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Yield, Yield Attributes and Weed Biomass of Rice (*Oryza sativa* L) as Influenced by Weed Control Treatments

Manisha [a*] and Nagendra Kumar Verma [a]

[a] *Department of Agronomy Indira Gandhi Krishi Vishwavidyalaya, Raipur, 492012, Chhattisgarh, India.*

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The present investigation was conducted during the Kharif of 2019 at Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. The experiment was laid out in randomized complete block design (RCBD) with three replications and ten weed management treatments viz. Pretilachlor (PE)750 g ha-1 , BispyribacNa (PoE) 25 g ha-1 , Fenoxaprop-p-ethy (PoE) l 56.25 g ha-1 , Cyhalofop-buty (PoE) l 80 g ha-1 ,Penoxsulam+ Cyhalofop butyl (PoE) 135 g ha-1, Penoxsulam(PoE) 22.5 g ha-1 , Metsulfuronmethy (early PoE) l 4 g ha-1 , 2,4-D Ethyl Ester (PoE) 750 g ha-1), weed free (HW) , at 20, 40 and 60 days after sowing and weedy check . Result was found that among the weed management treatments, the weed free treatment registered significantly highest value and was at par the application of Penoxsulam+ Cyhalofop butyl 135 g ha-1 , yield attributing characters, grain and straw yield and dry matter of Alternanthera sessilis it was found the lowest value in the application of Penoxsulam+ Cyhalofop butyl 135 g ha-1 (T5).

**Corresponding author: E-mail: nishadhurve251@gmail.com;*

Keywords: Direct seeded rice; herbicides; Pretilachlor; Bispyribac Na; Fenoxaprop-p-ethy; Cyhalofop-buty; Penoxsulam+ Cyhalofop butyl; Penoxsulam; Metsulfuronmethy; 2,4-D ethyl ester.

1. INTRODUCTION

"Rice (*Oryza sativa* L.) is a monocot type plant of the Oryza genus under the Poaceae family. Rice is the world's most extensively grown crop and the primary staple food of over 60 percent of the world's population. Under diversified conditions, rice occupies a major role among food crops. Approximately 90% of the world's rice is produced and consumed in Asia [1-3]. The world's total rice area is 167.0 mha and production is about 769.6 mt with productivity of 4.6 t per ha however , as per as estimate, about 40% of rice yield lost due to various pest, of which weeds have the most potential for loss as (32%) [4,5]. Because of the prevalence of congenial environment during the kharif season weeds posed a big problem in rice production. Direct seeded rice (DSR) provides a good crop establishment as well as good yield potential if adequately kept under weed free environment" (Rao *et al*. 2017). "On the other hand, rice yield was reduced by 35-100 per cent in direct seeded rice in the absence of proper weed control" [6]. In Chhattisagarh, area under direct seeded rice is increasing considerably due to availability of new seeding implements, use of pre emergence herbicide and non availability of labour during transplanting [7-11]. DSR also gives higher yield with less cost of cultivation. On the other hand, a complex weed flora present in direct seeded field which compete with rice plants severely and poses yield losses yield mainly due to the absence of impounding of water at crop emergence [12-16].

Alternanthera sessilis exists as a noxious weed in both wetlands and uplands and can grow on a variety of soil types and this weeds are posing a serious threat to agro-biodiversity in several countries in the world. Its common name in Hindi is Gudrisag, Garundi and in Chhattisgarhi it is named as Resham Kanta [17-19]. It is a herbaceous, weak, cylindrical, having with spreading branches from the base; yellowish-brown to light-brown in colour its nodes and internodes are distinct. Leaves are sessile, linear-oblong, or elliptic, obtuse or sub acute; no characteristic odour and taste. Flowers are small, axillary, sessile heads, white or tinged with pink colour. Fruit are utricle 1.5 mm. long, orbicular, compressed with thickened margins [20-24].

2. MATERIALS AND METHODS

Field experiment was conducted during kharif season of 2019. The experimental site was located at Research cum Instructional Farm Department of Agronomy, Indira Gandhi Agriculture University, Raipur, Chhattisgarh. The meteorological data recorded during study showed that crop received 975.4 mm rainfall during the crop period. The soil of the experimental field was sandy clay loam in texture. The soil was neutral in reaction. It had low nitrogen, medium phosphorus and high potassium contents. Rice variety Indira Rajeshwari-1 was direct seeded on 8th July 2019 in rows 20 cm apart using seed cum fertilizer drill using seed rate of 100 kg ha-1. The experiment was laid out in randomized complete block design (RCBD) with three replications of ten weed management treatments viz. Pretilachlor (PE)750 g ha^{-1} , Bispyribac Na (PoE) 25 g ha^{-1} , Fenoxaprop-p-ethy (PoE) l 56.25 g ha^{-1} , Cyhalofop-buty (PoE) l 80 g ha^{-1}, Penoxsulam+ Cyhalofop butyl (PoE) 135 g ha^{-1} , Penoxsulam (PoE) 22.5 g ha^{-1} , Metsulfuronmethy (early PoE) l 4 g ha^{-1} , 2,4-D Ethyl Ester (PoE) 750 g ha^{-1}, weed free (HW) , at 20, 40 and 60 days after sowing and one weedy check (T_{10}) . The pre emergence herbicide was applied 2 days after sowing (DAS) while early and late POE was applied at 16 and 22 DAS, respectively.

3. RESULTS AND DISCUSSION

3.1 Test Weight (g)

The result revealed that the different weed management treatmentdid not influence (P>0.05) the test weight significantly. However, numerically the highest test weight was obtained under the weed free treatment and the lowest was recorded under metsufuron methyl 4 g ha$^{-!}$ weedy check treatment. Among the herbicide treatment highest test weight was registered in the application of bispyribac sodium 25 g ha^{-1} followed by penoxsulam 22.5 g ha^{-1}, 2,4-D ethyl ester 0.750 kg ha^{-1} and metsulfuron methyl 4 g ha^{-1}.

3.2 Grain Yield (q ha^{-1})

Results pertaining to grain yield is presented in Table. "It was distinct from the result that the different weed management treatment significantly influenced the grain yield. Among the herbicide treatments, the highest grain yield (5.04 t ha^{-1}) was recorded under the application of penoxsulam+ cyhalofop-butyl 135 g ha^{-1} which was closely followed by the weed free (5.08 t ha^{-1}) compared to weedy check that yielded the lowest grain. This can be explained by less competition with weeds at critical stages of plant growth which resulted in higher number of grains bearing effective tillers compared to the unweeded plots that compete with the weeds throughout the growing season. These finding were in conformity with the finding of Bahar and Singh (2004) who stated the *Alternanthera sessilis* is responsible for grain yield losses of 45% in rice .The grain yield of rice decresed by 25-28% when *Alternanthera sessile* was not controlled effectively as under herbicidal treatment T1, T2 and T3, T4 and competed with rice up to maturity (Mishra and Singh, 2008). The higher grain yield of rice and reduced weed density effectively at different growth and at harvest through application of cyhalafop-butyl 120 g ha^{-1}, closely followed by pendimethalin 1.0 kg ha^{-1} reported by Bahar and Singh (2004) . Lowest grain yield obtained in weedy check treatment might be due to maximum growth of *Alternanthera sessilis. Alternanthera sessilis* was responsible for grain yield losses of 45, 19 and 20% in rice also reported by Yi (1992), Zhang *et al*. (2004). The lowest grain yield under the weedy check treatment might be due to season long weed competition exerted by the weeds at the critical stages of the crop growth which reduced the availability and uptake of nutrients and also the mutual shading by the weeds resulting in reduced photosynthesis and translocation of carbohydrate from source to sink.

3.3 Straw Yield (q ha^{-1})

“Result pertaining to straw yield are presented in Table 1. The result show that the maximum straw yield was obtained under weed free treatment. Among the herbicide treatments, the highest straw yield recorded under the application of penoxsulam+ cyhalofop-butyl 135 g ha^{-1} followed by penoxsulam 22.5 g ha^{-1}, bispyribac Na 25 g ha^{-1} and metsulfuron methyl 4 g ha^{-1}, which were at par with the weed free treatment compared to the weedy check hat recorded the lowest yield This finding were in confirmatory with the finding of Raj and Syriac (2016).

3.4 Harvest Index (%)

The result of harvest index is presented in Table 1. The data clarified that the herbicide treatments did not influence the harvest index significantly.

3.5 Weed Index (%)

Data with regards to weed index (WI) is shown in Table 1. “The weed index represent the percent reduction in grain yield due to weed competition. Among all the treatment, the weedy check treatment, showed the highest weed index, representing the highest reduction in yield due to weed competition. Among the herbicide treatment, the lowest weed index was recorded under the application of penoxsulam+ cyhalofop butyl 135 g ha^{-1} , followed by penoxsulam 22.5 g ha^{-1}, bispyribac Na 25 g ha^{-1} and metsulfuron methyl 4 g ha^{-1}. Application of penoxsulam producing higher grain yield and the lowest weed index resulting in great increase in yield over unweeded control.

3.6 Dry Weight of Weeds (g m^{-2})

3.6.1 Dry weight of *Alternanthera sessilis* (g m^{-2})

Results regarding the dry matter of *Alternanthera sessilis* at different intervals of crop growth are presented in Tables 2 ,3 and 4. At all the growth stages, among all the treatments, the highest dry matter of *Alternanthera sessilis* was recorded under the weedy check treatment and the lowest dry matter was recorded under the weed free plot. At 30 DAS, very less dry matter of weed was observed in the weed free treatment are presented in Table 2. Among the herbicides treatments, lowest dry matter of *Altenanthera* sessilis was observed under the application of 2, D ethyl ester 750 g ha^{-1} (2.62) .The highest dry matter of *Alternanthera sessilis* was recorded under the application of fenoxaprop-p-ethyl 56.25 g ha^{-1} (22.60).

3.6.2 Dry weight of *Echinochloa colona* (g m^{-2})

Dry matter of *Echinochloa colona* at different intervals of crop growth are presented in Tables 2 ,3 and 4. At all the growth stages, among all the treatments, the highest dry matter of *Echinochloa colona* was recorded under the weedy check treatment and the lowest dry matter was recorded under the weed free plot. At 30 DAS, very less dry matter of weed was observed under the weed free as shown in in Table 2. Among the herbicides treatments, lowest dry matter of *Echinochloa colona* was observed under the application of fenoxaprop-p-ethyl 56.25 g ha^{-1} (0.91). The highest dry matter of *Echinochloa colona* was recorded under the application of 2,4-D ethyl ester 750 g ha^{-1} (2.12) as it did not controlled the *Echinochloa colona.* At 60 and at harvest among the herbicide treatments, the lowest dry matter of *Echinochloa colona* was observed under the application of penoxsulam + cyhalofop-butyl 135 g ha^{-1} (2.17) closely followed by bispyribac Na 25 g ha^{-1} (Table 3).

3.6.3 Dry weight of *Cyprus iria* (g m^{-1})

"Dry matter of *Cyprus iria* at different intervals of crop growth are presented in Table 2 ,3 and 4 At all the growth stages, among all the treatments, the highest dry matter of *Cyprus iria* was recorded under the weedy check treatment and the lowest dry matter was recorded under the weed free plot. At 30 DAS, lowest dry matter of weed was observed under the weed free are presented in Table 2. Among the herbicides treatments, lowest dry matter of *Cyprus iria* was observed under the application of fenoxaprop-p-ethyl 56.25 g ha^{-1} (0.71).The highest dry matter of *Cyprus iria* was recorded under the application of 2,4-D ethyl ester 750 g ha^{-1} (1.35). At 60 DAS and at harvest among the herbicide treatments, the lowest dry matter of *Cyprus iria* was observed under the application of penoxsulam + cyhalofop-butyl 135 g ha^{-1} (0.82)" .The cyhalofopb-butyl 80 g ha^{-1} (6.94) treatment recorded the highest dry matter (Table 3) . At harvest, The weed free treatment recorded very less dry matter of the species under discussion. Among the herbicide treatments, the lowest dry matter of *Cyprus iria* was observed under the application of penoxsulam + cyhalofop-buty 135 g ha^{-1} (2.45) . The highest dry weight recorded under 2,4-D ethyl ester 750 g ha^{-1} (5.88) .

3.6.4 Dry weight of other weed (g m^{-1})

Dry matter of other weed species at different intervals of crop growth are presented in Table 2 ,3 and 4 At all the growth stages, among all the treatments, the highest dry matter of other weed was recorded under the weedy check treatment and the lowest dry matter was recorded under the weed free plot. Among the herbicides treatments, lowest dry matter of other weed was observed under the application of penoxsulam + cyhalofop-butyl 135 g ha^{-1} (0.35). The highest dry matter of other weed was recorded under the application of 2,4- D ethyl ester 750 g ha^{-1} (1.89) as it did not controld the other weed 30 DAS. At 60 DAS and at harvest, among the herbicide treatments, the lowest dry matter of other weed was observed under the application of penoxsulam + cyhalofop-butyl 135 g ha^{-1} (1.01 and 1.36). The highest dry matter of other weed was recorded under the application of 2, D ethyl ester 750 g ha^{-1} (2.40 and 7.16 g m^{-2}) treatment recorded the highest dry matter during all the both growth stages (Table 3) . At harvest, all the treatments observed (Table 4.) with reduction in dry matter of . The weed free treatment recorded very less dry matter of the species under discussion. Among the herbicide treatments, the lowest dry matter of other weed observed under the application of penoxsulam + cyhalofop-butyl 135 g ha^{-1} (1.36) .The highest dry matter of other weed was recorded under the application of 2, D ethyl ester 750 g ha^{-1} (2.77).

Table 1. Yield and yield attributing characters as influenced by different herbicide treatment in direct seeded rice

Treatment	Yield attributing characters				
	Test weight (g)	**Grain yield (t ha^{-1})**	**Straw yield (t ha^{-1})**	**Harvest index (%)**	**Weed index (%)**
Pretilachlor 750 g ha^{-1} PE	21.35	3.83	4.99	43.42	24.61
Bispyribac sodium 25 g ha^{-1} PoE	25.22	4.63	5.84	44.22	8.86
Fenoxaprop-p-ethyl 56.25 g ha^{-1} PoE	21.25	3.74	4.95	43.04	26.38
Cyhalofop Butyl 80 g ha^{-1} PoE	21.48	3.64	4.85	42.87	28.35
Penoxsulam + Cyhalofop135 g ha^{-1} PoE	22.29	5.04	5.96	45.83	0.79
Penoxsulam 22g ha^{-1} PoE	22.16	4.65	5.85	44.26	8.46
Metsulfuron methyl 4 g ha^{-1} early PoE	21.12	3.96	5.12	43.6	22.05
2,4-D Ethyl Ester 750 g ha^{-1} PoE	21.15	4.04	5.15	43.97	20.47
Weed free	22.45	5.08	6.00	45.85	0.00
Weed check	21.25	1.78	2.96	37.54	64.96
SEm±	0.25	0.16	0.24	3.28	-
LSD (P= 0.05)	NS	0.47	0.71	NS	-

Table 2. Weed dry weight at 30 DAS (g m^{-2}) as influenced by different herbicide treatment in direct seeded rice

Treatments	Dry weight , m^{-2} At 30 DAS				
	Alternanthera sassilis	***Echinochloa colona***	***Cyprus iria***	**Other weed**	**Total weed**
Pretilachlor 750 g ha^{-1} PE	3.65 (12.79)	1.23 (1.02)	1.24 (1.04)	1.48 (1.69)	4.13 (16.54)
Bispyribac sodium 25 g ha^{-1} PoE	3.99 (15.45)	1.21 (0.97)	1.36 (1.34)	1.03 (0.56)	4.34 (18.32)
Fenoxaprop-p-ethyl 56.25 g ha^{-1} PoE	4.81 (22.60)	1.19 (0.91)	1.04 (0.59)	1.33 (1.28)	5.09 (25.38)
Cyhalofop Butyl 80 g ha^{-1} PoE	4.13 (16.54)	1.32 (1.25)	1.36 (1.34)	1.44 (1.58)	4.61 (20.71)
Penoxsulam + Cyhalofop 135 g ha^{-1} PoE	1.78 (2.66)	1.45 (1.61)	1.12 (0.76)	0.92 (0.35)	2.42 (5.38)
Penoxsulam 22 g ha^{-1} PoE	1.77 (2.64)	1.56 (1.93)	1.16 (0.71)	1.47 (1.67)	2.73 (6.95)
Metsulfuron methyl 4 g ha^{-1} PoE	1.94 (3.26)	1.41 (1.50)	1.28 (1.15)	0.97 (0.45)	2.62 (6.36)
2,4-D Ethyl Ester 750 g ha^{-1} PoE	1.77 (2.62)	1.62 (2.11)	1.36 (1.35)	1.55 (1.89)	2.91 (7.97)
Weed free	1.33 (1.28)	0.87 (0.25)	1.10 (0.70)	0.84 (0.20)	1.71 (2.43)
Weedy check	4.90 (23.53)	1.75 (2.57)	1.65 (2.230	1.80 (2.76)	5.62 (31.09)
SEm±	0.15	0.25	0.31	0.81	0.27
LSD (P= 0.05)	0.44	0.74	0.94	0.54	0.81

**DAS: Days After Sowing; Figures in parentheses are original values, data were transformed to values √(x+1) are in bold letters*

Table 3. Weed dry weight at 60 DAS (g m^{-2}) as influenced by different herbicide treatment in direct seeded rice

Treatments	Dry weight , m^{-2} At 60 DAS				
	Alternanthera sassilis	***Echinochloa colona***	***Cyprus iria***	**Other weed**	**Total weed**
Pretilachlor 750 g ha^{-1} PE	6.19 (37.83)	1.65 (2.22)	1.29 (1.16)	1.94 (3.28)	6.71 (44.49)
Bispyribac sodium 25 g ha^{-1} PoE	6.75 (25.07)	1.73 (2.51)	1.40 (1.46)	1.29 (1.15)	5.54 (30.19)
Fenoxaprop-p-ethyl 56.25 g ha^{-1} PoE	6.94 47.64	1.72 (2.45)	1.18 (0.89)	1.66 (2.25)	7.33 (53.23)
Cyhalofop Butyl 80 g ha^{-1} PoE	5.06 (47.16)	1.75 (2.56)	1.40 (1.46)	2.05 (3.72)	7.44 (54.90)
Penoxsulam + Cyhalofop 135 g ha^{-1} PoE	3.66 (12.89)	1.63 (2.17)	1.15 (0.82)	1.23 (1.01)	4.17 (16.89)
Penoxsulam 22 g ha^{-1} PoE	3.69 (13.15)	1.85 (2.91)	1.19 (0.91)	1.66 (2.27)	4.44 (19.24)
Metsulfuron methyl 4 g ha^{-1} PoE	3.79 (13.84)	1.78 (2.67)	1.61 (2.09)	2.14 (4.06)	4.81 (22.66)
2,4-D Ethyl Ester 750 g ha^{-1} PoE	3.84 (14.22)	2.06 (3.74)	1.62 (2.12)	2.40 (5.27)	5.08 (25.35)
	1.48 (1.68)	0.89 (0.30)	1.15 (0.82)	0.76 (0.08)	1.84 (2.88)
Weedy check	7.04 (49.13)	1.76 (2.60)	1.69 (2.35)	3.17 (5.56)	7.75 (59.64)
SEm±	0.18	0.26	0.24	0.25	0.26
LSD (P= 0.05)	0.55	0.79	0.71	0.74	0.79

**DAS: Days After Sowing; Figures in parentheses are original values, data were transformed to values √(x+1) are in bold letters*

Table 4. Weed dry weight at at harvest (g m^{-2}) as influenced by different herbicide treatment in direct seeded rice

Treatments	Dry weight , m^{-2} At harvest				
	Alternanthera sassilis	***Brachiaria ramose***	***Sporobolus diander***	**Other weed**	**Total weed**
Pretilachlor 750 g ha^{-1} PE	7.64 (57.89)	2.31 (4.84)	2.52 (5.84)	2.34 (4.97)	8.60 (73.54)
Bispyribac sodium 25 g ha^{-1} PoE	6.90 (47.10)	2.28 (4.72)	2.49 (5.72)	1.79 (2.71)	7.79 (60.25)
Fenoxaprop-p-ethyl 56.25 g ha^{-1} PoE	9.25 (85.00)	2.03 (3.63)	2.26 (4.63)	2.01 (3.53)	9.86 (96.79)
Cyhalofop Butyl 80 g ha^{-1} PoE	8.86 (78.00)	2.31 (4.84)	1.93 (3.24)	2.41 (5.30)	9.59 (91.38)
Penoxsulam + Cyhalofop 135 g ha^{-1} PoE	5.30 (27.64)	2.20 (4.36)	1.72 (2.45)	1.36 (1.36)	6.03 (35.81)
Penoxsulam 22 g ha^{-1} PoE	5.44 (29.06)	2.32 (4.88)	2.39 (5.21)	2.11 (3.94)	6.60 (43.09)
Metsulfuron methyl 4 g ha^{-1} PoE	5.88 (34.06)	2.35 (5.03)	2.24 (4.53)	2.62 (6.35)	7.10 (49.97)
2,4-D Ethyl Ester 750 g ha^{-1} PoE	5.52 (29.97)	2.44 (5.46)	2.53 (5.88)	2.77 (7.16)	7.00 (48.47)
Weed free	2.33 (4.92)	1.17 (0.86)	1.54 (1.86)	0.88 (0.28)	2.90 (7.92)
Weedy check	9.81 (95.77)	2.50 (5.74)	2.54 (5.95)	3.58 (8.31)	10.78 (115.77)
SEm±	0.21	0.27	0.18	0.41	0.31
LSD (P= 0.05)	0.65	0.81	0.54	1.24	0.94

**DAS: Days After Sowing; Figures in parentheses are original values, data were transformed to values $\sqrt{(x+1)}$ are in bold letters*

3.6.5 Dry weight of total weed (g m^{-1})

Total weed dry matter of other weed species recorded at different time intervals are presented in Table 2 ,3 and 4. At all the growth stages, among all the treatments, the highest dry matter of total weeds was recorded under the weedy check treatment and lowest was observed under the weed free treatment. At 30, 60 DAS and at harvest among the herbicides treatments, the lowest dry matter of total weed was observed (Table 2) under the application of metsulfuron methyl 4 g ha^{-1} (16.75) followed by penoxsulam + cyhalofop-butyl 135 g ha^{-1} and penoxsulam 22 g ha^{-1} . The highest was dry matter of total weed measured under the application cyhalofop- butyl 80 g ha^{-1} . At 60 DAS, the weed free treatment recorded lowest weed dry matter. While among the herbicide treatment the lowest dry matter of total weed was observed (Table 3) under the application of penoxsulam + cyhalofop-butyl 135 g ha^{-1} followed by bispyribac Na 25 g ha^{-1} and the highest was dry matter of total weed measured under the application cyhalofop- butyl 80 g ha^{-1} . At harvest the weed free treatment recorded again lowest weed matter. Among the herbicide treatment the lowest dry matter of total weed was observed (Table 4.) under the application of penoxsulam + cyhalofop-butyl 135 g ha^{-1} , followed by penoxsulam 22 g ha^{-1} and the highest was found under the application of cyhalofop –butyl 80 g ha^{-1} as pre emergence effectively in reducing weed dry matter and increasing grain yield.

3.7 Weed Control Efficiency (%)

“Weed control efficiency (WCE) computed at 30, 60 and at harvest and are presented in Table 5. It was evident from the result that at all the growth stages, the highest weed control efficiency was recorded under the weed free treatment due to season long weed free condition. Among the herbicides, at 30 DAS, the highest weed control efficiency was ontained under the application of metsulfuron methyl 4 g ha^{-1} (64.09 %) followed by penoxsulam + cyhalofop-butyl 35 g ha^{-1} (63.24 %) 2,4-D ethyl ester 750 g ha^{-1} (56.89%) penoxsulam 22 g ha^{-1}(53.57%). Whie the lowest weed control efficiency was recorded under the application of cyhalofop-butyl 80 g ha^{-1} (40.49).

At 60 DAS the highest weed control efficiency was obtained under the application of penoxsulam + cyhalofop-butyl 135 g ha^{-1} (63.24) as compared with the lowest weed control efficiencyrecorded under the application of cyhalofop-butyl 80 g ha^{-1} (27.36).

At harvest, the highest weed control efficiency was recorded under the application of penoxsulam + cyhalofop-butyl 135 g ha^{-1} (68.98). While, the lowest was recorded under the application of cyhalofop-butyl 80 g ha^{-1} (29.16)”.This might be due to lower percentage reduction in weed density and biomass.

The highest weed control efficiency was recorded under the application of penoxsulam + cyhalofop-butyl 0.135 kg ha^{-1} was due to the pre-mix application of such suitable herbicides which performed better against diverse weed flora as compared to alone application of herbicide.

Table 5. Weed control efficiency (WCE) at different periods of plant growth stages as influenced by different herbicide treatments in direct seeded rice

Treatment	Weed control efficiency (%)		
	30 DAS	**60 DAS**	**At harvest**
Pretilachlor 750 g ha^{-1} PE	52.93	31.96	43.73
Bispyribac sodium 25 g ha^{-1} PoE	48.12	60.68	59.11
Fenoxaprop-p-ethyl 56.25 g ha^{-1} PoE	43.30	35.06	40.57
Cyhalofop Butyl 80 g ha^{-1} PoE	40.49	27.36	29.16
Penoxsulam + Cyhalofop 135 g ha^{-1} PoE	63.24	69.52	68.98
Penoxsulam 22 g ha^{-1} PoE	53.57	58.20	62.91
Metsulfuron methyl 4 g ha^{-1} PoE	64.09	47.38	47.70
2,4-D Ethyl Ester 750 g ha^{-1} PoE	56.89	54.78	54.83
Weed free	92.41	97.88	97.31
Weed check	0	0	0
SEm±	0.19	0.25	0.52
LSD (P= 0.05)	0.55	0.74	1.5

4. CONCLUSION

A complex weed flora present in direct seeded field which compete with rice plants severely and poses yield losses yield mainly due to the absence of impounding of water at crop emergence. The lowest grain yield under the weedy check treatment might be due to season long weed competition exerted by the weeds at the critical stages of the crop growth which reduced the availability and uptake of nutrients and also the mutual shading by the weeds resulting in reduced photosynthesis and translocation of carbohydrate from source to sink.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Mabbayad MO, Moody K. Herbicide seed treatment for weed control in wet-seeded rice. International Journal of Pest Management. 1992;38(1):9-12.
2. Mahajan G., Chauhan B S, Johnson D E, Weed management in aerobic rice in Northwestern Indo-gangetic plains, journal of crop improvement. 1992;23(4):366-382.
3. Mahajan G, Chauhan BS, Johnson DE. Weed management in aerobic rice in Northwestern Indo-Gangetic Plains. Journal of Crop Improvement. 2009;23(4):366-382.
4. Kumar V, Ladha JK. Direct seeding of rice: recent developments and future research needs. In *Advances in agronomy*). Academic Press. 2011;111:297-413
5. Mabbayad MO, Mody K. Herbicide seed treatment for weed control in wet-seeded rice. Journal Tropical Pest Management; 2008.
6. Kumar B, Kumar S, Mishra M, Singh SK, Sharma CS, Makhijani SD, Senthilkumar K. Distribution of pesticides, herbicides, synthetic pyrethroids and polychlorinated biphenyls in sediments from drains of Delhi, India. Organohalogen Compounds. 2008;70:1120-1123.
7. Bali AmarjitS, Singh Mahinder, Kachroo Dil eep, Sharma BC, Shivran DR, Efficacy of herbicides in transplanted, medium-duration rice (*Oryza sativa* L.) under sub-tropical conditions of Jammu, Indian Journal of Agronomy. 2006;51(2):128-130.
8. Bali AmarjitS, Singh Mahinder, Kachroo Dil eep, Sharma BC, Shivran DR. Efficacy of herbicides in transplanted, medium-duration rice (*Oryza sativa*) under sub-tropical conditions of Jammu, Indian Journal of Agronomy. 2006;51(2):128-130.
9. Chauhan BS, Abugho SB. Effect of growth stage on the efficacy of postemergence herbicides on four weed species of direct-seeded rice. The Scientific World Journal; 2012.
10. Choubey NK, Kobe S., Tripathi RS.Relativ e Performance of Cyhalofop butyl for Weed Control in Direct Seeded Rice. Indian Journal of Weed Science. 2001;33(3&4):132-135
11. Choubey NK, Kobe SS, Tripathi RS. Relative performance of cyhalofop butyl for weed control in direct seeded rice. Indian Journal of Weed Science. 2001;33 (3and4):132-135.
12. Choudhary VK, Dixit A. Herbicide weed management effect on weed dynamics, crop growth and yield in direct-seeded rice, Indian Journal of Weed Science. 2018;50 (1):6–12
13. Dwivedi SK, Shrivastava GK. Planting geometry and weed management for maize (*Zea mays*)-blackgram (Vigna mungo) intercropping system under rainfed vertisols. Indian Journal of Agronomy. 2001;56(3):202-208.
14. Hasanuzzaman M, Ali MH, Alam MM, Akther M, Alam KF. Evaluation of preemergence herbicide and hand weeding on the weed control efficiency and performance of transplanted aus rice, American-Eurasian Journal of Agronomy. 2009;2(3):138-143.
15. Jhoana L. Open˜ a1, Bhagirath S. Chauhan1*, Aurora M. Baltazar. Seed Germination Ecology of Echinochloa glabrescens and Its Implication for Management in Rice (*Oryza sativa* L.). Plos One. 2014;9(3).
16. Kumar J, Kumar A, Sharma BC. Effect of weed management and crop estabestablishment method an weed dynamics and productivity of rice, Indian journal of weed; 2009.
17. Majhi R, Thakur S, Upasani RR, Pal SK, Singh MK. Effect of integrated weed management on the productivity of direct seeded upland rice (*Oryza sativa*) in eastern India. SAARC Journal of Agriculture. 2011;9:23-28.

18. Olsen SR. Estimation of available phosphorus in soils by extraction with sodium bicarbonate US Department of Agriculture. 1954;939.
19. Parthipan T, Ravi V, Subramanian E. Integrated weed management practices on growth and yield of direct-seeded lowland rice. Indian Journal of Weed Science. 2013;45(1):7-11.
20. Rajkhowa DJ, Deka NC, Borah N, Barua I. C. Effect of herbicides with or without paddy weeder on weeds in transplanted summer rice (*Oryza sativa*). Indian Journal of Agronomy. 2007;52(2):107-110.
21. Ramesh K, Rao AN, Chauhan BS. Role of crop competition in managing weeds in rice, wheat, and maize in India: A review, Crop Protection. 2017;95:14-21
22. Rammohan J, Narayanan AL, Poonguzhal R, Mohan R, Hanifa A. Mohamed. Efficacy of Pre-emergence Herbicides for Weed Control in Lowland Transplanted Rice in the Coastal Saline Soils, Indian Journal of Weed Science. 1999;31(3&4):142-144.
23. Walkley A, Black IA. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil Science. 1934;37(1): 29-38.
24. Yadav DB, Singh S, Yadav A. Evaluation of azimsulfuron and metsulfuron-methyl alone and in combination for weed control in transplanted rice. Indian Journal of Weed Science. 2008;40(1and2): 16-20.

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