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Effect of different chemical weed management practices on grain yield and harvest index under direct seeded rice

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Abstract

The present investigation was conducted during the Kharif season 2016 at the Research Farm, Bihar Agricultural College, Sabour, to find out effect of different chemical weed management practices and varieties on grain yield, straw yield and harvest index of direct seeded rice. Significantly higher grain yield (37.88 q ha⁻¹) was recorded with sequential application of pendimethalin followed by bispyribac-sodium which was 50.14% higher over weedy check. As regards to varieties, Sahbhagi Dhan recorded significantly higher grain yield (38.82 q ha⁻¹) but remained at par (37.28 q ha⁻¹) with variety Swarna Shreya. Whereas, interaction effect between sequential application of pendimethalin followed by bispyribac-sodium x Sahbhagi Dhan produced significantly higher grain yield (46.00 q ha⁻¹) which showed (43.33 q ha⁻¹) parity with pendimethalin followed by bispyribac-sodium x Swarna Shreya.

Keywords: rice, weed management and harvest index

Introduction

Rice (*Oryza sativa* L.), 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, 2012) [3]. The slogan 'Rice is Life' is most appropriate for our country as it feeds about more than two third of the population of India. The area, production and productivity of rice in India is 43.38 m ha, 104.32 m t and 3.62 t ha⁻¹ (< world average 4.54 t ha⁻¹) respectively. In Bihar, it is cultivated in 3.15 m ha area with a production of 6.60 m t and productivity of 2.09 t ha⁻¹ (Anonymous, 2016). In India rice is cultivated under three major ecosystems: rainfed uplands (16%), irrigated lands (45%) and rainfed low lands (39%), with a productivity of 0.87, 2.24 and 1.55 t ha⁻¹, respectively (Anonymous, 2015) therefore, increasing rice productivity is essential specially under rainfed ecosystems. Furthermore, global rice demand is expected to rise from 439 m t in 2010 to 496 m t in 2020 and further increase to 553 m t in 2035, alarming to increase rice productivity to feed the burgeoning population. Traditionally, major growing area is under transplanted ecosystem which required huge labour cost incurred during nursery raising, puddling and transplanting operations. In Rainfed rice ecosystem, direct sown rice is alternative to transplanted ecosystem during kharif season. Direct seedling offers certain advantages *i.e.* saves labour, faster and easier planting helps in timely sowing, less drudgery, early crop maturity by 7-10 days, less water requirement, high tolerance to water deficit, often higher yield, low production cost and more profit, better soil physical condition for following crops and less methane emission (Balasubramanian and Hill, 2002) [1]. Direct seeded rice saves the water by tune of 12-35% (Kumar and Ladha, 2011) [7] and 29% saving of total cost of transplanting which needs only 34% of total labour requirement (Ho and Romli, 2000) [5] besides improving the physical condition of soil. However, direct sown rice under dry seeded, wet seeded, aerobic soil conditions, dry tillage practices and alternate wetting and drying conditions are conducive for germination and growth of highly competitive weeds, which cause 40-100% loss of grain yield (Choubey *et al.*, 2001) [2]. Weeds grow faster than the crop plants and absorb the available nutrients earlier, resulting in lack of nutrients for growth of the crop plants. The critical weed competition period is reported 30-35 days in transplanted rice, whereas, 50-60 days in direct seeded condition. Vairvan *et al.*, (2000) [10] found significantly higher yield attributes *viz.* effective tillers, panicle length, panicle weight, grains panicle⁻¹, test weight in DSR rice *cv.* ADT-36 with pre-emergence application of Pendimethalin at 1.0 kg ha⁻¹ followed by one hand weeding. Similarly, Singh *et al.*, (2002) reported higher yield attributes and yield with application of pendimethalin followed by two hand weeding compared to hand weeding and weedy plots. Gopinath and Pandey (2004) [4] reported that hand weeding recorded significantly higher number of panicles hill⁻¹ and grain weight panicle⁻¹.

Lakshmi *et al.*, (2006)^[8] reported that hand weeding twice on 20 and 40 DAS was found to be superior, yield attributing characters, grain yield (5444 kg ha⁻¹) and straw yield (5759 kg ha⁻¹) in direct seeded rice. Thakur *et al.*, (2011)^[9] revealed that sequential application of pendimethalin 1000 g ha⁻¹ *fb* penoxsulam 22.5 g ha⁻¹ effectively reduced density and biomass of weeds (grasses, sedges and broad leaf weeds) and grain filling percentage (77.61%), test weight (19.47 g), grain yield (1401.60 kg ha⁻¹) and harvest index (45.59) of direct seeded rice. Meanwhile, Khaliq *et al.*, (2011)^[6] revealed that, manual weeding also accounted for maximum panicle length (18.57 cm), grains panicle⁻¹ (117), 1000 grain weight (18.52 g), number of grains panicle⁻¹ (116.66) and was at par with post emergence application of penoxsulam. Keeping in view of above present research works were taken into consideration.

Materials and Methods

Experimental Site

The research farm of Bihar Agricultural University, Sabour is situated about 10 km away from city Bhagalpur which falls in the Middle Gangetic plain region of Agro-climatic Zone III A at 25.50° North latitude and 87.19° East longitudes with an altitude of 52.73 meters above the mean sea level. The experiment was laid out in 'K-Block', Research Farm, Bihar Agricultural University, Sabour. Experimental field was homogeneously fertile with even topography and uniform textural make up and was attached to the main irrigation channel connecting the farm tube well for life saving irrigation. Proper drainage facility was also provided in order to remove excess water during experimental period.

Experimental material

Five varieties of rice such as Swarna Shreya, Sahbhagi Dhan, DRR Dhan 41, DRR Dhan 42 and DRR Dhan 44 were taken which are suitable for rainfed ecosystem. The chemical weedicide used were pendimethalin as pre emergence, bispyribac-sodium as post emergence and pre emergence application of pendimethalin followed by post emergence bispyribac-sodium.

Experimental design

The experiment was laid out in split-plot design with four levels of weed management practices (W₁, W₂, W₃ and W₄) in main plot and five weed competitive varieties (V₁, V₂, V₃, V₄ and V₅) in sub plot with three replications during kharif 2016. The classified descriptions of the treatments with corresponding symbols are given below in order to facilitate their presentation in the text.

Results and Discussion

Grain yield

The effects of chemical weed management practices on grain yield are presented in Table 3. Perusal of data revealed beneficial effect of weed management practices on grains yield of direct seeded rice was reflected very well during year of investigation. The highest grain yield (37.88 q ha⁻¹) was recorded after the application of W₃ (pendimethalin *fb* bispyribac-sodium) which was significantly superior over rest of the treatments. However, W₄ (control) recorded the lowest grain yield (25.23 q ha⁻¹) among the treatments. Grain yield increased with sequential application of pendimethalin followed by bispyribac-sodium to the tune of 26.69, 14.68 and 50.14 % as compared to application of pendimethalin, application of bispyribac-sodium and weedy check,

respectively. Data showed (Table 3) different weed competitive varieties caused significant effect on grain yield. Significantly higher grain yield (38.82 q ha⁻¹) was noticed in V₂ (Sahbhagi Dhan) which remained at par with variety V₁ (Swarna Shreya) and proved significantly superior over rest of the varieties used. While V₄ (DRR Dhan 42) found to be lowest grain yielding varieties (23.07 q ha⁻¹) among the varieties during the investigation year. Further, it was noticed that *var.* Sahbhagi Dhan increased grain yield to a tune of 4.13, 24.46, 68.27 and 42.72 % over Swarna Shreya, DRR Dhan 41, DRR Dhan 42 and DRR Dhan 44, respectively. The interaction effect between weed management practice and varieties are given in Table 4. Data clearly showed that rice grain yield was significantly higher (46.0 q ha⁻¹) with W₃ (pendimethalin *fb* bispyribac-sodium) x V₂ (Sahbhagi Dhan) treatment over remaining treatments but remained at par to (43.33 q ha⁻¹) W₃ (pendimethalin *fb* bispyribac-sodium) x V₁ (Swarna Shreya) in the experimental year. However, lowest grain yield (16.57 q ha⁻¹) was noticed under the interaction of W₄ (control) x V₄ (DRR Dhan 42).

Straw yield

The perusal of data as presented in table 3 indicates that different weed competitive varieties caused significant effect on straw yield. Significantly higher straw yield (68.48 q ha⁻¹) was noticed in V₂ (Sahbhagi Dhan) which parity with variety V₁ (Swarna Shreya) and proves to be significantly superior over rest of the varieties used. While, V₄ (DRR Dhan 42) produced lowest straw yield (40.93 q ha⁻¹) among the varieties used during the experimental year. Further, it was noticed that V₂ (Sahbhagi Dhan) produced 67.31% higher straw yield over V₄ (DRR Dhan 42). The interaction effect between weed management practice and varieties are given in Table 4.7(b) was found significant. Data showed that straw yield (76.35 q ha⁻¹) was significantly higher with W₃ (pendimethalin *fb* bispyribac-sodium) x V₂ (Sahbhagi Dhan) treatment over remaining treatments but remained at par (74.76 q ha⁻¹) with W₃ (pendimethalin *fb* bispyribac-sodium) x V₁ (Swarna Shreya) in the experimental year. However, next best treatments in orders of W₁ (pendimethalin) x V₂ (Sahbhagi Dhan), W₂ (bispyribac-sodium) x V₁ (Swarna Shreya), W₂ (bispyribac-sodium) x V₂ (Sahbhagi Dhan) W₃ (pendimethalin *fb* Bispyribac-sodium) x V₃ (DRR Dhan 41) was noticed during the year. However, lowest straw yield (29.52 q ha⁻¹) was noticed under the interaction of W₄ (control) x V₄ (DRR Dhan 42).

Harvest index

The harvest index (%) as influenced by weed management practice and weed competitive varieties are presented in Table 3. The harvest index as affected by weed management practice did not reach to the level of significance. However, highest harvest index (37.15%) was recorded with W₃ (pendimethalin *fb* bispyribac-sodium) followed by W₂ (bispyribac-sodium) and W₁ (pendimethalin) and lowest in W₄ (control) during the experimental year. The effect of different varieties used under this experiment failed to produce significant result on harvest index. The maximum harvest index (36.06%) was recorded with V₂ (Sahbhagi Dhan) followed by in order of V₃ (DRR Dhan 41) > V₄ (DRR Dhan 42) > V₁ (Swarna Shreya) > V₅ (DRR Dhan 44) during the course of investigation. The interaction effect of harvest index between weed management practices and varieties did not found to vary significantly during experiment as presented in table 5.

Table 1: Experiment details

Variety	:	Swarna Shreya, Sahbhagi Dhan, DRR Dhan 41, DRR Dhan 42, DRR Dhan 44
Experimental site	:	B.A.C. farm, Sabour
Experimental Design	:	Split plot
Gross plot size	:	6.0 m x 4.0 m = 24.0 m ²
Net plot size	:	5.5m x 3.2 m= 17.6m ²
Main plots (4)	:	Weed management practices
Sub plots (5)	:	Weed competitive varieties
Treatment combinations	:	4 x 5= 20
Replications	:	03
Total plots	:	20 x 3 = 60

Table 2: Treatment details

Main plots:- Weed Management Practices	
W ₁	Pre-emergence herbicide application of pendimethalin 30%EC @ 750 g. a.i/ha
W ₂	Post-emergence herbicide application of bispyribac sodium 10SC @ 30g.a.i/ha
W ₃	Pre-emergence herbicide application of pendimethalin 30%EC @ 750 g.a.i/ha <i>Fb</i> Post-emergence herbicide application of bispyribac sodium 10SC@30g. a.i/ha
W ₄	Control
Sub plot :- Weed competitive varieties	
V ₁	Swarna Shreya
V ₂	Sahbhagi Dhan
V ₃	DRR Dhan 41
V ₄	DRR Dhan 42
V ₅	DRR Dhan 44

Table 3: Grain yield, straw yield and harvest index in relation to different varieties and weed control treatments in direct-seeded rice

Treatments	Grain Yield (q ha ⁻¹)	Straw Yield (q ha ⁻¹)	Harvest Index (%)
Weed management practices			
W ₁ - Pendimethalin @ 750 g a.i.ha ⁻¹ Pre-emergence	29.90	56.15	34.75
W ₂ - Bispyribac-sodium @ 30 g a.i.ha ⁻¹ Post-emergence	33.03	57.01	36.56
W ₃ - Pendimethalin @ 750 g a.i.ha ⁻¹ Pre-emergence <i>fb</i> Bispyribac-sodium @ 30g a.i.ha ⁻¹ Post-emergence	37.88	64.00	37.15
W ₄ - Control	25.23	47.87	34.68
SEm ±	0.66	1.16	0.78
CD (P=0.05)	2.38	4.20	NS
Weed competitive varieties			
V ₁ - Swarna Shreya	37.28	66.89	35.72
V ₂ - Sahbhagi Dhan	38.82	68.48	36.06
V ₃ - DRR Dhan 41	31.19	55.11	35.95
V ₄ - DRR Dhan 42	23.07	40.93	35.94
V ₅ - DRR Dhan 44	27.20	49.87	35.25
SEm ±	0.56	0.80	0.56
CD (P=0.05)	1.61	2.31	NS
Interaction WXV	S	S	NS

Table 4: Interaction effect of grain yield (q ha⁻¹) in relation to different varieties and weed management practice in direct-seeded rice

Treatments	V1	V2	V3	V4	V5	MEAN
W ₁	35.16	36.88	28.33	21.92	27.24	29.90
W ₂	39.62	40.88	31.52	24.68	28.45	33.03
W ₃	43.33	46.00	40.58	29.13	30.38	37.88
W ₄	31.01	31.53	24.34	16.57	22.72	25.23
Mean	37.28	38.82	31.19	23.07	27.20	
	SEm ±			1.12		
Comp. of twosubplots within main plot				3.22		
	SEm ±			1.19		
Comp. of two mainplots within sub plot				3.71		

W₁ - Pendimethalin @ 750 g a.i.ha⁻¹Pre-emergence, W₂ - Bispyribac-sodium @ 30 g a.i.ha⁻¹Post-emergence, W₃ - Pendimethalin @ 750 g a.i.ha⁻¹ Pre-emergence *fb* Bispyribac-sodium @ 30g a.i.ha⁻¹ Post-emergence, W₄ – Control, V₁ - Swarna Shreya, V₂ -Sahbhagi Dhan, V₃ -DRR Dhan 41, V₄ - DRR Dhan 42, V₅ - DRR Dhan 44

Table 5: Interaction effect of straw yield (q ha⁻¹) in relation to different varieties and weed control treatments in direct-seeded rice

Treatments	V ₁	V ₂	V ₃	V ₄	V ₅	MEAN
W ₁	66.41	69.17	51.32	41.53	52.33	56.15
W ₂	67.32	66.81	56.25	44.05	50.64	57.01
W ₃	74.76	76.35	66.63	48.63	53.63	64.00
W ₄	59.06	61.61	46.26	29.52	42.90	47.87
Mean	66.89	68.48	55.11	40.93	49.87	
	SEm ±			0.80		
Comp. of two subplots within main plot				2.31		
	SEm ±			1.61		
Comp. of two mainplots within sub plot				4.63		

W₁ - Pendimethalin @ 750 g a.i.ha⁻¹Pre-emergence, W₂ - Bispyribac-sodium @ 30 g a.i.ha⁻¹Post-emergence, W₃ - Pendimethalin @ 750 g a.i.ha⁻¹ Pre-emergence /b Bispyribac-sodium @ 30g a.i.ha⁻¹ Post-emergence, W₄ - Control, V₁ - Swarna Shreya, V₂ -Sahbhagi Dhan, V₃ -DRR Dhan 41, V₄ - DRR Dhan 42, V₅ - DRR Dhan 44

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