CHAPTER 2
LITERATURE REVIEW

The chilli thrips, *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae) is one of the most invasive pests due to their high degree of polyphagy, wide host range and easy dispersal on many horticultural crops. The Global Pest and Disease Database reported that *S.dorsalis* has infested more than 225 plant taxa in 72 different families and 32 orders of plants. It is important to study this pest because it is one of the greatest threats to different chilli cultivars of *Capsicum annuum* L. and *C.chinense* Jacquin. The *S.dorsalis* is one of the most important negative factors for chilli plant production in South East Asia according to a survey by the Asian Vegetable Research and Development Committee. This is also true of the aphid species *Myzus persicae* Sulzer, *Aphis gossypii* Glover and mite, *Polyphagotarsonemus latus* Banks.

2.1 Life cycle of *S. dorsalis*

The life cycle of *S. dorsalis* includes the stages of the egg, first and second instar larva, pre-pupa, pupa and adult. Depending upon environmental conditions, the female *S. dorsalis* insert their eggs inside plant tissue (above the soil surface) and eggs hatch between 5-8 days (Grimaldi et al., 2004 and Dev, 1964). There are two larval stages, the 1st and the 2nd instars that last for 6–7 days. These larval stages completely finished in 8-10 days. During this time they actively feed on the host plant. After 2.6-3.3 days, they complete the pupal stages. At this time, they do not feed on the plants.

Pupae are located in the leaf litter, on the axils of the leaves, and in curled leaves or under the calyx of flowers and fruits. Larvae and adults are mostly found near the mid-vein or borders of the damaged portion of leaf tissues. The complete life cycle of *S.dorsalis* takes about 14–20 days. The female can hatch 60 to 200 eggs in her lifetime.

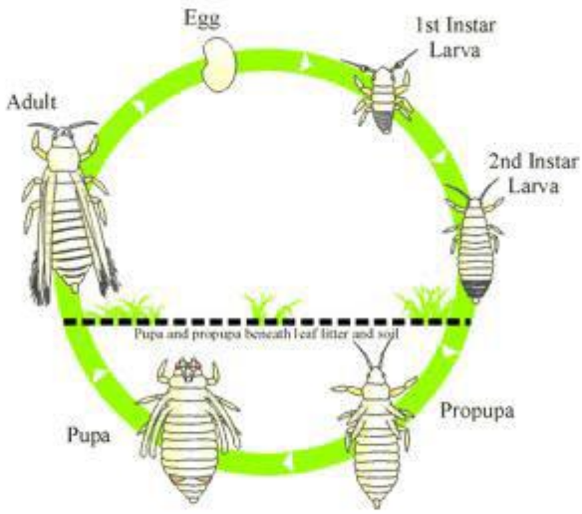

Figure 2.1a: Generalized *Scirtothrips*'s life cycle

The body of the adult *S. dorsalis* is pale yellow in color and has dark brown antecostal ridges on tergites and sternites. The size of the adults are less than 1.5 mm in length with dark wings. The head is not long but wide. The head bears closely spaced lineation and a pair of eight segmented antennae with a forked sensorium on each of the third and fourth segments. As seen dorsally on the abdomen the dark spots form incomplete stripes.

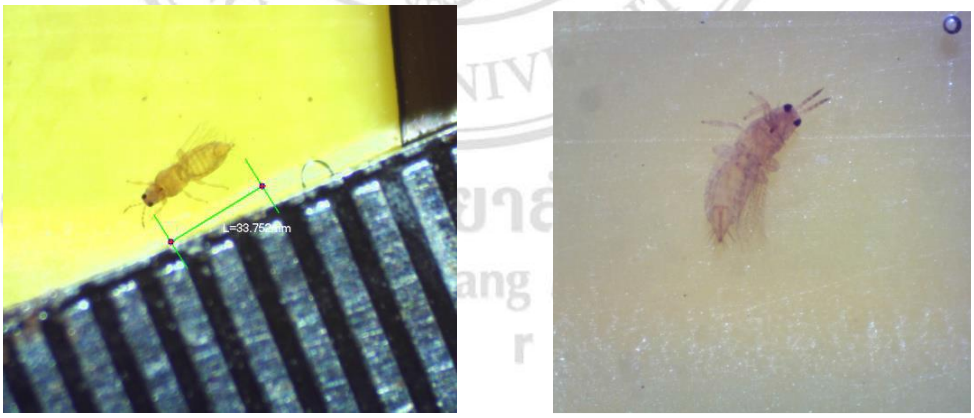

Figure 2.1b, c: The adult of *S. dorsalis* under the microscope

Holtz Z (2006) reported that the life span of *S. dorsalis* can change according to the host on which they feed. They found that it takes 11 days to be an adult from first instar larva on a pepper plant, but 15.8 days and 13.8 days can survive on eggplant and tomato plant. The generation rate is up to 8 times per year in temperate regions and 18 generations per year in warm subtropical and tropical regions. The population is higher in prolonged dry conditions than in moist rainy conditions.

The insect can grow at 9.7°C in minimum temperature and maximum temperatures as high as 33.0°C. In Japan, they start laying eggs in late March or early April when temperatures are favorable for development (Shibao et al., 1991) and first generation adults can be seen from early May (Masui, 2007). However, *S. dorsalis* cannot survive in regions where temperature remains below 4°C for five or more days (Nietschke et al., 2008).

2.2 Characteristics of chilli thrips on chill plant

The thrips prefer terminal and tender parts of the host plant and are not reported to feed on mature host tissues. Chilli thrips infestation demonstrates symptoms on the young leaves of the chilli plants, causing distortion of young leaves, discoloration of buds, flowers and young fruits. The chilli thrips, *S. dorsalis* is a piercing and sucking insect. It sucks the cell sap of the young leaves, causing the leaves to curl upward, become brittle and finally completely defoliate and yield loss.

Figure 2.2a, b: Symptoms of *S. dorsalis* on chilli plants

EPPO standard diagnosis protocols for *S. dorsalis* found that plants infested with *S. dorsalis* may show the following damage symptoms: (i) silvering of the leaf surface, (ii) linear thickening of the leaf lamina, (iii) brown frass markings on the leaves and fruits, (iv) grey to black markings on fruits, often forming a distinct ring of scarred tissue around the apex and (v) fruit distortion and premature senescence and abscission of leaves. They also carry seven plant virus diseases as vectors including chilli leaf curl virus (CLC), peanut necrosis virus (PBNV), peanut yellow spot virus (PYSV), tobacco streak virus (TSV), watermelon silver mottle virus (WsMoV), capsicum chlorosis virus (CaCV) and melon yellow spot virus (MYSV) (Ananthakrishnan, 1993; Mound et al., 1981; Amin et al., 1981; Satyanarayana et al., 1996; Rao et al., 2003 and Chiemsombat et al., 2008).

Figure 2.2c: Chilli plants infested by *S. dorsalis* in the greenhouse

The dead tissues of infested plant parts change from slivery to brown and black. The symptom of *S. dorsalis* on the host plant that show damage can be described as follows: slivery color of leaf surface, liner thickening of leaf laminar, the brown frass making of leaves and fruits, grey to black marking on the fruits, fruit distortion and premature senescence and abscission of leaves.

2.3 Sampling methods of chilli thrips

A lot of experiments have been conducted by entomologists to discover the presence of chilli thrips. The method of motoring and collection the thrips was described in Suwanbutr et al. (1992) by rinsing thrips from plant material with 70% ethanol and counted individuals collected on a fine muslin sieve. Takagi (1978) constructed at a trap make up sticky suction to monitor the flight of *S. dorsalis* and other tea pests.

Saxena et al. (1996) reported that *S. dorsalis* adults were attracted to white sticky traps. Adults also may be attracted to yellowish-green, green, or yellow boards (Tsuchiya et al., 1995 and Chu CC et al., 2006) found that that yellow sticky trap can be suggested to monitor *S. dorsalis* compared to three different blue, yellow and white colored sticky traps for the sampling of the pest. They suggested the yellow sticky card should be replaced every 7-10 days with a new one.

Figure 2.3a, b: The yellow sticky trap used in the experiment (a) and the yellow sticky trap with 16 square grids to count the number of thrips (b)

2.4 Insects and responses to UV light

Insects are able to sense Ultraviolet (UV) radiation. Some insect species such as whiteflies, thrips and aphids need UV light (primarily UV A from 320 nm to 400 nm) in order to orient themselves during the flight and to find the host plants and flower species (Kring, 1972; Rossel and Wehner, 1984; Scherer and Kolb, 1987; Greenough et al., 1990; Kring and Scherer, 1992; Goldsmith, 1993; Costa and Robb 1999). Insects have ocular photoreceptors in a bandwidth of ultraviolet (200-400 nm), visible or photosynthetically active radiation (PAR), 400-700 nm and the far red (700-800 nm) part of the electromagnetic energy spectrum (Fig. 2.4A). Antignus and Ben-Yakir (2004) found that wavelength in the UV region determine insect behaviors, such as, orientation, navigation, host finding and feeding (Fig. 2.4D). Therefore, the lack of UVA radiation affects orientation and dispersal activity of insects (Antignus et al., 2001 and Chyzik et al., 2003).

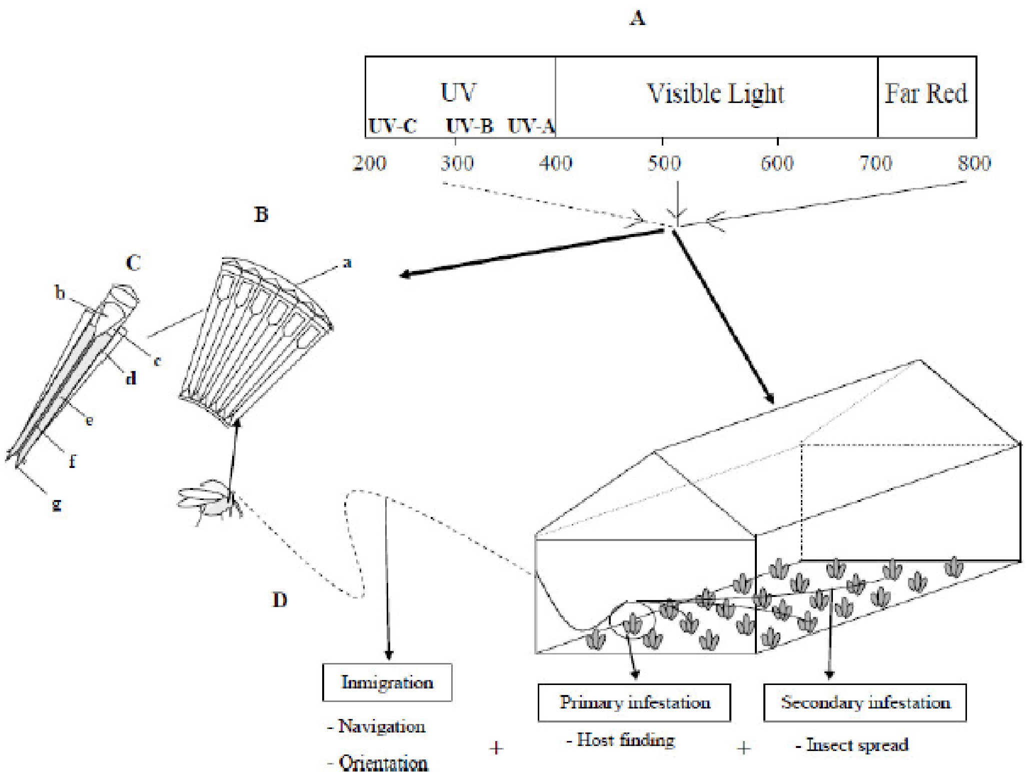

Figure 2.4 A: Different types of wavelengths of the electromagnetic energy spectrum, (B) and (C) Insect vision organs, (D) Insect colonization of protected crops. (A) Wavelengths are expressed in nanometers (nm). (B) Section of the compound eye showing a group of ommatidia and the cornea (a). (C) Diagram of a standard ommatidium showing its different parts, the crystalline cone (b), primary iris cells (c), secondary iris cells (d), retinulla (e), rhabdom (f) and nerve fiber (g). (D) UVblocking materials affecting insect orientation, navigation, host finding and the spread within a greenhouse structure.

2.5 Importance of pest control in protected cultivation systems

The use of a greenhouse is important because it allows ideal climatic and environmental conditions to exist under close supervision and control. Adverse weather conditions such as heavy rain, drought, extreme heat or cold can be avoided. Pest control is much easier to achieve and therefore, pesticide use can be reduced. Some of the problems with infestation in the greenhouse can be avoided simply by controlling the amount of UV light. Prabhat Kumar and Poehling (2006) studied these effects and concluded that fewer whiteflies, aphids and thirps entered the greenhouse that blocked UV compared with the ones having more UV intensity. Importantly, they found the thrips infestation is significantly less in the greenhouse with lower UV intensities. The greenhouse covered with UV-blocking plastic significantly reduced the pest infestation by *Basimia tabaci*, aphids and thrips (Antignus et al., 1996; 1998; 2001 and Antignus, 2000).

There are still many challenges, such as proper ventilation and the possibility of UV blockage plastic. In addition, very small sized pests such as thrips, mites and whiteflies can penetrate nets of various sizes and other barriers. A study found that thrips (*Thrips tabaci* Lindemann) can penetrate through the mesh of nets in the greenhouse (Korawan Sringram et al., 2013). Protective agriculture crops suffer important economic damage from insect pests as well as plant diseases caused by virus and their vectors (e.g. aphids, thrips, whiteflies), fungi (e.g. *Botrytis cinerea*, powdery mildew), and certain bacteria (e.g. *Clavibacter michiganensis* and *Pectobacterium* spp.). There has been a dramatic improvement in the development of pest control using plastic materials in agricultural production. It is now possible to control for the climatic conditions and weather related obstacles in greenhouse production.

Protected production has increased in the last decade with the development of new types of plastic films which have achieved a high degree of specialization with different applications and properties. At present, greenhouses are mainly distributed in two regions of the world; one of these is Asia, especially in China, Korea and Japan, with almost 80% of the total area, and in the Mediterranean region covering about 15% of the world (Espi *et al*. 2006). This protected production requires the use of 1.000.000 t/year of plastic films to cover all the protected crops grown worldwide (Espi *et al*., 2006).

In the past, the most extensive and common practice to control insect pests and plant pathogens was the application of large amount of pesticides. Photoselective plastics are a quite recent development that can block or modify the transmitted light to obtain specific benefits (Catalina *et al*., 2000). Nakagaki *et al*. (1982) reported the first evidence of the inhibitory effect of UV blocking materials on the invasion of greenhouses by insects.

In an environment with a low level of UV light, the insect vision is modified and in consequence its behavior also modified. Several studies have been conducted to evaluate the effect of this plastic materials used as nets and films to reduce insect population in protected crops. The name “UV-blocking materials” includes different plastic films and nets available in the market provided by various manufacturers with different capacities to absorb UV wavelength below 380 nm and with a proved action for reducing the damage caused by insect pests.

Presently a new family of agricultural films has been developed to manipulate their optical properties. Optical properties include the manipulation of different regions of the light spectrum that are necessary for photosynthesis and in consequence to enhance the process of plant growth and crop yield (Winsel, 2002). The same principle was used to manipulate the light spectrum in the UV region to improve pest and disease management. These types of materials act as a photoselective barrier by blocking the transmission of the UV radiation (280-400 nm) to the interior of the greenhouse (Espi *et al*., 2006). The lack of UV radiation has a positive effect on plant growth and contributes to reduce the damage due to insect pests and plant diseases.

A review of literature has revealed some intriguing results regarding thrips infestation but there is much more work to be done regarding the reduction and control of the thrips pest. The experiment being proposed by this research should make more information available for the use of pest control and minimizing thrips infestation. The goal of this study is to provide a more bountiful crop harvest and increased production.

The research is sparse regarding the influence of UV light on the chilli thrips of two different Capsicum cultivars in the greenhouse and open field conditions in Northern Thailand. Therefore, this study will be conducted with the following objectives.