



## Broad-spectrum weed management in wet-seeded rice by pre-mix herbicide combinations

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### Article information

DOI: 10.5958/0974-8164.2020.00074.X

Type of article: Research note

Received : 27 July 2020

Revised : 24 October 2020

Accepted : 27 October 2020

### Key words

Herbicide combinations, Weed management, Wet seeded rice, Yield

### ABSTRACT

Three pre-mix herbicide combinations at two different times of application, viz. pendimethalin + penoxsulam at 5 and 10 DAS, cyhalofop-butyl + penoxsulam and florpyrauxifen-benzyl + cyhalofop-butyl both applied at 12 and 18 DAS were evaluated along with sequential spray of cyhalofop-butyl *fb* chlorimuron-ethyl 10% + metsulfuron-methyl 10% at 18 and 19 DAS, bispyribac-sodium at 18 DAS, hand weeding at 20 and 40 DAS and unweeded control. At 30 DAS, the lowest weed dry matter and highest weed control efficiency was obtained with application of florpyrauxifen-benzyl + cyhalofop-butyl (150 g/ha) at 12 DAS. The highest numbers of yield attributes and crop yields in rice were recorded in hand weeding followed by florpyrauxifen-benzyl + cyhalofop-butyl at 12 DAS and pendimethalin + penoxsulam (625 g/ha) at 5 DAS.

In wet seeded rice culture, weed growth occurs throughout the season causing yield reduction of about 65% compared to weed-free situation (Mukherjee *et al.* 2008). Application of pre-mix herbicides in a single spray to control a broad spectrum of weeds is a viable option and nowadays several new commercial herbicides are available in markets.

In this study, an attempt to assess the effectiveness of three new pre-mix herbicides was made. The study was conducted during October 2019 to January 2020 in *Kole* areas of Alappad, Thrissur district (Kerala). The soil was clayey and belonged to Inceptisols with 1.2% organic carbon and pH 4.7. Available N, P and K content of soil were 178.3, 20.5 and 142.1 kg/ha, respectively. Pre-germinated seeds of rice variety '*Manuramna*' (100 days' duration) was broadcasted at the rate of 80 kg/ha. Plot size adopted was 20 m<sup>2</sup>.

The experiment was laid out in randomized complete block design with 10 treatments replicated thrice. Three pre-mix herbicides applied at two different times, viz. pendimethalin + penoxsulam 625 g/ha at 5 and 10 DAS, cyhalofop-butyl + penoxsulam 135 g/ha at 12 and 18 DAS, and florpyrauxifen-benzyl + cyhalofop-butyl 150 g/ha at 12 and 18 DAS were evaluated along with sequential spray of

cyhalofop-butyl 80 g/ha *fb* chlorimuron-ethyl 10% + metsulfuron-methyl 10% (8 g/ha) at 18 and 19 DAS, alone bispyribac-sodium 25 g/ha at 18 DAS, hand weeding at 20 and 40 DAS and unweeded check. All the herbicides were applied using 500 litres of water per hectare with knapsack sprayer.

At sampling time (30 and 60 DAS), weed dry weight was determined by placing 0.25 m<sup>2</sup> quadrat randomly at each plot, where the weeds were uprooted, cleaned and dried at 70°C for 48 hours. Weed control efficiency was calculated as per the standard formula. At harvest, number of panicles/m<sup>2</sup>, grains per panicle, percentage of filled grains, test weight (g) and crop yields (t/ha) were recorded along with computing harvest index. Statistical processing of data was done with OPSTAT (Sheoran *et al.* 1998) to evaluate the difference between treatments.

### Weed flora

The major weed species found in the study area were grasses comprised mainly of weedy rice (*Oryza sativa* f. *spontanea*), *Echinochloa stagnina* and *Leptochloa chinensis*; Sedges, composed of *Cyperus* spp and *Fimbristylis miliacea* as well as broad-leaf weeds such as *Ludwigia perennis*, *Limnophila heterophylla* and *Eichhornia crassipes* were also found.

### Weed dry matter production (WDMP)

At 30 DAS, the lowest WDMP was acquired in floryprauxifen-benzyl + cyhalofop-butyl (150 g/ha) sprayed at 12 DAS, followed by same herbicide applied at 18 DAS (**Table 1**). Among herbicide treatments, highest WDMP was in bispyribac-sodium (probably due to resistant biotypes of *Leptochloa chinensis*). By 60 DAS, the lowest WDMP was recorded in hand weeding followed by floryprauxifen-benzyl + cyhalofop-butyl (150 g/ha) at 12 DAS and pendimethalin + penoxsulam (625 g/ha) at 5 DAS.

At 30 DAS, the herbicide combinations pendimethalin + penoxsulam at 10 DAS, cyhalofop-butyl + penoxsulam at 18 DAS, and floryprauxifen-benzyl + cyhalofop-butyl at 12 DAS recorded less WDMP. However, at 60 DAS lowest WDMP was recorded in pendimethalin + penoxsulam at 5 DAS, cyhalofop-butyl + penoxsulam and floryprauxifen-benzyl + cyhalofop-butyl, both at 12 DAS.

### Weed control efficiency (WCE)

At 30 DAS, highest WCE of 84.71% was recorded in floryprauxifen-benzyl + cyhalofop-butyl (150 g/ha) applied at 12 DAS. The treatments pendimethalin + penoxsulam (625 g/ha) at 5 and 10 DAS, and floryprauxifen-benzyl + cyhalofop-butyl at 18 DAS recorded WCE greater than 83% (**Table 1**). Sreedevi *et al.* (2020) recorded a WCE of 78% and 85% in rice in years 2015 and 2016 respectively with floryprauxifen-benzyl + cyhalofop-butyl (150 g/ha) sprayed at 20 DAS. At 60 DAS, highest WCE of 92.63% was observed in hand weeding followed by floryprauxifen-benzyl + cyhalofop-butyl at 12 DAS (82.96%) and pendimethalin + penoxsulam at 5 DAS (81.18%).

Comparing the time of application of pre-mix herbicides, it was seen that application of both pendimethalin + penoxsulam applied at 5 and 10 DAS and floryprauxifen-benzyl + cyhalofop-butyl at 12 and 18 DAS resulted in higher WCE values, ranging from 83 to 84% at 30 DAS and from 79 to 82% at 60 DAS. Cyhalofop-butyl + penoxsulam had slightly lower values ranging from 76 to 78% at 30 DAS and from 73 to 74% at 60 DAS.

### Yield attributes of rice

The highest number of panicles (221 and 216 no./m<sup>2</sup>), grains per panicle (120 and 118 no.) and percentage of filled grains per panicle (91.86% and 91.66%) in rice were seen in hand weeding and floryprauxifen-benzyl + cyhalofop-butyl (150 g/ha) at 12 DAS, respectively (**Table 2**) and it was followed by pendimethalin + penoxsulam (625 g/ha) at 5 DAS. The lowest values for all the yield attributes were recorded in unweeded control.

### Grain and straw yield

The highest grain yield of 4.6 t/ha was recorded in hand weeding followed by floryprauxifen-benzyl + cyhalofop-butyl (150 g/ha) at 12 DAS with 4.5 t/ha and pendimethalin + penoxsulam at 5 DAS with 4.43 t/ha (**Table 2**). All the pre-mix herbicides were superior to sequential spray of cyhalofop-butyl *fb* chlorimuron-ethyl 10% + metsulfuron-methyl 10%, bispyribac-sodium and unweeded control and this could be due to high WCE obtained at 30 DAS, which fell within the critical crop-weed competition period as reported by Singh *et al.* (2008). Straw yield followed the trend of grain yield and there was no significant difference between the treatments in terms of harvest index.

**Table 1. Effect of herbicide combinations on weed dry weight and weed control efficiency**

Treatment	Weed dry weight (kg/ha)		Weed control efficiency (%)	
	30 DAS	60 DAS	30 DAS	60 DAS
Pendimethalin + penoxsulam 625 g/ha at 5 DAS	37.00 <sup>de</sup>	246.60 <sup>f</sup>	83.98	81.18
Pendimethalin + penoxsulam 625 g/ha at 10 DAS	36.66 <sup>de</sup>	265.00 <sup>e</sup>	84.13	79.78
Cyhalofop-butyl + penoxsulam 135 g/ha at 12 DAS	54.33 <sup>bcd</sup>	336.60 <sup>d</sup>	76.48	74.31
Cyhalofop-butyl + penoxsulam 135 g/ha at 18 DAS	49.33 <sup>cde</sup>	346.60 <sup>c</sup>	78.65	73.55
Floryprauxifen-benzyl + cyhalofop-butyl 150 g/ha at 12 DAS	35.33 <sup>e</sup>	223.30 <sup>g</sup>	84.71	82.96
Floryprauxifen-benzyl + cyhalofop-butyl 150 g/ha at 18 DAS	35.66 <sup>de</sup>	263.30 <sup>e</sup>	84.56	79.90
Cyhalofop-butyl <i>fb</i> chlorimuron-ethyl 10% + metsulfuron-methyl 10% 80+8 g/ha at 18 and 19 DAS	72.66 <sup>bc</sup>	350.00 <sup>bc</sup>	68.55	73.29
Bispyribac-sodium 25 g/ha at 18 DAS	76.33 <sup>b</sup>	386.60 <sup>b</sup>	66.96	70.49
Hand weeding 20 and 40 DAS	42.33 <sup>de</sup>	96.60 <sup>h</sup>	81.68	92.63
Unweeded control	231.00 <sup>a</sup>	1310.26 <sup>a</sup>	-	-
LSD (p=0.05)	5.59	3.32	-	-

**Table 2. Effect of herbicide combinations on yield attributes and rice yields**

Treatment	Yield attributes of rice				Crop yields		
	Panicles per m <sup>2</sup>	Grains per panicle	Filled grains (%)	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index
Pendimethalin + penoxsulam 625 g/ha at 5 DAS	208.89 <sup>b</sup>	115.87 <sup>a</sup>	90.60 <sup>a</sup>	29.05	4.43 <sup>a</sup>	4.47 <sup>a</sup>	0.5
Pendimethalin + penoxsulam 625 g/ha at 10 DAS	198.44 <sup>d</sup>	106.65 <sup>c</sup>	89.05 <sup>a</sup>	28.71	4.29 <sup>ab</sup>	4.51 <sup>a</sup>	0.49
Cyhalofop-butyl + penoxsulam 135 g/ha at 12 DAS	204.96 <sup>c</sup>	109.76 <sup>b</sup>	90.44 <sup>a</sup>	29.08	4.38 <sup>ab</sup>	4.40 <sup>a</sup>	0.5
Cyhalofop-butyl + penoxsulam 135 g/ha at 18 DAS	191.76 <sup>e</sup>	108.32 <sup>c</sup>	89.73 <sup>a</sup>	28.37	4.24 <sup>ab</sup>	4.41 <sup>a</sup>	0.49
Florpyrauxifen-benzyl + cyhalofop-butyl 150 g/ha at 12 DAS	216.57 <sup>a</sup>	118.85 <sup>a</sup>	91.65 <sup>a</sup>	29.13	4.50 <sup>a</sup>	4.58 <sup>a</sup>	0.5
Florpyrauxifen-benzyl + cyhalofop-butyl 150 g/ha at 18 DAS	201.47 <sup>d</sup>	109.43 <sup>b</sup>	90.56 <sup>a</sup>	28.84	4.32 <sup>ab</sup>	4.48 <sup>a</sup>	0.49
Cyhalofop-butyl fb chlorimuron-ethyl 10% + metsulfuron-methyl 10% 80+8 g/ha at 18 and 19 DAS	187.91 <sup>f</sup>	106.89 <sup>c</sup>	88.32 <sup>a</sup>	28.19	3.52 <sup>bc</sup>	3.68 <sup>a</sup>	0.49
Bispyribac sodium 25 g/ha at 18 DAS	176.64 <sup>g</sup>	107.93 <sup>c</sup>	87.34 <sup>b</sup>	28.55	3.40 <sup>c</sup>	3.61 <sup>a</sup>	0.49
Hand weeding 20 and 40 DAS	221.47 <sup>a</sup>	120.13 <sup>a</sup>	91.86 <sup>a</sup>	29.20	4.60 <sup>a</sup>	4.67 <sup>a</sup>	0.5
Unweeded control	125.29 <sup>h</sup>	80.71 <sup>d</sup>	75.42 <sup>c</sup>	27.24	1.99 <sup>d</sup>	2.11 <sup>b</sup>	0.48
LSD (p=0.05)	6.04	5.88	4.31	NS	0.72	0.54	NS

With regard to time of herbicide application, highest yield attributes and crop yields were recorded in pendimethalin + penoxsulam at 5 DAS and cyhalofop-butyl + penoxsulam and florpyrauxifen-benzyl + cyhalofop-butyl, both at 12 DAS.

The pre-mix herbicides, viz. pendimethalin + penoxsulam (625 g/ha) at 5 and 10 DAS, cyhalofop-butyl + penoxsulam (135 g/ha) and florpyrauxifen-benzyl + cyhalofop-butyl (150 g/ha) both applied at 12 and 18 DAS performed effective against weeds and were adjudged as good as two hand weeding (20 and 40 DAS) with respect to grain and straw yields in wet direct-seeded rice in the *Kole* areas of Thrissur.

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