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Beet Armyworm *Spodoptera exigua* (Lepidoptera: Noctuidae): a Major Pest of Welsh Onion in Vietnam

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Abstract

The beet armyworm *Spodoptera exigua* is known as a pest of Welsh onion or green bunching onion, an important fresh vegetable in many Asian countries. Here, a survey was conducted in farmers' fields to investigate the infestation of green bunching onion by the beet armyworm in relation to plant growing stages. Although the infestation levels differed among study fields and between seasons, high levels of infestation were often detected, indicating that chemical control did not work well. All growing stages of onion were attacked by the armyworm though there was a positive relationship between plant heights and infestation levels. The youngest class of stages, i.e., seedling, was much less frequently damaged. The results indicate that the management of the beet armyworm including IPM practices is essential to stable production of marketable Welsh onion.

Keywords:*Allium fistulosum,* crop pest, cartap,integrated pest management

1. Introduction

Welsh onion, *Allium fistulosum,* is known as Japanese bunching onion or green bunching onion. It is a perennial crop widely cultivated throughout the world where it is grown as an annual (Larkcom, 1991; Davies, 1992). In Vietnam and other Asian countries, Welsh onion is an important seasoning vegetable or flavoring herb or even a medical plant, which is of high commercial value (Dan and Nhu, 1989).

Pest control is crucial to stable production of marketable Welsh onions. Chemical control, i.e., the use of synthetic pesticides, is currently the sole measure (except 'hand-picking') for controlling pests of Welsh onion in Vietnam (Ueno, 2006). However, relying exclusively on chemicals can cause the resurgence of pest populations and the development of pesticide-resistance, making chemical control ineffective (Pimentel, 1997; Dent, 2000).

The beet armyworm *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae) is known as a cosmopolitan pest of many crops though it is native to southern Asia (CAB, 1972; Capinera, 2001). Infestation by this pest is often serious in subtropical or tropical regions (Burris et al., 1994; Zheng et al., 2000). Insecticide resistance is a major problem in the management of the beet armyworm because it has developed resistance to many insecticides (e.g., Burris et al., 1994; Moulton et al., 2000; Ahmad, M. and Arif, 2010; Lai and Su, 2011; Su and Sun, 2014).

The beet armyworm is commonly a serious pest of Welsh onion in many Asian countries (Kao and Tsai, 1989; Wakamura and Takai, 1992; Zheng et al., 2000; Ueno, 2006). Recent survey has shown that beet armyworm is one of the most damaging pests of Welsh onion in Vietnam (Ueno, 2006). However, the biology of the beet armyworm in Welsh onion fields and the extent of damage caused by the armyworm have not fully been examined in Vietnam and other Southeast Asian counties.

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Here I report the extent of Welsh onion infestation by the beet armyworm in Central Vietnam, specifically, in relation to plant growing stages. The results show the management of the armyworm is essential to stable production of marketable Welsh onions. I discuss the importance of IPM practices and the use of proper insecticides for the beet armyworm management.

2. Materials and Methods

Study was conducted in spring (February 22th-March 7th) and summer (July 3rd-17th), 2005, in Hue City, ThuaThien Hue Province, Central Vietnam, where Welsh onion is a year-round vegetable. All onion fields investigated in the present study were conventional farmers' fields. Farmers sprayed insecticides once or twice a week. Cartap was the sole insecticide used in onion fields surveyed, and no herbicides or fungicides were applied. Mixed cropping was the general rule; corn, lettuce, green mustard, soybean, snap bean, sweet potato, and chrysanthemum were also grown around the study fields.

Beet armyworm infestation was examined by inspecting individual onion plants in the field. When scouting fields, each field was sampled at a minimum of four points. Up to a total of 60 plants per field with 10-15 plants per inspection point were sampled. Skeletonization of onion leaves was characteristic of the beet armyworm damage, and the presence the pest was readily recognized. During the survey in summer, the height of selected plants was also measured as an index of growing stages of onion. In all, 12 and 24 onion fields were surveyed in spring and summer, respectively. Data were analyzed with the aid of JMP ver9.0 (SAS, 2010).

Figure 1: Beet armyworms and the infestation on green onion. An early instar on a leaf (left), a skeletonized leaf inside which a middle instar is present (middle) and a middle instar inside the leaf (right).

3. Results

Beet armyworms were abundant in the study fields. The early instar stages, i.e., 1st and 2nd instars, were found on onion leaves whereas middle stage instars were often detected inside the cylinder shape leaves (Figure 1). The presence of middle stage or later stage of beet armyworms was usually associated with skeletonized leaf damage (Figure 1). However, the populations markedly differed between spring and summer seasons. In spring, the infestation caused by the beet armyworm was generally severe and was found in all onion fields surveyed. The mean proportion of onion plants infested by beet armyworm was 0.42 ± 0.05 (SE). Beet armyworm infestation was also detected in all fields surveyed in summer but the mean proportion of onion plants infested was 0.12 ± 0.03, the value of which was lower that that in spring; a significant difference in infestation levels was detected between the seasons (Figure 2) (Wilcoxon's test; df =1, x^2= 8.49, P = 0.0036).

For the data collected in summer, the relationship between the plant height and the infestation level (the proportion of onion plants damaged) was examined because the onion growth stage differed markedly among the fields surveyed in summer; a highly significant positive correlation was detected between the two (Figure 3) (regression analysis; n = 24, df = 1, r^2 = 0.55, F = 27.19, P< 0.0001). Damage caused by the beet armyworm was more severe in onion fields with later growth stages

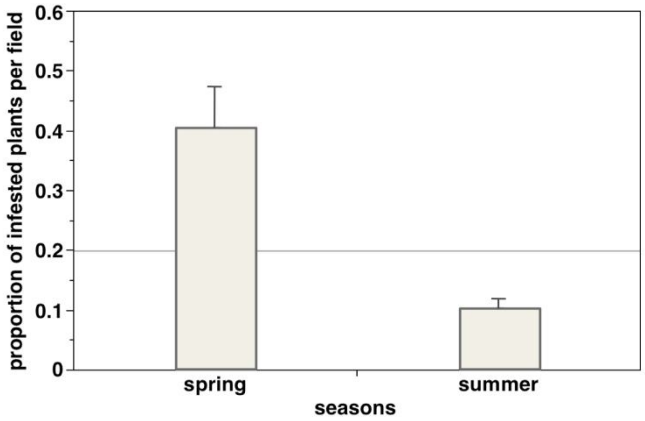

Figure 2: Beet armyworm infestation in spring and summer season. The proportions differ significantly (Wilcoxon's test; *P*< 0.005).

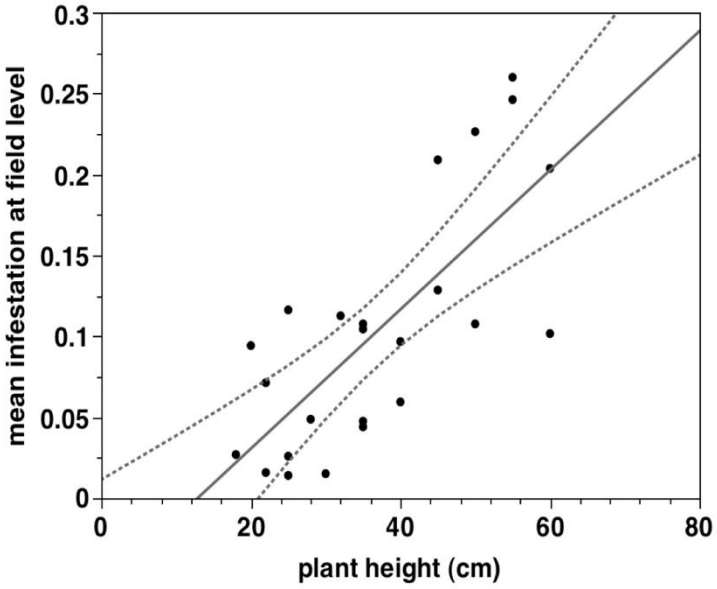

Figure 3: Relationship between plant growth stage and armyworm infestation. A significantly positive relationship is detected (regression ananlysis; P < 0.0001).

4. Discussion

The present study has revealed the current status of the beet armyworm in Vietnam and indicated the importance of beet armyworm control in Welsh onion production, highlighting the problems associated with uncontrolled and indiscriminate use of insecticides for managing the beet armyworm. IPM practices would therefore be required.

Repeated applications of chemicals are evidently ineffective in controlling armyworm numbers on Welsh onion in the field. *S. exigua* shows strong resistance to many insecticides, and insecticide applications can induce outbreak of this pest (Eveleens et al., 1973; Ruberson et al., 1994; Ueno, 2006; Knutson et al., 2011).

However, Cartap, the most frequently used pesticide, is generally thought to be a chemical tool against which resistance is difficult to develop (but see Cheng, 1988; Siqueira et al., 2000). It is thus not clear whether Vietnamese armyworms have developed resistance to cartap. A possible reason is that cartap, which is water-soluble, may not sufficiently be applied on the waxy leaf surface of onion and that frequent rainfall may wash out the chemicals before they become effective. Also, part of the reasons may lie in the fact that beet armyworms often enter the inside of the onion leaf; the armyworms can have less chance to contact the pesticides applied.

Several natural enemies attack the beet armyworm on Welsh onion (Ueno, 2006, 2015). However, the present study strongly suggests none are effective enough to provide reliable control in onion fields. Because of repeated applications of pesticides, natural enemies should have been excluded from the field. Together with possible resistance, detrimental effects of chemicals may be responsible for the increased population and damage in conventional fields (Eveleens et al., 1973; Ruberson et al., 1994; Knutson et al., 2011). It is not known whether natural enemies can provide good control of the beet armyworm if selective insecticides are used. Future studies should examine the impact of native natural enemies on *S. exigua* populations in non-sprayed fields.

The present results have also shown that growing stages of Welsh onion affect the extent of armyworm infestation. The positive relationship between plant height and infestation level or armyworm numbers may arise because younger plant stage is less attractive to adult moths searching for an oviposition site. During the survey, I did not find any case in which the beet armyworm caused serious stand loss or mortality of onion seedlings. However, onion plants of seedling stage, which have 2-3 thin leaves, may not tolerate strong feeding pressure by the beet armyworm. If the beet armyworm occurs in density beyond the level reported here, it can cause severe stand lost. Control of the armyworm would be important throughout all stages of green onion.

Although there are several effective methods to control beet armyworm such as sex pheromones and new insecticides (e.g., Wakamura and Takai, 1992; Burris et al., 1994; Dhadialla et al., 1998; Kerns, 2000), they may be unacceptable in Vietnam because the cost is too high. Future investigation should address proper, preferentially selective, chemicals that are reasonable enough for Vietnamese farmers and examine the usefulness of native tolerant varieties and natural enemies (Ruberson et al., 1994; Zheng et al., 2000; Knutson et al., 2011).

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