การใช้คลื่นความถี่วิทยุในการควบคุมเชื้อราและแมลงในเมล็ดพันธุ์ข้าวขาวดอกมะลิ105

Using Radio Frequency Heat Treatment to Control Seed-borne Fungi and Insect in Rice Seed (*Oryza sativa* L.) cv. Khao Dawk Mali 105

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Abstract

This investigation was to determine and evaluate the radio-frequency heat treatments on eliminating the seed-borne fungi and insects in rice seeds. The rice seeds cv. "KDML105" with the initial seed qualities before treated were: 10.4% moisture content, 80% viability, having *Trichoconis padwickii*, *Fusarium* sp., *Bipolaris oryzae* and *Curvularia lunata* seed-borne fungi, were further infested with lesser grain borer at the rate of 125 insects per 1 kg of rice seeds. Seeds were then subjected to radio-frequency heat treatments at 27.12 MHz under the temperatures of 70, 75, 80 and 85 ^{0}C for 180 seconds. Seed health test were assayed by blotter method, insect mortality assessment were taken after treated and various seed qualities were determined according to ISTA rules (2004). The results showed that the existing of fungi invasion, the survival insects and seed qualities after treatment were decreased with increasing of the temperature used. The fungi invasion were decreased to 33, 41, 54 and 80%, the insect mortality were 100% in all treatments and the rice seed viability was decreased to 71, 61, 50 and 27% after treated with the temperature of 70, 75, 80 and 85 ^{0}C, respectively. The optimal temperature level found from this experimental was 75 ^{0}C, at which the fungi invasion was partially controlled 41%, the survival insect was found 0%, the seed moisture content was decreased to 9.5% and the viability was 61%. Thus, it concluded that radio frequency heat treatment has a potential in controlling seed-borne fungi and lesser grain borer.

Key words : Radio Frequency, rice seed, fungi and insect control

บทคัดย่อ

การศึกษาผลกระทบของคลื่นความถี่วิทยุในการกำจัดเชื้อราและแมลงที่เข้าทำลายเมล็ดพันธุ์ข้าว โดยนำเมล็ดพันธุ์ข้าวขาวดอกมะลิ 105 ที่มีคุณภาพเบื้องต้น: ความชื้น 10.4% ความมีชีวิต 80% มีการปนเปื้อนของเชื้อรา *Trichoconis padwickii*, *Fusarium* sp., *Bipolaris oryzae* และ *Curvularia lunata* และจัดให้มีมอดข้าวเปลือกเข้าทำลายในอัตรา 125 ตัว ต่อ 1 กิโลกรัม เมล็ดพันธุ์ข้าว ถูกนำมาผ่านคลื่นความถี่วิทยุที่ระดับ 27.12 MHz ภายใต้อุณหภูมิ 70, 75, 80 และ 85 ^{0}C ระยะเวลานาน 180 วินาที ตรวจสอบการปนเปื้อนของเชื้อราด้วยวิธีเพาะบนกระดาษชื้น สังเกตความมีชีวิตของมอดข้าวเปลือก และตรวจสอบคุณภาพเมล็ดพันธุ์ตามกฎสากลของการตรวจสอบเมล็ดพันธุ์ (ISTA, 2004) พบว่าการปนเปื้อนของเชื้อรา, ความมีชีวิตของมอดข้าวเปลือก และคุณภาพเมล็ดพันธุ์ลดลง ตามระดับอุณหภูมิที่เพิ่มขึ้น ดังนี้ การปนเปื้อนของเชื้อราโดยรวมลดลง 33, 41, 54 และ 80% มอดข้าวเปลือก ตาย 100% ทุกระดับอุณหภูมิ และความมีชีวิตของเมล็ดพันธุ์เหลือ 71, 61, 50 และ 27% ตามลำดับ ระดับอุณหภูมิที่เหมาะสมที่สุดในการทดลองนี้ในการกำจัดเชื้อราและแมลง คือ 75 ^{0}C ซึ่งส่งผลให้การปนเปื้อนของเชื้อราลดลง 41%, ไม่พบมอดข้าวเปลือกที่รอดชีวิต, ความชื้นลดลงถึงระดับ 9.5% และเมล็ดพันธุ์ยังคงความมีชีวิตที่ 61 % ดังนั้นคลื่นความถี่วิทยุมีศักยภาพในการควบคุมการปนเปื้อนของเชื้อราและมอดข้าวเปลือก

คำสำคัญ คลื่นความถี่วิทยุ เมล็ดพันธุ์ข้าว การกำจัดเชื้อราและแมลง

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Introduction

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. The interesting in radio-frequency heat treatment is increased as a new thermal method for post-harvest treatment in agricultural commodities (Tang *et* al., 2000). Its application leaves no chemical residue on products, has provides acceptable product quality and has minimal impacts on the environment (Wang *et al*., 2003). The method makes it possible to eradicate seed-borne fungi and storage insects which permits effective planting and creates no chemical residue. 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 (Cwiklinski and von Hörsten, 1999).

Many studies have been conducted to explore the feasibility of using electromagnetic energies to control insect pests in agricultural commodities. A study reported by Andreuccetti *et al*. (1994) demonstrates the possibility of using 2,450MHz microwaves to kill woodworms by heating the larvae to 52–53 ˚C for less than 3 min. However, previous studies were not focused on seed-borne fungi and insect pests in rice seed.

Therefore, this experiment was established to find out the suitable temperature of the radio-frequency heating treatment in order to gain sufficient elimination of pathogens and store insects without reducing the rice seeds viability.

Materials and Methods

Rice crop (*Oryza sativa* L.) var. KDML105 was cultivated in Chiang Mai, Thailand. After harvested, the seeds were cleaned by laboratory aspirator. The rice seeds with initial seed moisture content at 10.4%, seed viability of 80% and having *Trichoconis padwickii, Fusarium* sp., *Bipolaris oryzae* and *Curvularia lunata* seed-borne fungi, were further infested with lesser grain borer (*Rhyzopertha dominica* (F.)) at the rate of 125 insects per 1 kg of rice seeds. Seeds were then subjected to radio-frequency heat treatments at 27.12 MHz under the temperatures of 70, 75, 80 and 85 ^{0}C for 180 seconds.

The radio-frequency unit (810 Watts heating power, 27.12 MHz) has been developed and built at the Instituted of Agricultural Engineering, University of Göttingen. The whole system consists of a magnetron, a power supply, a cavity, several thermometers, a scale for measurements of the moisture removal during the application. The temperature in the inside of the container is determined by fibre optic temperature measurement.

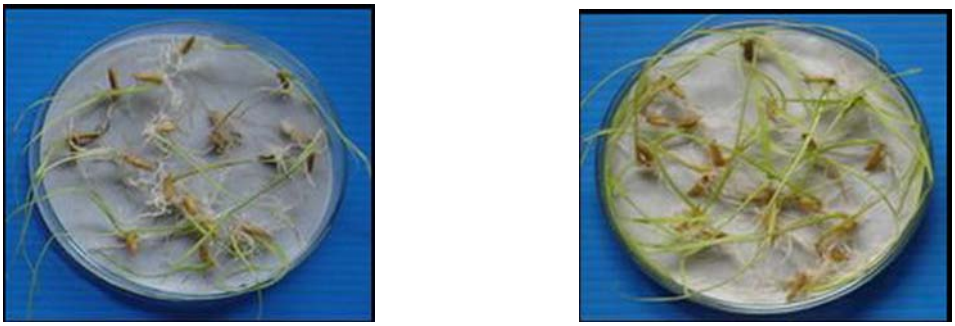
After treatment, the existing fungi were assayed by blotter method, insect mortality assessments were taken after treatments immediately by stereomicroscope and the viability and seed moisture content were investigated following International Rules for Seed Testing (ISTA, 2004).

Results

The exposure of rice seeds to radio-frequency heat treatments at 70, 75, 80 and 85 ^{0}C for 180 seconds, resulted in the corresponding decrease in percentage of fungi invasion, the insects infestation and the seed qualities. The fungi invasion was decreased to 33, 41, 54 and 80%, and the insect mortality was found to be 100% in all treatments. The lesser grain borers were found dead both inside and outside the seeds. As the assessment was done immediately after the treatment, the insect mortality is attributed to lethal temperature resulting from dielectric heating within the seed and the insects.

The seed quality assessments showed that seed moisture contents were decreased to 9.7, 9.5, 9.5 and

9.3% and the rice seed viability were decreased to 71, 61, 50 and 27% after treated with the radio-frequency heat treatments, respectively.



A B

Figure 1 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.

A B C D

Figure 2 A, B, C and D The lesser grain borers found dead outside and inside the rice seeds.

Discussion

The results from this experiment 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 ^{0}C and treatment times of 150 to 180 seconds, referring to an initial seed moisture content of 15% (w.b.). Wang *et al*. (2002) investigated process protocols to control field and storage pests in in-shell walnuts using a 27 MHz pilot scale radio frequency system, they found that after the RF heating to 55 ^{0}C and holding in hot air for at least 5 min resulted in 100% mortality of fifth-instar navel orangeworm. In addition, Wang and Tang (2004) reported the results of thermal death kinetics of targeted insects by using a 27 MHz radio frequency heat treatment, the results suggest that navel orangeworm were complete killed of 600 fifth-instar requires minimum exposures of 140, 50, 15, 6 and 1 min at 46, 48, 50, 52 and 54 ^{0}C, respectively.

Therefore, the result from this experiment corresponds with the above studies that the radio-frequency heat treatment had significantly resulted in eliminating seed-borne fungi and lesser grain borer (*Rhyzopertha*

dominica (F.)) both outside and inside the seeds. The suitable temperature of the radio-frequency heating treatment which had less affected to rice seeds viability was at 75 ^{0}C for 180 seconds, at which the fungi invasion was partially controlled 41%, the survival insect was found 0%, the seed moisture content was decreased to 9.5% and the viability was 61%.

Summary

The radio frequency heat treatment has a potential in controlling seed-borne fungi and lesser grain borer in rice seed storage. The optimal temperature level found from this experimental was 75 ^{0}C for 180 seconds.

Acknowledgments

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