

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 *Cynodon dactylon*, *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 (T_6) which result highest weed control efficiency at 60 DAT (80.77%) and UPH-814 (T_3), were highly effective in controlling weed flora. Among all the herbicidal treatments minimum weed population at 30 DAS, 45 DAS, 60 DAS obtained in T_3 , 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 T_6 , 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.

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) [1]. 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) [2]. 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

35 infested transplanted rice which reduced up to 48 per cent rice grain yield, accounting for a yearly loss of
36 15 million tonnes due to crop weed competition(Saha, 2009)[3]. For successful rice production, provision
37 of weed free environment and crop-weed competition prevention is necessary at the critical period of rice
38 growth either by physical methods or through herbicide. Manual weeding is a common weed control
39 practice among the farmers which gives a good result, but it consumes huge number of farmer and also it
40 is a time-consuming process. Therefore, application of herbicide is effective and viable option for weed
41 management in rice. Several pre- and post- emergence herbicides provide good control of weeds in
42 transplanted rice but due to continuous use of such herbicides, shifting of weed flora and evolution of
43 herbicide resistant weeds has been observed (Rajkhowa et al, 2006) [4]. Hence, new herbicide molecules
44 evaluation for the control of weed flora in wide spectrum is imperative. In this context, such new herbicide
45 molecules viz. pyrazosulfuron-ethyl, pretilachlor, mixture of bensulfuron methyl and pretilachlor, UPH-814
46 (pyrazosulfuron-ethyl 0.75% and pretilachlor 30% WG) etc. are evaluated to find out the effectiveness in
47 weed control in transplanted puddle rice. Bensulfuron methyl + pretilachlor is a new herbicide combination
48 which has effective control of grasses, broadleaved weeds and sedges in rice when applied at 3 DAT. It
49 has been found in rice for controlling complex weed flora without any phytotoxic symptoms in the crop
50 (Sunil *et al.* 2010) [5]. UPH-814 is a combination of pyrazosulfuron-ethyl 0.75% and pretilachlor 30% WG.
51 M/s UPL Ltd, Mumbai provided certified reference materials (with a 95% purity level) of pyrazosulfuron-
52 ethyl and pretilachlor, with a formulation of pyrazosulfuron-ethyl 0.75% + pretilachlor 30% WG (UPH-814).

53 2. MATERIALS AND METHODS:

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55 A field experiment was conducted in humid sub-tropic climate during the kharif season of 2020 at
56 Instructional farm, Jaguli, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal. The
57 experimental site was situated just south of tropic of cancer at 22°56' N latitude, 88°32' E longitude with an
58 elevation of 9.75 meter above MSL (mean sea level). The experiment was conducted on gangetic
59 alluvium soil in July and August. The soil was well-drained, had a good textural makeup, homogeneous
60 fertility, and uniform topography with moderate temperature. The experiment was laid out in Randomized
61 Block Design (RBD) with nine treatment combinations and replicated thrice. Treatments are T₁-UPH-
62 814(S) 1500 gha⁻¹; T₂-UPH-814(S) 2000 gha⁻¹; T₃-UPH-814(S) 2500 gha⁻¹; T₄-Pyrazosulfuron ethyl 10 %
63 WP 150 g ha⁻¹; T₅-Pretilachlor 50 % EC 1500 ml ha⁻¹; T₆-Bensulfuron methyl 0.6 % + Pretilachlor 6 % GR
64 10000 gha⁻¹; T₇- Hand weeding 20 & 40 DAT; T₈-Weedy check (control plot) and T₉-UPH- 814 (S) 4000
65 gha⁻¹. The variety Satabdi (IET-4786) was selected for the experiment, sown on 10th June
66 2020 and transplanted with the spacing of 20 cm × 10 cm. Urea, SSP (Single Super Phosphate) and MOP
67 (Muriate of Potash) were applied with recommended doses of N: P₂O₅: K₂O @ 60:30:30 kg ha⁻¹. Weed
68 control efficiency (%) is calculated by using below formula:

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

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

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

72 The all parameters of the collected data from the field experiment were subjected to analyze
73 statistically to the designed Randomized Block Design (RBD) by following the procedure laid out by
74 Gomez and Gomez (1984) [6].

75 **3. RESULT AND DISCUSSION**

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77 **3.1 Weed parameters**

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79 **3.1.1 Weed flora:**

80 Different types of weed flora were observed during growing season of the rice crop under this
81 experiment. The predominant observed grasses were *Cynodondactylon*, *Echinochloacolona*,
82 *Echinochloaglabrescence*, sedges were
83 *Cyperusrotundus*, *Cyperusdifformis*, *Scirpusvalidus*, *Fimbristylismiliacea* and broad-leaved
84 weeds were *Ammanniabaccifera L.*, *Marsileaquadrifolia*, *Eclipta alba*, *Ipomeaaquatica*,
85 *Commelinadiffusa* etc.

86 **3.1.2 Weed population:**

87 Hand weeding shows lower weed population at all growth stages of rice, the main reason
88 behind it, is timely uprooting of weed species. The outcomes agree with the conclusions made
89 by Dhaker *et al.* (2022) [7]. Among all the herbicidal treatments minimum weed population at
90 30 DAS, 45 DAS, 60 DAS obtained in T₃ (Pre-emergence application of UPH 814 (S) @ 2500
91 g ha^{-1}) which was at par with T₆ (Pre-emergence application of bensulfuron methyl 0.6% +
92 pretilachlor 6% GR @ 10000 g ha^{-1}). These observations are supported by Suganya *et al.*
93 (2022) [8]. Pretilachlor and pyrazosulfuron ethyl, two systemic and selective herbicides, are
94 primarily used to control annual grass, sedge, and broadleaf weeds in transplanted and direct
95 seeded rice. In the early growth stages of weed plants, pyrazosulfuron ethyl is absorbed by
96 the root, shoot, and translocated through the phloem. After a week of absorption, the weed
97 plants exhibit chlorosis and then necrosis. Pretilachlor is another herbicide that is readily
98 absorbed, translocated, affects germinated weed species, and prevents cell division and
99 elongation in seedling shoots by blocking protein synthesis. These two herbicides work better
100 in the field when applied in combination as pyrazosulfuron-ethyl 0.75% and pretilachlor 30%
101 WG which is named as UPH-814 than when administered alone, and they have a strong
102 inhibitory effect on the combined weed flora of transplanted plants, (Monda *et al.* 2018) [9]. At
103 30 DAS, 45 DAS, 60 DAS significantly higher weed population obtained in weedy check
104 (control) which significantly differed from all other herbicidal treatments. This could be

105 because weed and the crop are competing more for nutrients, light, space, and carbon
 106 dioxide (Tindall et al. 2005) [10] (Table 1).

107 **3.1.3 Weed dry weight:**

108 At 30 DAT the highest weed dry weight (20.85 g m⁻²) was recorded from T₈ (weedy check)
 109 which significantly differed with all other treatments and the lowest total weed dry matter
 110 (4.26 g m⁻²) was registered from T₇ (Hand weeding 20 &40 days after sowing).Among the
 111 herbicidal treatments the lowest value was observed in pre-emergence application of
 112 bensulfuron methyl 0.6%+ pretilachlor 6% GR @ 10000 ml ha⁻¹(T₆)(4.27 g m⁻²) which was at
 113 par with T₃ (4.30 g m⁻²) (Pre-emergence application of UPH 814 (S) @2500 mlha⁻¹). These
 114 findings were in accordance with previous studies Tejaet *al.*(2015) [11]. At 45 DAT, T₆(5.16 g
 115 m⁻²) was recorded significantly lowest total weed biomass which was atpar with T₃(5.20 g m⁻²).
 116 Andalso, there is no significant difference with hand weeding 20 &40 days after sowing
 117 (T₇) (5.18g m⁻²).Unweededcontrol had highest (25.54 g m⁻²) weed population than all
 118 othertreatments. At 60 DAT the minimum total dry weight of weed recorded in the treatment
 119 T₃ (5.35 g m⁻²) and maximum biomass observed in T₈ (29.81 g m⁻²), which is control plot.
 120 Among the all-treatments lower weed biomass recorded in T₃ (5.35 g m⁻²) which is statistically
 121 at par with T₇hand weeding 20 & 40 DAT and T₆ (Pre-emergence application of bensulfuron
 122 methyl 0.6%+ pretilachlor 6% GR @ 10000 mlha⁻¹) (Table 1).

123 **3.1.4 Weed control efficiency:**

124 Among all the herbicidal treatments highest weed control efficiency (74.79 %) was achieved
 125 by the treatment T₆ (Pre-emergence application of bensulfuron methyl 0.6% + pretilachlor 6%
 126 GR @ 10000 ml ha⁻¹) that was statisticallyat par with T₃(Pre-emergence application of UPH
 127 814 (S) @2500 ml ha⁻¹& T₇ (Hand weeding at 20& 40 DAT) at all the growth stages (Table 1).
 128 Mishra K. (2019) [12] also reported highest weed control efficiency with the application of
 129 bensulfuron methyl and pretilachlor.

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 131 **Table 1. Effect of different herbicidal treatments on total weed density (no. m⁻²),**
 132 **total weed dry weight (g m⁻²) and weed control efficiency in Kharif rice during**
 133 **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	3.31	3.48	3.74	4.30	5.20	5.35	73.37	75.72	75.34

814 (S) 2500 ml/ha	(10.52)	(11.67)	(13.53)							
T ₄ : Pyrazosulfuron ethyl 10% WP 150g/ha at 2-7 days after sowing	3.83 (14.21)	4.71 (21.71)	5.62 (31.13)	6.51	8.71	11.17	68.77	65.89	62.52	
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.

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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) [11] reported that plant height, no of tiller m⁻² was highest in hand weeding and application of bensulfuron methyl and pretilachlor.

148 **Table 2: Effect of different herbicidal treatments on growth parameters, yield and yield**
149 **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	174.9 6	530.56	768.39	75.30	506.0 0	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	207.2 9	569.19	733.13	86.93	603.3 3	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

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151 3.3 Yield and yield attributes:

152 Effective tiller m^{-2} , number of grains panicle $^{-1}$ were recorded in pre-emergence application of UPH
153 814(S) @ 2500 ml ha^{-1} (T₃) which is statistically at par with T₆ (Pre-emergence application of
154 bensulfuron methyl 0.6%+pretilachlor 6% GR 10000 ml ha^{-1}) and T₇ (Hand weeding). These
155 findings were in accordance with previous studies by Dibyenduet *al.* (2018) [9]. During the
156 experimentation the highest panicle length (23.90cm)wasobservedinT₆
157 whichsignificantlynotvariedwithT₃(UPH814(S) @2500ml ha^{-1}) and T₇(handweeding) and the
158 lowest was recorded in T₈ treatment (19.33 cm) (Table 2). Harvest index was an indicator of crop
159 performance and it was the coefficient of effectiveness of the crop. Generally, the yield of the crop
160 was dependent on the total dry matter production. The harvest index of the rice crop during the
161 experimentation varied between 42.30 % to 45.98 % and the maximum value had been recorded
162 in the treatment T₆ (Pre-emergence application of bensulfuron methyl 0.6%+ pretilachlor 6% GR
163 10000 ml ha^{-1}) and the lowest value was registered in the treatment T₈ (weedy check).The
164 maximum grain yield (3.67 t ha^{-1}) was recorded in treatment T₆ (Pre-emergence application of
165 bensulfuron methyl 0.6% + pretilachlor 6% GR 10000 ml ha^{-1}) which has no significant difference
166 with T₃(Pre-emergence application of UPH 814 (S) 2500 ml ha^{-1}) (3.65 t ha^{-1}) and T₇(H.W 20 &
167 40 DAT) (3.47 t ha^{-1}) and the lowest grain yield was noticed in treatment T₈ (weedy check).Saha
168 and Rao (2010) [13] confirmed about the higher yield of rice by application of Bensulfuron methyl
169 and Pretilachlor application.Findings of Patel *et al.* (2024) [14] supported that theyield obtained in
170 T₃ and T₇treatments are not significant. The maximum straw yield (4.31 t ha^{-1}) was recorded in
171 treatment T₆ (Pre-emergence application of bensulfuron methyl 0.6%+ pretilachlor 6% GR 10000
172 ml ha^{-1}) which has no significant difference with T₃ (Pre-emergence application of UPH 814 (S)

173 2500 ml ha⁻¹) (4.29 t ha⁻¹) and T₇ (H.W 20 &40 DAT) (4.23 t ha⁻¹) (Table 2).Sunil *et al.* (2010) [5]
174 reported that pre-emergence application of bensulfuronmethyl + pretilachlor recorded significantly
175 higher grain and straw yield, lower weed population and dry weight. The harvest index of the rice
176 crop during the experimentation variedbetween 42.30 % to 45.98 % and the maximum value had
177 been recorded in the treatment T₆ (Pre-emergence application of bensulfuron methyl 0.6%+
178 pretilachlor 6% GR 10000 ml ha⁻¹) and the lowest value was registered in the treatment T₈
179 (weedy check).

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181 **4. CONCLUSION:**

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

187

188 **DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

189 **Option 1:**

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

193

194 **COMPETING INTERESTS**

195 Authors have declared that no competing interests exists.

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