

Original Research Article

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Evaluation of Different Weed Management Practices and Crop Geometry on Weed Control Efficiency and Yield of Direct (Dry) Seeded Rice (*Oryza sativa* L.)

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ABSTRACT

A field experiment was conducted during *Kharif* season of 2017 in D₂ block at Norman E. Borlaug Crop Research Centre of G. B. Pant University of Agriculture and Technology, Pantnagar intending to find out the efficacy of different pre and post-emergence herbicides for controlling the weeds and also their effect on direct (dry) seeded rice in three planting geometries. The maximum weed control efficiency 96.59, 72.81, and 82.32 percent was obtained at a row spacing of 25 cm with the pre- and post-emergence application of pendimethalin 1kg/ha *fb* penoxsulam 22.5 g/ha at 40, 60 and 80 DAS. Row spacing of 25 cm recorded the highest grain yield (4.2 t/ha) which was comparable to 20 cm row spacing and significantly superior to 30 cm row spacing. Application of pendimethalin 1 kg/ha *fb* penoxsulam 22.5 g/ha recorded highest grain yield (4.4 t/ha) after weed free. Highest B:C ratio (2.0) was obtained with 25cm spacing along with the pre-emergence application of pendimethalin (1.0 kg/ha) *fb* post-emergence penoxsulam (22.5g/ha) which was followed by the row spacing of 20cm along with the post-emergence application of cyhalofop-butyl + penoxsulam (Readymix) 150g/ha (1.7).

Keywords

Direct seeded rice,
Grain yield,
Herbicides, Row
spacing, Weed
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Introduction

Rice is vital to more than half of the world's population. It is a major cereal crop and staple food for more than half of the world's population. About 90% of the world's rice is produced and consumed in Asia (FAO, 2014). Rice is grown by various methods depending

upon the resource availability like direct dry seeding in unpuddled beds, direct seeding in puddled beds and transplanting in puddled beds. Considering the difficulties in transplanting it is necessary to look for the substitute of rice establishment methods. Taking the advantages of saving water and labour and increasing system productivity,

dry direct-seeded rice has been believed to be an optimal option for rice production (Kumar and Ladha, 2011). Direct-seeded rice systems are subjected to much higher weed pressure than puddled transplanted rice systems (Rao *et al.*, 2007), in which weeds are suppressed by standing water and transplanted rice seedlings, which provide 'head start' over germinating weed seedlings. In direct-seeded rice, weeds emerge simultaneously with crop seedlings and grow more quickly in moist soil than in puddled transplanted rice (Khaliq and Matloob, 2011), resulting in severe competition for resources to the crop. Therefore, weeds present the main biological constraint to the success of direct-seeded rice (Chauhan, 2012), and failure to control weeds results in yield losses ranging from 50 to 90 % (Chauhan and Johnson, 2011; Chauhan and Opena, 2012). Crop geometry is another factor that affects the crop weed competition and grain yield and it has been hypothesized that narrow row spacing may decrease the interval of critical weed competition periods. Herbicides with different crop geometries may show the different effects on crop, hence standardization of herbicides and their application time with different row spacing is essential for efficient weed management and crop growth and development.

Materials and Methods

A field experiment was conducted during *Kharif* season of 2017 in D₂ block at Norman E. Borlaug Crop Research Centre of G. B. Pant University of Agriculture and Technology, Pantnagar intending to find out the efficacy of different pre and post - emergence herbicides for controlling the weeds and also their effect on direct (dry) seeded rice in three planting geometries. Three planting geometries (S1-20 cm, S2- 25 cm and S3- 30 cm) in main plots and four weed management practices (W1- Weedy check, W2- Pendimethalin @ 1kg/ha *fb*

Penoxsulam @ 22.5 g/ha, W3- Cyhalofop-butyl + Penoxsulam @ 150 g/ha, W4- weed-free) in subplots were studied in a split plot design (SPD), with four replications.

Seeds of "Pant dhan 18" were sown in lines at a seed rate of 40 kg/ha with a different row spacing of 20cm, 25cm and 30cm apart manually in all plots. Pendimethalin on the next day of sowing and post-emergence herbicides penoxsulam and cyhalofop-butyl at 20 DAS was applied using 500 litres of water by using knapsack sprayer fitted with flat fan nozzle. The weed control efficiency of all the treatments was calculated in relation to reduction of total dry weight of weeds in the treated plot over the weedy plot which was expressed as percentage. Weed control efficiency was calculated by using the following formula:

$$\text{WCE (\%)} = \frac{\text{DW of weeds in weedy plot} - \text{DW of weeds in treated plot}}{\text{DW of weeds in weedy plot}} \times 100$$

The number of panicles was counted from the marked plants observation area of one-meter row length before harvesting and effective shoots (m²) were worked out. This was converted to per unit area and expressed as the number of panicles per square meter. The same 5 panicles marked for plant height were manually threshed. The numbers of total grains were counted and the number of grains per panicle was calculated by averaging 5 panicles. The number of total grains from the sampled panicles was counted and their weight was recorded. Then grain weight was expressed by adjusting into 1000 grain weight in gram. In gross plot (5m x 3m) area, there were 12,15,9 rows in a respective row spaced treatment, out of which 8,7 and 6 rows, respectively were harvested as net plot area (4m x 2m), (4m x 1.75m), (4m x 1.5m) and remaining rows were left as border. The grain

harvested from the net plot area from each plot was recorded and expressed as tons per hectare. The weight of total produce (biological yield) per net plot as mentioned in grain yield parameter was weighed before threshing. The straw yield was calculated by subtracting grain yield from biological yield and expressed as tons per hectare. Harvest index (HI) was worked out by using the following formula:

$$HI = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

The common cost of production was calculated, and the additional weed management treatment was calculated. The benefit cost ratio was calculated to assess the economics of the crop produce influenced by different treatments.

Results and Discussion

Weed control efficiency

The maximum weed control efficiency (Table 1) 96.59, 72.81, and 82.32 per cent was obtained at a row spacing of 25 cm with the pre- and post-emergence application of pendimethalin 1kg /ha *fb* penoxsulam 22.5 g/ha at 40, 60 and 80 DAS. The maximum weed control efficiency was recorded in the row spacing of 25 cm with the pre- and post emergence application of pendimethalin 1kg/ha *fb* penoxsulam 22.5 g/ha (96.59%) followed by row spacing of 20 cm with cyhalofop-butyl + penoxsulam (Readymix) 150g/ha (86.75%) at 40 DAS.

At all the stages of the crop growth, row spacing of 25 cm with the application of pendimethalin 1kg/ha *fb* penoxsulam 22.5 g/ha proved to be better in terms of weed control efficiency over the other treatments. This might be due to the suppression of weed

more effectively through the pre and post-emergence herbicide. Weedy check plots recorded the lowest weed control efficiency. Among the weed control treatments, weed free plots resulted in the highest weed control efficiency (100 %) all the growth stages of the crop. These findings are in support from the observation of (Singh *et al.*, 2007).

Yield contributing characters

1000-grain weight

Variation in thousand grain weight (Table 2) attributed to different row spacing was found non-significant. All weed management practices provided significantly better conditions. Weed free recorded the highest 1000-grain weight (24.63g) which was significantly higher than the other treatments. Test weight is a character mostly governed by the genetic influence of the crop and hence, environmental and managerial factors usually have less influence.

Number of grains/panicle

The number of grains/panicle (Table 2) exhibited significant variation owing to different row spacings. Row spacing of 25 cm produced a significantly higher number of grains per panicle as compared to the other two row spacings. Among the herbicidal treatments, pendimethalin 1kg /ha *fb* penoxsulam 22.5 g/ha and weed free are at par with each other and significantly higher than the other treatments. The highest crop growth rate was also recorded with the same treatment.

Number of panicles/m²

Different row spacing of rice did not affect the number of panicles/m² (Table 2) significantly. Numerically highest number of panicles/m² recorded in 25 cm row spacing

and lowest in 20 cm row spacing, although the difference was non-significant. All the weed management practices produced significantly higher number of panicles/ m² over the weedy plot. Weed free plot recorded the highest number of panicles/ m² which was at par with the pendimethalin 1kg/ha *fb* penoxsulam 22.5 g/ha and significantly higher over the cyhalofop-butyl + penoxsulam (Readymix) 150 g/ha.

Grain yield

Grain yield (Table 3) was significantly affected by the different row spacings and weed management practices. Among different row spacing, 25 cm spacing obtained the highest grain yield (4.2 t/ha) which was comparable to 20 spacing and significantly superior to 30 cm spacing because of the optimum spacing which resulted in more effective tillers and more number of grains/panicle subsequently higher grain yield.

All the weed control measures applied plots produced significantly higher grain yield than a weedy check. Application of pendimethalin 1 kg/ha *fb* penoxsulam 22.5 g/ha recorded the highest grain yield (4.4 t/ha) after weed free which was comparable to application of cyhalofop-butyl + penoxsulam (Readymix) 150 g/ha. It might be due to higher no. of panicles/m² and no. of grains/panicle obtained with the pre-emergence application of pendimethalin 1 kg/ha *fb* penoxsulam 22.5 g/ha and 25 cm of spacing. Pre-emergence application of pendimethalin 1kg/ha supplemented with the post-emergence herbicide produced markedly higher grain yield and lesser weed dry weight as compared to other treatments Bahar and Singh, (2004).

Straw yield

Differences in straw yield (Table 3) due to different row spacings were found significant.

Among different row spacings, 25 cm spacing obtained the highest straw (8.3 t/ha) yield which was comparable to 20 cm spacing and significantly superior to 30 cm spacing. Within weed management practices, the highest straw yield (9.2 t/ha) was recorded with Readymix application of cyhalofop-butyl + penoxsulam @ 150 g/ha which was comparable to application of pendimethalin 1 kg/ha *fb* penoxsulam 22.5 g/ha and weed free situation.

Biological yield

Biological yield (Table 3) did not differ significantly owing to different row spacing. However, maximum biological yield was obtained under 25 cm row spacing was followed by 20 and 30 cm row spacing.

All the weed management practices applied plots produced significantly higher biological yield than weedy check. Ready mix application of cyhalofop butyl + penoxsulam 150 g/ha and weed free were statistically same and at par with pendimethalin 1 kg/ha *fb* penoxsulam 22.5 g/ha. Weedy plot recorded the lowest grain yield, straw yield, and biological yield.

Harvest index

Harvest index (Table 3) was found non-significant in varying row spacing and weed management practices also.

Economics

Through the analysis, it was observed that the maximum cost (Table 4) involved in the in case of weed free treatment. Maximum gross return (Table 4) was found under pendimethalin 1kg/ha *fb* penoxsulam 22.5 g/ha and in the weed free treatment with the 25cm row spacing.

Table.1 Effect of different row spacing and WMP on the WCE (%) at different stages of crop growth

Symbol	Treatments	40DAS	60DAS	80DAS
S1W1	20cm×Weedy	0	0	0
S1W2	20cm× Pendimethalin@1kg /ha <i>fb</i> Penoxsulam @22.5 g/ha	86.75	72.45	62.35
S1W3	20cm× Cyhalofop-butyl + Penoxsulam @ 150g/ha	69	61.9	65.76
S1W4	20cm×Weed free	100	100	100
S2W1	25cm×Weedy	0	0	0
S2W2	25cm× Pendimethalin@1kg /ha <i>fb</i> Penoxsulam @22.5 g/ha	96.59	72.81	82.32
S2W3	25cm× Cyhalofop-butyl + Penoxsulam @ 150g/ha	70.27	53.19	53.67
S2W4	25cm×Weed free	100	100	100
S3W1	30cm×Weedy	0	0	0
S3W2	30cm× Pendimethalin@1kg /ha <i>fb</i> Penoxsulam @22.5 g/ha	62.87	55.14	72.19
S3W3	30cm× Cyhalofop-butyl + Penoxsulam @ 150g/ha	55.47	39.71	47.94
S3W4	30cm× Weed free	100	100	100

Table.2 Effect of different row spacing and WMP on the yield attributes of aerobic rice

Treatments	Panicle/m ²	No. of grains/panicle	1000 grain weight (g)
A. Row spacing(cm)			
20	185	99	23.21
25	187	106	23.45
30	186	102	23.41
SEm±	2.78	0.78	0.16
C.D at 5%	NS	2.78	NS
B. Weed management			
Weedy	106	98	22.74
Pendimethalin@1kg/ha <i>fb</i> Penoxsulam @22.5 g/ha	218	105	23.35
Cyhalofop-butyl + Penoxsulam @ 150g/ha	199	101	22.71
Weed free	222	105	24.63
SEm±	3.44	0.88	0.17
CD at 5%	10.04	2.59	0.51

Table.3 Effect of different row spacing and WMP on the grain yield (t/ha), straw yield (t/ha), biological yield (t/ha) and grain: straw ratio

Treatments	Grain yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	Harvest index
Row spacing(cm)				
20	4.0	8.0	12.0	33.56
25	4.2	8.3	12.5	37.37
30	3.4	7.1	10.6	31.50
SEm±	0.25	0.39	0.54	1.63
C.D at 5%	0.72	0.86	NS	NS
Weed management				
Weedy	2.1	4.5	6.6	31.33
Pendimethalin@1kg/ha fb	4.4	8.8	13.2	35.25
Penoxsulam @22.5 g/ha				
Cyhalofop-butyl + Penoxsulam @150g/ha	4.3	9.2	13.5	33.50
Weed free	4.8	8.7	13.5	36.50
SEm±	0.14	0.44	0.48	2.34
CD at 5%	0.42	1.05	1.41	NS

Table.4 Effect of different row spacing and WMP on the cost of cultivation, gross return, net return and B: C ratio by crop at harvest

Treatments		Dose (g /ha)	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
Row spacing(cm)	Weed management					
s20	Weedy check	-	22480	32395	9915	0.4
20	Pendimethalin fb Penoxsulam	1000 fb 22.5	27,060	70060	43000	1.5
20	Cyhalofop-butyl + Penoxsulam	150	24980	66650	41670	1.6
20	Weed free (Pendimethalin+2HW 20 and 40 DAS)	1000 fb 20 and 40	27,300	75950	48650	1.7
25	Weedy check	-	22840	46965	24485	1.0
25	Pendimethalin + Penoxsulam	1000 fb 22.5	27,060	83235	56175	2.0
25	Cyhalofop-butyl + Penoxsulam	150	24980	68665	43685	1.7
25	Weed free (Pendimethalin+2HW at 20 and 40 DAS)	1000 fb 20 and 40	27,300	83700	56400	2.0
30	Weedy check	-	22840	26350	3510	0.1
30	Pendimethalin fb Penoxsulam	1000 fb 22.5	27,060	58900	31840	1.1
30	Cyhalofop-butyl + Penoxsulam	150	24980	60450	35470	1.4
30	Weed free (Pendimethalin+2HW 20 and 40 DAS)	1000 fb 20 and 40	27,300	65100	37800	1.3

Maximum net return (Table 4) was found under pendimethalin 1kg/ha fb penoxsulam 22.5 g/ha (56175 Rs/ha) after the weed free treatment (56400 Rs/ha). Highest B:C ratio (2.0) (Table 4) was obtained with 25cm spacing along with the pre-emergence application of pendimethalin (1.0 kg/ha) fb post-emergence penoxsulam (22.5g/ha) which was followed by the row spacing of 20cm along with the post-emergence application of cyhalofop-butyl + penoxsulam (Readymix) 150g/ha (1.7). Lowest net return, gross return, B: C ratio was recorded in the spacing of 30cm along with all the weed management practices after the weedy check. This might be due to the lowest grain yield and straw yield in this spacing

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