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AGRONOMY

Bio-efficacy of Bentazon against Weeds in Direct Seeded Rice under Kymore Plateau and Satpura Hill Zone

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ABSTRACT

The experiment was conducted at Research Farm of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India to study the "Bio-efficacy of Bentazon against Weeds in Direct Seeded Rice under Kymore Plateau and Satpura Hill zone" during *kharif* season of 2016 under edaphic and climatic conditions of Jabalpur (M.P.). The dominant weeds associated with direct seeded rice in the experimental field comprised of monocot like *Echinochloa colona* and *Dinebra retroflexa*, sedges like *Cyperus iria* and dicot weeds including *Mullogo pentaphylla* and *Alternanthera philoxeroides*. Experiment consisted of total ten treatments comprising of seven doses of Bentazon 600, 800, 1000, 1200, 1600, 1800 and 2000 g/ha, 2,4-D 380 g/ha as post-emergence, hand weeding twice at 20 and 40 DAS including weedy check, the experiment was laid out in randomized block design (RBD) with 03 replications. The post-emergence application of Bentazon at 1600 g/ha was found economically best suitable for effective control of dicot weeds in direct seeded rice. This treatment also enhanced the growth parameters (*viz.* plant height, number of tillers/m^2), yield attributes (*viz.* effective tillers/m^2, total and sound grains/panicle) and yield (grain and straw) as compared to rest of the treatments. It also produced higher benefit cost (B:C) ratio (2.2) therefore application of Bentazon 1600 g/ha was found more remunerative and productive.

HIGHLIGHTS

- Post-emergence application of Bentazon at 1600 g/ha controlled broadleaf weeds in direct seeded rice.
- Bentazon @1600 g/ha was the economically viable treatment.

Keywords: Grain yield, Bentazon, Dicot weeds, Direct seeded rice, Weed Control, Economics

Rice (*Oryza sativa* L.) is a staple food for more than 60% of the world's, seven billion people and more than 90% of rice is consumed in Asia (FAO 2014). India is the 2nd largest producer and consumer of rice in the world. According to Mishra *et al.* (2021) vast majority of rice producers are in Asia, which is the emblematic cereal. Rice provides 50-80% daily calorie intake to the consumer (Choudhary *et al*. 2011). At present in India, 43.86 million hectare area is under rice crop with production of 104.80 million tonnes with productivity 2390 kg/ha and it has the share of 21% in global rice production during 2014-15. In Madhya Pradesh, rice is grown in about 2.15 million hectares area with the production of 3.63 million tonnes which clearly indicates that the productivity of rice is quite low *i.e.* 1684 kg/ha (Agricultural Statistics at a glance 2015).

Direct seeding of rice has more benefits as compared to traditional transplanting like easier planting, timely sowing, less drudgery, early crop maturity

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by 7 to 10 days, less water requirement better soil physical condition for next crop and low production cost and more profit. Weeds are one of the limiting factors in direct seeded rice which reduced the yield 50-80% in rainfed uplands (Ranjit and Suwanketnkom 2005). The risk of crop yield loss due to competition from weeds is higher in DSR than for transplanted rice because of the absence of the size differential between the crop and weeds and, the suppressive effect of standing water on weed growth at crop establishment (Rao *et al*. 2007).

Apart from yield reduction, weeds deplete nutrients from soil to the extent of 42.07 kg nitrogen, 10 kg phosphorous, and 21.08 kg potassium per hectare, respectively (Puniya *et al*. 2007) Use of herbicides to keep the crop weed free at critical crop weed competition stages help in minimizing the cost of weeding as well as managing the weeds below the damaging level. Hand weeding is very easy and environment-friendly but tedious and highly labour intensive. Generally pre-emergence herbicides like Pretachlor, Butachlor, Anilophos, and post-emergence herbicides like 2,4-D, and Almix are used frequently to control grassy and broad-leaf weeds in direct seeded rice. Continuous application of these herbicides also result in weed flora shift and development of herbicidal resistance in weeds. This situation warrants for initiating research efforts to develop and evaluate new and alternate herbicides to overcome the problem of herbicidal resistance in weeds.

A number of herbicides have been found effective for weed control in direct seeded rice, but due to changing weed flora in changing climate, the development of new herbicide is continuous process. Bentazon has been found to be effective post-emergence herbicide for controlling broad-leaf weeds in soybean in different parts of the country. Bentazon mostly used to control broad-leaf weeds in soybean. However the information is very meagre regarding its efficacy against weeds in direct seeded rice under Kymore Plateau and Satpura Hill zone.

MATERIALS AND METHODS

A field experiment was carried out during *kharif* season of 2016 at Research Farm of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur. The experiment consisted of ten treatments, viz. Bentazon at different doses (600, 800, 1000, 1200, 1600, 1800 and 2000 g/ha) and 2,4-D @ 380 g/ha as well as hand weeding at 20 and 40 DAS and weedy check. The experiment was laid out in RBD with three replications. All herbicides were applied using knapsack sprayer fitted with flat fan nozzle at a spray volume of 500 l/ha. Sowing of seed was done with seed drill on July 26th, 2016. Sowing of seeds in each plot was done in rows 20 cm apart at the depth of 2-3 cm and then seeds were covered with fine soil. The crop was raised by following recommended packages of practices for rice. The data on weed density and weed dry weight were collected from each unit plot at before application, 15, 30 and 45 DAA by quadrate count method. The quadrate of 0.25 square metres (0.5 m × 0.5 m) was placed randomly and weed species within the quadrate was identified and their number were counted. The average number of sample was multiplied by four to obtain the weed density/meter square. The weeds inside the quadrate were uprooted, cleaned and then oven dried.

Dry matter of weeds was recorded and expressed in g/m^2. The data obtained on various observations were tabulated and subjected to their analysis by using the techniques of the analysis of variance (ANOVA) as suggested by Panse and Sukhatme (1967). Significance of the treatments was tested by F test. Critical difference (C.D.) at 5% level of significance was determined for each character to compare the differences among treatment means. The data on weed count and weed biomass were subjected to square root transformation *i.e.*$\sqrt{X}$ + 0.5, before carrying out analysis of variance and comparisons were made on transformed values. Weed control efficiency (WCE) was calculated on the basis of weed biomass. Yield and yield attributes were recorded at the time of harvesting. Each experimental plot was threshed by Paddy thresher to determine grain yield and it is presented as tonnes per hectare (t/ha).

RESULTS AND DISCUSSION

Effect on weeds

In the experimental field, *Echinochloa colona* (25.99 %) was the rampant weed closely followed by *Mullogo pentaphylla* (25.27%). However, monocot weeds like *Dinebra retroflexa* (17.32%) and *Cyperus iria* (16.65%) and dicot weed like *Alternanthera philoxeroides*

(14.77%) were also present in less numbers in weedy check plots. The weed density of grassy weeds and sedge at 30 and 45 DAA was not affected due to different weed control treatments except in hand weeding treatments, where weeds were uprooted manually.

It is evident from the data presented in Table 1 that the application of Bentazon at lower doses (*i.e.* 600 and 1600 g/ha) and 2,4-D (380 g/ha) caused reduction in the density of broad-leaf weeds and proved significantly superior to weedy check plots where weeds are not controlled throughout the growing season, but efficacy of these herbicides was further enhanced when its higher doses applied at 1800 and 2000 g/ha. The later treatment proved statistically superior over rest of the herbicidal treatments. However, none of the herbicidal treatments surpassed the hand weeding twice which reduced the density of *Mullogo pentaphylla* and *Alternanthera philoxeroides* to the maximum extent (2.79 and 1.68/m^2).

The higher weed control efficiency observed in case of Bentazon at 2000 g/ha (83.86%) followed by Bentazon 1800 g/ha (78.81%) for broad-leaf weeds (Table 2). The higher weed control efficiency under these treatments was because of effective control of weeds which resulted in the lowest weed biomass and ultimately the higher weed control efficiency. Chetan *et al.* (2015) also reported the poor efficacy of Bentazon against grassy weeds.

Effect on yield and economics

The minimum number of grain yield was noted under weedy check (2896.33 kg/ha) and it increased significantly when weed control measures were adopted (Table 2). The grain yield increased when Bentazon was applied at lower doses @ 600 to 1600 g/ha (3434.67, 3656.00, 3996.33, 4093.67 and 5353.33 kg/ha) and it declined under high doses of Bentazon @ 1800 and 2000 g/ha (4939.67 and 4926.67 kg/ha) and 2,4-D @ 380 g/ha (4636.00 kg/ha) due to phytotoxicity.

Yield attributes (*viz.* Effective tillers/m^2, total and sound grains/panicle) were significantly higher

Table 1: Effect of different treatments on weed density at 30 and 45 DAA

Treatment	Doses (g/ha)	Grassy weeds				Sedge		Broad-leaf weeds			
		Echinochloa colona		*Dinebra retroflexa*		*Cyperus iria*		*Mullogo pentaphylla*		*Alternanthera philoxeroides*	
		30 DAA	45 DAA	30 DAA	45 DAA	30 DAA	45 DAA	30 DAA	45 DAA	30 DAA	45 DAA
T1 Bentazon	600	7.40 (54.27)	8.09 (65.02)	6.25 (38.61)	6.94 (47.70)	6.09 (36.61)	7.08 (49.70)	4.10 (16.33)	3.85 (14.32)	2.68 (6.70)	2.31 (4.83)
T2 Bentazon	800	7.46 (55.19)	8.11 (65.23)	6.26 (38.66)	6.94 (47.70)	6.01 (35.66)	7.09 (49.70)	4.02 (15.68)	3.63 (12.71)	2.61 (6.33)	2.24 (4.53)
T3 Bentazon	1000	7.50 (55.70)	8.09 (64.87)	6.33 (39.52)	6.93 (47.50)	6.00 (35.52)	7.07 (49.50)	3.99 (15.46)	3.60 (12.51)	2.49 (5.71)	1.92 (3.18)
T4 Bentazon	1200	7.41 (54.37)	8.20 (66.73)	6.26 (38.73)	7.02 (48.73)	6.02 (35.73)	7.02 (48.73)	3.76 (13.68)	3.49 (11.68)	2.41 (5.30)	1.81 (2.79)
T5 Bentazon	1600	7.48 (55.43)	8.14 (65.70)	6.26 (38.69)	6.98 (48.25)	6.10 (36.69)	6.98 (48.25)	3.34 (10.68)	2.79 (7.29)	2.19 (4.33)	1.67 (2.29)
T6 Bentazon	1800	7.42 (54.61)	8.14 (65.77)	6.24 (38.50)	6.93 (47.58)	6.00 (35.50)	7.08 (49.69)	2.96 (8.28)	2.60 (6.25)	1.93 (3.23)	1.43 (1.55)
T7 Bentazon	2000	7.50 (55.73)	8.19 (66.57)	6.35 (39.83)	7.02 (48.73)	6.03 (35.83)	7.02 (48.73)	2.79 (7.28)	2.38 (5.18)	1.69 (2.35)	1.24 (1.04)
T8 2,4-D	380	7.51 (55.97)	8.16 (66.0)	6.24 (38.43)	7.01 (48.69)	6.08 (36.43)	7.01 (48.69)	3.63 (12.68)	3.33 (10.58)	2.37 (5.14)	1.75 (2.55)
T9 Hand weeding	—	1.83 (2.87)	1.53 (1.83)	1.33 (1.27)	1.13 (0.77)	1.31 (1.23)	1.06 (0.63)	2.41 (5.29)	1.68 (2.32)	1.34 (1.31)	1.12 (0.75)
T10 Weedy check	—	7.48 (55.40)	8.12 (65.43)	6.25 (38.54)	6.93 (47.47)	6.09 (36.54)	7.00 (48.47)	7.49 (55.62)	7.94 (62.56)	5.57 (30.53)	6.25 (38.53)
SEm±		**0.05**	**0.01**	**0.01**	**0.01**	**0.01**	**0.03**	**0.04**	**0.05**	**0.04**	**0.01**
CD at 5%		**0.14**	**0.02**	**0.03**	**0.03**	**0.03**	**0.09**	**0.11**	**0.15**	**0.13**	**0.02**

Figures in parenthesis are original values.

Table 2: Effect of different treatments on yield, economics and yield attributing characters of the direct seeded rice

Treatment Doses (g/ha)	WCE of dicot weeds (%)	Effective tiller/m²	Grains/ panicle	Grain yield (kg/ha)	Cost of cultivation (₹/ha)	NMR (₹/ha)	B:C Ratio
T1 Bentazon600	65.04	378.36	56.71	3434.67	38470	18081	1.5
T2 Bentazon800	65.59	382.98	56.90	3656.00	38670	21213	1.5
T3 Bentazon1000	68.15	386.23	57.51	3996.33	38870	26485	1.7
T4 Bentazon 1200	70.12	399.83	58.25	4093.67	39070	27813	1.7
T5 Bentazon1600	74.45	479.90	58.81	5353.33	39470	47463	2.2
T6 Bentazon1800	78.81	428.57	57.76	4939.67	39670	40741	2.0
T7 Bentazon2000	83.86	424.08	57.71	4926.67	39870	40317	2.0
T8 2,4-D 380	72.21	410.32	57.97	4636.00	38003	37603	2.0
T9 Hand weeding	90.83	503.16	59.10	6169.00	49470	50293	2.0
T10 Weedy check	0.00	361.06	54.60	2896.33	37470	10747	1.3
SEm±	—	4.08	0.14	106.47	—	—	
CD at 5%	—	—	**0.52**	**316.20**	—	—	

under hand weeding twice followed by Bentazon as post-emergence @1600 g/ha. While the test weight of rice was not influenced due to different weed control treatments. Bentazon @1600 g/ha was the economically viable treatment among all the weed control treatments. The cost of cultivation was maximum (₹ 49470 /ha) under hand weeding twice owing to an additional expenditure of ₹ 12000 on labour, weeding, showing that control of weeds through hand weeding was more expensive than the use of herbicide in rice crop. Although the gross monetary returns was maximum (₹ 99763 /ha) in hand weeding twice among all the treatments and net monetary returns was also maximum under hand weeding twice at 20 and 40 DAS (₹ 50293 / ha) but it was not economically viable as it gave only 2.0 B:C ratio which was lower to Bentazon @ 1600 g/ha (2.2).

CONCLUSION

Based on the results obtained in the present investigation, it can be concluded that the post-emergence application of Bentazon at 1600 g/ha controlled broadleaf weeds in direct seeded rice and increased rice grain yield however, higher dose of Bentazon was slightly phytotoxic to the rice crop. Bentazon at 1600 g/ha controlled broadleaf weeds effectively but failed to control grasses and sedges.

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