



P-ISSN: 2349-8528
 E-ISSN: 2321-4902
 IJCS 2020; 8(1): 1861-1865
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 Received: 22-11-2019
 Accepted: 24-12-2019

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Effect of different integrated weed management practices on yield and economics of dry direct seeded rice

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DOI: <https://doi.org/10.22271/chemi.2020.v8.i1aa.8535>

Abstract

A field experiment was conducted during 2017-2018 at N. E. Borlaug Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, to study effect of different integrated weed management practices on yield and economics of dry direct seeded rice in tarai region. Higher grain yield, biological yield, harvest index characters were recorded under pre emergence application of pendimethalin *fb* penoxsulam (PoE) *fb* 1HW 45 DAS at 25 cm spacing which was statistically at par with stale seed bed with shallow tillage *fb* application of pre-emergence application of pendimethalin *fb* 1 mechanical weeding (MW) with conoweeder at 25 DAS along with 1HW at 45 DAS, mulch *fb* penoxsulam (PoE) *fb* 1HW at 45 DAS, *Sesbania* line sowing with pre-emergence application of Pendimethalin *fb* 1 mechanical weeding *fb* 1HW at 45 DAS and stale seed bed with shallow tillage *fb* *Sesbania* line sowing *fb* pre-emergence pendimethalin *fb* brown manuring with 2,4-D at 500 g/ha *fb* 1HW at 45 DAS. Whereas, benefit cost ratio was found higher (2.1) under pre emergence application of pendimethalin *fb* penoxsulam (PoE) *fb* 1HW 45 DAS at 25 cm spacing which was statistically at par with stale seed bed with shallow tillage *fb* application of pre-emergence application of pendimethalin *fb* 1 mechanical weeding (MW) with conoweeder at 25 DAS along with 1HW at 45 DAS, mulch *fb* penoxsulam (PoE) *fb* 1HW at 45 DAS and *Sesbania* line sowing with pre-emergence application of pendimethalin *fb* 1 mechanical weeding *fb* 1HW at 45 DAS. From the study it can be concluded that above three integrated practices were same effective as recommended practice for controlling weed with higher return.

Keywords: Direct seeded rice, stalebed, penoxsulam, brownmanuring

Introduction

Rice (*Oryza sativa* L.) is being a major cereal and staple food grain crop of about more than half of the world's population. Direct seeding of rice requiring less water, labour and energy inputs is an alternative to puddling and transplanting. The direct-seeded rice matures earlier (7-10 days) than that of transplanted rice, thus allowing timely sowing of the succeeding crop. Weeds are the foremost limitation to the success of DSR in general and specifically to dry-DSR (Rao *et al.*, 2007) [12]. Due to greater variability in the growth habit of different weeds a single method of weed control cannot offer effective and season-long control in DSR which will also resulted in less grain yield and more cost of cultivation (Aulakh *et al.*, 2013) [1]. So integration of chemical method of weed control along with other physical, cultural and biological option are found to be more effective under dry direct seeded rice for controlling weed and enhancing yield with less cost of cultivation and higher benefit cost ratio. Intercropping of brown manuring crops with rice reduced weed densities by about 40-50 % (Mahajan *et al.*, 2012) [9]. In addition to brown manuring, stale seed bed technique can be integrate in weed control in direct seeded rice. So there is need to integrate other weed management strategies along with chemical control (Chahal *et al.*, 2014, 2015) [3, 4]. It has been found that herbicides in combination with other methods of weed control like physical and cultural result considerably superior weed control and better grain yield than the sole application due to their broad spectrum and long lasting weed control (Bhurer *et al.*, 2013) [2].

Material and Method

A field experiment was conducted at Norman E. Borlaug Crop Research Center of G.B. Pant University of Agriculture and Technology Pantnagar, District of Udham Singh Nagar (Uttarakhand) during 'kharif' season of 2017-2018. This centre is situated at an altitude of 243.84 metres above mean sea level, 29° N latitude and 79.3° E longitudes lies at the foot hills of "Shivalik" ranges of Himalaya, a narrow belt called "Tarai" where the climate is subtropical. The soil of the experimental site is clay loam texture,

The experiment was laid out in randomized block design with twelve treatments (T₁-stale seed bed with shallow tillage followed by post emergence application of penoxsulam (PoE) at 22.5g/ha, T₂-stale seed bed with shallow tillage followed by pre emergence application of pendimethalin (PE) at 1000 g/ha along with 1 hand weeding (HW) 30DAS, T₃-stale seed bed with shallow tillage followed by pre-emergence application of pendimethalin followed by 1 mechanical weeding (MW) with conoweeder at 25 DAS along with 1HW at 45 DAS, T₄-mulch (wheat straw of 4t/ha) followed by post emergence application of penoxsulam at 22.5g/ha followed by 1HW at 45 DAS, T₅-post emergence application of penoxsulam at 22.5g/ha followed by 1HW at 45 DAS, T₆-*Sesbania* line sowing with pre-emergence application of pendimethalin followed by 1 mechanical weeding 1t 25 DAS followed by 1HW at 45 DAS, T₇-*Sesbania* broadcasting followed by brown manuring with 2,4-D at 500 g/ha along with 1 HW at 45 DAS, T₈-stale seed bed with shallow tillage followed by *Sesbania* line sowing followed by pre-emergence pendimethalin followed by brown manuring with 2,4-D at 500 g/ha followed by 1 HW at 45 DAS, T₉-pre emergence application of pendimethalin followed by penoxsulam (PoE) followed by 1HW 45 DAS, T₁₀- pre-emergence application of pendimethalin followed by penoxsulam (PoE) followed by 1HW 45 DAS (20cm), T₁₁-weedy check and T₁₂-weedy free) which were replicated thrice. All the treatments were in 25 cm except one.

After harvesting of wheat, the field was prepared by two harrowing and levelling and after that 5-6 cm depth of irrigation was provided in the field. About 2 irrigations was provided in the field which allowed the weed seed to germinate. At 12th days germinated weed seedlings were ploughed by shallow tillage by power tiller. Rice seeds of 'Govind' variety was sown on 13th june, 2017 in lines at seed rate of 40 kg/ha with a spacing of 25 cm apart manually in all plots and in one treatment (T₁₀) recommended row to row spacing of 20 cm was maintained. For brown manuring, seeds of *Sesbania* were alternatively grown with rice at the seed rate of 40 kg/ha. And in case of broadcasting, seeds were broadcasted before sowing of rice on the same day. Crop was fertilized with 120: 60:40 kg/ha of N, P₂O₅, K₂O, respectively in the experimental area. Grain yield is calculated from the harvested grain under net plot area from each plot expressed as tons per hectare. The weight of total produce (biological yield) per net plot was weighed before threshing. The straw yield was calculated by subtracting grain yield from biological yield and expressed as tons per hectare. The weight

of the grain and straw will be taken separately and Grain: straw ratio will be calculated as under:

$$\text{Grain: straw ratio} = \frac{\text{Weight of grain}}{\text{Weight of the straw}}$$

Harvest index was calculated by using following formula and expressed in %

$$\text{Harvest index} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Economics

Common cost of production was calculated and the additional weed management treatment was calculated. Benefit cost ratio was calculated to assess the economics of rice due to various integrated weed management treatment.

Result and Discussion

Number of panicles (No./m²)

Different weed management methods have significant impact on number of panicles/m² (Table.1). All other treatments recorded significantly higher number of panicles/m² over weedy check. Weedy check treatment resulted lowest number of panicles/m² at all stages. Recommended practice with wider spacing (T₉) resulted significantly higher panicles/m² than recommended practice narrower spacing (T₁₀). This might be due to the fact that better development of early tillers up to reproductive phase of the crop while in case of closer seeding the production of tillers may take place but due to unavailability of sufficient amount of photosynthates due to higher plant density might have resulted lesser number of productive tillers. Similar result was also reported by Sultana *et al.*, 2012 [18]. Number of panicles significantly highest under weed free at all stages of crop growth, being at par with T₉, T₃, T₄, T₆ and T₈.

At recommended practice with wider spacing (T₉) resulted significantly higher panicle length, filled grains/panicle and total number of grains/panicles than recommended practice with narrower spacing (T₁₀). This might be due to reduced inter- and intra-plant competition which ultimately favored development of heavy panicles and healthy and plump grains at wider spacing (Sihag *et al.*, 2015) [15].

Panicle length and number of filled grains/panicle under weed free condition was statistically at par with T₃, T₅, T₆, T₈ and T₉. This might be due to frequent elimination of weeds that resulted in the reduced weed competition, better nutrient availability, better growth and length of panicle and number of grains per panicle. This findings was in accordance with Viren *et al.*, 2005 [19] and Gowda *et al.*, 2009 [6].

Different weed management practices did not have any significant impact on test weight of grain. Highest weight of 1000 grains (27.5g/1000 seeds) was recorded in weed free which was statistically at par with remaining eleven treatments. This result was in accordance with Nadeem *et al.*, 2011 [10] and Singh *et al.*, 2006.

Table 1: Effect of different weed management practices on yield attributes

S. No.	Treatment	Dose (g/ha)	Panicle (No./m ²)	Panicle length (cm)	Filled grain/panicle	Total grain/Panicle	1000 grain weight(g)
T ₁	SSB <i>fb</i> penoxsulam (PoE)	22.5	174.7	27.0	68.0	98.0	26.3
T ₂	SSB <i>fb</i> pendimethalin (PE) <i>fb</i> 1 HW 30 DAS	1000	182.0	27.1	73.3	98.0	26.5
T ₃	SSB <i>fb</i> Pendimethalin (PE) <i>fb</i> 1 MW <i>fb</i> 1HW 45 DAS	1000	226.0	28.9	78.7	100.0	27.2
T ₄	Mulch <i>fb</i> penoxsulam (PoE) <i>fb</i> 1HW 45 DAS	22.5	214.7	28.8	78.3	107.3	27.2
T ₅	Penoxsulam (PoE) <i>fb</i> 1HW 45 DAS	22.5	164.0	26.6	72.0	96.3	25.9
T ₆	<i>Sesbania</i> (LS) + Pendimethalin (PE) <i>fb</i> 1 MW 25 DAS <i>fb</i> 1HW 45 DAS	1000	220.7	28.7	77.7	112.0	27.1
T ₇	<i>Sesbania</i> (BC) brown manuring with 2,4-D <i>fb</i> 1 HW 45 DAS	500	156.0	26.0	72.7	94.7	25.7
T ₈	SSB <i>fb</i> <i>Sesbania</i> (LS) <i>fb</i> pendimethalin (PE) <i>fb</i> 2,4-D (PoE) 1 HW 45 DAS	1000+500	204.7	28.5	77.3	100.0	27.1
T ₉	Pendimethalin (PE) <i>fb</i> Penoxsulam (PoE) <i>fb</i> 1 HW 45 DAS	1000+22.5	219.3	28.9	79.3	110.3	27.3
T ₁₀	Pendimethalin (PE) <i>fb</i> Penoxsulam (PoE) <i>fb</i> 1 HW (20cm) 45 DAS	1000+22.5	178.0	27.3	74.7	99.0	27.0
T ₁₁	Weedy check		80.7	25.3	63.3	92.3	25.7
T ₁₂	Weed free		223.3	28.9	80.0	106.0	27.5
	SEm±		7.65	0.41	1.13	0.96	0.51
	C.D. (5%)		22.6	1.2	13.3	2.8	NS

Yield

Highest grain yield (4.4 t/ha) was recorded (table 2) in the weed free condition which was statistically at par with the treatments; recommended practice with wider row spacing (T₉) stale seed bed followed by shallow tillage followed by pre-emergence application of pendimethalin at 1000 g/ha followed by 1 mechanical weeding at 25 DAS with conoweeder along with 1 HW at 45 DAS (T₃), mulching integrated with post-emergence application of penoxsulam at 22.5 g/ha followed by 1 HW at 45 DAS (T₄), line sown *Sesbania* integrated with pre-emergence application of pendimethalin at 1000 g/ha followed by 1 MW at 25 DAS along with 1 HW at 45 DAS (T₆) and stale seed bed followed by shallow tillage along with line sown *Sesbania* followed by pre-emergence application of pendimethalin at 1000 g/ha followed by post-emergence application of 2,4-D at 500g/ha supplemented with 1 HW at 45 DAS (T₈). This was due to lower weed biomass accumulation which results in higher weed control efficiency. Similar result were also suggested by Gaire *et al.*, 2013 that *Sesbania* co-culture technology reduces the weed population by nearly about 50% with no adverse effect on rice yield as comprise of growing of of rice and *sesbania* together and then killing *Sesbania* with 2, 4-D as it provide smothering effect on weed and also use of 2,4-D effectively controls the broadleaf weeds. Also inclusion of mechanical weeding by conoweeder not only provided better weed control in inter rows but also also provided aeration in soil root zone resulting better root growth and tillering and finally the better crop yield (Kumar *et al.*, 2012).

Biological yield were significantly influenced by different IWM practices. All the treatments resulted significantly higher straw yield as compared to weedy check.

Highest straw yield and biological yield were recorded in weed free (T₁₂). This might be due to frequent elimination of weeds that resulted in the reduced weed competition, required particularly at most rapid tillering stage of rice (Mann *et al.*, 2007 and Yadav *et al.*, 2007) ^[13, 20]. Also this treatment was being statistically at par with pre-emergence application of pendimethalin at 1000g/ha *fb* post-emergence application of penoxsulam at 22.5 g/ha supplemented with 1HW at 45 DAS (T₉), pre-emergence application of pendimethalin at 1000g/ha *fb* post-emergence application of penoxsulam at 22.5 g/ha supplemented with 1HW at 45 DAS at 20 cm spacing (T₁₀), stale seed bed *fb* shallow tillage integrated with *Sesbania* line sowing *fb* pre-emergence application of pendimethalin at 1000 g/ha *fb* 2,4-D supplemented with 1 HW 45 DAS (T₈),

line sown *Sesbania* with pre-emergence application of pendimethalin at 1000g/ha *fb*1 MW along with 1 HW 45 DAS (T₆), stale seed bed *fb* shallow tillage *fb* pre-emergence application of pendimethalin at 1000 g/ha *fb* 1 MW at 25DAS with conoweeder along with 1 HW 45 DAS (T₃) and mulch integrated with post-emergence application of penoxsulam at 22.5 g/ha 45 DAS (T₄). Lowest straw yield and biological yield was obtained in weedy check plot.

Economics of different weed control treatments

Economic analysis of various weed management practices including total cost of cultivation, gross return, net return and benefit cost ratio are summarized Table. 2. Due to differences in cost of weed control among treatments, the total cost of production also varied within the treatments. From economic analysis it was observed that the maximum cost involved in case of weed free treatment. Among the integrated methods maximum cost was involved in stale seed bed *fb* shallow tillage with line sown *Sesbania* integrated with pre-emergence application of pendimethalin at 1000 g/ha *fb* 2,4-D 500 g/ha supplemented with 1 HW at 45 DAS (T₈).

Maximum gross return was found under both stale seed bed *fb* shallow tillage *fb* pre-emergence application of pendimethalin at 1000g/ha *fb* 1 MW at 25 DAS with conoweeder *fb*1 HW at 45 DAS (T₃) followed by recommended practice at wider spacing (T₉), line sown *Sesbania* with pre-emergence application of pendimethalin at 1000g/ha *fb* 1 MW at 25 DAS *fb* 1 HW at 45 DAS (T₆), mulch integrated with post-emergence application of penoxsulam at 22.5 g/ha (T₃) and stale seed bed technique with line sown *Sesbania* *fb* pre-emergence application of pendimethalin at 1000g/ha *fb* post-emergence application of 2,4-d at 500g/ha *fb*1 HW at 45 DAS (T₈).

Highest net return was found under stale seed bed *fb* shallow tillage *fb* pre-emergence application of pendimethalin at 1000g/ha *fb*1 MW at 25DAS with conoweeder supplemented with 1 HW at 45 DAS (T₃), while lowest net return was under post-emergence application of penoxsulam at 22.5 g/ha along with 1 HW at 45 DAS (T₅). This might be due lowest grain and straw yield that was obtained under this treatment. Benefit cost ratio was found highest (2.1) under recommended practice with wider spacing of 25cm (T₉) which was similar with stale seed bed followed by shallow tillage followed by pre-emergence application of pendimethalin at 1000 g/ha followed by 1 MW at 25 DAS with conoweeder supplemented with 1 HW at 45 DAS (T₃),

mulch followed by post-emergence application of penoxsulam at 22.5 g/ha along with 1 HW at 45 DAS (T₄) and Sesbania line sowing with pre-emergence application of pendimethalin at 1000 g/ha followed by 1 MW at 25 DAS along with 1 HW at 45 DAS (T₆). This might be resulted due to lower cost of cultivation and higher grain yield which resulted higher return. Similar results were reported by Narolia *et al.* (2014)^[11] and Jayadeva *et al.* (2011)^[7].

Conclusion

It can be concluded that pre emergence application of pendimethalin followed by post-emergence application of penoxsulam followed by 1 hand weeding (45 DAS) under 25cm resulted higher yield attributing parameters, grain yield

as compared to crop with same of weed control practice under 20cm spacing. However satisfactory weed management and similar rice yield attributes and yields can be achieved by combination of stale seed bed technique integrated with pre-emergence application of pendimethalin herbicide along with mechanical weeding, pre-emergence application of pendimethalin herbicide with Sesbania brown manuring with mechanical weeding and hand weeding at 45 DAS and wheat straw mulch with PoE application of penoxsulam followed by 1 hand weeding at 45 DAS. All these IWM practices have similar benefit cost ratio. So, farmers can choose any of these IWM packages for weed management in dry DSR which suits them best.

Table 2: Effect of different weed management practices on grain yield (t/ha), biological yield (t/ha) and economics

S. No.	Treatment	Dose (g/ha)	Grain yield (t/ha)	Biological yield (t/ha)	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
T1	SSB fb penoxsulam (PoE)	22.5	3.5	8.2	26920	50350	23430	1.9
T2	SSB fb pendimethalin (PE) fb1 HW 30 DAS	1000	3.6	8.7	27760	51775	24015	1.9
T3	SSB fb Pendimethalin (PE) fb1MW fb 1HW 45 DAS	1000	4.3	10.1	29080	61275	32195	2.1
T4	Mulch fb penoxsulam (PoE) fb 1HW 45 DAS	22.5	4.1	9.6	28040	58425	30385	2.1
T5	Penoxsulam (PoE) fb 1HW 45 DAS	22.5	3.2	7.7	27020	46075	19055	1.7
T6	Sesbania (LS) + Pendimethalin (PE) fb1 MW 25 DAS fb 1HW 45 DAS	1000	4.2	10.0	28240	59850	31610	2.1
T7	Sesbania (BC) brown manuring with 2,4-D fb1 HW 45 DAS	500	3.2	8.3	26540	45125	18585	1.7
T8	SSB fbSesbania (LS) fb pendimethalin (PE) fb 2,4-D (PoE) 1 HW 45 DAS	1000+500	4.0	9.6	29920	57475	27555	1.9
T9	Pendimethalin (PE) fbPenoxsulam (PoE) fb1 HW 45 DAS	1000+22.5	4.2	9.9	28960	59850	30890	2.1
T10	Pendimethalin (PE) fbPenoxsulam (PoE) fb1 HW (20cm) 45 DAS	1000+22.5	3.7	9.4	28960	52725	23765	1.8
T11	Weedy check		1.3	2.2	22840	18525	-4315	0.8
T12	Weed free		4.4	6.0	34060	62225	28165	1.8
	SEm±		0.12	0.21				
	C.D. (5%)		0.4	0.6				

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