Chemical Control Effect Against Spot Clothing Wax Cicada, *Lycorma Delicatula* (Hemiptera : Fulgoridae) Nymphs and Adults

The Korean Journal of Pesticide Science Vol. 14, No. 4, pp. 440~445 (2010)

Sun-Kook Kim, Gi-Yeul Lee, Yun-Ho Shin, and Gil-Hah Kim

*Translated by Jungkun Kim (Pennsylvania State University) Sept. 2016

*See original document for figures, tables, and literature cited

Introduction

Extreme climate changes are being reported all around the world. In Korea, the average temperature increased by 1.5°C over the last 100 years, 2 times the average temperature increase around the world (Meehl et al., 2007; IPCC, 2007). This disrupts insects' habitats, causing foreign pests to invade and reproduce. Zorka sp.(leaf hopper) (Hwang et al., 2009), The spot clothing wax cicada(Kim et al., 2009), and Lycorma Delicatula(Han et al., 2008) are some examples. Lycorma Delicatula is a sub-tropical pest that feeds and lays eggs on Tree of heaven and 23 other species of host plants in China (Xiao 1991). In Korea, there are 2 species of fulgoridae, 38 species of tree and 3 species of herb that they host on reported by Doi (1932) in 1932 to be hosts for Lycorma Delicatula (Park et al., 2009). Lycorma Delicatula makes people horrified because they live as a group from moment of their birth until they lay eggs. They feed on phloem. The team found out that Lycorma Delicatula feeds on tree of heaven and grapevine over 20 minutes and survived the longest among 7 different plant species (Lee et al., 2009).

In 2006, Lycorma Delicatula only inhabited in 1 ha in the Seoul and Gyeonggi-Do areas, but it spread to 2,946 ha of 5 Si, Do and 19 Si, Gun. In 2010, the area of Lycorma Delicatula's habitat increased 8000 times over 4 years to 8,378 ha to 9 Si,Do and 48 Si,Gun (Ministry for Food, Agriculture, Forestry and Fisheries, 2010). The rapid spread of Lycorma Delicatula is becoming an issue, and control of Lycorma Delicatula is needed.

A lot of research is currently being conducted on Lycorma Delicatula. Park et al., (2009) used 5 types of insecticides including deltamethrin on Lycorma Delicatula nymphs on tree of heaven, killing over 90% of nymphs in 24 hours. Song (2010) used 11 types of insecticides on grapevines and achieved a death rate over 90% on final stage nymphs and imagoes. Seven types – 1 carbanate, 1 organophosphate, 4 neonicotinoids and 1 mixed – of insecticides are registered and used on nymphs and imagoes of Lycorma Delicatula (KCPA, 2010). On Lycorma Delicatula eggs, the death rate of the insecticide chlorpyrifos's was 100%, according to Shin et al.(2010) In China, Dryinus browni Ashmead is reported as a natural enemy of Lycorma Delicatula. Dryinus browni Ashmead lays eggs on Lycorma Delicatula's eggs and hibernates as a nymph, and emerging as an adult around May (Toshiharu 2009). Current frequent insecticide use might breed resistance to insecticides, making it hard to control Lycorma Delicatula in the future.

This experiment selected insecticides that had been proven effective against nymphs and eggs, selecting 5 insecticides from an experiment initially conducted with 26 insecticides (Shin et al., 2010). These insecticides were used on 3rd stage nymphs and imagoes to test their sensitivity to drugs, as well as the penetration and

translocation of the insecticides, the insecticides' persistence, and the effectiveness of control in quarantine to provide information that can help people select which insecticide to use to control Lycorma Delicatula.

Materials and Method

Testing Insects

3rd and 4th stage Lycorma Delicatula nymphs and imagoes were collected from vineyards in Chung-ju-Si, Yong-am-Dong, and lands near grape laboratories in Chung-buk, Ok-cheon-Gun, Chung-sung-Meon, and San-gae-Ri, during 2010 after July, and used in this experiment. Collected nymphs and imagoes were placed in a clear acrylic box sized (30 x 28 x 39cm) with sheridan grapevine and tree of heaven. The temperature of the cage was kept between 24°C and 25°C. The lighting conditions were 16L : 8D. The humidity was kept at 50%-60%.

Tested Insecticides

There were 5 insecticides used on this experiment, one type of Organophosphates, one type of Pyrethroids, 2 types of Neonicotinoids and one type of mixture insecticides. Their common names, formulation, active ingredients, and recommended concentrations are found in Table 1.

Death Rates of Nymphs and Imagoes from Insecticides

Third stage Lycorma Delicatula nymphs and imagoes were placed in a plate sized 11.5 cm in diameter and 8 cm in height. A funnel sized 10.5 cm in height, 9 cm in bottom diameter, an 2 cm in top diameter was placed on top of the plate. Insecticide diluted in the recommended concentration was sprayed 10 times then nymphs and Imagoes were placed in a different plate sized 11.5 cm in diameter and 8 cm in height.

The tree of heaven was provided and death rate was checked after 48 hours. The experiment was done 3 times, and 15 Lycorma Delicatula insects were used per experiment.

Penetration and Translocation Test

Experiments on the penetration and translocation of insecticides on grapevines were done on 90-day-old grape vines with 5-7 leaves. 4 types of insecticides and 1 type specifically targeted towards Lycorma Delicatula were used for comparison. Experiments were done by using insecticides at half, the same, and double the recommended concentrations.

An experiment on leaves was done by soaking one grapevine leaves with insecticide for 1 minute then removing the leaf from the plant after 24 hours. Then 15 Lycorma Delicatula insects were placed inside of an acrylic box sized 30 x 26 x 26cm with the grapevine. The death rate was checked after 24 hours.

Experiments on roots were done by putting 50 ml of insecticide the grapevine's soil. The grapevine was planted in a pot with a diameter of 7.0 and a height of 6.5 cm. After 24 hours, the grapevine was placed inside the acrylic box sized 30 x 26 x 26cm with 15 Lycorma Delicatula insects. The death rate was checked after 24 hours. The penetration and translocation of insecticides were tested by the death rate. Every experiment was repeated 3 times.

Persistence Test

Persistence tests of the 5 insecticides were done on Lycorma Delicatula imagoes. The same types of seedlings were used in this experiment as in the penetration and translocation experiment. Insecticides were diluted to half of the

recommended concentration, the same recommended concentration, and double the recommended concentration, then sprayed all over leaves 12 to 15 times, which were then kept for 24 hours without touching any water. The Lycorma Delicatula imagoes used in this experiment were caught in trees of heaven in Okcheon-Gun Chung-sung-Meun forest in August 2010. The team adapted imagoes for 3 days by feeding them tree of heaven, then feeding grapevine, then feeding tree of heaven and so on. 15 Imagoes were placed in an acrylic box sized 30 x 26 x 26cm with a grapevine that had been exposed to insecticides. Comparisons were done on the differences in death rate between grapevines that were exposed to insecticides 3 days ago, 7 days ago, 14 days ago, and 21 days ago. Every experiment was repeated 3 times.

Control Effectiveness in Quarantine

A control effectiveness experiment was done in the No-zi vineyard in Chung-ju-Si Yong-am-Dong, a vineyard that had never used any insecticides before the experiment. 4 types of insecticides were used on 2nd to 4th stage Lycorma Delicatula nymphs and imagoes.Experiments on nymphs were done in the beginning of July and experiments on imagoes were done in end of August. Insecticides were sprayed on the tops and bottoms of leaves as well as on insects, using a 20 L chemical control sprayer. The death rate was checked after 3 days, 7 days, and 14 days. The effectiveness of control was checked by comparing the population of sprayed sections with the population of the non-sprayed section. Every experiment was repeated 3 times once per week in a randomized block design.

Result and Contemplation

Drug Sensitivity Depending on Developmental Stage

5 types of insecticides found on the market were used (at the recommended concentration) on 3rd stage Lycorma Delicatula nymphs and imagoes collected between July and August 2010. Their drug sensitivity is shown in Table 1. Checking an insecticide's effectiveness is the most important step in controlling a pest (Kim et al., 2004; Ahn et al., 2002). Since a pest's drug sensitivity is different for each developmental stage, it is also important to spray insecticides at the most effective time in order to best control the pest population (Saito et al., 1992). Since all insecticides caused an 100% death rate on 3rd stage Lycorma Delicatula nymphs and imagoes, it is shown that Lycorma Delicatula is sensitive to all types of 5 insecticides. This result complies with Park et al., (2009) and Shin et al., (2010)'s experiment where the death rate of insecticides was 100%. Shin et al., (2010) did additional research on chlorpyrifos, which also had an 100% death rate. He recorded how the death rate of pesticide-sprayed Lycorma Delicatula eggs varied depending on during what time the eggs were collected. 98% of eggs didn't hatch when they were collected on April 20th. 71% didn't hatch when they were collected on May 10th. 48% didn't hatch when they were collected on May 15th. The effectiveness of chemical control decreased as the date of collection was delayed. Therefore, chemical control should be done before the end of April in order to best control the population.

Insecticides' Penetration and Translocation

The result of the penetration and translocation of 4 insecticides chlorpyrifos, dinotefuran, etofenprox+diazinon, etofenprox and 1 comparison insecticide, imidacloprid

on leaves and roots using half, exact, and double of the recommended concentration is shown in Fig. 1.

When half of the recommended concentration of dinotefuran, etofenprox+diazinon was used on roots, the death rate was 82.2% and 84.4% respectively. The death rate of insecticides was low. When double the recommended concentration of Dinotefuran, etofenprox+diazinon, and chlorpyrifos was used on roots, the death rate was 100%. In double the recommended concentration, there wasn't much of a difference in the death rate, other than for etofenprox. It seems like insecticides penetrate well through roots, getting absorbed by phloem and vessels.

When insecticides were used at half and recommended concentrations, the death rate was below 65%, with the exception of dinotefuran. When double the recommended concentration was used,the death rate of chlorpyrifos, dinotefuran, and etofenprox was all over 81%. Overall, insecticides' penetration and translocation was a lot more effective through roots than through leaves. The penetration and translocation rate of the comparison insecticides imidaclorpid and dinotefuran was very different, even though they were both neonicotinoid insecticides. This seems to have happened because they had different molecular weights.

Persistence of Insecticides

5 types of insecticides (chlorpyrifos, dinotefuran, etofenprox+diazinon, etofenprox, and imidacloprid) were sprayed 3 times on 90- day-s old sheridan grapevines with 5-7 leafs with half, exact, and double the recommended concentrations.

The persistency of the insecticides are shown in the Fig. 2 The persistence of Chlorpyrifos and etofenprox in double the recommended concentration decreased dramatically after 3 days. On the 3rd day, the persistence of the insecticides was each 86.6% and 80.0% respectively. However, on the14th day, the persistence was 0% and 6.6%, which was similar to plants without insecticides. Ahn et al., (2002) used Dendrobium Phalaenopsis petasl to test 11 insecticides' persistence on thrips and found that the persistence of etofenprox decreased dramatically after 3 days.

The persistence of dinotefuran and etofenprox+diazinon's remained at 100%, untill the 14th day, when used at the recommended concentration. When double the recommended concentration was used, dinotefuran's persistency was 86.6% after 21 days, and etofenprox+diazinon's persistency was 93.3%. Since dinotefuran's persistency was 86.7% after 7 days, even with only half of the recommended concentration, it can still be used effectively on grapes. When other insecticides were used at half concentration, there was barely any persistency.

Control Effectiveness in Quarantine

The results of chemical control in a closed vineyard on Lycorma Delicatula nymphs and imagoes is shown in Fig.3. The results are from experiments on penetration and translocation, and persistence. The results were checked after 3 days, 7 days, and 14 days. At the beginning of July, experiments were done on the effect of 4 insecticides on Lycorma Delicatula nymphs.On the 3rd day, the death rate of chlorpyrifos was 93.6%, dinotefuran was 99.2%, etofenprox+diazinon was 100.0%, and etofenprox was 99.5%. After 7 days, they all maintained a death rate of over 90%. The death rate of chlorpyrifos was 91.8%, dinotefuran was 96.5%, etofenprox+diazinon was

98.7%, and etofenprox was 96.0%. The insecticides were all still active after 14 days. The death rate of chlorpyrifos after 14 days was 87.0%, dinotefuran was 93.2%, etofenprox+diazinon was 93.6%, and etofenprox was 89.9%. Chemical control experiments on Lycorma Delicatula imagoes were done in the beginning of August. When chlorpyrifos and etofenprox was used on imagoes, the death rate decreased over time. After 7 days, the death rate of chlorpyrifos was 77.2% and the death rate of etofenprox was 84%. After 14 days, the death rate of chlorpyrifos was 59.1%, and the death rate of etofenprox was 61.2%. The death rate of dinotefuran on imagoes was 92.9%, even after 14 days. The death rate of Etofenprox+diazinon after 14 days on imagoes was 90.6%, which was also high. Since Lycorma Delicatula lives as a group, Lycorma Delicatula insects will stunt the current year's grapevine growth as well as next year's growth and they also suck the sap of grapevine for their life extension and secrete honeydew that causes sooty mold disease, which decreases salability (Lee at el., 2009). Therefore, etofenprox+diazinon and dinotefuran, which showed good results in persistence tests, penetration and translocation tests, and closed quarantine tests can be used at the right time to continuously control the Lycorma Delicatula population. Kim et al.,(1993) said that the use of mixed insecticides can be a good solution to not only control populations that have developed resistances to certain chemicals, but also to delay how fast insects to form a resistance to insecticides. Therefore using a mixture of insecticides that are not registered in the insecticides user guide (KCPA, 2010) with neonicotinoid insecticides will help to control the Lycorma Delicatula population effectively.