# Effect of Rice Residue Incorporation on Seed Germination and Seedling Growth of Weedy Rice *(Oryza sativa var. spontanea)*

**A.S. Ranagalage, T.S.D. Jayakody and Deepthi L. Wathugala***
Department of Crop Science, Faculty of Agriculture, University of Ruhuna, Sri Lanka

## Abstract

Weedy rice (*Oryza sativa* var. *spontanea*) is one of the most destructive weeds widely spread in rice-growing areas in Sri Lanka. However, suitable and effective control method has not yet been used to manage weedy rice in paddy fields. Incorporation of rice residue is recommended for sustainable rice farming in all rice growing countries. An experiment was conducted to examine the germination ability and growth performances of weedy rice with different amount of rice residue incorporation. Rice residues from different rice cultivars ie; BG359, LD365, BG407, AT401, BG358, AT362, AT402, BG450 and BG300, Herathbanda and Handiran were used. The experimental design used was RCBD with three replicates. Results revealed that there was a significant reduction of weedy rice seed germination, mean germination index and plant height due to incorporation of rice residue into sand compared to the control. However dry weight per plant did not show significant reduction. When increasing amount of residue incorporation, germination % and mean germination time also decreased. It is suggested that the inhibition of weedy rice seed germination observed in this study may be due to the activities of allelochemicals released by decaying residue.

**Key words**: Weedy rice, seed germination, seedling growth, *Oryza sativa*

## Introduction

Rice is the world's most important crop, and it feeds most of the people in Africa, Asia, and Latin America. Weeds are plant species that compete with the rice crop for plant nutrients, water, and light. Rice growing areas in many parts of Sri Lanka are seriously affected by the presence of several weeds. The most troublesome weeds in rice are species of the genus Echinochloa. Weedy rice also distributes over a wide area in rice growing region around the world making serious threat in direct seeded rice systems. At present no single management technique can effectively control weedy rice.

Weedy rice occupy in family Poaceae which has taxonomically classified as the same species as cultivated rice, but it behaves superior and differently from cultivated rice. Weedy rice normally grows faster; makes better use of the available N; produces more tillers, panicles and biomass in general; shatters earlier; has better resistance to adverse dry conditions; and possesses longer dormancy in soil. As a destructive weed occurring in rice fields, it commonly causes yield reduction and affects the quality of rice grains (Hoagland and Paul, 1978). Most weedy rice strains seeds consist of red pericarp and some have white (Arrieta *et al*,. 2005). Morphologically, weedy rice is highly variable and appears to be an intermediate between wild and cultivated rice.

Rice residue incorporation in to the paddy field is a common practice in most south Asian countries. The main aims of this strategy is to control weeds and supply additional Nutrients. Several researches revealed that there is control ability of some weeds such as *Echinochloa crussgalli* by incorporating rice residue. They called this concept as allelophathic effect of rice plants (Seigler, 1996).

Scientists have payed great attention to study allelopathic properties and potential in plants as sustainable weed control measures. Allelopathy was defined by Rice (1984) to a 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. These chemical



***Corresponding author:** : lakmini077@yahoo.com

compounds called allelochemicals, mainly secondary plant metabolities such as terpenoids, steroids, phenols, coumarins, flavonoids, tannins, alkaloids, and cyanogenic glycosides, and their degradation products, have been known to be involved in allelopathic phenomena, and are important in all agro-ecosystems (Seigler, 1996). Allelopathy is an alternative approach to achieve the environment safe sustainable agriculture.

For rice, Chou and Lin (1976) identified six allelopathic compounds like p-hydroxybenzoic acid by thin layer chromatography from decomposing rice straw. Recently, Chung *et al.* (2000) identified some allelopathic compounds, such as ferulic acid, from straw extracts of different rice varieties and those compounds showed the inhibitory effect on the growth of barnyard grass. As far as these research findings are concerned, rice residue incorporation is sound alternative method for control weeds in rice fields. Although number of research has been conducted to examine the effect of rice residue incorporation on growth and development of common paddy field weeds like *E. crusgalli*, did not find data on weedy rice. Therefore, the main objective of this experiment was to assess the effect of residue incorporation into paddy soil on seed germination and seedling growth of weedy rice.

## Materials and Methods

Rice residues from nine varieties (BG407, AT401, BG358, AT362, AT402, BG450, BG300, BG354, LD365, Herathbanda and Handiran) were used for this experiment. All rice cultivars were separately grown at the field and harvested after their maturation. The harvested plants (leaves-plus-straw) were dried at room temperature and cut into small pieces before incorporation with sand. Weedy rice seeds were treated using 1:10(v/v) topsin for 10 min and rinsed several times with distilled water before seeding on pots.

Experiment was conducted in a protected house. Various amount of rice residue {2g (T1), 4g (T2) and 6g (T3)} from each cultivars were mixed thoroughly with 500g of river sand in each pot then allow two weeks to decay materials. Control plants were grown in river sand without residue. All pots were placed on Petridish to prevent the loss of water-soluble toxic substances. Plastic nets were placed in the bottom of each pot to prevent the loss of sand through the holes in the bottom. Twenty five topsin treated weedy rice seeds were planted uniformly in each pot after two weeks of residue incorporation. Seedling emergence was defined as the coleoptile protrusion through the soil surface and was measured each day for 10 days after planting. Water was added to each saucer to maintain adequate moisture. All plants were harvested 10 days after planting. Ten randomly selected weedy rice plants from each pot were measured for shoot length, and seedlings were placed in paper bags and then kept in an electric oven at 65 °C for 72 h to determine dry weight. Mean germination index (MGI) was calculated using the data of daily germination as per the formula described by Nicolis and Heydecker (1968).

$$MGI = \Sigma (n/t)$$

Where n= number of newly germinated seed at 't' time and t= days from sowing. The collected data were statistically analyzed using statistical analysis system (SAS) software. The mean differences were adjusted using DMRT.

## Results and Discussion

Mixing rice residue into sand significantly reduced percentage seed germination, rate of seed germination and plant height. But dry weight per plant did not show significant difference. However, reduced dry weight per plant was observed when rice residue mixed with sand. According to the Chung and Miller (1995) seedling dry weight is an important character of the size and vigor of the seedling which imply success in competition for other resources like land, space, and nutrients. The lowest seed germination (37.33%) was observed in T2 which was incorporated 4g of rice residue with sand. Although T3 treatment which was incorporated 6g of rice residue with sand showed 45.69% seed germination, there was no significant difference in between T2 and T3. Highest germination percentage (91.11%) was observed in control treatment. Mean germination time was also reduced in treatments with rice residue. When increasing residue concentration from 2g to 4g significant reduction was observed in mean germination time. Higher MGT represent quick germination of seeds whereas lower MGT represent reduced rate of seed germination. These results revealed that there is an effect from decaying rice residue to both germination% and rate of seed germination. Plant height also showed significant difference in between with and without rice residue incorporation. Plant height in all treatments with rice residue showed significant reduction; however in between these three treatments there was no significant difference.

Rice residue incorporation to the paddy field is a common practice in Sri Lankan paddy cultivation system. According to the past researchers and scientists, there are number of benefits with rice residue incorporation, such as reduction in amount of inorganic fertilizer application, as an alternative weed

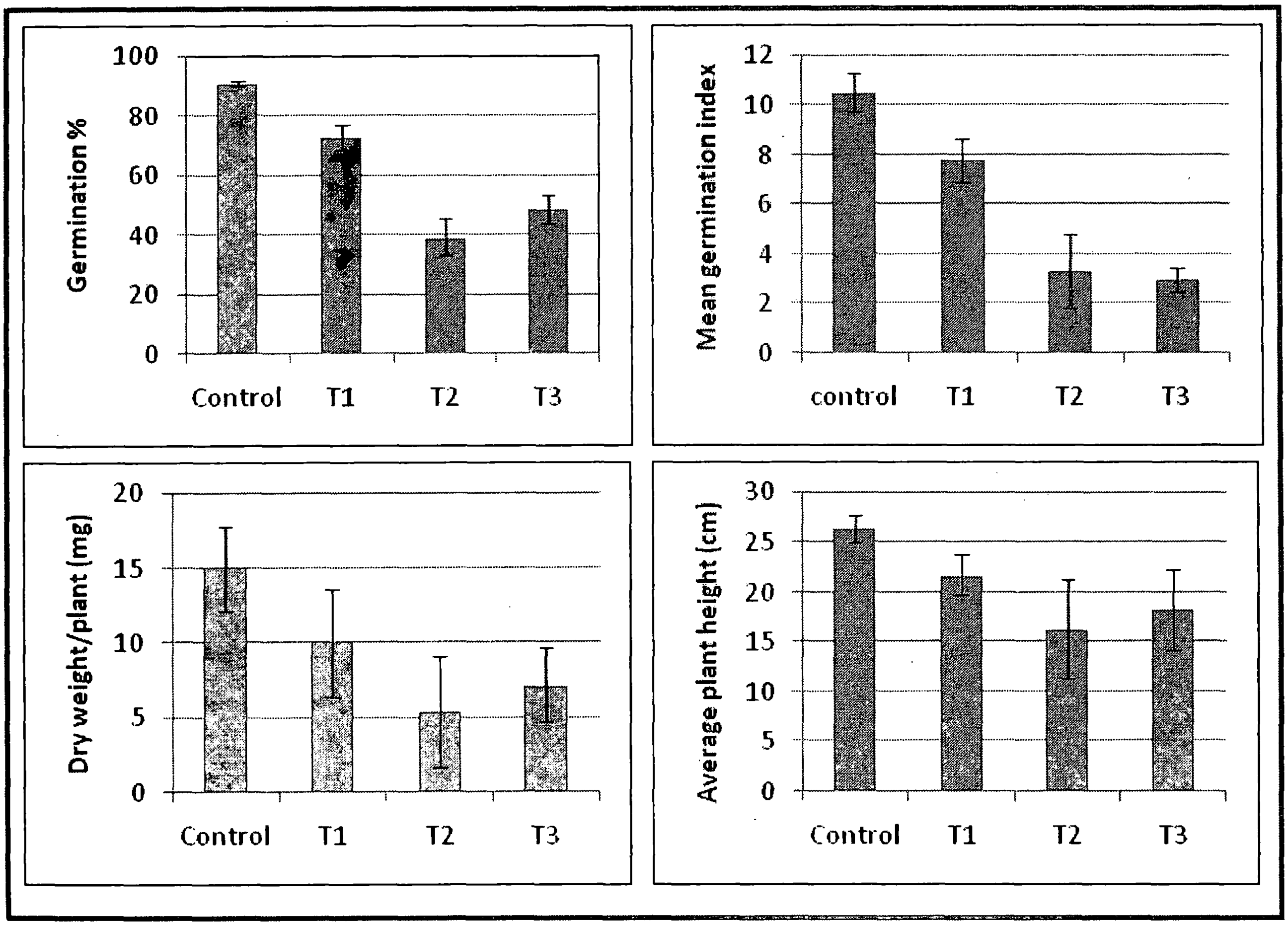


**Figure 1.** Variations of the means of seed germination percentage, mean germination index, dry weight per plant and plant height with different amount of rice residue incorporation. Error bars shows ± Standard error for the mean.

control method. Seed germination and growth inhibition of different weed species in soils incorporated with rice residues have been extensively conducted as a means of ecological weed management method. These studies suggest that the decomposing rice residue release allelochemicals that may inhibit the germination and growth of weeds like *E. crusgalli*. P-Hydroxybenzioc, vanillic, p-coumaric, o-hydroxypheylacetic acid and ferulic acids have been isolated from decomposing rice residue and all these compounds have been reported as common allelopathic compounds in plants (Chung *et al.*, 2000). Therefore, the significantly reduced seed germination, rate of seed germination and plant height and considerable reduction in seedling dry weight observed in this experiment might be the result of these toxic substances. Chung *et al* (2000) also showed that the allelopathic property is concentration dependent. Thus the more rice residue incorporated to the paddy field greater effect on weeds. The results observed in this experiment also showed greater reduction in all parameters measured when increasing amount of rice residue mixed with sand. However, it did not observe significant reduction in measured parameters when increasing amount of residue from 4g to 6g like when increasing amount of residue from 2g to 4g. Therefore according to the results observed in this experiment it can be concluded that the incorporation of rice residue facilitate management of weedy rice population in paddy fields. However, further studies are required on the effect of weedy rice seed germination and seedling growth with different quantities of rice residue incorporation into paddy soils. Moreover different rice varieties may have different responses on weedy rice seed germination and seedling growth and how these effects on subsequent growth of germinated seeds of cultivated rice in direct seeded paddy fields should also be investigated under paddy fields.

## References

Seigler, D.S. 1996. Chemistry and mechanisms of allelopathic interactions. *Agron. J*, 88: 876-885

Rice, E.L. 1987. Allelopathy: an overview. In: Waller GR (Ed.) Allelochemicals: Role in Agriculture and Forestry. ACS Symposium Series. American Chemical Society, Washington, DC: 8-22.

Chou, C.H., Lin, H.J. 1976. Autointoxication mechanism of *Oryza sativa*: Phytotoxic effects of decomposing rice residues in soils. *J. Chem. Ecol.* 2: 353-367.

Chung, I.M., Ahn, J.K., Kim, J.T., Kim, C.S. 2000. Assessment of allelopathic potentiality and identification of allelopathic compounds on Korean local rice varieties. *Korean J. Crop Sci*, 45: 44-49.

Arrieta, G., Sánchez, E., Vargas, S., Lobo, J., Quesada, T. and Espinoza, A.M. 2005. The weedy rice complex in Costa Rica: Morphological study of relationships between commercial rice varieties, wild *Oryza* relatives and weedy types. *Genetic Resources and Crop Evolution*, 52575-587.

Hoagland, R.E. and Paul, R.V. 1978. A comparative SEM study of red rice and several commercial rice (*Oryza sativa*) varieties. *Weed Science*, 26619-625

Nicolis, M.A. and Heydecker, W. 1968. Two approaches to the study of germination data. *Proc. Int. Seed testing association*, 33:531-540

Chung, I.M. and Miller, D.A. 1995. Allelopathic influence of nine forage grass extracts on germination and seedling growth of alfalfa. *Agron. J*, 87: 767-772