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INTEGRATED WEED MANAGEMENT IN DIRECT SEEDED RICE UNDER IRRIGATED CONDITION (*Oryza sativa L.*)

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ABSTRACT
A field experiment was conducted in *Kharif* season of 2015 at, J.N.K.V.V. College of Agriculture, Instructional Farm, Rewa (M.P.) under All India Coordinated Rice Improvement Project to study- "Integrated Weed Management in Direct Seeded Rice under Irrigated Condition (*Oryza sativa L.*)". The treatments comprised ten weed control methods which were laid out in randomized block design with three replications. The rice variety IR-64 was line sown under irrigated condition keeping seed rate 50 kg/ha and distances between rows 20 cm. The crop was grown as per recommended package of practices. The Study revealed that amongst the different weed control treatments, the equally highest grain yield (40.39 to 40.72q/ha) were obtained under pendimethalin + bispyribac sodium or 2,4-D (T_2 and T_3) and from butachlor + bispyribac sodium (T_6) treatments. The highest weed control efficiency (78.12%)and net income (Rs. 38612 /ha) was achieved under T_6 (Butachlor @1.5kg/ha(4DAS) + bispyribac sodium @ 35g/ha (20DAS) followed by T_2(pendimethalin@1.00kg/ha(4DAS) + bispyribac sodium @ 35g/ha (20DAS) 77.97% and Rs. 37.346/ha respectively.

INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food of almost 3 billion people, that is, about 50% of the world's population. Rice fields cover around 155 Mha, more than any other crop. Thus, the rice systems belong to the most important food production systems on Earth. Annual production of rice is about 700 MT in world. Most of the rice in tropical countries is produced in irrigated and rainfed lowland areas. Irrigated rice systems account for 78% of all rice production but only 55% of total harvested rice area is concentrated on alluvial floodplains, terraces, inland valleys, and deltas in the humid and sub-humid subtropics and humid tropics of Asia (Pathak et al., 2011). Rice contributes 43% of total food grain production and 46% of the total cereal production of the country, and plays a vital role in the national food grain supply. It is the most important crop of Vindhya region of Madhya Pradesh and is sown with different methods under upland and low land conditions. Rice is grown in an area of about 1.73 M ha with production of 1.89 M t.There is rapid switch over from traditional seeding to direct seeded rice (DSR) over the years due to lesser and timely availability of labors. In direct seeded rice (DSR), conditions are more favorable for the germination of weeds, which competes with rice for nutrients, moisture, sun light and space causing large yield losses. The most dominant weed flora of direct seeded rice were *Echinochloa colona*, *Commelinai commuins and Caesuliaaxillaris* (Dixit and Bhan 2003 and bhimwal and pandey, 2014). Weed completion is very serious during early growth stages (15-30 DAS),Yield in direct seeded rice (DSR) is often lower than traditionally planted rice (TPR) principally owing to poor crop stand and high weed infestation (Naresh *et al.,* 2010). Moreover, cost for weed control is usually higher than TPR. High weed infestation is a major constraint for broader adoption of DSR (Rao *et al.,* 2007). Therefore weed management is a major concern in direct seeded rice particularly at initial stage of crop growth to minimize the yield losses at later stage.

The direct seeding of rice under rainfed upland conditions create serious weed problem. Hand weeding is commonly followed which is time consuming, costly and may be delayed due to unavailability of labor. Under such conditions, chemical weed control has been found most beneficial. The application of herbicides combined with other methods such as cultural, mechanical and chemical are used for weed control leads to the reduction of weedy species and having impacts on farmland biodiversity and ecosystem function (Storkey et al., 2012). The control of weeds in the upland rice has been manifested in the recent past through the use of pre and post emergence herbicide (Singh *et al.*, 2001). The herbicides being selective may not be effective against all species of weeds (grassy, sedges and broad-leaved). Hence their performance alone as well as in combination with other herbicides is required time to time an account of the fact that new herbicides (pre and post emergence both) have been found more effective. Pre-emergence and post-emergence herbicide like pretilachlor, cyhalofop and pretilachlor+ WCAI effectively controlled weeds.Bispyribacsodium or pretilachlor + weed control action indicator (WCAI) effectively controlled weeds.

(Ramachandiran *et al.*, 2012, Chauhan *et al.*, 2015 and Raghavendra *et al.*, 2015). Keeping these facts in view the experiment was taken on the newly introduced post-emergence herbicides applied in combination with the existing herbicide.Objective of this paper was to find out the effect of weed control methods on weed flora and on growth and yield of rice under Irrigated conditions, best method of weed control under irrigated condition and to develop cost effective weed management in irrigated rice system.

MATERIALS AND METHODS

The present experiment was carried out at the JNKVV Regional Research Station, College Farm, Rewa (M.P.) during *Kharif* season of 2015 to study the integrated weed management on growth and yield of direct seeded rice var. IR-64. The soil texture was silty clay-loam having pH 7.5, electrical conductivity 0.45 dS/m, organic carbon 0.70%, available N 295 kg/ha, available P_2O_5 18.6 kg/ha and available K_2O 324 kg/ha. The total rainfall received during the crop season was 689.2 mm with 37 rainy days. There were ten integrated weed control treatments which were laid out in randomized block design keeping three replications. Ten integrated weed control treatments are Pendimethalin (30EC) @1.00Kg a.i.per ha (3-4 DAS)- T_1, Pendimethalin (30EC) @1.00Kg a.i. per ha.(3-4 DAS) + Bispyribac sodium (10%SC) @ 35gm a.i. per ha (15-20DAS)-T_2, Pendimethalin (30EC) @1.00Kg a.i. per ha. (3-4 DAS) + 2,4D Na Salt (80WP) @ 0.06 Kg a.i. per ha. (20-25DAS)-T_3, Pendimethalin (30EC) @1.00Kg a.i. per ha.(3-4 DAS) + (Chorimuron + Metsulfuronmethyl) 20WP @ 40gm a.i. per ha.(25-30 DAS)-T_4, Butachlor (50EC) @1.5Kg a.i.per ha.(3-4 DAS)-T_5, Butachlor (50EC) @1.5Kg a.i.per ha.(3-4 DAS) + Bispyribac sodium (10%SC) @ 35gm a.i. per(15-20DAS)-T_6, Butachlor (50EC) @1.5 Kg a.i.per ha.(3-4 DAS) + 2,4D,Na Salt(80WP)@0.06Kg a.i. per ha.(20-25DAS)-T_7, Butachlor (30EC) @1.5Kg a.i.per ha.(3-4 DAS) + (Chorimuron + Metsulfuronmethyl) 20WP @ 40gm a.i. per ha.(25-30 DAS)-T_8, Mechanical weeding /hand weeding at 20 & 45 DAS-T_9 and Un weeded check (control)-T_{10}. The plot size was 3x4 m^2. The rice crop var. IR-64 was sown on 2 July, 2015 by line sowing keeping seed rate of 100 kg/ha and 20 cm distance between rows. The fertilizer was applied @ 80 kg N, 60 kg P_2O_5 and 40 kg K_2O and 20 kg Zn SO4 /ha in the form of urea, single superphosphate, muriate of potash, and Zinc sulphate, respectively. Phosphorus and potash fertilizers were applied as basal and nitrogen was applied in three splits. The weed control treatments were applied as per well decided specifications. The crop was harvested on 21 October 2015. The periodical observations were recorded and the data were statistically computed before presenting the results.

RESULTS AND DISCUSSION

Studies on weeds

The most common weed-flora observed in the experimental field were *Parthanium sp*. *Paspalum sp, Setarnia sp, Cynodon dactylon, Echinochloa colonum, Panicum sp*. as grassy weeds; *Cyperus rotandus and Cyperas esculen*tus as sedges and Digra arvensis, Anagalis arvensis, *Launea sp.,Celasia angentia, Eclipta alba, Euphorbia hirta* as broad-leaved weeds.

Amongst the monocot (grassy weeds) Echimochloa sp. and cynodon dactylon were maximum with weed desity 25.7 to 31.7 %.Amongst dicot weeds, the above mentioned six types of weeds were ranged from.

All the herbicidal and HW treatments proved significantly superior to unweeded control with respect to number of weeds/ m^2fresh and dry weight of weeds/ m^2. The treatments having dual herbicides (pendimethalin with 2,4-D or chorimuron + metsulfuronmethyl with bispyribac sodium *i.e.*(T_2, T_3,T_4), butachlor with 2, 4-D or chorimuron + metsulfuronmethyl or bispyribac sodium (T_6, T_7,T_8) proved the best substitute of hand weeding twice(T_9) and proved significantly superior to single application of these herbicides (T_1 andT_5).

The above treatments T_2, T_3,T_4,T_6, T_7, andT_8 having dual herbicides resulted in higher WCE (68.38 to 77.97%), as where T_1 andT_5 having single herbicide resulted in lowest WCE (13.47 to 16.02%). The treatments showing higher WCE resulted in lower weed index (WI) where as the reverse trend persisted where WCE were in the lower range.

Growth parameters of rice

The plant height and tillers/m^2 were recorded periodically at 30, 60 DAS and at the harvest stage. Both these growth parameters were in general enhanced steadily with the advancement of plant growth up to the maturity stage of crop

Table 1: Weed studies in Direct seeded rice as influenced by integrated weed management

Treatments	Total no. of weeds/m^2		Fresh wt. of weeds/m^2(g)		Dry. wt. of weeds/m^2(g)		Weed control efficiency (%)	Weed index (%)
	Before	After	Before	After	Before	After		
T1	102.66	70.10	298.79	105.99	108.53	98.36	13.47	36.33
T2	90.20	15.63	441.67	63.87	173.60	25.35	77.97	19.07
T3	78.69	26.12	383.33	126.90	91.94	35.48	69.18	8.37
T4	80.22	19.25	395.00	86.22	143.70	33.55	70.85	2.72
T5	98.81	65.51	295.07	99.05	102.62	95.34	16.02	37.97
T6	76.32	13.28	365.00	57.55	176.90	25.19	78.12	17.36
T7	74.92	21.18	361.67	91.88	125.33	36.15	68.60	6.89
T8	73.80	20.13	351.67	90 .24	133.53	36.50	68.38	7.63
T9	76.33	39.70	300.00	186.97	83.87	35.19	69.43	0.00
T10	105.35	75.13	612.18	443.37	109.83	99.44	0.00	36.70
S.Em ±	1.24	1.02	18.74	13.15	7.04	4.87		
C.D. (P=0.05)	3.64	2.98	54.96	38.96	20.64	14.27		

Table 2: Growth, parameters of direct seeded rice as influenced by integrated weed management

Treatments	Plant population /m2	Plant height (cm)	Tillers /m2	Panicles /m2	Grains /Panicle	Filled grains/ panicle	Unfilled grains/ panicle	Test weight (gm)	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index	Net income (Rs./ha)	B:C ratio
T1	49.07	105.00	320.12	315.76	107.07	71.95	35.12	21.64	30.38	38.97	38.73	26243	1.98
T2	50.11	110.39	329.08	318.90	138.78	118.13	20.65	24.97	40.72	47.22	43.42	37346	2.36
T3	48.09	109.37	328.18	318.28	135.37	113.00	22.37	24.95	40.00	48.71	35.57	37110	2.39
T4	51.07	105.88	325.16	315.17	143.32	120.30	23.02	24.87	37.92	51.75	47.73	34151	2.28
T5	50.16	103.60	319.11	312.22	105.49	70.92	34.57	20.21	29.50	38.48	31.25	20176	1.74
T6	49.37	102.69	328.14	317.19	140.93	118.60	22.33	23.49	40.39	57.37	43.45	38612	2.46
T7	48.07	103.69	320.12	312.97	138.37	116.65	21.72	24.69	38.92	48.88	38.24	35003	2.29
T8	47.65	108.41	329.36	316.36	142.38	121.10	21.28	24.68	35.23	59.40	37.08	30190	2.11
T9	48.98	106.04	324.39	315.91	133.15	118.17	14.98	24.27	37.58	62.41	35.25	30441	1.99
T10	50.09	107.31	282.44	272.29	108.68	74.67	34.01	22.63	26.83	41.15	33.82	7971	1.31
S.Em ±	0.32	0.52	0.34	0.29	0.72	0.33	0.86	0.85	1.82	1.20	0.84		
C.D. (P=0.05)	0.94	1.53	1.00	0.84	2.17	0.96	2.34	3.46	5.35	3.52	2.47		

irrespective of the treatments influence. The plant height ranged from lowest 39.77 cm to maximum 46.76cm at 30 days stage, whereas the same was recorded from lowest (102.69 cm) to highest (10.39 cm) at the harvest stage. The number of tillers/ m^2 ranged from 169.19 to 237.94/m^2 at 30 day stage, whereas at the harvest stage these were ranged from 284.44 to 329.36/ m^2.

As regards with the treatments effect, the plant height as well as formation of tillers/m^2 was found significantly higher in case of T_2 and T_3 at every stage of observations. Thus amongst the IWM herbicidal treatments, T_2 and T_3 having pendimethalin with bispyribac sodium or 2,4-D exerted equal impact up on these parameters as that of hand weeding twice at every stage of observations. All the weed control treatments (T_1 to T_9) were found significantly superior to unweeded control (T_{10}) with respect to increase growth parameters at every stage of observations. Conclusively, the best treatments were T_2 and T_3 equal to that of hand weeding twice (T_9).

Yield attributing characters

Amongst the weed control treatments, T_2(pendimethalin @ 1.00 kg/ha (4 DAS) + bispyribac sodium @ 35 g/ha (20 DAS), T_3(pendimethalin @ 1.00 kg/ha (4 DAS) + 2,4-D Na Salt @0.06 kg/ha(25 DAS),and T_6 (Butachlor @ 1.5 kg/ha (4 DAS) + bispyribac sodium @ 35g/ha (20 DAS) brought about almost significantly higher panicles/m^2 total and filled grains /panicle and 1000 grain weight over most of the other treatments. These three herbicidal treatments were found to be equally effective and comparable with that of, Two hand weeding (T_9).

The treatment T_7 also proved equally better in encouraging yield attributing parameters as in case of other integrated weed management treatments (T_2, T_3 and T_6). All the weed control treatments (T_1 to T_9) proved significantly superior to unweeded control (T_{10}).

The unweeded control recorded significantly higher unfilled grains up to 34.01/panicle over all the remaining weed control treatments. The highly reduced number of unfilled grains/ panicle was recorded in case of T_2, T_8, T_4 and T_9 treatments (14.98 to 21.28/panicle). This was nearly half of the panicle number recorded in case of T_{10} (unweeded control) treatment.

Productivity parameters

Amongst the weed control treatments T_2 (pendimethalin @ 1.00 kg/ha (4 DAS) + bispyribac sodium @ 35g/ha (20 DAS), T_3(pendimethalin @ 1.00 kg/ha (4 DAS) + 2,4-D Na Salt @ 0.06 kg/ha(25 DAS),and T_6 (Butachlor @ 1.5 kg/ha (4 DAS) + bispyribac sodium @ 35g/ha (20 DAS) registered significantly higher grain yield up to 40.39 to 40.72 q/ha. This was followed by T_7 and T_9 treatments producing 38.92 and 37.58 q/ha grain respectively. The trend of influence of different treatments upon straw yield and harvest index was not found the same. The treatment T_2, T_4 and T_6 recorded the highest harvest index (43.42 to 47.73 %) where the straw yield was also found in the higher range. It was the higher grain yield in T_2 and T_6 treatments which raised the harvest index up to maximum extent. The other treatments like T_1, T_2, T_7 and T_8 also recorded equally higher harvest index (35.25 to 43.42%).

In case of unweeded control T_{10} and T_1, the straw yield was found significantly lowest (38.97 to 41.15 q/ha) over all other treatments, however this trend was not observed in case of harvest index. The treatments T_5 and T_{10} recorded equally lowest harvest index (31.25 to 33.82%).

Economical gain/ha

Application of butachlor + bispyribac sodium (T_6) gave the highest net income up to Rs. 38612/ha with B:C ratio 2.46. Almost equally higher net income was also obtained from T_2 and T_3, having pendimethalin + 2 4-D with bispyribac sodium (Rs. 37110 to Rs. 37346 /ha) with B: C ratio 2.36 to 2.39. It is apparent from these data that the application of the dual herbicides as in T_2, T_3 and T_6 may be the best substitute of hand weeding twice (T_9).

In case of other treatments, the net income decreased according to the extent of effectiveness of herbicide treatments. The treatments T_4 and T_7 gave equal net income. Similarly, T_8 and T_9 also gave the second range of identical net income(Rs.34151 to Rs.35003 /ha). There after the lower net income (Rs. 30190 to 30441/ha) was obtained from T_8 and T_9 treatments. The lowest net income only Rs.7971 /ha with B:C ratio 1.31 was recorded in case of unweeded control (T_{10}).

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