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The Paper wasp *Polistes olivaceus* (Hymenoptera: Vespidae) as an Important Predator of Beet Armyworm in Vietnam

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Abstract

Beet armyworm *Spodoptera exigua* is known as a pest of Welsh onion or green bunching onion in many Asian countries. Control of the armyworm solely by insecticides is often difficult. In the present study, a field survey was conducted to search natural enemies of the armyworm in the onion fields in Vietnam. Macao paper wasp *Polistes olivaceus* was found to be the most prevalent predator attacking the beet armyworm in summer. The wasp was detected rarely during early mornings but the number of wasps flying into onion fields increased during the daytime; they actively searched and predated the armyworm. The wasp was more abundant in onion fields with later plant growth stages where more armyworms were present. Conservation biological control together with other IPM practices may be useful in beet armyworm management.

Keywords: Pest management, vegetable pest, biocontrol, *Allium fistulosum,* social wasps

1. Introduction

Welsh onion *Allium fistulosum,* commonly known as Japanese bunching onion or green bunching onion, is a perennial crop widely cultivated in Asia (Larkcom, 1991; Davies, 1992). It is an important seasoning annual vegetable or flavoring herb or even a medical plant, which is of high commercial value (Dan and Nhu, 1989). Beet armyworm *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae) is a major pest of Welsh onion in Asia (CAB, 1972; Capinera, 2001) and also in Vietnam (Ueno, 2006, 2015).

Recent survey has shown that beet armyworm is one of the most damaging pests of Welsh onion in Vietnam (Ueno, 2006). Although the use of synthetic pesticides is currently the sole measure (except 'hand-picking') for controlling pests of Welsh onion, chemical control measures were not found effective in the country (Ueno, 2006, 2015). Integrated pest management is thus crucial to stable production of marketable Welsh onions.

Use of natural enemies, i.e., biological control, is one the main approaches upon constructing pest management strategy (Jervis and Kidd, 1996; Pimentel, 1997; Dent, 2000). Numerous species of natural enemies, such as parasitoids and predators, are usually associated with a pest concerned. However, the composition and abundance of natural enemies can vary depending on the regions and localities. Field survey is therefore essential to investigate the incidence and abundance of natural enemies in a given region or locality and to assess their potential role in pest management.

In Vietnam, very few studies have focused on natural enemies of beet armyworm, and little information is available on the extent to which natural enemies play a role in suppressing the armyworm populations. Here I report that Macao paper wasp *Polistes (Megapolistes) olivaceus*(De Geer) (Hymenoptera: Vespidae) is one of the main natural enemies of beet armyworm in Vietnam.

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I confirmed frequently predation of the armyworm by the wasp during the field survey. The findings suggest that conservational use of such a predacious natural enemy may be included in the management strategy of beet armyworm.

2- Materials and Methods

Field surveys were conducted in spring (February 22th-March 7th) and summer (July 3rd-17th), 2005 at Hue City in ThuaThien Hue Province, Central Vietnam, where welsh onion is a year-round vegetable and is widely cultivated. In the present study, 12 and 22 small-scale conventional fields of green onion were surveyed in spring and summer, respectively. Cartap was the sole insecticide applied in the onion fields while no herbicides or fungicides were used. Preliminary observations showed that infestation by beet armyworms was detected in all study fields, regardless of the seasons and insecticide applications.

During the field survey in spring and summer, natural enemies were searched visually and recorded. In summer, paper wasps flying around the onion fields were collected for identification. Although two species of paper wasps were detected, *Polistes olivaceus* occupied the majority (more than 95%) of the wasps and was readily distinguishable, on the basis of body color, from the other rare species. Then, instant visual identification of wasps was made in the field thereafter. Sampling was done with visual counting of the paper wasps for 9 days in fine weather day. When scouting fields, each field was walked 10m along the footpath or the margins. Because of the size and color (bright yellow), the wasps foraging in the field were easily detected. For each field, visual sampling was made 17-46 times from early in the morning (AM 6:30) to late in the afternoon (PM 18:00). When wasps landed and searched on onion plants, their behavior was directly observed. When the wasp predated an armyworm, the event was noted. The height of selected plants was also measured as an index of growth stages of onion.

3- Results and Discussion

During the survey, no major insect natural enemies could be detected, except paper wasps. Although some parasitoids were found, the majority of natural enemies observed were the paper wasp *Polistes olivaceus.* The wasp was frequently found to land on onion leaves infested by beet armyworm, searching for armyworms (Figure 1).

Figure 1: Foraging and predating behavior of *Polistes olivaceus* in the onion field. The wasp worker caste searching armyworms while flying (left), chewing an onion leaf to pick up an armyworm hiding inside the leaf (middle) and chewing the prey into a portable ball to bring it back to the nest (right).

The number of paper wasps markedly differed between the spring and summer seasons. In spring, no paper wasps were found in onion fields whereas in summer, the number was quite high. Numerous *P. olivaceus* was observed in all onion fields surveyed in summer; in all, 709 times of visual counting were made, and 451 waspworker castes were recorded. The incidence and abundance of the wasp depended on the time in day. The mean number of wasps in each field differed among the time of observations (Figure 2) (ANOVA; df = 21, $F = 2.86$, $P < 0.0001$). During early in the morning, the wasp was rarely observed in the field.

However, after 8:30 in AM, the number of *P. olivaceus* quickly increased and was peaked just before noon. During the noontime, when the temperature was very high, the activity was once low, and again became high. Then, it was lowered after 17:30 in PM.

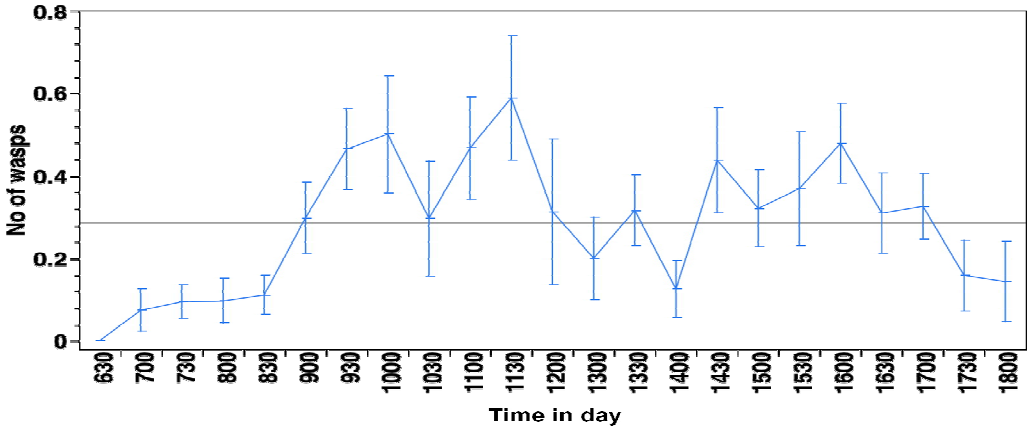

Figure 2: Daily activity of *Polistes olivaceus* in green onion fields during the summer season. Data are shown as mean ± SD. A horizontal line indicates the grand mean.

Most of the observed *P. olivaceus* frequently landed on onion leaves where the infestation by beet armyworm was present, and searched their target. When the wasps detected the armyworm, they captured the armyworm on the onion leaf or hidden inside the leaf. During the field survey, 14 out of 451 wasps (3.1%) successfully predated beet armyworms. There was no other case in which *P. olivaceus* predated insects other than beet armyworm. Thus, *P. olivaceus* workers evidently gathered into onion fields to capture beet armyworm. Given the number of *P. olivaceus* flying into the field, the accumulated predation pressure by *P. olivaceus* would be very high though the instant predation success was 3.1%.

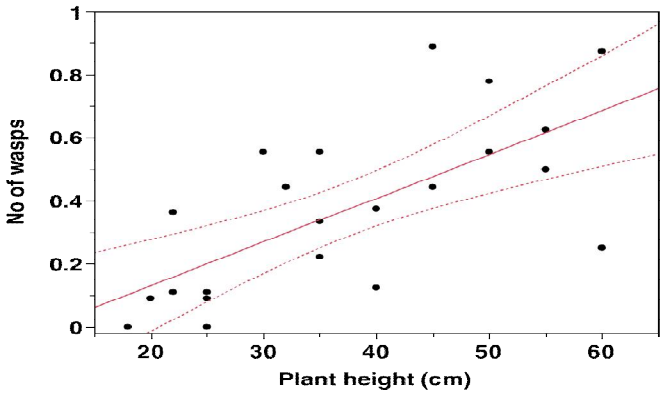

Figure 3: The relationship between the mean heights of onion plants at each field level and the mean numbers of *P. olivaceus* recorded for each field between AM 9:00 and PM 13:00. The regression line (solid line) and 95% confidence lines (dotted lines) are shown.

Because the number of *P. olivaceus* recorded was variable among the study fields, its relationship with plant stage was examined using the data collected between 9:00 AM and 13:00 PM. The mean number of *P. olivaceus* wasps observed in an onion field was positively correlated with the mean height of onion plants in that field (Figure 3) (regression analysis; n = 22, df = 1, r^2 = 0.47, F = 18.33, P = 0.0003). This result suggested that *P. olivaceus* attracted more to onion fields with later growth stages. The beet armyworm density is positively affected by plant height (Ueno, unpublished). The observed relationship between *P. olivaceus* abundance and onion plant height would emerge because beet armyworm density is higher in onion fields with later plant growth stages.

Although social wasps belonging to Vespidae are often recognized as an important group of natural enemies (Waterhouse, 1998), very few studies so far have examined whether *P. olivaceus* is an important natural enemy of pests in Asia. The present study has demonstrated that *P. olivaceus* is a main predator of beet armyworm in Welsh onion fields. This wasp is widely distributed in subtropical and tropical regions of Asia, including India, China, Taiwan, Vietnam, Borneo and Philippines (also introduced accidentally to other regions like Hawaii, Fiji, Madagascar, and Seychelles) (Harris, 1979; Yamane and Yamane, 1979; Kuhlmann, 2006). Despite of its widespread occurrence, the role of *P. olivaceus* in suppressing pest populations is not known; future studies should focus on this subject.

This study has shown that paper wasp abundance depend on seasons. This is simply because the nest size and number of wasp workers in summer are much larger than those in spring, explaining the rarity of the wasp in spring. Hence, effective predation of beet armyworm by *P. olivaceus* can be limited to summer seasons. Even so, conservational use of the wasp may be considered if it is possible at low cost. It is however evident that any single practice alone would not provide reliable and effective control. Given the highly developed resistance of beet armyworm to many pesticides (Ruberson et al., 1997), practices together with chemical control are needed. The combination of measures, such as crop spacing, resistant crop variety, conservation of natural enemies, etc., should allow practical and economically enough armyworm management in onion production (Pimentel, 1997; Dent, 2000).

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