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Weeds of direct-seeded rice influenced by herbicide mixture

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Abstract
The present study was carried out at Research Farm, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during the *Kharif* season of 2019. The experiment was laid out in Split Plot Design with two agro-ecosystems in the main plot and eight weed control treatments in sub plot and three replications. The study revealed that dominant weeds associated with direct-seeded rice in the experimental field were mainly comprised of monocot (*Echinochloa colona, Cynodon dactylon*), dicot (*Alternanthera sessilis*) and sedge (*Cyperus iria*) throughout the crop growing period. The post emergence application of bispyribac sodium at 25 g *a.i.*/ha being as good as weed-free check provided almost complete control of complex weed flora and it was better than other weed control treatments. However, the lowest values of density and dry weight of weeds were recorded in two hand weedings done at 20 and 40 DAS. Lower values of weed density and weed dry weight along with improved weed control efficiency was registered with bispyribac sodium at 25 g *a.i.*/ha, which was statistically at par with fenoxaprop-p-ethyl 6.7% EC + penoxsulam 24% SC at 60+26.7 g *a.i.*/ha under both the rainfed and irrigated agro-ecosystems.

Keywords: Agro-ecosystems, Bispyribac sodium, herbicides, direct-seeded rice, weeds

Introduction
Rice (*Oryza sativa* L.) is one of the most important crops in the world and is the foremost staple food in Asia, providing 35-60% of the dietary calories consumed by more than three billion people (Wang *et al.*, 2016) [14]. Rice plays a significant role in the economy of India and hence occupies a central position in national agriculture policy and food security (Dangwal *et al.*, 2011) [6]. In India, it is grown in nearly 43.39 m ha area with the production of 104.32 MT and productivity of 2404 kg/ha. In Madhya Pradesh, it occupies an area of 2.02 m ha with the production of 3.58 MT and productivity of 1768 kg/ha (Anonymous 2016). Direct-seeding of rice is suggested as a potential alternative and, currently, the area under direct-seeded rice (DSR) is increasing due to rapid depletion in ground water and escalating cost of its pumping vis-a-vis labour scarcity, besides several other production vulnerabilities under transplanted rice (Dass *et al.*, 2017) [7]. Direct-seeded rice (DSR) serves several advantages i.e. saves labour, helps faster, easier and timely planting, less drudgery, early crop maturity by 7-10 days, less water requirement, high tolerance to water deficit, often high yield, low production cost, more profit and less methane emission (Balasubramanian and Hill 2002) [2]. Weed management is the major challenge towards the success of this crop as weeds are comparatively denser in this system than in transplanted situations, because of the simultaneous emergence of rice and weeds due to the absence of standing water at the early stage of rice growth (Chauhan 2012) [3] and they compete with the crop for nutrients, light, space and moisture. The extent of yield reduction of rice due to weeds has been estimated up to 95% in India (Naresh *et al.*, 2011) [9]. Hand weeding is a common method of weed control adopted by farmers but comparatively; this method is time-consuming, coupled with high wages and a shortage of labours. Under such conditions, the use of suitable herbicides is the only substitute to get higher productivity with lower cost involvement. Generally, pre-emergence herbicides like pretilachlor, butachlor, anilophos and post-emergence herbicides like 2,4- D are used frequently to control grassy and broadleaved weeds in direct-seeded rice. Continuous application of the same herbicide may result in the shifting of weed flora and the development of herbicide resistance in weeds. To solve this problem, a new herbicide or herbicidal combination has been launched in India for large spectrum weed control in direct-seeded rice.

But the information on its efficacy against the weed flora in direct-seeded rice is very meagre. Keeping in view the above facts, an experiment was carried out to manage the weed problem in direct-seeded rice during the critical crop-weed competition period.

Materials and Methods

A field experiment was conducted in the sandy clay loam soil of the Research Farm of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during the *Kharif* season of 2019. The soil was neutral in reaction with a pH of 6.48, medium in available nitrogen and potassium and phosphorous. The variety used in the experiment was *MTU1010* and the crop was sown in July 2019. The experiment was laid out in split plot design comprising sixteen treatment combination with two agro-ecosystems viz., rainfed and irrigated in main plots and eight weed control treatments viz. bispyribac sodium 10% SC at 25 g *a.i.*/ha, fenoxaprop-p-ethyl 6.7% EC at 60 g *a.i.*/ha, fenoxaprop-p-ethyl 6.7% EC + penoxsulam 24% SC at 60 + 26.7 g *a.i* /ha, cyhalofop 10% EC + penoxsulam 24% SC at 135 + 26.7 g *a.i.*/ha, bispyribac sodium 10% SC + metsulfuron methyl 10% WP + chlorimuron ethyl 10% WP at 25+4 g *a.i.*/ha, triafamone 20% WG + ethoxysulfuron 10% WG at 40+20 g *a.i.*/ha as post-emergence herbicides, hand weeding twice at 20 and 40 DAS and weedy check in sub plots with three replications. Rainfall received during crop season in 2019 was 1396 mm. There was sufficient rain up to the first week of November, which did not cause any adverse effect on crop growth. During the crop growing season (July 2019 to Nov. 2019), maximum temperature (34.9 °C) was recorded in July and minimum (10.3 °C) in November months. Herbicides as per treatments were sprayed at 20 DAS using 300-500 l/ha water by a knapsack sprayer fitted with a flat-fan nozzle. The experimental data for various growth characters, yield attributing characters and yield were statistically analyzed.

Results and Discussion

Weed flora and relative density

The experimental plots under both rainfed and irrigated agro-ecosystems were infested with dominant four weed species belonging to three families. Two weed species were of the family Poaceae and one each of the family Amaranthaceae and Cyperaceae. Among the total weed, vegetation was annual and perennial (Table 1). Data on species wise weed density recorded in weedy check plots from both rainfed and irrigated agro-ecosystems. It is evident that there were predominance of *Echinochloa colona*, *Alternanthera sessilis*, *Cyperus iria* and *Cynodon dactylon* in both weedy plots of rainfed and irrigated agro-ecosystems. In experimental field, a total of four species were recorded, and out of these *Echinochloa colona* and *Alternanthera sessilis* recorded highest relative density presented in (figure 1 & 2). These findings are in agreement with the findings of Dixit and Bhan (2003) [8].

Table 1: Infesting species of weeds in the direct seeded rice of *Kharif* season

S. No.	Local Name	English Name	Scientific Name	Family	Morphological type
1.	Jungle rice	Water grass	*Echinochloa colona*	Poaceae	Grass
2.	Sessile Joyweed	Spiny pigweed	*Alternanthera sessilis*	Amaranthaceae	Broad leaved
3.	Motha	Rice flat sedge	*Cyperus iria*	Cyperaceae	Sedge
4.	Doub Grass	Bermuda grass	*Cynodon dactylon*	Poaceae	Grass

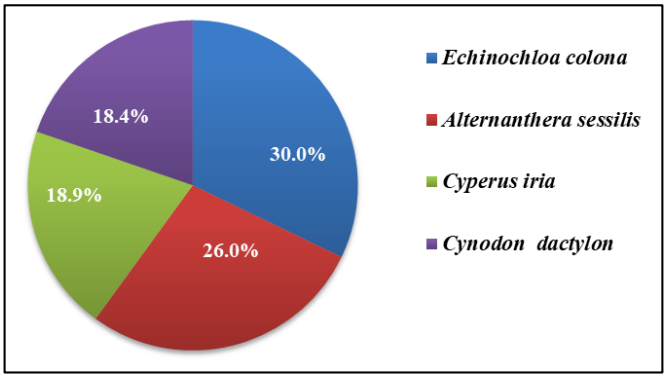

Fig 1: Relative density of weeds under rainfed agro-ecosystems

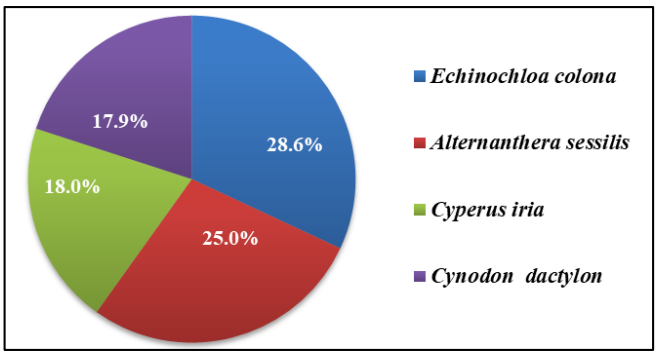

Fig 2: Relative density of weeds under irrigated agro-ecosystems

Weeds and weed control efficiency

Density and dry weight of weed represented the extent of competition posed by weeds on the crop. The treatment which exhibited the minimum density and dry weight for the weeds was considered the best. Weed management practices influenced the weed population greatly. The total weed population was reduced significantly due to various weed control treatments. At 30 DAS, the highest weed density and weed dry matter were recorded in weedy check plots where weeds were not controlled throughout the growing season and bispyribac sodium 10% SC at 25 g *a.i.*/ha was found to be more superior in curtailing the weed population and dry weight of weeds followed by fenoxaprop-p-ethyl 6.7% EC + penoxsulam 24% SC at 60+26.7 g *a.i.*/ha as compared to unwedded control (Table 2). Significantly, the lower weed density and dry weight were observed with two hand weeding where it was at par with bispyribac sodium 10% SC at 25 g *a.i.*/ha. This might be due to the timely eradication of weeds by intercultural tools, which uprooted and killed the weeds. The weed control efficiency was maximum (95.6%) under hand weeding twice. Among the combinations of agro-ecosystems along with different weed control treatments, the excellent weed control efficiency (WCE) was observed in irrigated agro-ecosystem and bispyribac sodium 10% SC at 25 g *a.i.*/ha and higher than other treatment combinations. These findings were in conformity to those of Sharma *et al.* (2020) [10] and Verma *et al.* (2021) [13].

Table 2: Effect of different treatments on total weed density, dry weight and weed control efficiency at 30 DAS in direct seeded rice

Treatments	Weed density (No./m^2)	Weed dry weight (g/m^2)	WCE % (30 DAS)	
Agro-ecosystems			**RF**	**IR**
Rainfed	5.65 (37.38)	6.25 (45.16)	-	-
Irrigated	5.33 (32.87)	6.05 (42.70)	-	-
LSD (P=0.05)	NS	NS		
Weed control treatments				
Bispyribac sodium 10% SC at 25 g *a.i.*/ha	4.13 (17.13)	4.78 (22.83)	83.3	83.4
Fenoxaprop-p-ethyl 6.7% EC at 60 g *a.i.*/ha	6.47 (41.78)	7.24 (52.38)	61.3	62.6
Fenoxaprop-p-ethyl 6.7% EC + penoxsulam 24% SC at 60+26.7 g *a.i.*/ha	4.56 (20.75)	5.14 (26.25)	80.6	81.1
Cyhalofop 10% EC + penoxsulam 24% SC at 135+26.7 g *a.i.*/ha	4.95 (24.77)	5.45 (29.87)	76.8	78.7
Bispyribac sodium 10% SC + metsulfuon methyl 10% WP + chlorimuron ethyl 10% WP at 25+4 g *a.i.*/ha	5.59 (31.30)	6.42 (41.17)	69.3	69.7
Triafamone 20% WG + ethoxysulfuron 10% WG at 40+20 g *a.i.*/ha	5.21 (27.42)	5.87 (34.60)	73.4	75.1
Twice hand weeding	2.43 (5.48)	2.54 (5.98)	95.2	95.6
Weedy check	10.60 (112.40)	11.77 (138.40)	0.0	0.0
LSD (P=0.05)	0.84	0.79		

RF= Rainfed, IR= Irrigated, WCE=Weed control efficiency

Conclusion

Based on this study, it can be concluded that in direct-seeded rice, the maximum weed control efficiency is obtained with post emergence application of bispyribac sodium 10% SC at 25 g *a.i.*/ha.

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