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RESEARCH ARTICLE :

Weed management for improvement in yield of aerobic rice

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SUMMARY : Rice is a major food for more than half of the population in world and India. The changes in establishment methods like transplanted rice to direct seeded (aerobic) rice cultivation and chemical weed control instead of hand weeding are rising in most of the countries to reduce the cost of cultivation and consumption of irrigation water as the availability of labour and fresh water are decreasing day by day. Keeping these facts in view a field experiment was conducted to studyweed management practices impact on the improvement of yield of direct seeded rice at Instructional farm, BCKV, Mohanpur, West Bengal, India during *Kharif*, 2015 and 2016. The experimental results revealed lesser weed density in Propanil 35% EC @3000 g a.i. ha^{-1} and recorded grain yield of 4.47 t ha^{-1}as compared to other herbicides namely oxyflourfen and cyhalofop butyl. Under the direct seeded condition Propanil35% EC @3000 g a.i. ha^{-1}can be recommended instead of laborious hand weeding without any harmful effects on growth and yield of rice.

KEY WORDS :
Direct seeded rice, Propanil, Rice yield, Weed density, Weed control efficiency

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BACKGROUND AND OBJECTIVES

Rice, the major cereal crop, playsa significant role in the food security of India. Direct-seeded upland rice is becoming more popular asan alternative to transplanted rice, as it is more remunerativeif the crop is managed properly. Direct seeding of rice has several advantages over transplanting rice (Farooq *et al.*, 2011). Direct-seeded crops are more rapidly and easily planted, less labour intensive, consume less water, mature 7 to 10 days earlier and have fewer methane emissions (Chauhan, 2012). In direct-seeded upland rice, weeds poseserious competition to the crop in early stage and cause aheavy reduction in rice yield. Weed is one of themajor constraints for low productivity of upland rice (Angiras and Attri, 2002). Uncontrolled weeds reducethe yield up to 80% in direct-seeded upland rice (Subbaiah *et al.*, 2005). Labour unavailability, increasing labour costs and the pressing need to raise yields and maintain profit on a progressively limited land base have been leadingto alternatives of manual weeding. Effective weed

management practice is an important prerequisite in direct seeded rice culture, with herbicide application seemingly indispensable (Azmi *et al.*, 2005). While herbicides remain inexpensive and effective options, use of herbicides in rotation with agronomic practices (Kone *et al.*, 2001) and the use of herbicide mixtures with different modes of action (Schmidt, 1997) was important for effective weed management in rice. Keeping all these in view, the present study was carried out to evaluate the various management practices for better weed control and improvement of direct seeded aerobic rice.

RESOURCES AND METHODS

Study area :

The experiment was conducted at University Institutional farm, Jaguli, BCKV, West Bengal, India during *Kharif*, 2015 and 2016. The experimental site was located at 22.9^0 N latitude, 88.5^0 E longitude with an altitude of 14.01m above MSL. It had a warm humid climate with an average minimum and maximum temperature of 10 and 35^0C, respectively. The area receives average annual rainfallof 1200 mm. The soil of the experimental field was sandy loam in texture with the pH of 6.5 and medium fertility status with low water holding capacity. The area was dominated by rice based farming system and crop-livestock mixed farming in which rice, jute,maize, sugar cane, potato, lentil, rape seed and mustard and green gram were the major crops.

Description of the experimental materials :

The rice variety selected for the experiment IET 4786 (Shatabdi) was suitable for irrigatedup - land condition for *Kharif* season and attains maturity in 105 – 110 days with semi-dwarfstature, long slender grain and blastresistant quality.

Treatments and experimental design :

The experiment was arranged in a Randomised Block design with eight weed control treatments comprising of Propanil 35% EC @ 1000 g a.i. ha^{-1}, Propanil 35% EC @ 2000 g a.i. ha^{-1},Propanil 35% EC @ 3000 g a.i. ha^{-1}, Propanil 35% EC @ 4000 g a.i. ha^{-1}, Oxyfluorfen 23.5% EC @ 240 g a.i. ha^{-1}, Cyhalofop-butyl 10% EC @ 80 g a.i. ha^{-1}, hand weeding twice at 15 and 30 days after sowing (DAS) and unweeded control. The plot size was 4m x 5m. Observations on weed population and their dry weights had been recorded using 1 m x 1 m quadrate three times per plot for each observation and the average calculated data were presented on m^{-2} basis at 45 and 75 DAA of herbicide. Weed control efficiency (WCE) and weed index (WI) had been calculated following the formula:

WCE = (WC-WT)/ WC X 100;

where WC= Dry weight of weeds in un weeded control plot, and

WT= Dry weight of weed in treated plot.

WI= (YHW- YT) / YHW X 100

where, YHW= yield of hand weeded weed free plot, and

YT= yield of treated plot.

Experimental procedures :

The experimental field was ploughed and harrowed thoroughly to get a fine seedbed and levelled manually before the field layout had been made. Rice seeds were sown on 13/08/2015 and 10/08/2016 and the crop had beenharvested on 29/11/2015 and 24/11/2016, respectively.At the time of sowing full amount of recommended dose (60:30:30:: $N:P_2O_5:K_2O$) of phosphorus and potash were applied. Nitrogen was applied in three splits (25 % as basal, 50 % as first top dressing at 20 DAS and 25% as second top dressing at 40 DAS). Fertilizers used were Urea, Single super phosphate and Muriate of potash.Oxyfluorfen 23.5 % EC was applied at 3 DAS, all the dosage of Propanil 35 % EC were applied at 11 DAS, while Cyhalofop-butyl 10% EC was applied at 18 DAS. Hand weeding was taken up twice on 15 and 30 DAS.Knapsack sprayer with flat fan nozzle had been used for spraying a spray volume of 500 l ha^{-1}.

Statistical data analysis :

Total weed population, weed dry weightand rice crop yield data were collected and statistically analysed, applying the technique of analysis of variance described by Gomez and Gomez (1984).The data were analyzed separately for 2015 and 2016 using ANOVA and data obtained in both the years were subjected to pooled analysis to obtain the trend

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following

heads:

Weed flora in the experimental field:

The important weed flora observed in the experimental site were *Echinochloa colona, Echinochloa crusgalli,Echinochloa glabrescens, Dactyloctenium aegyptium* and *Digitaria sanguinalis* among grasses, *Cyperus rotundus, Cyperus difformis* and *Fimbristylis miliacea* among sedges and *Amaranthus viridis, Alternanthera philoxeroides, Portulaca oleracea, Eclipta alba, Cleome viscosa*and *Commelina benghalensis* among broad leaf weeds (BLW).

Weed density and weed dry weight :

Analysis results from Table 1 revealed that Hand weeding twice at 15 and 30 DAS was best in controlling weed density and weed dry weight at 45 and 75 DAA. Among the herbicides Propanil 35% EC @ 4000 g a.i. ha^{-1}recorded lowest weed density and weed dry weight.Rice crop has the enzyme, aryl acylamidase which had the ability to transform Propanil to 3,4-dichloroaniline, which is non-phytotoxic, but weeds lack such property leads to wilting and death(Baltazar and Smith, 1994).Hand weeding twice at 15 and 30 DAS (7.9 g $m^{-2}$and 15.39g m^{-2}) significantly recorded the lowest weed dry weight at 45 and 75 DAS compared to other management practices. Among the herbicidal treatments

Table 1 : Weed density and weed dry weight at 45 and 75 DAA as influenced by different management practices (pooled data of 2015 and 2016)

Treatments	Weed density (no. m^{-2})						Weed dry weight (g m^{-2})					
	GRASSES		BLW		SEDGES		GRASSES		BLW		SEDGES	
	45 DAA	75 DAA	45 DAA	75 DAA	45 DAA	75 DAA	45 DAA	75 DAA	45 DAA	75 DAA	45 DAA	75 DAA
Propanil 35 % EC@ 1000 g a.i. ha^{-1}	4.20* (17.11)	4.62 (20.89)	6.09 (36.55)	4.40 (18.89)	4.01 (15.56)	6.91 (47.29)	5.6	9.05	15.56	22.83	5.65	7.25
Propanil 35 % EC@ 2000 g a.i. ha^{-1}	2.66 (6.55)	3.39 (11.00)	4.38 (18.67)	3.55 (12.11)	2.61 (6.33)	5.73 (32.34)	3.28	5.9	8.67	16.4	4.13	5.55
Propanil 35 % EC@ 3000 g a.i. ha^{-1}	2.37 (5.11)	2.97 (8.33)	3.75 (13.56)	3.22 (9.89)	2.17 (4.22)	5.08 (25.34)	2.81	4.35	6.76	12.72	3.28	4.87
Propanil 35 % EC@ 4000 g a.i. ha^{-1}	2.27 (4.66)	2.74 (7.00)	3.51 (11.79)	2.92 (8.00)	2.04 (3.66)	4.66 (21.21)	1.96	3.44	5.30	9.86	2.10	3.46
Oxyflurofen 23.5 %EC@ 240 g a.i. ha^{-1}	3.05 (8.78)	3.89 (14.66)	4.51 (19.88)	3.64 (12.77)	2.91 (7.99)	5.58 (30.67)	4.44	6.35	9.92	15.97	4.11	5.67
Cyhalofof butyl 10 % EC@ 80 g a.i. ha^{-1}	2.46 (5.56)	3.03 (8.67)	7.37 (53.79)	4.89 (23.45)	4.42 (19.00)	8.11 (65.30)	3.13	4.56	37.96	48.99	11.7	14.65
Hand weeding	1.96 (3.33)	2.44 (5.45)	3.31 (10.44)	2.78 (7.22)	1.96 (3.33)	4.44 (19.22)	1.82	3.16	4.47	8.93	1.70	3.30
Weedy check	5.37 (28.33)	5.93 (34.67)	7.77 (59.88)	5.33 (27.90)	4.93 (24.00)	8.37 (69.53)	18.53	19.5	44.07	47.48	16.10	18.67
C.D. (P=0.05)	0.74	0.82	1.26	1.02	0.97	1.82	1.48	2.76	4.25	7.48	2.45	2.26

*Figures in parentheses indicate original values

Table 2 : Weed control efficiency (WCE) at 45 and 75 DAA, weed index (WI) and yield of rice as influenced by different management practices (pooled data of 2015 and 2016)

Treatments	WCE (%)		Weed index (WI) %	Grain yield (t ha^{-1})
	45 DAA	75 DAA		
Propanil 35 % EC @ 1000 g a.i. ha^{-1}	65.36	53.23	20.41	3.90/5.26
Propanil 35 % EC @ 2000 g a.i. ha^{-1}	79.43	67.20	12.86	4.27/5.85
Propanil 35 % EC @ 3000 g a.i. ha^{-1}	83.51	74.16	8.77	4.47/5.99
Propanil 35 % EC @ 4000 g a.i. ha^{-1}	87.85	80.49	6.73	4.57/6.08
Oxyflurofen 23.5 % EC @ 240 g a.i. ha^{-1}	76.62	67.35	22.45	3.80/5.17
Cyhalofop butyl 10 % EC @ 80 g a.i. ha^{-1}	30.70	26.10	27.14	3.57/4.78
Hand weeding	89.59	82.15	-	4.90/6.76
Weedy check	0.0	0.0	32.65	3.30/4.36
C.D. (P=0.05)	-	-	-	0.58/0.81

Propanil 35% EC @ 4000 g a.i. ha^{-1}(9.36 g $m^{-2}$and 16.76 g m^{-2}) recorded lowest weed dry weightfollowed by Propanil 35% EC @ 3000 g a.i. ha^{-1}(12.85 g m^{-2} and 29.14 g m^{-2})at 45 and 75 DAS.Oxyfluorfen and Cyhalofop-butyl control the grassy weeds only resulted in higher weed dry weight production. Cyhalofop butylcontrols grassy weeds by inhibiting biosynthesis of fatty acids through controlling the production of acetyl coenzyme-Acarboxylase (ACCase) results in the loss of lipids and causes the death of activedividing cells at the growing points. The same results were also opined by Raj and Syriac, 2015.The electron transport chain reaction and conversion of CO_2 to carbohydrate precursors were inhibited by Propanil in weeds. That inhibits further development of all kind of weeds and reduces the competition to the rice crop (Ustyugova, 2007).

Weed control efficiency (WCE) :

Data regarding Weed Control Efficacy (Table 2) revealed that highest weed control efficiency was recorded in hand weeding twice at 15 and 30 DAS (89.59 % and 82.15 %) at 45 and 75 DAS. Among the herbicides Propanil 35% EC @ 4000 g a.i. ha^{-1} (87.85 % and 80.49 %) recorded highest WCE followed by Propanil 35% EC @ 3000 g a.i. ha^{-1}(83.51 % and 74.16 %) at 45 and 75 DAS. The highest weed control efficiency recorded in hand weeding was due to the season-long weed free condition in that treatment. The similar kind of results obtained by Channappagoudar *et al.* (2008) reported that in unweeded control, the crop was adversely affected by weeds due to heavy competition with the crop for moisture, nutrients, space and light, which can be attributed to suppressed crop growth.The response of weed flora differed with herbicides because different herbicides worked based on their site-specific mode of action(Rahman *et al*., 2012).

Weed index :

The highest value of weed index is obviouslynoticed in unweeded control treatment (32.65). The lowest weed index value (6.73) had been recorded with the herbicidePropanil 35% EC @ 4000 g a.i. ha^{-1} followed by Propanil 35% EC @ 3000 g a.i. ha^{-1} (8.77) which might be due to better weed management and boosting of crop yield in those treatments.

Rice yield :

The analysis results in Table 2 shows that the highest rice yield was achieved byhand weeding twice at 15 and 30 DAS (4.90 t ha^{-1}). Among herbicidal treatments, though Propanil 35% EC @ 4000 g a.i. ha^{-1}recorded the highest grain yield (4.57 t ha^{-1}) but no significant difference was noticed with Propanil 35% EC @ 3000 g a.i. ha^{-1}(grain yield4.47 t ha^{-1}). In the above three treatments (hand weeding twice, Propanil 35% EC @ 4000 g a.i. $ha^{-1}$and Propanil 35% EC @ 3000 g a.i. ha^{-1}), the weeds control measure worked properlywhich reduced competition between crops and weeds for nutrient, water, solar radiation and also growing space. No negative impact from herbicides to crop had been noticed and increased filled grain percentage due to higher photosynthetic efficiency and improved biological and physiological functions leads to higher grain yield in those treatments(Antralina *et al*., 2015).

Conclusion :

Based on the study,it can be concluded that post-emergence application of Propanil 35% EC @ 3000 g a.i. ha^{-1}in direct seeded rice cultivation for better weed controlresulted in higher grain yield. Thereby, the use of this herbicide could replace the manual weeding.

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