WEED MANAGEMENT IN DIRECT SEEDED RICE CROP

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ABSTRACT

Dry seeding of rice (Oryza sativa L.*) involves a major change in the production practices for attaining optimal plant density and high water productivity in the water-deficit areas of Pakistan. Weeds pose serious threat to sustainability and viability of direct seeded rice system. Information on weed management in dry seeding rice in Pakistan is lacking. A field experiment was conducted to identify appropriate, effective, and economical methods of managing weeds in dry-seeded rice. The major weeds associated with dry-seeded rice were Echinochloa crus-galli, Cyperus iria, C. difformis, Paspalum distichum, Eclipta prostrata, and Trianthema portulacastrum. Pendimethalin 750 g a.i. ha^{-1}, ethoxysulfuron at 18 g a.i. ha^{-1}, and 2,4-D (ester) at 500 g a.i. ha^{-1}, were equally effective in realizing higher rice grain yields by controlling broad leaf weeds and sedges. Among these, 2,4-D (ester) at 18 g a.i. ha^{-1} was found to be least expensive but effective for controlling broad leaf weeds. Effective and economical weed control methods include pre- and post-em herbicides along with one hand weeding was found effective in controlling weeds and producing higher paddy yield.*

Keywords: Direct and dry-seeding, rice herbicides, paddy yield., weed density, weed management,

INTRODUCTION

Rice is the main food staple after wheat and an exportable commodity. Traditionally, rice is grown by transplanting one-month old nursery seedlings into the puddled and continuous flooded soil condition. Puddling is done to create a hard pan below the plough-zone for reducing soil permeability. High losses of water occur through the puddling process, surface evaporation, and percolation. Rice consumes 21% of available fresh water in Pakistan. Water resources, both at

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surface and underground, are shrinking and may water become a limiting factor n future. Moreover, transplanting operation is usually performed by hired expensive labor. Due to urbanization and industrialization in our country, shortage of specialized labour for transplanting is becoming a major constraint to many rice growers for the timely transplanting and maintaining the required plant population to achieve higher productivity.

The rice in Punjab province has recently expanded to 0.65 million hectares of non-traditional belt, where puddling is not much practiced due to severe shortage of water (Mann, 2006). There is no appropriate rice crop establishment technology for such areas. Growing rice under “aerobic” environment can reduce water losses to a greater extent. Therefore, it is suggested that alternate method of planting viz., Direct-seeding should be adopted instead of the conventional transplanting to reduce the water and labour demand, which will ultimately decrease the cost of production.

Direct seeding rice avoids the puddling and maintains continuous moist soil conditions and thus reduces the overall water demand for rice culture. In South Asia, Direct seeded rice (DSR) is being practiced on terraced and sloppy lands of Bangladesh, along the coast and Western Himalayan region of India (Gupta et al., 2007). The productivity of the DSR rice is often reported to be lower, mainly due to problems associated with weed management. In order to save water and labor and promote conservation agriculture (CA), with no/reduced tillage, it is absolutely essential to replace puddled transplanting with direct seeding.

Weed infestation continues to be a serious problem in dry-seeded rice. Aerobic soil conditions and dry-tillage practices, besides alternate wetting and drying conditions, are conducive for germination and growth of highly competitive weeds, which cause grain yield losses of 50–91% (Elliot *et al*., 1984; Fujisaka *et al.*, 1993). Recently Singh *et al*. (2005) reported good success with dry-seeded rice production technology in large-scale farmer participatory trials in the Terai of Uttaranchal, India, when the stale-seed bed technique was combined with the application of pre-emergence herbicide, pendimethalin within 2 days after seeding (DAS). Thus, timely weed control is crucial to increasing rice productivity. Herbicides are considered to be an alternative supplement to hand weeding. The development of new and improved herbicides for dry-seeded rice is also needed (Gupta et al., 2003). Several pre-emergence herbicides including butachlor, thiobencarb, pendimethalin, oxadiazon, oxyfluorfen, and nitrofen alone or supplemented with hand weeding, have been reported to provide a fair degree of weed control (Janiya and Moody, 1988; Moorthy and Manna, 1993; Pellerin and Webster, 2004). But, most of them are not available in Pakistan. Thus, it is crucial to upgrade the DSR technology along with assured weed management, and make it more cost-effective, environment- and farmers' friendly.

MATERIALS AND METHODS

A field experiment was conducted at the Rice Research Institute, Kala Shah Kaku, Punjab, during 2003. A randomized complete block design (RCBD) with six treatments and three replications was used. The plot size was 6 x 4 m^2. Six treatments included weedy; weed free; pre-emergence herbicide (pendimethalin) + one hand weeding at 25 DAS; pre-emergence herbicide (pendimethalin) + two hand weeding-one at 25 DAS and second at 45 DAS; post-emergence herbicides (2-4-D ester and ethoxysulfuron) with one hand weeding at 45 DAS; and pre-emergence + post-emergence herbicides at 35 DAS. Weed density and weed dry weight data were recorded at 45 and 75 DAS. Four hand weeding were done to keep the crop weed-free, in the respective treatment.

Rice variety Super Basmati (long duration, long-grain, and aromatic) was used and drilled, using seed rate of 30 kg ha^{-1}. Land was prepared with a tractor, comprising six ploughings (two times disc harrow + four times cultivator) and three planking. For seed drilling, zero-tillage drill was used, having 23 cm row to row spacing. After seeding, pendimethalin @ 0.75 kg (a.i) ha^{-1} was applied as pre-em to the required treatments. Then, irrigation was applied to all the treatments and subsequent irrigations were applied to keep the field submergence for one month. Ethoxysulfuron (18 g (a.i) ha^{-1}) and 2,4-D (ester) (500 g (a.i) ha^{-1} were mixed and applied at 35 DAS. Fertilizer at the rate of 120-65-60 kg NPK ha^{-1} was applied in three splits. All the phosphatic and potash were given before seeding. Nitrogenous fertilizer was given in three splits, first at seeding, second at 30 DAS and third at panicle initiation stage. Normal irrigations were applied to keep the field in moist conditions. Recommended insecticides were also applied to protect the crop from insect attack.

Weed density was recorded with the help of a quadrant (0.5 x 0.7 m^2) placed randomly at two spots in each plot. To record weed dry weight, weeds were cut at ground level, washed with water, sun dried, subsequently dried at 70^{o}C for 48 h, and then weighed. The data of actual number of weeds were transformed by angular transformation for statistical analyses. Grain yield data were recorded in a 6 m^2 area in the center of each plot and expressed in tons ha^{-1} having 14% moisture.

RESULTS AND DISUSSION

The major weeds associated with the dry seeded rice were *Cyperus rotundus*, *C. iria*, *C. difformis*, *Eclipta prostrata*, *Trianthema portulacastrum* and *Portulaca oleracea* (Table-1). All the herbicide treatments resulted in lower weed density than the weedy check. The weedy check plot had as much higher weeds as upto 76 m^{-2} at 45 DAS and 82 weeds m^{-2} at 75 DAS. Pendimethalin as pre-emergence herbicide was found better to control early flush of weeds while, 2,4-D (ester) and ethoxysulfuron were equally effective in reducing post-emergence weeds. Ethoxysulfuron was also reported to be effective in controlling a wide range of broadleaf weeds as well as perennial sedges, alone (Beaty *et al.*, 1993; Hess and Rose, 1995) or in combination with anilofos (Nagappa *et al.*, 2002). Hand weeding is also required to control the weeds, particularly at the most rapid tillering stage of rice crop. A combination of two post-emergence herbicides like 2,4-D and ethoxysulfuron provides an encouraging results to control all kinds of weeds viz., grasses, sedges and broad leaf weeds (Table-2). Broad leaf weeds were relatively higher than the sedges. Dry weight of weeds at 75 DAS was as high as 72 g m^{-2} in the weedy plots. However, pendimethalin along with two hand-weeding also controlled the weeds to a great level.

Table-1. Weed species and density (No. m^{-2}) in DSR at 45 DAS.

Treatments	Weed species						
	Cyperus iria	***Cyperus difformis***	***Paspalum distichum***	***Eclipta prostrata***	***Trianthema portulacastrum***	**Other broad leaf weeds**	**Total**
Weedy	28	18	8	7	5	10	76
Weed-free	0	0	0	0	0	0	0
Pre-emergence herb.+ 1HW	3	5	1	-	2	1	12
Pre-emergence herb +2HW	1	1	-	-	1	2	5
Pos-emergence herb.+1HW	7	4	2	2	3	2	20
Pre- + Post-emergence herb	5	7	2	3	-	2	19

Table-2. Density and dry weight of weeds at 45 and 75 DAS.

Treatments	45 DAS				75 DAS			
	Density(no m^{-2})		Dry wt (g m^{-2})		Density (no m^{-2})		Dry wt (g m^{-2})	
	B. L. weeds	Sedges	B. L. weeds	Sedges	B. L. weeds	Sedges	B. L. weeds	Sedges
Weedy	30	46	9.5	12.2	34	48	63.5	72.2
Weed-free	0	0	0	0	0	0	0	0
Pre-emergence herb+1 hand weeding	4	8	1.0	1.2	12	22	24.3	38.3
Pre-emergence herb + 2 hand weeding	3	2	0.8	0.4	8	7	13.2	15.7
Post-emergence herb.+ 1 hand weeding	9	11	1.7	2.0	14	16	27.4	
Pre- + Post-emergence herbicides	7	12	1.6	2.2	23	28	36.8	63.6

B.L. weeds = Broad leaf weeds

The paddy yield and its components were found higher in all weed management treatments as compared to weedy check (Table-3). The grain yield of dry-seeded rice with weed-free treatment was close to other weed control treatments. The weed-free plot produced paddy yield of 3.8 t ha^{-1}, almost double than the weedy plot. Application of herbicides along with hand weeding also produced paddy yield at par with weed-free plot. Plant height, panicle length and grains per panicle also followed similar trend. Ethoxysulfuron as a post-emergence treatment effectively kept broad leaf weeds under control, resulting in paddy yield comparable with that of weed free treatment. Effective weed control and improved grain yields with ethoxysulfuron were earlier reported in transplanted rice (Bhowmick and Ghosh, 2002) and wet-seeded rice (Saini and Angiras, 2002). Based on these observations, it can be concluded that ethoxysulfuron at 18 g a.i. ha^{-1}, and 2,4-D (ester) at 500 g a.i. ha^{-1} were equally effective and essentially required in achieving higher grain yields by controlling broad leaf weeds in dry seeded rice. Increased yield through effective weed control was also noticed with fenoxyprop ethyl by Lourens *et al*. (1989).

The use of two or more herbicides sequentially or in combination to broaden the spectrum of chemical weed control, reduce production costs, and/or prevent the development of weeds resistant to certain herbicides (Kelly and Coats, 1999). It can be concluded from these studies that effective control of both grass and broad leaf weeds and

higher grain yield of dry seeded rice could be attained by application of either ethoxysulfuron (18 g a.i. ha^{-1}) at 35 DAS, with one hand weeding at 45 DAS or pendimethalin (750 g a.i. ha^{-1}) applied as pre-emergence and one hand weeding at 45 DAS. In fields, where broad leaf weeds predominate, ethoxysulfuron alone could be used. Selection of weed control measures based on the weed flora in dry seeded rice would enable farmers to control weeds with lower cost.

Table-3. Grain yield and other parameters of rice crop.

Treatments	Plant ht. (cm)	Panicles (m^{-2})	Panicle Length (cm)	Grains ($panicle^{-1}$)	Grain Yield ($t\ ha^{-1}$)
Weedy	98 b	140 c	22.7 b	75 c	1.91 b
Weed-free	113 a	215.6 a	27.3 a	120 a	3.70 a
Pre-emergence herb.+ 1 HW	112.3 a	196.0 b	26.5 a	113 ab	3.57 a
Pre-emergence herb + 2 HW	113.0 a	205.2 ab	26.8 a	114 ab	3.65 a
Post-emergence herb.+1HW	112.5 a	200.6 b	25.7 a	112 ab	3.53 a
Pre- + Post-emergence herb	111.6 a	198.7 b	26.1 a	110 b	3.48 a

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