Biological Characteristics of the Ginseng Stem Fungus Gnat (Phytosciara procera) and Its Environmental-friendly Control Using Modified Topping of Ginseng Peduncles

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Abstract: This study examined the biological characteristics of the insect and examined potential cultural controls using peduncle topping methods. Ginseng stem fungus gnat eggs hatched after 5 days; ecdysis lasted 3-4 weeks, and after 5 days pupation, adults emerged. Adults deposited eggs 1-2 days after emerging, and the entire life cycle lasted 32-40 days. The fungus gnats laid eggs 327 × 220 µm in size on cut planes of stems, but not on intact stem parts that had not been topped or wounded. Analyses of major weather data for the experimental areas and weather data for the past 30 years acquired from the Korea Meteorological Administration revealed that fungus gnat dispersion was prevalent under highly humid conditions and in areas with thick and frequent fogging. Among the topping times examined, fungus gnat damage to ginseng was lowest when topping occurred in late May. Among the five different topping methods evaluated on experimental ginseng farms, the cumulative fungus gnat damage to ginseng was low (0.8%) under partial peduncle topping (removal of peduncle with lateral fruit remaining) and removal of only flower buds (0.6%), with fungus gnat control effects of 82% and 86%, respectively, compared to conventional topping (removal of peduncle about 5 cm above its base). No fungus gnat damage to ginseng was observed under the no-topping treatment. These results suggest that partial topping of peduncles, while letting lateral fruits remain, is a potentially environmentally friendly method of controlling the ginseng stem fungus gnat.

Key words: Phytosciara procera, ginseng stem fungus gnat, environmental-friendly control

INTRODUCTION

Ginseng (Panax ginseng C. A. Meyer) is a large income crop that is highly prized for its medicinal properties. Commercial markets of 6-year-old ginseng have been enlarged to provide raw materials for the production of red ginseng. In ginseng cultivation, especially that of 6-year-old ginseng, the ginseng plants are exposed to various diseases and insect pests for a long period of time. Several fungi (Cylindrocarpon destructans) and the bacterial pathogens (Erwinia Pseudomonas, and Agrobacterium) are important causes of disease in ginseng [1-3]. Insect pests including four species of Lepidoptera, five species of Coleoptera, one species of Homoptera, three species of Orthoptera, and one species of Diptera are also known to cause ginseng damage [4]. Among these insect pests, the ginseng stem fungus gnat, Phytosciara procera, of the order Diptera, has been recently renamed based on detailed descriptions [5], although this insect was first observed to cause ginseng damage in Yongin in 1993 [4].

The stem fungus gnat deposits eggs on cut planes or other wound sites usually produced during the topping of ginseng peduncles, a method used for removing flower buds to prevent seed formation, thereby promoting the vegetative growth (root growth) of ginseng rather than reproductive development. Larvae of the ginseng stem fungus gnat, once hatched, damage internal ginseng tissues, which are then vulnerable to secondary infections of soft rot pathogens such as Erwinia carotovora subsp. carotovora, the causal agent of ginseng stem rot, rapidly enhancing the development of rot symptoms [5].

Insect pests are usually controlled using chemical pesticides, but the use of agrochemicals is limited in ginseng cultivation because of ginseng’s widespread use as a health food. The larvae of the stem fungus gnat develop inside the peduncles or stems, which makes it difficult to
detect the initial damage and even to control the insect using chemical pesticides after detection. Therefore, the goals of this study were to examine the growth, development, and reproduction of the ginseng stem fungus gnat in relation to environmental conditions and to identify a potentially environmentally friendly cultural control method by optimizing the timing and method of peduncle topping.

MATERIALS AND METHODS

Life cycle of the ginseng stem fungus gnat on selected experimental farms

Five- and 6-year-old ginseng fields in Yeongwol and Cheolwon, South Korea, respectively, were selected as experimental farms. Ginseng stem fungus gnats had been found in the fields in the previous year (2007) and larvae at the stage just before emergence were found on the basal stems of ginseng plants in April 2008. To study the fungus gnat life cycle, ginseng stems infested with fungus gnat larvae were collected from the experimental plots and placed in polyethylene containers incubated at 25 ± 1°C and a relative humidity of 75 ± 1% under 12-h light and 12-h dark conditions.

Oviposition characteristics of the ginseng stem fungus gnat

Oviposition characteristics of the ginseng stem fungus gnat, including preferred egg-laying locations and times, were examined. To examine the effect of peduncle topping on oviposition, 10 adults were inoculated on ginseng stems or peduncles with or without cuts on one side, and eggs laid by the insects on the cut planes, wound sites, and surfaces of stems and peduncles were observed with the naked eye and under a compound light microscope (Optiphoto-2; Nikon, Tokyo, Japan). To examine the effect of peduncle topping at different peduncle growth stages on fungus gnat oviposition, samples of the lower, middle, and upper portions of peduncles were collected at 10-day intervals from early May through early June from three different ginseng varieties (Jakyeong, Cheonpoong, and Yeonpoong) grown in experimental ginseng fields at the KT&G Central Research Institute in Suwon, South Korea. Hardness of the peduncle samples, which may have had an effect on stem fungus gnat oviposition, was measured using a Com- pac-100 rheometer (Sun Scientific Co., Ltd., Tokyo, Japan).

Peduncle topping methods and the occurrence of ginseng damage by the ginseng stem fungus gnat

Five different topping methods were applied in the experimental ginseng farms at Cheolwon and Yeongwol to examine the effects of topping on the occurrence of fungus gnat damage on ginseng: conventional topping (removal of peduncle about 5 cm above its base), partial topping (removal of the peduncle with lateral fruit remaining), main fruit topping (removal of the main fruit with the rest of the peduncle remaining), complete topping (removal of the entire peduncle), and no topping (peduncle not removed) (Fig. 1). Toppings were performed starting in late May, and fungus gnat damage to ginseng was examined at 10-day intervals from early June to examine the potentials of the topping methods to control the ginseng stem fungus gnat.

RESULTS AND DISCUSSION

Life cycle of the ginseng stem fungus gnat

Ginseng stem fungus gnats collected from the affected ginseng fields were reared in vitro with ginseng stems as food to examine the insect’s life cycle. It took 5 days for the larvae to hatch from the eggs. The larvae grew through ecdysis by feeding on ginseng stems and turned yellow just before pupating, with the larval stages from egg hatching to pupation taking 3-4 weeks (Fig. 2). Adult fungus gnats emerged from pupae after 5 days of pupation...