.14)	6.98 (48.20)	52.74	104.16	74.37	67.03
S.Ed	0.08	0.22	3.10	14.92	0.91	1.58
CD (p=0.05)	0.17	0.10	6.76	6.85	1.97	0.72

(Figures in parenthesis indicates original values)

The synergistic interaction between the component enterprises of fish culture and poultry as regards weed control in rice is evident from lesser weed counts, weed dry matter and higher weed control index in Annamalai rice + fish + poultry with twice hand weeding on 20 and 40 DAT (M_2S_2) related to Annamalai rice + fish + poultry along with PE application through tank mix of butachlor (50 % EC) @ 1.25 kg a.i. ha^{-1} + 2,4-DEE (38 % EC) @ 0.6 kg a.i. ha^{-1} (M_2S_3). The initial thrust and supplement for the growth and establishment of fish fingerlings by the poultry droppings as a food source helping to enhance the size and thereby voracious feeding habits of fishes could be suggested as the reason for this interaction.

In respect of weed control treatments, hand weeding twice under Annamalai rice + fish + poultry excelled all other treatments in respect of least weed counts, weed dry matter and higher weed control index. Any of the weed species that were successful in evading the complimentary weed control effect of the component enterprises *viz.,* fish culture and poultry, were physically removed once on 30 DAT and again on 60 DAT in the treatment, thereby ensuring the best weed control. This observation of better bio-efficacy as regarding weed control, with twice hand weeding is in conformity with the reports of Gnanavel and Kathiresan (2002).

A sustainable crop production strategy Butachlor 50 % EC 1.25 kg ha^{-1} pre-emergence herbicides of butachlor, an efficient pre-emergence broad spectrum herbicide, has been reported to be of a shorter persistence (Kathiresan *et al.,* 2001) and the weed control the grasses and sedges as well as 2,4-DEE controls broad-leaved weeds persists for a shorter period.

As a result, the late-emerging weeds in this treatment were not controlled, which led to greater weed counts, weed dry matter, and a worse weed control index as compared to twice hand weeding under IFS. Reports by Kathiresan and Vijayabaskaran (1993) lend support to this observation.

Conclusion

The results indicated that Annamalai rice farming systems show effective weed control on the various weeds than the rice monocropping. In weed management practice twice hand weeding on 20 and 40 DAT shows better weed control efficiency than the pre emergence herbicides.

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