SCREENING OF HERBICIDES AS POST-EMERGENCE APPLICATION FOR EFFECTIVE WEED CONTROL WITHOUT AFFECTING GROWTH AND YIELD OF DIRECT SEEDED RICE PLANT

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ABSTRACT

Trials were conducted at the experimental area of Rice Research Institute, Kala Shah Kaku, Lahore during the Kharif seasons of 2000 and 2001 to find out the best strategy of chemical weed control in direct seeded Super Basmati rice (*Oryza sativa* L.). The experiment was laid out in randomized complete block design and replicated thrice with a net plot size of 6 x 9 m^2. During each year, drill sowing was done on 10^{th} of June after soaking seed (paddy) for 24 hrs. Different herbicide treatments kept in the experiment were Sunstar 15WG, Machete 60 EC, Puma Super 69EW, Rifit 500L, Sunstar 15WG + Puma Super 69EW and Acer 50 EC in addition to untreated control. Spray was done 22 days after sowing. Puma Super 69EW, Sunstar 15WG + Puma Super 69EW and Acer 50 EC showed maximum phytotoxicity on rice crop whereas best weed control was achieved by Sunstar 15WG and Sunstar 15WG + Puma Super 69EW herbicide treatments. In terms of paddy yield, Sunstar 15WG was proved best whereas Machete 60 EC, Sunstar 15WG + Puma Super 69EW also expressed good performance. The untreated control treatment produced the lowest (2.24 t/ha) paddy yield than all other treatments.

Key words: Rice (*Oryza Sativa*); herbicides; Phytotoxicity; Yield

INTRODUCTION

Rice is the leading cereal crop in the world. One third of the world's population depends on rice for nearly two thirds of its food. In densely populated areas of Asia, rice is the main food. Rice is grown on more than 148 m. ha in 111 countries in the world; most in Asia (90%) and the rest 10% in the America, Australia and Europe (Datta and Baltazar, 1998). People living in the Asian continent account for 53% of world's 6.5 billion population (Malik and Moorthy, 1998). The growth of the world's population is expected to exceed up to 8.5 billion by the year 2020 and subsequently, this will require increased rice and other food production. This could be satisfied, either by increasing areas of the crops or by achieving higher crop yields. The first option may not be feasible for various economic and environmental reasons. In Asia during the past decade, rice areas in most of the major rice producing countries have remained static or even declined. Therefore production should be increased by increasing the yield per unit area (Labrada, 1998). In Pakistan, the rice is grown on an area of 6.18 million acre, with annual production of 4.95 million tones and an average yield of 8208 Kg/ha (Anonymous, 2004) which is much lower than many other rice growing countries of the world. There exists a great scope of increasing rice production, as present yield level is much lower than the potential of our existing varieties. Previous research conducted at Rice Research Institute Kala Shah Kaku showed that the control of weeds is, however major constraint in the adoption of direct seeding method of rice culture. There are so many yield-limiting factors, among them weeds are, without any doubt, a major pest and constraint to increasing rice production. It is estimated that weeds are reducing the yield usually 15-20 % but in some cases yield losses can be more than 50 %, depending upon the species and intensity of weeds. Weeds grow more in Kharif season crops especially in rice than Rabi season crops because two important inputs needed for weed germination and growth are water and high temperature that are easily available to weeds in rice fields. The most problematic weeds in rice in Sub-continent are *Echinochloa crus galli*, *Echinochloa glabrescens*, *Cyperus rotundus*, *Cyperus difformis*, *Cyperus iria*, *Cyperus maritimus*, *Paspalum distichum*, *Echinochloa Colona*, *Eleusine indica*, *Marsilea minuta* (Sandeep *et al.*, 2003, Rekha *et al.* 2003).These weeds are also problematic in the rice field of Punjab Province of Pakistan (Ahmad et.al., 2004).

Weeds in direct seeded rice can be controlled by two methods viz., cultural and chemical. Cultural methods are of two types. One is through land preparation (puddling for one month) and the other through labour. Both cultural methods are not economical and feasible because water and labour are expensive and scanty. In the current scenario, the only feasible and economical method of weeds control in rice is by the use of chemicals. Some researchers reported that weeds are easily controlled in rice by the use of herbicides (Sonawane and Ambekar, 1999) but they were toxic to nursery stage seedling (Fujita, 1996). Balasubramanian

and Veerbadran (1998) reported that thiobencarb gave slight toxicity to rice, pendimethaline slight stunting, and butachlor produced pronounced injury. Fujita (1996) reported that the degree to which seedling traits were affected depended on the herbicide application. In direct drill seeded rice, weed control is even more critical & difficult than in transplanted rice. Because all the herbicides used in rice to control the weeds are pre-emergence (used before the growth of weeds) & needed to stand the water in the field 5-7 days after their use which is not possible in the direct drill seeded rice. Weeds began emerging at the same time or 3-5 days after rice sowing (Hi-Jinhao *et al*. 1999).These weeds after rice germination are not controled by pre-emergence herbicides but cultural control is not easy because hand weeding in direct seeded rice is tedious, time consuming and not economical. Weeds compete with rice plant for light, space, air and nutrition. Owing to this reason rice plant produces lower yields. *Echinochloa crus-galli* plants are so identical with rice plants that labour can not easily differentiate it from rice plant at early stage of development while uprooting through hoeing. More competition will develop among weeds and rice plant because this weed plant has similar stem, leaves and root system as rice plant has. The present study was therefore designed to test the different herbicides as post-emergence to find out most appropriate post-emergence herbicide which can effectively control the weeds in direct seeded drill sowing with out showing any toxicity to rice plant.

MATERIALS AND METHODS

The experiment was conducted at the Rice Research Institute, Kala Shah Kaku during Kharif seasons of 2000 and 2001 to find out the suitable herbicides, which have no toxicity effect on young rice seedling and effectively control the weeds as post emergence in direct drill sown rice.

Table 1: Some physical and chemical properties of the soil used for the study

Parameter	0-15 cm depth	15-30 cm depth
E.C. dS/m	1.1	0.9
Soil pH	7.6	8.2
Organic Matter %	0.97	0.56
Nitrogen %age	0.044	0.028
Available Phosphorous (ppm)	9.3	8.3
Available Potash (ppm)	100	80
Saturation % age	40	38
Texture	Clay Loam	Loam

The experiment was laid out in a Randomized Complete Block Design (RCBD) and replicated three (3) times having a net plot size of 6 m x 9 m (54 m^2) Super Basmati was used as test variety in this study. The physio-chemical properties of experimental site are given in table 1.

In the experiment, five different herbicides viz., Sunstar 15WG, Machete 60 EC, Puma Super 69EW, Rifit 500L, Aser and one herbicide combination of Sunstar 15WG + Puma Super 69EW were compared with the control. Before direct seeding, land was well prepared. Direct seeded rice was sown on 10th June. Drilling of soaked seed was done through Zero-tillage drill machine and row to row spacing 9 inches (22.5 cm) was maintained. At the time of sowing 45 Kg N/ha, 84 Kg P/ha and 62 Kg K/ha were applied in the form of Urea, Di-ammonium Phosphate and Potassium Sulfate respectively through Zero tillage drill machine. Same amount of urea was applied at 35 & 55 days after seeding. Recommended herbicides with recommended doses were sprayed 22 days after sowing to the direct seeded plots through spraying to control the young weeds because maximum weeds germinate after 1st irrigation. Sparacino *et al*. (1991) reported that herbicides are more effective on very young weeds. Other agronomic and cultural practices were kept standard and uniform for all treatments for both years (2001 & 2002). During the course of study data regarding crop, weeds and crop tolerance were recorded.

Weed count data: Observations were recorded when the age of seedling was twenty two days i.e. on 2nd July. Three samples of one meter square area were selected at random from each repeat. Number of all the species of present in the field were calculated by taking the average of three samples.

Herbicide toxicity/ crop tolerance: The phytotoxicity of different herbicides was assessed by visual rating and containing the plant stand

Data on paddy yield and yield components: Data on paddy yield and yield components i.e. plant height. Productive tillers / meter^2, grains per panicle, sterility % age, 1000 grain weight and root length were recorded by counting the average of three samples taken randomly from each repeat.

Data analysis: Data collected were statistically analyzed using Fisher's Analysis of Variance technique and treatment means were compared by LSD at 0.05 probability (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

The effects of different treatments on crop tolerance/phytoxicity, weed control, paddy yield and

yield components were studied and the results are given below:

Table 1: Analysis of variance table of mean squares of weed count data before and after herbicide application, yield &yield components

S.O.V.	D.F.	Weed pop./m^2 BHA	Dead Weed pop./m^2 AHA	Alive weeds pop./m^2 AHA	Plant height (cm)	Tillers/m2	1000 grain weight.	Sterility % age	Yield (t/ha)
Rep.	2	54197.9	8642.5	25729.2	192.2	2719.3	0.20	38.17	0.032
Treat.	6	23485.1	50318**	72463.6*	106.5	1822.3	3.74**	10.16	0.358**
Error	12	14639.9	3628.4	16396.1	99.9	2107.9	0.16	20.77	0.030
CV %		39.63	58.95	61.46	8.44	13.23	1.90	29.06	6.60

AHA =after herbicide application, BHA = before herbicide application
* = Significant ($p < 0.05$), **= Significant ($p < 0.01$)

Crop Tolerance / Phytotoxicity: The phytotoxicity of different herbicides was assessed by visual rating and counting the affected plants is given in table-2.

Table-2 The phytotoxicity of different herbicides in direct seeded rice (Super Basmati)

Herbicide	Rate	%age Phytotoxicity
T_1 (Sunstar 15WG)	80 g / acre	5
T_2 (Machete 60 EC)	800 ml / acre	15
T_3 (Puma Super 69EW)	500 ml / acre	80
T_4 (Rifit 500L)	450 ml / acre	13
T_5 (Sunstar 15WG + Puma Super 69 EW)	55 g / acre + 300 ml / acre	62
T_6 (Acer 50 EC)	40 ml / acre	58
T_7 (Untreated Control)	-	0

Eight days after herbicides application as post emergence phytotoxicity was visually accessed. It was noted that Puma Super 69EW gave severe toxicity to rice plants and Machete 60 EC showed lesser toxicity than all other herbicides. Sunstar 15WG showed no phytotixicity effect to rice plant. Shibayama and Fujita (1989) reported that some herbicides applied as post emmergence to direct seeded rice resulted in reduced tiller production, decreased length of leaf sheath by approx. 20% and length &width of leaf blades by approximately 30 and 10% respectively. In addition, it caused delayed leaf emergence, inhibition of the emergence and elongation of crown roots and abnormal root branching as assessed 2-4 weeks after treatment. Zhang (1989) reported that trifluralin resulted in reduced plant density but not the individual grain weight or grain yield at harvest

Weed control: Rice crop is grown during Kharif season, so conditions in the rice field favour the growth and production of aquatic and semi-aquatic weeds. Three types of weeds were found in the direct drill seeded field of study i.e. Grasses, Broad leave weeds (BLW) and Sedges. The data on weeds count according to the type of weeds were recorded at 22 days after sowing(DAS) the rice (i.e. before herbicide application) and 30 days after sowing the rice DAS (i.e. 8 days after herbicide application). Data is presented in the table-3

From the data presented in table-3, it is revealed that the number of weeds in all the herbicide treated plots was less than untreated control plot. After herbicides application, weed population per $meter^2$ was maximum (377.0) in T7 (untreated control) where no herbicide was applied. Minimum weed population per $meter^2$ of 15.33 and 29.33 was recorded in T1 (Sunstar 15WG) and T5 (Sunstar 15WG + Puma Super 69EW) respectively which were statistically at par with each other and significantly lower from all other treatments. Same results were reported by Hi-Jinhao *et al*.(1999) From percent weeds control data (Table-3) it is evident that Sunstar 15WG gave excellent weed control than all other treatments. It was followed by Sunstar 15WG + Puma Super 69EW and least percent weed control was done by the herbicide Rifit 500L.

Table-3 Weed control in direct seeded rice through different herbicide application treatments

Herbicides	Rate/ Dose (ml/ ha)	Weed population /m^2 BHA (22 DAS)	Dead Weeds pop./m^2 8 DAH spray	No of weeds survive/ m^2 8 DAH spray	% weed control
T_1 (Sunstar 15 WG)	80 g / acre	337.3ab	322.0a	15.33c	95.48
T_2 (Machete 60 EC)	800 ml / acre	421.0a	30.0b	391.0a	7.13
T_3 (Puma Super 69EW)	500 ml / acre	320.0ab	46.67b	306.7a	14.58
T_4 (Rifit 500L)	450 ml / acre	153.0b	7.33b	145.7b	4.79
T_5 (Sunstar 15WG + Puma Super 69EW)	60 g / acre + 375 ml / acre	281.7ab	252.3a	29.33c	89.56
T_6 (Aser)	40 ml / acre	247.0ab	57.0b	193.3b	23.08
T_7 (Control)	-	377.3ab	0.00b	377.0a	0.0
LSD Values		215.4	107.2	227.8	

Peterson and Reed (1990) also reported that bensulfuron-ethyl and pyrasulfuron-ethyl and methyl provided good control of broad leave weeds and sedges compared to 2,4-D-butyl and others, *Echinochloa Cruss galli* and others weeds when applied in early stages of weed growth and as equally effective in non flooded & flooded field. They did not cause crop injury. Suzuki *et al*. (1990) found pyrasulfuron-ethyl to show excellent herbicidal activity as pre and post emergence for 12 major weeds of rice but not for *E. Crus galli.* Broad leaved weeds & sedges were especially sensitive to this herbicide. It has low toxicity to humans and terrestrial and aquatic fauna.

Table-4: Kinds of weeds which survive after herbicide application in each plot

Herbicide	Rate (ml/acre)	No. of Weeds/m2 survive 8 days after herbicide application			
		Grasses	Sedges	B.L.	Total
Sun Star	80 g / acre	2.2	10	3.2	15.4
Machete	800 ml / acre	2.7	385	3	390.7
Puma Super 69EW	500 ml / acre	1	294	10.1	305.13
Rifit 500L	450 ml / acre	1.3	142	2.2	145.5
SS+PS	55 g / acre + 300 ml / acre	1	25	1.3	27
Aser	100 ml / acre	10.83	179.2	3.33	193.3
Control	-	2.33	366	8.33	376.66

Table-5: Yield and yield components of direct seeded rice as affected by different herbicide application treatments

Herbicides	Rate/ Dose (ml/ acre)	Plant height (cm)	Tillers/m2	1000 grain weight.	Sterility % age	Yield (t/ha)
T1 (Sun Star)	80 g / acre	121.0	336.8	22.53a	15.76	3.323a
T2 (Machete)	800 ml / acre	114.2	319.2	20.21c	16.22	2.696b
T3 (Puma Super 69EW)	500 ml / acre	112.3	336.2	20.32c	18.62	2.385bc
T4 (Rifit 500L)	450 ml / acre	116.6	357.0	21.80b	15.36	2.524bc
T5 (Sunstar 15WG + Puma Super 69EW)	55 g / acre + 300 ml / acre	130.7	395.5	21.43b	16.50	2.689b
T6 (Aser)	100 ml / acre	117.4	350.8	21.53b	12.52	2.554bc
T7 (Control)	-	116.4	333.5	19.28d	14.89	2.243c
LSD Values		17.78	81.68	0.7094	8.107	0.3081

Mean values having the same letters are not significantly different

Data regarding plant height as affected by different treatments are given in table-5. It is clear from the data that T5 (Sunstar 15WG + Puma Super 69EW) produced taller plants (130.7 cm) than the rest of the treatments. The lowest plant height (112.3 cm) was recorded in T3 (Puma Super 69EW). Shibyama and Fujita (1989) reported that plant height increased from control values of 38 cm to 61-64 cm.

Number of tillers per hill as affected by different herbicide application treatments is shown in Table -5. Data from the table revealed that all the treatments showed non significant difference. However maximum number of tillers per m^2 (395.5) were found in T5 (Sunstar 15WG + Puma Super 69EW) whereas minimum (319.2) were recorded in T2 (Machete 60 EC). It is clear from the table that all the herbicides used as pre-emergence have no pronounced effect on plant population. Moorthy and Mittra 1992 claimed that herbicides increase the crop stand. Effect of different herbicides application treatment on sterility percentage of direct sown Super Basmati rice presented in table-5 revealed that all the treatments showed non significant difference among each other. However, the maximum value of sterility percentage (18.62%) was recorded in T3 (Puma Super 69EW) treatment as compared with minimum of 12.52% under T6 (Aser).

Tiwar et.al. (1991) reported that all other herbicide treatments resulted in 5-60%weed control efficiencies. Five parameters of rice growth i.e. pop. density, panicle length, No. of sterile & non sterile grains per panicle and shoot weight were improved from weedy control levels by many of the treatments. Rice grain yields were increased from a control value of 2.14 t/ha to 4.10 t/ha in manual weeding and also by some herbicide treatments.

Data given in Table-5 revealed that all the treatments showed significant difference between them regarding 1000 grain weight. However, on the basis of two year average data, 1000-grain weight varied from 19.28 g to 22.53 g. 1000 grain weight was recorded significantly higher (22.53 g) in treatment T1(Sunstar 15WG) while lowest (19.28 g) in treatment T7 (untreated control). 1000 grain weight in T4 (Rifit 500L), T5 (Sunstar 15WG +Puma Super 69EW) & T6 (Aser) was statistically at par with each other and significantly higher than T2 (Machete 60 EC) &T3 (Puma Super 69EW) and lower than T1 (Sunstar 15WG).

Paddy yield was significantly affected by different herbicide treatments (Table-5). Maximum paddy yield of 3.323 t/ha was obtained under the treatment T1 (Sunstar 15WG) which was statistically higher than all the other treatments, while the minimum paddy yield (2.243 t/ha) was observed under control treatment which was significantly lower than all other treatments except T3 (Puma Super 69EW), T4 (Rifit 500L) & T6 (Aser). In herbicide treated plot weed growth was insufficient to depress rice yield significantly. Hawton (1992) reported that Nutrient uptake increased by the removal of weeds so yield was high in herbicide treated plots. Fang and Wang (1990) reported that in herbicide untreated control plots, yield and yield components decreased and Weed crop competition was greatest 25-40 DAS.Yield losses of up to22.7 % were observed by Mukhopadhyay and Banerjee (1993) in unweeded direct seeded flooded rice (3238 Kg/ha) when compared to rice treated with thiobencarb or 2,4-D

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