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Effect of Different Application Times of Herbicides on Yield and Yield Components of Rice in Direct Wet Seeded Rice Culture

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Abstract: An experiment was conducted to study the effect of different times of application of herbicides on the yield and yield components of rice under direct wet seeded culture during 1999 and 2000. Results showed that time intervals of herbicide application only affected the dry weed biomass (g m^{-2}) during both the years. While significant differences were observed for number of panicles (m^{-2}) and 1000-grain weight (g) during 1999 and for spikelets per panicle and sterility percentage during 2000 only due to different application times. Results indicated that herbicides application resulted in significant differences of paddy yield and all the yield parameters including straw yield during both the years, except harvest index that was affected by the herbicide application during 1999 only. Curtly it is concluded that herbicides application boosted the paddy yield during both the years.

Key words: Application times, herbicides, direct seeding, weed biomass, *Oryza sativa*

Introduction

Rice (*Oryza sativa* L.) is the most important food crop of the world. It has been the primary staple food for millions of people for centuries. Rice is also the main livelihood of rural population in many Asian, African and Latin American countries (Labrada, 1998). In Pakistan, rice is cultivated on an area of 2.52 million ha with a production of 5.16 million tones annually having an average yield of 2050 kg ha^{-1} (Anonymous, 2000). The importance of rice for our country is manifold as it is agricultural commodity that adds 20% of the total foreign exchange to the national foreign exchange reserves (Anonymous, 2001). Though, the yield of rice ha^{-1} in Pakistan has increased from 970 to 2050 kg ha^{-1} during 1999-2000 due to the introduction of high yielding IRRI rice varieties. But still it is well below the world's average. Rice is generally planted by transplanting and direct seeding methods. However, transplanting involves costly labour, compaction of soil structure due to puddling and failure of nursery due to various factors i.e. unfavourable weather conditions, nutrient deficiencies and toxicities (Sohail *et al.*, 1999). Moreover, nursery raising in transplanted rice means engaging the field for nearly a month earlier to transplanting that requires additional expenditure and intensive care unlike direct seeding. Due to these reasons,

most of the farmers no more in the favour of raising rice crop through transplanting that has made shift unavoidable from transplanting culture to direct seeded culture. Most of the field experiments and on-farm research have proved accurate seed rate, timely seeding, efficient weed control and water management under direct seeded conditions gave as high yield as transplanted rice with comparatively lower production cost (Awan ***et al.***, 1989 and Baloch, 1994) while in some experiments higher than transplanted rice (Shad, 1983). Weed control has always been one of the major inputs in rice production (Seaman and De-Datta, 1968). Various methods are used for weed control such as cultural, biological, mechanical and chemical etc. The later weed control method is becoming among all the methods because it is most efficient means of reducing weeds competition with minimum labour cost (Seaman and De-Datta, 1968; Baloch, 1994). Ali ***et al.*** (1987) reported effective control of weeds when 1 kg ha^{-1} butachlor or Thiobencarb were applied 18 days after seeding (DAS) or in combination with 2 kg ha^{-1} Propanil at 16 DAS in lowland direct sown rice. Keeping in view the above mentioned objectives, this study was carried out to investigate the proper time of application of post emergence herbicides for raising rice crop through direct seeding to obtain maximum yield and minimum weed population.

Materials and Methods

The experiment was conducted during 1999 and 2000 at Agricultural Research Institute, Dera Ismail Khan, NWFP, Pakistan. During first year of the trial, the preceding crop was ***Brassica napus*** during second year of experiment, it was followed by the wheat crop. Split-plot arrangements were used in randomized complete block design (RCBD) with three replications. Sub-plot size was 3x5 m^2. Application time interval was allotted to main plots while herbicides as well as weedy check were kept in sub-plots. IR-6 was used as a check variety. Pre-germinated seed @ 100 kg ha^{-1} was broadcast in the moist plots. Weed samples were taken using three quadrates measuring 0.25 m^2 after two weeks of application of each herbicide and were oven-dried at 80 ℃ for 48 h. The data recorded were number of panicles m^{-2}, spikelets $panicle^{-1}$, sterility (%), 1000-grain weight (g), straw and paddy yield (t ha^{-1}) and harvest index. The data thus collected were subjected to analysis of variance technique appropriate for the design (Steel and Torrie, 1984). Upon obtaining significant difference among the treatment effects, Duncan's multiple range test (Duncan, 1955) was employed for comparing the treatment means.

Results and Discussion

Dry Weed Biomass (g m^{-2})

The herbicide application 3 weeks after seeding (WAS) produced significantly minimum while application of herbicides 9 WAS gave maximum dry weed biomass during both the years (Table 1). Similarly, herbicides affected the parameters significantly and Rifit herbicide gave the least and the weedy check the maximum dry weed biomass during 1999 and 2000. Results agree with the

Table 1: Dry weed biomass (g m^{-2}) 15 DAA* as affected by different times of application of herbicides in direct wet seeded rice culture in 1999 and 2000

	1999				2000			
	Times				Times			
Treatments/ Herbicides	3WAS**	6WAS	9WAS	Mean	3WAS	6WAS	9WAS	Mean
Ronstar 2 l ha^{-1}	100.0b	92.0c	107.0ab	99.7b	105.0de	98.3ef	110.0cd	104.4b
Topstar 100 g ha^{-1}	59.0fg	77.0e	64.0f	66.7d	78.0jk	88.0ghi	83.0ij	83.0d
Rifit 1 l ha^{-1}	48.0h	54.0gh	72.0e	58.0e	63.7l	73.0kl	91.0f-l	75.9e
Acelor 250 ml ha^{-1}	73.0e	85.0cd	79.0de	79.0c	86.0hij	96.0efg	95.0fgh	92.3c
Weedy check	114.0a	112.0a	120.0a	115.0a	120.0b	115.0bc	131.0a	122.0a
Means	78.8c	84.0b	88.4a		90.5b	94.1b	102.0a	

Table 2: Number of panicles m^{-2} as affected by different times of application of herbicides in direct wet seeded rice culture during 1999 and 2000

	1999				2000			
	Times				Times			
Treatments/ Herbicides	3WAS*	6WAS	9WAS	Mean	3WAS	6WAS	9WAS	Mean
Ronstar 2 l ha^{-1}	439.3b	418.0c	436.3b	431.2b	418.0fg	454.3de	415.0fg	429.0d
Topstar 100 g ha^{-1}	442.7b	434.7b	434.3b	437.2b	481.0c	469.1cd	479.3c	476.5a
Rifit 1 l ha^{-1}	496.0a	434.0b	438.0b	456.0a	502.9a	465.3cd	470.3cd	479.5a
Acelor 250 ml ha^{-1}	433.3b	394.0d	436.7b	435.7b	471.7cd	454.0de	454.9de	460.2c
Weedy check	397.0d	439.3b	394.3d	395.1c	409.0g	416.7fg	435.3ef.	420.3d
Means	441.7a	423.5b	427.9b		456.5ns	451.9	450.9	

Means followed by the same letter (s) are non-significant at 5 % level of probability.

* DAA- Days after application ** WAS- Weeks after seeding

findings of Gandapore (1999), Rashid (2000) and Awan ***et al.*** (2000).

Number of Panicles (m^{-2})

The herbicide application 3 WAS though produced maximum number of panicles during both the years but during 2000, 3 WAS interval did not differ from 6 and 9 WAS (Table 2). Rifit herbicide application gave more number of panicles during 1999 and 2000 but it was at par with Top star during second year for number of panicles. The results support the findings of Rizk ***et al.*** (1979) who obtained increased number of panicles with all the pre and post application treatments of Stomp and other herbicides in rice.

Table 3: Number of spikelets panicle^{-1} as affected by different times of application of herbicides in direct wet seeded rice culture during 1999 and 2000

	1999				2000			
	Times				Times			
Treatments/ Herbicides	3WAS	6WAS	9WAS	Mean	3WAS	6WAS	9WAS	Mean
Ronstar 2 l ha^{-1}	135.7cd	124.3e	137.7cd	132.6c	116.5de	114.0de	109.3e	113.3c
Topstar 100 g ha^{-1}	146.0b	133.7cd	136.0cd	138.6b	146.0a	114.0de	126.7bc	128.7a
Rifit 1 l ha^{-1}	156.0a	140.3bcd	137.3cd	144.5a	151.7a	118.3cde	126.3bc	132.1a
Acelor 250 ml ha^{-1}	141.7bc	133.3d	139.3bcd	138.1b	126.7bc	116.0de	128.0bc	123.6b
Weedy check	110.3f	110.3f	110.0f	110.2d	119.7cd	112.7de	112.0de	114.8c
Means	137.9ns	128.4	132.1		132.1a	115.0c	120.5b	

Table 4: Sterility (%) as affected by different times of application of herbicides in direct wet seeded rice culture during 1999 and 2000

	1999				2000			
	Times				Times			
Treatments/ Herbicides	3WAS	6WAS	9WAS	Mean	3WAS	6WAS	9WAS	Mean
Ronstar 2 l ha^{-1}	11.7ns	10.1	12.9	11.6ns	15.7i	23.1d	22.9d	20.6d
Topstar 100 g ha^{-1}	11.5	13.8	13.2	12.8	21.5e	23.4cd	25.2b	23.4b
Rifit 1 l ha^{-1}	10.2	11.8	12.3	11.4	17.9g	16.7h	19.2f	17.9e
Acelor 250 ml ha^{-1}	11.6	12.3	11.9	11.9	23.0d	23.4cd	19.1f	21.9c
Weedy check	20.2	22.5	22.2	21.6	24.2b	24.1b	28.5a	25.6a
Means	13.1ns	14.1	14.5		24.5c	22.2b	23.1a	

Means followed by the same letter (s) are non-significant at 5 % level of probability.

Number of spikelets panicle^{-1}

The application interval of 3 WAS produced more number of spikelets than the remaining two intervals during both the years but it did not differ for the trait significantly during 1999 (Table 3). However, Rifit herbicide produced significantly maximum number spikelets per panicle during both the years of the trial. The observations are in accordance with those of Rizk ***et al.*** (1979) and Nadeem ***et al.*** (1999). The later researcher recorded higher number of grains per spike in wheat crop with the application of post emergence herbicide.

Sterility (%)

Similar trend of sterility (%) was observed during both the years and herbicide application 3 WAS produced lower sterility (%) though it was at par with other two application time intervals

Table 5: 1000-grain weight (g) as affected by different times of application of herbicides in direct wet seeded rice culture during 1999 and 2000

	1999				2000			
	Times				Times			
Treatments/ Herbicides	3WAS	6WAS	9WAS	Mean	3WAS	6WAS	9WAS	Mean
Ronstar 2 l ha^{-1}	27.3b	24.7c	26.7b	26.2b	25.1b-e	23.9fg	25.2b-e	24.7cd
Topstar 100 g ha^{-1}	27.7ab	26.6b	26.6b	27.0a	27.0a	23.6g	25.8b	25.5ab
Rifit 1 l ha^{-1}	28.6a	26.8b	27.0b	27.5a	25.6bc	26.9a	24.5ef	25.7a
Acelor 250 ml ha^{-1}	26.7b	27.0b	26.9b	26.9ab	25.2b-e	25.3b-e	24.8cde	25.1bc
Weedy check	16.4d	16.4d	16.5d	16.5c	16.7h	16.7h	16.3h	16.6e
Means	25.3a	24.3b	24.8ab		23.9	23.3	23.3	

Table 6: Paddy yield (t ha^{-1}) as affected by different times of application of herbicides in direct wet seeded rice culture during 1999 and 2000

	1999				2000			
	Times				Times			
Treatments/ Herbicides	3WAS	6WAS	9WAS	Mean	3WAS	6WAS	9WAS	Mean
Ronstar 2 l ha^{-1}	6.0fg	6.7ef	5.7gh	6.12c	6.3	6.5	5.8	6.2b
Topstar 100 g ha^{-1}	8.5b	8.2bc	8.1bc	8.3ab	7.3	7.1	7.3	7.2a
Rifit 1 l ha^{-1}	9.5a	8.5b	8.1bc	8.7a	7.6	7.5	7.0	7.4a
Acelor 250 ml ha^{-1}	8.2b	7.0de	7.5cd	7.7b	7.2	6.7	6.9	6.9ab
Weedy check	5.1h	5.1h	5.2h	5.1d	5.0	5.0	5.7	5.3c
Means	7.5	7.1	6.9		6.7	6.6	6.5	

Means followed by the same letter (s) are non-significant at 5 % level of probability

during 2000 (Table 4). Rifit herbicide during 1999 gave significantly minimum spikelets than those of weedy check. During first year Rifit was at par with Ronstar and Acelor for the sterility (%). The results are in accordance with those of Kumar and Gautum (1988) who observed increased number of filled grains per panicle with the application of herbicides as compared to control. Qazzafi (2000) observed minimum number of unfilled grains when Rifit was applied. Awan ***et al.*** (2001) recorded lower sterility percentage with the application of Acelor.

1000-grain weight (g)

The time intervals differed significantly for grain weight during 1999 but 3 WAS interval was at par statistically with 9 WAS interval for the parameter (Table 5). During 2000, time intervals had no affect statistically on the grain weight. Top star, Rifit and Acelor were at par during 1999,

Table 7: Straw yield (t ha^{-1}) as affected by different times of application of herbicides in direct wet seeded rice culture during 1999 and 2000

	1999				2000			
	Times				Times			
Treatments/ Herbicides	3WAS	6WAS	9WAS	Mean	3WAS	6WAS	9WAS	Mean
Ronstar 2 l ha^{-1}	13.8gh	14.8fg	12.7fi	13.7bc	14.0bc	14.5abc	13.0cd	13.9ns
Topstar 100 g ha^{-1}	19.0ab	17.0cde	18.4abc	18.2a	15.4ab	15.2ab	15.5ab	15.4
Rifit 1 l ha^{-1}	19.8a	19.3ab	16.4de	18.5a	15.9a	15.8ab	15.2ab	15.6
Acelor 250 ml ha^{-1}	17.8bcd	15.5ef	16.1ef	16.5b	15.6abc	14.4abc	14.4abc	14.5
Weedy check	12.4hi	12.2hi	12.3hi	12.3d	12.4d	12.0d	13.4cd	13.0
Means	16.6ns	15.8	15.2		14.5ns	14.4	14.3	

Table 8: Harvest index (%) as affected by different times of application of herbicides in direct wet seeded rice culture during 1999 and 2000

	1999				2000			
	Times				Times			
Treatments/ Herbicides	3WAS	6WAS	9WAS	Mean	3WAS	6WAS	9WAS	Mean
Ronstar 2 l ha^{-1}	30.2fgh	31.1ef	29.9ghi	30.4d	30.8bcd	30.7cd	30.7bcd	30.8ns
Topstar 100 g ha^{-1}	33.3ab	32.3ab	32.8bc	32.8b	32.3ab	31.6abc	31.9abc	31.9
Rifit 1 l ha^{-1}	33.9a	32.7a	32.6bc	33.4a	32.4a	32.2abc	31.4abc	32.0
Acelor 250 ml ha^{-1}	32.3cd	30.8fg	31.7de	31.6c	32.9a	31.5abc	32.5a	32.3
Weedy check	29.5hi	29.3i	29.2i	29.3e	29.9de	28.6e	29.8de	29.4
Means	31.9ns	31.5	32.3		31.6ns	30.9	31.3	

Means followed by the same letter (s) are non-significant at 5 % level of probability

while Top star and Rifit did not differ from each other for grain weight during 2000. However, all the herbicides produced heavier grains than weedy check during both the years. The results agree with the findings of Rizk ***et al.*** (1979), Biswas and Thakur (1983), Nadeem ***et al.*** (1999) and Awan ***et al.*** (2001).

Paddy yield (t ha^{-1})

The application time interval of herbicides did not differ significantly for paddy yield during both the years but 3 WAS comparatively gave higher yield t ha^{-1} (Table 6). Topstar, Rifit and Acelor were at par statistically during 1999 and Top star and Rifit did not differ from each other for paddy yield during 2000. However, Rifit when applied 3 WAS produced significantly higher yield (9.5 t ha^{-1}) during 1999. (Pradhan and Chaudhary, 1989; Pandey and Shukla, 1990; Nadeem ***et al.*** 1999 and Awan ***et al.*** 2001).

Straw yield (t ha^{-1})

The application time intervals did affect the straw yield during both the years (Table 7). While Topstar and Rifit herbicides were at par with each other for straw yield during 1999. However, all the herbicides had no affect on straw yield during 2000, statistically. The results are in accordance with the observations of Rizk ***et al.*** (1979), Gandapore (1999) and Qazzafi (2000).

Harvest Index

The data recorded on the harvest index (Table 8) indicated that time intervals were at par for the parameter during both the years. Rifit gave significantly higher harvest index than those of all the herbicides as well as that of the weedy check during 1999. However, herbicides did not differ for harvest index during 2000. The results confirm the findings of Gandapore (1999) and Nadeem ***et al.*** (1999). It is concluded on the basis of two year data that post emergence application of herbicides 3 WAS affected yield and yield components positively, while Rifit applied 3 WAS gave higher yields in direct wet seeded rice culture.

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