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## Natural essential oils from lemon grass (*Cymbopogon citratus*) to control postharvest anthracnose of mango fruit

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Raweewon Duamkhanmanee

Faculty of Agricultural Technology and Agro-Industry,  
Rajamangala University of Technology,  
Suvarnabhumi, Ayudhya Huntra 13000, Thailand  
E-mail: d\_raweewon@yahoo.com

**Abstract:** Efficacy of essential oil extracted from lemon grass (*Cymbopogon citratus* Stapf.) on controlling postharvest anthracnose of mango fruit, Nam Dokmai, compared with a fungicide was evaluated before and after inoculation using spore suspension of *Colletotrichum gloeosporioides*. The experiment was carried out at Rajamangala University of Technology, Suvarnabhumi, Ayudhya Huntra, Thailand, by means of Completely Randomised Design (CRD) with four replications. The result showed that mango dipped into lemon grass oil at 4000 ppm concentration in hot water before and after inoculation gave the minimal disease scores with the means of 2.40 and 1.85, respectively, while the average disease scores from hot water treatment with carbendazim at 100 ppm concentration were 2.60 and 1.95, respectively.

**Keywords:** mango; anthracnose; *Colletotrichum gloeosporioides*; essential oil; *Cymbopogon citratus*; biofungicide.

**Reference** to this paper should be made as follows: Duamkhanmanee, R. (2008) 'Natural essential oils from lemon grass (*Cymbopogon citratus*) to control postharvest anthracnose of mango fruit', *Int. J. Biotechnology*, Vol. 10, No. 1, pp.104–108.

**Biographical notes:** Dr. R. Duamkhanmanee is an Assistant Professor at the Department of Plant Science, Faculty of Agricultural Technology and Agro-Industry in Rajamangala University of Technology, Suvarnabhumi, Thailand. She obtained the PhD-DAAD scholarship and completed her doctoral degree at Kassel University, Germany. Her work has focused on using natural products such as biofungicides and development of mushroom cultivation.

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### 1 Introduction

Anthracnose of mango caused by *Colletotrichum gloeosporioides* (Penz.) Sacc. is an important postharvest disease, which leads to losses of Thailand export values. Since side effects of chemicals used to protect and eradicate the disease have caused problematic results such as serious hazards to the population and to the environment, induction of non-target pests and fungicide resistance (Fry, 1982), several studies intend to find alternative ways to solve the problem. Lemon grass (*Cymbopogon citratus*) which is one of the natural sources used to control plant diseases is grown widely in Thailand for

direct consumption such as cooking ingredients in curries, salad and spicy soup (Tomyum Kung). Only the lower part of its leaf sheath is used, whereas the leftover is discarded in the field, though some cosmetic industries use this in mixture of shampoo or toilet cleaner. It is the fact that essential oil, as secondary metabolites, is made up of different volatile compounds, which are almost entirely classified as terpenes and phenylpropenes. The role of essential oil has been discussed in terms of antibiotic activity, allelopathy, attractants, feeding deterrents and phytoalexin. Many researches point out that essential oil from different herbal plants demonstrates antifungal activity against a wide range of postharvest pathogen (Wilson et al., 1987; Dube et al., 1989; Deans, 1991; Jobling, 2001; Duamkhanmanee, 2002; Mahanta et al., 2007). The previous work by Paranagama et al. (2003) on *C. citratus* also indicated that oil could inhibit the growth of *Aspergillus flavus*. A few researches of essential oil from plant presented against this pathogen of mango fruit. Thus, the aim of this study is to evaluate the efficacy of essential oil from lemon grass on *C. gloeosporioides*, a pathogen of mango fruit.

## 2 Materials and methods

Two experiments were conducted in this research as ten treatments of pre- and post-inoculations with four replications of five mangoes, each using Completely Randomised Design (CRD).

### 2.1 Oil extraction

Oil was extracted from lemon grass via water distillation. The method started with 300 g of fresh leaves cut into small pieces with 700 mL of water in a 2-L round flask placed on electrical mantel. The steam and extracted essential oil pass through a water condenser, allowing the volatile oil fraction to float on top of the water. The oil was collected by drawing out the water.

### 2.2 Isolation of fungi

*C. gloeosporioides* was isolated from mango fruit by means of tissue transplanting method.

### 2.3 Antifungal activity testing in vivo

Antifungal activity of lemon grass oils was tested in vivo before and after inoculation (pre- and post-inoculation treatments) with spore suspension ( $10^6$  spore/mL) of *C. gloeosporioides* on mango fruit. The bioassay comprised ten applications to compare the efficacy of natural citratus oil with another procedures as follows: dipping mango fruit into lemon grass oil, into hot water (51°C–55°C), into hot water combining with lemon grass oil, into carbendazim, into hot water combining with carbendazim, into the mixture of lemon grass oil and 70% ethyl alcohol and using volatile vapour; besides, there are two controls: inoculated and non-inoculated mango dippings in distilled water.

The dipping period was 5 min. The volatile vapour time took 12 h starting from  $1 \times 2 \times 0.5$  cm<sup>3</sup> sponge soaked in essential oil which was coated with cloth sheet and

then placed at each corner of a basket covered with moistured plastic bag for incubation. After the pre- and post-inoculation treatments, the mango fruit was incubated for 24 h in moistured plastic bag and 0.05% Tween 20 was added in each treatment for oil dispersion.

The evaluation was undertaken by observing the anthracnose symptom record of disease levels according to the infected surface area on the fruit after 7 and 10 days of inoculation, as shown in Figure 1, in which no infected surface area scored 1, whereas the infected surface areas of >0%–5%, >5%–25%, >25%–50%, >50%–75% and >75% scored 2, 3, 4, 5 and 6, respectively.

**Figure 1** Disease levels according to infected surface area on mango fruit



The result of each experiment was analysed to check the variance, and the means of disease score were compared to find significant difference at 95% level by Duncan's Multiple Range Test (DMRT).

### 3 Results and discussion

The result of pre-inoculation treatments, 10 days after inoculation (Table 1), showed that the mango dipped into lemon grass oil at the 4000 ppm concentration in hot water provided the minimum disease score (2.40), lesser than the score from those using carbendazim with and without hot water for which the mean scores were 3.30 and 2.60, respectively. The efficiency of lemon grass oil combined with hot water was better than the applied chemical. That means it is possible to use the essential oil as a biofungicide in the future.

With regard to the post-inoculation treatments, 10 days after inoculation (Table 2), it was found that the mangoes immersed into lemon grass oil at the 4000 ppm concentration with hot water gave the best result (mean score of 1.85), while the second best was using the hot water treatment with carbendazim at the 100 ppm concentration (mean score of 1.95). The results showed that the post-application of oil provided the better control than the pre-application of oil. Possibly, the essential oil might be used as an eradicant, not as a protectant due to the volatile characteristic.

**Table 1** Effects of essential oil and various treatments on average disease levels of mango fruits caused by *C. gloeosporioides* pre-inoculation, 7 and 10 days after inoculation\*

| Treatment                                                      | Average disease levels after inoculation |                      |
|----------------------------------------------------------------|------------------------------------------|----------------------|
|                                                                | 7 days                                   | 10 days              |
| Lemon grass oil 4000 ppm (dipping)                             | 2.60                                     | 4.15 <sup>d</sup>    |
| Lemon grass oil 4000 ppm + HW (dipping)                        | 2.15                                     | 2.40 <sup>a</sup>    |
| Lemon grass oil 5000 ppm (volatile vapour)                     | 2.25                                     | 3.25 <sup>abcd</sup> |
| Lemon grass oil 4000 ppm (in 70% alcohol) (dipping)            | 2.60                                     | 3.65 <sup>cd</sup>   |
| Lemon grass oil 2000 ppm (in 70% alcohol:water, 1:1) (dipping) | 2.60                                     | 3.40 <sup>bcd</sup>  |
| Carbendazim 100 ppm (dipping)                                  | 2.15                                     | 3.30 <sup>abcd</sup> |
| Carbendazim + hot water treatment (dipping)                    | 2.05                                     | 2.60 <sup>ab</sup>   |
| Hot water treatment (dipping)                                  | 2.30                                     | 2.85 <sup>abc</sup>  |
| Control (non-inoculated) (dipping)                             | 2.70                                     | 3.45 <sup>bcd</sup>  |
| Control (inoculated) (dipping)                                 | 2.35                                     | 3.10 <sup>abc</sup>  |
| CV (%)                                                         | 16.4 ns                                  | 17.4                 |

\* Different letters represent statistically significant difference at 95% level by DMRT.

**Table 2** Effects of essential oil and various treatments on average disease levels of mango fruits caused by *C. gloeosporioides* post-inoculation, 7 and 10 days after inoculation\*

| Treatment                                                      | Average disease levels after inoculation |                    |
|----------------------------------------------------------------|------------------------------------------|--------------------|
|                                                                | 7 days                                   | 10 days            |
| Lemon grass oil 4000 ppm (dipping)                             | 2.90 <sup>e</sup>                        | 3.55 <sup>d</sup>  |
| Lemon grass oil 4000 ppm + HW (dipping)                        | 1.70 <sup>ab</sup>                       | 1.85 <sup>a</sup>  |
| Lemon grass oil 5000 ppm (volatile vapour)                     | 2.90 <sup>e</sup>                        | 3.50 <sup>d</sup>  |
| Lemon grass oil 4000 ppm (in 70% alcohol) (dipping)            | 2.35 <sup>cd</sup>                       | 2.50 <sup>bc</sup> |
| Lemon grass oil 2000 ppm (in 70% alcohol:water, 1:1) (dipping) | 2.70 <sup>de</sup>                       | 3.10 <sup>d</sup>  |
| Carbendazim 100 ppm (dipping)                                  | 2.75 <sup>de</sup>                       | 3.20 <sup>d</sup>  |
| Carbendazim + hot water treatment (dipping)                    | 1.25 <sup>a</sup>                        | 1.95 <sup>a</sup>  |
| Hot water treatment (dipping)                                  | 2.00 <sup>bc</sup>                       | 2.30 <sup>ab</sup> |
| Control (non-inoculated) (dipping)                             | 2.50 <sup>cd</sup>                       | 3.00 <sup>cd</sup> |
| Control (inoculated) (dipping)                                 | 2.70 <sup>de</sup>                       | 3.10 <sup>d</sup>  |
| CV (%)                                                         | 13.9                                     | 12.4               |

\* Different letters represent statistically significant difference at 95% level by DMRT.

From this result, it is found that essential oil from lemon grass (*C. citratus*) which is classified in the Graminea family possesses an antifungal property. *C. citratus* oil is produced by lemon grass which are grown abundantly as home-garden vegetable in Thailand, and only the lower part of the leaf sheath is used for cooking. It is very interesting and valuable to improve the essential oil of herbal plants as biofungicides. Currently, biofungicides based on natural product are effective against plant diseases. The agricultural use of natural products is an advisable and desirable alternative to the

application of synthetic chemicals. Further research about the formulation and the way to apply is recommended.

#### 4 Conclusion

It can be concluded that the application of hot water treatment with lemon grass oil or carbendazim is not different for controlling postharvest anthracnose of mango fruit. It is evident that the essential oil from lemon grass can be employed as an alternative way to control the postharvest anthracnose of mango.

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