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Status of the major insect pests of squash plants at fruiting stage

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ABSTRACT

Squash is a common cucurbitaceous vegetable in tropical and sub-tropical regions that is infested by a wide variety of insect pests. Therefore, the experiment was conducted to assess the status of insect pests in three different squash varieties *viz*., Pahu, Ahung, and SQ10 during the reproductive stage. It was observed that the total number of insect pests in the Pahu variety was significantly higher than Ahung, and SQ10. During the fruiting stage, 10 insects have been identified as harmful, while 6 were recorded as beneficial. The harmful insects were the blue pumpkin beetle, red pumpkin beetle, green long-legged fly, fruit flies, ants, blowfly, butterfly, grasshopper, house fly, and mosquito. The blue pumpkin beetle was significantly higher than all other insect species in all the varieties followed by the green long-lagged fly, the red pumpkin beetle, and fruit flies. Meanwhile, the number of butterflies and blowflies were the lowest of all the varieties. The ladybird beetle, hoverfly, tachinid fly, bumble bee, and honeybee were the most common beneficial insects found in squash fruits. However, a significant difference was observed among the beneficial insects, and the number of ladybird beetles was significantly higher than that of other insects, regardless of the variety. Therefore, the variety Pahu is considered the most susceptible to insect pests compared to Ahung and SQ10.

Keywords: Squash variety, reproductive stage, beneficial insects, fumigation

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1 Introduction

Vegetables are good sources of proteins (peas, beans and garlic), vitamins (tomato, carrot, peas, garlic, green chillies and cole crops), minerals (drumstick pods) and carbohydrates (leguminous vegetables, methi, potato and sweet potato) (Kunjwal and Srivastava, 2018). Many of the vegetable crops, such as onion and garlic, possesses high medical value (Harris et al., 2001) that helps to reduce the risk of heart disease, stroke, certain types of cancer, gastrointestinal issues, high blood pressure, eye disease and many more. Insect pests are one of the major constraints in vegetable produciton throughout the world (Neupane et al., 2021; Sarker et al., 2020). The total worldwide food and preharvest losses due to insect pests, plant pathogens and weeds were estimated to be about 45% (of total food production) and 30%, respectively (Pimentel and Levitan, 1986). Among them, herbivorous insects are responsible for damaging one-fifth of the world's total crop production annually (Kunjwal and Srivastava, 2018).

Squash (*Cucurbita pepo* L.) is a popular cucurbitaceous vegetable that is grown in a number of countries as a human food source (Abou El-Saad et al., 2020). It is a highly essential vegetable crop grown throughout the world, particularly in tropical and subtropical regions (Paris, 1996). It has several pharmacological effects as antihypertensive, antidiabetic, antitumor, antibacterial, antimutagenic, immunomodulating, antalgic, antiinflammation and in-

testinal antiparasitic effects (Bannayan et al., 2011). In terms of fresh consumption, squash is one of the most important crops (A. et al., 2017). Despite its importance, squash production is strongly affected by insect pests (Sarwar, 2014). According to Hegab (2018), several insect pests attack squash during the growing season which decreased its yield. This crop may be infested by some insect pests throughout the entire cultivation period, resulting in 80% of the crop being damaged (Rahman and Uddin, 2016). As a result, farmers are discouraged from cultivating this crop, resulting in lower yields (Parajuli et al., 2020).

Squash is vulnerable to several chewing and sucking insect pests such as cucurbit fruit fly, red pumpkin beetle, flea beetle, whitefly, melon aphid, squash bug and squash lady beetles which are the most problematic that causes significant quality and yield loss (Kaiser and Ernst, 2018). Besides, the striped cucumber beetle and squash bug is the most prevalent insect pest on squash crops, which causes remarkable yield loss (Clifton, 2006). It is estimated that the red pumpkin beetle and the cucurbit fruit fly cause yield losses of up to 30-100%, depending on the season and cucurbit species (Hassan, 2012). Squash plants are severely infested with various sucking pests (melon aphid, whitefly, onion thrips and green leafhopper) from seedling to harvest, causing extensive damage not only by sucking plant juice but also by the transmission of pathogen and decrease in yield (Hayam, 2020; Garzón et al., 2016). Squash is highly susceptible to insects such as cucurbit fruit flies at reproductive stage, which are extremely destructive and serious pests (Sapkota et al., 2010). As a result of this pest, the yield, quality, and marketability of squash are significantly reduced (Wazir et al., 2019).

Cultivated area of squash increased during the last five years in Sylhet region of Bangladesh, both in open and protected plantations. Only a few research have been documented on squash pests. So, it is very important to observe the insects during reproductive stage. We also need to recognize the major harmful and beneficial insects for management of squash. Therefore, we investigated the harmful and beneficial insects of squash during its reproductive stage.

2 Materials and Methods

2.1 Experimental design and layout

This study was conducted in Entomology Research Field of Sylhet Agricultural University, Sylhet (Fig. 1). Field plots measured 10.4 m × 10.4 m and was separated from adjacent plots by 7.6 m of bare soil on all sides. Experimental plots were prepared and fumigated with methyl bromide 80/20 formulation (80% methyl bromide, 20% chloropicrin). Fumigation was done as a standard procedure for planting squash to kill soil pathogens, weeds, and nematodes. Two weeks before planting squash, the fumigant was injected into the soil. Treatments were arranged in randomized complete block design with 5 replications.

2.2 Treatments

Three treatments were evaluated in this study. Two different plants of each plot were randomly selected and considered as one replication. One advanced line (SQ10) and two hybrid variety (Ahung and Pahu) were used as treatment. Advanced line (which is developed from Department of Genetics and Plant breeding, Sylhet Agricultural University) and two hybrid varieties from companies (Nongwoo Bio Co. Ltd. and Farm Hannong Co. Ltd.) were collected.

2.3 Seedling raising and data collection

The seeds were sown in the pot at the end of the November. After seed germination, the plants were transplanted in the main field. Four plants were planted in a plot maintaining 60 cm plant to plant distance. All recommended agricultural practices were applied during the growing seasons except using chemical control. The harmful and beneficial insects of squash was identified in the field during fruiting stage from February to mid-March. The field was inspected, and insects were collected during fruiting stage of squash. The insect collection was done in the afternoon from 12.00 p.m. to 13.00 p.m. using sweeping net. These identified insects were transferred from the field to the laboratory of Entomology by using plastic bag. The microscopic insects were observed by the aid of a binocular microscope. The collected harmful and beneficial insects were carefully observed and counted. The daily data procured from net sweeping was used to prepare the list of insect fauna in Microsoft Excel.

2.4 Statistical analysis

Obtained data was statistically analyzed by applying the analysis of variance (ANOVA) using GenStat (VSNI 19th edition). Tukey's test was used to compare the means of harmful and beneficial insects' number among the treatments. $P<0.05$ was considered as statistically significant.

3 Results

3.1 Variation of insect diversity

The variation of insect diversity in three variety of squash plants are presented in Fig. 2a. The total number of different insects were found highest ($p<0.001$) in Pahu followed by Ahung whereas SQ10 showed the lowest number of insects. The insect number was also affected ($p<0.001$) by insect type (Fig. 2b). We

Figure 1. Study site shown on map of Sylhet Sadar Upazila, Bangladesh

found 16 different insects where blue pumpkin beetle was found to be highest, followed by green long lagged fly and red pumpkin beetle.

3.2 Insect diversity in Ahung variety

Ten different insects were classified as harmful, whereas the other 6 types remained as beneficial. The diversity of both harmful and beneficial insects in the Ahung variety of squash plants is shown in Fig. 3a and Fig. 3b, respectively. Among the harmful insects, the blue pumpkin beetle was found to be highest ($p<0.001$), followed by red pumpkin beetle whereas blow fly and butterfly both were found lowest (Fig. 3a). In contrast, the abundance of beneficial insects was found higher ($p=0.003$) for ladybird beetle compared to hover fly, bumble bee and pollinators which were similar, whereas the number of honeybee and tachinid fly were intermediate (Fig. 3b).

3.3 Insect diversity in Pahu variety

Among the harmful insects, the blue pumpkin beetle was found to be highest ($p<0.001$), followed by green long lagged fly and fruit fly, whereas the number of blow fly and butterfly both were found lowest (Fig. 4a). In contrast, the abundance of beneficial insects was found higher ($p<0.001$) for ladybird beetle compared to pollinators, bumble bee, honeybee, hover fly and tachinid fly which were comparable (Fig. 4b).

3.4 Insection diversity in SQ10 variety

The diversity of both harmful and beneficial insects in the SQ10 variety of squash plants is shown in Fig. 5. The abundance of harmful insects was found highest ($p<0.001$) for the blue pumpkin beetle, followed by green long lagged fly and red pumpkin beetle which were similar, whereas the butterfly was found lowest (Fig. 5a). In contrast, the abundance of beneficial insects was found higher ($p=0.002$) for ladybird beetle compared to pollinators, bumble bee and tachinid fly which were comparable, whereas the number of hover fly and honeybee were intermediate (Fig. 5b).

4 Discussion

Different harmful and beneficial insects attacked the squash varieties in the present study. Total number of insects was found highest in Pahu consider to the other varieties. Among different harmful insects, Pumpkin beetles were found in abundant numbers compared to other insects in all the three Squash varieties (Ahung, Pahu and SQ10). Similar results were found in other studies too. Hassan (2012) found that adult red pumpkin beetle (*Aulacophora foevicoliis*) is harmful and causes damage by feeding leaves, flower buds and flowers of plants. Beetle starts to attack the plant right after the germination and slows down the growth due to severe damage (Yamaguchi, 2012). Losses by the attack of this pest are obvious which

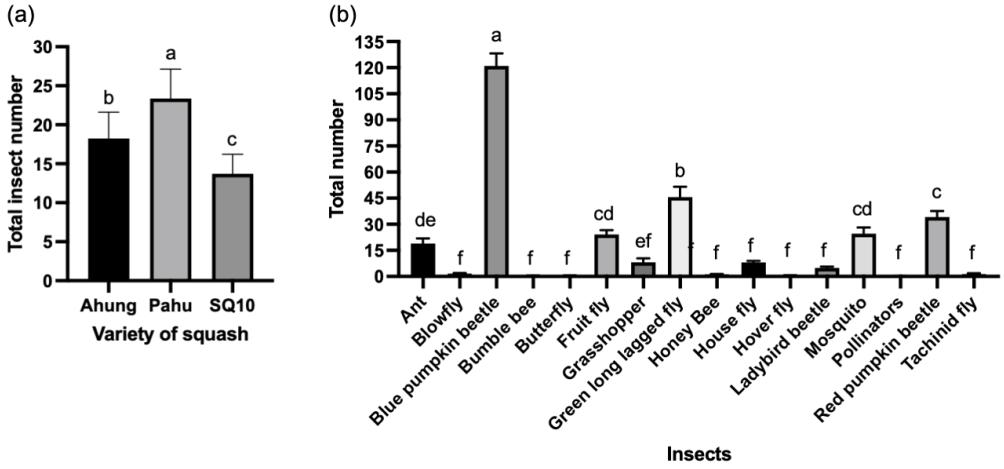

Figure 2. The effect of (a) variety of squash plant and (b) insect type on the abundance of total number of insects. Pooled SEM = 3.836; error bars indicate SEM values; variety, p<0.001, insect type, p<0.001

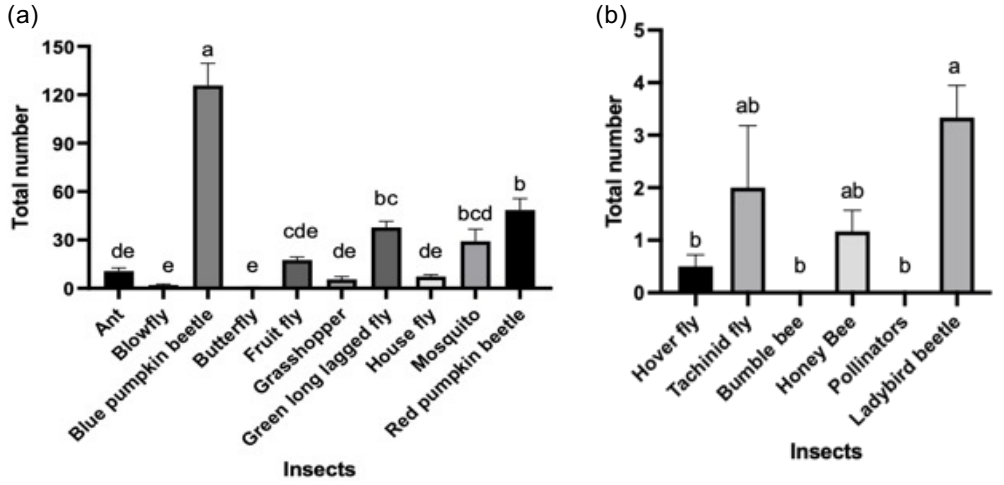

Figure 3. The diversity of (a) harmful and (b) beneficial insects in Ahung variety of squash plant. Error bars indicate SEM values. For harmful insects, pooled SEM = 5.45; insect, p<0.001. For beneficial insects, pooled SEM = 0.589; insect, p = 0.003

ranges from 35-75% at seedling stage and it declines as canopy increases (Kamal et al., 2014; Saljoqi and Khan, 2007). In some cases, it causes 30-100% yield loss in cucurbits (Atwal, 1976). Though in some cucurbits red pumpkin beetle is found higher than blue pumpkin beetle, our study showed that blue pumpkin beetles are dominant over the red one. In some crops, blue pumpkin beetles can be found in higher number than that of red pumpkin beetle. Similar findings were observed in other cucurbit vegetables like bitter gourd, ribbed gourd, and sponge gourd where blue pumpkin beetle was much higher than that of red pumpkin beetle (Khan, 2013). Sohrab et al. (2018) reported that red pumpkin beetle, epilachna beetle, squash bug, and melon fruit fly are the serious pests of squash cultivation, and the findings supported our results where red pumpkin beetle and fruit fly were recorded as harmful insects.

Although several studies identified cotton aphid (*Aphis gossypii*), white flies (*Bemisia tabaci*), two-Spotted spider mite (*Tetranychus urticae*), striped cucumber beetle (*Acalymma vittatum*), squash bug (*Anasa tristis*), cotton mealy bug (*Phenacoccus solenopsis*), potato leafhopper, onion thrips (*Thrips tabaci*) as the major insect pest of squash (Awadalla et al., 2018; El-Saad, 2015; El-Mesawy, 2018; El-Naggar et al., 2014). However, such sucking pests were not recorded in our study, which could be because we evaluated the insect pest at the squash fruiting pest. Moreover, Squash is a newly cultivated cucurbit vegetable in the study region, where the agroclimatic condition is not identical to that in other parts of the country. Therefore, the climatic conditions of the study area, such as temperature and relative humidity, can be an influential factor behind the low capture of major insect pests. Among different beneficial insects, ladybird beetle was found higher compared to other natural enemies and the number of honeybee and

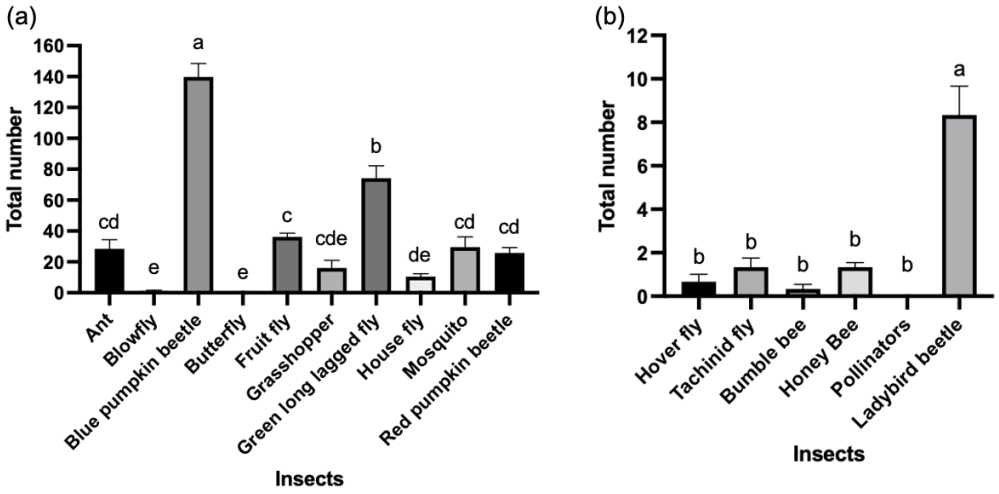

Figure 4. The diversity of (a) harmful and (b) beneficial insects in Pahu variety of squash plant. Error bars indicate SEM values. For harmful insects, pooled SEM = 4.52; insect, p<0.001. For beneficial insects, pooled SEM = 0.631; insect, p<0.001

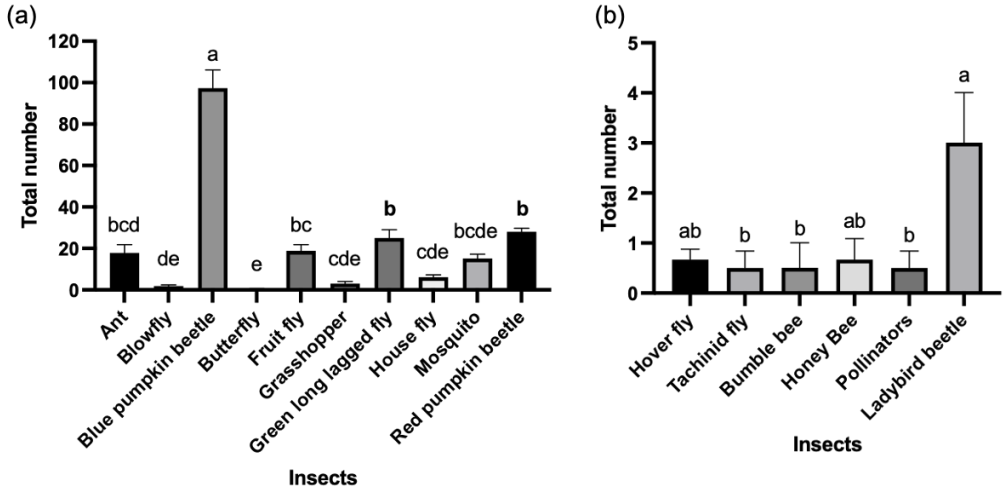

Figure 5. TThe diversity of (a) harmful and (b) beneficial insects in SQ10 variety of squash plant. Error bars indicate SEM values. For harmful insects, pooled SEM = 3.55; insect, p<0.001. For beneficial insects, pooled SEM = 0.554; insect, p = 0.022

tachinid fly were found intermediate among all the three varieties. Ladybird beetle is a popular natural enemy in different vegetables especially for cucurbits. The present results showed harmony with those of El Maghraby et al. (1994), Ali (1995) and Bachatly and Sedrak (1997) who found that, *C. undecimpunctata*, *C. carnea* and *S. corollae* were the most common predator species associated with the cucurbit pests. According to M. (2013), the common associated natural enemies inhabiting cucurbit fields were, *Coccinella septempunctata* L., *Chrysoperla carnea* Steph., and *C. undecimpuctata* aegyptiaca Reiche. Meanwhile, Koca et al. (2018) reported different species ladybird beetle (*Propylea quatuordecimpunctata*, *Coccinella septempunctata*, *Harmonia axyridis*) and hover fly (*Sphaerophoria scripta*, *Melanostoma mellinum* and *Metasyrphus corollae*) in the cucurbit vegetables which is identical to the present study although we did not identify the ladybird beetle species. Basha et al. (2021) observed three species of predatory mite, *Phytoseiulus persimilis* (Athias- Henriot), *Typhlodromips swirskii* (Athias- Henriot) and *Euseius scutalis* Chant against phytophagous two spotted spider mite, *Tetranychus urticae* Koch which is dominant pest of cucurbit vegetables. While our study did not record any predatory or phytophagous mites species.

5 Conclusion

The insect pest and beneficials insects of Squash has been identified at fruiting phase in this experiment. Several chewing and sucking insects' species and beneficial insects were recorded in the three different va-

rieties of Squash. Among the varieties, Pahu was found most infested variety than others. The results revealed that blue pumpkin beetle was the most abundant pest species while ladybird beetle was found the most prevalent beneficial insects as predator throughout the fruiting stage. Along with the presence of honey bee, a significant number of pollinator and parasitoid such as hover fly and tachinid fly has also been recorded which ensure a sustainable squash production. Therefore, the diversity of harmful and beneficial insects in squash would be crucial to implement sustainable pest management strategies.

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Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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