

## **Application of Phosphine Fumigant for Controlling Rice Storage Insect Pests in Foundation Seeds**

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### **Abstract**

The development of phosphine resistance in storage insect pests is now problematic, so the increase of rate and frequency of phosphine fumigation in a storage room is needed. However, an adverse effect on seed germination, and human hazard needs to be tested. This experiment was aimed to find the most suitable methods used in combination with phosphine fumigation to reduce the risk of phosphine exposure. The treatments were (1) phosphine fumigation for 7 days and then open a plastic cloth (2) phosphine fumigation for 7 days and continue to cover a plastic cloth (3) phosphine fumigation for 7 days and spray pirimiphos methyl on sack (4) phosphine fumigation for 7 days and use a light trap (5) treat seeds with sweet flag powder before phosphine fumigation for 7 days (6) no phosphine fumigation with plastic cloth opening and (7) no phosphine fumigation with plastic cloth covering. In each treatment, seeds were sampled every month for 12 months to determine seed quality and insect populations. The results showed that seeds treated with sweet flag powder and fumed with phosphine for 7 days can significantly control storage rice insect pests in the first and the second year of experiments. The seed moisture content in each treatment changed in a similar pattern throughout 12 months storage in both years (13.4 – 13.7%). The seed germination showed similar results (more than 80% after 6 months storage), except the treatment of 7 days phosphine fumigation with plastic cloth covering which resulted in a slowly decline in germination. Seed weight losses and numbers of insect pests in the treatment with sweet flag powder were significantly less than the others.

**Keywords:** rice seed, Leb Nok Pattani, storage rice insect pests, phosphine, sweet flag powder

### **Introduction**

Storage rice insect pests are the main cause of rice seed damage and deterioration by eating of seeds by both larvae and adults (Kaewnango et al., 2016). It also makes the amount of inert matter increases causing deterioration of seed quality and interferes in the standardization of grain types (Visarathanon et al., 2005). Particularly, the damage of the foundation seed from insect pests can affect the production of registered seed and certified seed. Phosphine fumigation is the most popular method for preventing insect pests damage to rice seeds after harvesting because it can kill insects at all stages of growth, no toxic residue and easy to operate. Phosphine fumigation under a sealed canvas for 7 days can kill insects at all stages of growth but if not used properly, it can cause insect resistance (Bullen, 2007). Increasing the frequency of use and rate of phosphine is a way to solve the problem of insect resistance; however, this method is not only harmful to the users, but also can impact on seed germination. So finding a safe way to undertake phosphine fumigation for control storage rice insect pests is probably a good solution to this problem. In addition to reducing the cost of seed storage, it also protects farmers from the toxic residues of phosphine in rice seeds.

### **Materials and Methods**

A two - year experiment was conducted at Pattani Rice Research Center, Rice Department, Thailand, with Randomized Complete Block Design (RCBD) of 4 replications. The details of the operation are as follows.

Foundation seeds of Leb Nok Pattani variety packed in 60 kilograms of jute sacks was used as test specimens.

Testing of insect pests control in rice seeds, which was prepared with 7 treatments include:

1. Phosphine fumigation of 7 days and open plastic cloth
2. Phosphine fumigation of 7 days and cover plastic cloth

3. Phosphine fumigation of 7 days and spray pirimiphos methyl on sack
4. Phosphine fumigation of 7 days and use light trap
5. Treat seed with sweet flag powder and fumigant phosphine for 7 days
6. No fumigation with open plastic cloth (control)
7. No fumigation with cover plastic cloth (control)

Placing of rice seeds that was tested with each treatment in the storage shed for 12 months. Each month, about 1 kilogram of rice seeds was sampled for the following purposes:

- 500 grams for identification of insect pest species and recording their numbers
- 250 grams for moisture content measurement
- 50 grams for counting and weighing of normal seeds and broken seeds to calculate percentage of weight losses by insect damage from the formula of Adams (1976)
- 400 seeds for germination test

Statistical analysis and Duncan's Multiple Range Test (DMRT) comparison.

The experiment of the first year was conducted during May 2014 to April 2015 and May 2015 to April 2016 in the second year.

## Results

The effect of using phosphine fumigant with other methods for control storage rice insect pests

The number of storage rice insect pests found in rice seeds from some treatments was highly significantly ( $p < 0.01$ ) in both years. The best treatment for insect pests control was found to be treating seeds with sweet flag powder and fumigation with phosphine for 7 days, as supported by the results of the lowest number of insect pests recorded in seed samples: 602.3 and 625.5 insects/500 grams seeds, in the first and second year, respectively. The second most successful treatment of seed was phosphine fumigation for 7 days and sprayed with pirimiphos methyl on sack and phosphine fumigation for 7 days and covered plastic cloth, respectively. While phosphine fumigation for 7 days and opened plastic cloth was effective in the first year only. We found that phosphine fumigation for 7 days and use of light trap was not able to control insect pests in both years (Tab. 1)

### Rice seed quality

The seed moisture content in each treatment changed similarly throughout 12 months storage in both years (13.4 - 13.7%). The seed germination showed similar results (more than 80% after 6 months storage) except the treatment of 7 days phosphine fumigation with plastic covering which result in slowly declined germination. Seed weight losses and number of insect pests in the treatment with sweet flag powder were significantly less than the others.

## Discussion

From the results which showed that seeds was treated with sweet flag powder and fumed with phosphine for 7 days was the best treatment for control storage rice insect pests because essential oils (acalamol aldehyde) in the rhizomes of sweet flag which is toxic to the nervous system of insects. It also has the effect of repelling, inhibit eating and inhibit the reproduction of insects. (Supawan, 2014) Whereas Paneru *et al.* (1997) studied on wheat seeds treated with sweet flag powder for control storage rice insect pests which found that wheat seeds was treated with 2% w/w of sweet flag powder could control 100% of adults of rice weevil (*Sitophilus oryzae* Linnaeus) and grain weevil (*Sitophilus granaries*) within 7 days. In addition, Shuka *et al.* (2009) also found that chick peas seeds that was treated with 0.3 - 0.4 mg/g of sweet flag powder could decrease oviposition and egg hatchability of southern cowpea weevil (*Callosobruchus sinensis* Linnaeus) and seed germination remained 100% after 6 months.

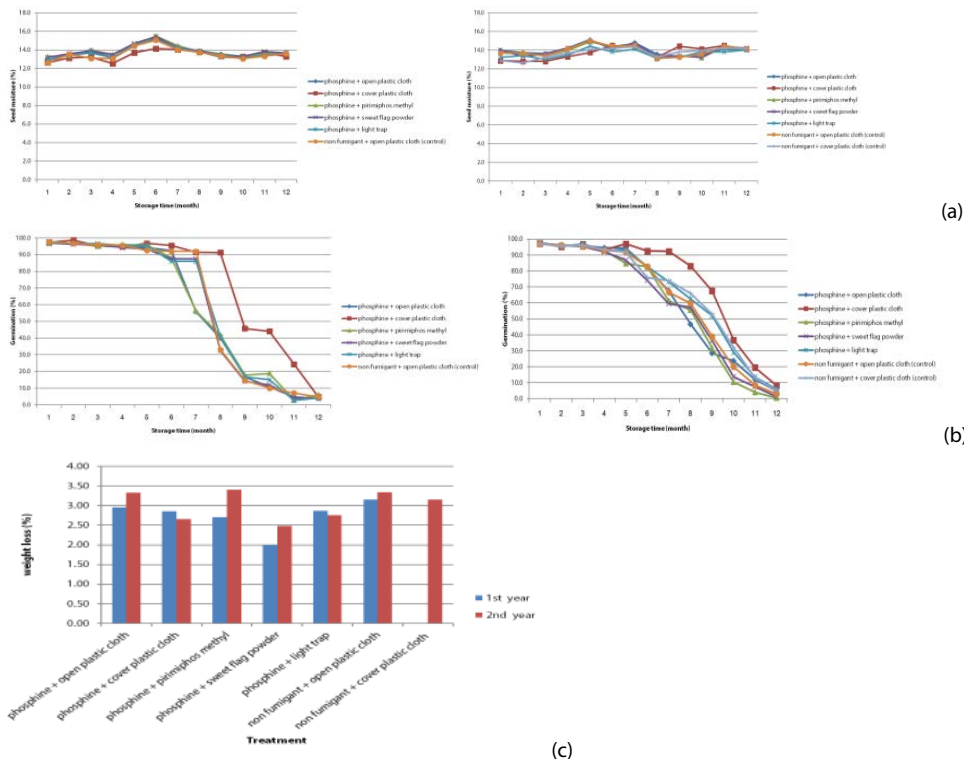
**Tab. 1** Total number of storage rice insect pests found in Leb Nok Pattani foundation seeds which applied phosphine fumigant with many methods at Pattani Rice Research Center during May 2014 - April 2015 and May 2015 - April 2016. (Fig.1)

Treatment	No. of insects/500 g of rice sample	
	1 <sup>st</sup> year	2 <sup>nd</sup> year
<b>Phosphine + open plastic cloth</b>	716.8 ab	1,321.3 c
<b>phosphine + cover plastic cloth</b>	702.0 ab	726.0 a
<b>phosphine + pirimiphos methyl</b>	725.3 ab	686.8 a
<b>phosphine + sweet flag powder</b>	602.3 a	625.5 a
<b>phosphine + light trap</b>	858.0 bc	1,083.5 b
<b>no fumigation + open plastic cloth (control)</b>	1,009.5 c	1,853.5 d
<b>no fumigation + cover plastic cloth (control)</b>	-	1,059.3 b
<b>CV (%)</b>	18.4	12.6

<sup>1</sup>/Average on 4 replications

<sup>2</sup>/Means in the same column followed by a common letter are not significantly different at 5% level by DMRT

(-) No treatment test



**Fig. 1** Line graph showing moisture in first and second year (a) germination in first and second year (b) and weight loss in first and second year (c) of Leb Nok Pattani foundation seeds which applied phosphine fumigant with many methods at Pattani Rice Research Center during April 2014 - May 2015 and April 2015 - May 2016.

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