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EFFECT OF SEEDING RATES AND HERBICIDES ON WEED DYNAMICS AND PADDY YIELD OF DIRECT WET-SEEDED RICE

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ABSTRACT

Field experiments were conducted at Agricultural Research Institute, Dera Ismail Khan, Pakistan during 1999 and 2000 to develop a viable and economically feasible rice weed management technology for the rice growers of southern area of NWFP. Main objective of the study was to establish an appropriate weed management strategy for effective control of weed flora in direct wet-seeded rice. The experiments consisted of three seeding rates of 60, 90 and 120 kg ha^{-1} in main plots and oxidizon (Ronstar 12L), oxidiargyl (Topstar), preticlachlor (Rifit) and acetachlor (Acelor) in the sub-plots were applied at post-emergence stage including weedy check. Herbicides pretilachlor and acetachlor with 120 kg ha^{-1} seed rate proved effective control of grasses and sedges and increased the yield and yield attributes with increased net return over other herbicides and weedy check.

Key words: Rice Topstar Acelor Rifit Ronstar weed management.

INTRODUCTION

Rice is the main livelihood of rural population in many Asian, African and Latin American countries. In Pakistan, it is also the staple food for millions of people and is next to wheat. It plays a pivotal role in the economy of Pakistan by adding a handsome amount of foreign exchange into the national exchequer (Anonymous, 2001). Weeds are, no doubt, a major pest and constraint to reducing rice production. Weeds share light, nutrients and water with the crop and thus interfere with rice growth in many ways. Living or decaying weeds can secrete toxic root exudates or leaf leachates that depress the normal growth of rice plant. Weed infestation provides a habitat for growth of various pest organisms (insects, nematodes and pathogens), which adversely effect the production of rice and other crops. Similarly weeds demand high labor inputs for control (Labrada, 1998). Weed control has always been one of the major inputs in rice production. Various methods like cultural, mechanical, biological and chemicals are used for weed control. The chemical weed control method is becoming popular among the farmers because it is the most efficient means of reducing weeds competition with minimum labor cost (Baloch, 1994; Awan, 1988). Moreover, judicious use of herbicides is the only and logical alternative weed control method, especially in the wet-seeded rice (Moody and Cordova, 1985). Besides, weed control through chemicals, the cultural control method including the manipulation of planting density (seeding rate) is also one of the most effective ways of weed control. Close spacing is essential to minimize weed infestation and increase paddy yield (Nigam *et al*., 1988).

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MATERIALS AND METHODS

Experiments were laid out in a randomized complete block (RCB) design with split-plot arrangement having three replications during 1999 and 2000. The plot size was kept as 5×3 m^2 during both the years. Main-plots consisted of three seeding rates (60, 90 and 120 kg ha^{-1}) while four herbicides and the weedy check were kept in the sub plots (Table-1).

Table-1. Detail of herbicidal treatments in sub-plots

Treatments / Herbicides	Common Name	Dose kg a.i ha^{-1}
Ronstar 12L	oxadiazon	0.24
Top Star 800WG	oxadiargyl	0.80
Rifit 500EC	pertilachlor	0.50
Acelor 50EC	acetachlor	0.125
Weedy check	(Control)	---

The land was prepared to form a fine tilth by ploughing, harrowing and tillering once each. A total quantity of fertilizer @ 120-90-60 kg ha^{-1} of N, P_2O_5 and K_2O were applied. Full dose of P_2O_5 and K_2O and half of N was applied at the time of planting, while the remaining half N was applied at the panicle initiation stage. Rice variety IR-6 seed was selected at a specific gravity of 1.13 in salt water, prepared by dissolving about ½ kg of salt in 100 liters of water. The seed that sank in the salt water was selected for sowing and the light, floating, and unviable seed was discarded. After rinsing the salt water, the seed was kept immersed in water for 24 hours and then under moist gunny bags for 36 hours to a pigeon breast like shape i.e. having pre-germinate swollen seed stage. Pre-germinated seed was used.

Water management

A thin layer of irrigation water was maintained following broadcasting of seed in the respective treatments. Three to four days later, irrigation water was applied again taking care that the small seedlings (1-2 leaf stage) were not submerged. This practice was continued for about two weeks. Afterwards, the irrigation was applied to the full extent to maintain a depth of 8 cm till one week before harvesting.

Weed sampling

Weeds samples were taken using a 0.25 m^2 quadrate randomly at three sites in each treatment after 45 days of seeding. Weed samples were counted and then oven-dried at 80 C for 48 hours. The oven-dried weed samples were then weighed for recording the dry weed biomass. Data recorded on dry weed biomass and weed count were converted to one m^{-2}, respectively. However, the following six parameters were recorded during the course of both experiments.

1. Dry weed biomass (g m^{-2}).
2. Number of panicles m^{-2}.
3. Number of spikelets $panicle^{-1}$.
4. Sterility (%).
5. 1000-grain weight (g).
6. Paddy yield t ha^{-1}.

All the data were subjected to the analysis of variance to determine the significance of treatment means (Steel and Torrie, 1984). Duncan's Multiple Range Test (DMRT) was used for comparing treatment mean (Duncan, 1955).

RESULTS AND DISCUSSION

Dry weed biomass (g m^{-2})

It is evident from the analysis of the data that herbicides, seeding rates and interaction of the herbicides with the seeding rates were significantly different during both the years for dry weed biomass (Table-2). Lowest dry weed biomass (77.57 g and 91.14 g) was recorded in the treatments applied with acetachlor herbicide during 1999 and 2000, respectively. It was statistically at par with preticlachlor (93.67 g) during 2000. The effective weed control of acetachlor may be due to its translocation from the leaves and shoots to the underground parts of the weeds and inhibiting the cell division. The highest dry weed biomass of 110.47 and 111.55 g was recorded in weedy check in both experiments. During 1999, oxadiangyl (89.70 g) and pretilachlor (88.24 g) were statistically equal for the said trait. The highest seed rate of 120 kg ha significantly affecting the weed biomass produced the minimum dry weight (81.99 g and 94.59 g) during 1999 and 2000, respectively. These results are in agreement with those of Moody (1977). Shad (1983) Sing *et al.* (1989), Mabbayad and Moody (1992) and Awan *et al.* (2000). regarding the effect of seeding rates and herbicides application on dry weed biomass.

Number of panicles m^{-2}

Results showed significant differences for seeding rates, herbicides and their interaction for number of panicles m^{-2} during both the years. The seeding rate of 120 kg ha produced higher number of panicles m^{-2} (432.9 and 593.4 ma^{-2}). However, it was statistically at par with seeding rate 90 kg ha^{-1} during first year. Acetachlor gave more panicles m^{-2} (458.1) than oxadiazon, but at par with pretilachlor (449.4 m^{-2}) during 1999 for the said trait. However, during 2000, the number of panicles produced by the acetachlor was significantly higher (580.4) than other herbicides. All the herbicides applications produced higher number of panicles than weedy check during both the years. Acetachlor herbicide when applied to 120 kg ha seeding rate produced highest number of panicles (473.3 and 678.0 m^{-2}), during 1999 and 2000, respectively (Table-3). This might have been due to high number of tillers in the plots where acetachlor was applied. The results are fully supported by the findings of Awan *et al.* (2000). They recorded significantly higher number of panicles with 120 kg ha seeding rates while acetachlor herbicide application produced more number of panicles per square meter being advocated by Qazzafi (2000). However, Awan *et al.* (2001) observed that pretilachlor herbicide caused more panicles production m^{-2}, whereas, Jones and Snyder (1987) reported higher panicle number with increased seeding rates.

Number of spikelets panicle^{-1}

Data regarding number of spikelets (Table-4) revealed that seeding rates, herbicides and their interaction influence the number of spikelets during both the years. The seeding rate of 120 kg ha gave the highest number of spikelets per panicles (132.7 and 144.9) during 1999 and 2000, respectively followed by 90 kg ha^{-1} seeding rate. Minimum spikelets were noted with 60 kg ha during both the years. Herbicide acetachlor produced significantly more spikelets per panicle (135.2 and 144.3) during 1999 and 2000, respectively. Pretilachlor followed acetachlor for number of spikelets during both the trial years. Weedy check gave the minimum number of spikelets per panicle during both the years. The plants in weedy check were of very poor growth due to severe crop-weed competition. The growth of weeds in check plots went unchecked which reduced the availability of moisture and other plant nutrients to crop plants and eventually resulted in reduced size of panicles with lesser number of spikelets. Interaction between the seeding rates and herbicides also affected the number of spikelets and higher number of spikelets was recorded (140.0 and 158.0) during 1999 and 2000, respectively in the 120 kg ha^{-1} seeding rate treated with acetachlor herbicide. Results were supported by Sohail *et al.* (1999), Awan *et al.* (2000) and Baloch *et al.* (2000), who observed maximum number of spikelets with 120 kg ha^{-1} seeding rate, However, Awan *et al.* (2001) recorded larger number of spikelets per panicle with the application of acetachlor herbicide.

Sterility (%)

Sterility is the name given to unfertilized and unfilled spikelets. Data regarding sterility percentage (Table–5) showing that sterility was affected by herbicides during both the years and interaction of seeding rates with herbicides during 1999 only, while seed rates itself did not differ significantly during both the years. Acetachlor reduced sterility significantly (11.40%) as compared to weedy check during first year. However, all the herbicides were at par with one another and with the weedy check for the trait. During 2000, the sterility percentage was also significantly lower (22.04%) with the acetachlor than other herbicides. All the herbicides except oxadiargyl during 2000 gave significantly lower sterile spikelets than weedy check. The acetachlor herbicide treatment in 120 kg ha^{-1} seeding rate produced lower sterility percentage (10.00% and 20.89%) during first and second year, respectively. Overall sterility percentage during 2000 was higher than that during the preceding year. This might have been due to difference in mean temperatures, humidity and weed flora during both years. The findings are in close agreement with Baloch *et al.* (2000), who reported higher sterility percentage with lower seeding rates in rice crop whereas, Awan *et al.* (2001) observed lower sterility percentage when acetachlor herbicide was applied. Qazzafi (2000) found no significant difference for the trait between the applications of different herbicides, including weedy check.

1000-grain weight (g)

Data regarding 1000-grain weight (Table–6), indicated that seedling rates, herbicides and their interaction during 1999 significantly influenced the 1000-grain weight during both years except seeding rates during 2000. The seeding rate of 120 kg ha^{-1} gave significantly heavier grains (24.13 g) than 60 and 90 kg ha^{-1}. Acetachlor produced grains (25.42 g), which were statistically equal in weight to pretilachlor (25.40 g), but were significantly higher in weight produced by oxadiazon (22.48 g), oxadiargyl (23.82 g) and weedy check (16.29 g) during 1999. During 2000, all the herbicides were at par for the said trait, but were significantly higher than the weedy check. Interaction between the seeding rates and herbicides differed significantly from each other during both the years of experimentation. Higher 1000-grain weight was recorded in the 120 kg ha^{-1} seeding rate with acetachlor (27.50 g) and oxadiargyl (27.10 g) during 1999. The heavier grains produced with the application of oxadiazon and oxadiargyl during the 2000 than when these herbicides were applied during 1999 might have been due to the higher percentage of sterility during the year than those during 1999 which may due to translocation of nutrients to the left over grains and might have caused the increase in the weight during 2000 as compared to that in 1999. Findings are in close agreement with results given by Awan *et al.* (2000) and Baloch *et al.* (2000), who observed heavier grain weight with 120 kg ha^{-1} seeding rate. However, Qazzafi (2000) noted maximum 1000-gain weight when herbicide pretilachlor was applied.

Paddy yield (t ha^{-1})

Analysis of the data regarding paddy yield indicated the significant effects of seeding rates, herbicide applications and their interaction during 1999 while during 2000 only herbicides significantly differed. Seeding rate of 120 kg ha^{-1} produced significantly higher yield (7.74 ha^{-1}), which was followed by 90 kg ha^{-1} (6.48 t ha^{-1}). Both the lower seeding rates did not differ significantly from each other during 1999. Herbicide acetachlor produced higher paddy yield (7.89 and 7.15 t ha^{-1}) during 1999 and 2000, respectively; but during the second year herbicides did not differ within themselves, while during first year acetachlor yield was at par with pretilachlor (7.50 t ha^{-1}). However, during both years, herbicides proved superiority to weedy check for paddy yield. Interaction between the seeding rate (120 kg ha^{-1}) and herbicide application of acetachlor during 1999 produced highest paddy yield (9.20 t ha^{-1}), which was at par with pretilachlor (8.50 t ha^{-1}) and oxadiargyl (8.33 t ha^{-1}) when applied to the same seeding rate during 1999. Acetachlor comparatively produced higher yield with 120 kg seeding rate during 2000, though the difference was not significant when compared within the same and the other seeding rates treated with herbicides (Table-7). Lower yields during the second year of the trial as compared to those obtained during 1999 might have been due to higher sterility percentage and comparatively more weed density. The results are in agreement with the findings of Parao, 1974; Gilal and Qureshi, 1976. All the workers reported increased paddy yield with narrow spacing. While, Baloch *et al.* and Awan *et al.* (2000) reported higher yields with 120 kg ha^{-1} seeding rates. Awan *et al.*. (2001) observed more yield with the application of acetachlor herbicide in direct wet seeded rice.

Table–2. Dry weed biomass (g m^{-2}) 45 DAS as affected by different seeding rates and herbicides application in direct wet-seeded rice during 1999 and 2000

Herbicides kg a.i. ha^{-1}	1999 Seeding Rates kg ha^{-1} 60	90	120	Herb. Mean	2000 Seeding Rates kg ha^{-1} 60	90	120	Herb. Mean
Oxadiazon 0.240	96.37c	106.25b	90.33d	97.65b	107.88c	94.27def	93.92def	98.69b
Oxadiargyl 0.80	95.46b	92.85cd	80.38f	89.70c	96.17de	95.13def	96.13de	95.81bc
Pretilachlor 0.60	95.51c	89.81de	79.45f	88.24c	94.52def	92.11ef	94.38def	93.67cd
Acetachlor 0.125	93.56cd	86.29c	52.87g	77.57d	92.24ef	91.31ef	89.88f	91.14d
Weedy Check	112.21a	112.86a	106.57b	110.47a	115.27b	120.76a	98.63 d	111.55a
Seeding Means	98.62a	97.57a	81.99b		101.22a	98.72b	94.59c	

1999	2000
CV = 2.46%	CV = 3.712%
$LSD_{0.05}$ = 1.920 (S. Rates)	$LSD_{0.05}$ = 2.148 (S. Rates)
$LSD_{0.05}$ = 2.219 (Herbicides)	$LSD_{0.05}$ = 3.105 (Herbicides)
$LSD_{0.05}$ = 3.843 (Interaction)	$LSD_{0.05}$ = 5.378 (Interaction)

Means followed by the same letter (s) in the respective category are non significant $P \leq 0.05$.

Table-3. Number of panicles (m^{-2}) as affected by different seeding rates and herbicides application in direct wet-seeded rice during 1999 and 2000

Herbicides kg a.i. ha^{-1}	1999 Seeding Rates kg ha^{-1}				2000 Seeding Rates kg ha^{-1}			
	60	90	120	Herb Mean	60	90	120	Herb Mean
Oxadiazon 0.240	344.7c	404.3b	435.3ab	394.8b	432.7h	520.7d	622.7b	525.3d
Oxadiargyl 0.80	316.7c	440.0ab	[illegible]	418.9b	484.3f	525.3d	625.3b	545.0[illegible]
Pretilachlor 0.50	440.0ab	460.0a	448.3a	449.4a	475.3f	580.0c	613.3b	556.2b
Acetachlor 0.125	438.3ab	461.7a	474.3a	458.1a	491.3e	572.0c	678.0a	580.2a
Weedy Check	334.3c	333.3c	336.7c	334.8c	449.7g	449.0g	427.7h	442.1e
Seeding Means	374.8b	419.9a	432.9a		466.7c	529.4b	593.4a	

CV = 6.00%
LSD $_{0.05}$ = 21.62 (S. Rates)
LSD $_{0.05}$ = 23.87 (Herbicides)
LSD $_{0.05}$ = 41.34 (Interaction)

CV = 1.55%
LSD $_{0.05}$ = 4.871 (S. Rates)
LSD $_{0.05}$ = 7.994 (Herbicides)
LSD $_{0.05}$ = 13.85 (Interaction)

Means followed by the same letter (s) in the respective category are non significant P < 0.05.

Table-4. Number of spikelets per panicle as affected by different seeding rates and herbicides application in direct wet-seeded rice during 1999 and 2000

Herbicides kg a.i. ha^{-1}	1999 Seeding Rates kg ha^{-1}				2000 Seeding Rates kg ha^{-1}			
	60	90	120	Herb Mean	60	90	120	Herb Mean
Oxadiazon 0.240	121.0 h	128.0fg	128.7fg	125.9g	121.0j	130.0gh	141.0cd	130.7d
Oxadiargyl 0.80	116.7i	131.3c-f	136.0g	128.0c	135.0efg	134.0efg	136.0def	135.0bc
Pretilachlor 0.50	130.7ef	134.3bcd	132.3cde	132.4b	136.0def	127.0hi	151.7b	138.2b
Acetachlor 0.125	131.0def	134.7bc	140.0a	135.2a	132.0fgh	143.7c	158.0a	144.3a
Weedy Check	125.3g	125.3g	126.3g	125.7d	123.7ij	127.0hi	137.7de	129.4d
Seeding Means	124.9c	130.7b	132.7a		129.6b	132.3b	144.9a	

CV = 1.56%
LSD $_{0.05}$ = 1.762 (S. Rates)
LSD $_{0.05}$ = 1.969 (Herbicides)
LSD $_{0.05}$ = 3.410 (Interaction)

CV = 2.43%
LSD $_{0.05}$ = 3.174 (S. Rates)
LSD $_{0.05}$ = 3.201 (Herbicides)
LSD $_{0.05}$ = 5.544 (Interaction)

Means followed by the same letter (s) in the respective category are non significant P < 0.05.

Table–5. Sterility percentage as affected by different seeding rates and herbicides application in direct wet-seeded rice during 1999 and 2000

Herbicides kg a.i. ha[1]	1999 Seeding Rates kg ha[1] 60	90	120	Herb. Mean	2000 Seeding Rates kg ha[1] 60	90	120	Herb. Mean
Oxadiazon 0.240	11.17de	14.77ab	12.13cde	12.69ab	28.75	25.80	27.11	25.22b
Oxadiargyl 0.80	10.97de	11.83cde	12.53cde	11.78ab	27.12	25.51	28.25	26.96ab
Pretilachlor 0.50	13.03bc	12.57cd	10.97de	12.19ab	26.92	24.33	25.00	25.42b
Acetachlor 0.125	10.70e	13.50cde	10.00de	11.40b	23.93	21.29	20.89	22.04c
Weedy Check	15.27a	12.00cde	12.23cde	13.17a	28.91	29.57	28.24	28.91a
Seeding Means	12.23	12.93	11.57		27.13	25.30	25.90	

CV = 8.99%
LSD $_{0.05}$ = 1.447 (Herbicides)
LSD $_{0.05}$ = 1.863 (Interaction)

CV = 11.37%
LSD $_{0.05}$ = 2.887 (Herbicides)

Means followed by the same letter (s) in the respective category are non significant $P \leq 0.05$.

Table-6. 1000-grain weight as affected by different seeding rates and herbicides application in direct wet-seeded rice during 1999 and 2000

Herbicides kg a.i. ha[1]	1999 Seeding Rates kg ha[1] 60	90	120	Herb. Mean	2000 Seeding Rates kg ha[1] 60	90	120	Herb. Mean
Oxadiazon 0.240	20.73fg	22.80ef	23.90cde	22.48b	24.97abc	24.70bc	24.70bc	24.98a
Oxadiargyl 0.80	19.70g	24.67b-e	27.10ab	23.82b	24.20c	25.23abc	25.57abc	25.02a
Pretilachlor 0.50	24.97b-e	25.73abc	25.50a-d	25.40a	24.13c	25.73ab	25.20abc	25.07a
Acetachlor 0.125	23.17def	25.50a-d	27.50a	25.42a	26.37a	24.67bc	24.67bc	25 20a
Weedy Check	16.40h	15.90h	16.57h	16.29c	16.21h	18.15g	18.25g	17.54b
Seeding Means	20.90b	22.92b	24.13a		23.18	23.70	23.62	

CV = 6.61%
LSD $_{0.05}$ = 2.068 (S. Rates)
LSD $_{0.05}$ = 1.458 (Herbicides)
LSD $_{0.05}$ = 2.526 (Interaction)

CV = 3.49%
LSD $_{0.05}$ = 1.98 (Herbicides)
LSD $_{0.05}$ = 1.472 (Interaction)

Means followed by the same letter (s) in the respective category are non significant $P \leq 0.05$.

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