RESEARCH ARTICLE

INFLUENCES OF SPACING AND WEED MANAGEMENT PRACTICES ON YIELD AND ECONOMICS OF WET DIRECT SEEDED RICE (*ORYZA SATIVA* L.)

Bhujendra Kumar*[1], H.L. Sonboir, Saurabh Kumar, Dinesh Kumar Marapi, Hemant Kumar Jangde, and Tej Ram Banjara

[1] Department of Agronomy, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, 492012, (C.G.)
Email: bkkothari13@gmail.com

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Abstract: A field experiment was conducted during *kharif* season of 2014-15 at the Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The experiment was laid out in randomized block design comprises of eleven treatments with three replications. Among the spacing 20×10 cm and 20×20 cm, the effective tillers m^{-2}, total grains $panicle^{-1}$, filled grains $panicle^{-1}$ were significantly higher at 20×20 cm with respective level of weed management. However, hand weeding twice and herbicidal weed management was at par with both spacing. Among the spacing 20×10 cm and 20×20 cm, At spacing 20×20 cm, bidirectional mechanical weeding thrice (T_{10}) produced the maximum grain (49.12 q ha^{-1}) and straw yield which was at par with bidirectional mechanical weeding twice. Among the spacing 20×10 cm and 20×20 cm, the grain and straw yield was at par with respective level of weed management. Among different spacing and weed management practices the higher gross return (₹ 69,759 ha^{-1}) obtained under bidirectional mechanical weeding thrice. However, the maximum net return (₹ 38,565 ha^{-1}) and benefit cost ratio (2.61) were obtained at spacing 20×20 cm with herbicidal weed management (Pyrazosulfuran as pre-emergence followed by Bispyribac-Na as post emergence).

Keywords: Management, Rice, Seed, Weed, *Kharif* season

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the world's most important stable food crops. Currently, more than one third of the human population relies on rice for their daily sustenance. Rice is the vital food for more than two billion people in Asia and four hundred million people in Africa and Latin America (IRRI, 2006). In world, rice has occupied an area of 156.1 m ha, with a production of 680 m t. In India, total area under rice was 45.5 m ha, with production of 106.65 m t and average productivity of 2419 kg ha^{-1}during 2013-14 (Anonymous, 2014). Chhattisgarh state is popularly known as "Rice Bowl of India" because of maximum area covered under rice during *kharif* and contributes major share in national rice production. Rice was cultivated over an area of 3.7 m ha with the production of 7.44 m t and productivity of 2020 kg ha^{-1} during 2013-14 (Anonymous, 2015). The labour requirement for transplanting is very high and also for a short period of the time. Further, the availability of labour is decreasing day by day due to various reasons. Therefore, an alternate technology to substitute transplanting method is needed to gear up rice production in irrigated ecology. One of the alternate technology may be wet direct seeded method. Therefore, the study was conducted to evaluate effect of wet direct seeded rice on yield attributes, yield and economics of rice.

*Corresponding Author

MATERIAL AND METHOD

The present investigation was conducted during *kharif* season of 2014-15 at the Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The soil of experimental field was *vertisol* in texture, low in nitrogen (223.30 kg ha^{-1}), medium in phosphorus (17.40 kg ha^{-1}) and medium in potassium (272.80 kg ha^{-1}) contents with neutral soil pH and 0.51 per cent organic carbon. The experiment was laid out in randomized block design comprises of eleven treatments with three replications. The treatments comprised spacing and weed management practices *viz*, T_1 – Direct Seeded 20×10 cm + hand weeding twice at 20 and 40 DAS, T_2 - Direct Seeded 20×10 cm + herbicidal weed management (Pre. eme. Pyrazosulfuron f.b. Bispyribac-Na), T_3 - Direct Seeded 20×10 cm + mechanical weeding unidirectional twice at 20 and 40 DAS, T_4 - Direct Seeded 20×10 cm + mechanical weeding unidirectional thrice at 20, 30 and 40 DAS, T_5 - Direct Seeded 20×20 cm + hand weeding twice at 20 and 40 DAS, T_6 - Direct Seeded 20×20 cm + herbicidal weed management (Pre. eme. Pyrazosulfuron followed by Bispyribac-Na), T_7 - Direct Seeded 20×20 cm + mechanical weeding unidirectional twice at 20 and 40 DAS, T_8 - Direct Seeded 20×20 cm + mechanical weeding unidirectional thrice at 20, 30 and 40 DAS, T_9 - Direct Seeded 20×20 cm + mechanical weeding bidirectional twice at 20 and 40 DAS, T_{10} - Direct Seeded 20X20 cm + mechanical weeding bidirectional thrice at 20, 30 and 40 DAS, T_{11} –

Transplanting 20X10 cm + herbicidal weed management (Pre. eme. Pyrazosulfuron followed by Bispyribac-Na). The test variety was maheshwari. Sowing of sprouted seeds was done in puddle soil. Sowing was done on June 29, 2014 and harvesting was done on November 10, 2014. Recommended dose of nutrients (100 kg N : 60 kg P_2O_5 : 40 kg K_2O ha^{-1}) was applied through urea, single super phosphate and murate of potash, respectively. The whole quantity of P and K was applied as basal dressing, while nitrogen was applied in three equal splits at basal, active tillering and panicle initiation stages. 3±2 cm level of water was managed after established of crop till growth stage. Among the treatments when herbicidal weed management was adopted, applied of pre emergence of pyrazosulfuron at 3 days after sowing followed by bispyribac-Na at 25 days after sowing was done. All the growth characters *viz*. number of effective tillers m^{-2}, panicle length, test weight, grain yield, straw yield and harvest index of wet direct seeded rice were recorded. The total weed density and total dry matter production weeds were also recorded and subjected to square root $\sqrt{x+0.5}$ transformation and statistically analyzed.

RESULT AND DISCUSSION

Effect on yield attributes

The result observed that the yield attributes of wet direct seeded rice was significantly influenced by spacing and weed management practices are presented in Table (1). At spacing 20×10 cm, mechanical weeding thrice (T_4) observed the highest number of effective tillers m^{-2}, total grains panicle^{-1} and filled grains panicle^{-1} which was at par with mechanical weeding twice (T_3), transplanting with herbicidal weed management (T_{11}) and hand weeding twice (T_1). At spacing 20×20 cm, bidirectional mechanical weeding thrice (T_{10}) observed the highest number of effective tillers m^{-2}, total grains panicle^{-1} and filled grains panicle^{-1} which was at par with most of the treatments. Among the spacing 20×10 cm and 20×20 cm, the effect of weed management practices on number of effective tillers m^{-2}, total grains panicle^{-1} and filled grains panicle^{-1} was significantly higher at spacing 20×20 cm than 20×10 cm with the respective level of weed management, except hand weeding twice and herbicidal weed management.

Higher number of effective tillers under bidirectional mechanical weeding thrice (T_{10}) due to more space to the crop to show their potential due to lower weed competition and mechanical weeding allow to increase aeration in soil and enhances the root growth for better growth and number of effective tillers. Similar results were reported by Shad 1986 and Gogoi *at el* 2000.

The data in respective of panicle length and test weight revealed that spacing and weed management practices unaffected on panicle length and test weight of wet direct seeded rice. The mean value showing the influence of weed management practices on the unfilled grains panicle^{-1} and sterility percentage are presented in Table (1). At spacing 20×10 cm, the significantly lowest unfilled grains panicle^{-1} and sterility per cent was recorded under mechanical weeding thrice (T_4) which was at par with mechanical weeding twice (T_3) and hand weeding twice (T_1). At spacing 20×20 cm, the lowest unfilled grains panicle^{-1} and sterility per cent was found under bidirectional mechanical weeding thrice (T_{10}) which was at par with bidirectional mechanical weeding twice (T_9) and unidirectional mechanical weeding twice (T_7). Among the spacing 20×10 cm and 20×20 cm, the effect of weed management practices on unfilled grains panicle^{-1} and sterility per cent was at with the respective level of weed management.

Effect on Yield

The result reveals that the grain yield of rice was significantly influenced by spacing and weed management practices are presented in Table (2). At spacing 20×10 cm, mechanical weeding thrice (T_4) produced the highest grain yield (44.25 q ha^{-1}) which was at par with mechanical weeding twice (T_3), hand weeding twice (T_1) and transplanting with herbicidal weed management (T_{11}). At spacing 20X20 cm, bidirectional mechanical weeding thrice (T_{10}) produced significantly the highest grain yield (49.12 q ha^{-1}) which was at par with bidirectional mechanical weeding twice (T_9). Among the spacing 20×10 cm and 20×20 cm, the effect of weed management practices on grain yield was at par with the respective level of weed management.

Grain production, which is the final product of growth and development, is controlled by the growth and yield attributing characters such as effective tillers, dry matter accumulation, test weight, etc. Growth and all yield attributing characters were more in bidirectional mechanical weeding thrice (T_{10}) because of lesser weed competition and better aeration which enhances better uptake of nutrients through enhanced root growth. The beneficial effect of mechanical weeding in rice production by System of rice intensification is attributed by different workers (Vijayakumar *et al.* 2004 and Rajendran *et al.* 2007).

The straw yield of rice was significantly affected by spacing and weed management practices. At spacing 20×10 cm, mechanical weeding thrice (T_4) significantly produced the highest straw yield (53.74 q ha^{-1}) which was at par with mechanical weeding twice (T_3), hand weeding twice (T_1) and transplanting with herbicidal weed management (T_{11}). At spacing 20×20 cm, bidirectional mechanical weeding thrice (T_{10}) produced the highest straw yield (59.21 q ha^{-1}) which was at par with the bidirectional mechanical weeding twice (T_9) and unidirectional mechanical weeding (T_8). Among the spacing 20×10 cm and 20×20 cm, the effect of weed management practices on straw yield significantly higher at spacing 20×20 cm compared to spacing 20×10cm, except hand weeding twice with respective level of weed management. Maximum straw yield was obtained in bidirectional mechanical weeding thrice (T_{10}) because of mechanical weeding by Ambika paddy weeder not only helped in reducing weed competition, but also improving root growth by increasing soil aeration and root pruning therefore increased tiller density and straw yield. Similar results were found by different workers (Shad 1986 and Thiyagarajan *at el*. 2002).

The data on harvest index for different treatments have been presented in table (2). Its value ranged between 45.69 and 44.07. The harvest index of rice was statistically unaffected due to different treatments. However, numerically, the maximum harvest index (45.69 per cent) was found under the transplanting with herbicidal weed management (T_{11}).

Effect on Economics

The data on cost of cultivation, gross return, net return and B:C ratio from rice as affected by different spacing and weed management practices are presented in Table (2). The highest gross return (₹ 69,759 ha^{-1}) was obtained under bidirectional mechanical weeding thrice (T_{10}) followed by bidirectional mechanical weeding twice (T_9). However, the highest net return (₹ 37,381 ha^{-1}) was recorded under herbicidal weed management (T_6) followed by bidirectional mechanical weeding twice (T_9). The highest B:C ratio (2.61) was recorded under herbicidal weed management (T_6) and minimum was noted under bidirectional mechanical weeding thrice (T_{10}). The reason for higher net return in herbicidal weed management was due to lesser cost of cultivation compared to other methods of weed management. Similar result was reported by different workers Mahajan *et al.* 2009.

Use of mechanical weeding was an efficient method for weed control in wet direct seeded rice. Mechanical weeding can be adopted where labour scarcity occurs. Nonetheless, the use of crop residues was an environmentally benign approach.

CONCLUSION

Based on the findings of the experiment, the following conclusion could be drawn at spacing 20×20 cm, bidirectional mechanical weeding thrice (T_{10}) observed the highest number of effective tillers m^{-2}, total grains panicle^{-1} and filled grains panicle^{-1} which was at par with most of the treatments. Among the spacing 20×10 cm and 20×20 cm, the effect of weed management practices on number of effective tillers m^{-2}, total grains panicle^{-1} and filled grains panicle^{-1} was significantly higher at spacing 20×20 cm than 20×10 cm with the respective level of weed management, except hand weeding twice and herbicidal weed management. While Among the spacing 20×10 cm and 20×20 cm, the effect of weed management practices on unfilled grains panicle^{-1} and sterility per cent was at with the respective level of weed management.

However, sowing of wet direct seeded rice at spacing 20×20 cm with bidirectional mechanical weeding thrice at 20, 30 and 40 DAS produced the maximum grain yield (49.12 q ha^{-1}) which was par with that of bidirectional mechanical weeding twice at 20 DAS and 40 DAS with the same spacing.

Maximum net return (37,381 ha^{-1}) with B:C ratio (2.61) was recorded with sowing of wet direct seeded rice at spacing 20×20 cm with herbicidal weed management *i.e.* Pyrazosulfuran as pre-emergence f.b. Bispyribac-Na as post emergence. The lower net return and B:C ratio in these treatments were due to higher cost of mechanical weeding.

Table 1. Influences of spacing and weed management practices on yield attributing characters of wet direct seeded rice

	Treatment	Effective tillers (No. m^{-2})	Panicle length (cm)	Test weight (g)	Total grains panicle^{-1}	Filled grains panicle^{-1}	Unfilled grains panicle^{-1}	Sterility per cent
T_1	DS 20X10 cm HW at 20 & 40 DAS	311.67	25.88	35.77	141.77	134.70	7.07	5.13
T_2	DS 20X10 cm HWM	305.00	25.93	35.14	139.87	130.93	8.93	6.72
T_3	DS 20X10 cm MWM at 20 & 40 DAS	314.67	25.99	33.96	146.60	139.33	7.27	4.97
T_4	DS 20X10 cm MWM at 20, 30 & 40 DAS	316.67	25.52	34.11	148.93	141.93	7.00	4.70
T_5	DS 20X20 cm HW at 20 & 40 DAS	317.00	26.75	35.57	147.97	140.30	7.67	5.18

T_6	DS 20X20 cm HWM	311.33	26.18	34.67	140.74	131.60	9.14	6.41
T_7	DS 20X20 cm MWM at 20 & 40 DAS uni.	326.00	26.64	35.18	147.77	140.90	6.87	4.64
T_8	DS 20X20 cm MWM at 20, 30 & 40 DAS uni.	328.33	26.65	35.29	150.30	142.97	7.33	4.89
T_9	DS 20X20 cm MWM at 20 & 40 DAS bi.	336.00	25.91	33.56	150.60	144.13	6.47	4.30
T_{10}	DS 20X20 cm MWM at 20, 30 & 40 DAS bi.	341.00	26.74	35.57	154.07	147.87	6.20	3.81
T_{11}	TP 20X10 cm HWM	315.00	26.69	34.29	141.33	132.63	8.70	6.46
SEm ±		**3.11**	**0.38**	**0.57**	**3.05**	**3.07**	**0.29**	**0.22**
CD (P=0.05)		**9.16**	**NS**	**NS**	**9.01**	**9.06**	**0.85**	**0.65**

DS=Direct seeded: HW= Hand weeding: MWM= Mechanical weed management: HWM= Herbicidal weed management: DAS= Days after sowing: TP= Transplanting: uni= Unidirectional: bi= Bidirectional.
***Significant at 5% level of significance**

Table 2. Influences of spacing and weed management practices on grain yield, straw yield, harvest index and economics of wet direct seeded rice

Treatment		Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	Cost of cultivation (₹ha^{-1})	Gross return (₹ha^{-1})	Net return (₹ha^{-1})	B:C ratio
T_1	DS 20X10 cm HW at 20 & 40 DAS	43.12	51.64	45.50	29699	61221	31522	2.06
T_2	DS 20X10 cm HWM	41.32	49.72	45.39	23547	58686	35139	2.49
T_3	DS 20X10 cm MWM at 20 & 40 DAS	43.18	52.04	45.37	26059	61331	35272	2.35
T_4	DS 20X10 cm MWM at 20, 30 & 40 DAS	44.25	53.74	45.17	28789	62867	34078	2.18
T_5	DS 20X20 cm HW at 20 & 40 DAS	43.40	53.34	44.86	29311	61695	32384	2.10
T_6	DS 20X20 cm HWM	42.64	50.90	45.59	23159	60540	37381	2.61
T_7	DS 20X20 cm MWM at 20 & 40 DAS uni.	43.58	54.13	44.62	25671	61980	36309	2.41
T_8	DS 20X20 cm MWM at 20, 30 & 40 DAS uni.	44.86	56.93	44.07	28401	63861	35460	2.25
T_9	DS 20X20 cm MWM at 20 & 40 DAS bi.	48.02	58.29	45.18	31131	68217	37086	2.19
T_{10}	DS 20X20 cm MWM at 20, 30 & 40 DAS bi.	49.12	59.21	45.34	36591	69759	33168	1.91
T_{11}	TP 20X10 cm HWM	43.43	51.63	45.69	30094	61651	31557	2.05
SEm ±		**0.78**	**1.31**	**0.32**				
CD (P=0.05)		**2.31**	**3.86**	**NS**				

DS=Direct seeded: HW= Hand weeding: MWM= Mechanical weed management: HWM= Herbicidal weed management: DAS= Days after sowing: TP= Transplanting: uni= Unidirectional: bi= Bidirectional.
***Significant at 5% level of significance**

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