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Effect of weed management practices on weed suppression, growth and yield of dry direct seeded rice

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Abstract
Field experiment was conducted during *kharif* seasons of 2016 and 2017 at National Rice Research Institute, Cuttack to study the effect of various weed management practices on weed density, weed dry weight, growth and yield of dry direct seeded rice. The experiment comprised of 10 treatments laid out in randomized complete block design with three replication. The result of experiment reveals that treatment early post emergence application bispyribac sodium 30 g ha^{-1} at 10 DAE *fb* mechanical weeding at 30 DAE at 25 cm row spacing significantly reduced weed growth and recorded higher weed control efficiency, growth parameters, grain and straw yields and it was at par with sequential application pendimethalin 750 g ha^{-1} (PE) *fb* Bispyribac sodium 25 g ha^{-1} (POE) at 25 DAE at 25 cm row spacing treatments. All other treatments of weed management practices were significantly superior to weedy check in all respect.

Keywords: Weed management, direct seeded rice, yield and bispyribac sodium

Introduction

Rice (*Oryza sativa* L.) is the leading cereal of the world and more than half of the people depend on rice for their daily calories. In Asian continent, more than 90% of world rice is grown and consumed. In many parts of the country rice is commonly grown by transplanting seedlings into puddle soil is a major practice. However, in recent years, this method being replaced by direct seeded of rice system (DSRs) because it require lower amount of water, labor, seeds and energy with 10-12 days early maturity (Yogananda *et al*, 2017) [11]. However, in direct seeded rice, weed flora tends to become more diverse and weeds emerge in several flushes during crop growth stage is the major drawback of this system. Thus, weeds are the most severe constraint to DSRs and timely weed management is crucial to increase the productivity of direct seeded rice. The key success of DSR is mainly depends on effective weed control with all possible means. The yield loss in DSR is as high as 50-60% due to simultaneous germination of both crop and weeds (Pinjari *et al.*, 2016). Though, manual weeding has been found very effective, but it is more expensive. Moreover, larger demand of labour during peak period and its scarcity necessitates the use of alternate weed control measures. Chemical weed control by using herbicides being cost effective and less labour dependent tools to overcome this constraint under DSR Broad spectrum of weed flora may not controlled by single application either pre-emergence or post-emergence (Mahajan *et al.*, 2013) [2]. Hence, use of sequential application of pre *fb* post-emergence herbicides or either pre- or post-emergence herbicide *fb* mechanical weeding could be more suitable in controlling the weed menace. By keeping above information in view, the present experiment was conducted with an objective to find out the best combination of herbicide and mechanical weeding to economical control weeds in direct seeded rice.

Materials and Methods

Field experiment was conducted at ICAR-National Rice Research Institute, Cuttack during *kharif* season of two consecutive years (2016 and 2017) to evolve suitable weed management practices on weed dynamics, growth attributes and yield of dry direct seeded rice. The experiment was laid out as randomized complete block design with three replications. It consisted of ten treatments viz., mechanical weeding twice at 20 and 40 days after eme (DAE) at 25 cm row spacing (T_1), pendimethalin 750 g ha^{-1} (PE) *fb* bispyribac sodium 25 g ha^{-1}

(POE) at 25 DAE at 25 cm row spacing (T_2), pendimethalin 750 g ha^{-1} (PE) *fb* mechanical weeding at 30 DAE at 25 cm row spacing (T_3), bispyribac sodium 30 g ha^{-1} at 10 DAE *fb* mechanical weeding at 30 DAE at 25 cm row spacing (T_4), one manual weeding at 30 DAE at 25 cm row spacing (T_5), one manual weeding at 30 DAE at 20 cm row spacing (T_6), weed free (15, 30, 45& 60 DAE) at 25 cm row spacing (T_7), weed free (15, 30, 45& 60 DAE) at 20 cm row spacing (T_8), weedy check at 25 cm row spacing (T_9) and weedy check at 20 cm row spacing (T_{10}). The physicochemical properties of soil were pH 6.37, Organic carbon 0.60%, available nitrogen 292 kg ha^{-1}, phosphorus 22 kg ha^{-1} and potassium 145 kg ha^{-1}. CR Dhan-304 was used as a test variety which was sown during June 10, 2016 and June 8, 2017 with 40 kg seed rate by direct hand drilling continuous in line was done at two different spacing at 20 cm and 25 cm row to row spacing. Full dose of P_2O_5 and K_2O (60 kg ha^{-1}) were applied before sowing at final land preparation and N (80 kg ha^{-1}) was applied equally in 3 splits at 30, 45 and 60 days after emergence (DAE). The required quantity of pre-emergence and post-emergence herbicides was sprayed as per treatment using spray volume of 500 l ha^{-1} with the help of knap sack sprayer fitted with flat fan nozzle. All the other cultural practices including plant protection measures were adapted to as per recommended packages of rice crop. The data on weed density and dry weight of weeds were recorded at 90 DAE with the help of a quadrate (0.5 m x 0.5 m) at 2 places and then converted into per square meter. These values were subjected to square root transformation to normalize their distribution. The data on growth parameters of rice like number of tillers, dry matter accumulation, leaf area index (90 DAE) and grain and straw yields were recorded. Weed control efficiency (%) was computed using the dry weight of weeds (Mani *et. al.,* 1973) [3].

Results and Discussion

Weed density and dry weight

All the weed management practices significantly reduced the total weed density and dry weight of weeds over weedy check during both the years (Table 1). It is evident from the data that, in both the year total density and dry weight was highest and lowest weed control efficiency in weedy check at 25 cm row spacing (T_9) in comparison to other tested treatment. Among the weed management treatment, weed free condition at 20 cm row spacing recorded significantly lowest weed density and dry weight of total weeds as compared to others but it was found at par to weed free check at 25 cm row spacing. However, treatment early post emergence application bispyribac sodium 30 g ha^{-1} at 10 DAE *fb* mechanical weeding at 30 DAE at 25 cm row spacing (T_4) and treatment sequential application pendimethalin 750 g ha^{-1} (PE) *fb* Bispyribac sodium 25 g ha^{-1} (POE) at 25 DAE at 25 cm row spacing (T_2) was proved better in terms of efficiently reduced the total density and dry weight of weeds during both the years. This might be due to better control of weeds at germination phase by the application of pre-emergence herbicides and later germinating weeds were controlled by post emergence herbicides and also by operation of mechanical weeders resulted lower total weed density, dry weight and higher weed control efficiency in above treatments. Similar findings were also reported by Saha and Rao (2010) [6] and Pramella *et al.* (2014) [5].

Crop growth

Among the weed management practices, weed free condition at 20 cm row spacing gave maximum number of tillers m^{-2}, dry matter accumulation g m^{-2} and leaf area index and it was found significantly superior over rest of treatments except weed free check at 25 cm row spacing (T_7) treatments during both the years (Table1). However, at the same time treatment early post emergence application bispyribac sodium 30 g ha^{-1} at 10 DAE *fb* mechanical weeding at 30 DAE at 25 cm row spacing (T_4) and treatment sequential application pendimethalin 750 g ha^{-1} (PE) *fb* Bispyribac sodium 25 g ha^{-1} (POE) at 25 DAE at 25 cm row spacing (T_2) might have controlled the weeds appearing in several flushes which resulted better performance of growth attributes in these treatments (Walia *et al.,* 2008) [10]. The lowest growth attributes was recorded in weedy check at 25 cm row spacing (T_9) followed by weedy check at 20 cm row spacing (T_{10}) during both the years. Season long competition between crop and weed in weedy check treatment restrict the availability of nutrient, light, water and space to growing plants which results in reduced the tillers m^{-2}, dry matter accumulation and leaf area index (Awan *et al.,* 2015) [1].

Grain and straw yield

The data pertaining to grain and straw yields were presented (Table 2). Among the weed management treatment, weed free condition at 20 cm row spacing recorded significantly higher grain and straw yield as compared to all other treatments, and it was found at par with weed free check at 25 cm row spacing during both the years. With respect to herbicide and integration of herbicide with mechanical weeding treatments, application of early post emergence application bispyribac sodium 30 g ha^{-1} at 10 DAE *fb* mechanical weeding at 30 DAE at 25 cm row spacing (T_4) recorded significantly higher grain and straw yield over rest of the treatments except treatment sequential application pendimethalin 750 g ha^{-1} (PE) *fb* Bispyribac sodium 25 g ha^{-1} (POE) at 25 DAE at 25 cm row spacing (T_2) during both the years. The increase in yield was mainly attributed due to better control of weeds throughout the crop growth periods resulting better availability of nutrients, light, water and space to the crop growth. This was reflected through increased in leaf area index, dry matter accumulation which leads to higher number of tillers and yield. These results were in accordance with Sangeetha (2006) and Singh and Painkra (2004). The lower grain and straw yields registered under weedy check at 25 cm row spacing (T_9) followed by weedy check at 20 cm row spacing (T_{10}) during both the years. This clearly indicated that severe weed competition exerted by weeds on crop which resulted in lower yield under weedy check (Singh *et al.,* 2016) [9].

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Table 1: Total weed density and dry weight of weeds and weed control efficiency at 90 DAE as influenced by weed management practices in dry direct seeded rice

Treatment	Total density of weeds at 90 DAE (no m^{-2})		Total weed dry weight at 90 DAE (g m^{-2})		Weed control efficiency at 90 DAE (%)	
	2016	2017	2016	2017	2016	2017
T_1	6.92 (47.33)	6.57 (42.67)	6.25 (38.65)	5.96 (35.05)	71.91	73.43
T_2	5.52 (30.00)	5.28 (27.33)	5.01 (24.67)	4.78 (22.35)	82.07	83.06
T_3	6.52 (42.00)	6.20 (38.00)	5.89 (34.26)	5.68 (31.75)	75.11	75.93
T_4	4.67 (21.33)	4.48 (19.67)	4.23 (17.40)	4.09 (16.29)	87.36	87.65
T_5	8.53 (72.33)	8.28 (68.00)	7.79 (60.23)	7.41 (54.36)	56.23	58.79
T_6	8.13 (65.67)	7.93 (62.33)	7.34 (53.34)	7.03 (48.94)	58.12	59.92
T_7	3.89 (14.67)	3.62 (12.67)	3.23 (9.93)	3.14 (9.34)	92.78	92.92
T_8	3.29 (10.33)	3.13 (9.33)	2.69 (6.77)	2.67 (6.66)	94.69	94.55
T_9	12.68 (160.33)	12.47 (155.00)	11.75 (137.62)	11.50 (131.92)	-	-
T_{10}	12.01 (143.70)	11.78 (138.30)	11.30 (127.40)	11.07 (122.10)	-	-
SEm ±	0.27	0.30	0.40	0.38	2.44	2.27
CD (p=0.05)	0.81	0.88	1.18	1.14	7.26	6.75

Square root $\sqrt{(x+0.5)}$ transformed values. Values in the parentheses are original values

Table 2: Effect of weed management practices on growth parameters and grain yield of dry direct seeded rice

Treatment	Number of tillers at 90 DAE m^{-2}		Dry matter accumulation at 90 DAE (g m^{-2})		Leaf area index at 90DAE		Grain yield (t ha^{-1})		Straw yield (t ha^{-1})	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
T_1	309.12	317.12	662.70	701.07	3.69	3.75	4.81	4.90	5.39	5.47
T_2	324.05	333.05	729.51	773.13	3.85	3.94	5.06	5.13	5.66	5.70
T_3	315.19	325.19	670.22	709.22	3.75	3.86	4.87	4.98	5.46	5.53
T_4	342.79	350.79	773.75	814.52	4.03	4.10	5.17	5.29	5.76	5.83
T_5	285.61	294.61	562.71	594.56	3.20	3.27	4.36	4.42	4.95	4.98
T_6	298.68	304.68	614.20	646.82	3.35	3.43	4.45	4.58	5.04	5.15
T_7	378.73	386.73	834.81	879.81	4.22	4.24	5.33	5.49	5.87	6.03
T_8	395.28	403.28	878.79	925.79	4.36	4.49	5.55	5.62	6.10	6.15
T_9	246.27	250.68	451.43	480.67	2.76	2.84	2.87	2.94	3.28	3.33
T_{10}	270.48	279.48	510.07	540.70	2.95	3.04	2.94	3.11	3.36	3.51
SEm ±	17.15	17.22	34.13	34.75	0.11	0.11	0.09	0.09	0.11	0.10
CD (p=0.05)	50.94	51.16	101.40	103.25	0.31	0.32	0.25	0.27	0.33	0.30

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