The Effect Fogging of Corn Kernels to Maize Weevil, *Sitophilus zeamais* Population

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Abstract. Maize weevil, *Sitophilus zeamais* (Coleoptera: Curculionidae) is a common pest of warehouses in Indonesia not only of corn kernels. The fog or smoke is used for many purposes especially for food, but as naturally pesticides that are rarely used in agriculture. The population of *S. zeamais* needs to be controlled to avoid huge damage of corn, including weight and texture loss. The common naturally method is fogging on kernel before and during storage. The purpose of this study was to assess the biological performance of *S. zeamais* including a number of individual and the amount of frasses in each treatment with different fogging duration. The research was conducted using a completely randomized design method with four levels of fogging duration of 0, 15, 30, 45 minutes under three replications for each treatment. The results showed that the duration of fogging had a significant effect on *S. zeamais* population. In contrast, the amount of frass was not significantly different between treatment. The 45 minutes was indicated as the most effective time controlling *S. zeamais* population. Fogging is an eco-friendly and cheapest method controlling pest rather than chemical treatments. The fogged kernels indicated the significant effect to control infestation of *S. zeamais* in corn kernels. This current research also revealed diverse utilize of smoke, either as natural smoke or liquid for pesticide.

1. Introduction

Storage of maize has constraints resulting in loss of yields caused by warehouse pest attacks. Post-harvest losses of grain due to insect attacks during storage periods are a major problem faced by small farmers, especially in the tropical regions of developing countries [1]. Based on the study, 5-15% of the total weight of the crop was lost after harvest. The main pests in corn during storage are the corn beetles. From a variety of cereals and grain's corn has a vulnerability to warehouse pest attacks with population and longer life time compared with rice, sorghum and millet (jewawut). This difference is influenced by the biological activity of *S. zeamais* fecundity, the egg and larval period and its ability to breed on any cereal plant.

Insects can infect mature corn before the penultimate time arrives and propagate themselves during storage [2]. Development of hybrid corn is not matched by plant resistance to warehouse pests; most farmers assume that the use of pesticides can control *S. zeamais*. However, the use of pesticides is very bad because it is dangerous for animal and human consumption.

S. zeamais has a population spread in the tropics and subtropics [3]. They put eggs on the seeds of corn in the days before harvesting until storage. After the eggs hatch into larva then eat corn kernels [4]. The life cycle of *S. zeamais* is in the seeds so that if any seeds have eggs, the seeds will be destroyed en masse [5].

The quality of maize is related to the appearance of maize, nutritional value, uniformity and salinity conditions. Insect attacks will cause damage in quality and quantity during storage. Loss of yield and decreased quality of maize are very difficult to avoid, as insects such as *S. zeamais* have the ability to breed rapidly [6]. It decreases in quality include porous outer fragments, and reduced

nutrients. Insects can sometimes attack food in the state of death and life. Based on the study, one S. *zeamais* larvae, when growing up, can metabolize 14 mg of single wheat kernels into water, CO_2, water, heat and dirt, while insects can consume 2/3 of endosperm [7]. Therefore, moisture content and temperature in corn kernels increase due to the metabolism [8].

In Indonesia, the yield of corn during the post-harvest period is between 15-20% per annum. And 0.5-2% of total life is caused by *S. zeamais*. To deal with mass destruction, a cheap and eco-environmentally method is needed, especially for small farmers [9]. The beetle attack begins during the planting period, but most of the damage occurs during the storage period [10-11].

Fogging is a method for avoiding the growth of bacteria in foodstuffs, seeds, the longer fuming the surface of the covered object so that the surface is thick, and bacterial growth is inhibited. Smoke produces a formaldehyde compound that affects large preservatives. Then Phenol can inhibit oxidative rancidity or as an antioxidant. However, there are carcinogenic compounds in wood smoke that can cause cancer. As long as the carcinogen content is very low, it does not affect the condition [12].

2. Methods

2.1 Experimental design

This research was conducted in Plant Pest and Disease Laboratory of Agrotechnology Department, University of Darussalam Gontor. Corn kernels used were obtained from the traditional market "Songgolangit", Ponorogo. The research was conducted using a completely randomized design method with four levels of fogging duration of 0, 15, 30, 45 minutes under three replications each treatment. The 100 gram corn kernels were designated as each replication.

The 100 gram of kernels after fogging was let to cool in sterile room before placed in 60 ml transparent bottles. The bottle was holed using two mm fined needle over the surface for aeration. Ten mature individual of beetles were put the inside bottle. Immediately bottles are tied with original cover and placed in room temperature.

The study was conducted for 35 days with observation three times a week. The parameters observed were the number of *S. Zeamais* and the weight of frass, also some insect behaviors were noted during observations.

2.2 Fogging source

The one kg of dried husk was used for source of fogging under gauze. It burned under 60 cm diameter metal column and 100 cm tall. The corn kernel was put it tops off gauze using the metal rack. Corn kernel was fogging based on duration.

3. Results and discussion

The result of 35 days observation on number of *S. zeamais* individual are presented in Table 1.

Table 1. Number of individual *S. Zeamais* and weight of frass during 35 days treatment.

Treatments (minutes)	Number individual	Frass (gram)
0	71 ± 22.67^{a}	$0{,}25\pm0.06^{a}$
15	144 ± 2.67^{b}	$0{,}23\pm0.11^{a}$
30	$72{,}3\pm14.8^{a}$	$0{,}14\pm0.07^{a}$
45	53 ± 10^{a}	$0{,}246\pm0.11^{a}$

*Different subscript in the same row mean a significant different ($P< 0.05$).

Number of individual *S. Zeamais* during treatment showed that the treatments of 15 minutes are the highest 144±2.67. On the other hand, treatments 0 (control), 30 and 45 minutes has no significance difference in an individual number. This result indicated that the treatments are affected in varies response. Well known that fogging is having a preservative effect to any agro industrial product not

only seed of any cereals but also for beef and fish [13]. The results which showed that number of individual are decreased as increased of fogging time. Following Ojo and Omoloye (2016) [14] several factors is affecting of maize weevil such as food host conditions, type of insect species, geographical locations, and experimental conditions. Any change of those factors may affect to the maize weevil growth and indirectly to population or individual replication. The present of preservative material, including fogging detained for weevil growth and replication.

The content of fog was listed and described by Tranggono *et.al* [15] including Phenol, 3-metil 1,2-siklopentadion, 2-metoksi phenol, 2-metoksi-4-metil phenol, 4-etil-2-metoksi phenol, 2,6-dimetoksi phenol, and 2,5-dimetoksi benzyl alcohol. Application of liquid fog for food was determined by [16] with maximum duration where 15 minutes, increasing of duration causing toxicity on food. These conditions were agreed with the result, that showing decreased number of individual *S. zeamais* after 15-minute treatments.

The utilized fog as crop basically was applied since traditional era of agriculture. Since revolution of agriculture, the synthetic pesticides were replaced this important function of treatment whole area's agriculture in Indonesia. The reestablishing fogging methods are very important for creating good environment of the agricultural system. The utilizing of fog as natural pesticides will support of organic agriculture. The pest and disease agents that controlled by fog, either as natural fog or liquid where *Gloeophyllum trabeum* (fungi), *Trametes versicolor* (fungi), *Streptomyces scabies* (bacteria), *Clavibacter michiganensis* subsp. *michiganensis* (bacteria), *Reticulitermes speratus* (insect pest), *Coptotermes formosanus* (insect pest), and *Coptotermes curvignathus* (insect pest) [17] [18] [19].

The food crops consumed are mostly depended on maize weevil performance, the variation of morphological size affected to volume of food take in by an insect [14]. In normal condition, the sizes are equivalent to the amount consumed food.

Table 1 showed also that frass amount as a biological indicator is uniform. Biological activities of maize weevil are mostly same. The frass which resulted from metabolism activity of weevil indicates the ability of insect to consume provided food (corn kernels). Increasing number of frass indicate indirectly of increasing either insect growth or duplications.

However, the present of fogging preservative material on corn kernels gives positive effect for the small farmers. The fogging methods with some notice are required to achieve better results for maize weevil control, especially in corn. It will also support farmers for maximizing usefulness of husk as a source of fog for controlling pest.

4. Conclusion

The conclusion of this research is that the fogging treatment on corn kernels, which was performed with the difference of fogging time between 0, 15, 30 and 45 minutes had a significant effect on the growth and replication of maize weevil, thus affecting the population of *S. zeamais*. Furthermore, the studies of insect variation to consumed food level are needed.

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