



## Influence of transplanting date and integrated weed management in system of rice intensification of aromatic black rice (*Oryza sativa*)

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### ABSTRACT

A field experiment was conducted during rainy seasons (*khari*) of 2019 and 2020 at the research farm of School of Agricultural Sciences, Nagaland University, Nagaland to study the effect of transplanting date and weed management practices on productivity and profitability of aromatic black rice (*Oryza sativa* L.) under system of rice intensification. The experiment was conducted in a split plot design (SPD) with 3 transplanting dates (D<sub>1</sub>, 15<sup>th</sup> June; D<sub>2</sub>, 30<sup>th</sup> June; and D<sub>3</sub>, 15<sup>th</sup> July) in main plot and 5 weed managements practices [W<sub>1</sub>, Weedy check; W<sub>2</sub>, Conoweeding at 20 and 40 DAT (days after transplanting); W<sub>3</sub>, Pretilachlor @0.75 kg/ha (PE) *fb* hand weeding (HW) at 40 DAT; W<sub>4</sub>, Pretilachlor @0.75 kg/ha (PE) *fb* conoweeder at 40 DAT; and W<sub>5</sub>, Pretilachlor at 0.75 kg/ha (PE) *fb* bispyribac-sodium @ 25 g/ha (PoE)] in sub-plot, replicated thrice. Results showed that the most abundant weed flora observed in the experimental field were *Fimbristylis quinquangularis* (Vahl) Kunth, *Cyperus esculentus* (L.), *Cyperus iria* (L.), *Rhynchospora colorata* (L.) H.Pfeiff., *Ludwigia linifolia* Poir, *Mimosa pudica* (L.), *Mimosa diplotricha* Sauvallé, *Scoparia dulcis* (L.) and *Eriochloa villosa* (Thunb.) Kunth. Transplanting on 15<sup>th</sup> June recorded highest growth and yield of black rice. The improvement in the grain yield was about 39% under 15<sup>th</sup> June over 15<sup>th</sup> July transplanting date. Among weed management practices, pretilachlor @0.75 kg/ha at 3 DAT *fb* HW at 40 DAT recorded minimum density of weeds resulting in higher growth attributes and yield of black rice. Economic analysis showed that highest benefit cost (B:C) ratio was obtained when black rice was transplanted on 15<sup>th</sup> June along with application of pretilachlor @0.75 kg/ha at 3 DAT *fb* bispyribac-sodium @25 g/ha at 20 DAT and demonstrated to be the best treatment for profitable production of black rice under system of rice intensification.

**Keywords:** Bispyribac-sodium, Black rice, Pretilachlor, Transplanting date, Weed management, Yield

Black rice, a special cultivar of rice (*Oryza sativa* L.) contains high amount of anthocyanin pigments, antioxidant, protein (8.16%) and low fat content (0.07%) in comparison to other rice varieties (Thomas *et al.* 2013). China is responsible for 62% production in the world followed by Sri Lanka (8.6%), Indonesia (7.2%), India (5.1%), Bangladesh (4.1%) (Chaudhary 2003). Manipur black rice cultivar, referred as *Chakhao* has recently got the GI tag in 2020 because of its unique aroma and attractive colour. Its cultivation is extended up to an area of 4.5 thousand hectares (Chanu *et al.* 2022) and constitutes around 10% of Manipur's total rice production.

Transplanting date which is related to climatic conditions, is an important agronomic factor and non-monetary input for obtaining optimum rice yields. Late

transplanting results in decreased yield and also reduced growth duration leads to minimum leaf area, effective tillers and test weight (Bashir *et al.* 2010). Weeds are one of the primary biotic factors lowering the rice productivity worldwide. Maheshwari *et al.* (2015) also showed that weeds could reduce grain yield up to 45–51%. Due to increased spacing and non-flooded condition in the field, severe weed infestation is a significant issue in system of rice intensification. Cono-weeding is a tiresome job under non-flooding situation requiring more labour investment. Under such conditions, the use of suitable herbicides is the better substitute to gain high productivity with low costs. Bispyribac-sodium is a systemic herbicide which inhibits the enzyme acetolactate synthase at low concentrations, affecting biosynthesis of essential branched-chain amino acids, cell division and growth of weeds (Biswas *et al.* 2020). Therefore, for successful rice cultivation, optimizing transplanting time and a weed free environment throughout the crucial stage of rice growth is required. In this context, a field investigation was conducted to study the effect of

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transplanting date and weed management practices on productivity and profitability of black rice under system of rice intensification.

## MATERIALS AND METHODS

A field experiment was conducted during rainy (*khari*) seasons of 2019 and 2020 at research farm of the School of Agricultural Sciences, Nagaland University, Medziphema (20°45'43" N latitude and 93°53'04" E at an altitude of 310 m amsl), Nagaland. The climate of the region is sub-tropical having hot and humid summers and cold winters. Throughout the cropping season from June to November, a total amount of rainfall of 1271.3 mm and 971.8 mm was obtained in the year 2019 and 2020, respectively with average maximum temperature recorded highest throughout August at 34.1°C and 33.7°C for the year 2019 and 2020. The lowest temperature recorded in November month at 16.3°C and 15.6°C for 2019 and 2020 respectively. Relative humidity ranged from 62–98% in 2019 and 55–98% during 2020. The soil texture was clayey loam with very strongly acidic in reaction (4.85 pH), high in organic carbon (1.21%), low in available N (253.12 kg/ha) and P (18.43 kg/ha) and medium in available K (142.62 kg/ha).

The experiment was laid out in split plot design (SPD) consisting of 3 dates of transplanting (D<sub>1</sub>, 15<sup>th</sup> June; D<sub>2</sub>, 30<sup>th</sup> June and D<sub>3</sub>, 15<sup>th</sup> July) in main plot; and 5 integrated weed management practices (IWM) [W<sub>1</sub>, Weedy check; W<sub>2</sub>, Conoweeding at 20 and 40 DAT (days after transplanting); W<sub>3</sub>, Pretilachlor @0.75 kg/ha (PE) *fb* hand weeding (HW) at 40 DAT; W<sub>4</sub>, Pretilachlor @0.75 kg/ha (PE) *fb* conoweeder at 40 DAT; and W<sub>5</sub>, Pretilachlor at 0.75 kg/ha (PE) *fb* bispyribac-sodium @ 25 g/ha (PoE)] in sub-plot, replicated thrice. The individual plot size was 4 m × 3 m. Younger seedlings of 12 days old of the cultivar *Chakhao Poireiton* were transplanted according to the treatment on 15<sup>th</sup> June, 30<sup>th</sup> June and 15<sup>th</sup> July at one seedling/hill with 25 cm × 25 cm spacing. Well decomposed farmyard manure (FYM) @7 t/ha was uniformly broadcasted over the field and incorporated thoroughly during the final land preparation. Nitrogen was applied in split through urea at 50 kg/ha while basal application of P at 30 kg/ha and K at 20 kg/ha was done through single super phosphate (SSP) and muriate of potash (MOP) irrespective of the treatment. Depending on the treatment, pretilachlor (50% EC) at 0.75 kg/ha and bispyribac-sodium (10% SL) at 20 g/ha were sprayed at 3 DAT and 20 DAT respectively. A flat fan nozzle fitted knapsack sprayer containing spray volume of 500 litre/ha was used for application of herbicides. Weed density of each plot was randomly taken using a quadrat of 1 m<sup>2</sup> and the data were subjected to square root transformation as per the formula  $\sqrt{x + 0.5}$ , in which  $x$  indicates the actual weed count. The data collected for various parameters were analyzed using analysis of variance technique as per split plot design given by Gomez and Gomez (1984). Critical difference of different groups of treatments and their interactions at 5% probability level were calculated to compare the treatment means.

## RESULTS AND DISCUSSION

*Weed density, dry weight and weed control efficiency:* Weed species found in the experimental field were identified and recorded as grasses, sedges and broad-leaf weeds. The dominant species of grasses were *Eriochloa villosa* (Thunb.) Kunth, *Setaria helvola* (L.f.) Roem. & Schult. and *Digitaria sanguinalis* (L.) Scop. while *Fimbristylis quinquangularis* (Vahl) Kunth, *Cyperus esculentus* (L.) and *Cyperus iria* (L.) were dominant among the sedges and in case of broad-leaf weeds *Ludwigia linifolia* Poir, *Mimosa pudica* (L.), *Alternanthera sessilis* (L.) R. Br. ex DC., *Ageratum conyzoides* (L.), *Scoparia dulcis* (L.) and *Ipomoea triloba* (L.) were the most dominated one. Transplanting date and weed management approaches significantly influences the density of weeds, dry weight and WCE (weed control efficiency) (Table 1). However, interaction of different date of transplanting and weed management practices showed no significant impact on weed density and WCE except weed dry weight. Transplanting on 15<sup>th</sup> June significantly lowers the density of weeds and dry weight and recorded higher WCE while maximum density and dry weight of weeds were observed when transplanting was done on 15<sup>th</sup> July. Decrease weed density and dry weight with 15<sup>th</sup> June transplanting date might be due to suitable climatic condition under early transplanted black rice which helped the crop to establish and overcome the weed. This ultimately improved the crop growth and competitiveness and eventually decreases the use of resources by weeds like moisture, nutrients, light and space as described by Kumar *et al.* (2017).

Pooled results showed that out of IWM, weedy check proved to increase the density and dry weight of weeds significantly due to uncontrolled weeds (Table 1). Application of pretilachlor at 0.75 kg/ha *fb* HW at 40 DAT was found to decrease the density and dry weight, and recorded significantly lowest values and highest WCE. Among the other weed management treatments, conoweeding twice recorded higher density and dry weight and were found to remained at par with pretilachlor at 0.75 kg/ha *fb* conoweeder at 40 DAT. Efficient management of various weed flora with spraying of pretilachlor during initial stage which inhibits cell division and germination of weeds followed by hand removal of weeds at later stage was also reported by Phukan and Deka (2021). The reason behind higher population and dry weight with conoweeding twice might be the result of difficulty in operating conoweeder under non-flooded situation as well as higher intervals between the two weedings. The findings are in line with the previous study conducted by Kunnathadi *et al.* (2014).

Data (Table 2) revealed that interaction effect between transplanting date and IWM were found to be significant in both the years of study on dry weight of sedges and broad-leaf weeds. Transplanting of black rice on 15<sup>th</sup> June with combined application of pretilachlor @0.75 kg/ha at 3 DAT *fb* HW at 40 DAT recorded significantly minimum dry weight while significantly maximum dry weight was observed under treatment combination of 15<sup>th</sup> July transplanting date and weedy check.

Table 1 Effect of transplanting date and integrated weed management practices on weeds density, dry weight, weed control efficiency, growth attributes, yield components, yield and economics of aromatic black rice during *kharif* 2019 and 2020 (Pooled data of 2 years)

Treatment	Grasses (no./m <sup>2</sup> at 60 DAT)	Sedges (no./m <sup>2</sup> at 60 DAT)	Broad-leaf weeds (no./m <sup>2</sup> at 60 DAT)	Grasses (g/m <sup>2</sup> at 60 DAT)	Sedges (g/m <sup>2</sup> at 60 DAT)	Broad-leaf weeds (g/m <sup>2</sup> at 60 DAT)	Weed control efficiency (%)	Plant height (cm)	Number of tillers/hill	Number of panicles/m <sup>2</sup>	Panicle length (cm)	Number of grains/panicle	Grain yield (t/ha)	Straw yield (t/ha)	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	Net production value	
<i>Date of transplanting</i>																			
D <sub>1</sub>	3.36 (14.03)	7.31 (61.8)	6.21 (49.03)	2.35 (6.34)	6.07 (50.4)	5.41 (41.71)	72.1	41.5	15.50	199.5	27.74	131.0	2.08	4.09	28724	66525	37800	1.31	
D <sub>2</sub>	4.24 (21.28)	8.48 (80.7)	7.06 (60.5)	3.15 (11.20)	6.73 (59.4)	6.33 (53.6)	70.4	36.12	13.65	179.8	24.84	119.5	1.68	3.84	28724	54206	25481	0.89	
D <sub>3</sub>	4.88 (28.02)	9.00 (89.8)	7.87 (73.1)	3.51 (14.32)	7.72 (72.8)	7.39 (72.3)	68.9	29.09	11.58	153.9	23.56	111.8	1.50	3.58	28724	48465	19740	0.68	
SEm±	0.09	0.18	0.14	0.06	0.07	0.10	0.29	0.89	0.28	3.38	0.48	1.89	0.03	0.04					
CD (P=0.05)	0.28	0.60	0.46	0.20	0.23	0.31	0.96	6.04	0.93	11.02	1.57	6.17	0.08	0.13					
<i>Integrated weed management</i>																			
W <sub>1</sub>	7.88 (62.9)	13.83 (191.4)	13.26 (176.2)	5.49 (30.51)	14.24 (202.6)	13.93 (195.6)	0.00	20.46	9.55	127.1	23.13	98.0	1.21	3.24	25453	39651	14197	0.56	
W <sub>2</sub>	3.80 (14.35)	8.04 (65.5)	6.80 (47.10)	2.85 (7.92)	5.63 (32.27)	5.44 (29.70)	84.0	29.16	12.02	175.1	25.29	111.8	1.65	3.70	31173	53077	21904	0.70	
W <sub>3</sub>	2.40 (5.78)	5.32 (28.47)	3.84 (14.72)	1.69 (2.57)	4.02 (16.12)	3.24 (10.78)	93.3	50.9	17.11	210.2	26.86	142.3	2.19	4.35	30875	69896	39021	1.26	
W <sub>4</sub>	3.64 (13.09)	7.70 (60.0)	6.35 (41.08)	2.68 (6.94)	5.46 (29.94)	5.07 (25.83)	85.6	33.99	13.14	180.6	25.54	120.4	1.75	3.84	29445	56249	26804	0.91	
W <sub>5</sub>	3.06 (9.39)	6.43 (41.61)	4.98 (25.45)	2.31 (5.16)	4.85 (23.43)	4.19 (17.60)	89.4	43.37	14.82	195.9	26.10	131.3	1.97	4.06	26675	63119	36443	1.37	
SEm±	0.11	0.18	0.20	0.10	0.09	0.11	0.37	1.25	0.59	2.96	1.03	2.61	0.03	0.06					
CD (P=0.05)	0.31	0.50	0.56	0.27	0.25	0.30	1.04	7.48	1.18	8.42	NS	7.43	0.08	0.16					

Original values were subjected to square root transformation. Figures in parenthesis are the original values. Treatment details are given under Materials and Methods. DAT, Days after transplanting.

*Growth and yield attributes of black rice:* Date of transplanting and weed management practices illustrated significant impact on plant height and number of tillers/hill of black rice (Table 1). Black rice transplanted on 15<sup>th</sup> June performed better than 30<sup>th</sup> June and 15<sup>th</sup> July and improved the plant height and number of tillers/hill significantly. This could be the result of favourable climatic condition and longer growth duration which helps in greater translocation of photosynthates throughout the plant parts. Similar findings were demonstrated by Mann and Dhillon (2021). Weedy check decreased the plant height and number of tillers/hill significantly and gave the lowest values. Significantly highest values were observed when pre-emergence herbicide pretilachlor was applied at 0.75 kg/ha *fb* HW at 40 DAT over the rest of the treatment. While, treatment W<sub>2</sub>, W<sub>4</sub> and W<sub>5</sub> gave similar results and remained comparable with one another, respectively.

Variations in the pooled data of no. of panicles/m<sup>2</sup>, panicle length and no. of grains/panicle due to date of transplanting were found to demonstrate significant effect (Table 1). The maximum values were obtained when transplanting of black rice was done on 15<sup>th</sup> June followed by 30<sup>th</sup> June. However, the minimum values were obtained with 15<sup>th</sup> July transplanting. Islam *et al.* (2021) also demonstrated lower yield attributes with later date of transplanting which may have exposed the crop reproductive phase and phenological events to an unfavourable temperature regime, leading to increased spikelet sterility and poor plant growth.

Significant difference was found in yield attributes due to weed management practices except length of panicle (Table 1). W<sub>1</sub>-weedy check reduced number of panicles/m<sup>2</sup> and no. of grains/panicle significantly owing to the presence of weeds throughout the crop cycle which caused the depletion and less absorption of nutrients by crops (Raj *et al.* 2022). On the other hand, application of pretilachlor at 0.75 kg/ha *fb* HW at 40 DAT significantly enhanced the numbers. Increased in yield attributes with combination of herbicides and HW was also reported by Lhungdim *et al.* (2019). Application of pretilachlor at 0.75 kg/ha *fb* conoweeder at 40 DAT and conoweeding twice performed similar and were found to remained comparable with one another.

Number of panicles/m<sup>2</sup> were also impacted significantly by the interaction of transplanting date and IWM (Table 2). However, other yield attributes remained unaffected by the interaction of transplanting date and IWM. Transplanting black rice on 15<sup>th</sup> June along with spraying of pretilachlor at 0.75 kg/ha *fb* HW at 40 DAT produce greater number of panicles/m<sup>2</sup> and was comparable with 15<sup>th</sup> June transplanting date along with pretilachlor at 0.75 kg/ha *fb* bispyribac-sodium at 25 g/ha and 30<sup>th</sup> June transplanting date with pretilachlor at 0.75 kg/ha *fb* HW at 4 DAT.

*Productivity of black rice:* Data on yield of black rice indicated significant effect by transplanting date and weed management techniques (Table 1). In case of transplanting date, the transplanted black rice on 15<sup>th</sup> June significantly recorded increased grain and straw yield. Significantly

lowest yield was recorded when black rice was transplanted on 15<sup>th</sup> July. Early transplanting on 15<sup>th</sup> June increased the grain yield by 39% and 24% and straw yield by 14.6% and 6.5% over 15<sup>th</sup> July and 30<sup>th</sup> June respectively. Increment in grain yield up to 41.1% under early paddy transplanting date than later one was also revealed by Singh *et al.* (2019).

Table 2 Effect of interaction of transplanting date and integrated weed management practices on dry weight of weeds, number of panicles/m<sup>2</sup> and grain yield of aromatic black rice during *kharif* 2019 and 2020 (Pooled data of 2 years)

Treatment	Sedges (g/m <sup>2</sup> ) at 60 DAT	Broad-leaf weeds (g/m <sup>2</sup> ) at 60 DAT	Number of panicles/m <sup>2</sup>	Grain yield (t/ha)
D <sub>1</sub> W <sub>1</sub>	13.48 (181.2)	12.39 (153.0)	163.5	1.38
D <sub>1</sub> W <sub>2</sub>	4.60 (20.84)	4.71 (21.92)	195.3	1.97
D <sub>1</sub> W <sub>3</sub>	3.28 (10.44)	2.34 (5.18)	231.0	2.59
D <sub>1</sub> W <sub>4</sub>	4.70 (21.71)	4.29 (18.09)	193.9	2.12
D <sub>1</sub> W <sub>5</sub>	4.28 (17.96)	3.34 (10.77)	214.2	2.36
D <sub>2</sub> W <sub>1</sub>	14.29 (203.9)	13.63 (185.2)	136.3	1.25
D <sub>2</sub> W <sub>2</sub>	5.33 (27.98)	5.44 (29.38)	173.8	1.54
D <sub>2</sub> W <sub>3</sub>	4.12 (16.73)	3.28 (10.49)	210.7	2.17
D <sub>2</sub> W <sub>4</sub>	5.15 (26.10)	4.96 (24.27)	184.8	1.58
D <sub>2</sub> W <sub>5</sub>	4.77 (22.32)	4.33 (18.48)	193.3	1.86
D <sub>3</sub> W <sub>1</sub>	14.94 (222.8)	15.78 (248.8)	81.4	1.02
D <sub>3</sub> W <sub>2</sub>	6.96 (48.00)	6.18 (37.82)	156.0	1.43
D <sub>3</sub> W <sub>3</sub>	4.64 (21.18)	4.12 (16.67)	188.9	1.79
D <sub>3</sub> W <sub>4</sub>	6.52 (42.02)	5.96 (35.13)	163.4	1.55
D <sub>3</sub> W <sub>5</sub>	5.52 (30.02)	4.89 (23.54)	180.0	1.69
D × W				
SEm±	0.15	0.18	5.13	0.05
CD (P=0.05)	0.43	0.52	14.58	0.14
W × D				
SEm±	0.12	0.16	5.30	.04
CD (P=0.05)	0.36	0.47	16.23	0.13

Treatment details are given under Materials and Methods. DAT, Days after transplanting.

Table 3 Correlation coefficient studies among weed density, growth, yield attributes and yield of black rice during *kharif* 2019 and 2020

Parameter	Plant height	No. of tillers/hill	Number of panicles/m <sup>2</sup>	Length of panicles (cm)	Number of grains/panicle	Grain yield (kg/ha)	Straw yield (kg/ha)	Grasses (no./m <sup>2</sup> )	Sedges (no./m <sup>2</sup> )	Broad-leaf weeds (no./m <sup>2</sup> )
Plant height	1									
No. of tillers/hill	0.984**	1								
Number of panicles/m <sup>2</sup>	0.941**	0.929**	1							
Length of panicles (cm)	0.834**	0.854**	0.879**	1						
Number of grains/panicle	0.987**	0.983**	0.920**	0.837**	1					
Grain yield (kg/ha)	0.954**	0.959**	0.915**	0.886**	0.967**	1				
Straw yield (kg/ha)	0.984**	0.992**	0.946**	0.862**	0.974**	0.956**	1			
Grasses (no./m <sup>2</sup> )	-0.922**	-0.878**	-0.934**	-0.779**	-0.880**	-0.869**	-0.910**	1		
Sedges (no./m <sup>2</sup> )	-0.929**	-0.886**	-0.901**	-0.735**	-0.890**	-0.872**	-0.918**	0.987**	1	
Broad-leaf weeds (no./m <sup>2</sup> )	-0.919**	-0.877**	-0.893**	-0.709**	-0.878**	-0.852**	-0.910**	0.986**	0.998**	1

\*\*Means significant at 1% level

Out of weed management techniques, decreased in grain and straw yield were observed significantly with weedy check while significantly maximum yield was recorded with application of pretilachlor at 0.75 kg/ha as pre-emergence *fb* HW at 40 DAT (Table 1) *fb* pretilachlor at 0.75 kg/ha (PE) *fb* bispyribac-sodium at g/ha as post-emergence. Increased in yield might be result of pretilachlor interference on weed by preventing the cell division, cell growth and hindering the germinating weeds during initial phases of crop. This was followed by removal of weeds manually and keeping the crop free from crop-weed competition for limited growth factors leading to higher tillers, panicles, grains/panicle and finally the yield (Singh *et al.* 2023). Treatment W<sub>2</sub> and W<sub>4</sub> gave similar results and were observed to remain comparable with one another. Weed infestation under weedy check reduces 44% grain yield due to crop-weed competition compared to pretilachlor at 0.75 kg/ha *fb* HW at 40 DAT.

Data pertaining to grain yield (Table 2) illustrated significant impact by the combination of transplanting date and weed management approaches. Significant increase in yield was obtained with black rice transplanted on 15<sup>th</sup> June along with application of pretilachlor at 0.75 kg/ha *fb* HW at 40 DAT while treatment D<sub>3</sub>W<sub>1</sub>, 15<sup>th</sup> July combined with weedy check gave significantly lower yield.

*Economics of black rice cultivation:* Economics of black rice were affected by different transplanting dates and weed management approaches (Table 1). The cultivation cost was same for all three dates of transplanting. The highest gross and net returns and net production value were obtained with black rice transplanted on 15<sup>th</sup> June while 15<sup>th</sup> July recorded lowest gross and net returns and net production value. Transplanting date is a non-monetary input, therefore, the highest returns and net production value obtained under D<sub>1</sub> might be the result of higher yield of black rice. Pertaining to integrated weed management, cultivation cost was

obtained highest in treatment W<sub>2</sub>-conoweeding twice while the minimum cultivation cost was incurred by W<sub>1</sub>-weedy check. In terms of gross and net returns the highest return obtained among the weed management practices was with treatment W<sub>3</sub>-pretilachlor at 0.75 kg/ha *fb* HW at 40 DAT. However, maximum net production value was recorded in W<sub>5</sub>-pretilachlor at 0.75 kg/ha *fb* bispyribac-sodium at 25 g/ha. Barla *et al.* (2021) also gave similar results when pre and post-emergence herbicides were sprayed in sequential which could be attributed to higher yield and less labour requirement in spraying herbicides as compared to manual and mechanical weeding.

*Correlation study:* Correlation studies revealed a significant and positive correlation between growth, yield attributes and yield of black rice (Table 3). However, all characters were significant but negatively correlated with density of weeds. Yield of black rice were highly correlated with plant height ( $r = 0.95$  and  $0.98$ ), number of tillers/hill ( $r = 0.96$  and  $0.99$ ), number of panicles/m<sup>2</sup> ( $r = 0.91$  and  $0.95$ ), length of panicle ( $r = 0.89$  and  $0.86$ ) and number of grains/panicle ( $r = 0.97$  and  $0.97$ ) respectively. Number of tillers/hill were highly correlated with plant height. Number of panicles/m<sup>2</sup> were significantly correlated with number of tillers/hill and plant height. Length of panicle and number of grains/panicle were also significantly and positively correlated with number of panicles/m<sup>2</sup>, number of tillers/hill and plant height.

Based on pooled data from 2-years experiments, it can be concluded that transplanting black rice on 15<sup>th</sup> June along with application of pretilachlor at 0.75 kg/ha (PE) *fb* HW at 40 DAT recorded highest growth and yield, and shown to be the optimum date of transplanting and effective weed management practice for increasing productivity. However, due to labour scarcity and high cost, transplanting black rice on 15<sup>th</sup> June combined with sequential application of pretilachlor at 0.75 kg/ha (PE) *fb* bispyribac-sodium at

25g/ha (PoE) could be recommended for higher income and profitable production of black rice.

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