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Control of Weeds by *Azolla* in Rice

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ABSTRACT

Culture of *Azolla pinnata* R.Br. in transplanted rice (*Oryza sativa* L.) fields as an intercrop was found to control growth of some weeds. Growth of the weeds *Scirpus articulatus* L. and *Marsilea quadrifolia* L. was less affected than *Cyperus difformis* L., *Polygonum punctatum* Ell., *Marsilea quadrifolia* L., *Cyanodon dactylon* (L) Pers., *Ludwigia perviflora* L. and *Echinochloa crusgalli* (L) Beaur. Algal weeds *Spirogyra* sp. and *Chara* sp., on the other hand, remained unaffected. *Azolla* dual cropping alone reduced the weed quantity by 50%, whereas green manuring plus dual cropping reduced weeds by 60% over uninoculated and unfertilized controls. The use of chemical fertilizer on the other hand increased weed growth.

Key words: Azolla, Rice, Dual culture, Weed control.

INTRODUCTION

Control of weeds in the economic crops is essential. Excessive weed growth causes loss in productivity, land use, product quality, efficiency of water management, human efficiency, and they also harbour insects, pests, and diseases. Weed growth reduces rice yield up to 34% in transplanted rice (1). Weeds are either left uncontrolled or manually controlled in most developing countries. The use of chemicals is practiced by few farmers. Therefore, it is necessary to develop effective and economic means of weed control in the tropical regions, especially for rice production.

The floating water fern *Azolla* is a potent source of organic-N fertilizer for increasing rice production (2, 4, 5, 6, 7, 8), but limited information is available on its influence on the weed control in the rice field (2, 4, 6, 7). This communication reports on the role of *Azolla* on the control of weeds in rice fields.

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MATERIALS AND METHODS

This study was conducted during the wet and dry seasons of 1980 and the dry season of 1981 at the Central Rice Research Institute (CRRI) farm. The rice cultivars CR 1009 (wet, 1980) and Kalinga-2 (dry, 1980, 1981) were grown in a sandy loam soil. *Azolla* was collected from CRRI *Azolla* breeding centre. There were nine treatments including the control, and each treatment was replicated three times. *Azolla* was inoculated at the rate of 0.2 kg fresh plant material per m^2 and allowed to grow for 25 days in the fallow plots (treatments T_4, T_7 and T_9), and then incorporated in the soil. Treatments T_2, T_3, T_7 and T_8 received a basal dose equivalent to one-third of the total N fertilizer in the form of urea. Rice seedlings were transplanted with a spacing of 15 cm by 20 cm in both the seasons. The control plots were kept flooded as the treatment but did not receive any source of chemical nitrogen fertilizer. Five days after transplanting, the same amount of *Azolla* (0.2 kg/m^2) was inoculated in the flooded rice fields in treatments T_5, T_6, T_8 and T_9. The fertilizer P_2O_5 was applied at the rate of 25 kg/ha in five split doses to encourage growth of *Azolla*. Twenty five days after inoculation, the *Azolla* covered the entire plot and its biomass was measured. Weed population was recorded prior to the incorporation of the *Azolla*. The weeds were uprooted from the experimental plots from known area by placing a sampling metallic frame (25 cm by 25 cm) in different areas of each plot following a random sampling technique. The plants collected from each plot were washed thoroughly with tap water and dried in the hot air oven kept at 80 C for 48hr for complete drying. The weight of the dried weeds were recorded, and then converted to kg/ha. During the dry 1980 season, the dry weight of weeds in each treatment was recorded separately by species.

RESULTS AND DISCUSSION

It was observed that inoculation of rice fields with *Azolla*

5 days after planting significantly affected weed populations (Table 1). Growth of *Scirpus articulatus* L. and *Marsilea quadrifolia* L. were not affected as the weeds developed befor the *Azolla* cover was complete. The early cover of *Azolla* eliminated *Cyperus difformis* L., *Polygonum punctatum* Ell., *Marsilea quadrifolia* L., *Cynodon dactylon* (L) Pers., *Ludwigia parviflora* L. and *Echinochloa crusgalli* (L) Beauv. from the paddy field, but did not reduce the growth of *Spirogyra sp.* and *Chara sp.* (Table 2). Total weed growth was found to be significantly less in the plots where *Azolla* was grown as a dual crop than the uninoculated field. *Azolla* as a dual crop alone (T_5) reduced the weed quantity by 57, 43 and 49% over uninoculated and unfertilized controls during the 1980 and 1981 dry seasons, and the wet 1980 season respectively. There was no significant difference in weed growth in the green manuring treatment (T_4) from the control. Weed growth was significantly higher in chemical-N fertilized treatments (T_2, T_3) than the control. Between the treatments, minimum weed population was recorded where *Azolla* was used as green manure plus dual crop ($T_9 = T_4 + T_5$); this treatment exhibited 69, 72 and 63% reduction in dry weight during the 1980 and 1981 dry seasons and the wet 1980 season, respectively. It was also interesting to note that the significant reduction in weed growth by *Azolla* cover was associated with an increased yield of rice (Table 1).

It is evident from the experimental findings that *Azolla* intercropping (dual cropping) with rice significantly reduced the weed population that ranged from 4 to 72% from the control. This reduction may be due primarily to the dense mat of *Azolla* which developed a few days after inoculation and effectively reduced light available for weed growth. This trial also indicated that, except for the growth of *Scirpus articulatus* L., all other weeds were suppressed by the *Azolla* inoculation. The needle-like leaves of the *S. articulatus* L. might easily pierce the thick *Azolla* mat. In other studies (4), mats of *Azolla filiculoides* in transplanted rice reduced significantly both *Cyperus difformis* L. and *Polygonum punctatum* Ell. but increased growth of *Echinocloa crusgalli* (L) Beauv. (4). The weed reduction in dual culture of *Azolla* and rice are reported from Taiwan in pot experiments (2) where weeds such as *Ludwigia prostrata* Roxb., *Lindernia pyxidaria* All., *Echinochloa colonum* (L.) Link., *Echinochloa crusgalli* (L.) Beauv., *Paspalum distichum* L., *Monochoria vaginalis* Presl., *Cyperus difformia* L. and *Fimbristyis miliacea* Yahl. were frequently found in control treatments, but only *Paspalum distichum* L. and *Echinochloa crusgalli* (L) Beauv. were observed in the treatments of covering *Azolla* mats. Since some noxious weeds like *Echinochloa crusgalli* (L.) Beauv., and *Paspalum distichum* L. appeared with *Azolla*, their control by labour or use of post-emergence herbicides is suggested to control both these weeds and *Azolla* in an *Azolla*-rice system (2, 3). This study suggests that use of *Azolla* biofertilizer as a source of organic-N fertilizer also controls weeds in *Azolla* rice dual culture systems.

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TABLE 1. EFFECT OF INORGANIC N FERTILIZER AND *Azolla* INOCULATION ON GRAIN YIELD AND TOTAL WEED POPULATIONS OF THE RICE FIELD.

Treatments	*Azolla* growth (t/ha)			Grain yield (t/ha)			Weed growth at 30 DAP[1] Dry weight (kg/ha)		
	Dry 1980	Wet 1980	Dry 1981	Dry 1980	Wet 1980	Dry 1981	Dry 1980	Wet 1980	Dry 1981
T_1 = Control (No N, No *Azolla*)	—	—	—	2.2	4.2	2.0	809	627	753
T_2 = 30 kg N/ha as urea	—	—	—	2.6	5.3	2.7	1089 (35)[2]	832 (33)	980 (30)
T_3 = 60 kg N/ha as urea	—	—	—	3.4	6.5	3.2	1215 (50)	923 (47)	1050 (39)
T_4 = *Azolla* incorporated before transplanting	16.7	18.8	14.5	2.5	5.5	3.1	841 (4)	639 (2)	710 (–6)
T_5 = *Azolla* dual cropping incorporated	22.1	17.0	17.5	2.7	5.4	3.3	346 (–57)	317 (–49)	427 (–43)
T_6 = *Azolla* dual cropping	21.1	17.2	22.7	2.0	5.6	3.1	325 (–60)	275 (–56)	375 (–50)
$T_7 = T_4$ + 30 kg N/ha as urea	16.4	19.2	14.4	3.5	6.6	3.4	721 (–11)	604 (–4)	702 (–7)
$T_8 = T_5$ + 30 kg N/ha as urea	19.4	17.4	19.7	3.7	7.0	3.5	302 (–63)	288 (–54)	355 (–53)
$T_9 = T_4 + T_5$	18.4+ 24.6	18.9+ 15.7	14.1+ 22.3	3.5	6.7	4.2	250 (–69)	231 (–63)	210 (–72)
C.D. at 5%	1.8	1.0	N.S.[3]	0.5	0.3	0.3	113	64	102
1%	2.5	1.4	N.S.	0.7	0.5	0.4	155	88	140

[1]DAP = Days after planting.
[2]Figures in parentheses represent % increase or decrease from control.
[3]N.S. = Not significant.

TABLE 2. EFFECT OF INORGANIC-N FERTILIZER AND *Azolla* INOCULATION OF THE WEED POPULATION OF THE RICE FIELD DURING DRY SEASON 1980.

Treatments	Weed growth (Dry weight, kg/ha)					
	Cyperus	*Scirpus*	*Echinochloa*	*Cynodon*	*Plygonum*	*Ludwigia*
T_1 = Control (No N, No *Azolla*)	611	166	18	2	8	3
T_2 = 30 kg N/ha as urea	730	318	16	0	15	10
T_3 = 60 kg N/ha as urea	833	354	21	3	3	1
T_4 = *Azolla* incorporated before transplanting	499	291	34	5	7	5
T_5 = *Azolla* dual cropping incorporated	90	232	11	4	5	4
T_6 = *Azolla* dual cropping unincorporated	114	200	0	0	6	3
T_7 = T_4 + 30 kg N/ha as urea	341	359	6	1	8	6
T_8 = T_5 + 30 kg N/ha as urea	94	203	2	0	3	0
T_9 = T_4 + T_5	51	188	5	0	4	2

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