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EFFICACY OF DIFFERENT WEED MANAGEMENT PRACTICES ON GROWTH AND YIELD OF DIRECT WET SEEDED RICE SOWN THROUGH DRUM SEEDER

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ABSTRACT
An investigation was conducted to ascertain the efficacy of different weed management practices on growth and yield of direct wet seeded rice (DWSR) sown through drum seeder. Eight weed control treatments were tested in randomized block design replicated thrice. All the weed control treatments significantly reduced the population and dry weight of weeds which resulted in significantly higher growth and yield of rice over unweeded check. The weed free treatment yielded (5800 kg ha^{-1}) significantly higher than all other treatments. Among the herbicides bispyribac sodium @ 25 g a.i. ha^{-1} at 25 DAS as PoE not only reduced population (2.89 No. m^{-2}) and dry weight of weeds (3.43 g m^{-2}) but also increased the grain yield (5367 kg ha^{-1}) of rice with the concomitant increase in the yield attributes (number of panicles per meter square, panicle length and filled grains per panicle 489, 21.28 cm and 103 respectively) and which was on par with tank mixture of cyhalofop-butyl @ 100 g a.i ha^{-1} + Chlorimuron-ethyl + metsulfuron-methyl (@ 4 g a.i ha^{-1}) at 15 DAS as PoE, pretilachlor + safener (0.4 kg a.i ha^{-1} at 3 days after seeding) + Hand weeding at 40 DAS and two hand weeding at 20 and 40 DAS. Hence these four treatments were found to be efficient weed management practices for improving the rice grain yield by eliminating early crop-weed competition in direct wet-seeded rice sown through drum seeder.

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important and widely cultivated crop in the world. Asia is the home of rice as more than two billion people are getting 60-70 % of their energy requirement from rice and its derived products. About 90 % of total rice is grown and consumed in Asia(Seema *et al.*, 2014). In India rice produces 106.54 million tonnes (GOI, 2014) and provides 29.9% of the total calories to rice consuming population (Timmer and Peter, 2010).Of the four ecologies of rice culture in India, irrigated ecology spreading over 26.54 million ha i.e. 58.7% of total acreage (FAI, 2011), which contributes over 75% of total production. Recently, however there is trend towards direct seeded rice because of labour and water scarcity (Mallikarjun *et al.*, 2014). To overcome these twin problems especially that of human labours involved in nursery preparation and transplanting operations, researchers as well as farmers are looking at mechanical transplanting and direct wet seeding options that were developed and adopted widely in South-East Asian countries. The establishment of rice crop through drum seeding technique is not only simple to use but also has been found effective in sustaining the production of rice. Direct wet seeding of rice through drum seeder offers the advantages of eliminates the nursery raising and transplanting operations, faster and easier planting, reduces labour requirement (only 1-2 labour ha^{-1}), hastens crop maturity and increase water use efficiency, thus 25% (250-300 man hours) of total human labour involved in rice cultivation were reduced making rice cultivation more profitable (Kachro and Bazaya, 2011). Rice crop sown through drum seeding technique by using sprouted seeds on puddled soil is associated with the problem of profuse growth of weeds and infestation of heterogeneous weed flora becomes the biggest biological constraint and the success of wet seeding entirely depends on efficient weed management practices because uncontrolled weeds in direct wet seeded rice can reduce yields to the tune of 53 percent (Nyarko and Datta, 1991) and losses were reported even up to 90 per cent (Bhat *et. al.*, 2011). The weed flora of wet seeded rice crop is entirely different from that of transplanted crop due to maintenance of saturation moisture at sowing and shallow depths of water up to 3 weeks after sowing. As weeds emerge almost at the same time as that of the crop in wet seeded rice

and weed competition with rice crop is greater, hence weed management by herbicide is more crucial (Singh and Singh, 2010). In this context present investigation is carried out to evaluate the efficient weed management practices under direct wet seeded rice crop sown through drum seeder.

MATERIALS AND METHODS

A field experiment was conducted during *Kharif* season 2012 at the college farm, college of agriculture, Acharya N.G. Ranga agricultural university, Rajendranagar, Hyderabad. The soil tested sandy clay loam in texture (Bouyoucos hydrometer method, Piper, 1966), with pH 8.2 (Glass electrode pH meter, Jackson, 1973), low in organic carbon (Walkley and Black, 1934) 0.47%, low in available nitrogen (Subbiah and Asija, 1956) 225.75 kg ha^{-1}, high in phosphorus (Olsen *et al.*, 1954) 33.65 kg ha^{-1} and available potassium (Stanford and English, 1949) 429.3 kg ha^{-1}. Vegetable-fallow rotation was followed at the experimental site for the previous two seasons. The sowing was done through 8 row drum seeder by using sprouted seeds under puddled condition with a row to row spacing of 20 cm. Eight weed control treatments were laid out in randomized block design with three replications. The treatments like T_1 – Weed free check (repeated hand weeding at 10 days intervals), T_2 – Unweeded check, T_3 – Two hand weeding at 20 and 40 DAS, T_4 – Metamifop (100 g a.i ha^{-1} at 3rd leaf stage) as PoE, T_5 – Pretilachlor + safener (0.4 kg a.i ha^{-1} at 3 days after seeding) as PE, T_6 – Bispyribac sodium (@ 25g a.i ha^{-1} at 25 DAS) as PoE, T_7 – Cyhalofop-butyl (100 g a.i ha^{-1}) + Chlorimuron-ethyl + metsulfuron-methyl (@ 4g a.i ha^{-1}) at 15 days after seeding as PoE and T_8 – Pretilachlor + safener (0.4 kg a.i ha^{-1} at 3 days after seeding) + Hand weeding at 40 DAS were taken for the study. A uniform fertilizer dose of 120-60-60-25 kg N-P-K-$ZnSO_4$ ha^{-1} was applied. Half dose of N and whole of P, K and $ZnSO_4$ were applied as basal before sowing. Remaining N was top-dressed in 2 equal splits at active tillering and panicle-initiation stage. Rice MTU-1010 of 110-120 days duration was used as test variety. Pre-germinated seed @ 38 kg ha^{-1} was used for wet drum seeding of rice. The total rainfall received during crop season was 579.8 mm. Pre-emergence and post-emergence herbicides were applied with the help of a sand mixture and hand-operated knapsack sprayer fitted with flat-fan nozzle respectively and water as a carrier at 600 litters ha^{-1} for post emergent herbicide application. Observations on weed population and weed dry matter were recorded with the help of a quadrate 0.5 m × 0.5 m placed randomly at two spots in each plot at 30, 60 and 90 DAS and expressed in number per meter square (No. m^{-2}) and gram per meter square (g m^{-2}) respectively. The data was subjected to square root transformation $\sqrt{(X+1)}$ to normalize their distribution and statistical analysis was done as suggested by Gomez and Gomez (1984). Weed control efficiency was calculated according to Mani *et al.* (1973) as per the standard formulae by using weed dry matter at 30, 60 and 90 DAS.

$$WCE\ (\%) = \frac{\text{Dry weight of weeds in control plot(g m}^{-2}) - \text{Dry weight of weeds in treated plot(g m}^{-2}) \times 100}{\text{Dry weight of weeds in control plot(g m}^{-2})}$$

And biometric observations for rice crop were recorded as per the guidelines given by the All India Co-Ordinated Rice Improvement Project (Haveten, 1997) and the net plot yield of wet drum seeded rice from the individual plots were taken and converted to kg per hectare.

RESULTS AND DISCUSSION

Effect on weeds

The dominant weed flora associated with experimental field were *Echinochloa colona*, *Echinochloa crusgalli*, *Denebra arabica*, *Dactylectanium aegypticum, Cynodon dactylon* in grasses; *Cyperus difformis* in sedges and *Ammania baccifera*, *Eclipta alba* and *Ludwigia parviflora* in broad-leaved weeds. Among the weed flora, the maximum relative percentage was *Cyperus difformis* (25.34%, 24.75% and 24.34%), *Echinochloa colonum* (15.66%, 19.58% and 19.06%), *Echinochloa crusgalli* (16.59%, 8.39% and16.12%) and *Ammania baccifera* (17.51%, 10.64% and 13.48%) at 30, 60, 90 DAS respectively similar result was also observed by (Singh and Singh, 2010). Among different weed management

Table 1: Effect of weed management practices on total weeds density (No. m^{-2}), total weeds dry matter (g m^{-2}) and weed control efficiency (%) of direct wet seeded rice sown through drum seeder

Treatment	Total weeds density(Grasses, Sedges and BLW)			Total weeds dry matter(Grasses, Sedges and BLW)			Weed control efficiency (%)		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	2.37(4.67)	2.37(4.67)	2.45(5.00)	2.70(6.32)	3.20(9.33)	3.78(13.39)	87.19	87.98	89.17
T_2	8.56(72.33)	9.90(97.00)	10.71(113.67)	7.09(49.31)	8.83(77.67)	11.12(123.67)	0.00	0.00	0.00
T_3	4.28(17.33)	3.41(10.67)	5.97(34.67)	3.96(14.75)	4.39(18.33)	6.83(45.67)	70.09	76.39	63.07
T_4	6.42(40.33)	7.30(52.33)	8.00(63.00)	5.26(26.85)	6.75(44.57)	8.62(73.33)	45.55	42.62	40.70
T_5	4.36(18.00)	6.05(35.67)	7.14(50.00)	4.21(16.82)	6.04(35.53)	8.16(65.60)	65.90	54.25	46.95
T_6	3.96(14.67)	2.89(7.33)	4.69(21.00)	3.62(12.13)	3.43(10.83)	5.73(31.87)	75.39	86.05	74.23
T_7	2.93(7.67)	3.46(11.00)	4.89(23.00)	3.07(8.47)	3.82(13.61)	6.04(35.50)	82.83	82.48	71.29
T_8	4.58(20.00)	3.25(9.67)	5.79(32.67)	4.40(18.47)	4.31(17.60)	6.64(43.37)	62.55	77.34	64.93
S.Em. ±	0.18	0.14	0.21	0.18	0.22	0.98			
CD (p=0.05)	0.54	0.43	0.65	0.54	0.66	0.32			

T1 – Weed free check (repeated hand weeding at 10 days intervals), T2 – Unweeded check, T3 – Two hand weeding at 20 and 40 DAS ,T4 – Metamifop @100 g a.i ha^{-1} at 3rd stage as PoE; T5 – Pretilachlor + safener @ 0.4 kg a.i ha^{-1} at 3 days after seeding as PE, T6 – Bispyribac sodium @ 25g a.i ha^{-1} 25 days after seeding as PoE; T7 – Cyhalofop-butyl @ 100 g a.i ha-^{1} + (Chlorimuron-ethyl + metsulfuron methyl) @ 4g a.i. ha^{-1} at 15 days after seeding as PoE; T8 – Pretilachlor + safener @ 0.4 kg a.i ha-1 at 3 days after seeding + Hand weeding at 40 DAS; Figures in parenthesis are means of original value that is transformed by √(X + 1) and given outside parenthesis, DAS- Days after sowing, PE- Pre emergent, PoE- Post emergent and BLW- Broad leaved weeds

practices, weed free check (T_1) had significantly reduced the weed density (2.37, 2.37 and 2.45 No. m^{-2}), weed dry matter (2.70, 3.20 and 3.78 g m^{-2}) and registered the highest weed control efficiency (87.19, 87.98 and 89.17 %) at 30, 60 and 90 DAS respectively (Table 1). Whereas among different herbicides at 30 DAS the application of cyhalofop-butyl @ 100 g a.i ha^{-1} + (Chlorimuron-ethyl + metsulfuron-methyl) @ 4g a.i ha^{-1} as a tank mixture (T_7) has reported the lower weed density (2.93No. m^{-2}), weed dry matter (3.07g m^{-2}) and highest weed control efficiency (82.83%) the reason would be due to high bio efficacy of herbicide mixture of cyhalofop-butyl + Chlorimuron-ethyl + metsulfuron-methyl in controlling the wide range weed species such as grasses, sedges and broad leaved weeds. It is attributed that grasses were effectively controlled by cyhalofop-butyl @ 100 g a.i ha^{-1} as reported by Kumar *et al.* (2012). While sedges and broad leaved weeds density were controlled by (Chlorimuron-ethyl + metsulfuron-methyl) @ 4g a.i ha^{-1} and similar result was also observed by Singh and Tiwari (2005). At 60 and 90 DAS bispyribac sodium 25 DAS @ 25 g a.i ha^{-1} as PoE (T_6) has lowered the weed density (2.89 and 4.69No. m^{-2} respectively), weed dry matter (3.43 and 5.73 g m^{-2} respectively) and recorded the highest weed control efficiency (86.05 and 74.23% respectively) this was due to absolute control of different weed flora by the broad spectrum herbicide, these findings were in accordance with the findings of Ramachandran *et al.* (2010) and Yadev *et al.* (2009). Highest weed density (8.56, 9.90 and 10.71 No. m^{-2}), weed dry matter (7.09, 8.83 and 11.12 g m^{-2}) and lowest weed control efficiency (0.00%) recorded in unweeded check (T_2) at 30, 60 and 90 DAS respectively. And this result correlated with the findings of Mallikarjun *et al.* (2014).

Effect on crop

Effect on growth parameters

Plant height, plant dry matter production and number of tillers per meter square (Table 2) varied significantly at 60 and 90 DAS. Whereas, at 30 DAS plant height and crop dry matter production not statistically significant. Among different weed management practices bispyribac sodium 25 DAS @ 25 g a.i ha^{-1} as PoE (T_6), has registered the higher growth parameters viz., Plant height (70.67 and 92.33 cm respectively), crop dry matter production (100 and 848.67 g m^{-2} respectively) and number of tillers per meter square(417 and 492 respectively)(Table 2) and which was on par with cyhalofop-butyl @ 100 g a.i ha^{-1} + (Chlorimuron-ethyl + metsulfuron-methyl) @ 4g a.i ha^{-1} as a tank mixture (T_7), Pretilachlor + safener @ 0.4 kg a.i ha^{-1} at 3 days after seeding + hand weeding at 40 DAS (T_8) and two hand weedings at 20 and 40 DAS (T_3) next to weed free check (Plant height (73.50 and 96.68 cm respectively), crop dry matter production (104 and 851.94 g

Table 2: Effect of weed management practices on growth parameters of direct wet seeded rice sown through drum seeder

Treatment	Plant height (cm)			Plant dry matter production (g m^{-2})			Number of tillers (m^{-2})		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	41.38	73.50	96.68	58.50	104.10	851.94	203	424	499
T_2	32.33	45.00	66.83	46.37	53.33	506.93	162	244	279
T_3	33.00	66.78	86.33	49.73	93.00	826.00	196	403	482
T_4	35.23	58.00	73.00	48.93	68.33	670.67	180	324	417
T_5	35.53	59.67	75.00	47.67	70.00	679.67	192	333	420
T_6	37.87	70.67	92.33	54.63	100.00	848.67	200	417	492
T_7	35.67	69.33	89.93	52.53	98.00	843.67	199	411	489
T_8	38.55	67.33	87.00	50.33	96.43	835.2	198	406	485
S.Em. ±	3.20	2.05	2.95	4.20	3.13	26.42	6.05	17.76	13.06
CD (p=0.05)	NS	6.23	8.94	NS	9.48	80.13	18.35	53.88	39.61

T_1 – Weed free check (repeated hand weeding at 10 days intervals), T_2 – Unweeded check, T_3 – Two hand weeding at 20 and 40 DAS; T_4 – Metamifop @100 g a.i ha^{-1} at 3rd stage as PoE, T_5 – Pretilachlor + safener @ 0.4 kg a.i ha^{-1} at 3 days after seeding as PE; T_6 – Bispyribac sodium @ 25g a.i ha^{-1} 25 days after seeding as PoE ; T_7 – Cyhalofop-butyl @ 100 g a.i ha^{-1} + (Chlorimuron-ethyl + metsulfuron methyl) @ 4g a.i.ha^{-1} at 15 days after seeding as PoE; T_8 – Pretilachlor + safener @ 0.4 kg a.i ha^{-1} at 3 days after seeding + Hand weeding at 40 DAS; PE- Pre emergent, PoE- Post emergent, NS- Non significant, DAS- Days after sowing

Table 3: Effect of weed management practices on yield parameters, grain yield, straw yield and harvest index of direct wet seeded rice sown through drum seeder

Treatment	No. of panicles m^{-2}	Panicle length (cm)	Filled grains panicle^{-1}	Test weight (g)	Grain yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})	Harvest index
T_1	497	21.59	107	22.5	5800	7000	0.45
T_2	273	16	61	20.33	2378	3500	0.41
T_3	478	19.08	98	21.33	5000	6100	0.45
T_4	413	17.67	85	20.5	3467	4526	0.43
T_5	415	17.93	87	21	3909	4993	0.44
T_6	489	21.28	103	22	5367	6500	0.45
T_7	484	20	100	21.67	5233	6333	0.45
T_8	481	19.12	99	21.5	5100	6200	0.45
S.Em. ±	14.04	0.54	2.93	0.8	136.47	158	0.03
CD (p=0.05)	42.58	1.65	8.88	NS	414	478	NS

T_1 – Weed free check (repeated hand weeding at 10 days intervals), T_2 – Unweeded check, T_3 – Two hand weeding at 20 and 40 DAS; T_4 – Metamifop @100 g a.i ha^{-1} at 3rd stage as PoE, T_5 – Pretilachlor + safener @ 0.4 kg a.i ha^{-1} at 3 days after seeding as PE; T_6 – Bispyribac sodium @ 25g a.i ha^{-1} 25 days after seeding as PoE; T_7 – Cyhalofop-butyl @ 100 g a.i ha^{-1} + (Chlorimuron-ethyl + metsulfuron methyl) @ 4g a.i.ha^{-1} at 15 days after seeding as PoE; T_8 – Pretilachlor + safener @ 0.4 kg a.i ha^{-1} at 3 days after seeding + Hand weeding at 40 DAS; PE- Pre emergent, PoE- Post emergent, NS- Non significant, DAS- Days after sowing.

m^{-2} respectively) and number of tillers per meter square (424 and 499 respectively)) (T_1) this may be due to broad spectrum of weed control, less weed competition throughout crop growth period and selectivity to rice crop. Similar result was also observed by Narendra (2011), Subhash Babu *et al.* (2008) and Ramana *et al.* (2007). Lowest growth parameters viz,, Plant height (45.00 and 66.83 cm respectively), crop dry matter production (53.33 and 506.93 g m^{-2} respectively) and number of tillers per meter square (244 and 279 respectively) observed in weedy check (T_2) fb metamifop @100 g a.i ha^{-1} at 3rd stage (T_4) and pretilachlor + safener (@ 0.4 kg a.i ha^{-1} at 3 DAS) in (T_5). Severe weed competition exerted by weeds for the available resources throughout the crop growth period might have lowered the plant height, dry matter production and number of tillers under unweeded check. Similar result was also reported by Porpavai *et al.* (2006).

Effect on yield attributes

The yield attributes *viz.* number of panicles per meter square (497), panicle length (21.59 cm) and number of grains per panicle (107) were recorded highest in weed free check (T_1), (Table 3) mainly due to the lowest weed dry weight and highest weed control efficiency. Among the weed control treatments, the highest yield attributes viz., number of panicles per meter square (489), panicle length (21.28 cm) and number of grains per panicle (103) were recorded with bispyribac sodium 25 DAS @ 25 g a.i ha^{-1} as PoE (T_6) fb cyhalofop-butyl @ 100 g a.i ha^{-1} + (Chlorimuron-ethyl + metsulfuron-methyl) @ 4g a.i ha^{-1} as a tank mixture (T_7), pretilachlor + safener @ 0.4 kg a.i ha^{-1} at 3 days after seeding + hand weeding at 40 DAS (T_8) and two hand weedings at 20 and 40 DAS (T_3) this was mainly due to lowest weed-crop competition during the crop growth (Table 3). And no significant difference was observed in 1,000-grain weight. Similar findings were also reported by Singh and Pairka (2014), AICRPWC (2010), Porpavai *et al.* (2006) and Vaiyapuri *et al.* (1999).

Effect on grain and straw yield

The result indicated that all the weed control treatments brought out a significant effect on yield of direct wet seeded rice as compared to unweeded check (Table 3). The significantly highest grain yield and straw yield were recorded in weed free (5800 and 7000 kg ha^{-1} respectively) treatment (T_1). Among the weed control treatments bispyribac sodium (@ 25g a.i ha^{-1}) at 25 DAS as PoE (T_6) recorded the highest grain yield and straw yield (5367 and 6500 Kg ha^{-1}) and which was on par with cyhalofop-butyl (100 g a.i ha^{-1}) + chlorimuron-ethyl + metsulfuron-methyl (@ 4g a.i ha^{-1}) at 15 days after seeding as PoE (T_7), pretilachlor + safener (0.4 kg a.i ha^{-1} at 3 days after seeding) + Hand weeding at 40 DAS (T_8) and two hand weeding at 20 and 40 DAS (T_3). The higher grain and straw yield were mainly due to the favourable condition created through the efficient weed control resulted in lesser weeds competition to the crop by reducing weed density, weed dry matter and better weed control efficiency, which favoured crop to produce more plant dry matter, increased productive tillers over unweeded check. The findings were in agreement with the earlier reports of Veeraputhiarn and Balasubramanian (2010), Narendra (2011), Kumaran (2012), Porpavai *et al.* (2006) and Ramesh and Veerabadran (1997). Significantly lower grain(3467 kg ha^{-1}) and straw yield(4526kg ha^{-1}) were observed in metamifop (100 g a.i ha^{-1} at 3rd leaf stage) as PoE (T_4) whereas, 3909 and 4993kg $ha^{-1}$of grain and straw yield were reported when pretilachlor + safener (0.4 kg a.i ha^{-1} at 3 days after seeding) as PE (T_5) was applied. The reduction in grain and straw yield in these treatments along with unweeded check (2378 and 3500 kg ha^{-1}) was mainly due to decrease in growth and yield components of rice under increased pressure of weed competition for space, light, nutrients and these results were in accordance with Sangeetha (2006) and Singh and Pairka (2014).

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