Using Radio Frequency Heat Treatment to Control Seed-borne *Trichoconis padwickii* in Rice Seed (*Oryza sativa* L.)

Pattaya Janhang\(^{a}\), Nattasak Krittigamas\(^{b}\), Wolfgang Lücke\(^{c}\), Suchada Vearasilp\(^{b}\)

\(^{a}\)Chiang Mai University, Postharvest Technology Institute, Chiang Mai Thailand.  
\(^{b}\)Chiang Mai University, Department of Agronomy, Chiang Mai Thailand.  
\(^{c}\)Georg–August University, Institute of Agricultural Engineering, Göttingen, Germany.

Abstract

*Trichoconis padwickii* is the main seed-borne fungus in many of seed crops especially in rice. They can cause the loss in germination, viability, and vigorous of the rice seeds. This study was to determine and evaluate the proper radio-frequency heat treatment on eliminating the seed-borne fungus, not only on the seed surface, but also inside the seed. The rice seeds cv. “KDML105” with the initial seed moisture content 10.4% and viability of 94% were treated with radio-frequency at the temperature of 70, 75, 80 and 85 °C for 180 seconds. Seed health test were assayed by blotter method and the various seed qualities were determined according to ISTA (2004). The existing of *Trichoconis padwickii* after treatment was decreased from 29% in control to 22.2, 17.8, 16, and 11.7% respectively. Other fungi were found as *Fusarium* sp., *Curvularia lunata*, and *Bipolaris oryzae*. However, among all fungi, *Trichoconis padwickii* found to be the main seed-borne in rice. The rice seed qualities assessment showed that their qualities were decreased with the increasing of the temperature used. The viability was reduced from 94% to 39% at the temperature 85 °C. Therefore, the radio-frequency had significantly showed the efficiency in controlling *Trichoconis padwickii* however it reduced the seed qualities. The best temperature used was 75 °C, *Trichoconis padwickii* infestation was dropped to 17.8% whereas the percentage of seed viability was as high as 82% and the moisture content has dropped to 9.5%. Longer treatment period and other temperatures used should have further research and investigate.

2 Background and Aim of the Study

Stackburn is one of the most common diseases in rice, caused by seed-borne fungus *Trichoconis padwickii*. It is found to be responsible for necrotic spots developed in the roots and coleoptiles of seedling. Heavily infected seedlings eventually die (Agarwal *et al.*, 1989). To solve this problem, the seeds are usually treated with fungicides which are not friendly to environment. According to the growing environmental awareness and health concern worldwide at present time have led to a consumer demand for safe and clean foods particularly those chemical-free products. This trend has invited the interest of both government and private sectors dealing with agricultural products to focus on alternatives to chemical control methods. Thermal method using radio-frequency heat treatment makes it possible to eradicate seed-borne fungi which permits effective planting and creates no chemical residue. It lead to short processing times and help saving energy (Cwiklinski and von Hörsten, 1999). The mechanism of rise in temperature is the dipole molecular in the materials are induced to oscillation in the same way of the electromagnetic field for many times in one second which generated two situation; first is intermolecule friction and second is hysteresis. The results of these is the rise in temperature
rapidly that the cause why these technology is use less time. Lozano et al. (1986) reported on using microwave oven treatment (1400 W heating power, 2450 MHz) to eradicated the seed-borne pathogens in cassava true seed for 120 seconds, the result showed that the effectiveness of this treatment depended on reaching an optimum temperature of 77 °C. Likewise, Cwiklinski and von Hörsten (1999) reported that a complete eradication of fungi on wheat seed can be reached by using electromagnetic treatment from 70 to 75 °C and treatment times of 150 to 180 seconds, referring to an initial seed moisture content of 15% (w.b.). Therefore, this experiment aims to find out the suitable temperature of the radio-frequency heating treatment in order to gain sufficient elimination of pathogens without reducing the rice seeds viability.

3 Methods
Rice crop (Oryza sativa L.) var. KDML105 with initial seed moisture content at 10.4%, seed viability of 94% and having 29% Trichoconis padwickii, 22% Fusarium sp., 11% Curvularia lunata and 10.5% Bipolaris oryzae seed-borne fungi, were treated with radio-frequency unit (810 Watts heating power, 27.12 MHz), which has been developed and built at the Instituted of Agricultural Engineering, University of Göttingen, Germany. The whole system consists of a magnetron, a power supply, a cavity, several thermometers and a field intensity registration units. The rice seeds were subjected to several of radio-frequency heat treatments of 70, 75, 80 and 85 °C for 180 seconds.

After treatment, the existing fungi were assayed by blotter method and the seed qualities such as seed viability and seed moisture content were investigated following International Rules for Seed Testing (ISTA, 2004).

4 Results and Discussion
Exposure of rice seeds to radio-frequency heat treatment to control seed-borne fungus Trichoconis padwickii with various temperature levels 70, 75, 80 and 85 °C, resulted in the reduction of seed-borne fungi, Trichoconis padwickii to 22, 17.8, 16 and 11.7% respectively. Other fungi such as Fusarium sp., Curvularia lunata, and Bipolaris oryzae were also found to be partially controlled. Fusarium sp. was decreased to 9.8, 9.2, 9.0 and 4.2%, Curvularia lunata was decreased to 6, 4.3, 3.8 and 0.8%, and Bipolaris oryzae was decreased to 9.5, 9.7, 7.2 and 5% with the increasing temperature used respectively.

The rice seed qualities were decreased with increasing of temperature used. The viability was decreased to 91, 82, 64 and 39%, and seed moisture content was decreased to 9.7, 9.5, 9.5 and 9.3%, respectively. In addition, the seed vigor by accelerated aging test were also decreased from 91% to 90, 79, 65 and 37% respectively.
Figure: A rice seedlings germinated from seeds which did not subject to radio-frequency heat treatment. B rice seedlings germinated from seeds after subjected to radio-frequency heat treatment.

Table: The comparison of means of viability and seed moisture content by several radio-frequency heat treatments.

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Seed viability (%)</th>
<th>Seed moisture content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td>94&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.4&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>70</td>
<td>91&lt;sup&gt;b&lt;/sup&gt;</td>
<td>9.7&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>75</td>
<td>82&lt;sup&gt;c&lt;/sup&gt;</td>
<td>9.5&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>80</td>
<td>64&lt;sup&gt;d&lt;/sup&gt;</td>
<td>9.5&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>85</td>
<td>39&lt;sup&gt;e&lt;/sup&gt;</td>
<td>9.3&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>CV (%)</td>
<td>0.73</td>
<td>1.31</td>
</tr>
</tbody>
</table>

The results corresponded with the report from Cwiklinski and von Hörsten (1999) that a complete eradication of fungi on wheat seed can be reached by using electromagnetic treatment from 70 to 75 °C and treatment times of 150 to 180 seconds, referring to an initial seed moisture content of 15% (w.b.). Therefore, the radio-frequency heat treatment had significantly resulted in eliminating seed-borne fungi. The suitable temperature of the radio-frequency heating treatment in order to gain sufficient elimination of *Trichoconis padwickii* which had less affected to rice seeds viability was at 75 °C for 180 seconds, which can maintain the rice seed viability as high as 82% and seed moisture content 9.5%. Anyhow, the complete eradication did not occur probably due to the initial moisture content of rice seed in this experiment was relatively low compare to the wheat seed moisture content from the experiment of Cwiklinski and von Hörsten (1999).

5 Conclusion
Using the radio-frequency heat treatment could effectively control seed-borne fungus *Trichoconis padwickii* in rice seeds cv. KDML105. Other temperature used and storage time should have further research and investigate.

Acknowledgments
This research is an activity of the programme Subject-related partnership between the University of Göttingen (Germany) and Chiang Mai University (Thailand) in the area of Academic Co-operation in Teaching and Research.
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