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Evaluation of bio-efficacy of BAS 625 04 H against grassy weeds in direct seeded rice (*Oryza sativa* L.)

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Abstract
A field experiment was conducted during the *kharif* 2021 at Instructional-cum-Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh to evaluate new molecules of on weed control in direct seeded rice. BAS 625 04 H is a member of Cyclohexenone group, post emergence herbicide used for annual grassy weeds in various field crops. Post-emergence (POE) application of BAS 625 04 H @ 75 g a.i. ha^{-1} with MSO adjuvant gave lower total weed density, weed dry weight and higher weed control efficiency at all the intervals which was at par with Cyhalofop butyl 10 % EC and BAS 625 04 H @ 55 g a.i. ha^{-1} with MSO adjuvant. Among the different doses of BAS 625 04 H higher grain yield and straw yield recorded under BAS 625 04 H @ 75 g a.i. ha^{-1} with MSO adjuvant and @ 55 g a.i. ha^{-1} with MSO adjuvant. Untreated control accounted for lower grain yield, higher weed density and dry weight due to heavy competition of weeds for nutrients, space and light.

Keywords: BAS 625 04 H, Cyhalofop butyl, direct seeded rice, yield attribute, yield

Introduction
Rice (*Oryza sativa* L.) is the principle source of food for almost 60% population of India (Biswas *et al*., 2019). India is an important rice growing country in the world and occupies an area of 45 million hectare with production of rice during 2020-21 is estimated at record of 102.36 million tones in 1st Advance Estimates (Ministry of Agriculture and Farmers Welfare 2020-21). Chhattisgarh is 7th in rice production with over 6 million metric tonnes (FY 2019). It was predicted that a 50 – 60 % increases in rice production will be required to meet the food demand of population growth by 2025 (Banerjee *et al.*, 2018). Severe and diversified weed infestation, high weed emergence during rice seed germination due to lack of standing water layer, and for the zero-seedling size benefit of rice over weed seedlings as both germinate simultaneously, managing weed in DSR system is very much challenging. Though many pre-emergence herbicides are available for controlling weeds, the need for post-emergence herbicide is often realized to combat the weeds emerged during later stages of crop growth (Kundu *et al.*, 2020). Among the post-emergence herbicides, bispyribac-sodium is a systemic herbicide absorbed by roots and leaves, and also inhibits the enzyme acetolactate sysnthase in susceptible weed plants (Pathak *et al.*, 2011). Fenoxaprop-p-ethyl also is a selective, post-emergent herbicide having action on broad-spectrum of grasses (Rana *et al.*, 2004). Shift in weed flora and development of herbicide resistance in weeds. Hence, the present investigation was to study the effect of different weed management practices on growth and yield of direct seeded rice.

Material and Methods
Field experiment was conducted during *kharif* season of 2021 at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, geographically, Raipur situated in mid–eastern part of Chhattisgarh state and lies at 21^{0}16′ North Latitude and 81^{0}36' East Longitude with an altitude of 314.15 m above the mean sea level. Climatologically, Raipur comes under the Chhattisgarh plains agro climatic sub zone which having sub humid climatic condition. The region receives an average of 1104 mm annual rainfall, out of which about 87 per cent received during the rainy season (June to September) and the rest of 13 per cent during the winter season (October to February). The soil was neutral (pH 7.1) in reaction with medium in fertility having 0.46% soil organic carbon, low nitrogen (214 kg ha^{-1}), medium phosphorus (17.5 kg ha^{-1}) and high potassium (301 kg ha^{-1}) content. The experiment was laid out in Randomized Block Design (RBD) with three replications.

The treatments comprised of nine treatments. The test variety used in experiment MTU-1010. It is recommended for direct- seeded upland and rainfed ecosystem in different region of the country (including Chhattisgarh). It is a semi dwarf variety matures about 115- 120 days. BAS 625 04 H @ 35 g a.i.ha^{-1}, BAS 625 04 H @ 55 g a.i. ha$^{-1,}$ BAS 625 04 H @ 75 g a.i.ha^{-1}, BAS 625 04 H @ 35 g a.i.ha^{-1} with MSO adjuvant, BAS 625 04 H @ 55 g a.i.ha^{-1} with MSO adjuvant, BAS 625 04 H @ 75 g a.i.ha^{-1} with MSO adjuvant, Cyhalofop butyl 10% EC @ 75 g a.i.ha^{-1}, hand weeding twice at 20 and 40 DAS and untreated control were used in the experiment. The water was required 1 liter per plot and application of herbicide at 18 DAS after sowing. Rice was sown in rows 20 cm apart during the second week of July and harvesting is done in November second week.

Results and Discussion

Plant height

Data with respect to the plant height are presented in table-1 significantly highest plant height (107.4) was recorded under hand weeding twice at all the stages of observation. However, it was at par to Cyhalofop butyl 10 % EC, BAS 625 04 H @ 75 g a.i. ha^{-1} with MSO adjuvant and @ 55 g a.i. ha^{-1} with MSO adjuvant at harvest. Similarly, the least plant height was observed in untreated control at all the stages of observation. The logic for variation in plant height of all the treatment may be due to the lower competition between weeds and crop for light, nutrients and space along with availability of water which allowed the crop to grow to their potential Yadav *et al* (2009), Saha and Rao (2010).

Dry matter accumulation

The data of dry matter production of crop plants are presented in table-1. It is evident from perusal of data that, the dry matter production of rice was increased with the advancement of crop age under all the treatments. Maximum dry matter (469 g m^{-2}) was recorded at under hand weeding which was at par with Cyhalofop butyl (464 g m^{-2}) followed by BAS 625 04 H @ 75 g a.i. ha^{-1} with MSO adjuvant resulted in to higher (458.1 g m^{-2}) dry matter accumulation among different doses of BAS 625 04 H which was at par with @ 55 g a.i. ha^{-1} with MSO adjuvant. The lowest dry matter of rice was recorded under untreated control which might be due to adverse effect of excessive crop-weed competition as evident from maximum dry matter production of weeds which resulted in decline of nutrient uptake and dry matter accumulation by crop. Similar results have been reported by Singh and Bhan (1998) and Sahu (2016).

Number of tillers

Data are presented in table-1 number of tillers was significantly affected by the different doses of herbicides. The maximum number of tillers m^{-2} (445) was recorded under hand weeding twice which were statistically superior over rest of the treatments. The minimum number of tillers m^{-2} (282) was recorded under untreated control. Among the different doses of BAS 625 04 H, its application @ 75 g a.i. ha^{-1} with MSO adjuvant which was at par with @ 55 g a.i. ha^{-1} with MSO adjuvant did produce higher number of tillers as compared to rest doses.

Leaf area index

Data are presented in table-1.The highest leaf area index (3.93) was recorded under hand weeding twice, followed by (3.65) with Cyhalofop butyl which was at par with BAS 625 04 H @ 75 g a.i. ha^{-1} (3.59) with MSO adjuvant and @55 g a.i. ha^{-1} with MSO adjuvant (3.57). While the minimum leaf area index (2.66) was noted under untreated control. Leaf area expantion might have reduced due to crop- weed competition and hence, the lower values of leaf area index have been observed in untreated control. On the other hand, due to weed free environment more leaf area index was noticed in hand weeding twice. Similar results were also reported by Halder and Patra (2010).

Effective tillers (No. m^{-2})

Grain yield of cereals is completely dependent upon the number of productive tillers produced by each plant. The data on effective tillers are presented in table-2. Data indicate that, hand weeding twice showed maximum number of effective tillers (422 m^{-2}) which was significantly superior over all treatments. BAS 625 04 H @ 75 g a.i. ha^{-1} with MSO adjuvant and @ 55 g a.i. ha^{-1} with MSO adjuvant did produce more number of tillers (215 m^{-2}) as compared to its other doses.

Panicle length (cm)

The data on panicle length as influenced by different treatments are presented in table-2. Observation of data acknowledges that, it was significantly affected by herbicidal treatments. The highest panicle length (23.43 cm) was observed under hand weeding twice which was statistically longer over all treatments followed by Cyhalofop butyl (21.5 cm). Longer panicles were produced when BAS 625 04 H was applied as post-emergence @ 75 g a.i. ha^{-1} and @ 55 g a.i. ha^{-1} with MSO adjuvant as compared to its other treatments. Larger panicle length from these treatments might be due to minimum crop- weed competition which allowed more growth of rice because of more availability of light, moisture, nutrients and space which led to production of longer size of panicle.

Panicle weight (g)

The data on panicle weight as affected by various treatments and are presented in table-2. Among all the treatments, the maximum panicle weight (3.38 g) was recorded under hand weeding treatment which was heavier over all treatment, however the lightest panicle (1.05 g) was produced with unweeded check. Heavier panicles might be due to better transfer of photosynthates to the sink which contributed to increase the weight of panicles. The results are in line with Saini (2005), Subramaniyam *et al* (2007) and Singh Parmajeet *et al* (2018).

Table 1: Effect of different weed management practices on crop growth of direct seeded rice

	Treatments	Plant height (cm) at harvest	Dry matter accumulation, g m^{-2} at harvest	No. of tillers m^{-2}	Leaf area index (60 DAS)
T_1	BAS 625 04 H @ 35 g a.i.ha^{-1}	87.67	403.2	331	3.24
T_2	BAS 625 04 H @ 55 g a.i.ha^{-1}	90.27	427.1	377	3.41
T_3	BAS 625 04 H @ 75 g a.i.ha^{-1}	91.82	435.5	380	3.43
T_4	BAS 625 04 H @ 35 g a.i.ha^{-1}+ MSO Adjuvant	88.94	408.6	334	3.22
T_5	BAS 625 04 H @ 55 g a.i.ha^{-1}+ MSO Adjuvant	100.11	452.3	398	3.57
T_6	BAS 625 04 H@ 75 g a.i.ha^{-1} + MSO Adjuvant	101.84	458.1	396	3.59
T_7	Cyhalofop butyl 10% EC@ 75 g a.i.ha^{-1}	103.31	464	406	3.65
T_8	Hand weeding twice	107.4	469	445	3.93
T_9	Untreated Control	80.77	306.2	282	2.66
SEm±		3.38	4.16	4.24	0.12
CD (P=0.05)		7.08	10.24	9.45	0.30

Number of grains panicle^{-1}

The data on total number of grains panicle^{-1} as affected by different treatments are presented in table-2. Among all the treatments, the highest number of grains panicle^{-1} (138) was observed in hand weeding twice which was significantly superior over all treatments followed by Cyhalofop butyl (129), BAS 625 04 H @ 75 g a.i. ha^{-1} with MSO adjuvant(124) and @ 55 g a.i. ha^{-1} with MSO adjuvant (122). The minimum number of grains panicle^{-1} (80) was recorded under untreated control. The higher number of grains panicle^{-1} recorded in these treatments which might be due to the lower weed competition in terms of dry matter of weeds which created

Table 2: Effect of different weed management practices on yield attributes of direct seeded rice.

	Treatments	Effective tillers (No.m^{-2})	Panicle length (cm)	Panicle weight (g)	No of grains panicle^{-1}	1000 grain weight (g)
T_1	BAS 625 04 H @ 35 g a.i.ha^{-1}	335	18.56	1.82	101	22.72
T_2	BAS 625 04 H @ 55 g a.i.ha^{-1}	368	19.61	2.16	106	23.19
T_3	BAS 625 04 H @ 75 g a.i.ha^{-1}	370	19.75	2.29	108	23.22
T_4	BAS 625 04 H @ 35 g a.i.ha^{-1}+ MSO Adjuvant	339	18.93	2.04	103	22.88
T_5	BAS 625 04 H @ 55 g a.i.ha^{-1}+ MSO Adjuvant	385	20.67	2.75	122	24.19
T_6	BAS 625 04 H@ 75 g a.i.ha^{-1} + MSO Adjuvant	388	20.82	2.8	124	24.37
T_7	Cyhalofop butyl 10% EC@ 75 g a.i.ha^{-1}	391	21.5	3.02	129	24.97
T_8	Hand weeding twice	422	23.43	3.38	138	25.73
T_9	Untreated Control	215	16.24	1.05	80	21.98
SEm±		4.08	0.82	0.15	3.4	0.33
CD (P=0.05)		10.04	2.16	0.35	8.01	0.75

Table 3: Effect of different weed management practices on yield of direct seeded rice.

	Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)	Weed index (%)
T_1	BAS 625 04 H @ 35 g a.i.ha^{-1}	2.865	4.28	40.1	46.79
T_2	BAS 625 04 H @ 55 g a.i.ha^{-1}	3.739	4.95	43.03	30.55
T_3	BAS 625 04 H @ 75 g a.i.ha^{-1}	3.801	5.02	43.09	29.4
T_4	BAS 625 04 H @ 35 g a.i.ha^{-1}+ MSO Adjuvant	2.946	4.34	40.43	45.28
T_5	BAS 625 04 H @ 55 g a.i.ha^{-1}+ MSO Adjuvant	4.716	5.86	44.59	12.41
T_6	BAS 625 04 H@ 75 g a.i.ha^{-1} + MSO Adjuvant	4.818	5.98	44.62	10.51
T_7	Cyhalofop butyl 10% EC@ 75 g a.i.ha^{-1}	4.899	6.05	44.74	9.01
T_8	Hand weeding twice	5.384	6.65	44.74	-
T_9	Untreated Control	2.474	3.73	39.88	54.05
SEm±		0.18	0.25	0.2	2.6
CD (P=0.05)		0.45	0.54	NS	5.21

overall congenial environment for growth and development of rice which resulted more availability of light, moisture, nutrients and space for rice plant which led to produce more number of sound grains panicle^{-1}. The results of investigation confirm the findings of Saini *et al* (2001).

1000-grain weight (g)

The weight of thousand grains is also an important attributes to yield and data are presented in table-2. The highest weight of 1000-grain (25.73 g) was found under hand weeding twice which was statistically superior over all treatments and the lowest weight of 1000-grain (21.98 g) was found in untreated control. These results are similar to the findings of Ganeshwor and Gadadhar (2000) [10], Khan and Tarique (2011) [12] and Popy *et al* (2017).

Grain yield (t ha^{-1})

On perusal of data given in table-3 reveal that the highest grain yield (5.384 t ha^{-1}) was recorded under hand weeding twice which was significantly superior over all treatments followed by Cyhalofop butyl (4.899 t ha^{-1}), BAS 625 04 H @ 75 g a.i. ha^{-1} with MSO adjuvant (4.818 t ha^{-1}) and @ 55 g a.i. ha^{-1} with MSO adjuvant (4.716 t ha^{-1}). Higher grain yield is due to better control of weeds at critical stages and thus, providing favourable environment for better growth and development leading to enhanced yield and yield

attributes. The minimum grain yield (2.474 t ha^{-1}) was recorded under untreated control. In rice, productivity is mainly decided by the weed control efficiency of weed management methods as earlier observed by Abraham et al (2010) [1]. This corroborates the result of Singh *et al* (2007).

Straw yield (t ha^{-1})

On perusal of data given in table-3 reveal that the highest straw yield (6.65 t ha^{-1}) was recorded under hand weeding twice which was significantly superior over all treatments followed by Cyhalofop butyl (6.05 t ha^{-1}), BAS 625 04 H @ 75 g a.i. ha^{-1} with MSO adjuvant (5.98 t ha^{-1}) and @ 55 g a.i. ha^{-1} with MSO adjuvant (5.86 t ha^{-1}). The minimum grain yield (2.474 t ha^{-1}) was recorded under untreated control. Higher straw yield may be because of better weed control which reduces the competition with crop and thus, better crop growth and thus, yield (Azad *et al.*, 1990).

Weed index (%)

On perusal of data on weed index table showed that, there was maximum yield reduction to the yield of 54.05% under untreated control, however the least yield reduction of 9.01 % was observed in Cyhalofop butyl. Among different doses of BAS 625 04 H, application of its 75 g a.i. ha^{-1} with MSO adjuvant and 55 g a.i. ha^{-1} with MSO adjuvant the least yield reduction (9.57%) as against its 35, 55, 75 g a.i. ha^{-1} and 35 g a.i. ha^{-1} with MSO adjuvant. The more grain yield reduction is obviously due to greater weed infestation which negatively affected the plant growth, yield attributes and yield of direct-seeded rice. On the other hand yield was relatively less reduced in the treatment having better weed control. Similar result was found by Mukherjee and Singh (2005).

Conclusion

Significantly higher values of yield attributes, grain yield, straw yield and harvest index were recorded under hand weeding twice (20 and 40 DAS) followed by Cyhalofop butyl, BAS 625 04 H @ 75 g a.i. ha^{-1} with MSO adjuvant and @ 55 g a.i. ha^{-1} with MSO adjuvant.

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