Indian J. Weed Sci. **36** (3 & 4) : 193-198 (2004)

Weed Dynamics in Wheat as Affected by Rice and Wheat Establishment Methods

Shailendra Singh, Govindra Singh and V. P. Singh
Department of Agronomy
G. B. Pant University of Agriculture & Technology, Pantnagar-263 145 (Uttaranchal), India

ABSTRACT

Phalaris minor density was highest in wheat after dry seeded rice (DSR). It was 21.8 and 37.6% higher than in wheat after wet seeded rice (WSR) and transplanted rice (TPR), respectively. *Chenopodium album* density in wheat after DSR was 38.0 and 49.6% higher than in wheat after WSR and TPR, respectively. *Polypogon monspeliensis* density in wheat after DSR was 67.5 and 75.0% higher than in wheat after WSR and TPR, respectively. In conventional tillage wheat (CTW), *P. minor, C. album, P. monspeliensis* and other weeds had 84.8, 77.8, 71.8 and 33.3% higher density than in zero tillage wheat (ZTW), respectively.

INTRODUCTION

Wheat is the most important winter cereal of the Gangetic plains of India. The wheat crop sown after harvest of transplanted rice is generally delayed due to intensive tillage operations for seedbed preparation required under conventional sowing resulting in reduced yields due to shorter crop duration. Rice production systems are undergoing various types of changes and one such change has been the shift from transplanting to direct seeding. Direct seeding for rice establishment is spreading rapidly in Asia particularly Philippines, Malaysia and Thailand as the farmers seek high productivity and profitability to offset increasing costs and scarcity of farm labour (Balasubramanian and Hill, 2002). The main driving forces of this change are the rising wage rates, scarcity of water and labour and at the same time the availability of advanced technologies of integrated weed management (Singh, 2004). In the beginning of 1990, through interaction with farmers during diagnostic surveys in rice-wheat areas, it was felt that one of the major causes of low wheat yield in sequence with rice was its late sowing for various reasons like delay in rice transplanting which affects the sowing of succeeding wheat crop. To advance the sowing time and economize the energy use and tractor time, zero/reduced tillage options are considered. After rice harvest, wheat can be sown with residual moisture and in many situations pre-sowing irrigation can be avoided and irrigation water used in first irrigation in zero tillage (ZT) fields is much less than in conventional tillage (CT) fields. Weeds are another serious problem in wheat cultivation and unchecked weed growth reduces crop yield upto 57% (Singh *et al.*, 1997). In rice-wheat system, direct seeded rice produced significantly higher straw and similar grain yield to that of transplanted rice and also significantly increased the straw and grain yield of following wheat crop (Tripathi, 2001). Singh *et al.* (2002) at Pantnagar also reported similar yields of transplanted and direct seeded rice and higher wheat yield after direct seeded rice grown in sequence.

Considering above conditions direct seeding of rice and zero tillage of wheat in rice-wheat cropping system can go a long way in rectifying the above situations and making rice wheat as sustainable system. In the alternative systems of rice-wheat establishment, the behaviour of weeds in wheat crop as function of preceding rice establishment may change. Therefore a necessity was felt to understand the weed dynamics in wheat after different rice establishment methods.

MATERIALS AND METHODS

A field trial was conducted at the Crop Research Centre of Govind Ballabh Pant University of Agriculture & Technology, Pantnagar (Udham Singh Nagar) during winter seasons of 2002-03 and 2003-04 consisting of three rice establishment methods, two levels of weed control practices in rice, and two methods of wheat establishment. In all, there were 12 treatment combinations arranged in split-split design with three replications. Main plot consisted of three rice establishment methods (dry seeding in unpuddled soil, wet seeding in puddled soil and transplanting in puddled soil). During winter season, wheat was sown as sub-plot treatment as zero tillage (ZT) and conventional tillage (CT). Each plot where rice was sown in **kharif** season, was divided into two parts, half of which was sown as with CT wheat and rest was sown as ZT wheat.

In CT wheat after the harvest of transplanted rice and wet seeded rice, four harrowings were done by tractor, simultaneously planking was done which was followed by one roller. One operation by rotavator was done and field was levelled. In CT wheat after dry seeded rice, roller and rotavator operations were not done. Wheat cv. PBW-343 at 100 kg seed ha^{-1} was sown on 25 November, 2002 and 15 November, 2003 in CT wheat after dry seeded and wet seeded rice, while CT wheat after transplanted rice was sown on 29 November, 2002 and 15 November 2003. ZT wheat after harvest of rice was sown directly without any tillage operation by Pant-zero till-ferti-seed drill at 125 kg seed ha^{-1} on 9 November, 2002 and 4 November, 2003 after dry seeded and wet seeded rice, while ZT wheat after transplanted rice was sown on 14 November, 2002 and 4 November, 2003. The observations on weed density in wheat were recorded at 30 days stage before the application of herbicides. In wheat herbicides (isoproturon at 1 kg ha^{-1} + metsulfuron methyl at 4 g ha^{-1} as tank mixture) were applied in 600 litres of water per hectare with the help of Maruti foot sprayer fitted with flat fan nozzle at 35 days after sowing in all wheat establishment methods.

RESULTS AND DISCUSSION

Effect on Weeds

The major species were *Phalaris minor, Chenopodium album, Polypogon monspeliensis,* while some minor species like *Medicago denticulata, Rumex acetosella, Anagallis arvensis, Coronopus didymus, Cyperus rotundus* and *Melilotus alba* were clubbed together as "other weeds" (Tables 1 and 2).

The density of *P. minor* in wheat after dry seeded rice (DSR) during both the years was significantly more than in wheat after transplanted rice (TPR). There was non-significant variation in density of *P. minor* in wheat after wet seeded rice (WSR) and TPR. However, in first year the density of this weed after DSR and WSR was at par but during second year *P. minor* density after WSR was significantly lower than after DSR. Though interaction effects were non-significant but there was definite trend during both the years of reduced population of *P. minor* in zero tillage wheat (ZTW) than in conventional tillage wheat (CTW) irrespective of rice establishment methods. During first year, the population of *C. album* also varied like that of *P. minor* under different rice-wheat establishment methods. But in second year significantly more number of *C. album* was observed in wheat after DSR than after WSR and TPR. Here again though interaction effects were non-significant but density of *C. album* was reduced to a great extent in ZTW than in CTW irrespective of rice establishment methods.

The population of *P. monspeliensis* in wheat after DSR was more than after WSR and TPR during both the years but the differences were non-significant after WSR and TPR. The effect of ZTW and CTW after rice establishment methods was similar to that of *P. minor* and *C. album*. The population of "other weeds" in wheat after all the rice establishment methods during both the years did not vary significantly. The effect of ZTW and CTW was similar to that of *P. minor, C. album* and *P. monspeliensis* (Tables 1 and 2).

Table 1. Effect of crop establishment methods of rice and wheat on weed density in wheat at 30 days stage during 2002-03

Establishment	*P. minor*			*C. album*			*P. monspeliensis*			Other weeds		
methods	CTW	ZTW	Mean	CTW	ZTW	Mean	CTW	ZTW	Mean	CTW	ZTW	Mean
DSR	208 (5.33)	38 (3.65)	123 (4.49)	111 (4.69)	36 (3.39)	74 (4.04)	52 (3.94)	16 (2.83)	34 (3.38)	26 (3.26)	22 (3.09)	24 (3.18)
WSR	196 (5.28)	27 (3.29)	112 (4.29)	81 (4.40)	21 (3.07)	51 (3.74)	12 (2.44)	5 (1.80)	9 (2.12)	20 (3.05)	10 (2.34)	15 (2.69)
TPR	151 (5.01)	27 (3.29)	89 (4.16)	74 (4.32)	12 (2.52)	43 (3.42)	11 (2.39)	4 (1.61)	7 (2.00)	17 (2.84)	9 (2.29)	13 (2.56)
Mean	185 (5.21)	31 (3.42)		89 (4.47)	23 (2.99)		25 (2.92)	8 (2.08)		21 (3.05)	14 (2.58)	
		LSD (P=0.05)			LSD (P=0.05)			LSD (P=0.05)			LSD (P=0.05)	
Rice establishment methods		0.25			0.38			0.43			NS	
Wheat establishment methods		0.22			0.17			0.59			0.28	
Interactions 'F' test		NS			NS			NS			NS	

NS–Not Significant.

Table 2. Effect of crop establishment methods of rice and wheat on weed density (No. m^{-2}) in wheat at 30 days stage during 2003-04

Establishment	*P. minor*			*C. album*			*P. monspeliensis*			Other weeds		
methods	CTW	ZTW	Mean	CTW	ZTW	Mean	CTW	ZTW	Mean	CTW	ZTW	Mean
DSR	78 (4.36)	7 (1.93)	42 (3.14)	47 (3.79)	5 (1.75)	26 (2.77)	8 (2.16)	4 (1.59)	6 (1.88)	27 (3.15)	10 (2.41)	19 (2.78)
WSR	31 (3.44)	3 (1.38)	17 (2.41)	20 (3.04)	3 (1.33)	11 (2.18)	8 (2.02)	0 (0.00)	4 (1.01)	15 (2.77)	5 (1.83)	10 (2.30)
TPR	27 (3.34)	2 (0.98)	14 (2.15)	179 (2.85)	0 (0.00)	8 (1.42)	6 (1.79)	0 (0.00)	3 (0.89)	8 (2.17)	4 (1.24)	6 (1.71)
Mean	45 (3.71)	4 (1.42)		28 (3.24)	3 (1.03)		7 (1.99)	1 (0.52)		21 (2.69)	14 (1.83)	
		LSD (P=0.05)			LSD (P=0.05)			LSD (P=0.05)			LSD (P=0.05)	
Rice establishment methods		0.54			0.22			0.76			NS	
Wheat establishment methods		0.41			0.50			0.50			0.61	
Interactions 'F' test		NS			NS			NS			NS	

Values in parentheses were transformed to log (x+1) for analysis.

DSR–Direct seeded rice in unpuddled soil, WSR–Wet seeded rice in puddled soil, TPR–Transplanted rice in puddled soil, CTW–Conventional tilled wheat, ZTW–Zero tilled wheat, NS–Not Significant.

The minimum weed population was recorded in ZT sown crop which was significantly less than CT sown wheat. This might be due to the fact that puddling operation carried out during rice buried weed seeds in deeper soil layer, whereas intensive tillage in CT system brought them in favourable moist upper soil layer for germination, while they remained in deeper layer under ZT system. Similar results were also reported by Yadav (2002), NATP (1999-2003) and Skorda *et al.* (1997).

Effect on Crop

ZTW recorded significantly more grain yield than CTW during both the years but the difference was non-significant (Table 3). The wheat grain yields after DSR and WSR were significantly more than that of TPR during first season while in second season the wheat grain yields after DSR, WSR and TPR did not vary significantly but the wheat yield was relatively more after DSR than after TPR (Table 3). Tripathi *et al.* (1999) reported that zero tilled wheat after dry seeding of rice gave significantly higher yield (4.9 t ha^{-1}) than conventionally tilled wheat (4.3 t ha^{-1}) after transplanted rice. In another study at Karnal, wheat yield after dry seeded rice was significantly higher (8.2%) than after transplanted rice. The main reasons for higher yield in zero tillage wheat after direct seeded rice in both the above studies were attributed to increase in yield attributing parameters as compared with that of conventional tillage.

In this study also, the mean wheat grain yield was higher when grown after DSR (5055 kg ha^{-1}), which was followed by that of WSR (5301 kg ha^{-1}) and TPR (4665 kg ha^{-1}). The lowest grain yield of wheat was obtained after TPR which was associated with less number of spikes (415 m^{-2}), low number of grains per spike (46 $spike^{-1}$), low test weight (37.9 g) and smaller spikes (9.4 cm) as compared to wheat after DSR with more number of spikes per unit area (444 m^{-2}), more number of grains per spike (54 $spike^{-1}$), higher test weight (39.9 g) and longer spikes (10.3 cm) (Tables 4 and 5). Puddling of soil for rice adversely affected the following wheat crop. Wheat sown after dry sowing of rice where no puddling was done (DSR) gave more yield than the wheat in plots which were puddled sown (WSR) and puddled transplanted (TPR). Puddling of soil for rice adversely affected the following wheat crop because puddling creates soil physical conditions which are detrimental to following wheat crop (Hobbs and Morris, 1996). In this experiment, ZTW did better than CTW treatments during both the years because of much earlier planting. Data from many experiments have shown that wheat yields decline by 0.7-1.5% per day of delay from optimum planting time (Ortiz-Monasterio *et al.,* 1994).

Table 3. Wheat grain yield (kg ha^{-1}) as influenced by crop establishment methods of rice and wheat

Establishment methods	Grain yield (kg ha^{-1})					
	2002-03			2003-04		
	CTW	ZTW	Mean	CTW	ZTW	Mean
DSR	4829	4979	4904	5154	5259	5206
WSR	4849	4970	4909	5050	5258	5154
TPR	4312	4654	4483	4829	4866	4848
Mean	4663	4868		5011	5128	
		LSD (P=0.05)			LSD (P=0.05)	
Rice establishment methods		280			NS	
Wheat establishment methods		NS			NS	
Interactions 'F' test		NS			NS	

Table 4. Effect of crop establishment methods of rice and wheat on yield attributing characters of wheat during 2002-03

Establishment	Number of spikes m^{-2}			Number of grains $spike^{-1}$			1000-grain weight (g)			Spike length (cm)		
methods	CTW	ZTW	Mean	CTW	ZTW	Mean	CTW	ZTW	Mean	CTW	ZTW	Mean
DSR	426	439	432	41	47	44	38.5	39.5	39.0	9.0	9.5	9.8
WSR	408	437	418	40	40	40	37.6	38.0	37.8	8.9	8.9	8.9
TPR	400	421	411	38	39	39	37.5	37.6	37.5	8.5	8.8	8.6
Mean	416	436		40	42		37.8	38.4		8.8	9.1	
		LSD (P=0.05)			LSD (P=0.05)			LSD (P=0.05)			LSD (P=0.05)	
Rice establishment methods		NS			2			NS			0.4	
Wheat establishment methods		17			NS			NS			0.2	
Interactions 'F' test		NS			NS			NS			NS	

NS–Not Significant.

Table 5. Effect of crop establishment methods of rice and wheat on yield attributing characters of wheat during 2003-04

Establishment	Number of spikes m^{-2}			Number of grains $spike^{-1}$			1000-grain weight (g)			Spike length (cm)		
methods	CTW	ZTW	Mean	CTW	ZTW	Mean	CTW	ZTW	Mean	CTW	ZTW	Mean
DSR	427	441	434	62	70	66	40.5	41.4	40.9	11.5	11.6	11.4
WSR	412	437	424	58	67	62	38.5	40.4	39.4	10.4	11.4	10.9
TPR	410	432	421	54	55	55	38.4	38.5	38.5	10.1	10.2	10.2
Mean	417	437		58	64	61	39.1	40.1		10.6	11.1	
		LSD (P=0.05)			LSD (P=0.05)			LSD (P=0.05)			LSD (P=0.05)	
Rice establishment methods		NS			7			1.1			0.6	
Wheat establishment methods		12			5			0.7			NS	
Interactions 'F' test		NS			NS			NS			NS	

NS–Not Significant.

REFERENCES

Balasubramanian, V. and J. E. Hill, 2002. Direct seeding of rice in Asia : Emerging issues and strategies research needs for the 21st century. In : International Workshop on Direct Seeding in Asian Rice System, Pandey *et al.* (*eds.*), 25-28 January, 2000, Bangkok, Thailand. International Rice Research Institute, Los Banos (Philippines). 38 pp.

Hobbs, P. R. and M. L. Morris, 1996. Meeting South Asia's future food requirements from rice-wheat cropping systems : Priority issues facing researcher in the post-green revolution era. NRG Paper 96-101, CIMMYT, Mexico.

NATP, 1999-2003. Conservation tillage in rice-wheat cropping system under irrigated agro-ecosystem. Final Report, Department of Agronomy, NATP Project, Pantnagar, India.

Ortiz-Monasterio, J. I., S. S. Dillon and R. A. Fischer, 1994. Date of sowing effects on grain yield and yield components of irrigated spring wheat cultivars and relationship with radiation and temperature in Ludhiana, India. *Fields Crops Res.* **37** : 169-184.

Singh, R. K., D. K. Singh and R. P. Singh, 1997. Weed-crop competition in wheat as affected by different weed species. *Indian J. Weed Sci.* **29** : 69-71.

Singh, Y. 2004. Direct seeding of rice in Asia. Paper presented in Seminar on "Weed Management in Direct Seeded Rice" under UP-DASP-SAU Research Management on February 24-25, 2004 at N. D. Univ. of Agric. & Tech. (Kumarganj), Faizabad, India.

Singh, Y., A. K. Bhardwaj, S. P. Singh, R. K. Singh, D. C. Chaudhary, A. Saxena, V. Singh, S. P. Singh and A. Kumar, 2002. Effect of rice *(Oryza sativa)*-establishment methods, tillage practices in wheat *(Triticum aestivum)* and fertilization on soil physical properties and rice-wheat system productivity on a silty clay Mollisol of Uttaranchal. *Indian J. Sci.* **72** : 200-205.

Skorda, E. A., A. T. Zamains and P. G. . Efthiniada, 1997.Along term study on effect of no tillage on weed development and yield of continuous wheat and barley. Brighton Crop Protection Conference. Proc. International Conference Brighton, U. K., 17-20 Nov. **3** : 997-1002.

Tripathi, J. 2001. Effect of tillage and crop establishment practices on the productivity of the rice-wheat system. National wheat research programme, Bhairahawa (Nepal). Proc. Wheat Research Papers, Bhairahawa (Nepal). National Wheat Research Programme. pp. 135-141.

Tripathi, S. C., S. Nagarajan and D. S. Chauhan, 1999. Evaluation of zero tillage in wheat (*Triticum aestivum*) under different methods of rice (*Oryza sativa*) transplanting. *Indian J. Agron.* **44** : 219-222.

Yadav, S. K. 2002. Studies on weed dynamics in rice-wheat cropping system with special reference to *Phalaris minor* Retz. Ph. D. thesis, G. B. P. U. A. & T., Pantnagar (U. S. Nagar). 140 p.