ORIGINAL RESEARCH ARTICLE OPEN ACCESS

Production Potential of Rice-Zero till Maize Cropping System under Various Weed Management Practices

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Received: 2nd December, 2014; Accepted: 22nd August, 2015

Abstract

A field experiment was conducted to evaluate the efficacy of different herbicide treatments on *kharif* rice and *rabi* maize in rice-maize sequence during 2014-15 season. *Kharif* rice research results revealed that significantly higher rice grain yield (6378 kg ha^{-1}) was obtained with pre emergence application of pretilachlor @ 750 g ha^{-1} at 3-5 DAT followed by hand weedingat 25-30 DAT and was onpar with hand weeding twice at 20 DAT and 40 DAT (5924 kg ha^{-1}) was found to be more economical with B.C ratio of 2.19 and 1.88 respectively. In similar way higher weed control efficiency (91.01 and 92.66) and lower weed index values (0.0 and 8.8) were noticed in vice versa. In *rabi* zero tillage maize higher grain yield (5631 kg ha^{-1}) was obtained with hand weeding twice at 20 and 40 DAS and was on a par with either pre-emergence application of atrazine @ 1000 g ha^{-1}+paraquat @.600 g ha^{-1} (4886 kg ha^{-1}) or pre-emergence application of oxyfluorfen 150 g ha^{-1}+paraquat @.600 g ha^{-1} (4869 kg ha^{-1}) with B.C ratio of 2.35, 2.43 and 2.41 respectively. In similar way higher WCE and lower WI values were observed with similar treatments. Higher system productivity (12555 kg ha^{-1}) was noticed with farmers practice twice both for *kharif* rice and *rabi* maize and was followed by pre emergence application of pretilachlor @ 750 g ha^{-1} at 3-5 DAT followed by hand weeding at 25-30 DAT for *kharif* rice and in sequence pre emrgence application of atrazine 1000 g+paraquat @ 600 g ha-1 for *rabi* maize recorded higher rice grain equivalent yields (12341 kg ha^{-1}). Economic analysis of system productivity indicates that higher economic returns were obtained with pre emergence application of pretilachlor @ 750 g ha^{-1} at 3-5 DAT followed by hand weeding at 25-30 DAT for *kharif* rice and in sequence PE application of atrazine 1000 g+paraquat @ 600 g ha-1 for *rabi* maize.

Key Words: Rice-maize, system productivity, weed management practices

Introduction

Weeds constitute a major component among the bottlenecks for successful crop production. Intense weed competition is one of the major constraints in productivity of crops. In Krishna delta of Andhra Pradesh, due to late release of water, transplanting of rice is much delayed and ultimately timely sowing of blackgram as relay crop is not possible since 2003. Therefore, farmers are switching over to non-traditional crop like maize in rice fallows as an alternative to blackgram due to yellow vein mosaic and *Cuscuta* problem. Under the emerging and potential crop sequence (rice-maize) in coastal region of Andhra Pradesh, the conventional tillage for planting maize under heavy textured soil of rice needs 25-30% higher energy for field preparation that not only limits the farm profitability but also delays planting of maize which in turn leads to lower productivity. Generally rice is harvested during second fortnight of November. In case of zero tillage under rice-maize rotation the farmers can plant maize in time. Further the no till maize in rice fallow demonstrated a potential benefit of saving on cost of production changing from Rs 3800-5500 ha^{-1} (Mukundam *et al*., 2011). Conventional tillage has a long been contributing negatively to soil quality in fracturing the soil, disrupting the soil structuring, accelerating surface runoff and soil erosion. Intense tillage system reduced the soil organic carbon (SOC) content 20% less after 20 year (Mann, 1986). Introduction of crop residue in the soil offers the best means to restore carbon in agriculture soils (Regmi *et al*., 2002). Timsina *et al*. (2010) hypothesized that the establishment of maize after rice with reduced or no tillage, and retaining of crop residues,

could help to conserve soil organic matter (SOM) and maintain soil fertility if improved nutrient management is practiced. Similarly, weed infestation is one of the major causes that leads to 20 to 80% maize yield reduction (Chikoye and Ekeleme, 2003). Conservation agriculture like zero tillage, residue management along with proper nutrient management strategy and effective weed management practice helps to conserve the soil properties, reduce the cost of production, reduce the yield losses due to weed infestation and produce the sustainable yield in longer run, which lead to the sustainability of rice-maize cropping system. Mukundam *et al*. (2011) also observed superior productivity of the rice-zero till maize system with herbicide treatments over no-herbicide. Therefore, an attempt was made in order to evaluate the impact of different weed management practices in sequence for *kharif* rice and *rabi* maize under zero till sown condition with an objective, to identify the good production system with higher productivity, weed control efficiency and total water use efficiency.

Materials and Methods

The experiment was carried out at college farm, Professor Jayashankar Telangana State Agricultural university, Rajendranagar, Hyderabad situated at an altitude of 542.3 m above mean sea level at 17°19' N latitude and 78°23' E longitude. The experiment was laid out in complete randomized block design with 4 replications having 5 weed management treatments viz.. T_1: Pretilachlor @ 750 g ha^{-1} as PE at 3-5 DAT followed by hand weeding at 25-30 DAT, T_2; Bispyribac sodium as PoE at 20-25 DAT @ 25 g ha^{-1} followed by hand weeding at 40-45 DAT, T_3; Pretilachlor followed by ethoxysulfuron @750/18.75 at 25 DAT (3-4 leaf stage), T_4 ; Farmers practice (20, 40 DAT hand weeding), T_5; Unweeded check with MTU -1010 as test variety. Nursery was raised on 07-07-2014. Twenty two days old seedlings were transplanted on 29-07-2014. Entire dose of P, half of the potash and one third of N was applied just before planting. The remaining nitrogen was applied in two equal splits 20 and 40 DAT (180-60-40 NPK k g ha^{-1}). *Rabi* maize was sown under zero till condition on 19-11-2014 with 5 weed management treatments viz.. T_1: Atrazine 1000 g + paraquat @600g ha^{-1} as PE, T_2; Oxyfluorfen 150 g ha-1 + paraquat @.600 g ha^{-1} as PE, T_3; Atrazine EPoE @1000 g ha^{-1} at 15-20 DAS, T_4; Farmers practice (20, 40 DAT hand weeding), T_5; Unweeded check in sequence with dekalb 900M as test hybrid. The herbicide treatments were imposed as per the technical programme of the work and the remaining package of practices was fallowed as per the recommendations of PJTSAU for both the crops. Data on growth and yield attributes of transplanted rice and maize was taken at 30, 60 and 120 DAS (Harvest). Weed density and dry matter were recorded at various stages with the help of quadrate and then converted in per square metre. The data on weed density and dry weight were subjected to square root transformation $\sqrt{x+0.5}$ before statistical analysis to normalise their distribution (Panse and Sukhatme, 1978).

The yield of maize crop, rice straw and maize stover was converted into rice equivalent yield (REY). Sale price of crop commodities for calculating equivalent yield were: rice grains = Rs. 14/ kg; ricece straw = Rs. 1.50/kg; Maize grain = Rs. 13.1/ kg; maize straw = Rs.1.50/kg.

System productivity was calculated after converting *rabi* maize grain yields, rice straw yield and maize stover yield into rice equivalent yields using following formulae.

$$\text{REY (kg ha}^{-1}) = \frac{\text{Rice yield (k g ha-1) + Maize yield (k g ha-1) x Price (Rs./kg)}}{\text{Rice Price (Rs/ha)}}$$

Results and Discussion

Kharif rice

Weed flora

Transplanted rice was infested with a less number of weeds owing to flooding and puddle conditions. Prominent weed species recorded were *Cyprus rotundus, Cyperus difformis, E.crusgulli, E.colonum, Eclipta alba, Fimbristilis dichotoma* and *paspalum distichum.*

Weed dry matter (g m^{-2})

Hand weeding twice at 20 and 40 DAT recorded significantly the lowest weed dry matter at all the crop growth stages (Fig.1) and was on a par with pre emergence application of pretilachlor @ 750 g ha-1 at 3-5 DAT followed by hand weeding at 25-30 DAT treatment at 30 DAT and 60 DAT but inturn this was on a par with bispyribac sodium as PoE at 20-25 DAT @25 g ha^{-1} followed by hand weeding at 40-45 DAT and Pretilachlor followed by ethoxysulfuron @750/18.75 at 25 DAT (3-4 leaf stage) treatment at 60 DAT. At harvest hand weeding twice did not differ significantly in weed dry matter production with bispyribac sodium as PoE at 20-25 DAT @ 25 g ha^{-1} followed by hand weeding at 40-45 DAT and pretilachlor @ 750 g ha^{-1} as PE at 3-5

DAT followed by hand weeding at 25-30 DAT treatment respectively.

Weed Density (no/m^2)

Significantly less weed density was observed with pre emergence application of pretilachlor @ 750 g ha^{-1} at 3-5 DAT followed by hand weeding at 25-30 DAT and was significantly superior over all other treatments (Fig.2). But at 60 DAT and at harvest significantly the lowest weed density was observed with farmers practice and was onpar with bispyribac sodium as PoE at 20-25 DAT @ 25 g ha^{-1} followed by hand weeding at 40-45 DAT, pre emergence application of pretilachlor @ 750 g ha^{-1} as PE at 3-5 DAT followed by hand weeding at 25-30 DAT and pre emergence application of pretilachlor followed by ethoxysulfuron @ 750/18.75 at 25 DAT (3-4 leaf stage).

Yield, weed control efficiency and weed index

Pre emergence application of pretilachlor @ 750 g ha^{-1} at 3-5 DAT followed by hand weeding at 25-30 DAT recorded more grain (6378 kg ha^{-1}) and straw yield (6966 kg ha^{-1}) and was significantly superior over bispyribac sodium as PoE at 20-25 DAT @ 25 g ha^{-1} followed by hand weeding at 40-45 DAT and pre emergence application of pretilachlor followed by ethoxysulfuron @750/18.75 at 25 DAT but it was not differed significantly with hand weeding twice. Significantly the lowest grain yield and straw yield was recorded with unweede check treatment (Fig.3).

Rabi zero till maize

Weed flora

The predominant weed flora observed in maize during crop growing season at 30 DAS was *Cyprus rotundus, E.crusgulli, Paspalum distichum, Trianthema portula castrum, Parthenium hysterophotus, Sonchus sp, Acalypha indica and Eclipta alba.* At 60 DAS *Fimbristylis dichotoma, E. crusgulli, Paspalum distichum, Alternanthera* and *Dinebra retroflexa.* At 90 DAS in addition to 60 days weed spp *Grangea maderaspatana, Ageratum conyzoides, Amaranthus polygamous, Melilotus alba, Digera muricata* and *Cleome viscosa.*

Weed dry matter (g m^{-2})

Hand weeding twice at 20 and 40 DAS recorded significantly the lowest weed dry matter at 30, 60, 90 and 120 DAS, however it was on par with pre-emergence application of oxyfluorfen 150 g ha^{-1} + paraquat @.600 g ha^{-1} treatment at 30, 60 and 120 DAS but inturn this was onpar with pre-emergence application of atrazine @ 1000 g ha^{-1} + paraquat @.600 g ha^{-1} and early post-emergence application of atrazine @ 1000 g ha^{-1} treatment at 30 DAS (Fig.4).

Weed Density (no/m$^{2)}$

Significantly lower weed density was recorded with farmers practice at 60 and 90 DAS and was onpar with pre-emergence application of atrazine @ 1000 g ha^{-1} + paraquat @.600 g ha^{-1} and early post-emergence application of atrazine @ 1000 g ha^{-1} treatment at 60 and 90 DAS. But at 30 DAS pre-emergence application of oxyfluorfen @ 150 g ha^{-1} + paraquat @.600 g ha^{-1} recorded the lowest density. The highest weed density was recorded with weedy check (Fig.5).

Yield, weed control efficiency and weed index

Significantly higher grain yield (5631k g ha^{-1}) and stover yield (6111 k g ha^{-1}) was obtained with hand weeding twice (Fig.6) and was on a par with pre-emergence application of atrazine @ 1000 g ha^{-1} + paraquat @.600 g ha^{-1} and pre-emergence application of oxyfluorfen 150 g ha^{-1} + paraquat @.600 g ha-^{1}, inturn this was showed on a par yield with early post-emergence application of atrazine @ 1000 g ha.$^{-1}$ Higher WCE values at 60, 90 and at physiological maturity stages and lower weed index values at physiological maturity stage were noticed with hand weeding twice and it was followed by T_2, T_1 and T_3 treatments up to harvest stage.

Rice–zero till maize system productivity

Economic analysis of system productivity showed higher rice grain equivalent yields (12533 kg ha^{-1}) with hand weeding twice at 20 and 40 DAS both for *kharif* rice and *rabi* maize and it was followed by pre emergence application of pretilachlor @ 750 g ha^{-1} at 3-5 DAT followed by hand weeding at 25-30 DAT for *kharif* rice and in sequence PE application of atrazine 1000 g+paraquat @ 600 g ha^{-1} for *rabi* maize recorded higher rice grain equivalent yields (12341 kg ha^{-1}). In terms of economic returns higher net returns of Rs 104421 were obtained with pre emergence application of pretilachlor @ 750 g ha^{-1} at 3-5 DAT followed by hand weeding at 25-30 DAT for *kharif* rice and in sequence PE application of atrazine 1000 g+paraquat @ 600 g ha^{-1} for *rabi* maize and there after hand weeding twice for *kharif* rice as well as for *rabi* maize with net returns of Rs 93713. This reduced net returns was due to increased cost of cultivation (Rs 81750) as human labour engaged in hand weeding operation. Total rainfall use efficiency of 18.94 kg ha^{-1} mm^{-1} and 18.66 kg ha^{-1} mm^{-1} for *kharif* rice and *rabi* maize respectively was obtained with hand weeding twice in rice-zero till maize sequence (Table.1).

Conclusions

Pre-emergence applicaton of pretilachlor @ 750 g ha^{-1} at 3-5 DAT followed by hand weeding at 25-30 DAT for *kharif* rice and was followed by PE application of atrazine 1000 g+paraquat @ 600 g ha^{-1} for *rabi* maize recorded higher system net returns. But hand weeding twice for *kharif* rice followed by *rabi* zero till sown maize obtained more system productivity and higher total water use efficiency of cropping system due to higher weed control efficiency.

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Table 1. System productivity of rice-maize cropping system under different weed management practices

Treatment	REY of *Kharif* rice (kg/ha)	REY of *Rabi* Maize (kg/ha)	Rice CC Rs/ha	Maize CC Rs/ha	Total CC Rs/ha	System productivity	Gross return	Net returns	Total water use efficiency
T_1	7124	5217	40720	27635	68355	12341	172776	104421	18.66
T_2	5268	5206	40650	32612	73262	10473	146627	73365	15.83
T_3	5928	5003	41432	30970	72402	10931	153030	80628	16.52
T_4	6609	5924	44000	37750	81750	12533	175463	93713	18.94
T_5	2585	5217	36000	30250	66250	5699	79785	13535	8.61

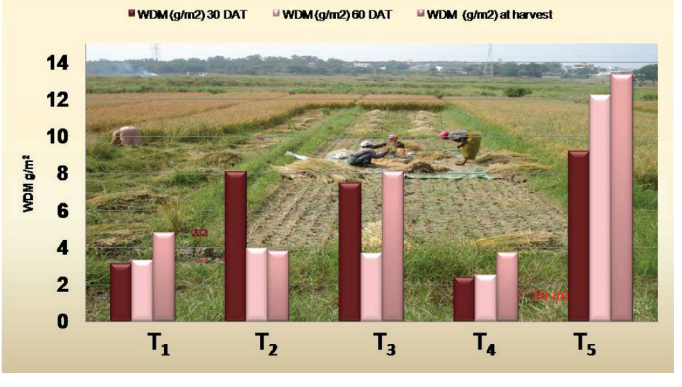

Fig.1. Effect of weed management practices on weed dry matter of rice in rice -maize cropping system (*Kharif*, 2014-15)

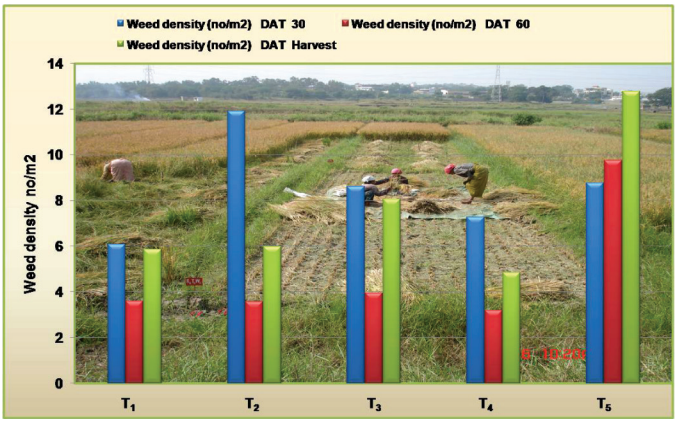

Fig. 2. Influnce of weed management practices on weed density of rice in rice -maize cropping system (*Kharif*, 2014-15)

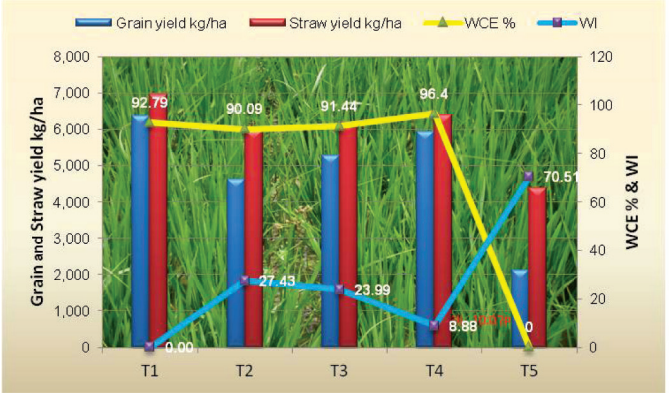

Fig. 3. Influence of weed management practices on WCE, WI and grain and straw yield of rice in rice -maize cropping system (*Kharif*, 2014-15)

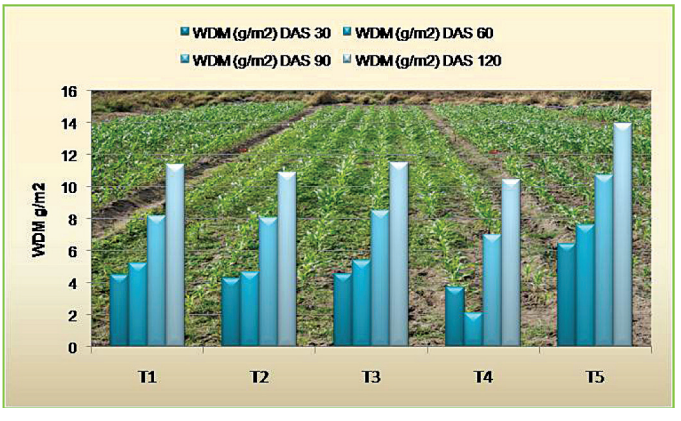

Fig. 4. Influnce of weed management practices on weed dry matter of zero till sown maize in rice -maize cropping system (*rabi*, 2014-15)

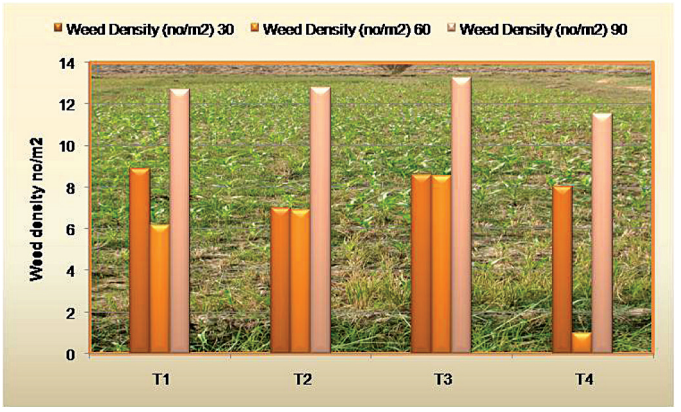

Fig. 5. Influnce of weed management practices on weed density of zero till sown maize in rice -maize cropping system (*rabi*, 2014-15)

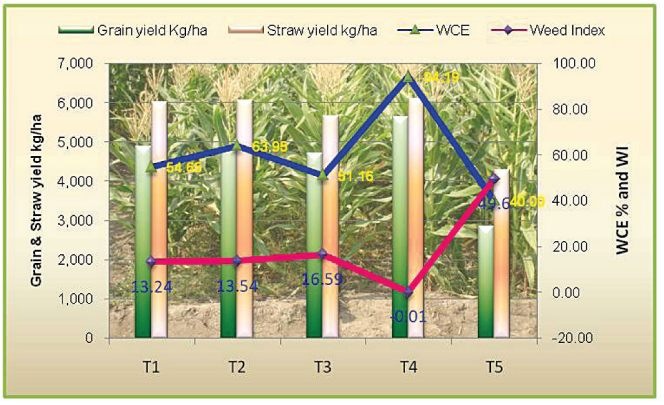

Fig. 6. Influence of weed management practices on WCE, WI and grain yield of maize in rice -maize cropping system (*Rabi*, 2014-15)