Genetic Variation in Allelopathic Activity of Traditional Rice Cultivars on *Echinocloa crusgalli* (Barnyard Grass)

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Abstract

Economical and eco friendly weed control methods are very much important for the present agricultural production systems due to over usage of chemicals in agriculture. Exploitation of allelopathic potential of different traditional rice cultivars is a better solution for a sustainable weed management system. Genetic variation in allelopathic activity among rice cultivars has been extensively demonstrated. In the present study allelopathic effect of rice straw of traditional rice cultivars on germination percentage and plant height of *Echinocloa crusgalli* was evaluated in laboratory experiments. Rice straw of thirty eight rice cultivars were separately mixed with non-rice grown sterilized soils in four replicates using plastic cups (diameter 6 cm and height 5 cm). Surface sterilized *Echinocloa crusgalli* seeds were sawn in decomposed soil samples. Control experiment was carried out in non-rice grown sterilized soil samples collected in to the same sized plastic cups. Allelopathic effect of rice cultivars was evaluated according to reduction of germination percentage and plant height of *Echinocloa crusgalli* in soil samples mixed with rice straw compared to those of in control soil samples. Germination and growth of *Echinocloa crusgalli* were significantly suppressed in soil samples prepared using rice straw of the most traditional rice cultivars. There was a positive correlation between reduction of germination percentage and plant height ($r=0.58923$, $\alpha=0.0001$) of *Echinocloa crusgalli* in soil samples mixed with straw of different rice cultivars. *Ingirisi Wee, Bala Ma Wee, Karayal,* and *Lumbini* are the best allelopathic rice cultivars found in the present study. Rice cultivars those showed significantly higher germination reductions and plant height in *Echinocloa crusgalli* can be further tested to confirm their allelopathic effect at the field conditions.

Key words: Allelopathic effect, Traditional rice, *Echinochloa crusgalli*

Introduction

Allelopathy refers to the effects of metabolic secretion of plants or microorganism on the environment (Dali et al., 2003). Rice plants possibly release allelochemicals into the neighboring environment. A large number of compounds such as phenolic acids, Fatty acids, indoles and terpenes have been identified in rice root exudates and decomposing rice residue as putative allelochamicals which possess growth inhibitory activity against neighboring plant species. Thus, these compounds may play an important role in defense mechanism of rice in the rhizosphere for competition with invading root system of neighboring plants (Kata-Noguchi *et al.*, 2008).

Weeds such as barn yard grass are the most sever and widespread biological constrains in the rice production (Zimdhal, 2004). Selection of rice cultivars for allelopathic effect on *Echinochloa crusgalli* has been well practiced (Naderi *et al.*, 2012). Other than barnyard grass, desert horsepurslane (*Trianthema portulacastrum*), ducksalad (*Heteranthera limosa*), and toothcup (*Rotala ramosior*) (Olofsdotter, 2001), dirty dora (*Cyperus difformis*), lance-leaved water, plantain (*Alisma lanceolatum*), starfruit (*Damasonium minus*), arrowhead (*Sagittaria montevidensis*) and *S. graminea* (Seal *et al.*, 2013) have been used as biological tools in evaluation of allelopathy in rice cultivars.

A large amount of straw is left in rice production and a huge amount of straw is combusted on fields just to remove the bulk for the next cropping season in rice. Straw can be used for mulching which prevents weed growth and supplies organic matter for the next cropping season (Devasinghe *et al.*, 2011). Rice

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allelopathy can be utilized in weed management by applying rice straw in the field. It will be a natural source of herbicides. Need of a universal bioassay method which is easy to carry out, reliable and economical in any conditions is essential because the same rice cultivar shows different responses depending upon the screening method used. Asghari *et al.*, (2006) has found inhibitory activity of rice hulls in allelopathic rice cultivars. Extraction of water-soluble chemical compounds from young leaves (Dali 2003), smashed seeds (Kabir *et al.*, 2010). The genetic differences among rice cultivars exhibit variation in allelopathic effects on barnyardgrass growth. The barnyardgrass roots were more sensitive to hull extracts than the shoot extracts. The allelopathic potential of rice were evaluated in a set of laboratory, greenhouse, and field experiment by using extracts and residues, and the results showed that there was genetic variation in allelopathic activity among cultivars (Chung *et al.*, 2001). Naderi *et al.*, (2012) reported the prevalence of rice cultivars with prominent allelopathic effect on the growth of barnyardgrass and it confirmed that there is a genetic variation in allelopathic activity among cultivars.

Allelopathic rice varieties can be used as gene resources for breeding for allelopathic potentiality and can be incorporated with high yielding rice varieties to generate allelopathic high yielding rice (Kabir *et al.*, 2010). The present study was carried out with the aim of assessing the allelopathic effect of different traditional rice cultivars. Allelopathic effects can include poor germination, impared root growth and stunted shoot growth. Different parts of rice contained different alleopathic effects (Dali 2003). In the present study alleopathic effect was evaluated by assessing suppression of seed germination and plant height of *Echinochloa crusgalli* in traditional rice straw.

Materials and Methods

The experiment was carried out at Faculty of Agriculture, University of Ruhuna. Rice straw of thirty eight rice cultivars was separately mixed with non-rice grown sterilized soils in four replicates using plastic cups (diameter 6 cm and height 5 cm). Surface sterilized *Echinocloa crusgalli* seeds were sawn in decomposed soil samples. Twenty seeds of the *Echinocloa crusgali* were established per each replicate and the experiment was carried out according to the randomized complete block design with four replicates. Control experiment was carried out in non-rice grown sterilized soil samples collected in to the same sized plastic cups. One month after the seeding of *Echinocloa crusgali,* allelopathic effect of rice cultivars was evaluated according to reduction of germination percentage and plant height of *Echinocloa crusgalli* in soil samples mixed with rice straw compared to those of in control soil samples. Data were analyzed using ANOVA with Statistical Analysis System (SAS inc. 2011).

Results and Discussion

Germination of *Echinocloa crusgalli* was significantly suppressed in soil samples prepared using rice straw of traditional rice cultivars named *Ingirisi Wee, Bala Ma Wee, Karayal, Lumbini,* BG 357, BG 35-2. However, suppress of *Echinocloa crusgalli* growth was significant in soil samples prepared using straw of rice cultivars *Ingirisi Wee, Bala Ma Wee, Karayal, Lumbini, Halabawa,* and *Dik wee* compared to the value of control sample. There was a positive correlation between reduction of germination percentage and plant height ($r=0.58923$, $\alpha=0.0001$) of Echinocloa crusgalli in soil samples mixed with rice straws of different rice cultivars.

Table 01. Reduction of germination percentage and plant height of Echinocloa crusgalli grown in soil samples mixed with rice straw compared to those of in control soil samples

Varieties	PGRC Acc. No.	Reduction of germination %	Reduction of plant height(cm)
SuduGoda wee	3477	-0.506^{bc}	1.87^{abcdef}
Madabaru	3650	3.271^{abc}	-2.61^{ef}
Mudukiriel	3591	1.604^{abc}	-2.092^{def}
Jamis wee	3612	3.271^{abc}	5.185^{abcdef}
InduruKarayal	3646	3.271^{abc}	5.019^{abcdef}
Suduru Samba	3594	1.604^{abc}	-2.380^{def}
Suduru Samba	3572	8.27^{ab}	2.54^{abcdef}
Heendik Wee	3641	1.604^{abc}	2.841^{abcdef}
Bathkiri el	3550	-0.0611^{abc}	0.796^{bcdef}
Karayal	3463	1.604^{abc}	-2.75^{ef}
Muthumanikkam	3645	6.604^{abc}	3.552^{abcdef}
KiriNaran	3479	8.271^{ab}	6.713^{abcdef}
Suduru	3660	11.604^{a}	0.463^{bcdef}
Herath Banda	3677	3.271^{abc}	4.602^{abcdef}
Kahata Samba	3642	11.6031^{a}	14.29^{ab}
Kotathavalu	3659	-0.0611^{abc}	1.407^{abcdef}
BurumaThavalu	3652	3.271^{abc}	9.519^{abcdef}
Dik Wee 328	3504	8.271^{ab}	11.77^{ab}
Kotathavalu	3675	11.604^{a}	7.896^{abcdef}
BG 357		9.94^{ab}	9.70^{abcdef}
DingiriMenika	3567	4.94^{abc}	9.474^{abcdef}
Rata Wee	3655	6.604^{abc}	11.407^{abcdef}
Lumbini	3613	11.604^{a}	10.963^{abcdef}
MahaamurungaBadulla	3511	6.604^{abc}	9.030^{abcdef}
Geraga Samba	3498	8.271^{ab}	7.092^{abcdef}
Sinnanayan398	3497	8.271^{ab}	2.685^{abcdef}
A6-10-37	3416	4.94^{abc}	-1.803^{def}
Sinnanayam	3614	8.271^{ab}	4.29^{abcdef}
Heenpodi Wee	3588	8.272^{ab}	8.963^{abcdef}
BG34-8	3415	1.611^{ab}	4.29^{abcdef}
Halabewa	3451	6.605^{abc}	9.730^{abcdef}
Ingirisi Wee	3658	9.939^{ab}	15.130^{a}
WanniHeenati	3401	8.271^{ab}	6.430^{abcdef}
Naudu Wee	3427	3.271^{abc}	3.79^{abcdef}
BG35-2	3409	9.94^{ab}	9.49^{abcdef}
Bala Ma Wee	3598	11.604^{a}	13.29^{abc}
Karabewa	3447	4.94^{abc}	5.863^{abcdef}

PGRC Plant genetic resource center
The groups with the same letters are not significantly differed

There was a positive correlation between reduction of germination percentage and plant height (r=0.58923, α=0.0001) of *Echinocloa crusgalli* in soil samples mixed with straws of different rice cultivars.

Straw of traditional rice cultivars show allelopathic effect on *Echinocloa crusgalli* and there is a genetic differentiation of allelopathic effect among used traditional rice cultivars. *Allelopathic* effect of rice straw reduces germination percentage and growth of *Echinocloa crusgalli. Ingirisi Wee, Bala Ma Wee, Karayal,* and *Lumbini* are the best allelopathic rice cultivars among all the other tested traditional rice cultivars. This property can be utilized for weed management in rice fields in different ways such as for mulching, seasonal cropping and incorporating high yielding rice varieties to generate allelopathic high yielding rice. Usage of allelopathic rice may lead to reduce weeding cost and environmental pollution of rice cultivation.

Acknowledgements

PGRC Gannoruwa and TURIS/UoR

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