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Short Communication

Effect of rice straw incorporation on weed management and crop growth in rice

Pratibha Singh and S.K. Guru
Department of Plant Physiology, College of Basic Science and Humanities, G.B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand)
E-mail : skguru123@yahoo.com

ABSTRACT

Among the treatments, weedy and butachlor plots had higher population of weeds. Weed population was lower at all the doses of rice straw incorporated with the lowest in 500 g/m^2 rice straw treatment. Data on weed dry weight recorded at 60 DAT revealed a significant decrease in all the plots where rice straw was incorporated as compared to weedy and butachlor treated plots. Grain yield was also higher at all the doses of rice straw incorporation while it was lowest (2658 kg/ha) in the weedy treatment (Table 3). Highest grain yield (3,925 kg/ha) was obtained, irrespective of cultivars, in the treatment with the highest rice straw incorporation (500 g/m^2). A total of 17 compounds were recorded in the straw. Among these, four compounds could be identified after comparing with phenolic standards. These were gallic acid, *p*-hydroxy benzoic acid, ferulic acid and vanillic acid.

Key words : Incorporation of rice straw, Weed management.

Rice (*Oryza sativa* L.) being an important staple food for more than 50% of the world's population has considerable economic and agricultural importance. Weeds are the major biotic stress in rice production world wide, accounting for about 35% of yield losses in the tropics (Oerke and Dehne 2004). They cause serious yield reduction particularly in upland rice. In aerobic rice, weeds are the greatest yields limiting constraint, contributing about 50% to yield gaps, followed in importance by N-deficiency, pest and diseases. Losses can be much higher in aerobic rice (Balasubramanium and Hill 2002). Although herbicide use has increased productivity, there are several weed problems that remain unsolved and want solutions that should be cost effective and environment friendly. Earlier findings revealed that allelopathic cultivars of rice can control both monocot and dicot weeds under field conditions with some selectivity observed amongst such weeds, suggesting that certain compounds with selective action might be implicated in rice allelopathy (Olofsdotter 2001, Olofsdotter *et al.* 2002). The rice crop yields a large amount of rice straw which is a agricultural wastes. The new approaches of using rice straw for controlling weeds in different crops, indicated that rice straw can be used for mulching, which benefits in preventing weed growth as well as supplies organic matter for N-fixation by heterotrophic N-fixing microorganisms (Mendoza and Samson 1999). Thus, use of rice straw as fertilizer as well as suppressing the weed growth due to its allelopathic potential can be a good approach to reduce the herbicide load.

An experiment was conducted at Crop Research Centre, Pantnagar during the rainy season 2008 to study the effect of rice straw incorporation into the soil on the weed flora and growth in rice. Three different doses (100, 200 and 500 g/m^2) of finely cut straw of rice cultivars *Narendra* and *Sarju 52* were incorporated into the soil about two weeks before transplanting. Transplanting was done in small plots (3.0 × 2.8 m) with a spacing of 20 x 10 cm. Four rice cultivars *viz., Pant Dhan 18*, *Pant Sugandha Dhan 15*, *Govind* and *Pusa 44* were transplanted in a split plot design with three replications with weed management as the main plot treatments and cultivars as the sub plot treatment. Butachlor (1.5 kg/ha) was sprayed after three days of transplanting and weedy plots were maintained as checks. Data on weed flora and weed biomass were recorded at 60 DAT while crop biomass and yield were recorded at harvest. The phenolic contents of rice straw were analyzed by HPLC following the method of Ramakrishna *et al*. (1989). The dried phenolic residues were dissolved in 2 ml water: methanol (75:25, v/v). The samples were filtered through 0.22 µm flouropore filters before injecting into HPLC column (C18 reverse phase). Absorbance was recorded at 254 and 280 nm with PDA (photo diode array) detector. The mobile phase, acetonitrile : water : acetic acid (85:12:3) was used with a flow rate of 1 ml/min.

Weed flora

The experimental field was infested with grassy weeds *Ehinochloa crusgalli, Ehinochloa colona, Leptochloa chinensis, Ishaemum rugosum* and *Paspalum* *scrobiculatum*. The sedges consisted of *Cyperus iria, Cyperus difformis, Frimbistylis miliaceae* and broad leaved weeds (BLW) such as *Caesulia axillaris, Ammania baccifera* and *Alternanthera sessilis* were present. Among the treatments, weedy and butachlor plots had higher population of weeds. Weed population was lower at all the doses of rice straw incorporated with the lowest in 500 g/m^2 rice straw treatment (Table 1). Data on weed dry weight recorded at 60 DAT revealed a significant decrease in all the plots where rice straw was incorporated as compared to weedy and butachlor treated plots (Table 2). Weed dry weight was maximum in weedy plot (480.3 g/m^2) and minimum in 500 g/m^2 rice straw incorporated treatment (283.7 g/m^2).

Total dry matter production of four rice cultivars at the time of harvest was higher in all the rice straw incorporated treatments as compared to weedy plots (Table 3). It was maximum (9290 kg/ha) at the highest dose of rice straw (500 g/m^2) and minimum in the weedy treatment (7330 kg/ha). Total dry matter was higher in all the four rice cultivars where rice straw was incorporated and significant increase in total dry matter was obtained in cultivar Pant Dhan18.

Grain yield was also higher at all the doses of rice straw incorporation while it was lowest (2658 kg/ha) in the weedy treatment (Table 3). Highest grain yield (3925 kg/ha) was obtained, irrespective of cultivars, in the treatment with the highest rice straw incorporation (500 g/m^2). Reduction in grain yield in weedy treatment was 32.27% as compared to the highest dose of rice straw incorporated treatment. The grain yield in all the four rice cultivars were higher in the plots where rice straw was incorporated into the soil. Therefore, it is concluded from the findings that higher concentration of rice straw was more effective in controlling weed growth and promoting the crop growth and yield. Using crop residues for weed suppression has been reported earlier (Barnes and Putnam 1983)

The data obtained from the HPLC analysis (Table 4) showed that a total of 17 compounds were present in the straw. Among these, four compounds could be identified after comparing with phenolic standards. These were gallic acid, *p*-hydroxy benzoic acid, ferulic acid and vanillic acid. Presence of allelochemicals in rice have been reported by various workers (Chung *et al.* 2001, Kato-Noguchi *et al*. 2002). Ferulic acid is reported to be one of

Table 1. Weed population (no./m^2) at 60 DAT under different doses of rice straw incorporation in rice

Name of weed species	Rice straw incorporation			Butachlor 1.5 kg/ha	Weedy check
	100 g/m^2	200 g/m^2	500 g/m^2		
		Population (/m^2)			
Grasses and sedges					
Echinochloa crusgalli	96	86	84	100	104
Ehinochloa colona	28	16	16	28	36
Leptochloa chinensis			20	12	24
Paspalum schrobiculatum	28	40	16	16	24
Frimbristylis miliaceae			16	20	23
Cyperus iria	8	10	12	9	20
Cyperus difformis	16	9	4		8
Ischaemum rugosum	4				8
Broad leaf weeds					
Caesulia axillaris	56	84	40	88	23
Ammania baccifera	9	24	12	16	32
Alternathera sessilis	10				12
Total	255	269	220	289	323

Table 2. Effect of different doses of rice straw incorporation on weed dry weight (g/m^2) at 60 DAT in rice

Rice Cultivars	Rice straw incorporation			Butachlor 1.5 kg/ha	Weedy check
	100 g/m^2	200 g/m^2	500 g/m^2		
Weed dry weight (g/m^2)					
Pant Sugandha Dhan 15	454.6	440.0	326.6	626.6	654.6
Pant Dhan 18	294.6	280.0	258.0	263.3	313.3
Govind	213.3	372.0	293.3	386.6	606.6
Pusa 44	286.6	260.0	256.6	273.3	346.6
Mean	312.3	338.0	283.7	387.5	480.3
LSD (P = 0.05)	192.89	130.78	292.43		

Table 3. Effect of different doses of rice straw incorporation on total dry matter production and grain yield (kg/ha) of rice at harvest

Rice Cultivars	Rice straw incorporation			Butachlor 1.5 kg/ha	Weedy check
	100 g/m^2	200 g/m^2	500 g/m^2		
Total dry matter production (kg/ha) in rice					
Pant Sugandha Dhan15	7830	733	7830	6330	6500
Pant Dhan 18	9330	900	10830	12330	8670
Govind	6170	673	9330	8170	7170
Pusa 44	7000	833	9170	8000	7000
Mean	7580	785	9290	8710	7330
LSD (P=0.05)	1875	146	3282		
Grain yield (kg/ha) of rice					
Pant Sugandha Dhan 15	2800	2900	3133	2633	1800
Pant Dhan 18	3960	4166	4733	5266	3833
Govind	2166	2433	3800	3166	2300
Pusa 44	3200	3233	4033	3200	2700
Mean	3033	3183	3925	3566	2658
LSD (P=0.05)	680	775	171		

the allelopathic chemicals in rice and the phytotoxicity of certain rice straw extracts has been attributed to higher levels of the phenolic acids *p*-hydroxy benzoic, *p*-coumaric acid and ferulic acid (Matsuo 2001, Chung *et al.* 2001). Use of natural products as herbicide has already been advocated (Duke *et al*. 2002). Thus, the findings of the present study suggest that rice straw waste can utilized for management of weeds in crops. It can also be utilized for producing new group of natural herbicides.

Table 4. Phenolic content of rice straw analyzed by HPLC

Total number of compounds	Phenolic acids identified	Concentration (ppm)
17	Ferulic acid	1.211
	Gallic acid	2.519
	*p-h*ydroxy benzoic acid	2.659
	Vanillic acid	1.166

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