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Article

**Efficacy of Fogging on Corn Kernels to Biological Performance of Maize weevil, *Sitophilus maize L***Haris Setyaningrum<sup>1\*</sup>, Topan Adi Pondra<sup>2</sup>, Fariqul Alifudin<sup>3</sup>, Muhammad Rizqy Cahyadi<sup>4</sup>, Iqbal Maulana Mustofa<sup>5</sup><sup>1,2,3,4,5</sup>Universitas Darussalam Gontor, Indonesia\*Corresponding Address: [haris.setyaningrum@unida.gontor.ac.id](mailto:haris.setyaningrum@unida.gontor.ac.id)**Article Info**

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**ABSTRACT**

Natural grain's fogging is a Indonesian traditional method which applied since many years ago. Recently, no specific research was approving this method, especially for maize. Maize weevil, *Sitophilus maize L* is a common destructive insect pest considered many losses on stored grains. The aim of this research is to determined fogging effect on grains to biological effect of *S.maize L*. This research conducted using a complete randomized design with three levels of fogging durations 0, 15, 30, 45 minutes with three replications. Observation factors were weevil behavior (*S.maize L*), frasses, and grain level infestation. The results showed that the level of infestation decreased as well as the increasing of fogging duration. Fogging is a good method for safeness of weevil control on stored grain. Formaldehyde in fog affected prevents grains from attacking weevil. Fogging is a cheap and safe control method regarding the environmental issues.

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**INTRODUCTION**

Corn, *Zea mays* is an important commodity in Indonesia and major food of main Indonesian. Otherwise corn is also vital raw material for processed food industries. Corn is the second source of carbohydrates after rice which plays a role in supporting food security, adequate supply of animal feed, and has recently even been used as a raw material for alternative energy (biofuel). Based on Department statistic of Indonesia (2015), Several kind of corn are import and exported from Indonesia such as sweet corn, popcorn, dry kernels, and seeds. In end of 2014, recorded land cultivated is 3.8 million hectares and produced at least 19.03 million tons of corn. In order to strengthen the food ecosystem and strengthen national food, the government continues to look for solutions to increase corn production to meet domestic demand for corn, as well as to meet export market demand. The government has prepared a policy related to the acceleration of corn development by establishing a strategy

for developing corn towards sustainable self-sufficiency through the 2022-2024 Corn Roadmap. Currently, several corn-exporting countries apply export restrictions to prioritize meeting their domestic needs. This policy resulted in an increase in world corn prices, as well as the impact of the current global geopolitical conditions due to the Russia-Ukraine conflict. The average price of corn has increased, with an average price update in June 2022 reaching USD 335.71/ton. International corn prices reached their highest price in April 2022 of USD 348.17/Ton and tended to experience a slight decline until June 2022 (Aldillah, 2017). Estimation of corn production with a Moisture Content (KA) of 27.81% (Wet Coated Corn at Farmers), until the end of the year could reach 25.3 million tons. While the estimated production of corn with KA 14% (Corn Stored in the Warehouse) reached 18.7 million tons. Meanwhile, the need for industry, especially the animal feed industry, is around 15 million tons, so there are still around 3 million tons of national corn reserves, which are prioritized for national demand reserves.

The tendency for world corn prices to improve in January-June 2022, which rose by 21.53% compared to the same period in 2021, is an opportunity for Indonesia to export corn. Through intensification in the form of increasing productivity and extensification in the form of expanding new planting areas, the Government hopes to increase corn production, both to meet domestic supply and meet demand from other countries. Post harvested crops are critically point, to maintain stored product clean from any pest. occasionally eggs, larvae and caterpillars are brought during primary process of harvested and growing till adults during storage(Kartasapoetra, 1991). Major stored pest of corn is *Sithophilus maize* L or commonly known as Maize weevil. In Kenya, *S. Maize* are the most destructive stored pest with 40% loosed(Charles A.O Midega et al, 2016). Also, maize weevil are the most destructive pest in tropical countries such as Indonesia, with losses 20-90% from total healthy corn kernels (Delima,1987; Giga and Mazura, 1991).

Maize weevil mostly controlled by chemical pesticides(Dhliwayo and Pixely, 2003) rather than organic or natural pesticides, with several environmental issues such as resistance pest(Isman, 2007; Talukder, 2006). Farmers have so far depended on the use of chemical pesticides to control pests and plant diseases. Besides being expensive, chemical pesticides also have a lot of bad impacts on the environment and human health. The negative impacts of using chemical pesticides include: pests becoming resistant; new pest explosion (resurgence); accumulation of chemical residues in crop yields; killing of natural enemies; environmental pollution by chemical residues. One of promising control method is kernel fogging during storage. This method are used several communities of Indonesian, and in certain areas are compulsory method for storage corn kernels. The chemical component of fog are save health and low level concentration such as phenol and formaldehyde also 14 another chemical compounds(Soeparno, 1992; Lawrie, 1995). All those chemical compound are antibacterial and bacteria static agent which useful for kernels preservation (Winarno et al, 1980). These current research aimed to determine efficacy of fogging on corn stored kernel under Maize weevil ,*S. maize* L infestation.

## METHODS

Materials used for these research were corn kernels, husk, and adult maize weevil, *S. maize* L. The fogging makes from burning of 1 kg of drought husk under stove. One ones of healthy and free insect infestation of corn kernel were wrapped using muslin cloth and be fogging upper 50 cm of burned husk. The duration of fogging was designed 0, 15, 30 and 45 minutes. Each wrapped corn kernels was poured onto 60 ml holed plastic bottles and leaved till kernels colds. Ten adults of maize weevil were released onto bottles and tied with cover. Each treatment was three replicates. The infestation of weevils was keep in 35 days under room temperature.

The parameters observation were the level of kernel destruction which categorized as non destructive (0%), light ( $\geq 30\%$ ), middle and (31-50%) heavy ( $\leq 51\%$ ) destructive. The category non destructive of corn kernels when the condition of corn is free infestations symptom such as holes and frass on kernels. Light destructive explained kernels are small damaging such as one small hole and hard kernels. Middle destructive when we found many holes in kernels and soft kernels. And the last heavy destruction when the corn kernels in very soft, light, cracked and undefined shapes. The Collected data of number destructed kernels were analyzed using MANOVA with MS Excel 2007 version from Microsoft.

## RESULTS AND DISCUSSION

Hybrid corn seeds are designed for planted once, but because of the price very expensive compared to corn seed composites and the risk of crop failure due limited water in the second or dry season, Some farmers do the sorting of corn seeds which is good for seeds from the crop season first to serve as seed in the season drought. These types of seeds are called hybrid seeds regeneration or derivative (recycled hybrid). Corn productivity using seeds. This regeneration is for single cross hybrid seeds (single cross hybrid) decreased by about 42 percent and for three-lane cross hybrid seeds (three way cross hybrid) reduced by about 22 percent of the initial hybrid corn productivity. Fogging time to kernels give an affect to reducing of level destruction. The result are presented in Table 1. The number of non destructive kernels are highest in 0 minutes ( $256,33 \pm 16,62$ ) treatment while light category, 45 minutes are the lowest one ( $3,17 \pm 3,61$ ). This condition reflected that increasing duration of fogging are affected for decreasing insect infestation. The increasing time are simultaneously affected to accumulation of preservative chemical compound such as formaldehyde and other chemical compound. Presentation of chemical fogging from husk burning was affect for insect infestation (Oramahi, et.al, 2014).

The attacked corn kernels marked by holes and powder mixed up with grime of weevils. The heavy destruction can reduce 40% of corn's yields (Rukmana, 2008). The conditions of physical, physiological and sanitary quality of stored corn has correlation to weevils infestations (Caneppele et. al, 2003). It was considered that environmental conditions played as important role during insect infestation.

The table 1, shown also that the treatments has significant affect for level of category destruction. This condition reflected that level of weevils biological activities during treatments are differently from each treatments. From each treatment of fogging we can find the different data's between them. The non destructed kernels indicate that no more biological activities on it, while the heavy destructed indicate highly activities of weevils such as feeding.

**Table 1.** Number of corn kernel after infestation and 35 fogging treatment

Fogging time (minutes)	Destruction			
	Non destructive	Light	Middle	Heavy
0	$256,33 \pm 16,62^a$	$11,00 \pm 5,57^b$	$29,33 \pm 10,60^c$	$38,33 \pm 21,46^d$
15	$193,00 \pm 52,89^a$	$12,00 \pm 7,81^b$	$63,33 \pm 48,22^c$	$75,00 \pm 23,30^d$
30	$226,33 \pm 46,00^a$	$4,33 \pm 1,53^b$	$13,67 \pm 6,03^c$	$108,33 \pm 35,23^d$
45	$214,83 \pm 46,69^a$	$3,17 \pm 3,61^b$	$28,17 \pm 10,15^c$	$99,17 \pm 35,12^d$

Means followed by the same letter in the line do not differ by MANOVA test ( $P < 0.05$ )

The kernels conditions after fogging are point of view for weevil infestation. The heat from burning can makes microbes die and reduced water contain on kernels. Low water contain can make weevil is more difficult to destroy corn kernels (Darmadji, 1996). The loss

of water on kernels caused increasing of hardness, which affect for finding preposition of insect feeding site.

Fogging on kernel causing accumulation of formaldehyde either surface or inside kernels. Formaldehyde are able to reduce bacterial contaminated inside kernels also reduce commutation of aflatoxin which become health issue problem (Kankolongo et al, 2009; Pingali and Pandey, 2001; Smalley, 1998). In other side, fogging also prevent of wild bacterial to growth such us *Escheria coli* and *Staphylococcus aureus* (Darmadji, 2002)

Fogging also give an extra preservative which are working with formaldehyde so prevent weevil to destruct. The other impact of fogging also makes corn more acidic because of exposure to the burning chaff's smoke. It prevents weevil from attacking corn kernels, because the smoke contains carboxylic acid, formic acid, acetate acid, and butyrate acid (Winarto et al, 1980). Carbonyl also has a big impact on the formation of brown color on corn kernels. The most important component of carbonyl are aldehyde glyoxal and metal glyoxal, meanwhile formaldehyde and hydroxyacetol gave the low role. Phenol also has a good impact on the formation of brown color although the intensity is not as big as carbonyl.

Fogging can reduce water content and have anti-microbial properties (Darmadji, Supriyadi, Hidayat, 1996). Fogging is creating a color, giving the smell of smoke so that the smoked material has a longer shelf life than the non-smoked food. in corn kernels that make corn more durable along with the entry of phenol compounds as anti-microbial and formaldehyde as preservative. These compounds can simultaneously act as antimicrobials, antioxidants and give the effect of color, the distinctive taste of product smoke as soon as possible. Phenol compounds present in wood smoke are generally aromatic hydrocarbons composed of a benzene ring with a number of attached hydroxyl groups. These phenolic compounds can also bind other groups such as aldehydes, ketones, acids and esters. The antioxidative components of smoke are phenolic compounds which act as hydrogen donors and are usually effective in very small amounts to inhibit oxidation reactions (Girard, 1992). The antioxidative properties of smoke are due to the high boiling point of phenols, especially 2,6-dimethoxyphenol, 2,6-dimethoxy-4-methylphenol and 2,6-dimethoxy-4-ethylphenol. Low boiling point phenol exhibits weak antioxidative properties. Derivatives of phenolic compounds in liquid smoke which are also antioxidative are pyrocatecol, hydroquinone, guaicol, eugenol, isoeugenol, vanillin, salicyldehyd, 2-hydroxybenzoic acid and 4-hydroxybenzoic acid (Darmadji, 2002).

According to Reynold (1993), phenol is an antiseptic and disinfectant compound that is effective against vegetative forms of gram-positive and negative bacteria, some fungi and viruses but less effective against spore forms. Mounthey and Gould (1988), suggested that *Bacillus* is gram-positive and can form spores that are resistant to heat, drought and many disinfectants. The mechanism of the antimicrobial activity of phenolic compounds can be through several ways including reacting with the cell membrane which causes an increase in cell membrane permeability with the consequent loss of cell contents; by inactivation of essential enzymes or by functional destruction/inactivation of genetic material. Reynold (1993), stated that phenol at a concentration of 1% is bacteriostatic, whereas at higher concentrations it is bactericidal. (Daun, 1979).

## CONCLUSION

Based on the results of research on the effect of fuming on corn preservation and weevil activity using chaff material, that smoking using husk can reduce weevil activity and decrease the attack on corn. Because the process of smoking contains phenol and formaldehyde that can protect corn kernels from microbial attacks. And conclusion fogging are effective to control maize weevil, *S. Maize*. This study can provide information to all groups of people, especially those who work as corn farmers, corn farming families, and also does not rule out

the possibility that in the world of education the information in this study is very important considering that in the material in high school subjects there is material related to biotechnology and about this maize species.

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