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Weed dynamics and yield of rice under mechanized system of rice intensification

G. PRIYANKA, K. V. RAMANA MURTHY AND A. V. RAMANA

Department of Agronomy, Agricultural College,
Acharya N.G. Ranga Agricultural University,
Naira - 532 185, Andhra Pradesh

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ABSTRACT

An experiment was conducted at the Agricultural College Farm, Naira during kharif 2014 and results of the field experiment revealed that at 50 DAP and at harvest, lowest dry weight in all group of weeds were recorded with sequential pre and post emergence application of Orthosulfamuron viz., grasses (0.75 and 0.75 g m^{-2}) broad leaved weeds, (0.75 and 1.58 g m^{-2}) and sedges (0.71 and 0.91 g m^{-2}). It has also recorded the highest weed control efficiency (87.85%) and weed management index (1.01) than other weed management practices. Orthosulfamuron @ 100 g a.i. ha^{-1} as pre-emergence sand mix application + Orthosulfamuron @ 100 g a.i. ha^{-1} as post emergence at 20-25 DAP (T_{10}) registered highest productive tillers (232 No m^{-2}), grain yield (5489 kg ha^{-1}) and benefit cost ratio (1.21).and hence was found to be effective for management of weeds under mechanized SRI in North Coastal Zone of Andhra Pradesh.

Keywords: Mechanized SRI, orthosulfamuron, weed control efficiency, weed management index, yield

Rice is the "Global Grain" in 89 nations with an annual production of 518 million tonnes. It plays a pivotal role in Indian economy with an area of 39.47 million hectares with an annual production of 87.83 million tones and productivity of 2284 kg ha^{-1}. In Andhra Pradesh rice is grown in an area of 40.06 lakh hectares in *kharif* and *rabi* with a production of 12.88 million tonnes and productivity of 3217 kg ha^{-1} (Ministry of Agriculture, Govt. of India, 2011-2012).Improving the productivity of rice is one the major challenge that India is facing today. However, low cost and energy saving approach, has been recently developed the mechanized system of rice intensification (MSRI). Mechanization combined with improved crop management results in yields of 6.5 t ha^{-1}, indicating a yield gap of more than 3 t ha^{-1}.

Among several factors responsible for low productivity of rice, weed competition is one of the most important. When rice fields are not flooded continuously and plants are widely spaced as recommended under SRI, weeds get a better chance to grow. Weeds when left uncontrolled reduced the grain yield of transplanted rice by 62.6 per cent (Singh *et al*., 2005). Successful SRI cultivation will largely depend on effective weed control. The use of herbicides causes environmental pollution and induces the proliferation of resistant weed biotypes. These risks and the costs of labour for weeding prompt research on environment friendly, low volume and labour efficient methods through integrated weed management for mechanized SRI. In this backdrop, the present study was taken up to find out the most effective weed management practice for machine transplanted rice and its effect on yield.

MATERIALS AND METHODS

An experiment on weed management practices suitable for machine transplanted rice was carried out during *Kharif* 2014 at upland block of Agricultural College Farm, Naira of Acharya N.G Ranga Agricultural University, Andhra Pradesh, situated at 18.24^0 N latitude, 83.84^0 E longitude and at an altitude of 27 m above mean sea level in the North Coastal Zone of Andhra Pradesh. The soils were sandy clay loam in texture, low in organic carbon (0.32%) and available nitrogen (183 kg ha^{-1}), medium in available phosphorous (54 kg ha ^{1}) and potassium (259 kg ha ^{1}). The weather parameters *viz.*, temperature, rainfall, relative humidity, evaporation and bright sunshine hours during the period of study did not deviate much from the normal values of the location and were favourable for the optimal performance of the crop. The experiment was laid out randomized block design and replicated thrice. The treatments consisted of ten weed management practices (T_1-Weedy check, T_2-Hand weeding at 20 and 40 DAT**,** T_3-Oxadiargyl @100g *a.i.* ha^{-1} pre emergence as sand mix application(SMA), T_4-Running power weeder at 20 and 40 DAP, T_5-Orthosulfamuron@100g *a.i.* ha^{-1} as pre-emergence sand mix application,T_6-Orthosulfamuron@ 100 g *a.i.* ha^{-1} as post-emergence at 20-25 DAP**,** T_7- T_3*fb* T_4**,** T_8- T_3 *fb* T_6 **,** T_9- T_5 *fb* T_4**,** T_{10}- T_5*fb* T_6). Transplantation was done by using Yanmar transplanter with fourteen day's aged seedlings by adopting 30 × 14 cm. The test variety was Pushyami (MTU-1075) and a fertilizer dose of 120-60-40 kg N, P_2O_5 and K_2O/$^{-1}$ha was applied uniformly to all the experimental plots. Nitrogen was applied in three equal splits, one each at basal, active tillering and panicle initiation. All the other cultural practices were followed as per the recommended package of practices. Observations on weed and yield parameters and economics of rice crop were analysed following standard statistical analysis of variance as suggested by Panse and Sukhatme (1985) and arcsine transformation for

Email: priyanka.golla153@gmail.com

Weed Control Efficiency was calculated by the using readymade values suggested by Gomez and Gomez (1984). Weed management index was calculated using the formula- % of crop yield over control / percentage of control of weeds

RESULTS AND DISCUSSION

The weed flora of experimental field consisted of five species of grasses, three species of sedges, three species of broadleaved weeds (BLW) and one species of aquatic weed. Among the grasses, *Echinochloa crusgalli* was the predominant species followed by *Cynodon dactylon, Echinochloa crus-galli, Cynotis axillaris* and *Heteropogon contortus.* Among the sedges, the dominant species was *Cyperus rotundus,* followed by *Fimbristylis miliacea* and *Cyperus difformis*. Among the Broad Leaved Weeds, *Ammannia baccifera, Eclipta alba* and *Ludwigia parviflora* and aquatic weed of *Monochoria vaginalis* were predominant during the period of study.

The data pertaining to dry weight of weeds were presented in table 1. At 25 DAP, Hand weeding twice at 20 and 40 DAP (T_2) recorded the lowest grass dry weight and was on par with pre-emergence sand mix application of Oxadiargyl @ 100 g *a.i.* ha^{-1} (T_3) and both of them are comparable with Oxadiargyl @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Running power weeder at 20 and 40 DAP (T_7), Oxadiargyl @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Orthosulfamuron @ 100 g *a.i.* ha^{-1} as post emergence foliar spray at 20-25 DAP (T_8) and Running power weeder at 20 and 40 DAP (T_4). Overall, dry weight of grasses in all the treatments was found to be significantly lower than Weedy check (T_1), which recorded the highest dry weight of grasses.

At 50 DAP, lowest dry weight of grasses was recorded with the Orthosulfamuron @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Orthosulfamuron @ 100 g *a.i.* ha^{-1} as post emergence foliar spray at 20-25 DAP (T_{10}) and was *on par* with Hand weeding twice at 20 and 40 DAP (T_2). All the treatments are significantly superior to Weedy check (T_1) which recorded the highest weed dry weight of grasses in the present experiment. Similar trend of influence of weed management practices on the weed dry weight was observed at harvest.

At 25 DAP, the lowest dry weight of broad leaved weeds was recorded with pre- emergence sand mix application of Orthosulfamuron @ 100 g *a.i.* ha^{-1} (T_5) and was on par with Orthosulfamuron @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Running power weeder at 20 and 40 DAP (T_9), Hand weeding twice at 20 and 40 DAP (T_2) and Orthosulfamuron @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Orthosulfamuron @ 100 g *a.i.* ha^{-1} as post emergence foliar spray at 20-25 DAP (T_{10}). Overall, dry weight of broad leaved weeds in all the treatments was found to be significantly lower than Weedy check (T_1), which recorded the highest dry weight of broad leaved weeds.

At 25 DAP, lowest dry weight of sedges was recorded with pre- emergence sand mix application of Orthosulfamuron @ 100 g *a.i.* ha^{-1} (T_5) and was on par with all the treatments *viz.*, T_9, T_{10}, T_8, T_2, T_3, T_7 and T_4 except T_6 and T_1 which found disparity with each other. The highest dry weight of sedges was recorded with T_1 which was found significantly inferior to rest of the treatments.

At 50 DAP and at harvest, lowest dry weight of broad leaved weeds and sedges was recorded with Orthosulfamuron @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Orthosulfamuron @ 100 g *a.i.* ha^{-1} as post emergence foliar spray at 20-25 DAP (T_{10}) which was, however, on par with all other integrated practices, *viz.*, T_7, T_8 and T_9. All the treatments were significantly superior to Weedy check (T_1).

The highest weed control efficiency (Table 2) was recorded with Orthosulfamuron @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Orthosulfamuron @ 100 g *a.i.* ha^{-1} as post emergence foliar spray at 20-25 DAP (T_{10}) and it was significantly superior to all other treatments at 50 DAP but at harvest it was *on par* with Orthosulfamuron @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Running power weeder at 20 and 40 DAP (T_9). Both of them are comparable with Oxadiargyl @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Running power weeder at 20 and 40 DAP (T_7), HW at 20 and 40 DAP (T_2), power weeding at 20 and 40 DAP (T_4) and Oxadiargyl @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Orthosulfamuron @ 100 g *a.i.* ha^{-1} as post emergence foliar spray at 20-25 DAP (T_8)

Orthosulfamuron @ 100 g *a.i.* ha^{-1} as post emergence foliar spray at 20-25 DAP (T_{10}) and it was on par with Oxadiargyl @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Running power weeder at 20 and 40 DAP (T_7) and Orthosulfamuron @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Running power weeder at 20 and 40 DAP (T_9) all these treatments were comparable with Oxadiargyl @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Orthosulfamuron @ 100 g *a.i.* ha^{-1} as post emergence foliar spray at 20-25 DAP (T_8) and Hand weeding at 20 and 40 DAP (T_2). Among all the treatments lowest number of productive tillers m^{-2} was recorded with Weedy check (T_1).

Highest grain yield was recorded with Orthosulfamuron @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Orthosulfamuron @ 100 g *a.i.* ha^{-1} as post emergence foliar spray at 20-25 DAP (T_{10}) and it was on par with Oxadiargyl @ 100 g *a.i.* ha^{-1} as pre- emergence sand mix application + Running power weeder at 20 and 40 DAP (T_7) and Orthosulfamuron @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Running power weeder at 20 and 40 DAP (T_9). The treatments pre-emergence sand mix application of Oxadiargyl @ 100 g *a.i.* ha^{-1} + Orthosulfamuron @ 100 g *a.i.* ha^{-1} as post emergence foliar spray at 20-25 DAP (T_8) and Hand weeding at 20 and 40 DAP (T_2) were registered next better performance. Overall, grain yield of rice in all the treatments was found to be significantly higher than Weedy check (T_1), which recorded the lowest grain yield.

Benefit cost ratio (BCR) was highest with Orthosulfamuron @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Orthosulfamuron @ 100 g *a.i.* ha^{-1} as post emergence foliar spray at 20-25 DAP (T_{10}). However, it was on par with Orthosulfamuron @ 100 g *a.i.* ha^{-1} as post emergence foliar spray at 20-25 DAP (T_6), pre- emergence sand mix application of Orthosulfamuron @ 100 g *a.i.* ha^{-1} (T_5) and Oxadiargyl @ 100 g *a.i.* ha^{-1} as pre-emergence sand mix application + Orthosulfamuron @ 100 g *a.i.* ha^{-1} as post emergence foliar spray at 20-25 DAP (T_8). Benefit Cost Ratio of rice established with mechanized SRI was the lowest with Weedy check (T_1) and it was on par with Hand weeding at 20 and 40 DAP (T_2).

The elevated stature of these results might be due to effective control of weeds at early stages of crop growth with pre emergence application and that of the late emerged weeds, due to post emergence application of Orthosulfamuron which provided the favourable growing conditions for the crop, at critical period of crop weed competition. Further, effective translocation of photosynthates to sink, might have contributed to the better development of yield attributing characters, which ultimately resulted in higher grain yield as well as higher economic returns. These results were in close conformity with those of Subrata *et al.* (2005) and Sindhu *et al.* (2007) and many researchers also reported that sequential application of herbicides increased the performance of rice yield (Ishaya *et al*., 2007 and Eskandari *et al*., 2011). In all the given parameters next best performance was achieved by the integrated weed management practices. This might be due to effective removal of weeds throughout the crop growth period with combination of cultural and chemical weed management practices.

In conclusion, the study revealed that rice can be successfully grown under mechanized SRI in north coastal zone of Andhra Pradesh, with sequential application of Orthosulfamuron@ 100 g *a.i.* ha^{-1} as pre and post emergence for higher productivity and profitability.

Table 1: Dry weight of weeds (g m^{-2}) of rice under MSRI as influenced by weed management practices

Treatment	Grasses			Broad Leaved Weeds			Sedges		
	25 DAP	50 DAP	Harvest	25 DAP	50 DAP	Harvest	25 DAP	50 DAP	Harvest
T_1	5.91 (34.39)	9.16 (83.39)	20.66 (426.49)	3.11 (9.17)	4.57 (20.42)	3.51 (11.84)	2.53 (5.92)	6.04 (36.04)	2.54 (5.94)
T_2	1.70 (2.40)	1.45 (1.60)	0.92 (0.35)	0.84 (0.20)	1.21 (0.97)	2.01 (3.53)	0.75 (0.06)	0.99 (0.49)	1.21 (0.97)
T_3	1.84 (2.87)	3.41 (11.13)	9.88 (97.12)	1.24 (1.03)	1.42 (1.51)	2.92 (8.04)	0.79 (0.13)	1.81 (2.79)	1.60 (2.05)
T_4	2.00 (3.49)	2.00 (3.49)	1.32 (1.25)	1.33 (1.26)	1.32 (1.24)	2.06 (3.74)	0.90 (0.31)	1.03 (0.57)	1.22 (0.99)
T_5	2.15 (4.12)	3.47 (11.54)	4.89 (23.38)	0.75 (0.06)	1.47 (1.68)	3.24 (10.00)	0.71 (0.00)	3.22 (9.85)	1.57 (1.98)
T_6	3.03 (8.67)	2.33 (4.92)	3.75 (13.60)	1.82 (2.80)	1.44 (1.59)	2.76 (7.10)	1.37 (1.37)	1.40 (1.46)	1.36 (1.36)
T_7	1.92 (3.20)	1.85 (2.91)	0.92 (0.35)	1.22 (1.00)	0.75 (0.06)	2.00 (3.49)	0.82 (0.17)	0.75 (0.06)	1.11 (0.72)
T_8	1.98 (3.43)	1.51 (1.78)	0.79 (0.12)	1.08 (0.66)	0.75 (0.06)	1.89 (3.08)	0.75 (0.06)	0.87 (0.25)	1.00 (0.50)
T_9	2.11 (3.93)	1.67 (2.30)	0.75 (0.06)	0.79 (0.13)	0.83 (0.19)	1.92 (3.20)	0.71 (0.00)	0.84 (0.20)	0.87 (0.26)
T_{10}	2.12 (4.02)	0.79 (0.13)	0.75 (0.06)	0.86 (0.25)	0.75 (0.06)	1.58 (1.99)	0.75 (0.06)	0.71 (0.00)	0.91 (0.33)
SEm(±)	**0.12**	**0.22**	**0.28**	**0.10**	**0.06**	**0.16**	**0.06**	**0.11**	**0.09**
LSD (0.05)	**0.37**	**0.66**	**0.83**	**0.28**	**0.19**	**0.48**	**0.19**	**0.32**	**0.26**

Note: Figures in parentheses indicate square root transformed $\left(\sqrt{X+3.5}\right)$ *values.*

Table 2: Weed indices, productive tillers, grain yield and benefit cost ratio of rice under MSRI as influenced by different weed management practices

Treatments	WCE (%)		Weed index (%)	Weed management Index	Productive tillers m ^{2}	Yield (kg ha^{-1})	B:C ratio
	50 DAP	harvest					
T_1	0.33 (0.00)	0.33 (0.00)	5.78 (33.56)	0.71 (0.00)	63	3645	0.64
T_2	81.59 (97.75)	83.86 (98.84)	2.41 (5.42)	0.97 (0.45)	208	5181	0.67
T_3	70.56 (88.94)	60.52 (75.68)	4.26 (17.70)	0.91 (0.34)	120	4518	0.92
T_4	78.64 (96.11)	83.11 (98.46)	3.41 (11.53)	0.92 (0.37)	178	4856	0.85
T_5	66.03 (83.47)	73.69 (91.97)	2.83 (8.95)	0.95 (0.41)	176	4995	1.11
T_6	75.93 (93.80)	77.17 (95.01)	2.54 (6.57)	0.97 (0.45)	177	5144	1.17
T_7	81.59 (97.82)	84.29 (98.97)	1.48 (1.97)	1.00 (0.51)	229	5381	0.98
T_8	83.02 (98.46)	82.79 (99.16)	2.31 (5.60)	0.97 (0.46)	224	5192	1.10
T_9	81.95 (97.95)	84.84 (99.21)	1.69 (2.84)	0.99 (0.50)	227	5333	0.94
T_{10}	87.85 (99.86)	85.76 (99.46)	0.71 (0.00)	1.01 (0.54)	232	5489	1.21
SEm(±)	**0.94**	**0.86**	**0.41**	**0.03**	**10.21**	**157.71**	**0.06**
LSD (0.05)	**2.80**	**2.54**	**1.21**	**0.08**	**30**	**221**	**0.19**

Note: Data is subjected to square root transformation $(\sqrt{X+0.5})$ *for weed index and weed management index and arcsine transformation for weed control efficiency*

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