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Comparative Study of Variable Seeding Rates and Herbicides Application for Weed Control in Direct Wet-seeded Rice (*Oryza sativa* L.) Culture

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Abstract: An experiment was conducted at the Agricultural Research Institute, Dera Ismail Khan, during the year 1999. The experiment was laid out in split-plot arrangements with three replications using Randomized Complete Block Design. IR-6 (coarse rice variety) was sown at 60, 90 and 120 kg seed rate ha^{-1}. Four herbicides viz. Ronstar 12 L @ 2 lit. ha^{-1}, Topstar @ 100 g ha^{-1}, Rifit @ 1 lit. ha^{-1} and Acelor @ 250 ml ha^{-1} were applied 32 days after seeding to all plots except weedy check (control). Weeds were effectively controlled at the seed rate of 120 kg ha^{-1} with herbicides application. Maximum number of tillers m^{-2} (360.33), panicles m^{-2} (351.7) Spikelets $panicle^{-1}$ (132.0), 1000-grain weight (24.74 g), paddy yield (6.78 t ha^{-1}), straw yield (16.22 t ha^{-1}) and harvest index (29.64 %) were obtained at the seed rate of 120 kg ha^{-1} treated with Ronstar 12 L @ 2 lit. ha^{-1}. Economic analysis of the yield data showed highest benefit cost ratio with 120 kg seed ha^{-1} using Ronstar 12 L.

Keywords: *Oryza sativa,* seeding rates, herbicides, wet-seeded culture, weeds, biomass, sterility, harvest Index, rice efficacy against seed rates & herbicides.

Introduction

Rice is the staple food of millions of people in Pakistan and is next to wheat in this respect. But, its importance for Pakistan as one of the major agricultural commodity cannot be over emphasized. It plays a pivotal role in the economy of Pakistan by adding 20% of the total foreign exchange into national exchequer. In our country, it is cultivated on an area of 2.32 million hectares with a production of 4.33 million tones annually, (Anonymous, 1999). Weed control has always been one of the major inputs in rice production. Various methods are used for weed control such as cultural, biological, mechanical and chemical. The later weed control method is becoming popular among all the methods because it is most efficient means of reducing weeds competition with minimum labor cost (Baloch, 1994). Kandasamy and Palaniappan (1990) recorded the best weed control of *Echinochloa colonum*, *Cyperus rotundus* etc. with pre-emergence application of thiobencarb at 1 kg ha^{-1} of dry sown and 4.6 t ha^{-1} of wet sown rice. Weed weights were generally less and crop yields were increased in herbicide-treated plots compared with untreated plots, regardless of the application method (Mabbayad and Moody, 1992). To achieve the maximum yield potential of rice crop, weeds control practices like chemical weed control, adequate fertilizer application and use of high seed rate may be the most attractive alternatives from agronomic, ecological and economic points of view. Keeping in view the above objectives, the present integrated research work was carried out under the local ecological conditions of Dera Ismail Khan.

Materials and Methods

Research pertaining to the comparative study of variable seeding rates and herbicides application for weed control in direct wet-seeded rice (*Oryza sativa* L.) culture was carried out at the Agricultural Research Institute, Dera Ismail Khan during the year 1999. The experiment was laid out in split-plot arrangements with R.C.B.D. having three replications. Each sub-plot size was 5 x 3 m^2 (15 m^2). The crop was sown on May 13, 1999. A recommended dose of 120-90-60 kg NPK ha^{-1} was uniformly applied in the form of Urea, D.A.P. & S.O.P. to all the plots. Wet pre-germinated seeds were broadcast in standing water. Irrigation was applied whenever required and the water level on the soil surface was maintained to a depth of 5 cm from seeding till maturity. Last irrigation was applied one week before harvesting. The relative herbicides at their proper rates were applied 32 days after seeding. The crop was harvested at maturity on October 5, 1999. The detail of experimental treatments is given as under;

Main plots (Seeding Rates)	Sub - plots (Herbicides)
S1 - 60 kg ha^{-1}	T1 - Ronstar 12 L @ 2 lit. ha^{-1}
S2 - 90 kg ha^{-1}	T2 - Topstar @ 100 g ha^{-1}
S3 - 120 kg ha^{-1}	T3 - Rifit @ 1 lit. ha^{-1}
	T4 - Acelor @ 250 ml ha^{-1}
	T5 - Weedy Check (Control)

The following observations were recorded during the course of study.

1. Total weed population (m^{-2}) (Before and After Spraying).
2. Fresh weed biomass (g m^{-2}) (Before & After spraying).
3. Dry weed biomass (g m^{-2}) (Before & After spraying).
4. Number of tillers (m^{-2}).
5. Number of panicles (m^{-2}).
6. Number of spikelets $panicle^{-1}$.
7. Sterility percentage.
8. 1000-Grain weight (g).
9. Paddy yield (t ha^{-1}).
10. Straw yield (t ha^{-1}).
11. Harvest index (%).
12. Economic analysis (BCR).

Statistical analysis: The data was analyzed by using the Analysis of Variance Techniques (Steel and Torrie, 1984) and Duncan's Multiple Range Test (Duncan, 1955) was used to check the differences among the treatment means, if any.

Results and Discussion

Weeds population m^{-2} (30 DAS & 45 DAS): The data recorded on weed population m^{-2} 30 DAS are presented in Table 1. It is evident from the data that number of weeds m^{-2} 30 DAS were significantly affected by different seeding rates. The number of weeds m^{-2} in S1 was 26.87 followed by S2 and S3, respectively. It may be attributed to the more space availability for the growth of weeds in S1. Number of weeds m^{-2} after 45 days of seeding was non-significant by seeding rates. However, minimum number of weeds m^{-2} was obtained in S3. It may be ascribed to less space availability for weeds growth. The highest number of weeds m^{-2} was observed in S1 that may be due to more space availability and less

competition with the crop plants. The effect of herbicides was statistically significant. Among them, Ronstar proved to be more effective than the Topstar, Rifit & Acelor which resulting in the minimum number of weeds m^{-2}. The control plots produced much more number of weeds m^{-2} than all other treatments because of no herbicide application.

Fresh weed biomass g m^{-2} (45 DAS): Data pertaining to fresh weed biomass revealed that S1 produced the highest fresh weed biomass followed by S2 and S3. As regards the herbicidal treatments, all the four treatments i.e. T1, T2, T3 and T4 produced fresh weed biomass of 5.89, 9.89, 12.00 and 13.00 g m^{-2}, respectively. The highest dry weed biomass was obtained in control plots. Thus the effect of herbicides was statistically significant. The results are in agreement with those the findings of Mabbayad and Moody (1992) who concluded reduced weed biomass in herbicide treated plots.

Dry weed biomass g m^{-2} (45 DAS): Dry weed biomass was non-significantly affected by seeding rates. Among the seeding rates, S3 produced the lowest dry weed biomass. The effect of herbicides was statistically significant. The lowest dry weed biomass was obtained in T1 and the highest was achieved in T5 (weedy check). These findings are supported by the results of Mabbayad and Moody (1992). They evaluated less weed weight and increased rice yield through the application of herbicides.

Number of tillers m^{-2}: The data recorded on the number of tillers indicated that tillers were affected significantly by both the seeding rates and herbicides application (Table 2). It revealed that more number of tillers by S3 and less number of tillers was produced by S1. As regards the herbicidal treatments, Ronstar 12 L proved to be the best weedicide producing more number of tillers that was statistically significant over Topstar, Rifit and Acelor. The minimum number of tillers was produced in control. The more number of tillers may be attributed to the availability of sufficient amount of nutrients and moisture at tillering initiation stage, reduced weed competition and suitable physiological, and environmental conditions. These findings are supported by Qayyum *et al.* (1989) and Awan *et al.* (1993) who revealed that herbicides application increased the tillering in rice.

Number of panicles m^{-2}: Seeding rates significantly affected the number of panicles. The more number of panicles was produced by S3 followed by S2. The effect of various herbicides treatments was also significant. Ronstar 12 L produced maximum number of panicles as compared to the rest of the treatments. These results coincide with Awan *et al.* (1993) who recorded more number of tillers in rice.

Number of spikelets panicle^{-1}: Table 3 (Spikelets panicle^{-1}) showed that both seeding rates and herbicides application exerted significant influence on the number of spikelets panicle^{-1}. Among the seeding rates, S3 produced the highest number of spikelets panicle^{-1} followed by S2 and S1 spikelets panicle^{-1}. In case of herbicides, Ronstar 12 L followed by Topstar, respectively, produced the highest number of spikelets panicle^{-1}. However, the number of spikelets panicle^{-1}

Table 1: Effect of variable seeding rates and herbicides on the production of rice

	Weed population m^{-2} (30 DAS)				Weed population m^{-2} (45 DAS)			
	Seeding Rates (kg ha^{-1})				Seeding Rates (kg ha^{-1})			
Herbicides	S1-60	S2-90	S3-120	Mean	S1-60	S2-90	S3-120	Mean
T1-Ronstar 12 L	25.33^{NS}	18.33	14.33	19.33^{NS}	1.66^{NS}	1.687	0.33	1.22 b
T2- Topstar	26.33	20.00	14.00	20.11	4.00	2.677	1.00	2.56 b
T3- Rifit	26.67	18.67	1400	19.78	3.00	3.00	1.33	2.44 c
T4- Acelor	25.33	19.67	13.33	19.44	2.67	2.33	1.33	2.11 b
T5- Control	30.67	19.33	14.00	21.33	32.7	26.7	22.0	271.1 a
Means	26.87 a	19.20 b	13.93 c	s		8.80^{NS}	7.27	5.20

Figures in columns not sharing a letter in common differ significantly at 5% level of probability.

Table 2: Effect of variable seeding rates and herbicides on the production of rice

	Fresh weed biomass g m^{-2} (45 DAS)				Dry weed biomass g m^{-2} (45 DAS)				Number of tillers m^{-2}			
	Seeding Rates (kg ha^{-1})				Seeding Rates (kg ha^{-1})				Seeding Rates (kg ha^{-1})			
Herbicides	S1-60	S2-90	S3-120	Mean	S1-60	S2-90	S3-120	Mean	S1-60	S2-90	S3-120	Mean
T1-Ronstar	8.33^{NS}	7.33	2.00	5.89 b	3.00^{NS}	2.33	0.33	1.89 b	299.67^{NS}	381.67	405.67	360.33 a
T2- Topstar	12.67	11.33	5.67	9.89 b	6.67	3.00	1.67	3.78 b	279.67	364.00	394.67	346.11 ab
T3- Rifit	15.33	12.67	8.00	12.00 b	5.00	2.67	2.00	3.44 b	273.33	351.33	395.33	340.00 b
T4- Acelor	20.67	10.33	8.00	13.00 b	4.67	2.17	2.00	3.11 b	253.33	335.67	377.33	324.11 c
T5-Control	16.33	128.70	108.30	133.40 a	35.33	29.67	23.00	29.33 a	213.33	280.00	308.66	267.33 d
Means	44.07^{NS}	34.07	26.40		10.93^{NS}	8.20	5.80		263.87c	342.53b	376.33a	

Figures in columns not sharing a letter in common differ significantly at 5% level of probability.

Table 3: Effect of variable seeding rates and herbicides on the production of rice

	Number of panicles m^{-2}				Spikelets panicle^{-1}				1000-grain weight (g)			
	Seeding Rates (kg ha^{-1})				Seeding Rates (kg ha^{-1})				Seeding Rates (kg ha^{-1})			
Herbicides	S1-60	S2-90	S3-120	Mean	S1-60	S2-90	S3-120	Mean	S1-60	S2-90	S3-120	Mean
T1-Ronstar	287.33ns	372.33	395.33	351.7 a	125.27ns	128.52	142.08	132.0 a	24.63ns	24.00	25.68	24.74 a
T2- Topstar	275.33	353.67	385.33	338.1 b	121.62	125.37	140.55	129.2 b	24.54	23.37	25.11	24.37 ab
T3- Rifit	265.67	341.00	387.00	331.2 b	120.51	124.71	141.46	128.9 b	24.13	23.53	23.53	24.24 ab
T4- Acelor	251.33	325.00	373.33	316.6 c	120.41	124.39	139.72	128.2 b	23.27	22.23	25.00	23.53 b
T5-Control	197.00	265.33	294.00	252.1 d	108.95	115.55	120.12	114.9 c	19.07	20.93	22.18	20.37 c
Means	255.3 c	331.5 b	367.0 a		119.4 c	123.7b	136.8 a		23.13 b	22.83 b	24.61 a	

Figures in columns not sharing a letter in common differ significantly at 5% level of probability.

Table 4: Effect of variable seeding rates and herbicides on the production of rice

	Paddy yield (t ha $^{-1}$)				Straw yield (t ha $^{-1}$)				Harvest index (%)			
	Seeding Rates (kg ha $^{-1}$)				Seeding Rates (kg ha $^{-1}$)				Seeding Rates (kg ha $^{-1}$)			
Herbicides	S1-60	S2-90	S3-120	Mean	S1-60	S2-90	S3-120	Mean	S1-60	S2-90	S3-120	Mean
T1-Ronstar	5.47	7.07	7.88	6.78 a	14.13ns	17.07	17.50	16.22a	28.05ns	29.99	30.87	29.64 a
T2- Topstar	5.23	7.07	7.67	6.66 a	14.50	16.50	17.50	16.17a	26.44	29.70	30.14	28.76 a
T3- Rifit	5.07	6.93	7.53	6.51 a	14.03	16.70	16.60	15.38ab	26.53	29.33	31.26	29.04 a
T4- Acelor	5.10	6.87	7.63	6.53 a	13.33	16.37	16.00	15.50ab	27.48	26.55	31.26	28.43 a
T5-Control	4.57	5.90	6.63	5.70 b	13.36	16.03	16.60	15.34b	25.78	26.83	28.69	27.10 b
Means	5.09 c	6.79 b	7.45 a		13.77 b	16.53 a	17.00a		26.86ns	28.48	30.44	

Figures in columns not sharing a letter in common differ significantly at 5% level of probability.

Table 5: Economic analysis of Rice variety IR-6 as affected by different seeding rates and herbicides in direct wet-seeded culture.

Treatments	Total Cost Rs. ha $^{-1}$	Gross income Rs. ha $^{-1}$	Net income Rs. ha $^{-1}$	B.C.R.
S_1T_1	15178	35490	20312	2.33
S_1T_2	15453	33995	18542	2.19
S_1T_3	16203	32890	16687	2.02
S_1T_4	15203	33150	17947	2.18
S_1T_5	13953	29835	15882	2.13
S_2T_1	15358	45890	30532	2.98
S_2T_2	15633	45890	30257	2.93
S_2T_3	16383	45045	28662	2.74
S_2T_4	15383	44590	29207	2.89
S_2T_5	14133	38350	24217	2.71
S_3T_1	15538	50700	35162	3.26
S_3T_2	15813	49790	33977	3.14
S_3T_3	16563	48750	32187	2.94
S_3T_4	15563	49595	34032	3.18
S_3T_5	14313	43095	28782	3.01

Price of Ronstar @ 2 lit ha $^{-1}$ = Rs.1225/-
Price of IR-6 = Rs.6.5/- per kg.
Price of Topstar @ 100 g ha $^{-1}$ = Rs.1500/-Price of Acelor @ 250 ml ha $^{-1}$ = Rs.1250/-. Price of Rifit @ 1 lit ha $^{-1}$ = Rs.2250/-

of all the treated plots was much higher than the untreated plots. These findings are supported by Awan *et al.* (1993) who reported more number of spikelets panicle $^{-1}$.

1000-grain weight (g): The data pertaining to 1000-grain weight (g) are presented in Table 3. The data suggested that the 1000-grain weight was influenced by both the seeding rates and herbicides application significantly. Among the seeding rates, S3 produced the highest 1000-grain weight followed by S1 and S2. As regards the herbicidal treatments, Ronstar 12 L produced the highest 1000 grain weight and Acelor produced the lowest grain weight. Nigam *et al.* (1988) reported highest 1000-grain weight with 100 kg ha $^{-1}$ sowing rate.

Paddy yield (t ha $^{-1}$): Data in Table 4 regarding paddy yield t ha $^{-1}$ revealed that seeding rates had a significant effect on paddy yield. S3 produced the highest paddy yield as compared to S2 and S1. As far as the herbicidal treatments are concerned, statistically significant differences and much higher yield (6.78 t ha $^{-1}$, Ronstar) was recorded than that of the control treatment. The probable reason for high paddy yield may be due to more number of tillers per unit area, more number of panicles per unit area, good plant stand and low weeds infestation. These observations are in accordance with those obtained by Nigam *et al.* (1988) and Awan *et al.* (1993) who recorded the best paddy yield by various seeding rates and herbicides.

Straw yield (t ha $^{-1}$): It was evident from Table 4 that both seed rates and herbicide application had significantly affected the straw yield. Maximum straw yield was obtained in S3. This may be ascribed to more number of plants and tillers in S3 compared to S2 and S1. In case of herbicidal treatments, the highest straw yield was achieved in Ronstar 12 L and the lowest in Acelor. All these were higher than that produced by control plots. The results are in agreement with Sohail *et al.* (1999) who observed progressive increase in straw yield.

Harvest index (%): The data regarding harvest index are presented in the Table 4. Analysis of the data showed that harvest index was influenced non-significantly by seeding rates. During the trial year, more harvest index was obtained in S3 that is followed by S2 and S1. As regards the herbicidal treatments, they affected the harvest indices significantly. The combination of both the factors had non-significant influence on harvest index.

Economic analysis (BCR): Economic analysis of rice given in the Table 5 showed that maximum net income of Rs.35162/- ha $^{-1}$ was obtained in seed rate of 120 kg ha $^{-1}$ with the application of Ronstar 12 L against the minimum of Rs.15882/- ha $^{-1}$ obtained in seed rate of 60 kg ha $^{-1}$ with no herbicide applications.

Conclusion: It can be concluded from the above discussion that weeds were effectively controlled at the seed rate of 120 kg ha $^{-1}$ along with the application of Ronstar 12 L. It gave higher yield than the other treatments.

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