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HERBICIDAL EFFICACY OF ROOT EXUDATES OF RICE (*ORYZA SATIVA* L.) ON BARNYARD GRASS (*ECHINOCHLOA CRUS-GALLI* L.)

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ABSTRACT

A laboratory study was conducted to assess the herbicidal potential of root exudates of three rice cultivars (ADT-36, BPT and IR-20) against germination and growth of common crop field weed, barnyard grass (*Echinochloa crus-galli L.*). Various concentrations (5, 10, 15 and 20%) of root exudates were prepared from the underground part of rice cultivars from the postharvest rice fields. The studies revealed that all the three rice cultivars were exhibited significant inhibition on growth and development of weed species. Among the rice cultivars, ADT-36 exhibited the greatest inhibition on the seed germination (86%), seedling growth (83%), dry weight (81%) of barnyard cross than BPT and ADT-36. The percentage of inhibition on concentration depends. The order of inhibition of the rice cultivars was ADT-36 > BPT > IR-20 on barnyard grass.

Keywords: Herbicidal potential, rice cultivars, barnyard grass, *Echinochloa-crus-galli.*

1. INTRODUCTION

In modern agriculture, various methods of weed control have been studied. In particular, the exploitation of allelopathic properties in plants may give promising results for controlling the weed (Chung *et al.*, 2003). Allelopathy was defined by Rice (1984) to mean the direct or indirect harmful or beneficial effects of one plant on another through the production of chemical compounds that escape into the environment. Certain plant species or their residues selectively inhibit the development of particular species. This differential sensitivity observed in field, green house and laboratory experiments with residues, extracts and purified allelochemicals (Djurdjevic *et a*l 2004 and Leslie, A.W.1996). Plants are thought to produce about 200,000 natural products (Dixon and Strack 2003). These products are transferred to leaf, stem, seeds and roots. Plant roots exude metabolites as much as 10%, or even more, of photosynthetically fixed carbon into the soil (Werner, 1992). Root exudates contain sugars, amino acids, organic acids, flavonoids, enzymes, and nucleotides (Rovira 1969).Rice residues and their aqueous extracts suppressed the growth of lettuce and *Phalaris minor* (Khan *et al.,*2001) and aqueous and organic solvent extracts of rice plants inhibited the growth of several plant species (Das and Goswami, 2001;Kato-Noguchi, 2002). Several phenolic acids, such as p-hydroxybenzoic acid, vanillic acid p-coumaric acid and ferulic acid were found in aqueous extracts of rice straws, roots and residues (Chung *et al.,* 2001).Phenolic acids were also found in rice root exudates. Although phenolic acids are often mentioned as putative allelochemicals, it is unclear whether concentrations of phenolic acids measured in rice ecosystems are sufficient for causing growth inhibition of neighboring plant species (Olofsdotter, 2001). Rice has been extensively studied with respect to its allelopathy as part of a strategy for sustainable weed management, such as breeding allelopathic rice strains (Takeuchi *et al.,* 2001). A large number of rice varieties were found to inhibit the growth of several plant species when grown together under field and or laboratory conditions (Azmi *et al.,* 2000).These findings suggest that rice may produce and release allelochemical(s) into the neighboring environment, thus encouraging the exploration of allelochemicals in rice.

Hence the purpose of this study was to determine the allelopathic effects of aqueous rice root exudates of some rice cultivars (ADT-36, BPT and IR-20) on germination and seedling growth of weed barnyard grass (*Echinochloa crus-galli L.*) as an bioherbicidal tool for controlling the weed.

2. MATERIALS AND METHODS

Root parts of all three rice cultivars (IR-20, BPT and ADT-36) were collected from the post harvest rice fields of Annamalai Nagar, Tamil Nadu and thoroughly washed with tap water by 3 to 4 times and soaked in 5% hydrogen peroxide solution for providing maximum sterilization then allow to wash by tap water and finely chopped into small pieces, About 5kg root parts of each cultivar were soaked with tap water of 10 litters at 7 days and leaching were collected through draining. Various concatenations (5, 10, 15 and 20%) of exudates were prepared from stock solution for studying their effect on seed germination and growth of barnyard grass.

Seeds of barnyard grass were surface sterilized with water:bleach solution (10:1) and were placed evenly on filter paper in sterilized 9cm Petri dishes. Ten milliliters of extract solution of exudates was added to Petri dishes and distilled water was used as a control. All Petri dishes were placed in a lighted room at 25ºC. After 7 days, germination percentage. Seedling length lengths, fresh weight and dry weight of barnyard grass were recorded. All data were analyzed one way ANOVA at 0.05 probability levels.

3. RESULTS AND DISCUSSION

The differences among rice root exudates were highly significant in all parameters. Rice cultivars root exudates exhibited different allelopathic potential on barnyard grass seedling growth. The original stock solution showed higher inhibitory activities as compared with 5, 10, 15 and 20% concentration and the control. Result showed that barnyard grass root growth was more sensitive to rice root exudates than shoot growth.

Table-1 shows that all the three rice cultivars have inhibitory effect on the seed germination of barnyard grass. At low concentration of root exudates inhibitory effect was not so much pronounced. But as soon as concentration increased, inhibitory effects were also increased. ADT-36 showed maximum negative effect than BPT and IR-20. ADT-36 caused 86% of germination retardation at 20% root exudates over control. BPT caused 75% germination failure compare with control at 20% aqueous exudates and IR-20 caused least inhibitory effect (57%).

Root exudates shown phytotoxic effect over the growth of weed seedling. Root showed highest reduction percentage than the shoot of weed seedlings. ADT-36, BPT and IR-20 caused significantly inhibitory effect respectively 75%, 65% and 56% on root length of barnyard grass seedlings.The allelopathic effect was less pronounced in the case of shoot length. Though, results were similar as in the case of root length of barnyard grass. ADT-36 showed 76% negative effect over control on weed seedling shoot length at 20% aqueous concentration. BPT caused 65% reduction over control and IR-20 caused least reduction on shoot length and exhibited 51% negative effect over control seedlings of barnyard grass. This finding is supported by Zohair *et al., (*2007) who mentioned that plumule length decreased when treated by aqueous extract of barley. Allelopathic potential can be a valuable trait to incorporate into rice cultivars to improve weed control. Greater inhibitory effects on roots as compared with shoots may be due to the direct contact of the root system to the extract solution in the growth media.

Table 1. Roots exudates of rice cultivars on germination percentage on root length (cm/plant) and shoot length (cm/plant) of barnyard grass.

Exudates Conc.	Germination %			Root Length			Shoot Length		
	ADT-36	BPT	IR-20	ADT-36	BPT	IR-20	ADT-36	BPT	IR-20
C	98	98	98	2.15	2.15	2.15	3.18	3.18	3.18
5	82 (-16.32)	86 (-12.24)	89 (-9.18)	1.60 (-25.58)	1.71 (-20.46)	1.93 (-10.23)	2.68 (-15.72)	2.78 (-12.57)	2.92 (-8.17)
10	64 (-34.49)	69 (-29.59)	75 (-23.46)	1.24 (-42.32)	1.41 (-34.41)	1.55 (-27.90)	2.29 (-27.98)	2.49 (-21.69)	2.61 (-17.92)
15	24 (-75.51)	29 (-70.40)	52 (-46.93)	0.96 (- 55.34)	1.11 (-48.37)	1.19 (-44.65)	1.82 (-42.76)	2.11 (-33.69)	2.28 (-28.30)
20	13 (-86.73)	24 (-75.51)	42 (-57.14)	0.53 (-75.34)	0.75 (-65.11)	0.85 (-60.46)	1.18 (-62.89)	1.45 (-54.40)	1.51 (-52.51)
Avg.	56.2	61.2	71.2	6.48	7.13	7.67	11.05	12.01	12.5
F	26.128			50.74075			57.11101		

(-) indicates percentage of phytotoxicity over control.

Table 2. Roots exudates of rice cultivars on fresh and dry weight (g/plant) of barnyard grass.

Exudates concentration	ADT-36		BPT		IR-20	
	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight
C	2.14	1.31	2.14	1.31	2.14	1.31
5	1.84 (-14.01)	1.03 (-21.37)	1.97 (-7.94)	1.24 (-5.34)	1.98 (-7.47)	1.16 (-11.45)
10	1.63 (-23.83)	0.87 (-33.58)	1.72 (-19.62)	0.93 (-29)	1.72 (-19.62)	1.12 (-14.50)
15	0.98 (-54.20)	0.68 (-48.09)	1.16 (-45.79)	0.85 (-35.11)	1.30 (-39.25)	0.98 (-25.19)
20	0.56 (-73.83)	0.41 (-68.70)	0.64 (-70.09)	0.63 (-51.90)	0.92 (-57)	0.81 (-38.16)
Average	1.43	4.3	1.526	4.96	1.612	5.69
F	FW.-73.768:DW.-11.867					

(-) indicates percentage of phytotoxicity over control.

Phytotoxic effects of root exudates were negatively pronounced on shoot than the root fresh and dry weights of barnyard grass. ADT-36 root exudate was retarding highly on the fresh weight of weed seedling than BPTand IR-20. Negative allelopathic was more pronounced in ADT-36 followed by BPT and IR-20. ADT-36. Root exudates shown maximum inhibitory effect (73%) at 20% root exudates. BPT shown inhibitory effect above 70% in the higher concentrations of aqueous root exudates. IR-20 had least inhibitory effect (57%) at 20% root exudates. Root exudates of ADT-36 shown maximum phytotoxic effect at 20% aqueous exudates and caused 68% dry weight loss over control. BPT showed 51% dry weight loss by 20% aqueous root exudates treatments over control. These results are agree with other studies reporting that water extracts of allelopathic plants had more pronounced effects on radical growth than on plumule growth (Turk and Tawaha, 2002, 2003 and chung and miller, 1995). A number of secondary metabolites, phenolic acids, phenylalkanoic acids, hydroxamic acids, fatty acids, terpenes and indoles, were identified in rice extracts (Rimando & Duke, 2003). The results showed that the maximum reduction in germination was by ADT-36 followed by BPT than IR-20 rice cultivars. Similar results also found by Agnes Rimando (2010) who mentioned that allelopathic potential may be differ from variety to variety. The results of this study are in agreement with those of Ahn *et al.* (2000), Chung *et al*. (2003), Asghari and Dilday *et al*. (1991). From the present investigations,it can be concluded that variation in detrimental allelopathic activity exists among cultivars. Among the three rice cultivars used in this study, ADT-36 and BPT exudates were highly reduced the germination percentage, seedling length, total dry weight and fresh weight than IR-20 cultivar.

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