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**Research Article**

# Effect of Rutin in *Amaranthus spinosus* L. on Antioxidative Metabolism for Rice (*Oryza sativa* L.)

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**Abstract:** Rice (*Oryza sativa* L.) was prepared and used as the experiment material; Seed germination and seedling growth of rice were used to analyze allelopathy and effect on antioxidative metabolism of rice seedling. The results showed that rutin was potential allelochemical in *Amaranthus spinosus* L., at high concentrations, rutin imposed inhibitory on seed germination. The growth of rice seedlings either aboveground or roots have been promoted, while the high concentrations of rutin aqueous solution imposed a stronger effect on seedling growth inhibition in rice. The content of Glutathione (GSH) increased, Superoxide Dismutase (SOD) and Catalase (CAT) activity increased first, then decreased with increasing concentration of rutin. While POD activity sustained increase. The content of MDA increased, led to the cell membrane damaged, which influenced the growth and development of the rice seedling.

**Keywords:** *Amaranthus spinosus L.*, allelopathy, antioxidative metabolism, rice, rutin

## INTRODUCTION

The novel weapons hypothesis argues that exotics exude allelochemicals that are relatively ineffective against well-adapted neighbours in origin communities, but highly inhibitory to naïve plants in recipient communities (Hierro and Callaway, 2003; Muller, 1969). The Novel Weapons Hypothesis proposes that non-native plants are particularly allelopathic against native competitors because natives have never been exposed to their novel phytotoxins (Shannon-Firestone and Firestone, 2015). Mere production of chemicals by a plant is not sufficient to ensure their allelopathic potential. Abiotic and biotic environmental conditions determine the allelopathic potential of chemicals in soil (Callaway *et al*., 2004; Inderjit *et al*., 2011).

Biogeographic differences in the effects of particular compounds between native and invaded ranges may occur in part through a lack of adaptation by species and soil communities in the invaded ranges. However, these types of biogeographic differences may also emerge or intensify because of particular conditions in the novel environment. Such as, soil biota can be powerful ecosystem mediators of biogeographic differences in allelopathic effect (Eppinga *et al*., 2006; Kourtev *et al*., 2002; Lankau, 2011; Liu *et al*., 2013; Xu *et al*., 2013). Centaurea maculosa, a forb that is native to Eurasia, Controlled laboratory experiments suggest that the phytotoxic effects of (±)-catechin may be stronger on some North American species than on some European species. some species in the native range of C. maculosa may be adapted to its particular biochemical traits, raising the possibility that interactions among plant species may be affected by a common evolutionary history (Thorpe *et al*., 2009).Soil biota may have stronger or weaker effects on allelopathic interactions depending on how allelochemicals are delivered (Kaur *et al*., 2009; Zhu *et al*., 2011). The invasive plants can also inhibit the growth of native plants, indirectly by changing the nutrient cycling of soil elements and enhance the competition ability of invasive plants. Biogeographic differences in the way a plant species alters nitrogen cycling through the direct effects of root exudates (Thorpe and Callaway, 2011). China has 20 kinds of amaranth, of which 17 species are exotic species, harm upland crops, fruit, tea and vegetables (Li, 1998; Li and Xie, 2002). The inclusion of invasive alien species cataloged China (Xu and Qiang, 2004), China Agricultural Pest Information System and the invasion of alien species biosafety genetic resources (Xu *et al*., 2004) *A. spinosus*, wrinkled fruit amaranth (*A.viridis* L.) and other *Amaranthaceae* Amaranthus important invasive weeds have not been reported allelopathy.

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Table 1: Effect of germination and growth allelopathy of Rutin on rice

| Treatment (μg/mL) | Germination rate (%) | Germination index | Root length (mm) | Shoot length (mm) | Fresh weight (mg) |
|---|---|---|---|---|---|
| 0 | 95.00±0.04a | 37.26±4.66ab | 33.42±9.07b | 28±4.78b | 59.81±8.16b |
| 25 | 97.50±0.05a | 43.34±5.19a | 59.92±11.81a | 44.17±2.15a | 72.83±2.00a |
| 50 | 97.50±0.05a | 45.90±3.46a | 53.25±13.30a | 46.58±4.63a | 73.33±4.72a |
| 100 | 93.75±0.03a | 45.33±0.64a | 60.58±2.64a | 45.08±3.47a | 73.09±5.89a |
| 200 | 77.50±0.16b | 32.28±8.38b | 24.33±12.82b | 23.17±6.54b | 52.04±4.33b |

Data in the table is the average of four repeat, the same column the same character who represents test (p = 0.05) was not significantly different.

Rice is the most important, the largest cultivated area of crops, from food to food safety point of view, as a test crop of rice research object has a positive practical significance. After the field investigation found that the presence of thorn amaranth in rice fields, so this potential use in thorn amaranth rutin Allelochemicals change on growth and physiological characteristics of rice research of its mechanism of action, in order to facilitate understanding of the characteristics of its role, modalities and mechanisms to provide a theoretical basis for future use or reduce allelopathy rutin.

## MATERIALS AND METHODS

**Material:** rice seeds are available at Zhejiang Academy of Agricultural seed shop.

**Methods:**

**Rutin on rice seed germination and seedling growth:** The rutin were dubbed the concentration gradient of 25, 50, 100, 200 μgm/L solution, with these solutions as a source, grown rice seed germination and seedling test in a Petri dish, each dish put 30 seeds, 25°C, 4000lx under cultivation, the number of seeds germinated survey day after 14d culture, calculate the germination rate and germination index, the 30 germinated seeds into the dish, cultured 7 d measure the length of shoots and roots of seedlings and weighed fresh weight of seedlings to four seedlings as a repeat, with four replications, distilled water as a control.

**Potential allelochemicals rutin on rice seedlings growth physiological indices determination:** After the cultivation of rice 30d with Hoagland nutrient solution, then with a concentration gradient of 25, 50, 100, 200 μgm/L solution treated rutin 7 d, rice leaves were determined after taking treatment each index. $O_2^-$ generation rate, SOD, POD, CAT activity and MDA content measurement method Cai Chong (Cai, 2013); ascorbic acid oxidase was determined by Vyas and Kumar (2005); Glutathione (GSH) content (Guri, 1983) with Guri method.

**Data processing:** Use Excel 2007 data processing and graphics, SPSS13.0 variance (LSD and SNK Test) analyze the differences between the different treatments of the parameters.

## RESULTS AND DISCUSSION

**Influence of potential allelochemicals rutin on seed germination and seedling growth of rice:** As shown in Table 1, at low concentrations, rice germination rate of change is very small; when the concentration of 200μ/gmL, the germination rate between the control group decreased by 18% and the difference was significant. Germination index decreased significantly lower concentrations difference in treatment under high concentration rutin, but no significant difference compared with the control group. At low concentrations of rutin, the growth of rice seedlings either aboveground or roots have been promoted, but with the increasing concentration of weakened promotion showed some inhibition. Fresh weight of rice seedlings at a relatively low concentration of rutin control group significantly increased, with the increase in the concentration process, promoting weakened, showing a certain extent.

**Effect of potential allelochemicals on antioxidant system of rice seedling:**

**The effect of rutin on MDA content of rice seedling:** Overall, the rutin aqueous solution tended to cause the MDA content of rice seedlings increased (Fig. 1). rutin concentration of 200 μg/mL, MDA content is relatively increased by 62.25% in the control group.

**The effect of rutin on the rate of $O_2^-$ generation of rice seedling:** Rutin rice seedlings $O_2^-$ Affect the performance of production rate followed by rutin concentration increased first and decreased (Fig. 2). In 25 μg/mL concentrations, the rice seedlings $O_2^-$ Production rate than the control group improved 12.26%, in the 50μg/mL concentration rutin, rice seedlings $O_2^-$ Production rate increased by 43.92% and the control group were significantly different ($p<0.05$).

**Effect of rutin on SOD activity of rice seedling:** When the rice seedlings treated by rutin, rice seedling SOD activity continued to increase at a concentration of 50 μg/mL SOD activity reached the maximum when the concentration continues to increase, SOD activity of seedlings began to decline (Fig. 3). In 200 μg/mL SOD activity decreased 27.09% compared with CK and significant ($p<0.05$) difference with CK.

**Effect of rutin on POD activity of rice seedling:** POD activity of rice seedlings showed rutin rutin

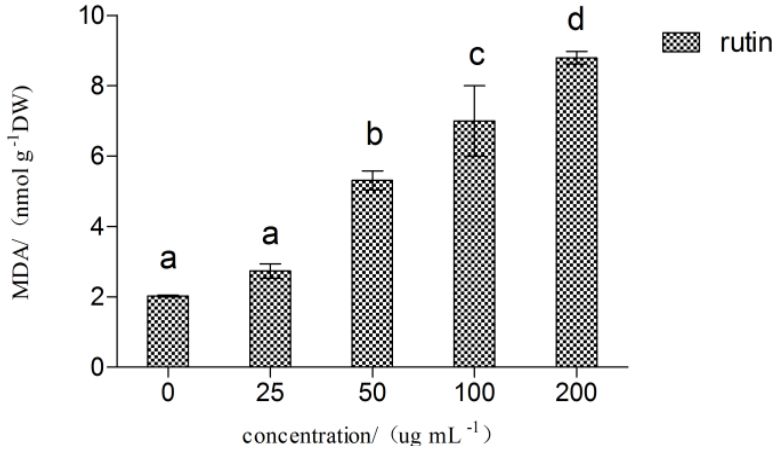


Fig. 1: The effect of Rutin on MDA content of rice seedling

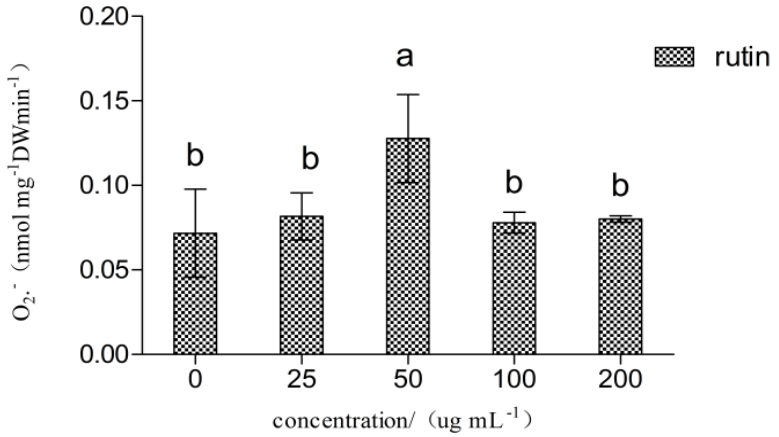


Fig. 2: The effect of Rutin on the rate of O2. -generation of rice seedling

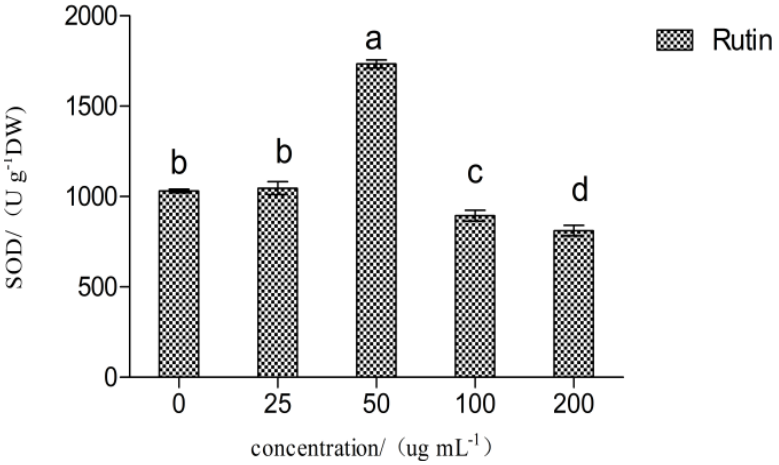


Fig. 3: Effect of Rutin on SOD activity of rice seedling

concentration increased with the overall first and then increased and then decreased (Fig. 4). 50 μg/mL treated rutin POD activity increased to a maximum and with the control group, the difference was significant ($p<0.05$), while the 100 and 200 μg/mL POD activity of rice seedlings decreased but still higher.

**Effect of rutin on CAT activity of rice seedling:** When rice seedlings subjected rutin treatment, CAT activity in vivo rice seedlings sharp rise at a concentration of 50 μg/mL maximum CAT activity compared the control group increased by 64.35% and the difference was significant ($p<0.05$), when the

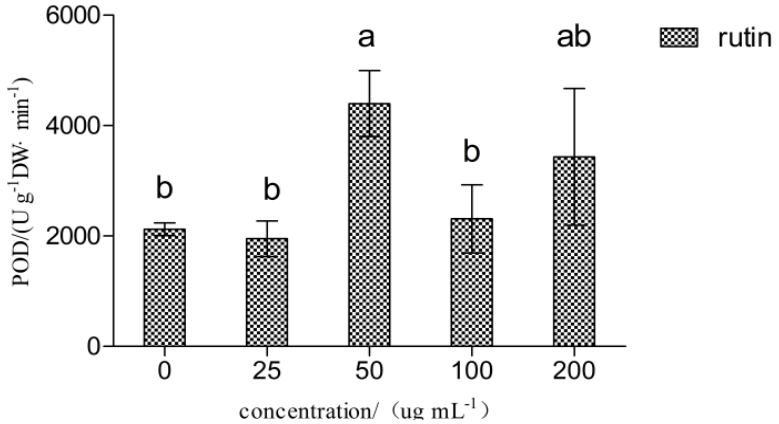


Fig. 4: Effect of Rutin on POD activity of rice seedling

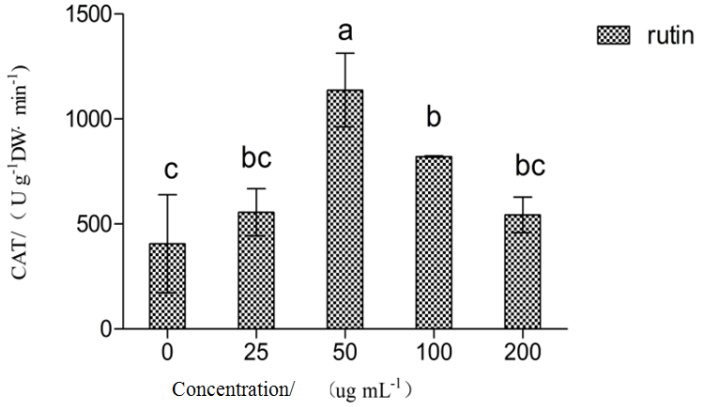


Fig. 5: Effect of rutin on CAT activity of rice seedling

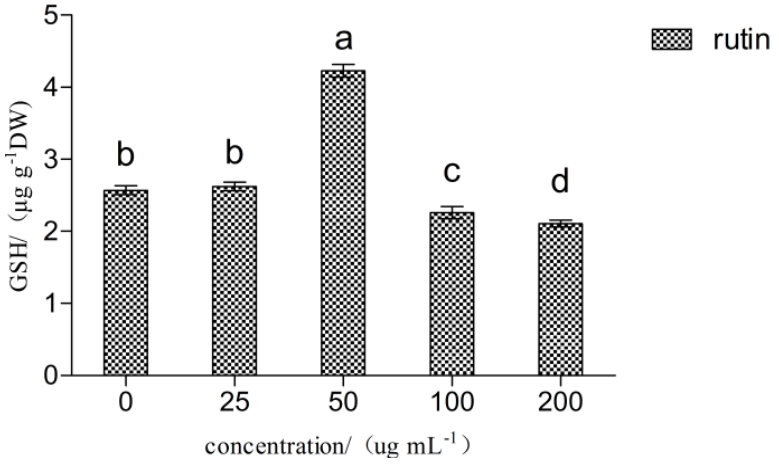


Fig. 6: The effect of rutin on the GSH content of rice seedling

concentration continues increases, CAT activity began to decline, reaching the lowest at 200μg/mL, but this time in vivo activity of CAT in Rice Seedlings are still higher than the control group (Fig. 5).

**The effect of rutin on GSH content of rice seedling:** GSH content of rice seedlings treated with increasing concentration of rutin showed the first increase after decreasing trend (Fig. 6). When 25μg/mL rutin seedlings GSH increased compared with CK increased by only 1.97%, a significant increase when 50μg/mL GSH content of rutin, an increase of 39.18% than CK and CK and other treatments with significant differences ($p<0.05$), when 200μg/mL seedling GSH content of rutin comparative control group decreased by 21.98%.

Rutin is closely related to rice allelopathy intensity and the concentration effect. At low concentrations shown to inhibit or promote the role, but at high concentrations it showed inhibition. This is similar to results of previous studies (Chen *et al*., 2011; Ahrabi *et al.*, 2011). Seed germination process parameters is a measure commonly used indicator allelopathic effect (Seguin *et al*., 2002), plant biomass and morphological indicators also been widely adopted (Hesammi, 2012). Seed germination is inhibited can be divided into seed germination and seed without delay germination both cases, the use of seed germination rate measured allelopathic effects of different substances is clearly not a good reaction after a suppression, Rice field under cultivation slow germination of seeds in the competition situation is undoubtedly at a disadvantage, even if eventually germinate often grow weak, difficult to form seedlings. During the experiment, more sensitive to changes in rice seed germination index, using allelopathic effect on seed germination index indicator can better respond to the different time points. At high concentrations greater variation width of rice root length indicators, the impact on the root rutin more significant, which other researchers use the results obtained in different plants similar (Hesammi, 2012). During plant growth, allelochemical to play the role we must first be absorbed by plant roots is the first organ to be affected by the plant, which will be affected more significantly than the other parts. Rapid inhibition of hypocotyl growth while promoting radical growth will undoubtedly further increase the rice plants shoot ratio, which for the cultivation of rice seedlings, inhibit excessive growth is extremely beneficial, assuming an appropriate concentration added to the nursery matrix, for nurture thereby increasing the resistance of rice seedling seedling whether adverse environmental benefit is worth further exploration.

With the increase of superoxide radical content of rutin treatment concentration accumulation, the role of the oxidation reaction occurs in membrane lipid peroxidation, the formation of a large number of MDA, which led to the enzyme structural damage, resulting in reduced activity. SOD activity *in vivo* after rice seedlings treated rutin downward after the first rise, which could potentially explain oxygen radicals may in turn aggravate the harm to plants by inhibiting its enzymatic activity after allelochemicals reaches a certain concentration. In the study of lettuce has a similar result, lettuce pepper SOD activity in vivo exudates potential allelopathic substance treatment also showed a drop in the trend after the first increase (Sun and Wang, 2012). POD generally higher activity in aging tissues, is an important physiological indicator of tissue aging, inhibition experiments with the stress concentration increases rice growth was more and more obvious, the degree of tissue aging deepening, POD activity of most of the performance continued to rise (Zhang *et al*., 2013). CAT activity *in vivo* is the first change of rice increased, then decreased. Lettuce CAT activity in *vivo* after dibutyl phthalate process also showed the same trend (Geng *et al*., 2008).Directly affect the potential of rice allelochemicals rutin antioxidant metabolism is to reduce the synthesis of GSH or GSH accelerated decomposition, or both, thereby affecting the proton transfer ascorbic acid, reducing the content of ascorbic acid, induced APX activity reduce. Research on lettuce also have similar results in vivo activity of APX pepper lettuce exudates potential allelochemicals process and results of this study similar (Sun and Wang, 2012).

Allelochemicals by global Influence on plant physiological and biochemical metabolic processes which play a role in protecting enzymes of just one part, but also by other aspects of absorption (L *et al*., 2002) and photosynthesis (Yang *et al*., 2002)on mineral elements in the final on plants growth impact. This is a complex control system, a single change by studying the protective enzyme system is still not enough to explain this complex situation, the need for a variety of metabolic pathways Changes Allelochemicals treatment plants may only do in-depth research to further clarify the mechanism (Xie *et al.*, 2014). For a long time, people *Amaranthus spinosus* L study allelopathy has not been enough attention, the current *Amaranthus spinosus* L allelopathic very superficial understanding of the role, it is necessary to A*maranthus spinosus* L Allelochemicals its biological activity for further systematic and thorough the study, also need the appropriate field tests to validate their allelopathic really can play a role.

## CONCLUSION

We concluded that at low concentrations of rutin, the growth of rice seedlings either aboveground or roots have been promoted, while the high concentrations of rutin aqueous solution imposed a stronger effect on seed germination and seedling growth inhibition in rice. The production rate of ROS and the accumulation of MDA content in rice seedlings were improved by the rutin. This led to oxidative stress, which influenced the growth and development of the rice seedling.

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