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EVALUATION OF RICE GENOTYPES AND THEIR RESPONSE TO DIFFERENT HERBICIDES IN ONION/RICE AND WHEAT/RICE CROPPING PATTERNS OF LOWER SWAT

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Abstract

Two experiments were conducted in 'Kharif' of 1992 at farmer's fields at Mingora, Swat on evaluation of rice varieties, viz., Basmati-385, J-P-5 and Swat-1, subjected to five weed control treatments, Saturn 93L (thiobencarb) @ 2 Kg ai/ha, Butacide 50EC (isoproturon) @ 2 Kg ai/ha, Basagran 48L (bentazon) @ 2 Kg ai/ha, Machete 60EC (butachlor) @ 1.2 Kg ai/ha and a Weedy Check. The varieties and treatments were arranged in factorial way using RCB Design. One of the experiment was conducted on a field which had wheat while the other on a field having onion as 'rabi' (winter) crop. Total grain yield and 1000 grains weight was significantly affected by Cropping pattern, varieties; cropping pattern by varieties interaction and effect of herbicides was also significant for 1000 grain weight. With onion based cropping pattern, total grain yield and 1000 grain weight was higher. Among the varieties, J-P-5 had a higher grain weight, followed by Swat-1 and Basmati-385, respectively. Among the herbicide treatments, 1000 grain weight was reduced with butachlor, the other treatments at par with each other, thiobencarb making transition between the former and the other treatments. As a whole the effect of weed control treatments was not significant on yield. Total crop biomass was also higher in onion based cropping pattern; among the varieties, Basmati-385 yielded higher followed by J-P-5 and Swat-1, respectively. Averaged over varieties and herbicide treatments, lodging was significantly higher in wheat based cropping pattern; among the varieties, J-P-5 lodged most followed by Swat-1, whereas no lodging was observed in Basmati-385; the height of the varieties also ranged in the same sequence. Days to 50% flowering and maturity was not affected by cropping pattern and treatments. Basmati-385 took longer to 50% flowering and maturity followed by J-P-5 and Swat-1, respectively. Panicle length and sterility was not affected by cropping pattern and weed control treatments, however, among the varieties, Basmati-385 had longer panicles and more sterility followed by Swat-1 and J-P-5, respectively. Grains number/panicle was higher in Basmati-385 followed by J-P-5 and Swat-1, respectively. Averaged over weed control treatments, Basmati-385 showed

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19.67% injury followed by Swat-1 having 17.33% injury while J-P-5 had no sign of herbicide injury. Among the weed control treatments, isoproturon caused 30.83% injury on the average, followed by butachlor (14.72%) and thiobencarb (12.78%). Weed infestation in mid and late-season was more in wheat-based compared to onion based cropping pattern. Herbicide treated plots had significantly less weeds compared to control plots, however, there was no significant difference among the herbicides themselves.

Introduction

Rice is an important 'Kharif' crop of Pakistan, ranking second to wheat as a staple food. Rice has gradually moved to occupy a pre-dominant position in agricultural economy of Pakistan. Depending on crop variety and climatic conditions, 9-63 % losses have been reported in rice yield from weed competition in the Indian sub-continent (Ahmad and Majid, 1975; Ahmad et al., 1977; Ghauri et al., 1979; Bhargavi and Reddy, 1990; Misra and Singh, 1089; Zafar, 1989). Yield reduction due to weeds has been estimated as 40% of the total produce in lower Swat (Rosh and Syed, 1986). According to Agricultural Statistics of Pakistan for 1986-87, area under rice was 21,000 hectares or over 10% of the total cultivated area of Swat district. Traditionally, wheat and onion are the major 'rabi' crops of this area, followed by rice in Kharif season. This valley is an important onion growing area and accounts for about 64% of the onion production in NWFP. Within a span of about five years from 1986 to 1991, area under onion has increased from 1000 to 3000 ha, mainly replacing wheat in the area (Nieuwkoop, 1990; Nieuwkoop and Hussain, 1991).

In lower Swat, two cropping sequences, viz., Rice after onion and rice after wheat are predominant. The later one has been followed for many years, however, rice after onion is becoming more common recently. But along with such a shift in the cropping pattern, there are certain problems associated with. For example, wheat is harvested in May/June, while onion is harvested in June/July, as a result lesser time is available for onion farmers to get the field prepared for rice transplantation. Therefore, poor land preparation after the harvest of onion results in increased weeds' problem in rice (Defoer et al 1992). Weeds are much more efficient at normal fertility level to consume more nutrients than the crop (Ahmad et al., 1977). And this problem is more of a concern that farmers are not aware of herbicides that can control weeds in rice. Some of the rice varieties are susceptible to certain herbicides (Hassan, 1992; Hassan et al., 1993), therefore, sound recommendations should be based on performance of different rice varieties recommended for the area against the rice herbicides.

About 90% farmers of the lower Swat use Tribunil (methabenzthiazuron), a selective herbicide for selective weed control in onion. As such herbicide is slow on grasses and sedges, therefore, abundance of such weeds late in onion season become a big problem during rice season. Resultantly such differences in cultural and management practices has made the weeds' problem in rice rather worse (Marwat et al., 1992).

Three rice cultivars viz., J-P-5, Basmati-385, and Swat-1 are the recommended varieties and found on the farmers' fields frequently. However,. no data is available for comparative performance of these varieties under the two cropping systems, the onion-rice and wheat-rice. Moreover, farmers are willing to use herbicide for weed control in rice, therefore, there performance under various herbicides, (registered and candidate ones) need to be tested before making any recommendations to the farmers (Marwat et al., 1992). Moreover, rice is one the few such crops where varietal differential susceptibility to various herbicides has been identified, is intensively under investigation (Street and Snipes, 1987; Smith 1974; Clay and Oelke, 1988; and Smith 1988), but day to day introduction of new varieties has made such problem more complex than ever before. Keeping in view these facts, a study was conducted to evaluate rice varieties, adapted to the lower Swat under the two cropping patterns, rice after wheat and rice after onion and to evaluate such varieties in terms of their tolerance against herbicides.

Materials and Methods

Nursery of rice varieties was raised at Agriculture Research Station, Swat on May 23, 1992 and then transplanted to field on July 10, 1992. Two farmers' fields were selected adjacent to Agriculture Research Station, Swat for this experiment. One of those fields was having onion while the other was having wheat as Rabi crop. As wheat is harvested earlier than onion, therefore, such field was plowed once when the onion was harvested from the other field. Both these fields were adjacent to one another and were having similar soil. Both the fields were puddled three times, that is on July 6, 7, and 8, 1992. NPK fertilizer was applied @ 120:60:40 Kg per hectare, half of nitrogen was applied at the time of transplantation, while half 30 days after transplantation. Three varieties and five weed control treatments were arranged in a factorial way using RCB Design, having three replications. Three rice varieties used were Basmati-385, J-P-5, and Swat-1; while the five weed control treatments were, Saturn 93L (thiobencarb) @ 2 Kg ai/ha, Butacide 50EC (isoproturon) @ 2 Kg ai/ha, Basagran 48L (bentazon) @ 2 Kg ai/ha, Machete 60EC (butachlor) @ 1.2 Kg ai/ha and a Weedy Check. A total of 45 plots, having size of 2 x 2.3 meters each were arranged. Each plot had 10 rows, having plant to plant and row to row distance of 20 cm. Butachlor and thiobencarb were applied 7 days while bentazon and isoproturon were applied 30 days after rice transplantation.

Data was collected on days to 50% flowering, days to maturity, plant height, number of tillers/hill, panicle length, number of grains/panicle, 1000 grain weight, percent sterility, crop yield at a constant moisture of 11%, Crop injury (using percent scale, following Burrill et al., 1976), lodging (visual percentage), crop biomass and straw yield.

Results and Discussion

As there were two experiments on rice with similar treatments, one conducted on a field having wheat as Rabi crop while the other conducted on a field which had onion as Rabi crop, combined analyses were done to see the impact of cropping pattern on different variables, using analysis of variance procedure. The means were then subjected to LSD

test to see differences if any, using MSTATC[1]. Abstract of these findings has already been published (Khattak and Marwat, 1994).

Days to Fifty percent flowering and maturity: Cropping pattern and treatment had no significant effect on 50% flowering and overall maturity. However, varieties differed in terms of 50% flowering among themselves. Basmati-385 took longer (65.77 days) to 50% flowering, followed by J-P-5 (62.63 days) and Swat-I (61.23 days), respectively. Averaged over cropping pattern and treatments, varieties were significantly different in terms of time period required to attain full maturity. Basmati-385 took longer period (117 days), followed by J-P-5 (110.6 days) and Swat-I (101.97 days), respectively (Table 1,2). As days to flowering and maturity are genetically controlled, therefore, herbicide treatments and cropping pattern had no significant effect on these parameters. Rosh and Syed (1986) have reported similar results regarding performance of these varieties in Swat.

Plant height: Cropping pattern had no effect on the plant height. Averaged over cropping pattern and weed control treatments, varieties were significantly different regarding plant height. J-P-5 was the tallest one having height of 131.353 cm, followed by Swat-I (117.980 cm) and Basmati-385 (110.707 cm), respectively (Table 1,2). Plant height being varietal character is controlled genetically.

Lodging: Cropping pattern, varieties and treatments had significant effect on visual lodging of rice. Lodging was significantly higher in wheat based cropping pattern (35.89%) than onion based (17.56%). Lodging score was also significantly different among varieties. There was no lodging in Basmati-385, whereas in Swat-I and J-P-5 lodging score of 22.83% and 57.33% was observed, respectively (Table 1,2).

Cropping pattern by varieties interaction was significant for lodging. Basmati-385 was not affected by the cropping pattern, whereas in J-P-5 there was 74.67% lodging in wheat based followed by onion based cropping pattern having 40% lodging. Similarly Swat-I lodged more (33%) in wheat based cropping pattern compared to onion based (12.67) (Table 4). In general taller varieties are more susceptible to lodging. May be wheat based field was better fertility wise, therefore may have affected lodging more compared to onion based cropping pattern. Weed density was statistically higher in wheat based field compared to onion based field, resulting in more competition which led to taller plants, being susceptible to lodging. However, in these studies Basmati-385 was not affected by cropping pattern at all.

Number of tillers per hill and Panicle length: Cropping patterns has no significant effect on the number of tillers per hill panicle length. Averaged over two cropping patterns, varieties were significantly different in terms of number of tillers/hill and panicle length. Swat-I had the higher capacity for tillering (16.797 tillers/hill), followed by

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Basmati-385 (14.647 tillers/hill) and J-P-5 (12.953 tillers/hill), respectively. Basmati-385 had longer panicle length of 28.76 cm followed by Swat-I & J-P-5 having panicle length of 25.19 cm & 22.54 cm, respectively (Table 2). These characters are determined by the genetic make-up of the varieties, therefore, these parameters were not affected by the cropping pattern and treatments.

Number of grains/panicle: Averaged over cropping pattern and weed control treatments, varieties differed significantly in terms of number of grains per panicle. The total number of grains per panicle was greater in Basmati 385 (167.84 grain/panicle) followed by J-P-5 and Swat-I having 143.17 & 132.72 grains/panicle, respectively. Effect of cropping pattern, weed control treatments and interactions were not significant. Highest Number of grains per panicle was found in Basmati-386, responding to its longer panicle, followed by J-P-5 and Swat-I, respectively (Table 1,2).

Percent Sterility: Cropping pattern and weed control treatments had no significant effect on average sterility of the varieties. However, varieties differed significantly for % sterility; 18% sterility was found in Basmati-385, followed by Swat-I and J-P-5, having 11.82% and 7.285% sterility, respectively (Table 2). As Basmati is basically a longer duration variety and more suitable for plains, therefore, had more sterility, while J-P-5, being a local variety acclimatized to the environment was more fertile. Varieties by weed control treatment interaction was significant. Weed control treatments had similar effect in terms of their impact on % sterility in Basmati-385 and J-P-5, however, surprisingly sterility was higher in Swat-I in untreated plots compared to other treatments.

Herbicide Injury: Effect of cropping pattern was not significant; however, averaged over cropping pattern and weed control treatments varietal response was significantly different from each other in terms of injury due to herbicide application. Basmati-385 & Swat-I had 19.67 and 17.33% injury due to herbicides, respectively, while J-P-5 showed little or no sign (10%) of herbicide injury (Table 1,2).Weed control treatments were significantly different among themselves in terms of causing injury. Basagran caused least injury (10%) while injury was severe in Isoproturon treated plots (30.83%) followed by Machette (14.72%) and Saturn (12.78%), respectively (Table 3).

Weed control treatments by varieties interaction was significant. Highest injury of 50% was observed in Basmati-385 plots treated with isoproturon followed by Swat-I having 33% injury treated with the same herbicide (isoproturon). Cropping pattern by varieties by herbicide interaction was not significant (Table 6). In general fine grain varieties, like Basmati-385 are more susceptible to herbicides, while course grain varieties, like J-P-5 are tolerant to herbicides, while medium type like Swat-1 showed a trend in between the two varieties. Similar trend was reported for Basmati and J-P-5 by Hassan (1992) and Hassan et all 1993, respectively, while using fenoxaprop, a selective rice herbicide for grass weed control.

Total Biomass and straw yield: Cropping pattern had significant effect on the total biomass of the rice varieties. Onion based cropping pattern had higher biomass of 22136 Kg/ha compared to wheat based cropping pattern, being 19499.93 Kg/ha. Varieties

significantly differed in terms of their total biomass averaged over cropping pattern and treatments. Total biomass was highest in Basmati-385 (24090.90 kg/ha), followed by J-P-5 (20409.09 kg/ha) and Swat-I (17931.82 kg/ha), respectively. Weed control treatments and its interaction with varieties, cropping pattern was not significant (Table 1,2).

1000 grain weight: Cropping pattern had significant effect on 1000 grain weight, field having onion as Rabi crop resulted in higher grain weight (24.25 gm) compared to wheat (23.06 gm) as a Rabi crop. Averaged over two cropping patterns, differences among the varieties were significant. J-P-5 had highest 1000 grain weight of 26.56 gm followed by Swat-1 & Basmati-385, having grain weight of 24.9 and 19.52 gm, respectively (Table 1,2).

Cropping pattern by varieties interaction was significant. As shown in Table 5, Swat-1 and Basmati-385 were similar in performance in both the cropping patterns. However, J-P-5 yielded significantly higher in onion based cropping pattern (27.87) compared to wheat (25.24). As grain size is the major determinant of the ultimate yield and a genetic potential of a variety, therefore, differed substantially among the varieties. Similar difference in grain weight of rice varieties are reported by Hassan et al (1993). Averaged over cropping patterns and varieties, treatment effect was significant. Looking at means using LSD test grain weight was significantly lowers in Machette treated plots compared to Saturn, Basagran, Isoproturon and control, however, the later four were not different significantly from each other. Similarly Machette and Saturn were not significantly different from each other (Table 3). Interactions for cropping pattern by herbicide treatments, varieties by herbicide treatments, and cropping pattern by varieties by treatment were not significant.

Straw Yield: Effect of cropping pattern was significant of straw yield, with 14215 Kg/ha for onion, while 12750 Kg/ha for wheat based cropping pattern (Table 17,27). Varieties were also significantly different in terms their straw yield. Straw yield of Basmati, J-P-5, and Swat-1 was 17455, 12324, and 10669 Kg/ha, respectively, significantly different from each other (Table 1,2). According to Gul 1991, straw yield in wheat-rice and onion-rice was 3715 kg and 3871 kg/acre respectively, similar to our findings, however, in this case of difference these difference were not different statistically. Varietal response was also in the pattern of total biomass, being highest in Basmati-385 followed by J-P-5 and Swat-1, respectively.

Grain Yield (Kg/ha): Cropping patterns had significant effect on average yield of rice varieties. The particular field which was planted with onion as a Rabi crop resulted in higher yield (6400.941 kg/ha) as compared to wheat 5378.121 as a Rabi crop (Table 22). Averaged over two cropping patterns, varieties were significantly different in terms of yield/ha. Among others, J-P-5 was the most successful variety having yield of 6609.694 kg/ha, followed by Swat-I (6269.683) and Basmati-385 (4789.216 kg/ha), respectively (Table 1,2). During a study in India, difference response has been reported for different varieties to various weed control methods.

Onion based cropping pattern had higher grain yield than wheat based. Among the varieties J-P-5 had highest yield followed by Swat-1 and Basmati, respectively. While

comparing onion/rice with wheat/rice cropping pattern, rice yield was higher in onion based compared to wheat based cropping pattern. Similarly, grain weight and total biomass was also higher in onion based cropping pattern compared to wheat based. Number of tillers probably genetically controlled was not affected by cropping pattern. There could be three reasons for increase in overall yield of onion-based cropping pattern, the most important being that wheat is a very exhaustive crop compared to onion as it is deep rooted and stays for longer period in the field and therefore, consumes more of nutrients from the soil. The second reason may be that of higher lodging score in wheat based crop compared to onion based. However, the second reason may not be the main one as it did not show any impact on percent sterility of the cropping pattern. The third possibility of lower yield in wheat-based crop may be the higher number of mid-season and late-season weeds in wheat based cropping pattern compared to onion based. As there was virtually no weed control measure implied in wheat, while season long hand weeding and use of Tribunil (methabenzthiazuron) in onion decreased the weed problem in onion based cropping pattern. Although Gul (1991) has reported higher yield in wheat based cropping pattern in farmers' field compared to onion based. But in case of farmers fields, rice sowing is done earlier in wheat-based compared to onion based, therefore, less degree days are available for rice in onion cropping pattern resulting in lower yield. But in this experiment sowing was done on the same date in both the cropping patterns, therefore, wheat based cropping pattern was not having the advantage of more time period for rice crop. Moreover, in this experiment as already indicated, more weeds were reported in wheat based cropping which could have affected the yield as well.

Conclusion and Recommendations

1. J-P-5 adopted very well to the local conditions of Swat, and is relatively short duration variety, fits very well in the onion-based cropping pattern. Therefore, whenever, there is a problem of late sowing, farmers should go for J-P-5.

2. In wheat based cropping pattern or when timely sowing of rice is possible, Basmati-385 may be recommended, as it is full season variety, will give better yields compared to Swat-1 and J-P-5. Moreover, market value of Basmati-385 is higher compared to other varieties. Swat-1 can also be tried in wheat-based cropping pattern, but definitely needs further assessment.

4. As Basmati-385 has higher capacity of producing more tillers compared to J-P-5, therefore, equal number of seedlings per hill may not be the proper way when comparing the two varieties.

5. In this particular experiment, sowing was done on the same date for onion-based as well as wheat-based fields. However, in actual farmers fields, sowing in onion based fields is delayed because of late harvest of onion.

6. In different locations, the relevant varieties with special reference to Basmati-385, J-P-5, and Swat-1 need to be tested at different sowing times with similar agronomic practices.

Table 1. Effect of Cropping Patterns (CP) averaged over Varieties and Weed Control Treatments, on Days to Maturity (DTM), Days to 50% flowering (DTF), Panicle Length (PL), 1000 grain weight (GW), Grain Yield (YLd), Number of Tillers/hill (NT), Crop Biomass (CB), Lodging Percentage (LP), Percent Sterility (SP), Plant Height (PH), Straw Yield (SY), Herbicide Injury (HIN) and Grain Number per Panicle (GNP).

CP	DTM	DTF	PL	GW	Yld	NT	CB	LP	SP	PH	SY	HIN	GNP
Onion	110	62.89	25	24.25	6401	15.07	22136	17.56	12.33	119	14216	15.8	149
Wheat	110	63.53	25	23.06	5398	14.52	19500	35.89	12.59	120	12750	15.6	147
F-V	00.2	2.57	0.0	13.45	11.6	1.27	23.93	35.37	0.04	0.9	8.25	0.05	0.2
Prob	NS	0.11	0.0	00.00	00.0	0.27	00.00	00.00	NS	NS	0.00	NS	NS

CP = Cropping Patter
Prob = Probability
DTF = Days to 50 % flowering
GW = 1000 grain weight (g)
NT = Number of tillers per hill
LP = Lodging percentage
PH = Plant Height (cm)
HIN = Herbicide injury to crop

FV = F-value
DTM = Days to Maturity
PL = Panicle length (cm)
Yld = Grain Yield (Kg/ha)
CB = Crop Biomass
SP = Sterility percentage
SY = Straw Yield (Kg/ha)
GNP = Grain numbers per panicle

Table 2. Effect of Varieties averaged over Cropping Patterns and Weed Control Treatments, on Days to Maturity (DTM), Days to 50% flowering (DTF), Panicle Length (PL), 1000 grain weight (GW), Grain Yield (YLd), Number of Tillers/hill (NT), Crop Biomass (CB), Lodging Percentage (LP), Percent Sterility (SP), Plant Height (PH), Straw Yield (SY) and Herbicide Injury (HIN).

Var	DTM	DTF	PL	GW	Yld	NT	CB	LP	SP	PH	SY	HIN
Bas	117 a	66 a	28.7 a	19.5 c	4789 b	14.6 b	24091 a	0.0 c	18.3 a	110 c	17445 a	19.67 a
J-P	111 b	63 b	22.3 c	26.5 a	6610 a	12.9 c	20409 b	57.3 a	7.2 c	131 a	12324 b	10.00 b
Swt	102 c	61 c	25.1 b	24.9 b	6270 a	16.7 a	17932 c	22.8 b	11.8 b	117 b	10669 c	17.33 a
LSD	1.37	0.99	0.54	0.79	737.7	1.20	1318	7.56	2.90	3.22	1252	2.38

Var = Varieties
J-P = J-P-5
LSD = LSD at alpha 0.05
DTF = Days to 50 % flowering
GW = 1000 grain weight (g)
NT = Number of tillers per hill
LP = Lodging percentage
PH = Plant Height (cm)
HIN = Herbicide injury to crop

Bas = Basmati-385
Swt = Swat-1
DTM = Days to Maturity
PL = Panicle length (cm)
Yld = Grain Yield (Kg/ha)
CB = Crop Biomass
SP = Sterility percentage
SY = Straw Yield (Kg/ha)

Table 3. Effect of weed control treatments on 1000 grain weight and crop injury.

Weed control treatments	1000 Grain weight	Crop injury
Machette	22.70 B	14.72 B
Saturn	23.40 AB	12.78 BC
Basagran	24.00 A	10.00 C
Butacide	24.35 A	30.83 A
Control	23.84 A	10.00 C
LSD (0.05)	1.026	3.07

Table 4. Cropping pattern by varieties interaction for lodging.

Cropping pattern	Basmati-385	J-P-5	Swat-I
Onion/rice	0.00 d	40.00 b	12.67 c
Wheat/rice	0.00 d	74.67 a	33.00 b

LSD at alpha 0.05 = 10.70

Table 5. Cropping pattern by varieties interaction for 1000 grain weight

Cropping pattern	Basmati-385	J-P-5	Swat-I
Onion/rice	19.71 C	27.87 A	25.17 B
Wheat/rice	19.33 C	25.24 B	24.63 B

LSD at alpha 0.05 = 1.12

Table 6. Varieties x treatments interaction for percent crop injury.

Varieties	Machete	Saturn	Basagran	Butacide	Control
Basmati	15.00 CD	13.33 D	10.00 D	50.00 A	10.00 D
J-P-5	10.00 D	10.00 D	10.00 D	10.00 D	10.00 D
Swat-I	19.17 C	15.00 CD	10.00 D	32.50 B	10.00 D

LSD at alpha 0.05 = 5.32

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