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Role of Variety and Plant Geometry on Weed Management in Transplanted Rice (*Oryza sativa* L.)

R. S. Ghuman, L. S. Brar and U. S. Walia
Department of Agronomy
Punjab Agricultural University, Ludhiana-141 004 (Punjab), India

ABSTRACT

Field studies were conducted to evaluate the competing ability of weeds with different rice varieties in relation to variable plant populations. Rice variety PR 108 exhibited greater smothering effect on weeds but PR 118 obtained maximum grain yield as compared to PR 108, PR 114 and PR 116 grown under puddled transplanted conditions. The plant population of 50 plants/m^2 was found to be significantly superiror to 33 and 25 plants/m^2 as it recorded significantly less weed dry matter and highest grain yield compared to other population levels. Application of pretilachlor at 0.75 kg/ha as pre-emergence proved to be very effective in reducing weed dry matter and increasing grain yield upto a significant level as compared to unweeded check.

Key words : Variety, plant population, pretilachlor, transplanted rice

INTRODUCTION

Rice is the most important staple food in Asia, providing on average 32% of total calorie uptake (Maclean *et al.,* 2002). Because of growing population, the demand for rice is expected to increase in the coming decades (Pingali *et al.,* 1997). However, to meet this demand the crop should perform to its full potential. Certain factors tend to restrict the crop's potential performance. Weed competition is one of the major factors responsible for low yield of rice. The inadequate plant population, random planting and less competing ability of dwarf varieties of rice to smother weeds like *Echinochloa crusgalli* L., *Ischaemum rugosum* L. and *Cyperus iria* L. is one of the factors. Depending upon intensity of weed infestation and management practices adopted, losses in paddy yield due to weed competition may vary from 25-55% under transplanted conditions (Gautam and Mishra, 1995; Saikia and Purshothamam, 1996). Competition between crop and weeds can be modified by manipulating crop geometry as increase in crop density can enhance the crop's share of the total resource pool and reduce their availability to weeds (Aldrich, 1984). Hence, high tillering and early establishing varieties exert a smothering effect on weeds which may then be easily controlled manually or with lower dose of herbicides in transplanted rice.

Keeping the above factors in view, the study was planned to know the competing potential of rice varieties against weeds in relation to plant population in transplanted rice.

MATERIALS AND METHODS

The field experiment was conducted at the Research Farm of the Department of Agronomy, Punjab Agricultural University, Ludhiana during **kharif** seasons of 2004 and 2005. The experimental soil was loamy sand, normal in reaction and low in organic carbon (0.31%). The soil was low in available N (225.8 kg/ha) and medium in available P (16.9 kg/ha) and K (128.9 kg/ ha). The treatments comprised four varieties (PR 108, PR 114, PR 116 and PR 118) as main plots and combination of three plant populations (50, 33 and 25 plants/m^2) and two weed control treatments (pretilachlor at 0.75 kg/ha and unweeded check) as sub-plots; laid out in split plot design with four replications. A population of 33 plants/m^2 is recommended by Punjab Agricultural University. The recommended doses of nutrients (120 kg N, 30 kg P_2O_5 and 30 kg K_2O/ha) were applied to the crop. Full dose of P and K and one third of N were broadcasted before puddling. The remaining N was applied in two splits after three and six weeks of transplanting. Basal dose of zinc sulphate (62.5 kg/ha) was applied before puddling. As per the treatments, pretilachlor @ 0.75 kg/ha was applied after three days of transplanting in standing water of 5 cm depth by mixing in 100 kg/ha sand. The number of effective tillers was recorded with a 40 x 40 cm quadrate and expressed as tillers/m^2. Crop samples for dry matter accumulation (DMA) by the crop were taken at 30, 60 and 90 days after transplanting (DAT) and at harvest from the penultimate rows on both sides of the plots. The samples were oven-dried at 60°C till the constant weight was achieved and was expressed as q/ha.

Periodic leaf area per plant at 30, 60, 90 DAT and at harvest was measured using leaf area meter (KVM-12D). The green leaves were separated from the plant and distinguished into three categories (large, medium and small) and the area of representative leaves from each category was measured and multiplied with the number of leaves of particular category and expressed as leaf area index (LAI).

Penetration of PAR in the range of 0.40 to 0.76 microns was measured between 12 noon to 1 p. m. at two spots from each plot. These observations were recorded at 30, 60 and 90 DAT using line quantum sensor and expressed as percentage of light penetrated to the bottom of crop canopy. Harvested produce from the net plot was threshed manually and grain and straw yield was recorded and expressed as q/ha.

Periodic weed dry matter accumulation at 30, 60, 90 DAT and at harvest of the crop was recorded by removing weeds from quadrate of 30 x 30 cm from each plot. These samples were oven dried at 60°C till constant weight achieved and expressed as q/ha.

RESULTS AND DISCUSSION

Weed Dry Matter

Weed flora of the experimental field consisted of broad leaf weeds (*Caesulia axillaris, Eclipta alba, Sphenochlea zeylanica*), grasses (*Echinochloa crusgalli, Ischaemum rugosum*) and sedges (*Cyprus iria*). Dry matter accumulation by these weeds was higher in PR 114 followed by PR 116 and PR 118, while PR 108 registered significantly lesser weed dry matter accumulation both in 2004 and 2005 (Table 1). The less weed biomass in PR 108 might be due to its vigorous growth. The biomass production by weeds was reduced significantly under 50 plants/m^2 over 33 and 25 plants/m^2 in both the years. Pretilachlor application reduced the biomass production by weeds to a level of 93% over unweeded check (mean of both the years).

Interaction of plant population and weed control treatment (Fig. 1) was found significant with respect to biomass production of weeds in 2004. Under pretilachlor treatment, the weed dry matter was almost same as under 33 and 25 plants/m^2 but a significant reduction was noticed with 50 plants/m^2 by a margin of 29.8 and 40.4% over 33 and 25 plants/m^2, respectively. Under unweeded check each plant population affected the weed biomass production and it was highest with lower plant population. Gogoi and Sarma (1994) have also reported similar results.

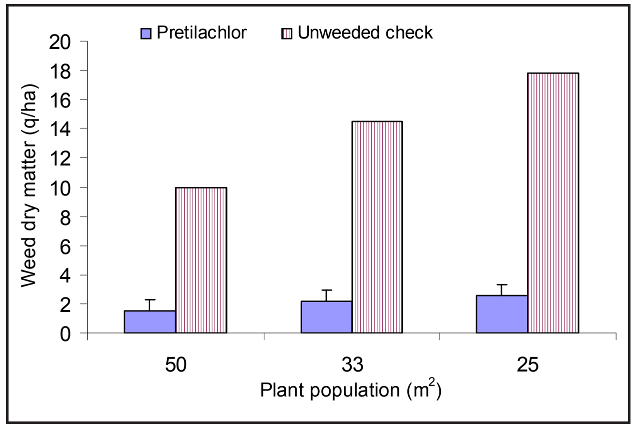

Fig. 1. Interaction effect of plant population × weed control treatment on weed dry matter (q/ha).

Crop Performance

Leaf area

Leaf area is considered as an important index in relation to canopy formation and weed suppressing potential. Gibson and Fischer (2001) identified leaf area as a growth parameter associated with competitive ability of rice. The data in Table 1 reveal that all the treatments had a significant influence on the leaf area index (LAI).

PR 108 recorded significantly higher value of LAI at all growth stages followed by PR 118, PR 114 and PR 116, respectively. Genetic make up and better canopy structure might be the key factor for higher LAI of PR 108 compared to other varieties and this might be the reason for weed suppression capacity. Highest plant population of 50 plants/m^2 recorded significantly higher value of LAI than 33 and 25 plants/m^2 and supportive of the fact that dense canopy structure under closer spacing could help in smothering the weeds (Minotti and Sweet, 1981; Berkowitz, 1988).

Significantly higher value of LAI was obtained with pretilachlor treatment than unweeded check at all growth stages except at 30 DAT, where unweeded check recorded significantly higher LAI than pretilachlor treatment which might be due to dense canopy structure in unweeded (control) treatment due to taller plants.

Table 1. Influence of varieties, plant populations and weed control treatment on weed dry matter accumulation and leaf area index of rice

Treatment	Weed dry matter (q/ha)		Leaf area index			
	2004	2005	30 DAT	60 DAT	90 DAT	At harvest
Variety						
PR 108	5.33	7.63	2.57	4.82	5.63	5.40
PR 114	11.04	15.62	1.79	3.83	4.24	4.03
PR 116	8.81	12.15	1.38	3.2	4.12	3.92
PR 118	7.23	10.92	2.15	4.62	5.40	4.63
LSD (P=0.05)	0.61	3.10	0.22	0.19	0.20	0.64
Plant population/m^2						
50	5.75	6.21	2.25	5.66	5.58	5.97
33	8.35	10.63	1.73	3.98	5.00	4.95
25	10.21	17.90	1.42	2.89	3.95	3.22
LSD (P=0.05)	0.51	1.73	0.22	0.30	0.48	0.28
Weed control treatment						
Pretilachlor	2.10	0.49	1.61	4.52	5.45	4.99
Unweeded check	14.11	22.67	1.79	3.83	4.24	4.26
LSD (P=0.05)	0.42	1.41	0.09	0.25	0.69	0.23

Effective tillers

The interaction effect between plant populations and weed control treatment during 2004 (Table 2) was found to be significant, and it was found that 50 plants/m^2 under unweeded check recorded statistically similar number of effective tillers as recorded by 25 plants/m^2 under pretilachlor treatment. Dense population of crop overcrowds weeds due to shading effect and lack of PAR interception (Sangha, 1983). Dense plant population recorded significantly higher number of effective tillers than thinner population. Pretilachlor @ 0.75 kg/ha resulted in 41% increase in number of effective tillers over unweeded check.

Table 2. Interaction effect of plant population × weed control treatment on effective number of tillers

Plant population/m^2	Pretilachlor	Unweeded check
50	435.5	318.7
33	381.5	290.7
25	302.2	235.5
LSD (P=0.05)	25.11	

Dry matter accumulation

The interaction effects between varieties and plant populations for dry matter accumulation (DMA) by crop were significant in 2004 (Table 3) and it was found that higher DMA was recorded in PR 108 and PR 118 under all plant populations, which were significantly superior to PR 114 and PR 116. In any of the varieties the crop dry matter was statistically same when we increased the plant population from 33 to 50 plants/m^2 but each variety produced significantly lesser dry matter when population was 25 plants/m^2 instead of 33 plants/m^2 which shows that 25 plants/m^2 are not a suitable population to produce optimum level of dry matter compared to 33 plants/m^2. DMA by PR 108 and PR 118 under 25 plants/m^2 was at par with PR 116 and PR 114 with 50 plants/m^2 indicating better growth and development of former varieties.

Table 3. Interaction effect of variety and plant population on dry matter accumulation of crop (q/ha)

Variety	Plant population/m^2		
	50	33	25
PR 108	175.2	165.8	148.7
PR 114	150.4	148.5	104.5
PR 116	153.6	145.4	133.6
PR 118	168.4	168.3	151.4
LSD (P=0.05)		9.92	

Grain yield

Maximum grain yield was obtained by PR 118, which was statistically higher than all other varieties during 2004 but was at par with PR 116 during 2005.

PR 114 gave the lowest yield in both the years (Table 4). Grain yield was significantly higher in dense population of 50 plants/m^2 during both the years because of greater weed suppression, which resulted in higher crop dry matter and effective number of tillers. The plant population of 50 plants/m^2 recorded 6.05 q/ha (average of both the years) higher yield than 33 plants/m^2 which economically means Rs. 5294/ha extra income (Rs. 875/q), while the extra expenditure on labour involved in transplanting was 1.5 times i. e. Rs. 4500/ha instead of Rs. 3000/ha (economics as per data of **kharif** 2008). Similar findings have also been reported by Brar and Walia (2001). Application of pretilachlor increased grain yield over unweeded check due to better weed control during both the yrears.

Interaction effect of plant populations and weed control treatment on grain yield during 2004 (Fig. 2) showed that due to pretilachlor treatment, the grain yield increased by 31.5% with 50 plants/m^2 over unweeded check. While at 33 and 25 plants/m^2, the increase in grain yield was, respectively, 53.6 and 88.0% over unweeded check. It was further observed that at higher plant population, the yield differences between pretilachlor treated plot and unweeded check were minimum but were maximum with 25 plants/m^2.

Table 4. Effect of varieties, plant populations and weed control treatment on photosynthetically active radiation (PAR), grain yield and straw yield of rice

Treatment	PAR penetration (%)			Grain yield (q/ha)		Straw yield (q/ha)	
	30 DAT	60 DAT	90 DAT	2004	2005	2004	2005
Variety							
PR 108	32.9	21.9	16.8	41.7	39.0	134.9	129.2
PR 114	34.8	25.0	21.6	36.0	37.3	101.4	103.3
PR 116	37.2	36.6	20.9	42.4	40.8	129.0	121.5
PR 118	40.8	38.0	20.9	47.7	45.9	131.9	124.6
LSD (P=0.05)	2.5	2.4	1.8	2.93	5.7	13.6	11.3
Plant population/m^2							
50	27.5	22.7	15.9	47.9	44.5	139.1	130.2
33	38.1	27.9	19.0	41.3	39.0	120.6	111.6
25	43.7	40.5	25.4	36.7	38.7	112.0	108.5
LSD (P=0.05)	2.0	1.8	1.4	1.88	3.1	7.82	8.02
Weed control treatment							
Pretilachlor	41.7	40.8	24.1	51.0	47.3	151.5	145.8
Unweeded check	31.1	20.0	16.1	33.1	34.2	109.6	112.7
LSD (P=0.05)	1.6	1.4	1.2	1.53	2.5	6.38	8.9

PR 108 recorded highest straw yield in both the years followed by PR 118 and PR 116, which was significantly higher than PR 114 (Table 4). The higher plant population (50 plants/m^2) recorded significantly higher straw yield than 33 and 25 plants/m^2 and had an edge of about 16 and 22%, respectively (mean of both the years). The pretilachlor treated plots registered significantly higher straw yield (34%) over unweeded check (mean of two years).

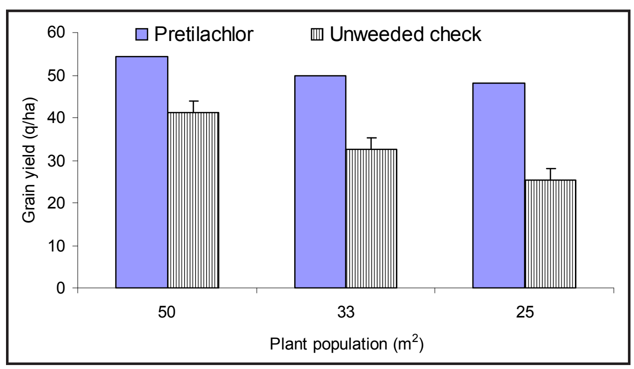

Fig. 2. Interaction effect of plant population × weed control treatment on grain yield (q/ha).

Photosynthetically active radiation (PAR)

The radiation intercepted by crop canopy is a good index to determine the canopy structure of a crop. The PAR penetration was significantly lower in PR 108 at 90 DAT as compared to other cultivars; however, at early growth stage (30 and 60 DAT) it was statistically at par with PR 114 (Table 4). PR 108 reduced the PAR penetration by 22.0, 19.5 and 19.5% over PR 114, PR 116 and PR 118, respectively, during 2004. Low amount of PAR penetration by PR 108 might be due to its higher LAI (Table 1).

PAR penetration in the treatment of denser plant population with 50 plants/m^2 was significantly less as compared to 33 and 25 plants/m^2. Similarly, Sangha (1983) reported that dense canopy under closer spacing played a significant role in checking the light penetration to the weeds beneath the canopy. The data also revealed that unweeded check recorded significantly lesser PAR penetration than pretilachlor treated plots. This might be due to more ground coverage and more LAI because of the presence of weeds.

REFERENCES

Aldrich, R. J. 1984. *Weed-Crop Ecology : Principles in Weed Management.* North Scitruate, M.A. Breton. pp. 189-214.

Berkowitz, A. R. 1988. Competition for resources in weed-crop mixtures. In : *Weed Management in Agro-ecosystems : Ecological Approaches*, Altieri, M. A. and Liebman, M. (eds.). Boca Raton, F. L. CRC Press. pp. 89-120.

Brar, L. S. and U. S. Walia, 2001. Influence of nitrogen levels and plant densities on the growth and development of weeds in transplanted rice (*Oryza sativa*). *Ind. J. Weed Sci.* **33** : 127-131.

Gautam, K. C. and J. S. Mishra, 1995. Problems, prospects and new approaches in weed management. *Pesticides Information* **21** : 7-19.

Gibson, K. D. and A. J. Fischer, 2001. Relative growth and photosynthetic response of water-seeded rice and *Echinochloa oryzoides* (Ard). Fritsch. to shade. *Int. J. Pest Manage.* **47** : 305-309.

Gogoi, A. K. and M. Sarma, 1994. Effect of varieties and herbicides on weed growth in upland direct seeded rice. *Ind. J. Weed Sci.* **26** : 89-92.

Maclean, J. L., D. C. Dawe, B. Hardy and G. P. Hettel, 2002. *Rice Almanac, 3rd edn.* IRRI, Los Baños, Philippines. pp. 253.

Minotti, P. L. and R. D. Sweet, 1981. Role of crop competition in limiting losses from weeds. In : *Handbook of Pest Management in Agriculture*, Pimentel, D. (ed.). Boca Raton Fl : CRC Press. pp. 351-367.

Pingali, P. L., M. Hossain and R. V. Gerpacio, 1997. Asian Rice Market : Demand and Supply Prospects, Asian Rice Bowls : The Returning Crisis? CAB International, Wallingford, UK and International Rice Research Institute, Los Baños, Philippines. pp. 126-144.

Saikia, M. and S. Purshothamam, 1996. Competitive ability of weed flora in low land rice (*Oryza sativa*). *Ind. J. agric. Sci.* **66** : 70-72.

Sangha, G. S. 1983. Influence of variable plant populations and nitrogen levels on competing ability of transplanted paddy (*Oryza sativa*) with weeds. M. Sc. thesis, Punjab Agricultural University, Ludhiana.