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Effect of Transplanting Date and Integrated Weed Management on Growth, Phenology and Yield of Black Rice (*Oryza sativa* L.) under SRI

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ABSTRACT: Delayed transplanting and excessive weed growth cause huge reduction in yield and quality parameters due to higher spikelet sterility and poor plant growth under unfavourable temperature regime and intermittent irrigation practice in system of rice intensification. In this context, a field experiment was conducted to study the effect of transplanting date and integrated weed management on growth, phenology and yield of black rice (*Oryza sativa* L.) under SRI at the experimental farm of SASRD, Nagaland University, Medziphema campus during the kharif season of 2019 and 2020. The experiment was laid out in split plot design with three transplanting dates in the main plots and five integrated weed management in the sub-plots and replicated thrice. Transplanting on 15th June recorded significantly highest growth attributes, maximum days to 50% flowering, days to 50% physiological maturity, days to maturity and yield of black rice. Among the integrated weed management, pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb hand weeding at 40 DAT gave significantly highest growth attributes, phenology and yield of black rice.

Keywords: Black rice, hand weeding, integrated weed management, phenology, transplanting date, yield.

INTRODUCTION

Rice is the second largest cereal production in the world which is grown in 114 countries constituting nearly 11 percent of the world's cultivated land. India is the world's second largest rice producer and consumer next to China. Rice plays a pivotal role in Indian agriculture and is the staple food for more than 70 percent of population. It contributes 43 percent of total food grain production and 46 percent of total cereal production in India. White rice is the most commonly consumed rice, but there are several rice cultivars which contain color pigments. Black rice is a special type of rice species *Oryza sativa* L. which is high in protein, fiber, anthocyanin, antioxidants, vitamin B and E, iron, thiamine, magnesium, niacin and phosphorus. Black rice has been eaten throughout Asia for thousands of years and has a significant history of use in China, India, and Thailand. China is responsible for 62 percent of global production of black rice followed by Sri Lanka (8.6%), Indonesia (7.2%), India (5.1%), Bangladesh (4.1%) and a few in Malaysia (Chaudhary, 2003).

Time of transplanting is one of the key factors in influencing the crop yield and indirectly determines soil temperature and weather conditions to which young seedlings and rice plants are exposed during different development stages. Rice crop mainly depends on moisture, temperature, solar radiations for its successful growth and development. It has been brought out that transplanting rice after the optimum dates can result in higher disease and insect incidence, tropical storm-related lodging, and possible cold damage during heading and the grain filling period resulting in low yields (Groth and Lee 2003). Delay in planting exposes the reproductive phase as well as phenological events of the crop to an unfavourable temperature regime and cause high spikelet sterility and poor plant growth.

Among the factors responsible for low yield, weeds are also a major factor and a prime yield- limiting biotic constraint. Weeds adversely affect the yield, quality and cost of production due to competition for various growth factors (Singh *et al.,* 2008; Salam *et al.,* 2020; Tasmin *et al.,* 2019). The extent of yield reduction due to weeds alone is estimated to be 15-30% for transplanted rice, 30-35% for direct seeded rice under puddle condition and over 45-90% for upland rice culture (Pal *et al.,* 2016). SRI, due to heavy weed infestation cause by wider spacing and non flooded situations, repeated weeding either by hand or by machine weeders such as the cono weeder is required. Due to higher labour investment, application of herbicides could effectively control weeds in low cost but intensive and repeated use of herbicides might cause environmental pollution and development of resistant weed biotypes. Therefore, an integrated approach of combining different weed control options are essential for developing a cost effective, sustainable and eco-friendly farm management system for rice to increase its productivity. Application of pre- emergence herbicide of pretilachlor 0.75 kg a.i. ha^{-1} + one hand weeding at 25 DAT proved to be agronomically efficient, eco friendly and economically viable technology for improving growth, yield and economics of rice (Suseendran *et al.,* 2020). Keeping the above points in view, a field experiment was carried out to study the effect of transplanting date and integrated weed management on growth, phenology and yield of black rice (*Oryza sativa* L.) under SRI

MATERIALS AND METHODS

The field experiment was conducted in kharif season of 2019 and 2020 at the experimental research farm of the School of Agricultural Science and Rural Development (SASRD), Medziphema campus, Nagaland University, Nagaland, India. The farm is located at 20°45'43" N latitude and 93°53'04" E longitude at an altitude of 310 m above mean sea level. It lies in the humid sub-tropical zone with an average rainfall ranging from 2000-2500 mm per annum. The soil condition of the experimental plot was categorized as clayey loam with a pH of 4.85, high in organic carbon (1.21%), low in available nitrogen (253.12 kg ha^{-1}), low in available phosphorus (18.43 kg ha^{-1}) and medium in available potassium (142.62 kg ha^{-1}). The experiment was laid out in split plot design with three dates of transplanting viz. D_1-15th June, D_2- 30th June and D_3- 15th July in the main plots and five integrated weed management treatments viz. W_1- Weedy check, W_2- Conoweeding at 20 and 40 DAT, W_3- Pretilachlor 0.75 kg/ha at 3 DAT fb hand weeding at 40 DAT, W_4- Pretilachlor @0.75 kg ha^{-1} at 3 DAT fb conoweeder @ 40 DAT and W_5- Pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb Bispyribac-Na @ 25 g a.i ha^{-1} at 20 DAT in the sub-plots with 15 treatment combinations and replicated thrice. The experimental plot size was 4 m × 3 m. Cultivar used was Chakhao Poireiton. Transplanting was done at one seedling $hill^{-1}$ with a spacing of 25 cm × 25 cm using 12 days old seedling. RDF at 50:30:20 kg NPK ha^{-1} in the form of urea, single super phosphate and muriate of potash were applied in all the plots irrespective of the treatment for both the years.

The observations were recorded on 3 randomly selected plants for growth and yield attributes. Plant height was measured from the base of the plant to the tip of the topmost leaf prior to panicle emergence and to the tip of the tallest panicle after emergence of the tagged hills in centimeters from each plot and average value was recorded. Days to 50% flowering, 50% physiological maturity and maturity was recorded by counting the number of days from the date of transplanting till the date when 50% of the plants flower, 50% of the plants matured and turned golden yellow in colour and 90% of the panicles matured, respectively. The grains and straw separated after threshing were sundried and the weight of the grain was recorded plot wise and expressed in kg ha^{-1}. Quality parameters such as hulling percentage, milling percentage and head rice recovery (%) were determined by using the formula (Ghosh *et al.,* 1971).

$$\text{Hulling percentage (\%)} = \frac{\text{Weight of brown rice (g)}}{\text{Weight of rough rice (g)}} \times 100$$

$$\text{Milling percentage (\%)} = \frac{\text{Weight of milled rice (g)}}{\text{Weight of rough rice (g)}} \times 100$$

$$\text{Head rice recovery (\%)} = \frac{\text{Weight of whole polished rice (g)}}{\text{Weight of rough rice (g)}} \times 100$$

Protein content in grain was worked out by using the formula.

Protein content (%) = % N content × 6.25

Data obtained from various studies were statistically analyzed in split plot design using the technique of Analysis of Variance as described by Gomez and Gomez (2010). The significance differences were tested by 'F' test. Critical difference of different groups of treatments and their interactions at 5 per cent probability level were calculated whenever 'F' test was significance.

RESULTS AND DISCUSSIONS

Plant height, Number of green leaves $plant^{-1}$ and Number of tillers $hill^{-1}$. Significant effect of date of transplanting and integrated weed management was observed on growth parameters of black rice at 60 days after transplanting (Table 1). Among the three transplanting dates, tallest plant height (109.70 cm and 112.18 cm), highest number of green leaves $plant^{-1}$ (36.80 and 35.65) and number of tillers $hill^{-1}$ (16.50 and 15.07) were obtained from transplanting on 15th June, while transplanting on 15th July recorded shortest plant height (98.89 cm and 100.68), lowest number of green leaves $plant^{-1}$ (26.79 and 25.83) and number of tillers $hill^{-1}$ (11.16 and 10.97) during both the years of study respectively. Tiwari *et al.* (2018); Singh *et al.* (2019); Islam *et al.* (2021) also reported higher growth parameters with early transplanting date due to the availability of prolonged period for vegetative growth with optimum photoperiod and temperature which enabled the plant to improve its growth and development.

During 2019 and 2020, among the various weed management practices, application of pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb handweeding at 40 DAT recorded the maximum plant height (117.35 cm and 119.02 cm), number of green leaves $plant^{-1}$ (47.51 and 46.24) and number of tillers $hill^{-1}$ (17.92 and 16.42), respectively. Pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb conoweeder @ 40 DAT and conoweeding at 20 and 40 DAT performed similar and were statistically at par with each other during both the years. Weedy check recorded significantly the lowest plant height, number green leaves $plant^{-1}$ and number of tillers $hill^{-1}$ due to the intense competition for water, nutrients and solar radiation posed by the uncontrolled weeds. The higher growth parameters with W_3 treatment could be the result of inhibition of cell division in weeds and effectively controlling them during initial stages of crop growth with application of pre-emergence herbicides pretilachlor followed by removal of later emergence weeds through hand weeding. Afroz *et al.* (2019);

Salam *et al.* (2020) also found that rice without weed competition recorded higher growth parameters due to greater space use by rice and earlier canopy closure due to better competitive ability and nutrient use efficiency.

Among the growth parameters, number of tillers hill^{-1} was affected significantly with interaction of transplanting date and integrated weed management in the year 2019 (Table 2). Transplanting black rice on 15th June along with application of pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb handweeding at 40 DAT recorded significantly highest number of tillers hill^{-1} (21.09). This was followed by 15th June transplanting with application of pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb Bispyribac-Na @ 25 g a.i. ha^{-1} at 20 DAT (19.06) which was at par with 30th June transplanting in combination with application of pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb handweeding at 40 DAT (18.12).

Phenological parameters. The differences in number of days taken for the crop to 50 % flowering, 50% physiological maturity and maturity were found to be significant due to date of transplanting (Table 3). However, effects of integrated weed management on phenological parameters were found to be non-significant during both the years. Among the dates of transplanting, transplanting on 15th June took more number of days to 50 % flowering (112.91 and 112.85), 50% physiological maturity (132.30 and 132.75) and maturity (145.14 and 145.17) and recorded significantly maximum days as compared to 30th June and 15th July which were statistically at par with each other. Temperature and light together plays a major role in the production of rice since rice require higher light intensity and is temperature dependent (Sharma *et al.,* 2011). The minimum days taken by the last date of transplanting might be due to unfavourable weather condition and less crop growth duration. Vishwakarma *et al.* (2016); Wani *et al.* (2017) also reported that earlier sown crop took more number of days to reach various phenological stages as compared to late sown crop.

Quality parameters. Data with regard to milling percentage, hulling percentage, head rice recovery and protein content presented in Table 4 revealed that there was no significant effect due to the transplanting date during both the years of study. Integrated weed management also did not show any significant effect on quality parameters except protein content. Application of pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb handweeding at 40 DAT recorded slightly higher values as compared to other weed management treatments and was statistically at par with each other except weedy check which gave the lowest protein content in both the years. Significant increase in protein content in grain was recorded due to reduced crop-weed competition for limited resources. Thus, reduced crop-weed competition led to an overall improvement in crop growth as reflected by plant height and dry matter accumulation which in turn led to greater development of reproductive structure and translocation of photosynthates to the sink (Deewan *et al.,* 2017).

Weight of panicle (g) and test weight (g). Different date of transplanting and integrated weed management significantly influences the weight of panicle in both the years. However, neither date of transplanting nor integrated weed management showed any significant effect on test weight of black rice (Table 5). Significantly highest weight of panicle was recorded with transplanting on 15th June followed by 30th June which was at par with 15th July in the year 2019 while in 2020, transplanting on 15th July recorded significantly lowest panicle weight. Significant increase in panicle weight could be the result of availability of longer period for plant parts to develop better and accumulate more photosynthates which in turn improve the yield attributes viz., panicle weight (Deka *et al.,* 2018; Mann and Dhillon 2021). Reduction in panicle weight could be the result of unfavourable environmental conditions which produced more sterile panicle per plant (Nangyal *et al.,* 2016).

Among the integrated weed management, weedy check recorded significantly lowest weight of panicle during both the years while application of pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb handweeding at 40 DAT recorded significantly highest panicle weight. The results are in line with findings of Lhungdim *et al.* (2019). In the year 2019, Pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb conoweeder at 40 DAT and Conoweeding at 20 and 40 DAT performed similar and were found to be statistically at par with each other. Effective elimination of weeds throughout the critical period of weed competition offered by integrated weed management treatments minimised the nutrient depletion by weeds allowing the crops to accelerate their nutrient absorption and ultimately resulted in increase weight of panicle (Suseendran *et al.,* 2020).

Grain yield (kg ha^{-1}), Straw yield (kg ha^{-1}) and Harvest index (%). Significant differences in grain yield, straw yield and harvest index were observed due to different transplanting date and integrated weed management during both the years (Table 5). Black rice transplanted on 15th June recorded significantly highest grain yield (2030.1 and 2132.1 kg ha^{-1}), straw yield (4063.2 and 4119.9 kg ha^{-1}) and harvest index (33.0 and 33.7%). Increase in grain yield up to 39% and 24% and straw yield up to 14.6% and 6.5% were observed when black rice was transplanted on 15th June compared to 15th July and 30th June, respectively. Transplanting at 15th July recorded the lowest grain yield (1441.2 and 1551.0 kg ha^{-1}), straw yield (3532.0 and 3633.6 kg ha^{-1}) and harvest index (28.7 and 29.8%). Grain yield reduction might be due to shortening of the vegetative period and spikelet sterility. Higher straw yield could be due to larger leaf area as well as number of tillers which utilized the resources more efficiently resulting in higher dry matter accumulation and ultimately straw yield Vishwakarma *et al*. (2016); Moond *et al.* (2023) also reported similar results.

During both the years of study, weedy check recorded significantly lowest grain yield (1163.5 and 1264.1 kg ha^{-1}), straw yield (3286.6 and 3188.2 kg ha^{-1}) and harvest index (26.0 and 28.3%). Grain and straw yield was reduce up to 44.4% and 25.7%, respectively in weedy check due to heavy weed infestation compared to Pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb handweeding at 40 DAT. Nivetha *et al.* (2017); Sinha *et al*. (2018) also reported a minimum grain and straw yield in weedy check with a yield loss of 59.8% and 35.9 %, respectively. Pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb handweeding at 40 DAT recorded significantly highest grain yield (2124.1 and 2245.0 kg ha^{-1}) and straw yield (4300.7 and 4419.0 kg ha^{-1}) as compared to the rest of the treatments. This was followed by pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb Bispyribac-Na @ 25 g a.i. ha^{-1} at 20 DAT. While pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb conoweeder at 40 DAT and Conoweeding at 20 and 40 DAT were found to be statistically at par with each other during both the years. The higher yield with W_3 treatment could be due to the effective weed control which kept the field free from weeds and facilitated the crop for absorption of greater amount of plant nutrients, moisture and greater reception of solar radiation for better growth. Tasmin *et al.* (2019); Salam *et al.* (2020); Manisankar *et al.* (2021) also reported similar findings. Slightly higher values (32.9% and 33.5%) of harvest index was observed with application of pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb handweeding at 40 DAT as compared to other weed management treatments and the values were observed to be at par with each other. Dubey *et al.* (2018); Kashyap *et al.* (2020) also reported higher harvest index with application of herbicides along with one hand weeding and lower HI in weedy check.

Data presented in Table 6 revealed that interaction of transplanting date and integrated weed management were found to be significant during both the years of experiment. Black rice transplanted on 15th June along with application of pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb handweeding at 40 DAT recorded significantly highest grain yield (2527.54 and 2655.04 kg ha^{-1}) while transplanting on 15th July in combination with weedy check gave the lowest yield (968.34 and 1078.59 kg ha^{-1}). Favourable climatic condition and photoperiod at the time of tillering, flowering and grain filling stages along with effective weed management might have helped the plant to utilize the resources efficiently resulting in higher growth and yield attributes and ultimately yield. Patel *et al.* (2019) also revealed from different studies that the highest yield potential of a rice crop is usually obtained when the crop is exposed to the best temperature range which can be managed by sowing at the right time. Similar results were reported by Mubeen *et al.* (2014).

Table 1: Transplanting date and integrated weed management effects on plant height, number of green leaves plant^{-1} and number of tillers hill^{-1}.

Treatment	Plant height			Number of green leaves plant^{-1}			Number of tillers hill^{-1}		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Date of transplanting									
D_1	109.70	112.18	110.94	36.80	35.65	36.23	16.50	15.07	15.78
D_2	102.85	103.79	103.32	32.37	31.63	32.00	13.60	12.75	13.18
D_3	98.89	100.68	99.79	26.79	25.83	26.31	11.16	10.97	11.06
SEm±	1.56	1.80	1.19	1.03	0.83	0.66	0.36	0.30	0.23
CD (P=0.05)	6.13	7.06	3.88	4.06	3.27	2.17	1.40	1.18	0.76
Integrated weed management									
W_1	89.79	92.48	91.13	16.56	16.12	16.34	9.21	9.13	9.17
W_2	99.31	101.31	100.31	25.98	25.34	25.66	12.34	11.67	12.00
W_3	117.35	119.02	118.18	47.51	46.24	46.87	17.92	16.42	17.17
W_4	103.45	104.24	103.85	30.21	29.04	29.63	13.56	12.92	13.24
W_5	109.19	110.70	109.94	39.68	38.44	39.06	15.73	14.51	15.12
SEm±	2.75	2.79	1.96	1.87	1.53	1.21	0.27	0.44	0.26
CD (P=0.05)	8.01	8.15	5.57	5.47	4.48	3.44	0.79	1.28	0.73

Table 2: Interaction of transplanting date and integrated weed management effects on number of tillers hill^{-1}.

Treatment	Number of tillers hill^{-1}		
	2019	2020	Pooled
D_1W_1	10.86	10.88	10.87
D_1W_2	15.48	14.10	14.79
D_1W_3	21.09	18.86	19.98
D_1W_4	16.00	15.15	15.58
D_1W_5	19.06	16.33	17.70
D_2W_1	9.13	9.03	9.08
D_2W_2	12.14	11.39	11.77
D_2W_3	18.12	16.07	17.10
D_2W_4	13.48	12.71	13.10
D_2W_5	15.12	14.57	14.85
D_3W_1	7.64	7.48	7.56
D_3W_2	9.39	9.53	9.46
D_3W_3	14.54	14.32	14.43
D_3W_4	11.21	10.89	11.05
D_3W_5	13.00	12.62	12.81
SEm± (D×W)	0.47	0.76	0.45
SEm± (W×D)	0.55	0.54	0.39
CD (P=0.05) (D×W)	1.36	NS	NS
CD (P=0.05) (W×D)	1.92	NS	NS

Table 3: Transplanting date and integrated weed management effects on phenological parameters.

Treatment	Days to 50% flowering			Days to 50 % physiological maturity			Days to maturity		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Date of transplanting									
D_1	112.91	112.85	112.88	132.30	132.75	132.52	145.14	145.17	145.15
D_2	98.85	97.27	98.06	121.02	121.68	121.35	134.70	134.89	134.80
D_3	89.42	88.42	88.92	113.94	113.04	113.49	125.52	125.47	125.50
SEm±	1.63	1.80	1.21	2.80	2.63	1.92	2.56	2.56	1.81
CD (P=0.05)	6.38	7.07	3.95	10.98	10.31	6.25	10.06	10.07	5.91
Integrated weed management									
W_1	99.88	99.46	99.67	122.92	122.08	122.50	134.98	134.69	134.84
W_2	100.14	99.36	99.75	121.91	123.01	122.46	135.12	135.22	135.17
W_3	100.32	99.22	99.77	121.98	121.91	121.94	135.10	135.49	135.29
W_4	100.67	100.14	100.41	122.72	122.83	122.77	135.84	135.50	135.67
W_5	100.96	99.38	100.17	122.58	122.62	122.60	134.56	134.98	134.77
SEm±	2.34	2.46	1.70	4.13	2.51	2.42	2.99	3.95	2.48
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 4: Transplanting date and integrated weed management effects on quality parameters.

Treatment	Hulling percentage (%)			Milling percentage (%)			Head rice recovery (%)			Protein (%)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Date of transplanting												
D_1	72.2	71.6	71.9	64.0	62.3	63.2	50.8	52.1	51.5	10.2	10.3	10.3
D_2	71.4	72.3	71.9	63.3	61.1	62.2	50.9	51.1	51.0	9.9	10.1	10.0
D_3	71.5	70.5	71.0	62.1	60.9	61.5	51.3	51.3	51.3	9.8	9.9	9.9
SEm±	0.78	1.27	0.74	0.58	0.79	0.49	0.65	1.09	0.64	0.11	0.11	0.08
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Integrated weed management												
W_1	71.9	71.9	71.9	61.3	60.6	60.94	50.9	51.3	51.1	9.3	9.3	9.3
W_2	71.4	71.0	71.2	63.0	62.7	62.83	50.8	51.6	51.2	9.8	9.9	9.8
W_3	72.0	72.4	72.2	64.8	63.3	64.06	50.4	51.6	51.0	10.5	10.6	10.6
W_4	72.3	71.1	71.7	62.9	60.2	61.56	51.8	52.0	51.9	10.1	10.3	10.2
W_5	70.8	70.9	70.8	63.6	60.4	62.00	51.3	51.0	51.2	10.3	10.4	10.3
SEm±	0.87	0.93	0.64	0.84	1.04	0.67	0.99	0.81	0.64	0.16	0.15	0.11
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.46	0.44	0.31

Table 5: Transplanting date and integrated weed management effects on yield attributes and yield of black rice.

Treatment	Weight of panicle (g)			Test weight (g)			Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})			Harvest index (%)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Date of transplanting															
D_1	4.66	4.73	4.70	27.57	27.47	27.52	2030.1	2132.1	2081.1	4063.2	4119.9	4091.6	33.0	33.7	33.4
D_2	4.22	4.31	4.26	27.49	27.51	27.50	1621.7	1736.0	1678.8	3799.6	3881.8	3840.7	29.6	30.7	30.2
D_3	3.85	3.95	3.90	26.84	27.19	27.02	1441.2	1551.0	1496.1	3532.0	3633.6	3582.8	28.7	29.8	29.2
SEm±	0.10	0.08	0.06	0.19	0.35	0.20	33.84	38.81	25.75	61.63	57.55	42.16	0.26	0.46	0.26
CD (P=0.05)	0.39	0.33	0.21	NS	NS	NS	132.88	152.39	83.97	241.99	225.97	137.50	1.01	1.80	0.86
Integrated weed management															
W_1	3.38	3.44	3.41	27.01	27.19	27.10	1163.5	1264.1	1213.8	3286.6	3188.2	3237.4	26.0	28.3	27.2
W_2	4.01	4.08	4.05	27.11	27.30	27.21	1593.5	1698.6	1646.1	3635.7	3754.5	3695.1	30.3	31.0	30.7
W_3	4.94	5.03	4.98	27.80	27.95	27.87	2124.1	2245.0	2184.6	4300.7	4419.0	4359.8	32.9	33.5	33.2
W_4	4.30	4.38	4.34	27.42	27.42	27.42	1696.4	1797.7	1747.0	3780.2	3896.8	3838.5	30.8	31.4	31.1
W_5	4.61	4.71	4.66	27.15	27.09	27.12	1910.8	2026.4	1968.6	3988.3	4133.7	4061.0	32.2	32.8	32.5
SEm±	0.10	0.10	0.07	0.33	0.35	0.24	37.93	42.68	28.55	81.08	75.01	55.23	0.51	0.70	0.43
CD (P=0.05)	0.30	0.28	0.20	NS	NS	NS	110.70	124.59	81.18	236.67	218.94	157.04	1.48	2.05	1.23

Table 6: Interaction of transplanting date and integrated weed management effects on grain yield (kg ha^{-1}).

Treatments	Grain yield (kg ha^{-1})		
	2019	2020	Pooled
D_1W_1	1340.20	1410.03	1375.12
D_1W_2	1917.11	2015.63	1966.37
D_1W_3	2527.54	2655.04	2591.29
D_1W_4	2068.23	2168.36	2118.30
D_1W_5	2297.54	2411.67	2354.61
D_2W_1	1181.91	1303.69	1242.80
D_2W_2	1487.86	1592.39	1540.13
D_2W_3	2106.44	2232.96	2169.70
D_2W_4	1528.16	1629.83	1579.00
D_2W_5	1803.99	1921.25	1862.62
D_3W_1	968.34	1078.59	1023.47
D_3W_2	1375.70	1487.83	1431.76
D_3W_3	1738.30	1847.13	1792.71
D_3W_4	1492.69	1595.03	1543.86
D_3W_5	1630.81	1746.34	1688.57
SEm± (D×W)	65.69	73.93	49.45
SEm± (W×D)	56.16	64.08	42.60
CD (P=0.05) (D×W)	191.73	215.79	140.61
CD (P=0.05) (W×D)	186.49	213.37	128.32

CONCLUSIONS

From the above experiment, it can be concluded that transplanting black rice on 15th June with combined application of pretilachlor @ 0.75 kg ha^{-1} at 3 DAT fb hand weeding at 40 DAT recorded highest growth, phenology and yield of black rice and found to be the best transplanting date and efficient weed management practices for increasing the yield of black rice under SRI.

FUTURE SCOPE

As weeds are the major biotic constraints under system of rice intensification and none of the control measures in single can provide acceptable levels of weed control, effectiveness of different integrated weed management practices should be studied in black rice.

Conflict of Interest. None.

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