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ECO_2FUME AS A QUARANTINE FUMIGANT FOR EXPORT PAPRICA, CHERRY TOMATO AND STRAWBERRY

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ABSTRACT

ECO_2FUME, a cylinderized gas formulation of 2% phosphine and 98% carbon dioxide by weight, is an alternative fumigant to methyl bromide (MB) in grain fumigation and its applications are being extended for quarantine purposes in fruit and vegetables globally. With the increasing global trades and protection of agro-ecosystem in importing and exporting counties against quarantine pest, QPS (Quarantine & Pre-shipment) fumigation in perishable commodities is much more important in terms of quality maintenance of fumigated commodities. Currently, there is limited use of MB fumigation in perishable commodities due to its reduced effectiveness at low temperatures and its phytotoxicity at ambient temperature. Phosphine gas has demonstrated higher efficacy at low temperature and less phytotoxicity to a wide range of commodities due to good penetration properties. In this paper, more systematic data are presented on application of ECO_2FUME to different Korean exported perishable commodities such as paprika, cherry tomato and strawberry, in terms of correlation between *ct*-product (concentration X time) and biological efficacy to several target pests.

Key words: Phosphine gas, ECO2fume, quarantine, methyl bromide chemical alternatives, export, paprika, cherry tomatoes, strawberry, *ct*-product

INTRODUCTION

Methyl bromide (MB) is a widely used quarantine fumigant to control different quarantine insect pests. However, quarantine use of MB is also subject to phasing out in many countries globally and the European Union (EU) has issued banning announcement of MB in 2010.

For higher standards of quarantine, insect pests that remained in fruits and vegetables must be completely controlled. However, in terms of international trade, quality maintenance of fumigated commodities is no less important than quarantine control on exportation. But methyl bromide, which is often used for fumigation of export commodities, can cause phytotoxicity on several crops. For this reason, there is increasing demand on alternatives of MB. In Korea, strawberry, cherry tomato and paprika are among the most important exported

crops. According to Rural Development Administration of Korea, the most important insect pests of strawberry are *Myzus persicae* (green peach aphid), *Aphis gossypii* (cotton aphid) and *Frankliniella occidentalis* (western flower thrips), and the most important insect pest of cherry tomato is *Bemisia tabaci* (sweetpotato whitefly), and the most important insect pest of paprika is *Spodoptera litura* (tobacco cutworm).

This study was conducted to obtain the efficacy data of ECO_2FUME on treatment of these pests in export strawberry, cherry tomato and paprika as these insects can easily remain in these export commodities in big numbers.

MATERIALS AND METHODS

Materials

Three kind of important export crops (strawberry, cherry tomato, paprika) in Korea were used for this trial. Nymph and adult stages of *Myzus persicae* (green peach aphid), *Aphis gossypii* (cotton aphid) and *Frankliniella occidentalis* (western flower thrips) were gathered at field conditions and inoculated on export strawberry for the efficacy test of phosphine. In the same way, larva and adult stages of *Bemisia tabaci* (sweetpotato whitefly) were inoculated on export cherry tomato, and larval stages of *Spodoptera litura* (tobacco cutworm) were inoculated on export paprika. ECO_2FUME (2% PH_3 + 98% CO_2) for fumigation studies was supplied by Cytec Industries via its local distributor, Dongbu Hannong Co., Ltd in Korea.

Measurement of Phosphine and Calculation of *ct*-product (concentration X time)

Concentrations of phosphine were measured at 0.5, 2, 6, 24 h after the first injection into the fumigation chamber (8.3 L glass desiccators). The gas samples were stored in gas-tight Tedlar® sampling bags before analysis. The *ct*-products (concentration x time) of the fumigant were calculated from the arithmetic average of phosphine concentration readings during the 24 h exposure period. Fumigant concentrations were determined with a gas chromatograph (Agilent 7890A, FPD, USA), fitted with a DB-WAX, FFD at 320^{o}C, injection temperature of 200^{o}C (helium as carrier gas) and oven temperature of 200^{o}C.

Fumigation Methods for Dose Response (8.3 L desiccators)

The calculated amount of phosphine was injected in gas-tight 8.3 L glass desiccators with known volume for 24 h at 2 and 10℃ for strawberry and at 13℃ for cherry, tomato and paprika. The desiccators were sealed with glass stoppers containing a septum through which the mixture gas was injected at several doses and gas samples were taken for analysis by gas chromatography. The dosage and required volume for the fumigant concentration were calculated according to Ren et al (2011). After 24 hours of fumigation, the desiccators were opened in the fume hood for aeration. Mortality of each insect was assessed under a microscope after incubation for 1 and 3 days.

RESULTS

1. Dose Response of Phosphine to *M. persicae*, *A. gossypii*, and *F. occidentalis* on strawberry

The *ct*- products (g h m^{-3}) of phosphine that achieved more than 99% mortality of nymphs and adults of *M. persicae*, *A. gossypii*, and *F. occidentalis* was 23.06 and 37.38 mg h L, 23.06 and 23.06 g h m^{-3}, 1.74 and 4.64 g h m^{-3}at 2℃ (Fig. 1), respectively; and 11.15 and 19.78 g h m^{-3}, 11.15 and 19.78 g h m^{-3}, 10.66 and 6.97 g h m^{-3}at 10℃(Fig. 2), respectively.

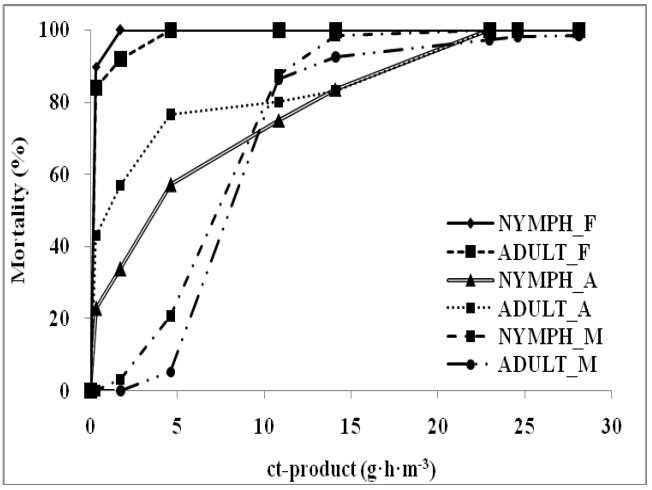

Fig. 1- Mortality of nymph and adult stages of *M. persicae* (_M), *A. gossypii* (_A) and *F. occidentalis* (_F) by phosphine fumigation on export strawberry at 2℃.

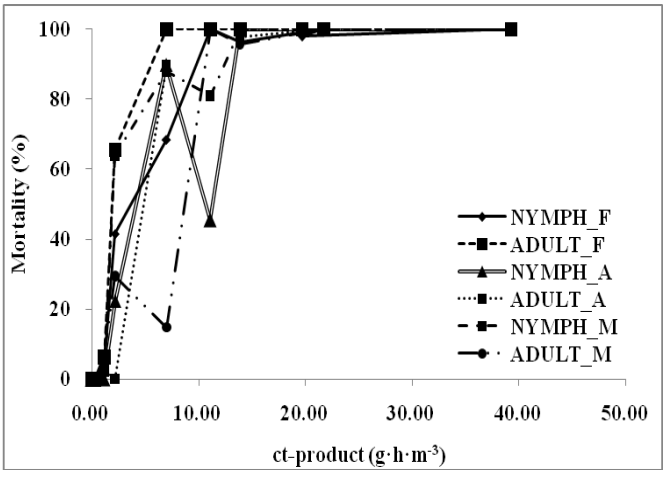

Fig. 2- Mortality of nymph and adult stages of *M. persicae* (_M), *A. gossypii* (_A) and *F. occidentalis* (_F) by phosphine fumigation on export strawberry at 10℃.

2. Dose Response of Phosphine to *B. tabaci* on cherry tomato

The *ct*-products (g h m^{-3}) of phosphine that achieved more than 99% mortality of larvae and adults of *B. tabaci* was 0.74 g h m^{-3} at 13℃. CT product of phosphine to *B. tabaci* was shown in Fig. 3.

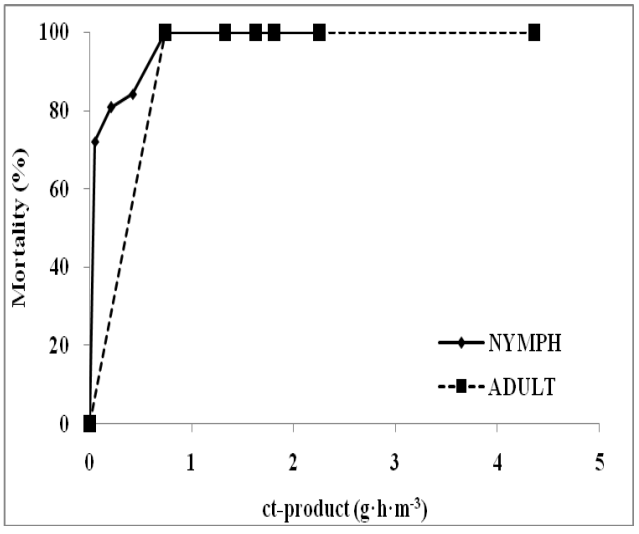

Fig. 3- Mortality of larva and adult stages of *B. tabaci* by phosphine fumigation on export cherry tomato at 13℃.

3. Dose Response of Phosphine to *S. litura* on paprika

The *ct*-products (g h m^{-3}) of phosphine that achieved more than 99% mortality of 3rd and 4th instar larvae of *S. litura* were 0.76 and 0.96 g h m^{-3}at 13°C, respectively. The *ct*-products of phosphine to *S. litura* was shown in Fig. 4.

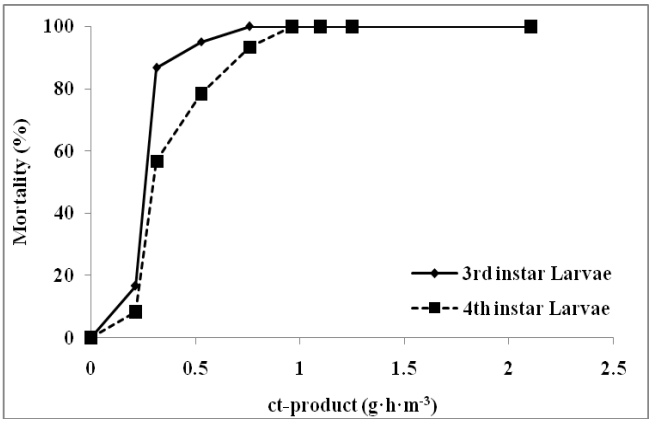

Fig. 4- Mortality of larva and adult stages of *S. litura* by phosphine fumigation on export paprika at 13℃.

DISCUSSION

Preliminary test of phosphine fumigation for export commodities in Korea was conducted in this study. The *ct*-products of phosphine at >37.38 g h m^{-3} in well-sealed fumigation chamber at 2^{o}C and >19.78 g h m^{-3} at 10^{o}C was shown to be suitable doses for controlling important insect pest of export strawberry compared to current MB applications. The *ct*-products of phosphine at >0.74 g h m^{-3} on cherry tomato and >0.96 g h m^{-3} on paprika were also suitable doses to control target pest.

Recently, there have been several studies on phosphine for postharvest treatment of several important agricultural pests on perishables. Liu (2011) reported that the mixture of phosphine and oxygen enhances the control efficacy of postharvest pests including *Frankliniella occidentalis* (western flower thrips), *Liriomyza langei* (leafminer), *Pseudococcus maritimus* (grape mealybug) and *Plodia interpunctella*(indian meal moth). Horn et al (2005) reported that high mortality of *Pseudococcus kraunhiae* was achieved at 2.1 g $m^{-3}$of phosphine after 48 h fumigation.

Phosphine from ECO_2FUME appears be a suitable alternative fumigant to currently used of MB for various exports of fresh commodities for quarantine purpose not only in terms of 100% efficacy but also without or minimal phytotoxic injury.

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