

Effect of new molecules of herbicide on weed infestation, growth and yield of kharif Rice

ABSTRACT

The research was conducted to study the effect of different herbicides on weed infestation, growth and yield of kharif rice. Field trial was conducted during the kharif season of 2020 at the Instructional Farm, Jaguli, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, under a randomized block design with nine treatment combinations. The variety Satabdi (IET-4786) was selected for the experiment and transplanted with the spacing of 20 cm × 10 cm. Treatments included various doses of UPH-814, a combination of bensulfuron methyl and pretilachlor, pyrazosulfuron ethyle, pretilachlor and hand weeding. The predominant weed species included *Cynodactylon*, *Echinochloa spp.*, *Cyperus spp.*, and various broadleaved weeds. Results showed that hand weeding achieved the lower weed population at all growth stages, among herbicidal treatments, particularly the combination of bensulfuron methyl and pretilachlor (T₆) and UPH-814 (T₃), were highly effective in controlling weed flora without phytotoxic effects on rice. Among all the herbicidal treatments minimum weed population at 30 DAS, 45 DAS, 60 DAS obtained in T₃, pre-emergence application of UPH 814 (S) @ 2500 g ha⁻¹. These treatments also resulted in the highest dry matter accumulation (810.90 g/m²) at the time of harvest, grain and straw yields, with T₆, Bensulfuron methyl 0.6%+ Pretilachlor 6% GR @10000 g/ha achieving a grain yield of 3.67 t/ha and a straw yield of 4.31 t/ha. Thus, UPH-814 and the combination of bensulfuron methyl and pretilachlor are promising options for effective weed management in kharif rice, contributing to higher yield outcomes.

Key word: New herbicide molecules; weed population; weed control efficiency; transplanted kharif rice; yield.

1. INTRODUCTION:

Rice (*Oryza sativa*) is the staple food of a billion people worldwide. It is the life- blood of Asia-Pacific region where 56 % of human lives and consumed more than 90 % of the world rice (FAO, 2014). Rice is the staple food for more than 60% of the world's population and in Asia more than 90% of this rice is consumed (Fukagawa, 2019). In India, there are various factor behind lower rice production, among them weed infestation is an important factor. Under low-land ecosystems, heterogeneous weed flora infested

transplanted rice which reduced up to 48 per cent rice grain yield, accounting for a yearly loss of 15 million tonnes due to crop weed competition (Saha, 2009). For successful rice production, provision of weed free environment and crop-weed competition prevention is necessary at the critical period of rice growth either by physical methods or through herbicide. Manual weeding is a common weed control practice among the farmers which gives a good result, but it consumes huge number of farmer and also it is a time-consuming process. Therefore, application of herbicide is effective and viable option for weed management in rice. Several pre- and post- emergence herbicides provide good control of weeds in transplanted rice but due to continuous use of such herbicides, shifting of weed flora and evolution of herbicide resistant weeds has been observed (Rajkhowa et al, 2006). Hence, new herbicide molecules evaluation for the control of weed flora in wide spectrum is imperative. In this context, such new herbicide molecules viz. pyrazosulfuron-ethyl, pretilachlor, mixture of bensulfuron methyl and pretilachlor, UPH-814 (pyrazosulfuron-ethyl 0.75% and pretilachlor 30% WG) etc. are evaluated to find out the effectiveness in weed control in transplanted puddle rice. Bensulfuron methyl + pretilachlor is a new herbicide combination which has effective control of grasses, broadleaved weeds and sedges in rice when applied at 3 DAT. It has been found in rice for controlling complex weed flora without any phytotoxic symptoms in the crop (Sunil *et al.* 2010). UPH-814 is a combination of pyrazosulfuron-ethyl 0.75% and pretilachlor 30% WG. M/s UPL Ltd, Mumbai provided certified reference materials (with a 95% purity level) of pyrazosulfuron-ethyl and pretilachlor, with a formulation of pyrazosulfuron-ethyl 0.75% + pretilachlor 30% WG (UPH-814).

2. Materials and Methods:

A field experiment was conducted in humid sub-tropic climate during the kharif season of 2020 at Instructional farm, Jaguli, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal. The experimental site was situated just south of tropic of cancer at 22°56' N latitude, 88°32' E longitude with an elevation of 9.75 meter above MSL (mean sea level). The experiment was conducted on gangetic alluvium soil in July and August. The soil was well-drained, had a good textural makeup, homogeneous fertility, and uniform topography with moderate temperature. The experiment was laid out in Randomized Block Design (RBD) with nine treatment combinations and replicated thrice. Treatments are T₁-UPH-814(S) 1500 gha⁻¹; T₂-UPH-814(S) 2000 gha⁻¹; T₃-UPH-814(S) 2500 gha⁻¹; T₄-Pyrazosulfuron ethyl 10 % WP 150 g ha⁻¹; T₅-Pretilachlor 50 % EC 1500 ml ha⁻¹; T₆-Bensulfuron methyl 0.6 % + Pretilachlor 6 % GR 10000 gha⁻¹; T₇- Hand weeding 20 & 40 DAT; T₈-Weedy check (control plot) and T₉-UPH- 814 (S) 4000 gha⁻¹. The variety Satabdi (IET-4786) was selected for the experiment, sown on 10th June 2020 and transplanted with the spacing of 20 cm × 10 cm. Urea, SSP (Single Super Phosphate) and MOP (Muriate of Potash) were applied with recommended doses of N: P₂O₅: K₂O @ 60:30:30 kg ha⁻¹. Weed control efficiency (%) is calculated by using below formula:

$$\text{Weed control efficiency (\%)} = \frac{\text{DWC} - \text{DWT}}{\text{DWT}} \times 100$$

Whereas, DWC = Dry weight of weed in un-weeded plot (g m^{-2})

DWT = Dry weight of weed in control plot (g m^{-2})

The all parameters of the collected data from the field experiment were subjected to analyze statistically to the designed Randomized Block Design (RBD) by following the procedure laid out by Gomez and Gomez (1984).

3. RESULT AND DISCUSSION

3.1 Weed parameters

3.1.1 **Weed flora:**

Different types of weed flora were observed during growing season of the rice crop under this experiment. The predominant observed grasses were *Cynodon dactylon*, *Echinochloa colona*, *Echinochloa glabrescens*, sedges were *Cyperus rotundus*, *Cyperus difformis*, *Scirpus validus*, *Fimbristylis miliacea* and broad-leaved weeds were *Ammannia baccifera* L., *Marsilea quadrifolia*, *Eclipta alba*, *Ipomea aquatica*, *Commelinadiffusa* etc.

3.1.2 **Weed population:**

Hand weeding shows lower weed population at all growth stages of rice, the main reason behind it, is timely uprooting of weed species. The outcomes agree with the conclusions made by Dhaker et al. (2022). Among all the herbicidal treatments minimum weed population at 30 DAS, 45 DAS, 60 DAS obtained in T₃ (Pre-emergence application of UPH 814 (S) @ 2500 g ha⁻¹) which was at par with T₆ (Pre-emergence application of bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10000 g ha⁻¹). Pretilachlor and pyrazosulfuron ethyl, two systemic and selective herbicides, are primarily used to control annual grass, sedge, and broadleaf weeds in transplanted and direct seeded rice. In the early growth stages of weed plants, pyrazosulfuron ethyl is absorbed by the root, shoot, and translocated through the phloem. After a week of absorption, the weed plants exhibit chlorosis and then necrosis. Pretilachlor is another herbicide that is readily absorbed, translocated, affects germinated weed species, and prevents cell division and elongation in seedling shoots by blocking protein synthesis. These two herbicides work better in the field when applied in combination as pyrazosulfuron-ethyl 0.75% and pretilachlor 30% WG which is named as UPH-814 than when administered alone, and they have a strong inhibitory effect on the combined weed flora of transplanted plants, (Dibyendu et al. 2018). At 30 DAS, 45 DAS, 60 DAS significantly higher weed population obtained in weedy check (control) which significantly differed from all other herbicidal treatments. This could be because weed and the crop are competing more for nutrients, light, space, and carbon dioxide (Tindall et al. 2005) (Table 1).

3.1.3 **Weed dry weight:**

At 30 DAT the highest weed dry weight (20.85 g m⁻²) was recorded from T₈ (weedy check) which significantly differed with all other treatments and the lowest total weed dry matter (4.26 g m⁻²) was registered from T₇ (Hand weeding 20 &40 days after sowing). Among the herbicidal treatments the lowest value was observed in pre-emergence application of bensulfuron methyl 0.6%+ pretilachlor 6% GR @ 10000 ml ha⁻¹(T₆)(4.27 g m⁻²) which was at par with T₃ (4.30 g m⁻²) (Pre-emergence application of UPH 814 (S) @2500 mlha⁻¹). These findings were in accordance with previous studies Tejaet *al.*(2015). At 45 DAT, T₆(5.16 g m⁻²) was recorded significantly lowest total weed biomass which was atpar with T₃(5.20 g m⁻²). Andalso, there is no significant difference with hand weeding 20 &40 days after sowing (T₇) (5.18g m⁻²).Unweededcontrol had highest (25.54 g m⁻²) weed population than all othertreatments. At 60 DAT the minimum total dry weight of weed recorded in the treatment T₃ (5.35 g m⁻²) and maximum biomass observed in T₈ (29.81 g m⁻²), which is control plot. Among the all-treatments lower weed biomass recorded in T₃ (5.35 g m⁻²) which is statistically at par with T₇hand weeding 20 & 40 DAT and T₆ (Pre-emergence application of bensulfuron methyl 0.6%+ pretilachlor 6% GR @ 10000 mlha⁻¹) (Table 1).

3.1.4 **Weed control efficiency:**

Among all the herbicidal treatments highest weed control efficiency (74.79 %) was achieved by the treatment T₆ (Pre-emergence application of bensulfuron methyl 0.6% + pretilachlor 6% GR @ 10000 ml ha⁻¹) that was statistically at par with T₃(Pre-emergence application of UPH 814 (S) @2500 ml ha⁻¹ & T₇ (Hand weeding at 20& 40 DAT) at all the growth stages (Table 1). Mishra K. (2019) also reported highest weed control efficiency with the application of bensulfuron methyl and pretilachlor.

Table 1. Effect of different herbicidal treatments on total weed density (no. m⁻²), total weed dry weight (g m⁻²) and weed control efficiency in Kharif rice during 2020.

Treatment details	Total Weed Density (number m ⁻²)			Total Weed Dry Weight (g m ⁻²)			Weed Control Efficiency (%)		
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS
T ₁ : Pre-emergence application of UPH 814 (S) 1500 ml/ha	4.72 (21.87)	5.56 (30.47)	6.57 (42.68)	8.93	10.93	13.10	56.95	57.20	56.05
T ₂ : Pre-emergence application of UPH 814 (S) 2000 ml/ha	4.71 (21.72)	6.07 (36.39)	7.07 (49.55)	8.81	11.56	13.50	57.74	54.81	53.67
T ₃ : Pre-emergence application of UPH 814 (S) 2500 ml/ha	3.31 (10.52)	3.48 (11.67)	3.74 (13.53)	4.30	5.20	5.35	73.37	75.72	75.34
T ₄ : Pyrazosulfuron ethyl 10% WP 150g/ha at 2-7 days after sowing	3.83	4.71	5.62	6.51	8.71	11.17	68.77	65.89	62.52

	(14.21)	(21.71)	(31.13)							
T ₅ : Pre-emergence application of Pretilachlor 50% EC 1500 ml/ha	4.04 (15.87)	5.37 (28.37)	6.64 (43.72)	7.69	10.15	12.04	63.11	60.25	59.61	
T ₆ : Pre-emergence application of Bensulfuron methyl 0.6%+ Pretilachlor 6% GR @10000 g/ha	3.39 (11.00)	3.61 (7.97)	3.79 (13.91)	4.27	5.16	5.73	74.79	79.79	80.77	
T ₇ : Hand weeding 20 &40 days after sowing	3.36 (10.83)	4.25 (17.64)	4.77 (21.72)	4.26	5.18	6.95	74.77	74.80	75.00	
T ₈ : Weedy check (Control)	7.42 (54.66)	8.84 (77.69)	11.63 (134.8)	20.85	25.54	29.81	00	00	00	
T ₉ : Pre-emergence application of UPH 814(S) 4000ml/ha	4.77 (21.72)	6.07 (36.39)	7.07 (49.55)	9.89	11.63	13.39	52.56	54.46	55.08	
SEm((±))	0.27	0.28	0.36	0.53	0.63	0.65	2.18	2.29	2.00	
C.D(P=0.0 5)	0.73	0.81	1.05	1.59	1.89	1.90	6.44	6.76	5.90	

*Data in parenthesis are square root transformed value ($\sqrt{X+0.5}$) and used for statistical analysis.

3.2 Crop Growth parameter:

Among the all treatments at maturity stage significantly maximum plant height was obtained with T₃ (86.93 cm) which is statistically at par with T₆ (83.80 cm) and also comparable with T₇ (H. W 20 & 40 DAS) (83.12 cm) (Table 2). At the time of harvesting lowest plant height was observed in control plot which is 74.66 cm. From 30 DAT to 90 DAT, weedy check (T₈) having the lower dry matter accumulation which increased appreciably at all the growth intervals. Pre-emergence application of UPH 814 (S) 2000 ml ha⁻¹ (T₃) recorded the higher dry matter accumulation (207.29 g m⁻², 569.19 g m⁻², and 733.13 g m⁻² at 30, 60, and 90 DAT respectively) followed by T₆ & T₇ from 30 DAT to 90 DAT over the other treatments (Table 2). The maximum no of tillers m⁻² at the time of maturity was recorded in T₆ followed by T₃, T₇. Teja et al. (2015) reported that plant height, no of tiller m⁻² was highest in hand weeding and application of bensulfuron methyl and pretilachlor.

Table 2: Effect of different herbicidal treatments on growth parameters, yield and yield attributes in Kharif rice during 2020.

Treatment details	Dry matter accumulation (g m ⁻²)			At harvest								
	30 DAS	45 DAS	60 DAS	Plant height (cm)	No. of tiller / m ⁻²	Effective tiller m ⁻²	Panicle length (cm)	Grains panicle ⁻¹	1000 seed weight	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Harvest Index (%)
T1: Pre-emergence application of UPH 814 (S)1500 ml/ha	180.87	464.95	641.43	77.86	511.00	314.79	22.22	127.54	18.48	2.87	3.87	43.15
T2: Pre-emergence application of UPH 814 (S) 2000 ml/ha	174.96	530.56	768.39	75.30	506.00	304.69	22.03	125.40	18.39	2.77	3.67	43.12
T3: Pre-emergence application of UPH 814 (S) 2500 ml/ha	207.29	569.19	733.13	86.93	603.33	351.22	23.80	143.13	19.04	3.65	4.29	45.96

T4: Pyrazosulfuron ethyl 10% WP 150g/ha at 2-7 days after sowing	189.0 2	528.27	733.13	78.81	541.0 0	327.60	22.37	128.93	18.56	3.29	4.00	45.35
T5: Pre-emergence application of Pretilachlor 50% EC 1500 ml/ha	182.3 7	487.11	682.10	78.52	511.6 7	320.20	22.22	128.40	18.52	2.93	3.81	43.47
T6: Pre-emergence application of Bensulfuron methyl 0.6%+ Pretilachlor 6% GR @10000 g/ha	204.7 1	565.77	810.90	85.80	610.0 0	346.43	23.90	138.50	19.01	3.67	4.31	45.98
T7: Hand weeding 20 &40 days after sowing	202.9 5	560.56	800.30	83.12	598.0 0	340.10	23.70	132.43	18.85	3.47	4.23	45.24
T8: Weedy check (Control)	165.1 9	361.84	510.50	74.66	500.8 3	272.75	19.33	108.16	18.28	2.26	3.20	42.30
T9: Pre-emergence application of UPH 814(S) 4000ml/ha	175.1 2	433.54	625.03	76.70	504.0 0	295.38	22.17	124.10	18.45	2.83	3.75	43.03
SEm((±)	3.78	8.72	12.78	1.24	10.94	7.99	0.36	4.63	0.33	0.11	0.12	-
C.D(P=0.0 5)	11.46	26.4 6	37.38	3.68	32.52	23.38	1.07	13.77	NS	0.34	0.37	NS

3.3 Yield and yield attributes:

Effective tiller m^{-2} , number of grains panicle $^{-1}$ were recorded in pre-emergence application of UPH 814(S) @ 2500 ml ha^{-1} (T_3) which is statistically at par with T_6 (Pre-emergence application of bensulfuron methyl 0.6%+pretilachlor 6% GR 10000 ml ha^{-1}) and T_7 (Hand weeding). These findings were in accordance with previous studies by Dibyenduet *al.* (2018). During the experimentation the highest panicle length (23.90cm)wasobservedin T_6 whichsignificantlynotvariedwith T_3 (UPH814(S) @2500ml ha^{-1}) and T_7 (handweeding) and the lowest was recorded in T_8 treatment (19.33 cm) (Table 2). Harvest index was an indicator of crop performance and it was the coefficient of effectiveness of the crop. Generally, the yield of the crop was dependent on the total dry matter production. The harvest index of the rice crop during the experimentation varied between 42.30 % to 45.98 % and the maximum value had been recorded in the treatment T_6 (Pre-emergence application of bensulfuron methyl 0.6%+ pretilachlor 6% GR 10000 ml ha^{-1}) and the lowest value was registered in the treatment T_8 (weedy check).The maximum grain yield (3.67 t ha^{-1}) was recorded in treatment T_6 (Pre-emergence application of bensulfuron methyl 0.6% + pretilachlor 6% GR 10000 ml ha^{-1}) which has no significant difference with T_3 (Pre-emergence application of UPH 814 (S) 2500 ml ha^{-1}) (3.65 t ha^{-1}) and T_7 (H.W 20 & 40 DAT) (3.47 t ha^{-1}) and the lowest grain yield was noticed in treatment T_8 (weedy check).Saha and Rao (2010) confirmed about the higher yield of rice by application of Bensulfuron methyl and Pretilachlor application.The maximum straw yield (4.31 t ha^{-1}) was recorded in treatment T_6 (Pre-emergence application of bensulfuron methyl 0.6%+ pretilachlor 6% GR 10000 ml ha^{-1}) which has no significant difference with T_3 (Pre-emergence application of UPH 814 (S) 2500 ml ha^{-1}) (4.29 t ha^{-1}) and T_7 (H.W 20 &40 DAT) (4.23 t ha^{-1}) (Table 2).Sunil *et al.* (2010) reported that pre-emergence application of bensulfuronmethyl + pretilachlor recorded significantly higher grain and straw yield, lower weed population and dry weight. The harvest index of the rice crop during the experimentation variedbetween 42.30 % to 45.98 % and the maximum value had been recorded

in the treatment T₆ (Pre-emergence application of bensulfuron methyl 0.6%+ pretilachlor 6% GR 10000 ml ha⁻¹) and the lowest value was registered in the treatment T₈ (weedy check).

4. Conclusion:

Based on the findings in respect of weed management, it may be concluded that for appreciable growth, grain yield and good economic returns, pre-emergence application of either new molecule UPH 814 (S) @ 2500 g ha⁻¹ or bensulfuron methyl 0.6%+ pretilachlor 6% GR 10000 g ha⁻¹ or hand weeding twice at 20 and 40 DAT may be recommended for weed control in transplanted kharif rice depending on timely availability of labour, chemical herbicide and capital at hand.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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