# Possibility of Biological Seed Coating Application on Direct-Seed Rice Production: Emphasis on Plant Productivity and Environment Awareness

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## Abstract

Seed and soil-borne are major courses, which is a deterrent in adopting direct rice production system. Seed coating, an application to control those pathogens and improve crop growth, could be an attractive approach. The aim of this experiment was to investigate the possibility of biological seed coating strategies on agronomic characters, grain yield and fungicide residues of rice grain in direct-seed rice production system. The experiment was laid out in RCB design under the field condition. Seeds were coated with various substances i.e. captan (conventional treatment; CA), biological seed coating substances are only chitosan-lignosulphonate polymer (CL) and eugenol incorporated into chitosan-lignosulphonate polymer (E+CL). Untreated seeds were used as control (CO). The results of growing in seasons 2006 and 2007 indicated that CL and E+CL coating substances improved seed germination, and seedling establishment. Moreover, those substances improved plant growth, and kernel yield. CA and E+CL could control seedling and grain infection. However, CA treatment led to residues of organochloride-fungicide in both soil and rice grain, which is seriously affecting to consumers health. Thus, the results concluded that the application of biological seed coating substances as CL and E+CL polymers may be a promising strategy to improve the biological rice production.

**Keywords:** Seed coating technology, rice seed, rice production, biological control

## Introduction

Transplanting is a principle method of rice cultivation in the world, which nursery seedlings are raised and then transplanted into flooded fields. However, in Thailand, the farmers have been used germinated seeds for rice nursery sowing, which resulted in poor, delayed germination and seriously infection by several fungi. This resulted in lower tillering capacity and thus reducing the final yield. It is the limiting factors in the traditional rice production system (Reddy, 2004).

Seed coating technique are used to protect the seeds from fungi infection. Moreover, this application may also improve the seedling performances, i.e. the seedling emergence time, synchronized emergence, improve emergence rate, and better seedling stand production in many field crops (Jett *et al*., 1996) like wheat (Chowdhary and Baset, 1994), maize (Dell Aquilla and Tritto, 1990) and rice (Basra *et al*., 2005, Pitipong *et al.,* 2008).

The technique of film coating involves the application of thin layer of a polymer binder often in combination with other components onto the seed coat. These other components may include color (effective pigment) and/or a variety of active additives, i.e. pesticides, fertilizers or plant regulators. The objectives of film coating seeds include the safe, accurate and dust free incorporation of seed treatment chemicals, the addition of nutrients or plant strengtheners for the improvement of the seeds ability (Du and Toung, 2002). Chitosan-lignosulphonate polymer or eugenol incorporated into chitosan-lignosulphonate polymer were found to be the most effective seed coating materials for rice seed borne fungi control. Furthermore, these applications led to vigorous seedlings, decreased germination time, and they improved the uniformity of seedling stand population under field conditions (Pitipong *et al*., 2006).

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The presented research was aimed to study the appropriate technique for improving direct-seed rice cultivation, to evaluate the effect of seed coating substances on plant productivity, agronomical traits, nutrient uptake, plant yield and fungicide residues in soil and harvested grain.

## Materials and Methods

The field experiments were conducted at the Agronomy Research Station, Faculty of Agriculture, Department of Agronomy, Chiang Mai University, Chiang Mai, Thailand during August - December in 2006 and 2007. The randomized complete block design (RCBD) with four replications was applied. The treatments were: control (untreated seeds) (CO), captan (CA), only chitosan lignosulphonate polymer (CL) and eugenol incorporated into chitosan lignosulphonate polymer (E+CL). At 14 days after sowing, the field emergence was evaluated as follows: from 10 points of 1x1 $m^2$ areas the numbers of germinated seeds were determined. At the $30^{th}$ day after sowing, the seedlings were tested for vigor and the seedling dry weights were taken after drying at 70°C for 48 hrs (Basra *et al.*, 2006). At harvesting time, yield components as panicle $m^{-2}$, kernels $panicle^{-1}$, 1000 seeds weight (g) and yield (ton $ha^{-1}$) were determined according Farooq (2007). At 30 days after sowing, the plant infection was recorded at 10 points of 1x1 $m^2$ area in each plot. At 100 days after sowing, rice grain infection was recorded. The TRACOR MT-220 gas chromatograph was used for organochloride fungicide residue determination in both soil and rice grain samples. The analysis of variance was performed for data analysis and differentiated with LSD test at $p<0.05$ using the software SX release 8.0 (Analytical software, Tallahassee, USA).

## Results

Comparison of the effects of seed treatment variants on rice production revealed that CA treatment significant reduced the seedling emergence and establishment under field conditions (Table 1). This result was significant different from CO, CL and E+CL treatments. CL and E+CL led to higher seedling emergence under field conditions. However, these results were non-significant different from the control plot. As shown in Table 6.2, at 2 weeks after sowing, the CA treatment significantly decreased seedling dry weight, shoot and root dry weight when compared with the biological seed coating substances. CL and E+CL improved the seedling establishment.

**Table 1** The effect of seed coating substances on field emergence in season 2006 and 2007*

| Treatment | Field emergence (%) (Mean ± SD) | |
|---|---|---|
| | 2006 | 2007 |
| CO | 80 ± 4.16 a | 81 ± 7.72 a |
| CA | 57 ±19.17 b | 64 ± 4.79 b |
| CL | 84 ± 7.95 a | 82 ± 8.88 a |
| E+CL | 76 ± 5.00 a | 80 ± 7.80 a |

* The different letters indicate the statistically significant difference by LSD at 5% level.

**Table 2** The effect of seed coating substances on seedling performances after germination (2 weeks after sowing) in season 2006 and 2007*

| Treatment | (Mean ± SD) | | | | | |
|---|---|---|---|---|---|---|
| | Seedling dry weight (mg) | | Shoot dry weight (mg) | | Root dry weight (mg) | |
| | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 |
| CO | 46.11±1.63b | 35.05±1.24b | 25.78±2.03ab | 19.60±1.55ab | 20.33±0.58bc | 15.45±0.43b |
| CA | 44.24±3.94b | 34.51±3.07b | 24.05±3.73b | 18.76±2.91b | 20.18±0.29c | 15.75±0.23b |
| CL | 52.79±3.53a | 36.95±2.48ab | 28.74±0.71a | 20.12±0.50ab | 24.04±3.10a | 16.83±2.17ab |
| E+CL | 50.64±1.23a | 39.50±0.96a | 27.67±0.54a | 21.60±0.42a | 22.97±0.86ab | 17.92±0.67a |

* The different letters indicate the statistically significant difference by LSD at 5% level.

At four weeks after sowing, the plants of the control plot were impaired as a consequence of the highest percentage of seedlings infected (Table 3). The plants from E+CL coated seeds were less infected than those from the CO. CA treatment completely inhibited seedlings infection. At twelfth weeks after sowing, pre-harvesting grain infection was significantly higher in the CO plot than in the plots with the other treatments. The results demonstrated that the percentage of infected grains was significantly different between grains from CA treatment plot and E+CL polymer plot.

The influence of seed coating substances on yield and yield components of rice grain are presented in Table 4. The results demonstrated that in both seasons 2006 and 2007 the influence of seed coating substances did not affect the number of panicles per area. These results were none significantly different. The seed coating substances influenced the number of bearing kernels per panicle. Especially, CO and CA treatment showed the lowest number of bearing kernels per panicle. However, higher numbers of panicle were recorded from plants raised from CL and E+CL. The seed coating substances affected also the 1,000 seeds weight. Table 4 indicated that the variant with E+ CL had the highest 1,000 seeds weight and the seeds obtained from the control plot had the lowest 1,000 seed weight. The studied seed treatment variants had no influence on the grain yield. However, compared to CA treatment, the use of biological seed coating substance treatments showed a tendency in both seasons to increase the yield.

**Table 3:** The effect of seed coating substances on seedlings and rice grain infection in season 2006 and 200[7*]

| Treatment | Seedlings infection[1/] (%) (Mean ± SD) | | Grain infection[2/] (%) (Mean ± SD) | |
|---|---|---|---|---|
| | 2006 | 2007 | 2006 | 2007 |
| CO | 16.91±0.01 a | 16.18±0.02 a | 44.44±0.57 a | 50.00±2.59 a |
| CA | 0 d | 0 d | 0 d | 0 d |
| CL | 11.09±0.03 b | 10.15±0.04 b | 16.67±0.06 b | 27.78±0.36 b |
| E+CL | 5.06±0.04 c | 8.04±0.07 c | 6.95±0.10 c | 16.67±0.11 c |

* The different letters indicate the statistically significant difference by LSD at 5% level.

1/ : Seedling infection data were recorded at 14 days after sowing based on averaged 100 seedlings of 10 points 1 $m^2$ sampling area/plot for each treatments.

2/ : Rice grain infection data were recorded at 110 days after sowing (10 days before harvesting) based on averaged 25 panicles in 10 points of 1 $m^2$ sampling area/plot for each treatments.

**Table 4:** The efficiency of seed coating substances on yield components and agronomic yield of direct-seeded rice production

| Treatment | Yield component evaluation (Mean ± SD) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Panicle $m^{-2}$ | | kernels/Panicle | | 1000 kernels weight (g) | | Yield (ton $ha^{-1}$) | |
| | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 |
| CO | 204±37.78a | 208±38.71a | 128±9.43b | 131±9.43b | 26.75±0.30b | 25.41±0.27b | 3.49±0.70a | 3.65±0.71b |
| CA | 189±24.01a | 193±24.43a | 137±7.34ab | 140±7.35b | 27.03±0.53ab | 25.63±0.53ab | 3.56±0.43a | 3.60±0.39b |
| CL | 198±22.28a | 218±24.70a | 142±6.08a | 156±6.65a | 27.17±0.22ab | 25.81±0.21ab | 3.82±0.45a | 4.59±0.54a |
| E+CL | 189±25.31a | 199±26.70a | 146±5.25a | 154±5.25a | 27.50±0.36a | 26.09±0.35a | 3.78±0.61a | 4.20±0.67ab |

* The different letters indicate the statistically significant difference by LSD at 5% level.

**Table 5** The effect of seed coating substances on total organochlorine fungicides residue contamination in soil and harvested rice grain

| Treatment | Organochlorine residue in soil sample (mg $L^{-1}$) | | Organochlorine residue in harvested grain (mg $L^{-1}$) | |
|---|---|---|---|---|
| | (Mean ± SD) | | | |
| | 2006 | 2007 | 2006 | 2007 |
| CO | 0.2222±0.06 b | 0.2970±0.03 b | 0.0216±6.27x$10^{-3}$ b | 0.0167±3.05 x$10^{-3}$ b |
| CA | 0.4403±0.07 a | 0.6470±0.10 a | 0.0540±0.01 a | 0.0413±0.01 a |
| CL | 0.1900±0.02 b | 0.2590±5.00 x$10^{-3}$ b | 0.0217±2.51E-3 b | 0.0143±4.93 x$10^{-3}$ b |
| E+CL | 0.2117±0.03 b | 0.2880±0.08 b | 0.0203±1.53E-3 b | 0.0163±1.52 x$10^{-3}$ b |

* The different letters indicate the statistically significant difference by LSD at 5% level.

## Conclusions and Discussions

This experiment found that the CA seed treatment application completely controlled fungi infection in seedling and grain. However, the chemical compounds, which were used here, influenced seed germination, seedling establishment, plant growth rate and other mechanisms related to the plant productivity. Therefore, many academic researches are explored and examined the new seed treatment application that has fewer side effects on plant production system. Seed coating with biological substances is a possibility, which provides a satisfied accomplishment in plant production system. This technique can protect plants from various kinds of pest, improve stand quality and uniformity, increase yields, and increase return on investment.

These findings strongly suggest that seed coating with E+CL, which was studied here, is an interesting strategy in direct-seed rice production system. Physiological changes occurring in kernels led to the increase of yield. E+CL polymer improved seedlings vigor, caused better plant growth, improved chlorophyll accumulation, yield attributes, and minerals uptake efficiency. Moreover, it did not produce any undesirable chemical residue contaminating soil and grain.

## References

Basra, S.M.A., Farooq, M., and Tabassum, R. (2005). Physiological and biochemical aspects of seed vigor enhancement treatments in fine rice (*Oryza sativa* L.). Seed Science and Technology. 33, 623-628.

Chowdhary, A.Q., and Baset, Q.A. (1994). Effect of soaking period and aerobic condition on germination of wheat seeds. J. Chittagang Univ., 18, 83-87.

Dell Aquilla, A., and Tritto, V. (1990). Ageing and osmotic priming in wheat seeds: effects upon certain components of seed quality. Ann Bot., 65, 21-26.

Du, L.V., Tuong, T.P. (2002). Enhancing the performance of dry-seeded rice: effects of seed priming, seedling rate, and time of seedling. In: Pandey S., Mortimer M., Wade L., Tuong T.P., Lopes, K., Hardy B. (eds) Direct seeding: research strategies and opportunities. International Rice Research Institute, Manila, Philippines, 241-256.

Jett, L.W., Welbaum, G.E., and Morse, R.D. (1996). Effects of matric and osmotic priming treatments on broccoli seed germination. J Am Soc Hort Sci. 12, 423-429.

Reddy, S. (2004). Agronomy field crops. Kalyani Publishers, New Delhi, India.

Thobunluepop, P., Thanapornpoonpong, S., Vearasilp, S., Pawelzik, E. (2006). The Comparison of the Biological and Chemical Seed Coated Substances on Rice Seed (KDML 105) Storability. Conference of Mahasarakham University, 2 nd, 6-8 September 2006. 160 pp.

Thobunluepop, P. (2008). Characterization of a botanical fungicide from Thai origin and its efficiency in rice production. Ph. D. Thesis. Cuvillier Verlag Göttingen, German. 156 pp.