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Performance of Different Herbicides in Dry Direct Seeded Rice

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Abstract: ***Weeds are the major problem in dry direct seeded conditions competing with the different resources provided to the crop. Hence, field experiments were conducted during rainy seasons of 2013 and 2014 at the experimental field of Rice Research Program, Hardinath, Dhanusha to identify the effective herbicides for control of broad spectrum of weeds in dry direct seeded rice. The experiment was laid out in a randomized complete block design with four replications. Four weed control methods (pendimethalin @ 1000 g a.i./ha as pre-emergence followed by 2,4-D @ 1000 g a.i./ha as post-emergence, pendimethalin @ 1000 g a.i./ha as pre-emergence followed by penoxsulam @ 22.5 g a.i./ha as post-emergence, pyrazosulfuron ethyl @ 20 g a.i./ha as pre-emergence followed by 2,4-D @ 1000 g a.i./ha as post-emergence, pyrazosulfuron ethyl @ 20 g a.i./ha as pre-emergence followed by Bispyribac sodium @ 25 g a.i/ha + azimsulfuron @ 17.5 g a.i./ha and weedy check as control) were evaluated. The statistical analysis showed that the effect of weed control methods on yield and yield attributing parameters of the tested rice varieties was significant. Of the tested herbicides, the highest grain yield of 4.1 t/ha was recorded in pyrazosulfuron fb bispyribac sodium + azimsulfuron. This treatment was found to control broad spectrum of weeds and reduced the weed biomass by 92%.***

Keywords: Dry direct seeded, herbicides, weed biomass

1. Introduction

Rice occupies the first position in terms of area (0.134 M ha) and production (5.20 M tons) and its productivity is 3.35 t/ha [1]. This crop contributes about 22% in national agricultural growth domestic product. In Nepal, rice is predominantly grown by transplanting into puddle soil with continuous flooding which provides multiple benefits to rice including reduction in weed population and percolation losses and increases availability of nutrients [2]. However, it deteriorates soil physical properties which adversely affect the growth and productivity of of succeeding wheat crop. The conventional transplanting method of rice cultivation requires a huge amount of water, labor, and energy, which are gradually becoming scarce and more expensive [3]. All these factors have increased the interest of farmers to shift from the conventional practice of transplanting to direct seeded rice especially dry direct seeded rice. Direct seeding is a good alternative of conventional transplanting and yield potential of direct seeded rice is comparable to the transplanted rice under good water management and weed control conditions [4]. Despite multiple benefits of dry direct seeded rice, weed control remains one of the major challenges for its success in South Asia [5, 6 and 7]. Weed control is more difficult in direct seeded rice than conventional transplanted rice because of simultaneously emerging rice seedlings with seeds in direct seeded rice. In Nepal, it has been observed that weeds caused yield loss in direct seeded rice ranging from 14-93% where as in transplanted rice it is 17-47% [8]. The risk of yield loss from weeds in direct-seeded rice is greater than the conventional transplanted rice [7]. Similarly, the yield reduction up to 48, 53 and 74% has been reported in transplanted, direct seeded flooded and direct seeded aerobic rice, respectively [9]. Usually, dry direct seeded rice is much more affected with a broader weed spectrum than flooded transplanted rice [10]. Therefore, an effective and efficient weed control strategy needs to be implemented to meet the demand of rice for increasing population in Nepal. Thus, this experiment was carried out to explore the most suitable and economical methods of weed management in dry direct seeded rice.

2. Materials and Methods

Field experiments were carried out at the research block of National Rice Research Program, Dhanusha, Nepal in rainy seasons of 2015 and 2016. The experimental site is located at the latitude of 26°49' E and longitude of 86°01' N with an altitude of 93 m from mean sea level. Agro-ecologically, the area comes under sub-tropical region. The climate is warm and moist having hot and humid summer and mild winter. The maximum temperature in summer is 44°C and minimum temperature in winter is 4.8°C. The average annual rainfall is 1281 mm and maximum rainfall occurs in July and 80% of the total annual rainfall comes between June and September. The experiment was laid out in a randomized complete block design with four replications. A total of four weed control methods were included as treatments. The details of treatments included in the experiment are given in Table 1.

Rice seeds were direct seeded at a rate of 35 kg/ha at a soil depth of 2-3 cm. The herbicides were applied using a battery operated back-pack knapsack sprayer fitted with a flat-fan nozzle and calibrated to deliver 500 lit/ha for pre-spray and 375 lit/ha for post spray. Fertilizers were applied @ 90:30:30 N:P_2O_5:K_2O kg/ha. Half dose of the N, full dose of P_2O_5 and K_2O was applied as a basal application. Remaining N was splitted into two equal parts and applied at 40 and 60 DAS as a top dress. Weed species were counted from two quadrates of 0.5 m^2 size each per plot was taken at 30, 60 and 90 DAS from weedy check plots. Weeds were categorized into grass, sedge and broadleaf weeds. Weed biomass was determined at 20 and 45 DAS from a randomly selected 0.5 m^2 quadrate in each plot. Weed samples were oven dried before weighing at 70°C till the constant weight was achieved. At harvesting, five rice plant clusters were randomly selected from each treatment to collect data for plant height (cm), panicle length, number of grains/panicle. Effective tillers were recorded from 1 m^2 area for each treatment at harvesting. The crop was harvested leaving the border area of 22.5 cm from each side of the plot. Crop from net area was harvested, sun dried and threshed manually. Grain and straw thus separated were kept separately, dried and finally weighed. Data were subjected to analysis of variance using CropStat V.07. Means were separated using Least Significant Difference (LSD) test at $P \leq 0.05$.

Table 1: Details of treatments included in the experiment

Treatments	Details	Dose (g a.i./ha)	Time of application (Days after sowing)
W_1	Pendimethalin fb 2, 4-D	1000 fb 1000	3 fb 21
W_2	Pendimethalin fb penoxsulam	1000 fb 22.5	3 fb 21
W_3	Pyrazosulfupron fb 2, 4-D	20 fb 1000	3 fb 21
W_4	Pyrazosulfuron fb bispyribac sodium + azimsulfuron	20 fb 25 +17.5	3 fb 21
W_5	Weedy check (control)	-	-

Abbreviation: fb = followed by.

3. Results

Yield and yield parameters

The effects of different weed management practices on grain yield and major yield contributing parameters of rice is presented in Table 2 and 3. The effects of different weed treatments were significantly higher for yield attributing parameters like number of effective tillers/m^2, number of filled grains per panicle and 1000-grains weight were significantly higher in both years. The effect of pyrazosulfuron fb bispyribac sodium + azimsulfuron (W_4) treatment played significant role in contributing the higher values for number of effective tillers/m^2, number of filled grains per panicle and 1000-grains weight. However, it was at par with the treatments W_2 and W_3. The minimum values for all the measured traits of yield attributes were in control plots (weedy check). The highest grain yield of 4.1 t/ha was recorded in pyrazosulfuron fb bispyribac sodium + azimsulfuron (W_4) followed Pendimethalin fb penoxsulam (W_2) and Pyrazosulfupron fb 2, 4-D (W_3). All the herbicide applications resulted in significantly higher grain yield compared to weedy check (control).

Table 3: Yield and yield attributing characters of rice as influenced by varieties and weed control methods in 2013 at NRRP, Dhanusha, Nepal

Treatment	Days to heading	Plant height (cm)	Panicle length (cm)	No. of effective tillers/m^2	1000-grains weight (g)	No. of filled grains/panicle	Grain yield (t/ha)
W_1	104	82	24	386	23	131	3.41
W_2	101	80	23	434	29	117	3.86
W_3	103	81	22	381	25	116	3.02
W_4	102	80	23	424	28	122	4.15
W_5	103	82	21	291	23	80	1.03
F-test	ns	ns	ns	ns	*	**	*
$LSD_{0.05}$	5.013	15.35	4.012	88.3	5.	94.37	59.5
CV%	3.5	13.1	9.7	17.2	12.9	11.3	11.3

* and ** = Significant at 1 and 5%, respectively, CV = Coefficient of variation

Table 4: Yield and yield attributing characters of rice as influenced by varieties and weed control methods in 2014 at NRRP, Dhanusha, Nepal

Treatment	Days to heading	Plant height (cm)	Panicle length (cm)	No. of effective tillers/m^2	1000-grains weight (g)	No. of filled grains/panicle	Grain yield (t/ha)
W_1	104	88	24	370	24	128	3.17
W_2	103	89	23	410	27	119	3.77
W_3	103	85	21	373	26	119	2.89
W_4	104	91	21	402	25	121	4.12
W_5	104	83	23	287	23	91	1.97
F-test (tret)	ns	ns	ns	ns	ns	*	**
$LSD_{0.05}$	4.098	14.85	3.005	82.04	4.329	92.95	44.2
CV%	2.6	10.5	8.3	15.5	10.6	9.9	13.3

* and ** = Significant at 1 and 5%, respectively, CV = Coefficient of variation

Weeds flora

The major weed flora recorded in the weedy check plots is presented in Table 4. The general ground coverage by weeds at (45 DAS) was 87% (48% grassy weeds, 30% broad leaf weeds and 9% sedges. The important weeds infesting the experimental area were *Cynodon dactylon*, *cyperus iria*, *C. rotundus*, *C. difformis* and *Echinocloa cruss-galli*.

Table 4: Composition of weed species at experimental site (weedy check plots)

Grassy weeds (48%)	**Broad leaf** (30%)	**Sedges** (9%)
Echinocloa cruss-galli	*Digera arvensis*	*Cyperus difformis*
Dactyloctenium aegyptium	*Ageratum conyzoides*	*Cyprus iria*
Leptochloa chinensis	*Cleome viscose*	*Cyperus rotundus*
Paspalum distichum	*Ludwigia parviflora*	
Cynodon dactylon	*Eurphorbia hirta*	
	Eclipta alba	

Weeds control

Data on effects of weeds controls methods reduction in dry weed biomass (%) over control are presented in Fig. 1. Weed biomass (dry weight basis) was identical in all the three varieties in both years (Data not shown). Among the herbicides, 91% reduction in weed biomass over control was recorded in treatment W_4. This reduction was at par with W_2.

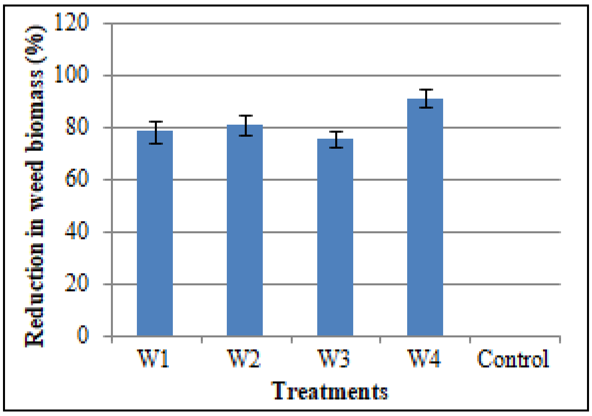

Figure 1: Effect of herbicidal treatments on weed biomass reduction over control (bars on the graph indicates ± standard deviation)

4. Discussion

Different type of weeds belonging to grass, broad leaf and categories were observed in the experimental site and the dominant weed species belonged grass followed by broad leaf weeds. Previous researchers also reported broad spectrum of weed species especially grass and broad leaf in upland rice ecosystem under direct seeded condition [5, 12]. The weed biomass recorded at 45 DAS was reduced by 91% over control with the application of pyrazosulfuron fb bispyribac sodium + azimsulfurons. The results of the current study are in conformity with previous reports of effective weed control in DSR with pre-emergence application of pendimethalin fb bispyribac sodium as post-emergence [13]. The combination of Azimsulfuron with bispyribac sodium for post-emergence application broadens the spectrum of weed control because azimsulfuron effectively controls sedges and broad leaf weeds [14]. The higher rice grain and economic returns with post-emergence application of bispyribac sodium [15]. In dry direct seeded rice, the applications of herbicides were found effective to control broad spectrum weeds. Our study suggests that pre-emergence application of of pyrazosulfuron fb bispyribac sodium + azimsulfurons could be effective to control broad spectrum weeds in dry direct seeded rice.

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