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Effect of chemical and crop establishment methods on weeds and yield of rice and their residual effects on succeeding wheat crop

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ABSTRACT

A field experiment was conducted on sandy loam soil at Research Farm of SKUAST-J, Chatta, Jammu during the years 2006 and 2007 to study the effect of weed management and crop establishment methods on weeds and grain yield of rice as well as residual effect of treatments (applied to rice) on weeds and yield of wheat. There was severe competition between *Echinochloa crusgalli* and *Echinochloa colona* with rice and between broad leaf weeds and wheat. *Phalaris minor* infestation was lower during the experiment. Among weed management methods, maximum yield of rice (4256 kg/ha and 4393 kg/ha) during 2006 and 2007, respectively was recorded in the treatment where mechanical hoeing using conoweeder (at 15 and 30 DAT) was done during the first and second years of study. Fenoxaprop-p-ethyl (0.06 kg/ha, 20 DAT) + 1 HW at 30 DAT, metasulfuron methyl + chlorimuron ethyl (0.004 kg/ha, 20 DAT) + 1 HW at 30 DAT and fenoxaprop-p-ethyl (0.06 kg/ha, 20 DAT) and metasulfuron methyl + chlorimuron ethyl (Almix 0.004 kg/ha, 20 DAT) were the next best treatments. However, metasulfuron methyl + chlorimuron ethyl (0.004 kg/ha) was found to be more effective against broad leaf weeds and very little to sedges, hence failed to control major grassy weeds during the experiment. Among the establishment methods of rice, conventional and system of rice intensification (SRI) methods were at par with respect to grain and straw yield. The residual effect of treatments (applied to rice) was not well pronounced on weed population, weed dry matter accumulation by weeds and yield of wheat during both the years. Under wheat establishment methods, the two tillage systems did not produce significant variation with respect to total weed population, weed dry matter accumulation and grain yield. However, conventional tillage exhibited a marginal edge over zero tillage during both the years.

Key words : Weed management, Crop establishment methods, Herbicides, Rice, Wheat, Yield

Rice (*Oryza sativa* L.) - wheat (*Triticum aestivum* L.) is one of the most important cropping systems in India occupying an area of about 10.5 million hectares and contributing about 38% foodgrains to the national food basket (Gangwar *et al.* 2007). In recent years, however, this system is showing signs of 'fatigue' due to various reasons. As there is a meager scope of horizontal expansion of net cropped area, it becomes imperative to increase the vertical productivity through agronomical manipulations involving establishment methods, which still have the vast potential for realizing the potential yields of rice and wheat in rice-wheat cropping system along with better control of weeds. Unchecked weeds lower the productivity of the system by 20-40% (Pandey 2002). Thus, the best establishment method along with timely and effective control of weeds is pivotal to augment the productivity of this cropping system. Chemical weed control is the most acceptable and widely used measure in many rice-wheat zone of Indo-Gangetic plains (IGP). Increasing use of herbicides, however, causing concern about their potential ecological effects. Some herbicides are being used in both rice and wheat crop, but very little information is available on this residual effect on succeeding crop. Hence , a study was undertaken to study the effect of weed management and crop establishment techniques in rice and their residual effects on succeeding wheat crop sown under different establishment methods.

MATERIALS AND METHODS

A field experiment was conducted at Research Farm, Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu during 2006 and 2007 to examine the effect of weed management and crop establishment methods on weeds and grain yield of rice as well as residual effect of treatments (applied to rice) on weeds and yield of wheat. The soil of the experimental field was sandy loam in texture having a pH of 8.1, low in organic carbon and nitrogen, medium in available phosphorus and potassium. The experiment was laid out in factorial randomized block design with 14

treatments, comprising of seven weed management practices and two establishment methods *viz.,* conventional transplanting (27 days old seedling and 2-3 seedling/hill) and system of rice intensification (SRI) (10 days old seedling and 1 seedling/hill) in rice and with a split plot design in wheat with two establishments methods (conventional sowing and zero tillage) as sub-plots in wheat during *rabi* seasons of 2006 and 2007 with three replications each. Two types of nurseries were raised for the rice crop. In case of conventional technique, raised beds of 10 x 1.25 m were prepared with the help of tractor and spade. The seed of *PC-19* variety 40 kg/ha was sown 10 cm apart in rows, whereas for raising seedlings under system of rice intensification (SRI), four raised beds of 3.0 x 1.25m were prepared with a water channel of 0.5m width made around consisting of alternate layers of soil and well decomposed FYM of 1.5" and 1" thickness respectively, until it was 6" above the ground level having final layer of 2.5" thickness. On these beds, pre-germinated seeds (8 kg/ha) were broadcasted and the beds were mulched for first three days to avoid bird damage. Beds of both the nurseries were irrigated frequently to maintain adequate soil moisture. Transplanting of rice crop was done manually on 7th and 10th of July during *kharif* seasons of 2006 and 2007, respectively for both the establishment techniques.

In case of conventional technique, 27-28 days old seedlings and 2-3 seedlings/hill were planted in normal spacing of 20 x 10 cm whereas in case of SRI, 10 days old seedlings were removed carefully along with soil from the nursery bed without damaging the root zone and then single seedling/hill was transplanted, 1-2 cm deep into the soil that was muddy but not flooded at a spacing of 25 x 25 cm on the same day of transplanting. Rice crop was grown with a uniform application of recommended NPK (120 kg N, 60 kg P and 25 kg K/ha) in conventionally established plots while in SRI established crop, 25% of the recommended dose of NPK was supplied through well decomposed FYM on oven dried N content basis (0.62%) and remaining amount of NPK was supplied through inorganic sources of nutrients through urea, DAP and MOP, respectively. One third amount of N and full dose of P and K were applied as basal dose at the time of transplanting. Remaining N was top dressed in two equal splits at 30 days intervals. Irrigation was applied at regular intervals in conventional method of rice establishment to keep the water standing in the plots throughout the crop season with intermittent drainage whereas in case of system of rice intensification (SRI), plots were irrigated so as to keep the soil moist and no water was allowed to stand in the plot until the crop entered the reproductive stage. After panicle initiation, a thin layer of water (1-2 cm) was maintained until 10-15 days before the crop was harvested. All the herbicides were applied with the help of Knapsack sprayer 20 days after transplanting as per treatment.

Likewise, the wheat variety (*PBW-343*) was sown on 8th and 11th November during *rabi* seasons in zero tilled plots directly without any preparatory tillage at the specified spacing (20 cm) with the the help of liner by 'Kera' method, whereas sowing was accomplished on 14th and 17th November of *rabi* seasons of 2006 and 2007, respectively, in conventionally tilled plots after the preparatory tillage, keeping the same spacing. No weed management practice was imposed in wheat crop, except for the uniform application of recommended NPK in all the plots of both conventional and zero tillage methods of sowing. Half of N and full dose of P and K were applied as basal dose at the time of sowing and the remaining amount of N was top dressed in two equal splits, one at 30 days and the other at 60 days after sowing as per treatments.

RESULTS AND DISCUSSION

Weed flora

The experimental site was infested with both grassy and broad leaved weeds. *Echinochloa colona* and *Echinochloa crusgalli* being the dominant weeds which severely competed with rice crop. Next to them were *Cyperus* spp. Besides these, *Eclipta alba*, *Cesualia axillaris* were also present, but the competition by these species was insignificantly as their populations were small. *Anagallis arvensis*, *Trachyspermum* and *Phalaris minor* were the major weeds infesting wheat. *Vicia sativa*, *Medicago denticulata*, *Avena ludoviciana* were also present in few numbers (Table 1).

Effect on weeds in rice

All the weed control treatments and establishment methods significantly reduced weed population compared to that in weedy check plots. Among the weed management practices, mechanical hoeing using cono weeder (twice at 15 days interval) reduced the total weed population and dry weed weight significantly at all the crop growth stages than weedy check but was at par with fenoxaprop-p-ethyl (0.06 kg/ha, 20 DAT) + 1 HW (30 DAT) followed by metasulfuron methyl + chlorimuron ethyl (0.004 kg/ha, 20 DAT) + 1 HW (30 DAT), fenoxaprop-p-ethyl (0.06 kg/ha, 20 DAT) and metasulfuron methyl + chlorimuron ethyl (0.004 kg/ha, 20 DAT). However, metasulfuron methyl + chlorimuron ethyl (0.004 kg/ha) was found to be more effective against broad leaf weeds and very little to sedges and hence failed to control major grassy weeds during both the years, while fenoxaprop-p-ethyl (0.06 kg/ha) effectively controlled grassy weeds and sedges. These results are in conformity

Table 1. Relative density of individual weed species (%) of the total weed density in rice and wheat crops under weedy conditions

Weed species	Rice (at 60 DAT)		Weed species	Wheat (at 60 DAS)	
	2006	2007		2006	2007
Grassy weeds			**Grassy weeds**		
Echinichloa colona	38.8	34.0	*Phalaris minor*	6.1	7.8
Echinochloa crusgalli	24.4	26.7	*Avena ludoviciana*	4.1	4.0
Broad leaved weeds			**Broad leaved weeds**		
Caesulia axillaris	10.5	11.4	*Angalis arvensis*	54.5	52.4
Trachyspermum sp.	6.2	7.4	*Medicago denticulata*	6.5	4.4
Sedges			*Trachyspermum* sp.	10.1	14.2
Cyperus sp.	17.5	12.8	*Chenopodium album*	10.0	7.0
			Vicia sativa	2.0	1.6
Others	2.6	7.7	**Others**	6.88	8.6

with those observed by Singh *et al* (2003) and Uphoff (2005). Among the establishment techniques, non-significant results were reported regarding weed population and dry weight during critical growth stages, though weed population and dry matter were numerically lower in conventionally sown plots than SRI plots.

Yield attributes and yield

Grain yield is a resultant of yield attributes and therefore, maximum expression of yield attributes *viz*. panicles/m^2, grain weight/panicle and 1000 grain weight due to reduced crop weed competition in weed free plots resulted in higher grain yield by 34.0 and 33.7% than that observed in weedy check plots during two crop seasons, respectively. Weed control treatments brought about significant increase in panicles/m^2, grain weight /panicle and 1000 grain weight compared to weedy check (Table 2). Among the weed management practices, mechanical hoeing using conoweeder twice (15 and 30 DAT) recorded higher values of yield attributing characters and hence resulted in more yield which was at par with metasulfuron methyl + chlorimuron ethyl + 1 HW, metasulfuron methyl + chlorimuron ethyl (0.004 kg/ha) + 1HW and fenoxaprop-p-ethyl (0.06 kg/ha), but significantly were superior to metasulfuron methyl + chlorimuron ethyl (0.004 kg/ha) (Table 2). However, effective tillers were slightly lower in treatment where mechanical hoeing was done using conoweeder twice (15 and 30 DAT) as compared to fenoxaprop-p-ethyl (0.06 kg/ha) due to presence of more percentage of unfertile tillers, but both were statistically at par with each other. The possible reason for the better performance of these treatments in terms of grain and straw yield could be attributed to better expression of their yield attributes due to better management practices and reduction in crop-weed competition, resulting in significant reduction in dry weed weight and weed population. The results wer in close conformity to those reported by Singh *et al*, (2003) and Singh *et al*, (2006). Lowest grain yield of rice was recorded in treatment where only metasulfuron methyl + chlorimuron ethyl (0.004 kg/ha) was applied. This might have happened due to inefficiency of this herbicides mixture to control heavily infested grassy weeds.

However, under establishment methods, statistically non-significant results were observed with respect to yield attributing characters and yields of both the conventional and SRI methods of establishment, but slightly higher values were recorded under conventional method. The possible reason for higher yield under conventional method can be attributed to higher plant density per unit area as well as more productive tillers. Similar findings have also been reported by Latif *et al*. (2004), Salem (2006) and Dixit *et al* (2007).

Wheat

Residual effect: The residual effect of treatments (applied to rice) was not well pronounced on weed population, dry matter accumulation by weeds and yield of wheat in both the years. Gopinath and Pandey (2004) reported similar results. However, direct effect of establishment methods of wheat exhibited statistically insignificant differences under two tillage methods. This could be due to various favourable factors under zero tillage like advancing the sowing date, proper placement of seed in narrow slit, early emergence of wheat seedlings and availability of higher moisture content, which might have helped the crop to compete better with weeds than with the crop sown under conventional method. These results conform to the findings of Kumar and Yadav (2005) and Gupta, *et al* (2007).

Table 2. Effect of weed management and establishment methods on weed dry weight, yield attributes and yield of rice

Treatments	Doses (kg/ha)	Weed dry weight (g/m^2)		Panicles/m^2		Grain weight/ panicle (g)		1000 grain weight (g)		Grain yield (kg/ha)	
		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Weed management methods											
Weedy check	--	14.0 (195.2)	13.4 (177.7)	180.2	194.3	1.51	1.55	1.51	1.55	3075	3145
Weed free	--	0.7 (0.0)	0.7 (0.0)	238.1	240.3	2.18	2.23	2.18	2.23	4662	4745
Metasulfuron methyl + chlorimuron ethyl	0.004 kg/ha (20DAT)	5.3 (27.4)	5.2 (27.0)	211.4	215.8	1.64	1.72	1.64	1.72	3700	3818
Metasulfuron methyl + chlorimuron ethyl + I HW	0.004 kg/ha (20DAT)	5.1 (25.5)	5.0 (24.6)	223.4	225.9	1.82	1.90	1.82	1.90	4054	4166
Fenoxaprop-p-ethyl	0.06 kg/ha (20DAT)	4.9 (23.5)	4.8 (22.5)	218.0	222.4	1.77	1.87	1.77	1.87	3983	4087
Fenoxaprop-p-ethyl + I HW	0.06 kg/ha (20DAT)	4.0 (15.3)	3.3 (10.4)	228.6	230.2	1.88	1.96	1.88	1.96	415	4268
Mechanical hoeing using conoweeder (15 and 30 DAT)	--	3.7 (12.8)	3.3 (10.4)	224.7	228.7	1.95	2.04	1.95	2.04	4256	4393
LSD (P=0.05)		0.6	0.3	10.7	8.3	0.19	0.18	0.19	0.18	345	315
Rice establishment methods											
Conventional	--	5.3 (23.5)	5.1 (25.2)	218.2	223.9	1.81	1.88	22.39	22.73	3992	4109
SRI	--	5.5 (30.1)	5.2 (26.7)	217.4	221.1	1.84	1.91	22.18	22.48	3974	4068
LSD (P=0.05)	--	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

DAT- Days after transplanting, original values are given is parentheses.

Table 3. Residual effect of weed management and establishment methods of rice on weed population, weed dry weight and yield of succeeding wheat sown under two establishment methods

Treatments	Doses (kg/ha)	Weed population/m^2		Weed dry weight (g/m^2)		Grain yield (kg/ha)	
		2006	2007	2006	2007	2006	2007
Weed management methods							
Weedy check	--	19.7(387.2)	19.0(361.1)	5.99 (35.36)	5.95 (34.90)	3364	3437
Weed free	--	18.3 (35.5)	18.1(325.7)	5.00(24.49)	4.96(24.10)	3463	3523
Metasulfuron methyl + chlorimuron ethy l	0.004 kg/ha (20 DAT)	18.7(349.9)	18.4(337.0)	5.48 (29.52)	5.53(30.10)	3431	3509
Metasulfuron methyl + chlorimuron ethyl + I HW	0.004 kg/ha (20 DAT)	18.4(339.2)	18.2(329.3)	5.44 (29.10)	5.39(28.54)	3456	3512
Fenoxaprop -p-ethyl	0 .06 kg/ha (20 DAT)	19.4(375.8)	18.8(352.9)	5.98 (35.26)	5.94(34.78)	3375	3460
Fenoxaprop -p-ethyl + I HW	0.06 kg/ha (20 DAT)	19.0(360.9)	18.7(350.3)	5.90 (34.31)	5.82 (33.37)	3415	3462
Mechanical hoeing using conoweeder	--	18.9(356.3)	18.7(347.7)	5.86 (33.83)	5.81 (33.25)	3419	3492
LSD (P=0.05)	--	NS	NS	NS	NS	NS	NS
Rice establishment methods							
Conventional	-	19.0(357.9)	18.4(336.6)	5.72 (32.20	5.68(31.76)	3375	3469
SRI	-	18.9(356.3)	18.3(332.6)	5.62 (31.10)	5.57 (30.52)	3460	3502
LSD (P=0.05)	-	NS	NS	NS	NS	NS	NS
Wheat establishment methods							
Conventional tillage	--	18.8(352.6)	18.2(328.9)	5.60 (30.85)	5.59 (30.74)	3431	3515
zero tillage	-	19.0(361.6)	18.4(336.6)	5.70 (31.96)	5.65(31.42)	3406	3410
LSD (P=0.05)		NS	NS	NS	NS	NS	NS

Original values are given in parentheses.

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