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【Short Report】

A Quick Seeding Test for Allelopathic Potential of Bangladesh Rice Cultivars

Hisashi Kato-Noguchi, Md. Abdus Salam and Tsuyoshi Kobayashi

(Department of Applied Biological Science, Faculty of Agriculture, Kagawa University, Miki, Kagawa 761-0795, Japan)

Abstract : The allelopathic potential of 102 Bangladesh rice cultivars (60 traditional and 42 high yielding) against four test plant species, cress (*Lepidium sativum* L.), lettuce (*Lactuca sativa* L.), barnyardgrass (*Echinochloa crus-galli* (L.) Beauv) and *Echinochloa colonum* (L.) Link was determined for shoot and root growth. In the two-way analysis of variance, the effect of rice cultivar, test plant species and their interactions were significant ($P<0.0001$). The significant effects of cultivar and the interactions indicated that there was variation in allelopathic activity among the rice cultivars. This result suggests that rice cultivars which were allelopathic against one plant species were not always allelopathic towards other plant species. However, the high-yielding rice cultivar, BR17 marked the greatest inhibitory activity with an average of 59% growth inhibition on shoots and roots of cress, lettuce, barnyardgrass and *E. colonum*. The present research suggests that BR17 is the most allelopathic among 102 Bangladesh rice cultivars and may be one of the candidates for research on Bangladesh rice allelopathy for isolation and identification of allelochemicals.

Key words : Allelopathy, Bangladesh rice, Barnyardgrass, Cress, Donor-receiver bioassay, *Echinochloa colonum*, Lettuce.

Rice is the staple food in Bangladesh and also the main food in Asia, Africa and Latin America (IRRI, 1985). However, crop productivity in Bangladesh is lower than that in other rice producing countries. Severe weed infestation is one of the major reasons for such low yield of rice in Bangladesh (Mamun, 1988). Weeds reduced the grain yield of direct seeded summer (*aus*) rice by 68–100%, that of autumn (*aman*) rice by 16–48% and that of modern winter (*boro*) rice by 22–36% (Mamun, 1990). Hand weeding is the most commonly used weed control method in this country, but it is often imperfect and/or delayed because of limited budgets for hiring labor and availability of labor during peak periods.

Since Dilday et al. (1991) reported that some rice accessions possess allelopathic activity in weed suppression, rice allelopathy has been received a great deal of attention and may be an alternative to the chemical and mechanical control of weeds in paddy field (Dilday et al., 1998; Kim et al., 1999; Olofsdotter et al., 1999; Azmi et al., 2000). The allelopathic effect of rice on weeds could be applied to reduce use of chemical herbicides, which might results in improved water quality and less environmental contamination and might also reduce labor for hand weeding. It was therefore of interest to assess the allelopathic potential of Bangladesh rice cultivars for weed control purpose.

Materials and Methods

Sixty traditional and 42 high-yielding cultivars of Bangladesh rice (*Oryza sativa* L.) were chosen (Table 1) and their allelopathic potential was determined by donor-receiver bioassay as describe below. Traditional rice cultivars have a long stature and lodge easily. Grain yield is half of straw weight. High yielding rice cultivars have a short stature and leaves are dark-green and vertical. Grain yield is almost equal to straw weight (BRRI, 1995).

These rice seeds were collected by permission of the authorities in Genetics Resource Division, Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur, Bangladesh Institute of Nuclear Agriculture (BINA) and farmers of Patuakhali and Dinajpur districts. All the rice cultivars used in this study were indica and non sticky rice. Cress (*Lepidium sativum* L.), lettuce (*Lactuca sativa* L.), barnyardgrass (*Echinochloa crus-galli* (L.) Beauv) and *Echinochloa colonum* (L.) Link were used as test plant species since cress and lettuce are often used as model plants for bioassay and barnyardgrass and *E. colonum* are serious paddy weeds.

Rice seeds were kept at 45–48°C for 7 ds to break dormancy. The seeds were then soaked in distilled water for 24 hr and sown on a sheet of moist filter paper (No. 2; Toyo Ltd, Tokyo, Japan) at 25°C in the

Received 23 October 2007. Accepted 6 June 2008. Corresponding author: H. Kato-Noguchi (hisashi@ag.kagawa-u.ac.jp, fax +81-87-891-3086).

Table 1. Bangladesh rice cultivars used in this research.

Traditional cultivar				High yielding cultivar		
Badshabhog	Deshibalam	Jhingashail	Manikjour	BR1	BR17	BRRI dhan35
Baron	Dhepa	Jogly	Marichbati	BR2	BR19	BRRI dhan36
Bashful	Dhepa2	Jotabalam	Matiagorol	BR3	BR20	BRRI dhan37
Bashiraj	Dudhkalam	Kachamota	Mohanbhog	BR4	BR21	BRRI dhan38
Bashmoti	Dudhlaki	Kalamanik	Motaman	BR5	BR22	BRRI dhan39
Binnaful	Dudshor	Kalizira	Nizershial	BR6	BR23	BRRI dhan40
Biroi	Dular	Kartikshail	Pajam	BR7	BR26	BRRI dhan42
Buta	Gabura	Kataribhog	Pashushail	BR8	BRRI dhan27	BRRI dhan43
Chandon	Gangasagor	Kazliboro	Patnai31-675	BR9	BRRI dhan28	BRRI dhan45
Chikon aman	Ganjia-3	Khoiyaboro	Pusur	BR10	BRRI dhan29	Binadhan-4
Chiniatop397	Goai	Kumari	Rajashail	BR11	BRRI dhan30	Binadhan-5
Chiniatop398	Gobolshail	Lakkhidigha	Sadajira19-287	BR12	BRRI dhan31	Iratom-24
Chinigura	Gobrijoshua	Lalaman	Shakkhorkona	BR14	BRRI dhan32	
Chinisagor	Hashikalmi	Madhabjota	Shorna	BR15	BRRI dhan33	
Choiyamura	Jamainaru	Maliabhangor	Tepiboro	BR16	BRRI dhan34	

Table 2. Two-way analysis of variance (ANOVA) for relative shoot or root length of treated plants (%) to control plants of cress, lettuce, barnyardgrass and *E. colonum*.

Factor	d.f.	Shoot				Root			
		SS	MS	F	P	SS	MS	F	P
Rice cultivar (C)	101	650300	6439	4.487	<0.0001	2111000	20900	7.69	<0.0001
Test plant species (T)	3	71310	23770	16.566	<0.0001	353000	117700	43.302	<0.0001
C × T	303	1301000	4295	2.993	<0.0001	4174000	13780	5.07	<0.0001
Error	7752	1112000	1435			21070000	2718		

d.f., degrees of freedom; SS, sum of squares; MS, mean square; P, probability.

dark. After 48 hr the seeds were transferred to a growth chamber with a 12 hr photoperiod. Light was provided from above with a white fluorescent tube (irradiance, 2.9 W m^{-2} at plant level; FL40SBR, National, Tokyo, Japan). After another 48 hr, the uniform germinated rice seedlings were transferred to 5.5 cm Petri-dishes (six seedlings per dish) each containing a sheet of filter paper moistened with 2.5 mL 1 mM phosphate buffer (pH 7.0) and grown for further 48 hr. Then ten seeds of cress or lettuce, or ten germinated seeds of barnyardgrass or *E. colonum* were sown on the filter paper in each Petri-dish, and grown together with the rice seedlings under conditions as describe above. After 48 hr, the lengths of the shoots and roots of cress, lettuce, barnyardgrass and *E. colonum* were measured with a ruler. Control seedlings of cress, lettuce, barnyardgrass and *E. colonum* were incubated in Petri dish without rice plants under the same condition. All experiments were repeated twice using a randomized design with 10 plants for each determination.

Effects of rice cultivar, test plant species and their interactions on the length of shoot or root of test plants were surveyed using two-way analysis of variance (ANOVA). Relative values (% of control plant) in each experiment were used for ANOVA. For the rice cultivar BR17, significant difference between length of treatment and control plants were examined by Welch's *t*-test for each test plant species.

Results and Discussion

Allelopathic potential of 102 Bangladesh rice cultivars (Table 1) were determined against the growth of shoots and roots of cress, lettuce, barnyardgrass and *E. colonum*. These 102 rice cultivars, on average, inhibited the shoot growth of cress, lettuce, barnyardgrass and *E. colonum* to 89.2, 84.4, 92.4 and 91.6% of the control, respectively, and the root growth of cress, lettuce, barnyardgrass and *E. colonum* to 73.9, 91.9, 81.6 and 85.9% of the control, respectively.

The effects of 102 Bangladesh rice cultivar, four test

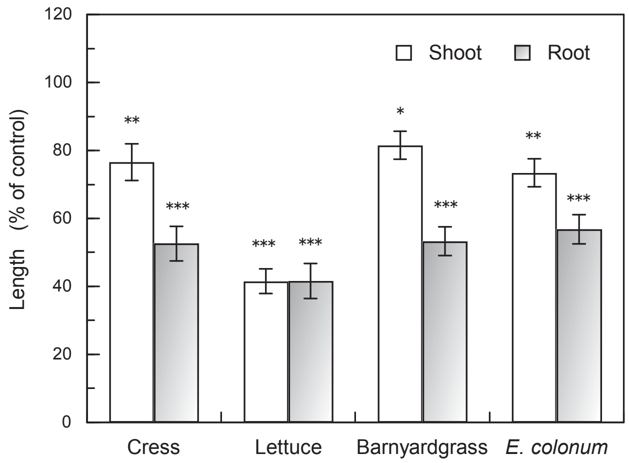

Fig. 1. Effects of high yielding rice cultivar BR17 on the length of shoot and root of cress, lettuce, barnyardgrass and *E. colonum.* Bars represent SE (N = 20). Asterisks show significant difference to control. *, P<0.05; **, P<0.01; ***, P<0.001 (Welch's *t*- test)

plant species and their interactions were significant both for shoot and root growth (P<0.0001 using two-way ANOVA; Table 2). Significant effects of cultivar and the interactions indicated that there was variation in allelopathic activity among 102 rice cultivars. This variation might result, in part, from the difference in sensitivity to allelochemicals of the test plant species. It was also found that rice cultivars which were allelopathic against one plant species were not always allelopathic towards other plant species (Dilday et al., 1994; Olofsdotter et al., 1995; Chung et al.,1997; Dilday et al., 1998; Hassan et al., 1998), which suggests that all allelochemicals released from rice plants may not be able to inhibit all plant species. In the present experiment, however, BR17 marked the greatest inhibitory activity with an average of 59% growth inhibition on shoots and roots of cress, lettuce, barnyardgrass and *E. colonum* (Fig. 1). This inhibition by BR17 was greater in the roots than the shoots for all test plant species.

In spite of the heavy use of commercial herbicides to control weeds, crop yield loss from weed remains high (Putnam 1988; Weston 1996; Einhellig 1996). The negative impacts of commercial herbicide use on the environmental contamination make it necessary to diversify weed management options. Controlling weeds through allelopathy is one strategy to reduce commercial herbicide dependency (Putnam 1988; Macias 1995; Duke et al. 2000). The present research suggests that rice cultivar BR17 is the most allelopathic of the 102 Bangladesh rice cultivars. This cultivar, therefore, may be one of the candidates for research on Bangladesh rice allelopathy for isolation and identification of allelochemicals.

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