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Efficacy of Propanil against Weeds in Direct Seeded Rice and Its Effect on Succeding Crop

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Authors' contributions

This work was carried out in collaboration between all authors. Author YMR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MB and AKG managed the analyses of the study. Authors DK and MRU managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To assess the efficacy of propanil against weeds in direct seeded rice.
Place and Duration: A field study was conducted during *Kharif* 2015 and *summer* 2016, at Agricultural Research Station, Dhadesugur, University of Agricultural Sciences, Raichur, Karnataka, India.
Methodology: An investigation comprises of eight treatments and replicated thrice. The weeds which were dominant in trials field are *Echinichloa sp. Panicum repens, Leptochloa chinensis, Brachiaria mutica, Digitaria sanguinalis* among grasses, *Eclipta alba*, *Ludwigia parviflora* and *Commelina communis* as broad leaf weeds and *Cyperus sp.* as sedge.
Results: Application of Propanil 80% DF @ 4 kg a.i./ha and twice hand weeded check at 30 and 45 days after sowing found significantly (p=0.05) superior over the application of Propanil 80% DF @ 3 kg a.i./ha and rest of the treatments in controlling the weeds in direct seeded rice and increases the grain yield of rice without any phytotoxic effect.
Conclusion: Propanil 80% DF @ 3 kg a.i./ha could be recommended for post-emergence application at 10 to 15 days after sowing of paddy crop to achieve effective control of weeds.

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Keywords: Dry weight of weeds; weed control efficiency; Propanil; grain yield.

1. INTRODUCTION

Cereals are the most important part of our diet throughout the world and thus, play major role in our food security. Among cereals, rice has been staple food for more than 60 per cent of the world population, providing energy for about 40% of the world population where every third person on earth consumes rice every day in one form or other [1]. Therefore, crop paddy (*Oryza sativa* L.) is an important crop which is extensively grown in tropical and subtropical regions of the world. There are several reasons for its low productivity but the losses due to weeds are one of the most important. More than one third of the total loss (33%) is caused by weeds alone [2]. Weeds are most severe and widespread biological constraints to crop production in India. Weeds are responsible for heavy yield losses in paddy, to the extent of complete crop failure under severe infestation conditions. Irrespective of the method of paddy establishment, weeds are a major impediment to paddy production due to their ability to compete for resources. In general, weeds problem in transplanted paddy is lower than that of direct seeded paddy because of puddling and stagnation of water in transplanted paddy during early growth stage of crop. But in some cases where continuous standing water cannot be maintained particularly for the first 45 days, weed infestation in transplanted paddy also may be as high as direct seeded paddy. Weeds can reduce the grain yield of dry-seeded paddy (DSR) by 75.8%, wet seeded paddy (WSR) by 70.6% and transplanted paddy (TPR) by 62.6%. Weeds by virtue of their high adaptability and faster growth dominate the crop habitat and reduce the yield potential [3]. Therefore, the present investigation was undertaken to study the effect of early post emergent herbicide for control of major weeds in direct seeded rice.

2. MATERIALS AND METHODS

2.1 Background of the Study

A field study was taken during *Kharif*-2015 and *Summer*-2016 at Agricultural Research Station, Dhadesugur. The soil of the experimental site was medium deep black and neutral in pH (8.04), EC (0.47 ds/m), medium in organic carbon content (0.41%), low in nitrogen (189 kg/ha), medium in phosphorus (58.5 kg/ha) and potassium (287.5 kg/ha).

2.2 Treatment Details

This experiment was comprises of eight treatments *viz*., **T_1:** Propanil 80% DF @ 1.0 kg a.i/ha, **T_2:** Propanil 80% DF @ 2.0 kg a.i/ha, **T_3:** Propanil 80% DF @ 3.0 kg a.i/ha, **T_4:** Propanil 80% DF @ 4.0 kg a.i/ha, **T_5:** Oxyfluorfen 23.5% EC @ 240 g a.i./ha, **T_6:** Cyhalofop butyl 10% EC @ 80 g a.i./ha, **T_7:** Hand weeding and **T_8:** Weedy check.

2.3 Trial Details

This study was laid out with randomized complete block design and replicated thrice with a plot size of 6 m in length and 4 m in width. Land is prepared well with harrowing and brings in to fine tilth condition. Dry paddy seeds were sown at a spacing of 21 cm x 15 cm in first week of July during Kharif 2015 and first week of December in summer 2016. Immediately after sowing, irrigation was given and later irrigation was given as and when crop requires. Recommended dose of fertilizer (150:75:75 kg NPK/ha) was applied uniformly in three equal splits (Application of 50% N through urea, 100% P_2O_5 through DAP and 50% potash through MOP at first split. Application of 25% N through urea and 25% potash through MOP at second split and application of remaining 25% N through urea and 25% potash through MOP at third split). Other agronomic and plant protection measures were adopted as recommended during the crop growth.

2.4 Application of Herbicides and Efficacy Evaluation

Herbicides were sprayed as per the treatments (at 10-15 days after sowing of crop or at 2-3 leaf stage of weeds) using a Knapsack sprayer fitted with a flat nozzle at a spray volume of 500 l/ha. The efficacy of different treatments on weeds was evaluated at crop maturity. Quadrates (0.25 m^2) were placed in each plot at random to determine the weed density. Weed seedlings within these quadrates were counted and the efficacy of weed control treatments was evaluated by comparing the density with the untreated control. Weeds were cut at ground level, washed with tap water, oven dried at 70℃ for 48 hours and then weighed for dry matter. The weed control efficiency was calculated using the formula as follows [4].

$$\text{Weed control efficiency (WCE)} = \frac{\text{Dry weight of weeds under control plot - Dry weight of weeds under treatments}}{\text{Dry weight of weeds under control plot)}} \times 100$$

2.5 Data Collection and Economics

After harvest and threshing of crop, grain yield was recorded in net plot wise and converted to grain yield per hectare basis. The cost of inputs that were prevailing at the time of their use was considered for working out the economics of various treatments. Net return per hectare was calculated by deducting the cost of cultivation from gross returns per hectare, gross returns was calculated by using the total income obtained from grain and straw yield of rice and the benefit cost ratio was worked out as follows.

$$\text{Benefit cost ratio} = \frac{\text{Gross returns (Rs/ha)}}{\text{Cost of cultivation (Rs/ ha)}}$$

2.6 Succeeding Crop

To see the impact of herbicides on succeeding crop, the black gram crop was sown after harvesting of the paddy from the herbicides treated plots and the data recorded on germination of seed and impact on crop growth and development *viz*. Leaf injury on tips and Leaf surface, Wilting, Vein clearing, Necrosis, Epinasty, Hyponasty, stunted growth *etc*. after 7, 15 and 21 days after germination (DAG). The data from in each year analysed separately.

2.7 Data Analysis

MSTAT was used for statistical analysis of data and means were separated using critical difference (CD) at p=0.05. The data on weeds were transformed by square root transformation before being subjected to ANOVA [5].

3. RESULTS AND DISCUSSION

3.1 Weed Flora in the Experimental Field

The weeds which were dominant in trials field are *Echinichloa sp. Panicum repens, Leptochloa chinensis, Brachiaria mutica, Digitaria sanguinalis* among grasses, *Eclipta alba*, *Ludwigia parviflora* and *Commelina communis* as broad leaf weeds and *Cyperus sp.* as sedge.

3.2 Effect of Propanil on Weed Density

The data on weed density is presented in Tables 1 and 2. Results revealed that, all the weed management treatments were significantly (p=0.05) reduced weeds populations as compared to Oxyfluorfen 23.5% EC @ 240 g a.i./ha and weedy check in *Kharif* 2015 and *Summer* 2016 when observed at 45 DAS in direct seeded rice. Among the herbicidal treatments, application of Propanil 80% DF @ 4 kg a.i./ha was recorded significantly (p=0.05) lowest weeds population and which was onpar with the application of Propanil 80% DF @ 3 kg a.i./ha and twice hand weeded check at 45 DAS. Further, application of Propanil 80% DF @ 2 kg a.i./ha was the next treatment in terms of controlling weeds after Oxyfluorfen 23.5% EC @ 240 g a.i./ha. These results are conformity with the findings of Amarasinghe and Marambe [6].

3.3 Effect of Propanil on Dry Weight of Weeds

The data on dry weight of weeds is presented in Table 3. Results observed that, application of Propanil 80% DF @ 4 kg a.i/ha, 3 kg a.i./ha and twice hand weeded check recorded significantly higher dry weight of weeds over the application of Propanil 80% DF @ 2 kg a.i./ha and rest of the treatments except Oxyfluorfen 23.5% EC @ 240 g a.i./ha. Similarly, application of Propanil 80% DF @ 4, 3 and 2 kg a.i//ha doses were recorded least dry weight. These results are conformity with the findings of Abeysekera [7] stated that, application of tank mixture of quichlorac @ 50 g/ha + propanil @ 1.08 kg/ha controlled effectively the grassy weeds and recorded lower dry weight in wet seeded rice in mid country region of Srilanka. Whereas, higher dry weight of grassy weeds was observed in weedy check treatment.

3.4 Effect of Propanil on Weed Control Efficiency (WCE)

Results revealed that, all the weed management treatments are significantly recorded higher weed control efficiency as compared to weedy check in *Kharif* 2015 and *Summer* 2016 when observed at 45 DAS in direct seeded rice. Among the herbicidal treatments, application of Propanil 80% DF @ 4 kg a.i/ha was recorded significantly higher weed control efficiency (85.2 and 86.52% during Kharif 2015 and summer 2016, respectively) and which was onpar with the application of propanil 80% DF @ 3 kg a.i./ha and twice hand weeded check over the rest of the treatments except Oxyfluorfen 23.5% EC @ 240 g a.i./ha. Further, application of Propanil 80% DF @ 4, 3 and 2 kg a.i//ha doses were recorded significantly least weed control efficiency.

Table 1. Effect of weed control treatments on weed population (count/m^2) in DSR at 45 DAS (1st season-Kharif 2015)

Treatments	Grasses					Broad leaf weeds			Sedges
	Echinichloa sp.	***Panicum repens***	***Leptochloa chinensis***	***Brachiaria mutica***	***Digitaria sanguinalis***	***Eclipta alba***	***Ludwigia parviflora***	***Commelina communis***	***Cyperus sp.***
T_1: Propanil 80% DF @ 1.0 kg a.i/ha	2.00	1.33	1.33	1.00	1.67	1.33	2.00	3.30	7.67
	(1.73)	(1.53)	(1.53)	(1.41)	(1.63)	(1.53)	(1.73)	(2.07)	(2.94)
T_2: Propanil 80% DF @ 2.0 kg a.i/ha	0.67	0.33	0.33	0.67	0.33	0.33	0.33	0.67	6.33
	(1.29)	(1.15)	(1.15)	(1.29)	(1.15)	(1.15)	(1.15)	(1.29)	(2.71)
T_3: Propanil 80% DF @ 3.0 kg a.i/ha	0.33	0.00	0.00	0.33	0.00	0.00	0.00	1.00	5.67
	(1.15)	(1.00)	(1.00)	(1.15)	(1.00)	(1.00)	(1.00)	(1.41)	(2.58)
T_4: Propanil 80% DF @ 4.0 kg a.i/ha	0.00	0.33	0.00	0.00	0.33	0.00	0.33	0.67	6.33
	(1.00)	(1.15)	(1.00)	(1.00)	(1.15)	(1.00)	(1.15)	(1.29)	(2.71)
T_5: Oxyfluorfen 23.5 % EC @ 240 g a.i./ha	6.33	4.33	3.33	4.33	3.33	1.00	3.67	2.33	4.33
	(2.71)	(2.31)	(2.08)	(2.31)	(2.08)	(1.41)	(2.16)	(1.82)	(2.31)
T_6: Cyhalofop butyl 10 % EC @ 80 g a.i./ha	0.00	0.00	1.33	0.67	0.33	7.67	4.00	7.00	13.00
	(1.00)	(1.00)	(1.53)	(1.29)	(1.15)	(2.94)	(2.24)	(2.83)	(3.74)
T_7: Hand weeding	0.00	0.00	0.33	0.67	0.00	0.00	0.00	0.00	1.67
	(1.00)	(1.00)	(1.15)	(1.29)	(1.00)	(1.00)	(1.00)	(1.00)	(1.63)
T_8: Weedy check	11.33	3.33	5.67	7.33	4.00	7.00	4.33	6.67	12.67
	(3.51)	(2.08)	(2.58)	(2.89)	(2.24)	(2.83)	(2.31)	(2.77)	(3.70)
CD at 5%	**0.41**	**0.35**	**0.35**	**0.33**	**0.44**	**0.31**	**0.35**	**0.29**	**1.34**

Note: Figures in the parenthesis are square root transformed values (sq. root of x+1), DAS: Days after sowing

Table 2. Effect of weed control treatments on weed population (count/m^2) in DSR at 45 DAS (2nd Season -summer 2016)

Treatments	Grasses					Broad leaf weeds			Sedges
	Echinichloa sp.	*Panicum repens*	*Leptochloa chinensis*	*Brachiaria mutica*	*Digitaria sanguinalis*	*Eclipta alba*	*Ludwigia parviflora*	*Commelina communis*	*Cyperus sp.*
T_1: Propanil 80% DF @ 1.0 kg a.i/ha	3.33 (2.08)	1.00 (1.41)	3.67 (2.16)	1.67 (1.63)	0.67 (1.29)	1.67 (1.63)	4.33 (2.31)	1.67 (1.63)	5.67 (2.58)
T_2: Propanil 80% DF @ 2.0 kg a.i/ha	1.00 (1.41)	0.00 (1.00)	1.33 (1.53)	0.67 (1.29)	0.33 (1.15)	1.00 (1.41)	1.00 (1.41)	0.67 (1.29)	4.00 (2.24)
T_3: Propanil 80% DF @ 3.0 kg a.i/ha	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	1.00 (1.41)	1.00 (1.41)	1.00 (1.41)	3.67 (2.16)
T_4: Propanil 80% DF @ 4.0 kg a.i/ha	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.33 (1.15)	0.67 (1.29)	1.00 (1.41)	3.33 (2.08)
T_5: Oxyfluorfen 23.5 % EC @ 240 g a.i./ha	4.67 (2.38)	1.67 (1.63)	3.30 (2.07)	3.00 (2.00)	1.67 (1.63)	2.00 (1.73)	2.33 (1.82)	2.00 (1.73)	5.33 (2.52)
T_6: Cyhalofop butyl 10 % EC @ 80 g a.i./ha	0.00 (1.00)	0.00 (1.00)	1.00 (1.41)	0.33 (1.15)	0.00 (1.00)	4.67 (2.38)	10.33 (3.37)	5.33 (2.52)	9.00 (3.16)
T_7: Hand weeding	0.00 (1.00)	0.33 (1.15)	0.00 (1.00)	0.00 (1.00)	0.33 (1.15)	0.00 (1.00)	0.00 (1.00)	1.00 (1.41)	1.00 (1.41)
T_8: Weedy check	8.33 (3.05)	2.67 (1.92)	7.33 (2.89)	4.67 (2.38)	2.00 (1.73)	5.67 (2.58)	9.67 (3.27)	4.67 (2.38)	8.33 (3.05)
CD at 5%	**0.51**	**0.34**	**0.63**	**0.40**	**0.23**	**0.25**	**0.48**	**0.20**	**0.34**

Note: Figures in the parenthesis are square root transformed values (sq. root of x+1), DAS: Days after sowing

Table 3. Assessment of weeds dry weights (g/m^2) from different herbicidal treatments in DSR at 45 DAS

Treatments	Weed dry weight (g/m^2)									
	Grasses		BLW		Sedges		Total		WCE (%)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
T_1: Propanil 80% DF @ 1.0 kg a.i/ha	6.34	6.88	4.96	4.70	5.41	3.75	16.72	15.34	62.93	57.48
T_2: Propanil 80% DF @ 2.0 kg a.i/ha	3.26	2.71	1.36	1.67	4.30	2.50	8.93	6.88	82.42	80.92
T_3: Propanil 80% DF @ 3.0 kg a.i/ha	2.03	1.04	0.90	2.08	4.08	1.97	7.02	5.10	84.44	85.87
T_4: Propanil 80% DF @ 4.0 kg a.i/ha	1.58	1.03	1.11	1.75	3.98	2.08	6.67	4.86	85.20	86.52
T_5: Oxyflourfen 23.5 % EC @ 240 g a.i./ha	15.63	9.78	5.90	4.38	2.94	3.33	24.47	17.49	45.74	51.51
T_6: Cyhalofop butyl 10 % EC @ 80 g a.i./ha	3.85	1.46	12.70	15.03	8.84	8.57	25.38	25.06	43.72	30.51
T_7: Hand weeding	1.81	2.72	1.24	0.75	2.04	1.17	5.09	4.64	88.72	87.13
T_8: Weedy check	21.76	17.52	14.50	12.30	8.84	6.26	45.10	36.07	--	--
CD at 5%	**1.43**	**1.68**	**1.77**	**2.04**	**1.88**	**1.10**	**3.24**	**4.58**	--	--

DAS: Days after sowing

Table 4. Effect of Propanil 80% DF on the grain yield of direct seeded rice

Treatments	Grain Yield (q/ha)*		C:B ratio	
	2015	2016	2015	2016
T_1: Propanil 80% DF @ 1.0 kg a.i/ha	57.38	52.3	1:1.15	1:1.35
T_2: Propanil 80% DF @ 2.0 kg a.i/ha	60.88	58.12	1:1.98	1:1.84
T_3: Propanil 80% DF @ 3.0 kg a.i/ha	62.48	58.90	1:2.23	1:2.41
T_4: Propanil 80% DF @ 4.0 kg a.i/ha	62.12	59.12	1:2.19	1:2.34
T_5: Oxyfluorfen 23.5 % EC @ 240 g a.i./ha	56.61	49.43	1:0.92	1:1.05
T_6: Cyhalofop butyl 10 % EC @ 80 g a.i./ha	55.35	50.12	1:1.05	1:1.33
T_7: Hand weeding	60.21	58.11	1:2.00	1:2.33
T_8: Weedy check	51.67	45.62	1:0.68	1:0.82
CD (P=0.05)	**4.10**	**5.41**	-	-

**Mean of 3 replications*

Table 5. Phytotoxicity effect on growth parameters of succeeding crop black gram as influenced by the application of Propanil 80% DF (Mean data of 2015 and 2016)

Treatments	Phytotoxic effect (%)*			Germination percent
	7 DAG	15 DAG	21 DAG	
T_1: Propanil 80% DF @ 1.0 kg a.i/ha	0.0	0.0	0.0	93.0
T_2: Propanil 80% DF @ 2.0 kg a.i/ha	0.0	0.0	0.0	92.0
T_3: Propanil 80% DF @ 3.0 kg a.i/ha	0.0	0.0	0.0	93.6
T_4: Propanil 80% DF @ 4.0 kg a.i/ha	0.0	0.0	0.0	92.0
T_5: Oxyfluorfen 23.5 % EC @ 240 g a.i./ha	0.0	0.0	0.0	91.6
T_6: Cyhalofop butyl 10 % EC @ 80 g a.i./ha	0.0	0.0	0.0	92.6
T_7: Untreated	0.0	0.0	0.0	93.6

**Mean of 3 replications, DAG: Days after germination*

These results are conformity with the findings of Amarasinghe et al. [8] stated that, application of quichlorac @ 500 g/ha recorded higher weed control efficiency in wet seeded rice in mid country region of Srilanka. Similarly, lower weed control efficiency was noticed in weedy check treatment (Table 3).

3.5 Grain Yield and Economics of Direct Seeded Rice

Among the weed management treatments, Hand weeding at 15 and 45 days after sowing gave significantly higher grain yield over weedy check. However, application of Propanil 80% DF @ 4 kg a.i/ha was at par with its lower dose i.e. Propanil 80% DF @ 3 kg a.i./ha, found to be significantly superior and on par with recorded higher grain yield followed by twice hand weeding at 15 and 45 days after sowing. Moreover, maximum cost benefit ratio was observed in plots treated with Propanil 80% DF along with twice hand weeded check (Table 4). These results are conformity with the findings of Seema, et al. [9] stated that, higher grain yield of aerobic rice was recorded in weed control treatments over the un-weeded treatment.

3.6 Effect of Herbicides on Succeeding Crop

The phytotoxicity effect on succeeding black gram in terms of leaf necrosis, chlorosis or wilting was observed at 7, 15 and 21 days after germination (DAG) at all dosages of Propanil 80% DF and other herbicides including untreated control. Results indicated that, there was no phytotoxicity effect (rating 0) noticed in all the plots in both the season (Table 5). Further there was no impact on germination of black gram seed which was sown after harvesting of paddy crop from Propanil 80% DF treated plot in both the season.

4. CONCLUSION

Results says that, application of Propanil 80% DF @ 3 kg a.i./ha could be recommended for post-emergence application at 10 to 15 days after sowing of paddy crop to achieve effective control of *Echinochloa spp. (E. colona, E. crusgalli), Panicum repens, Leptochloa chinensis, Brachiaria mutica, Digitaria sanguinalis, Eclipta alba, Ludwigia parviflora, Commelina communis* and *Cyperus sp.* Further,

it produces higher grain yield and benefit cost ratio due to effective control of weeds in direct seeded rice.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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