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RESEARCH ARTICLE

Weed management in dry direct-seeded rice under rainfed ecology of Southern Chhattisgarh

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ABSTRACT

A field study was conducted during rainy (*Kharif*) seasons of 2019, 2020 and 2021 at S.G. College of Agriculture and Research Station, IGKV, Jagdalpur, Chhattisgarh to identify effective and economical weed management measure in dry direct-seeded rice in view of the importance of weeds in successful direct-seeded rice production. Hand weeding twice at 20 and 40 days after seeding (DAS) led to significant reduction of grassy, broad-leaved weeds and sedges and was at par with post-emergence application (PoE) of ethoxysulfuron 18 g/ha. Hand weeding twice at 20 and 40 DAS has significantly increased the tillers/m^2, panicles/m^2, seeds/panicle, 1000 seed weight and grain yield of dry direct-seeded rice. Both bispyribac-Na 25 g/ha PoE and pyrazosulfuron 25 g/ha PoE were as effective as hand weeding twice at 20 and 40 DAS in attaining higher weed control efficiency, enhancing rice growth parameters and yield of dry direct-seeded rice.

Keywords: Dry direct-seeded rice, Ethoxysulfuron, Hand weeding, Herbicides, Pyrazosulfuron, Weed management

INTRODUCTION

Rice is a major cereal in Indian diet and feeds almost 80% population of country. Rice covers 43.8 Mha with production of 116.4 mt, which share 40.86% of total food grain production of India. India has its average productivity of 2.66 t/ha (GoI 2020). Rice occupies 3.60 Mha with productivity ranging 1.2 to 1.6 t/ha under rainfed ecology in Chhattisgarh. Productivity (1.46 t/ha) of Chhattisgarh state is much lower than national yield due to many factors like weeds, timeliness, management of crop (Directorate Agriculture, Chhattisgarh 2020). The southern Chhattisgarh covers 39.06 lakh ha geographical area and 6.40 lakh ha cultivated lands. Among many factors for low rice productivity, the loss due to weeds infestations is of paramount important. Weeds are most serious biological menace in crop production and weeds itself cause 33% of losses due to pests (Verma *et al*. 2015). Irrespective of the method of crop establishment, weeds are a main culprit in rice farming due to their inherent character to compete for growth resources. In general, weeds infest more in direct-seeded rice (DSR) as compared to transplanted rice (Rao *et al*. 2007). Weeds have capacity to grow faster and dominate the crop habitat due to high adaptability and reduce the yield of crop. The dry aerobic rice system is prone to greater infestation of weeds during initial 45 days and weed infestation in DSR results in higher yield loss. Weeds can reduce the grain yield of DSR by 75.8% (Singh *et al*. 2004). Hence, efficient weed management in DSR is main critical issue for attaining optimum rice productivity (Rao *et al*. 2015). Therefore, the present study was undertaken to identify effective and economically sustainable weed management practices in dry direct-seeded rice under rainfed agro-ecology.

MATERIALS AND MTHODS

A field experiment was conducted during rainy (*Kharif*) seasons of 2019, 2020 and 2021at S.G. College of Agriculture and Research Station, IGKV, Jagdalpur, Chhattisgarh. The soil of the experimental site was sandy loam and neutral in pH (6.95) with an EC of 0.35 dS/m. It was low in organic carbon content (0.39%), low in nitrogen (153.93 kg/ha), medium in phosphorus (47.75 kg/ha) and high potassium (302.15 kg/ha). Six herbicidal treatments, *viz*. post-emergence application (PoE) of ethoxysulfuron 18 g/ha, bispyribac-Na 25 g/ha, pyrazosulfuron 25 g/ha, penoxsulam 22.5 g/ha PoE, hand weeding twice at 20 and 40 days after sowing (DAS) and weedy check were arranged in a randomized block design (RBD) with four replications. Each plot size was 5 x 5 m (25 m^2). All the herbicides were applied at 15 DAS using a

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knapsack sprayer with a flat-fan nozzle in stock solution of 500 litres/ha. Rice seeds were sown after optimal tilth by maintaining row spacing of 20 cm. Later, seed sown furrows were covered with soil to ensure proper germination of rice seeds. Recommended dose of fertilizers (80:60:40 kg N:P:K/ ha) were applied and 50% nitrogen and total phosphorus and potash were given as basal dose and remaining 50% nitrogen was top dressed at 40 DAS. Other agronomic and plant protection measures during the crop growth were followed as per the recommendation. Quadrat (0.25 m^2) was randomly placed at three places in each of the plot to count weeds prior to uprooting the weeds for biomass measurement. Weed control efficiency of treatments were computed by comparing the control plot. Roots of weeds were separated at root-shoot junction, the foliage of weeds were subjected to oven drying at 65°C for 48 hours and then biomass was recorded. Using biomass, weed control efficiency was computed (Tawaha *et al*. 2002). Grain yield was recorded after harvesting in net plot and converted the yield into t/ha. The data of each year was analyzed separately in OPSTAT for statistical analysis and means were compared using least significant difference (LSD) at p=0.05. The weed data were transformed by square root transformation ("x+0.5) and transformed data were subjected to ANOVA analysis (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Effect on weeds

Cynodon dactylon L., *Cyperus iria* L., *Echinochloa colona* (L.) Link., *Rotala indica* (Willd.) Koehne, *Spilanthes acmella* (L.) Murray, *Ludwigia perennis* L., *Commelina nudiflora* L., *Ludwigia octovalvis* (Jacq.) P.H. Raven., *Oplismenus burmannii* (Retz.) P. Beauv., *Ammannia baccifera* L., *Brachiaria reptans* (L.) C.A. Gardner and C.E. Hubb., *Sacciolepis indica* (L.) Chase., *and Cyperus difformis L.* were the dominant weeds in the study area.

Hand weeding twice at 20 and 40 DAS caused significant reduction of grasses, broad-leaved weeds (BLWs) and sedges density and biomass as compared to other weed control treatments and was being at par with ethoxysulfuron at 18 g/ha PoE and bispyribac-Na 25 g/ha PoE was equally effective in reduction of density of grasses, BLWs and sedges. The reduction in density of weeds is coupled with efficient suppression of weed flora with hand weeding twice (Singh *et al*. 2007). However, during 2019, bispyribac-Na was not found significantly effective. It was observed that sedges were not controlled effectively with ethoxysulfuron at 18 g/ha PoE during three years of study. The highest weed density and biomass were recorded in weedy check (**Table 1** and **2**). These results are in conformity with the findings of Pradhan *et al*. (2012), Jason *et al* (2007) and Mishra *et al*. (2007).

The higher weed control efficiency was observed with hand weeding twice at 20 and 40 DAS, which was significantly superior over rest of the weed control treatments. Among the herbicidal treatments, application of ethoxysulfuron at 18 g/ha PoE and bispyribac-Na at 25 g/ha PoE were equally effective in attaining higher weed control efficiency during three years of experimentation. Penoxsulam at 25.6 g/ha PoE was more effective than pyrazosulfuron at 25 g/ha PoE in direct-seeded rice and the lowest WCE was recorded under weedy check (**Table 4**) due to remarkably higher weed

Table 1. Effect of weed control treatments on weed density in dry direct-seeded rice

Treatment	Weed density (no./m^2)								
	Grasses			Broad-leaved weeds			Sedges		
	2019	2020	2021	2019	2020	2021	2019	2020	2021
Ethoxysulfuron 18 g/ha PoE	3.58 (12.34)	3.78 (13.82)	4.00 (15.48)	4.46 (19.36)	4.71 (21.68)	4.98 (24.28)	3.05 (8.79)	3.39 (10.99)	3.58 (12.31)
Bispyribac-Na 25 g/ha PoE	4.89 (23.41)	5.48 (26.22)	6.13 (29.37)	7.67 (36.72)	8.59 (41.13)	9.62 (46.06)	3.48 (16.67)	4.35 (20.85)	4.88 (23.35)
Pyrazosulfuron 25 g/ha PoE	6.64 (43.54)	7.43 (48.76)	8.32 (54.62)	10.41 (68.30)	11.66 (76.49)	13.06 (85.67)	4.73 (31.01)	5.91 (38.78)	6.62 (43.43)
Penoxsulam 25.6 g/ha PoE	6.10 (36.75)	6.84 (41.16)	7.66 (46.10)	9.57 (57.65)	10.72 (64.56)	12.01 (72.31)	4.35 (26.17)	5.44 (32.73)	6.09 (36.66)
Hand weeding twice at 20 and 40 DAS	2.72 (6.92)	3.05 (7.75)	3.42 (8.68)	4.27 (10.85)	4.79 (12.16)	5.36 (13.62)	1.94 (4.93)	2.43 (6.16)	2.72 (6.90)
Weedy check	8.24 (67.34)	9.22 (75.42)	10.33 (84.47)	12.92 (105.63)	14.47 (118.31)	16.21 (132.50)	5.87 (47.96)	7.34 (59.97)	8.22 (67.17)
LSD (p=0.05)	0.88	1.08	1.12	2.08	2.56	1.85	1.39	1.43	0.94

*The data in parentheses were transformed with square root transformation $\sqrt{x+0.5}$; PoE = post-emergence, DAS= days after seeding

Table 2. Effect of weed control treatments on weed biomass in dry direct-seeded rice

Treatment	Weed biomass (g/m²)								
	Grasses			Broad-leaved weeds			Sedges		
	2019	2020	2021	2019	2020	2021	2019	2020	2021
Ethoxysulfuron 18 g/ha PoE	1.86 (2.96)	1.95 (3.31)	2.05 (3.71)	2.27 (4.64)	2.39 (5.20)	2.51 (5.82)	1.61 (2.11)	1.77 (2.64)	1.86 (2.95)
Bispyribac-Na 25 g/ha PoE	5.46 (5.61)	1.98 (6.29)	2.47 (7.04)	2.77 (8.81)	3.10 (9.86)	1.12 (11.05)	1.40 (4.00)	1.57 (5.00)	1.76 (5.60)
Pyrazosulfuron 25 g/ha PoE	7.41 (10.44)	2.68 (11.69)	3.36 (13.10)	3.76 (16.38)	4.21 (18.34)	1.52 (20.54)	1.91 (7.44)	2.13 (9.30)	2.39 (10.41)
Penoxsulam 25.6 g/ha PoE	6.82 (8.81)	2.47 (9.87)	3.09 (11.05)	3.46 (13.82)	3.87 (15.48)	1.40 (17.34)	1.75 (6.28)	1.96 (7.85)	2.20 (8.79)
Hand weeding twice at 20 and 40 DAS	3.04 (1.66)	1.10 (1.86)	1.38 (2.08)	1.54 (2.60)	1.73 (2.92)	0.63 (3.27)	0.78 (1.18)	0.88 (1.48)	0.98 (1.66)
Weedy check	9.20 (16.15)	3.33 (18.09)	4.17 (20.26)	4.66 (25.33)	5.22 (28.37)	1.89 (31.77)	2.36 (11.50)	2.65 (14.38)	2.97 (16.11)
LSD (p=0.05)	1.87	0.68	1.23	1.35	1.31	0.81	0.68	0.61	0.82

*The data in parentheses were transformed with square root transformation $\sqrt{x+0.5}$; PoE = post-emergence, DAS= days after seeding

Table 3. Effect of weed control treatments on yield attributing characters in dry direct-seeded rice

Treatment	Yield attributing characters											
	Tillers/m²			Panicles/m²			Seeds/panicle²			1000-seed wt. (g)		
	2019	2020	2021	2019	2020	2021	2019	2020	2021	2019	2020	2021
Ethoxysulfuron 18 g/ha PoE	260	310	331	249	303	361	238	303	320	24.45	25.51	26.35
Bispyribac-Na 25 g/ha PoE	276	315	334	256	308	364	246	308	333	24.64	25.70	26.56
Pyrazosulfuron 25 g/ha PoE	279	323	342	262	312	373	248	317	343	25.29	26.38	27.26
Penoxsulam 25.6 g/ha PoE	270	311	330	248	302	360	233	302	320	24.42	25.47	26.32
Hand weeding twice at 20 and 40 DAS	290	336	356	273	326	388	256	328	355	26.26	27.39	28.30
Weedy check	262	304	321	246	283	330	221	296	321	23.74	24.77	25.59
LSD (p=0.05)	13.02	22.04	23.33	20.08	18.95	24.56	10.08	20.69	22.39	NS	NS	NS

PoE = post-emergence application, DAS= days after seeding

Table 4. Effect of weed control treatments on grain yield, harvest index, weed control efficiency (WCE) and B:C ratio in dry direct-seeded rice

Treatment	Grain yield (t/ha)			Harvest index (%)			Weed control efficiency (%)			Benefit: Cost		
	2019	2020	2021	2019	2020	2021	2019	2020	2021	2019	2020	2021
Ethoxysulfuron 18 g/ha PoE	3.27	3.86	3.77	50.15	51.81	43.43	80.68	78.33	75.97	2.07	2.22	2.34
Bispyribac-Na 25 g/ha PoE	3.65	3.72	4.08	53.05	47.33	44.44	78.24	81.27	80.73	2.27	2.46	2.57
Pyrazosulfuron 25 g/ha PoE	3.67	4.21	4.34	50.14	50.97	44.51	35.34	38.61	41.02	2.29	2.56	2.68
Penoxsulam 25.6 g/ha PoE	2.97	3.26	3.52	56.04	53.80	49.86	45.43	57.63	49.73	1.77	1.90	2.00
Hand weeding twice at 20 and 40 DAS	4.08	4.86	4.43	50.12	52.26	40.87	85.72	88.02	86.15	2.73	2.93	3.08
Weedy check	1.76	1.94	1.02	47.31	48.87	31.00	-	-	-	0.34	0.36	0.38
LSD (p=0.05)	0.66	0.72	0.78	1.28	1.46	1.70	7.35	8.03	7.53	0.48	0.51	0.54

PoE = post-emergence application, DAS= days after seeding

density and biomass accrued owing to uncontrolled weed growth as reported by Janusch and Tjiirdema (2005), Pathak *et al.* (2020) and Jason *et al.* (2007).

Growth and yield of rice

Hand weeding twice had significantly higher plant height as compared to other weed control treatments during all the three years of experimentation. Pyrazosulfuron at 25 g/ha PoE was comparable to the hand weeding twice in attaining significantly higher plant height (**Table 3**). Tillers/m² were significantly higher with hand weeding twice at 20 and 40 DAS and was at par with both bispyribac-Na 25 g/ha PoE and pyrazosulfuron 25 g/ha PoE. Similar trend was observed in panicles m^{-2} and seeds per panicle. No significant difference was noticed in 1000 seed weight under various weed control treatments.

During three years of experimentation, hand weeding twice (20 and 40 DAS) recorded significantly higher rice grain yield (4.08, 4.86 and 4.48 t/ha in 2019, 2020 and 2021, respectively) and was at par bispyribac-Na 25 g/ha PoE and pyrazosulfuron 25 g/ha PoE. The higher rice yield with hand weeding twice might be attributed to effective control of weed flora and improved growth of rice crop along with its yield attributing characters; straw yield also followed same trend in response to weed management treatments (Pradhan *et al.* 2014).

Conclusion

Hand weeding twice at 20 and 40 DAS caused remarkable reduction in weeds density and biomass and was at par with ethoxysulfuron at 18 g/ha PoE and bispyribac-Na 25 g/ha PoE which were equally effective in attaining higher weed control efficiency being enhancing growth parameter and yields of direct-seeded rice.

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