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Integrated weed management on weed dynamics, crop growth and yield of direct seeded rice

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Abstract
The experiment was comprising of 12 weed management practices with different herbicidal doses and inter-culture practices was conducted on sandy loam textured soil during Kharif season of 2018 at the Agronomical Research Farm of BAU, Ranchi, with the objectives to find out the effect of integrated weed management practices on weed dynamics, growth, yield and economics of direct seeded rice.The relative composition of grassy, broad-leaf and sedges accounted for 37.36%, 20.39% and 42.24%, respectively. Irrespective of weed management practices, total density (30 and 60 DAS), total dry weight of weeds (30 and 60 DAS) and weed control efficiency were higher in 3 Hand weeding which was on par with Pretilachlor @ 1.00 kg a.i /ha (PE) fb Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS, were being at par with Pendimethalin @ 0.75 kg a.i /ha (PE) fb Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS over weedy check. Grain and straw yield (41.70 and 61.30 q/ha, respectively) were significantly higher with 3 Hand weeding as compared to weedy check. However, the net return (Rs 61,864 per ha) were significantly higher with pre-emergence application of Pretilachlor @ 1.00 kg a.i /ha (PE) fb Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS which was on par with 3 Hand weeding (Rs 53,541 per ha) but highest B:C ratio was obtained from the application of pre-emergence application of Pretilachlor @ 1.00 kg a.i /ha (PE) fb Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS.

Keywords: Weed flora, direct seeded rice, Pretilachlor, bispyribac sodium, hand weeding

Introduction
Rice is the world's most important crop and is a staple food for more than half of the world's population. About 90% of the world's rice is grown and produced in Asia. Rice production in world about 161.1 million hectares and annual production of 751.9 million tonnes (FAO 2017) [4]. It is grown on an area of 44.15 million hectare in India with a total production of 116.48million tonnes and productivity of 2.63 tons/ha (GoI 2018). Transplanting is the traditional system of rice cultivation and it is in vogue in many rice growing areas. Such a rice production system, however, requires a large amount of water during puddling and transplanting (Chauhan 2012a, Chauhan et al., 2012b) [1, 2]. Though direct-seeded rice (DSR) yields comparable with transplanted crop, increased weed infestation is major drawback of this system. Success of DSR is mainly depends on effective weed control with all the possible means. The yield loss in DSR is as high as 50-60% due to simultaneous germination of both crop and weeds seeds (Pinjari *et al.* 2016) [11]. Though the hand weeding has been found effective, but it is very expensive. Moreover, heavy demand of labour during peak period and its scarcity necessitates the use of alternate weed control measures. Chemical weed control by using preemergence herbicides being cost effective and less labour dependent is recommended to overcome this constraint under DSR. Broad spectrum of weed flora may not be controlled by spraying pre-emergence herbicides alone, as flushes of weeds come up at different growth stages. Hence, use of sequential application of pre-*fb* post-emergence herbicides or pre-emergence herbicides *fb* manual weeding could be more convenient in containing the weed menace. By keeping above information in view, the present investigation was carried out to study the effect of weed management practices on direct seeded rice in upland condition of Jharkhand.

Materials and Methods
A field experiment was conducted at agronomical research farm of Birsa Agricultural University, Ranchi, Jharkhand with objective to find out the efficacy of integrated weed management practices for controlling weeds in direct seeded rice under medium land situation.

The experimental field was sandy loam in texture, poor in organic carbon (0.38%), available nitrogen (228.12 kg/ha) and medium in available phosphorus (18.92 kg/ha) and potash (154.30 kg/ha). The experiment consisted of altogether 12 treatments viz. Pendimethalin (30 EC) @ 0.75 kg a.i. /ha PE (T_1), Pendimethalin (30% EC) @ 0.75 kg a.i./ha as PE *fb* 1 hand weeding at 25 DAS (T_2), Pendimethalin (30% EC) @ 0.75 kg a.i./ha as PE *fb* 2 hand weeding at 25 DAS and 40 DAS (T_3), Pendimethalin (30% EC) @ 0.75 kg a.i. /ha PE *fb* Sesbania incorporation at 25 DAS (T_4), Pendimethalin (30% EC) @0.75 kg a.i. /ha as PE *fb* Bispyribac Sodium (10% SC) @ 0.025 kg a.i. /ha PoE (T_5), Pretilachlor (50% EC) @1.00 kg a.i. /ha PE (T_6), Pretilachlor (50% EC) @ 1.00 kg a.i. /ha PE *fb* 1 hand weeding 25 DAS (T_7), Pretilachlor (50% EC) @1.00 kg a.i. /ha PE *fb* 2 hand weeding at 25 DAS and 40 DAS (T_8), Pretilachlor (50% EC) @ 1.00 kg a.i. /ha *fb* Sesbania incorporation at 25 DAS (T_9), Pretilachlor (50% EC) @ 1 .00 kg a.i. /ha PE *fb* Bispyribac Sodium (10% SC) @ 0.025 kg a.i. /ha PoE (T_{10}), 3 Hand weeding at 25, 40 and 55 DAS (T_{11}) and Weedy check (T_{12}) were laid out in randomized block design and replicated thrice. Rice variety "Sahbhagi dhan" was seeded directly using 80 kg seed/ ha in rows spaced at 20 cm on 22th June 2018 after basal application of fertilizer. Sesbania was direct line sown in soil using 40 kg seed/ ha after sowing of rice. Recommended dose of chemical fertilizer 80 kg N + 40 kg P_2O_5 + 20 kg K_2O/ha was applied through urea, diammonium phosphate and muriate of potash respectively. Half dose of nitrogen and full amount of phosphorus and potassium were applied in experimental field as basal. Rest half of nitrogen was applied in two splits as top dressing i.e. first top dressed at maximum tillering stage and second dressed at panicle primordial initiation. Sesbania was incorporated in the soil on 18thJuly 2018 at 5 weeks after sowing of sesbania . incorporation of sesbania was done by using spade. From sowing to emergence the soil was kept near moist but not saturated to avoid seed rotting. The field was saturated from three leaf stage to tillering, panicle initiation and grain filling stages to avoid water stress at these stages. However, at anthesis the excess water was drained out to avoid sterility. Weed counts (number/m^2) and dry weight (g/m^2) were recorded by putting a quadrate (25 x 25 cm) at two random spots in each plot at 30 and 60 days after sowing (DAS) of crop. Weed control efficiency (WCE) was also calculated on the basis of dry matter production of weeds. The experimental data recorded for growth, yield attributes and yield were statistically analyzed. Data on weed density and dry weight of weeds were transformed using square root transformation ($\sqrt{X+0.5}$) before statistical analysis.

The weed control efficiency was calculated on the basis of reduction in dry matter production in treated plot in comparison with the control plot and expressed in percentage.

$$WCE\ (\%) = \frac{DWC - DWT}{DWC} \times 100$$

Where,
WCE = Weed control efficiency
DWC = dry weight of weeds in weedy check plot (g/m2)
DWT = dry weight of weeds in treated plot (g/m2)

Weed index is defined as the magnitude of yield reduction due to presence of weeds in comparison to weed free plot. Weed index was calculated by using the following formulae by Gill and Vijayakumar (1966) [5]:

$$WI\ (\%) = \frac{YWFC - YT}{YWFC} \times 100$$

Where,
WI = Weed index
YWFC = Yield of the crop in weed free check (kg/ha)
YT = Yield of the crop in plot under treatment (kg/ha)

Leaf area index (LAI) is the leaf area per unit land area (Watson, 1947) [17]. Periodic leaf area index at 30 and 60 DAS were recorded. For this, 50 pieces of 2cm x 2cm size leaves were cut from leaf samples taken for dry matter accumulation and were oven dried at 60 ± 5 °C. After complete drying they were weighed. Leaf area of whole plant was calculated from total dry weight of leaves using unitary method. Ground area per plant was calculated by plant spacing data. Then LAI was worked out using the following formula.

$$\text{Leaf area index} = \frac{\text{Leaf area } (cm^2)}{\text{Ground area } (cm^2)}$$

CGR represents dry matter accumulation per unit area per unit time.. The unit of CGR is g/m2/day. Crop growth rate was calculated between 30-60 and 90 DAS to maturity stage. The values were calculated by using the following formula.

$$\text{Crop Growth Rate } (g/m^2/day) = \frac{W_2 - W_1}{T_2 - T_1}$$

Where,
W_1 = Dry weight of plant per m^2 at time T_1
W_2 = Dry weight of plant per m^2 at time T_2
$T_2 - T_1$ = Interval in days between collection of plant sample for dry matter.

Results and Discussion

Effect on weeds

The predominant weed flora observed in the experimental field in association with the direct seeded rice were among grasses, *Echinocloa crusgalli* (L.) P Beauv., *Dactyloctenium aegyptium* (L.) and *Eleusine indica* Gaerts, *Cynodon dactylon* Pers., in broad-leaf category - *Aeschynomene indica*, *Ageratum conyzoides* (L.), *Commelina nodifolia* (L.), *Alternanthra sessilis* (L.) and *Coronopus didymus* (L.) and in sadges - *Cyperus rotundus* and *Cyperus iria* (L.), *Fimbristylis miliacea* (L.) Vahl weeds were dominant. The relative composition of grassy, broad-leaf and sedges accounted for 37.36%, 20.39% and 42.24%, respectively. While relative weed density of major weed species were namely, *Fimbristylis miliacea* (L.) Vahl-23.65 %, *Eleusine indica Gaerts*-18.27%, *Echinocloa crusgalli* (L.)P. Beauv -13.38%, *Cyperus rotundus* L. -12.72%, *Aeschynomene indica*– 6.85%, *Alternanthra sessilis* (L.)- 5.87%, *Commelina nodifolia* (L.) – 4.57%, *Dactyloctenium aegyptium* (L.)-4.08 %, *Ageratum conyzoides*– 3.10%, *Cynodon dactylon* Pers.-1.63% of respective weed flora of the experimental field. Grassy weeds dominated the weed flora throughout the crop growth seasons as reported by Mukherjee and Maity (2011) [21].

Weed free plot (3 Hand weeding at 25, 40 and 55 DAS) significantly reduced the density of weeds (257/m^2 and 230/m^2, respectively) at 30 DAS and 60 DAS. However among other weed control treatments combination of different chemicals i.e. application of Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS, Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS and Pretilachlor @ 1.00 kg a.i /ha PE *fb* Sesbania incorporation 25 DAS (Table 2). The reduction in the weed population and weed dry weight in these treatments was mainly due to effective control of weeds at all stages of crop growth period. These results are in conformity with the findings of Brar and Bhullar (2012) [15]. These results are in conformity with the finding of Raj and Syriac., 2016 [22]. Among weed management practices, weed free plot (3 Hand weeding at 25, 40 and 55 DAS) had significantly reduced total dry weight of weeds (87.67 g/m^2 and 102.67 g/m^2, respectively) at 30 and 60 DAS which was on par with application of Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS and Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS. Whereas, weedy check recorded significantly higher weed population and weed dry weight, respectively (Table 2). The critical period of crop weed competition in rice was identified to be around 20 to 60 days after sowing. in dry matter accumulation of broad leaved weeds and sedges due to application of bisparibac-sodium have also been reported by Kumar *et al.* (2013) [8], Rawat *et al.* (2012) [12], Walia *et al*. (2012) [16] and Yadav *et al*. (2009) [18] in rice crop.

However, the weed control efficiency (83.59% and 82.80%, respectively) at 30 and 60 DAS significantly reduced that weed free plot (3 Hand weeding at 25, 40 and 55 DAS) followed by Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS. Which might be due to decrease in weed dry matter as compared to rest of the weed management practices. The highest WCE with 3 hand weeding also reported by Singh *et al*. (2014) [14], Walia *et al.* (2012) [16].

Effect of plant growth

All weed management practices significantly improved the growth components of rice over weedy check (Table 3). The highest values of plant height (109.00 cm at maturity), leaf area index (4.15 at 90 DAS), dry matter accumulation (1140.3 g/m2 at maturity), total number of tillers (353 /m^2 at maturity) and Crop growth rate (6.79 g/m^2/day at 90 DAS- Maturity) were recorded under weed free plot (3 Hand weeding at 25, 40 and 55 DAS) which was on par with Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS, Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS and Pretilachlor @ 1.00 kg a.i /ha PE *fb* Sesbania incorporation 25 DAS. The enhancement of crop growth components could be due to less competition by the weeds for crop these factors throughout the crop growth period due to control of early emerged weeds before sowing through preemergence application of herbicides and late emerged weeds through inter-culture. The results are in agreement with those reported by Mandal *et al.*, 2011 [10], Kiran *et al*. (2010) [7] and Singh N.K and Singh U.P (2014) [14].

Effect of yield and economics

Among different weed management practices, 3 hand weeding at 25, 40 and 55 DAS observed significantly higher grain, straw yield and harvest index (41.70 q/ha 61.30 q/ha, and 40.49%, respectively) of direct seeded rice as compared to weedy check. However, it was on par with Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS and Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS (Table 4). The minimum Grain and straw yield in weedy check could be due to the severe weed competition as evidenced by the maximum weed density, weed dry matter which resulted in less number of tillers, lower plant dry matter and plant height. The greater remobilization of stem reserve towards the grain resulted in higher grain yield. Some amount of carbohydrates formed before flowering are stored in culms and leaf sheaths and later re-translocated to the grain (Reddy and Reddy, 2005) [13]. The results are in conformity with Daniel *et al.* (2012) [3], Walia *et al.* (2009) [15] and Mahajan and Timsuna (2011) [9]. A critical analysis of data on economics revealed that the highest gross returns (Rs 85,228 per ha) was obtained with 3 hand weeding at 25, 40 and 55 DAS but also higher cost of cultivation in 3 hand weeding at 25, 40 and 55 DAS due to engagement of more labourers for weeding. This confirms the finding of Tuti *et al.,* (2016) [23]. Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS and Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS had reduced cost of cultivation compared to 3 hand weeding at 25, 40 and 55 DAS (Table 4). Maximum net return (Rs. 61,864 per ha) and B:C ratio (2.94) were obtained with Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS, was comparable to Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS. The weedy check recorded significantly minimum net returns (Rs 2652 per ha) and B:C ratio (-0.14). The higher net returns in this treatment when compared to 3 hand weeding at 25, 40 and 55 DAS was not because of higher yield but because of lower cost involved in herbicide application and inter-culture than weed free plot. The results are corroborating with those reported by Yadav *et al.* (2018) [19] and Yogananda *et al.* (2017) [20].

Table 1: Dominant weed flora and relative weed density (%) of weedy check plot in the experimental field at 40 DAS .

Common Name	English Name	Botanical Name	Family	Number/m^2	Relative Weed Density (%)
Grassy					
Banmadua	Goose grass	*Eleusine indica Gaerts.*	Poaceae	112	18.27
Sawa	Barnyard grass	*Echinocloa crusgalli* (L.)P. Beauv	Poaceae	82	13.38
Makra	Crow foot grass	*Dactyloctenium aegyptium* (L.)	Poaceae	25	4.08
Dub	Bermuda grass	*Cynodon dactylon* Pers.	Poaceae	10	1.63
Broad leaved					
Budda pea	Indian jointvetch	*Aeschynomene indica*.	Commelianaceae	42	6.85
Garundi	Wetland amaranth	*Alternanthra sessilis* (L.)	Amaranthaceae	36	5.87
Kena	Common day flower	*Commelina nodifolia* (L.)	Commelianaceae	28	4.57
Mahkua	Tropical ageratum	*Ageratum conyzoides* L.	Asteraceae	19	3.10
Sedges					
Choti bhui	Globe fringerwh,	*Fimbristylis miliacea* (L.) Vahl	Cyperaceae	145	23.65
Motha	Purple nut sedge	*Cyperus rotundus* L.	Cyperaceae	78	12.72
Umbrella sedge	Rice foot sedge	*Cyperus iria* L.	Cyperaceae	36	5.87
Total				**722**	**100%**

Table 2: Effect of weed control treatments on total weed density, weed dry weight and weed control efficiency parameters of direct seeded rice.

Treatments	Total Weed density (number / m^2)		Weed dry weight (g/m^2)		Weed control efficiency (%)	
	30 DAS	30 DAS	30 DAS	60 DAS	60 DAS	60 DAS
T_1: Pendimethalin @ 0.75 kg a.i /ha (PE)	24.95 (625)	25.68 (663)	13.96 (194.67)	17.30 (299.00)	57.26	49.83
T_2: Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* 1Hand weeding at 25 DAS	23.27 (541)	24.75 (623)	12.57 (157.67)	16.78 (284.67)	67.31	52.22
T_3: Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* 2 Hand weeding at 25 and 40 DAS	23.20 (539)	24.17 (586)	12.28 (150.33)	15.80 (256.00)	67.24	57.20
T_4: Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* Sesbania incorporation 25 DAS	21.85 (437)	23.53 (563)	11.32 (109.67)	15.22 (231.33)	71.17	61.12
T_5: Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS	19.87 (395)	19.67 (396)	9.93 (111.67)	12.45 (155.00)	75.99	73.99
T_6: Pretilachlor @ 1.00 kg a.i /ha (PE)	24.47 (600)	25.31 (647)	12.61 (161.00)	16.94 (286.33)	65.81	51.93
T_7: Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* 1Hand weeding at 25 DAS	23.54 (555)	24.33 (595)	12.30 (154.67)	15.97 (264.00)	68.95	55.48
T_8: Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* 2 Hand weeding at 25 and 40 DAS	23.03 (533)	23.85 (569)	12.17 (147.67)	15.6 (244.00)	67.49	58.98
T_9: Pretilachlor @ 1.00 kg a.i /ha (PE)*fb* Sesbania incorporation 25 DAS	20.18 (418)	21.58 (474)	10.97 (120.33)	14.50 (217.00)	73.96	63.39
T_{10}: Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* Bispyribac Sodium@ 0.025 kg a.i/ha PoE 20 DAS	16.50 (272)	15.89 (252)	8.95 (93.33)	10.80 (118.67)	80.76	80.17
T_{11}: 3 Hand weeding at 25, 40 and 55 DAS (weed free plot)	16.03 (257)	15.19 (230)	8.45 (82.67)	10.07 (102.67)	83.59	82.80
T_{12}: Weedy Check	31.27 (979)	33.79 (1158)	21.62 (471.67)	24.42 (596.00)	0.00	0.00
SE m ±	1.43	1.32	1.30	1.21	3.68	6.18
CD (P = 0.05)	4.19	3.88	3.80	3.56	10.78	18.12
CV%	11.08	9.71	10.10	13.57	9.84	18.69

Note: Data in parenthesis were transformed to $\sqrt{X} + 0.5$ before analysis

Table 3: Effect of weed control treatments on plant height, leaf area index, dry matter accumulation, total number of tillers (at maturity) and crop growth rate (at 90 DAS- Maturity) parameters of direct seeded rice.

Treatments	Plant height (cm)	Number of tillers / m^2 At Maturity	Dry matter accumulation (g)	Leaf area index	CGR ($g/m^2/day$)
T_1: Pendimethalin @ 0.75 kg a.i /ha (PE)	87.44	215	656.67	3.42	3.77
T_2: Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* 1Hand weeding at 25 DAS	89.44	241	791.00	3.46	4.76
T_3: Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* 2 Hand weeding at 25 and 40 DAS	92.22	265	901.00	3.52	5.03
T_4: Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* Sesbania incorporation 25 DAS	94.22	276	956.00	3.72	5.88
T_5: Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS	105.33	321	990.33	3.98	6.07
T_6: Pretilachlor @ 1.00 kg a.i /ha (PE)	88.44	221	740.33	3.34	4.10
T_7: Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* 1Hand weeding at 25 DAS	90.22	249	875.00	3.48	4.81
T_8: Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* 2 Hand weeding at 25 and 40 DAS	92.33	275	924.00	3.54	5.50
T_9 : Pretilachlor @ 1.00 kg a.i /ha (PE)*fb* Sesbania incorporation 25 DAS	102.26	314	964.67	3.73	6.04
T_{10}: Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* Bispyribac Sodium@ 0.025 kg a.i/ha PoE 20 DAS	111.33	349	1120.00	4.13	6.71
T_{11}: 3 Hand weeding at 25, 40 and 55 DAS	112.63	353	1140.33	4.15	6.79
T_{12}: Weedy Check	76.00	125	195.00	2.88	1.66
SE m ±	5.79	16.44	46.57	0.18	0.27
CD (P = 0.05)	16.97	48.22	136.57	0.53	0.79
CV%	10.53	13.91	9.44	8.63	9.22

Table 4: Effect of weed control treatments on yield, harvest index and weed index parameters of direct seeded rice.

Treatments	Grain yield (q/ha)	Straw yield (q/ha)	Net return (Rs/ha)	B:C ratio
T_1: Pendimethalin @ 0.75 kg a.i /ha (PE)	23.07	36.68	29078	1.56
T_2: Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* 1 Hand weeding at 25 DAS	27.97	44.21	32794	1.31
T_3: Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* 2 Hand weeding at 25 and 40 DAS	32.12	50.06	36144	1.20
T_4: Pendimethalin @ 0.75 kg a.i /ha (PE) *fb* Sesbania incorporation 25 DAS	34.07	52.35	43149	1.60
T_5: Pendimethalin (PE) *fb* Bispyribac Sodium @ 0.025 kg a.i/ha PoE 20 DAS	35.66	53.02	51518	2.40
T_6: Pretilachlor @ 1.00 kg a.i /ha (PE)	25.71	40.79	34933	1.92
T_7: Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* 1Hand weeding at 25 DAS	30.90	48.62	39221	1.60
T_8: Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* 2 Hand weeding at 25 and 40 DAS	33.00	50.83	38263	1.29
T_9 : Pretilachlor @ 1.00 kg a.i /ha (PE) *fb* Sesbania incorporation 25 DAS	34.88	52.67	46342	1.84
T_{10}: Pretilachlor @ 1.00 kg a.i/ha (PE) *fb* Bispyribac Sodium@ 0.025 kg a.i/ha PoE 20 DAS	40.52	60.09	61864	2.94
T_{11}: 3 Hand weeding at 25, 40 and 55 DAS	41.70	61.30	53541	1.69
T_{12}: Weedy Check	6.67	10.50	-2650	-0.16
SE m ±	1.63	2.564	3364	0.11
CD (P = 0.05)	4.78	6.51	9864	0.33
CV%	12.25	13.49	9.28	12.41

Conclusion

On the basis of result obtained, it can be concluded that application of Pretilachlor (50% EC) @ 1.00 kg a.i. /ha as pre-emergence *fb* Bispyribac sodium (10% SC) @ 0.025 kg a.i. /ha post-emergence was found to be best as weed management practice for better weed control efficiency, crop growth, higher productivity and profitability in direct seeded rice production under upland condition.

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