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Nutrient Uptake by Red Sprangletop [*Leptochloa chinensis* (L.) Nees] and Transplanted Rice under Different Cultural and Weed Management Practices*

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ABSTRACT

The nutrient uptake by red sprangletop (*Leptochloa chinensis*) and transplanted rice was studied under three off-season land management practices (raising green manure, undisturbed land and frequent cultivations after wheat harvest) in main plots with three crop plant densities (22, 33 and 44 hills/m^2) and two weed management practices (pyrazosulfuron 0.015 kg/ha and two hand weedings) alongwith an unweeded control in sub plots. The frequent cultivations were able to significantly reduce the nutrient removal by the weed and increase the nutrient uptake by rice as compared to green manured and undisturbed land after wheat harvest, the latter two being at par. The increase in crop plant density from 22 to 44 hills/m^2 reduced the nutrient removal by the weed and increased the nutrient uptake by rice. Two hand weedings and pyrazosulfuron 0.015 kg/ha were equally effective in reducing the nutrient removal by the weed and increased nutrient uptake by rice and were significantly better than the unweeded control.

Key words : Plant density, nutrient uptake, off season land management

INTRODUCTION

Rice (*Oryza sativa* L.) is a major food crop in Asia and many other tropical and sub-tropical countries of the world. Weeds are one of the most important biological constraints in their production and about 31 different weed species infesting rice in Punjab have been reported by Shetty *et al.* (1975). Singh *et al.* (2002) reported 48.9% yield reduction in weedy check as compared to two hand weedings in transplanted rice at Ludhiana.

Red sprangletop (*Leptochloa chinensis* synonym *Poa chinensis*), an invasive alien weed in rice in Cauvery Delta region in Tamil Nadu, was effectively controlled with pre-emergence application of butachlor (Kathiresan, 2004). Yield reductions of 14 to 44% are reported at various densities of *L. chinensis* in transplanted rice (Prusty *et al.*, 1993). The ability of weed communities to shift in response to weed control practices suggests the need for more integrated and diverse approaches to weed management (Buhler *et al.,* 2000).

The present studies were conducted with an objective to get information on the effect of off-season land management practices (after wheat harvest), crop plant densities and weed management practices on the nutrient depletion by *L. chinensis* and its effect on crop yield.

MATERIALS AND METHODS

The experiment was conducted on the research farm of Department of Agronomy and Agrometeorology, Punjab Agricultural University, Ludhiana during **kharif** 2003 and 2004. The soil was sandy loam with a pH of 8.2 and EC of 0.21 dS/m, low in organic carbon (0.21%), medium in available nitrogen (315 kg/ha) and potassium (224 kg/ha) and high in available phosphorus (31.4 kg/ha).

Three off-season land management practices after wheat harvest (raising green manure, undisturbed land and frequent cultivations) were maintained in the main plots and three plant densities [22 (30 x 15 cm), 33 (20 x 15 cm) and 44 (15 x 15 cm) hills/m^2] and two weed management practices (pyrazosulfuron 0.015 kg/ha and two hand weedings) alongwith an unweeded control were maintained in the sub-plots. In frequent cultivation treatment, the field was irrigated alongwith irrigations to the green manured plots and cultivated subsequently. It took five additional cultivations than the green manured and undisturbed field. The field was kept submerged in 7.5 cm deep water during first 15

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days after transplanting the crop. An irrigation was given two days after the ponded water had infiltrated taking care that cracks did not appear in the field. The population of *L. chinensis* in the experimental field was ensured by artificial charging field with one year old seeds of the weed. All other weeds, except *L. chinensis*, were manually removed at the time when they could be differentiated from the *L. chinensis*. The herbicide was applied as pre-emergence by mixing with sand (150 kg/ha) within two days of transplanting the rice in 4-5 cm standing water.

The recommended doses of fertilizers viz., 125 kg N/ha in the form of urea, 30 kg P_2O_5/ha in the form of single super phosphate, 30 kg K_2O/ha in the form of muriate of potash and 62.5 kg/ha zinc sulphate were applied. Full dose of phosphorus, potassium, zinc and one-third of nitrogen were applied before puddling and remaining two-third of nitrogen was applied in two splits, three and six weeks after transplanting. The rice variety PR 116 was transplanted on 26 and 25 June and harvested on 18 and 20 October during the 1st and 2nd years, respectively.

The oven dried grounded samples of crop and weed were digested with concentrated H_2SO_4 in the presence of digestion mixture ($HgO+SeO_2+CuSO_4+K_2SO_4$) for the determination of total nitrogen by modified Kjeldahl's method. The phosphorus was determined by Vanadomolyb dophosphoric yellow colour method in nitric acid system and potassium content was estimated with the help of Lange's Flame Photometer from the extract prepared for phosphorus (Jackson, 1967).

The nutrient uptake by the weed was determined by multiplying the per cent N, P and K content in the plant with the above ground dry matter of the weed. The same for the crop was determined by multiplying the per cent N, P and K content of grain and straw with their respective dry matter values.

RESULTS AND DISCUSSION

Nutrient Uptake

Nitrogen, phosphorus and potassium uptake by *L. chinensis* was inversely related to the efficiency of different treatments to check the growth of the weed.

Effect of off-season land management practices : The nutrient (NPK) removal by the weed was significantly lower while that by the crop was significantly higher under frequent cultivations treatment than the green manure and undisturbed land treatments during both the years of study (Table 1). The latter two treatments were statistically at par with each other in respect of the nutrient removal by weed and crop. The mean of two years' data showed that the weed removed 3.6, 3.3 and 2.0 kg N; 1.0, 0.9 and 0.6 kg P and 5.2, 5.0 and 2.9 kg K/ha and the crop removed 140, 137 and 155 kg N; 35, 34 and 38 kg P and 140, 140 and 150 kg K/ha under green manure, undisturbed land and frequent cultivation treatments, respectively. The lower nutrient removal by the weed and higher by the crop under frequent cultivations might be due to less weed population and dry matter accumulation by the weed.

Effect of crop plant densities : The nitrogen removal by the weed increased and nutrient uptake (NPK) by the crop decreased significantly and progressively with decrease in crop plant density from 44 to 22 hills/m^2 during both the years of study. Phosphorus and potassium removal by the weed was significant during the second year only (Table 1). During the first year, phosphorus and potassium removal by the weed under crop plant density of 33 hills/m^2 was statistically at par with plant densities of 22 and 44 hills/m^2. However, the weed removed significantly higher amount of phosphorus and potassium under plant density of 22 hills/m^2 than that under 44 hills/m^2. The mean of two years' data showed that the weed removed 3.7, 3.0 and 2.3 kg N; 1.0, 0.9 and 0.6 kg P and 5.3, 4.3 and 3.3 kg K/ha and crop removed 132, 144 and 156 kg N; 33, 36 and 38 kg P and 133, 144 and 153 kg K/ha under crop plant densities of 22, 33 and 44 hills/m^2, respectively. The lower nutrient removal by weed and higher removal by the crop under higher crop plant densities might be due to weed suppression leading to lower dry matter accumulation by the weed. Reddy (2000) also reported decreased nutrient removal by the weeds under higher crop plant densities.

Effect of weed management practices : The nutrient uptake by the weed under unweeded control was significantly higher and that by the crop was significantly lower than the chemical and hand weeded treatments, the latter two being statistically at par (Table 1). The mean of two years' data showed that the weed under unweeded control conditions removed 16.5, 3.5 and 25.8 kg N, P and K/ha, respectively. N, P and K uptake by the crop under unweeded control was 121, 30 and 120 kg/ha, respectively, and that under herbicide application and twice hand weedings was 157, 39 and 156 kg/ha and 154, 38 and 154 kg/ha, respectively. The herbicide application and

Table 1. Nutrient (NPK) uptake (kg/ha) by *L. chinensis* and transplanted rice under different treatments

Treatment	*L. chinensis*									Rice								
	Nitrogen			Phosphorus			Potassium			Nitrogen			Phosphorus			Potassium		
	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean
Green manure	3.7 (2.04)	3.5 (2.01)	3.6	1.0 (1.23)	0.9 (1.18)	1.0	5.5 (2.45)	4.9 (2.32)	5.2	140	139	140	33	36	35	144	136	140
Undisturbed land	3.3 (1.96)	3.3 (1.96)	3.3	0.9 (1.20)	0.9 (1.20)	0.9	5.0 (2.34)	4.9 (2.32)	5.0	140	134	137	33	35	34	147	132	140
Frequent cultivations	2.2 (1.64)	1.7 (1.47)	2.0	0.6 (1.05)	0.6 (0.99)	0.6	3.3 (1.95)	2.4 (1.70)	2.9	155	155	155	36	39	38	155	144	150
LSD (P=0.05)	0.13	0.22	-	0.11	0.09	-	0.29	0.23	-	9	11	-	2	3	-	7	6	-
22 hills/m^2	3.7 (2.05)	3.6 (2.02)	3.7	1.0 (1.24)	1.0 (1.22)	1.0	5.5 (2.45)	5.1 (2.37)	5.3	133	131	132	31	34	33	139	127	133
33 hills/m^2	3.0 (1.88)	2.9 (1.83)	3.0	0.9 (1.16)	0.8 (1.12)	0.9	4.6 (2.26)	4.0 (2.12)	4.3	145	143	144	34	37	36	149	138	144
44 hills/m^2	2.5 (1.72)	2.0 (1.59)	2.3	0.7 (1.08)	0.5 (1.02)	0.6	3.6 (2.03)	2.9 (1.85)	3.3	157	154	156	37	39	38	158	147	153
LSD (P=0.05)	0.15	0.13	-	0.09	0.08	-	0.28	0.16	-	7	9	-	3	2	-	5	8	-
Pyrazosulfuron	0.0 (0.71)	0.0 (0.71)	0.0	0.0 (0.71)	0.0 (0.71)	0.0	0.0 (0.71)	0.0 (0.71)	0.0	158	155	157	37	40	39	163	149	156
Hand weeding	0.0 (0.71)	0.0 (0.71)	0.0	0.0 (0.71)	0.0 (0.71)	0.0	0.0 (0.71)	0.0 (0.71)	0.0	155	153	154	37	39	38	161	146	154
Unweeded control	17.3 (4.22)	15.7 (4.02)	16.5	3.7 (2.06)	3.3 (1.95)	3.5	27.8 (5.32)	23.8 (4.93)	25.8	121	120	121	28	31	30	122	118	120
LSD (P=0.05)	0.15	0.13	-	0.09	0.08	-	0.28	0.16	-	7	9	-	3	2	-	5	8	-

Figures in parentheses are $\sqrt{X+0.5}$ transformed data.

Table 2. Interaction between off-season land management/crop plant density and weed control treatments for nutrient (NPK) uptake (kg/ha) by *L. chinensis*

Off-season management/ weed control	Off-season land management																	
	Nitrogen						Phosphorus						Potassium					
	Green manure		Undisturbed land		Frequent cultivations		Green manure		Undisturbed land		Frequent cultivations		Green manure		Undisturbed land		Frequent cultivations	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
Pyrazosulfuron	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
Hand weedings	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
Unweeded	4.69	4.60	4.47	4.47	3.51	3.49	2.26	2.13	2.17	2.18	1.74	1.54	5.92	5.55	5.61	5.55	4.45	3.68
Plant density/							**Crop plant density (hills/m^2)**											
Weed control		22 33	44	22	33	44	22	33	44									
Pyrazosulfuron	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
Hand weedings	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
Unweeded	4.72	4.64	4.22	4.08	3.73	3.36	2.29	2.25	2.06	1.94	1.81	1.66	5.92	5.70	5.37	4.95	4.68	4.13
LSD (P=0.05)	2003 :	0.26,	2004 :		0.22	2003 :		0.15,	2004 :		0.14	2003 :		0.48,	2004 :		0.27	

The data are √X+0.5 transformed data.

hand weedings almost completely controlled the weed leading to less nutrient removal by the weed and more by the crop as compared to unweeded control. Singh *et al.* (1999) also reported significantly lower nitrogen uptake by weeds with herbicide application and twice hand weedings than weedy check.

Weed control treatments had a significant interaction with off-season land management practices and crop plant densities in respect of nutrient removal by the weed. The different off-season land management practices were statistically at par in respect of nutrient removal by the weed under herbicide application and twice hand weedings, whereas frequent cultivations treatment was significantly better in arresting the nutrient removal than the green manure and undisturbed land treatments under unweeded control conditions (Table 2).

The effect of higher crop plant densities on checking the nutrient removal by the weed was significant only under unweeded control conditions, whereas under herbicide application and two hand weedings, the effect of crop plant densities was non-significant (Table 2).

Effect on Grain Yield of Rice

Effect of off-season land management practices : The frequent cultivations during off-season registered significantly higher grain yield than that of raising green manure and keeping the field undisturbed, the latter two being statistically at par with respect to grain yield (Table 3). Mean of two years' data showed that frequent cultivations during off-season gave 17.3 and 19.3% higher yields than that of raising green manure and keeping the field undisturbed, respectively. This might be due to the increased nutrient uptake of crop resulting from less competition by the weed. The carry-over effect of off-season cultivations in managing weeds attained significance in influencing the crop yields as compared to the other two off-season land management treatments. Frequent cultivations might have a solid contribution in the depletion of weed seed reserves in the soil as compared to raising green manure crop and its burying or keeping the field undisturbed during off-season. Gnanavel and Kathiresan (2002) also reported that off-season ploughings twice gave the highest grain yields of transplanted rice than raising a green manure crop or leaving the land fallow.

Effect of crop plant densities : The grain yield of rice showed a significant and progressive increase with increase in the crop plant density from 22 to 44 hills/m^2 (Table 3). The mean of two years' data showed that higher plant density (44 hills/m^2) gave 10.9% more and lower plant density (22 hills/m^2) resulted 9.5% less grain yield than the recommended one i. e. 33 hills/m^2.

Table 3. Effect of different treatments on dry matter accumulation by *L. chinensis* and grain and straw yield of transplanted rice

Treatment	*L. chinensis*			Rice					
	Dry matter accumulation (q\ha)			Straw yield (q/ha)			Grain yield (q/ha)		
	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean
Off-season land management									
Green manure	3.83 (2.08)	3.58 (2.02)	3.71	88.0	98.0	93.0	60.8	58.4	59.6
Undisturbed land	3.34 (1.96)	3.46 (1.99)	3.4	89.0	97.0	93.0	59.9	57.3	58.6
Frequent cultivations	2.29 (1.67)	1.69 (1.48)	1.99	107.0	111.0	109.0	69.1	70.6	69.9
LSD (P=0.05)	0.15	0.20	-	16.0	10.0	-	6.8	5.1	-
Crop plant densities									
22 hills/m^{-2}	3.79 (2.07)	3.66 (2.04)	3.73	82.0	92.0	87.0	56.1	56.8	56.5
33 hills/m^{-2}	3.19 (1.92)	2.89 (1.84)	3.04	92.0	101.0	97.0	62.7	62.0	62.4
44 hills/m^{-2}	2.46 (1.72)	2.06 (1.60)	2.26	109.0	112.0	111.0	70.9	67.5	69.2
LSD (P=0.05)	0.14	0.11	-	6.0	8.0	-	3.2	3.8	-
Weed control									
Pyrazosulfuron	0.00 (0.71)	0.00 (0.71)	0.00	107.0	103.0	105.0	68.1	67.5	67.8
Hand weeding	0.00 (0.71)	0.00 (0.71)	0.00	104.0	108.0	106.0	67.4	67.2	67.3
Unweeded control	17.82 (4.28)	16.06 (4.07)	16.94	83.0	94.0	89.0	54.3	51.7	53.0
LSD (P=0.05)	0.14	0.11	-	0.6	0.8	-	3.2	3.8	-

Figures in parentheses are $\sqrt{X+0.5}$ transformed data.

This might be due to the increased nutrient uptake by the crop resulting from lesser weed competition under higher crop plant densities. Higher crop plant densities encouraged early and more crop canopy cover and higher leaf area index (LAI) resulting in significantly less dry matter accumulation by *L. chinensis* as compared to lower plant densities (Table 3). In lower crop plant density of 22 hills/m^2, there was significantly higher dry matter accumulation by the weed which resulted in more competition to the crop and adversely affected the yield attributes and grain yield of rice. Brar and Walia (2001) also observed higher grain yield of transplanted rice with higher crop plant density.

Effect of weed management practices : The application of pyrazosulfuron 0.015 kg/ha and two hand weedings, statistically at par with each other, produced significantly higher grain yield than that under unweeded control conditions (Table 3). The mean of two years' data showed that herbicide application and two hand weedings produced 27.9 and 27.0% higher grain yield than unweeded control. The better yield performance of herbicide application and hand weedings might be the result of increased nutrient uptake by the crop due to no dry matter accumulation by the weed under these treatments (Table 3). Reddy and Reddy (2000) also reported equal effectiveness of hand weeding and herbicide application for higher grain yield of transplanted rice. Shekhar *et al.* (2004) observed an increase of 30.9% in grain yield of transplanted rice with pyrazosulfuron 0.025 kg/ha over weedy check.

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