Journal of Crop and Weed, 10(2):445-450(2014)

Weed control methods in direct seeded rice under medium land condition

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Received: 26-08-2014, Revised: 25-09-2014, Accepted: 30-09-2014

ABSTRACT

A field experiment was conducted at Agronomical Research Farm of Birsa Agricultural University, Ranchi with objective to find out the efficacy of herbicides for controlling weeds in direct seeded rice under medium land situation laid out in a randomized block design with three replications. The experimental plot was dominated among narrow weeds comprising Digitaria sanguinalis, Echinocloa colona, Echinocloa crusgali, Paspalam indicum and Panicum crusgali, among broad leaved Ludvigia parviflora,Sphellanthus acmella, Commelina benghalensis, Eclipta alba and Marsillia quadrifolia, among sedges- Cyperus iria, Fimbristlis milliaceae, Kyllinga sp. and Cyperus difformis. Pooled yield attributes and yield data of two years revealed that application of Pyrazosulfuron 25 g ha^{-1} *3-7 DAS being at par with pretilachlor – S 50% 750* g ha^{-1} *0-5 DAS cyhalofopbutyl 10% 90* g ha^{-1} *25-30 DAS, fenoxaprop 9.3% 30 DAS 60* g ha^{-1}, *azimsulfuron 50 DF 35* g ha^{-1} *35 DAS, fenoxaprop 60 g + ethoxysulfuron 15* g ha^{-1} *25 – 30 DAS, oxysulfuron 23.5 EC 300 g + 2,4-D 80% 500* g ha^{-1} *and two hand weeding at 20 and 40 days after sowing recorded 7.6, 15.7. 19.02 and 93.17% significantly higher grain yield and 11.43, 29.76, 38.48 and 90.00 % higher straw yield as compared to cyahalofopbutyl 10 % 90* g ha^{-1} *25-30 DAS + Almix 25-30 DAS 20* g ha^{-1}, *fenoxaprop 9.3 % 60* g ha^{-1} *+ Almix 20g* g ha^{-1} *25-30 DAS, bisparibac sodium 10% 25* g ha^{-1} *25 DAS and weedy check respectively. Application of pyrazosulfuron 25* g ha^{-1} *3-7 DAS and pretilachlor – S 50% 750* g ha^{-1} *0-5 DAS recorded maximum net return (Rs. 3216* g ha^{-1}*) and B:C ratio (3.7) compared to rest of the treatments.*

***Keyword*: Direct seeded rice, herbicides, weeds**

Rice (*Oryza sativa* L.) is the most important and extensively grown crop in tropical and subtropical regions of the world as it is staple food for more than 60% of the world population. Though India has the largest rice hactarage with 44.8 million hectares it stands second after China with respect to production 106.0 million tones in 2013-14. Currently India produces rice that is sufficient not only to meet the domestic demand but was largest exporter during 2012. However, the rapidly increasing population projected to be 1.6 billion by 2050 calls for stepping up the current production of 106 million tones of milled rice to 140 million tones at enhanced productivity of 3.5 t ha^{-1}. Transplanting is the traditional system of rice cultivation and it is in vogue in many rice growing areas. Such a rice production system, however, requires a large amount of water during puddling and transplanting (Chauhan 2012a, Chauhan *et al*., 2012b). In India, water use for rice has been reported as 1140 mm in Bihar and 1560 mm in Haryana (Gupta *et al*., 2002). Direct seeding of rice aides in quick establishment and early harvest than transplanted rice and consequently facilitates timely wheat seeding (Singh *et al*., 2007) thus enhances sustainability of both rice and wheat in rice-wheat cropping system (Singh *et al*., 2005). DSR has several advantages over puddle transplanting rice. Weeds are the main biological constraint to the production of direct seeded rice (Chauhan, 2012b; Chauhan and Johnson, 2010; Chauhan and Opena , 2012; Chauhan, *et al*., 2012b). Uncontrolled weeds cause up to 80% reduction in grain yield and sometime also results in complete failure of crop (Gopinath and Kundu, 2008). The main reasons for high weed pressure in DSR are the absence of a weed-suppressive effect of standing water at the time of crop emergence and the absence of a seedling. Weeds in DSR systems are mainly managed by using herbicides and manual weeding. In Jharkhand state, farmers generally control weeds manually. The physical methods are costly and labour intensive and advantage of manual weeding could only be achieved when it is performed timely.

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MATERIALS AND METHODS

A field experiment was conducted at agronomical research farm of Birsa Agricultural University, Ranchi, Jharkhand with objective to find out the efficacy of herbicides for controlling weeds in direct seeded rice under medium land situation. The experimental field was sandy loam in texture, poor in organic carbon (0.38%), available nitrogen (237 kg ha^{-1}) and medium in available phosphorus (21 kg ha^{-1}) and potash (281 kg ha^{-1}). The treatments comprised of application of herbicides *viz*. pyrazosulfuron25 g ha^{-1} 3-7DAS – $T_{1,}$ pretilachlor-S 50% 750 g ha^{-1} 0-5 DAS – $T_{2,}$ cyhalofopbutyl 10% 90 g ha^{-1} 25-30 DAS – $T_{3,}$ fenoxaprop 9.3% 30 DAS 60 g ha^{-1} – $T_{4,}$ cyhalofopbutyl 10% 90 g ha^{-1} 25-30 DAS + Almix 25-30 DAS 20 g ha^{-1} – $T_{5,}$ fenoxaprop 9.3% 60 g ha^{-1} +

Almix 20 g ha^{-1} 25-30 DAS – T_6, azimsulfuron 50 DF 35 g ha^{-1} 35 DAS – $T_{7,}$ bisparibac Sodium 10% 25 g ha^{-1} 25DAS – $T_{8,}$ fenoxaprop 60 g + ethoxysulfuron 15 g ha^{-1} 25-30 DAS – $T_{9,}$ oxyfluorfen 23.5EC 300g + 2,4-D 80% 500 g ha^{-1} – $T_{10,}$ 2 HW 20 and 40 DAS – T_{11} and weedy check – T_{12} . The experiment was laid out in a randomized block design with three replications. The crop was sown on 28.06.11 and harvested on 26.10.11. The rice variety "lalat" with a seed rate of 70 kg ha^{-1} was used for sowing and fertilized with NPK @ 120: 60: 40 kg ha^{-1}. Half of nitrogen and full dose of phosphorus and potash was applied at the time of sowing. The rest half of nitrogen was applied at 25 and 50 days after sowing. The crop was sown in rows at 20 centimeters apart under sufficient moisture condition. From sowing to emergence the soil was kept near moist but not saturated to avoid seed rotting. The field was saturated from three leaf stage to tillering, panicle initiation and grain filling stages to avoid water stress at these stages. Howevere, at anthesis the excess water was drained out to avoid sterility. The observations on weed density and weed dry matter was recorded from one meter squire area with the help of a quadrate at 30 and 60 days after sowing from two randomly selected places in each plot.

RESULTS AND DISCUSSION

Effect on weed density and weed dry matter

Two hand weeding performed at 20 and 40 days after sowing recoded reduced density of grassy, broad leaf and sedges weeds at 30 and 60 days after sowing. Among chemical methods of weed control application of pyrazosulfuron 25 g ha^{-1} 3-7DAS (T_1) being similar to cyhalofopbuty l10% 90 g ha^{-1} 25-30 DAS (T_3), azimsulfuron 50DF 35 g ha^{-1} 35 DAS (T_7) and fenoxaprop 60g + ethoxysulfuron 15 g ha^{-1} 25-30 DAS (T_9) at 30 DAS and azimsulfuron 50 DF g ha^{-1} 35 DAS (T_7), bisparibac sodium 10% 25 g ha^{-1} 25DAS (T_8) and fenoxaprop 60 g + ethoxysulfuron 15 g ha^{-1} 25-30 DAS (T_9) at 60 DAS recorded significantly reduced density of narrow weeds. Similarly, application of pyrazosulfuron25g ha^{-1} 3-7DAS (T_1) being similar to cyhalofopbutyl10% 90 g ha^{-1} 25-30 DAS + Almix 25-30 DAS20 g ha^{-1} (T_5), fenoxaprop 9.3% 60 g ha^{-1} + Almix 20 g ha^{-1} 25-30DAS (T_6), azimsulfuron 50DF 35 g ha^{-1} 35 DAS (T_7) and oxyfluorfen 23.5 EC 300g +2,4-D 80% 500 g ha^{-1} (T_{10}) at 30 and 60 DAS recorded reduced broad leaf weeds density. Application of pyrazosulfuron 25 g ha^{-1} 3-7DAS (T_1) being similar to pretilachlor-S 50% 750 g ha^{-1} 0-5DAS (T_2),

Table 1: Effect of weed control methods on weed density and dry matter accumulation by weeds (2010)

Treatments	Weed density m^{-2}						Dry matter accumulation by weeds (g m^{-2})	
	30 DAS			60DAS				
	Narrow	Broad	Sedges	Narrow	Broad	Sedges	30 DAS	60 DAS
T_1	13.6(187)	5.83(48)	0.71(0)	11.9(144)	6.45(58.67)	0.71(0)	14.88(207)	16.38(268)
T_2	16(261)	12.6(176)	0.71(0)	14.3(213.3)	9.25(101.3)	0.71(0)	29.4(867)	32.2(1034)
T_3	15.3(210)	11.7(139)	7.23(74.7)	16.9(298.7)	14.7(229.3)	5.81(85.33)	21.8(498)	26.5(731)
T_4	15.7(251)	11.6(139)	7.81(69.33)	14.4(208)	12.3(155)	3.75(32)	21.2(475)	19.7(417)
T_5	16.8(288)	2.79(16)	1.83(5.33)	14.2(208)	5.39(32)	0.71(0)	19.8(395)	18.6(352)
T_6	16.8(283)	0.71(0)	1.83(5.33)	16(256)	4.27(26.67)	0.71(0)	22.5(511)	26(691)
T_7	14.5(213)	4.58(32)	0.71(0)	13.1(171)	9.13(85.33)	2.94(10.67)	17.9(324)	16.7(290)
T_8	16.1(261)	11.2(10.67)	2.94(10.67)	13.2(176)	11(122.7)	0.71(0)	30.8(1019)	30.7(942)
T_9	15.4(240)	11.4(171)	5.03(26.67)	11.2(128)	11.8(144)	5.59(42.67)	18.9(388)	21.8(532)
T_{10}	16(272)	6.00(37.3)	1.83(5.333)	17.6(330.7)	7.45(64)	0.71(0)	9.37(91.2)	9.75(104)
T_{11}	10.5(123)	14.7(240)	4.01(37.33)	6(37.33)	17.2(320)	0.71(0)	17.6(321)	16.3(273)
T_{12}	21.2(448)	19.00(411)	10.6(128)	17.5(309)	23.7(565)	12.2(147)	55(3040)	34(1204)
SEm(±)	**2.20**	**3.76**	**2.56**	**2.15**	**2.96**	**2.60**	**4.27**	**4.20**
LSD(0.05)	**6.45**	**11.00**	**7.52**	**6.29**	**8.68**	**7.63**	**12.50**	**12.30**

Note: Original data in parenthesis were subjected to square root (x+0.5) before analysis

Table 2: Effect of weed control methods on weed density and dry matter accumulation by weeds (2011)

Treatments	Weed density m^{-2}						Dry matter accumulation by weeds ($g\ m^{-2}$)	
	30 DAS			60DAS				
	Narrow	Broad	Sedges	Narrow	Broad	Sedges	30 DAS	60 DAS
T_1	18.43(340)	11.86(142	12.85(183)	16.04 (258)	10.36(110)	10.99(132)	17.42(303)	21.36(456)
T_2	21.77(474)	14(198)	15.17(256)	18.94(360)	12.23(153)	12.98(184)	19.18(443)	22.45(600)
T_3	19.53(382)	12.56(159	13.61(206)	16.99(290)	10.98(123)	11.65(148)	17.21(356)	20.14(483)
T_4	21.35(456)	13.73(190)	14.88(246)	18.58(347)	12(147)	12.73(177)	18.81(426)	22.02(577)
T_5	22.87(523)	14.7(218)	15.93(283)	19.9(398)	12.85(169)	13.63(203)	20.15(489)	23.58(662)
T_6	22.67(514)	14.58(215)	15.8(278)	19.72(391)	12.74(166)	13.51(199)	19.97(480)	23.38(651)
T_7	19.67(387)	12.65(162)	13.71(209)	17.11(294)	11.06(125)	11.73(150)	17.33(361)	20.28(490)
T_8	21.77(474)	14(198)	15.17(256)	18.94(360)	12.23(153)	12.98(184)	19.18(443)	22.45(600)
T_9	20.88(436)	13.43(182)	14.55(235)	18.16(331)	11.73(141)	12.45(169)	18.4(407)	21.53(552)
T_{10}	22.23(494)	14.29(206)	15.49(267)	19.34(376)	12.49(160)	13.25(192)	19.58(462)	22.92(626)
T_{11}	14.96(223)	9.625(93.3)	10.43(121)	13.01(170)	8.414(72.2)	8.928(86.7)	13.18(209)	15.42(283)
T_{12}	31.71(1016)	24.75(639)	25.11(639)	27.35(762)	26.92(727)	24.86(630)	28.76(1025)	33.66(1396)
SEm(±)	**0.72**	**0.82**	**0.42**	**0.67**	**0.46**	**0.77**	**1.01**	**1.13**
LSD(0.05)	**2.08**	**2.35**	**1.22**	**1.93**	**1.34**	**2.24**	**2.92**	**3.27**

Note: Original data in parenthesis were subjected to square root (x+0.5) before analysis

azimsulfuron 50 DF 35 g ha^{-1} 35 DAS (T_7) and fenoxaprop 60 g + ethoxysulfuron 15 g ha^{-1} 25-30 DAS (T_9) at 30 and 60 DAS and also with rest of the treatments except cyhalofopbutyl10% 90 g ha^{-1} 25-30 DAS (T_3) recorded significantly reduced density of sedges.

Application of pyrazosulfuron25 g ha^{-1} 3-7DAS (T_1) being similar to azimsulfuron 50DF 35 g ha^{-1} 35 DAS (T_7) and oxyfluorfen 23.5 EC 300 g +2,4-D 80% 500 g ha^{-1} (T_{10}) at 30 and 60 DAS and also fenoxaprop 9.3% 30DAS 60 g ha^{-1} at 60 DAS (T_4) recorded significantly reduced weed dry matter accumulation by weeds compared to rest of the treatments. Reduced dry matter owing to application of pyrazosulfuron has also been reported by Dixit and Varshney (2008), and Halder *et al*. (2005). Similarly, reduction in dry matter accumulation of broad leaved weeds and sedges due to application of bisparibac-sodium have also been reported by Kumar *et al*. (2013), Rawat *et al.* (2012), Walia *et al*. (2012) and Yadav *et al.* (2007) in rice crop. The effective control of weeds by application of pyrazosulfuron – ethyl can be explained by its mode of action. It as an inhibitor of essential amino acids valine and isoleucine, hence, stopping cell division and plant growth. Pyrazosulfuron-ethyl is a systemic herbicides, which is absorbed by root/and or leaves and translocated to the meristems Gopinath *et al*. (2008).

Effect on yield attributes and yield

Hand weeding at 20 and 40 DAS, recorded significantly higher test weight, number of filled grains per panicle, total tillers as well as effective tillers during 2010 and 2011 and also when data of two years pooled. Among chemical weed control methods, pooled data revealed that application of pyrazosulfuron 25 g ha^{-1} 3-7 DAS (T_1) recorded higher test weight, filled grains, total and effective tillers and was at par with pretilachlor-S 50% 750 g ha^{-1} 0-5 DAS (T_2) and oxyfluorfen 23.5 EC 300g + 2,4-D 80% 500 g ha^{-1} (T_{10}) , consequently, hand weeding at 20 and 40 DAS, recorded significantly higher grain and straw yield. While, Among chemical weed control methods, under pooled data application of pyrazosulfuron 25 g ha^{-1} 3-7 DAS (T_1) being on par with pretilachlor-S 50% 750 g ha^{-1} 0-5 DAS (T_2), and oxyfluorfen 23.5 EC 300 g +2,4-D 80% 500g/ha (T_{10}) recorded 49.04 and 73.23 percent significantly higher grain and straw yield compared to the mean grain yield recorded by rest of the treatments. Halder *et al*. (2005) have also found

Table 3: Effect of weed control methods on weed density and dry matter accumulation by weeds (Pool)

Treatments	Weed density m^{-2}						Dry matter accumulation by weeds (g m^{-2})	
	30 DAS			60DAS				
	Narrow	Broad	Sedges	Narrow	Broad	Sedges	30 DAS	60 DAS
T1	16.24(263.5)	9.77(47)	9.59(91.5)	14.19(201)	9.21(84.33)	8.15(66)	15.98(255)	19.03(362)
T2	19.18(367.5)	13.69(187)	11.33(128)	16.94(286.65)	11.30(127.15)	9.61(92)	25.60(655)	28.59(817)
T3	17.21(296)	12.22(149)	11.87(140.35)	17.17(294)	13.29(176.15)	10.82(116.66)	20.67(427)	24.64(607)
T4	18.81(353.5)	12.84(164.5)	12.57(157.66)	16.67(277.5)	12.30(151)	10.25(104.5)	21.24(450.5)	22.30(497)
T5	20.14(405.5)	10.84(117)	12.02(144.16)	17.42(303)	10.04(100.5)	10.09(101.5)	21.03(442)	22.52(507)
T6	19.97(398.5)	10.39(107.5)	11.92(141.66)	18.00(323.5)	9.84(96.33)	10.00(99.5)	22.36(495.5)	25.91(671)
T7	17.33(300)	9.85(97)	1.025(104.5)	15.24(232.5)	10.27(105.16)	8.99(80.33)	18.52(342.5)	19.76(390)
T8	19.18(367.5)	10.23(104.33)	11.57(133.33)	16.38(268)	11.76(137.85)	9.61(92)	27.04(731)	27.77(771)
T9	18.49(338)	13.30(176.5)	11.46(130.83)	15.16(229.5)	11.95(142.5)	10.31(105.83)	19.99(397.5)	23.29(542)
T10	19.58(383)	11.05(121.65)	11.69(136.166)	18.81(353.35)	10.60(112)	9.82(96)	16.64(276)	19.11(365)
T11	13.17(173)	12.92(166.65)	8.92(79.165)	10.20(103.66)	14.02(196.1)	6.62(43.35)	16.29(265)	16.68(278)
T12	27.06(732)	22.29(525)	19.59(383.5)	23.15(535.5)	25.42(646)	19.72(388.5)	45.09(2032.5)	36.06(1300)
SEm(±)	**0.77**	**0.84**	**0.64**	**0.81**	**0.50**	**0.81**	**1.08**	**1.18**
LSD(0.05)	**2.23**	**2.45**	**1.86**	**2.34**	**1.46**	**2.34**	**3.12**	**3.43**

Original data in parenthesis were subjected to square root (x+0.5) before analysis

Table 4: Effect of weed control methods on yield attributes and yields of rice

Treatments	1000 grain weight(g)			No. of grains panicle^{-1}			Tillers m^{-2}					
							Total			Effective		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
T_1	25.33	28.13	26.73	64	51	58	442	428	435	349	330	340
T_2	25.00	28.23	26.62	64	50	57	423	424	424	339	320	330
T_3	24.33	26.14	25.24	51	41	46	400	382	391	311	282	297
T_4	24.67	26.20	25.44	54	46	50	404	408	406	314	303	309
T_5	24.67	26.15	25.41	52	45	48	403	405	404	313	302	308
T_6	24.33	25.22	24.78	50	41	45	400	362	381	307	273	290
T_7	24.67	27.31	25.99	54	47	50	409	409	409	331	310	321
T_8	24.33	25.15	24.74	48	38	43	395	360	378	304	268	286
T_9	24.67	28.22	26.45	55	49	52	416	412	414	331	316	324
T_{10}	24.67	28.12	26.40	60	49	54	418	423	421	338	320	329
T_{11}	25.33	33.15	29.24	72	51	62	444	454	449	352	339	346
T_{12}	23.67	19.01	21.34	37	33	35	388	269	329	162	201	182
SEm(±)	**0.24**	**0.04**	**0.11**	**1.45**	**0.72**	**1.41**	**8.35**	**3.49**	**5.94**	**4.24**	**3.97**	**4.14**
LSD(0.05)	**0.70**	**0.11**	**0.32**	**4.20**	**2.10**	**4.10**	**24.22**	**10.12**	**17.23**	**12.30**	**11.52**	**12.00**

highest grain and straw yield with hand weeding at 20 and 40 days after transplanting treatment closely followed by the treatments pyrazosulfuron ethyl 10% WP @ 15g/ha.

Economics

Hand weeding at 20 and 40 DAS, recorded significantly maximum gross return whereas among chemical weed control methods application of pyrazosulfuron 25g/ha 3-7 DAS (T1) being on par with pretilachlor-S 50% 750 g ha^{-1} 0-5DAS (T_2), fenoxaprop 60g + ethoxysulfuron 15 g ha^{-1} 25-30 DAS (T9) and Oxyfluorfen 23.5 EC 300 g +2,4-D 80% 500 g ha^{-1} (T_{10}) recorded maximum gross return during 2010 and 2011. Maximum net return (pooled Rs 35192) and B:C ratio (pooled 2.81) were recorded with application of pyrazosulfuron 25 g ha^{-1} 3-7 DAS (T_1) being on par with pretilachlor-S 50% 750 g ha^{-1} 0-5 DAS (T_2), and oxyfluorfen 23.5 EC 300 g +2,4-D 80% 500g/ha (T_{10}) compared to rest of the treatment during both the years as well in pooled . Mishra *et al*. (2009). Mandal *et al*. (2011) and Hussain *et al*. (2008) have also observed that chemical method of weed control proved more economical in terms of net return and benefit cost ratio.

It can therefore be concluded that the laborious, time consuming, costly and cumbersome hand weeding practice can economically be replaced by low dose herbicide like pyrazosulfuron 10% WP @ 25g/ha 3-7 DAS in direct seeded rice resulting an effective control of weeds giving an optimum yield of the crop.

Table 5: Effect of control methods on economics of rice production (Pooled)

Treatments	Yield (Kg ha^{-1})						Gross return (Rs ha^{-1})			Net return(Rs ha^{-1})			B:C		
	Grain			Straw											
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
T_1	3119	3900	3510	5344	7263	6304	41878	53526	47702	29368	41016	35192	2.35	3.28	2.81
T_2	3050	3900	3475	4687	7240	5964	39874	53480	46677	26716	40322	33519	2.03	3.06	2.55
T_3	2284	2900	2592	3419	4691	4055	29678	38382	34030	15373	24077	19725	1.07	1.68	1.38
T_4	2439	3233	2836	3695	5406	4551	31780	43142	37461	18025	29387	23706	1.31	2.14	1.72
T_5	2364	2967	2666	3540	5303	4422	30720	40276	35498	16186	25742	20964	1.11	1.77	1.44
T_6	2269	2833	2551	3372	4603	3988	29434	37536	33485	15670	23772	19721	1.14	1.73	1.43
T_7	2660	3233	2947	3961	6167	5064	34522	44664	39593	20002	30144	25073	1.38	2.08	1.73
T_8	2186	2233	2210	3259	4342	3801	28378	31014	29696	15838	18474	17156	1.26	1.47	1.37
T_9	2710	3367	3039	4105	6201	5153	35310	46072	40691	13455	24217	18836	0.62	1.11	0.86
T_{10}	2900	3867	3384	4282	6422	5352	37564	51514	44539	24378	38328	31353	1.85	2.91	2.38
T_{11}	3613	4000	3807	4550	7322	5936	45230	54644	49937	21227	30641	25934	0.88	1.28	1.08
T_{12}	1326	1867	1597	1981	3640	2811	17222	25950	21586	5219	13947	9583	0.43	1.16	0.80
SEm(±)	**127.24**	**93.78**	**112.56**	**551**	**442**	**400.68**	**2261**	**2674**	**2348.62**	**2261**	**2674**	**2348.62**	**0.23**	**0.20**	**0.25**
LSD(0.05)	**369**	**270.8**	**326.42**	**1616**	**1276**	**1162**	**6557**	**7754**	**6811**	**6557**	**7754**	**6811**	**0.68**	**0.59**	**0.72**

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