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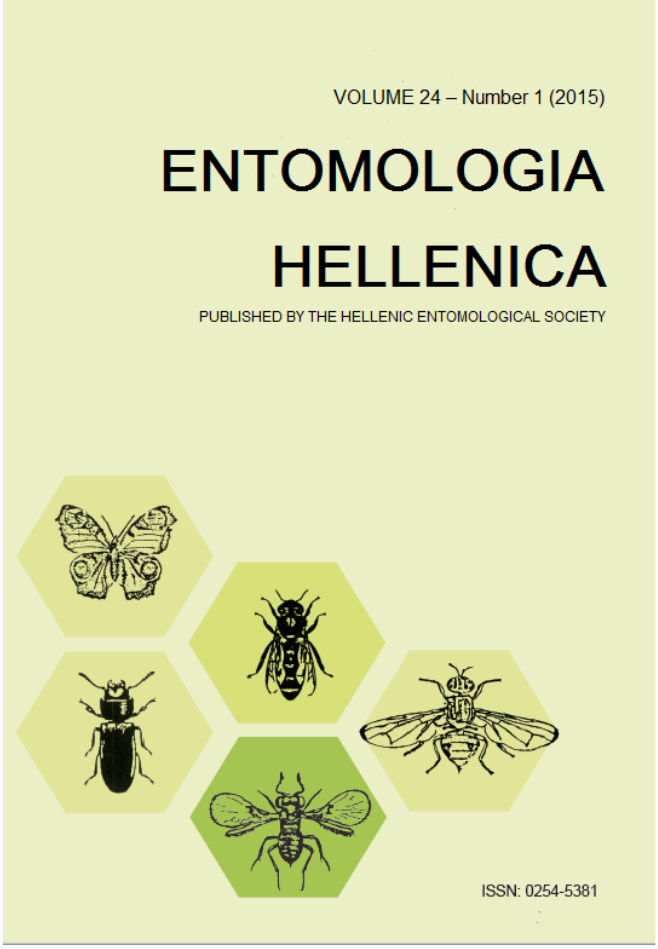

Varietal performance of cabbage on the incidence of flea beetles (Phyllotreta spp.)

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Varietal performance of cabbage on the incidence of flea beetles (*Phyllotreta* spp.)

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ABSTRACT

A study was conducted at the Sher-e-Bangla Agricultural University, Bangladesh, during September 2007 to February 2008 to evaluate the varietal performance of cabbage on the incidence of flea beetles [*Phyllotreta* spp., (Coleoptera: Chrysomelidae)]. The experiment was laid out in a Randomized Complete Block Design comprising seven varieties viz. V1: BARI badhakopi-1/Provati, V2: BARI badhakopi-2/Agrodot, V3: Atlas-70, V4: Autumn queen, V5: Tropical queen, V6: T-776 and V7: Seisho YR. Among the different varieties of cabbage V_5 (Tropical queen) performed as the best variety in terms of the lowest incidence of flea beetles (0.00 larvae/plant), lowest percent of leaves infestation (0.87 %) as well as plant infestation (2 %) caused by flea beetles. These findings will be valuable for the most appropriate management of flea beetles.

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KEYWORDS: cabbage varieties, flea beetle, plant infestation, yield.

Introduction

Cabbage (*Brassica oleracea* var. *capitata* L.) locally known as 'Bhadha Kopi' or 'Pata Kopi' is the most common winter vegetable crop grown in Bangladesh as well as in the other countries (Daly and Tomkins 1995, Nyambo and Lohr 2005).

Cabbage is grown on 3.1 million ha globally excluding Chinese cabbage (*Brassica campestris*). It has been recognized as a very important vegetable to the farmers in providing income and nutrition worldwide (Oruku and Ndungu 2001, Kfir 2004, Lohr and Kfir 2004, FAOSTAT 2007).

Cabbage is rich in vitamin C and tryptophan, an important amino acid for human (Rashid 1993). Consumption rate of vegetables in our country is 30 kg/head/yr but in developed countries it is 7-8 times higher. FAO claimed that at least 5% total calories should have come from vegetables and fruits, which may fulfill the requirement of vitamins and minerals for human. In Bangladesh during 2003-2004, 129 thousand metric tons (BBS 2004) of cabbage was produced, which ranked fifth among the cultivated vegetables. The yield produced by cabbage in

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Bangladesh is 75-100 ton/ha depending on the variety and season (Rashid et al. 2006).

The production of cabbage is threaten by the insect pests, diseases, variety, soil nutrients and weather conditions. There are many insects that infest cabbage such as cabbage caterpillar [*Spodoptera litura*, (Lepidoptera: Noctuidae)], flea beetles [*Phyllotreta* spp. (Coleoptera: Chrysomelidae)], cabbage aphid [*Brevicoryne brassicae* (Hemiptera: Aphidi-dae)], semilooper [*Trichoplusia* spp. (Lepidoptera: Noctuidae)], diamondback moth [*Plutella xylostella*, (Lepidoptera: Plutellidae)], cutworm [*Agrotis ipsilon*, , (Lepidoptera: Noctuidae)], cabbageworm [*Hellula undalis*, (Lepidoptera: Crambidae)], whitefly [*Bemisia tabaci* (Hemiptera: Aleyrodidae)] etc (Butani and Jotwani 1984, Bhat et al. 1994).

Flea beetles, *Phyllotreta* spp., are included in the most important pests of cruciferous plants (Csonka and Toth 2006). The adults are active leaf-feeders which when occurring in large numbers can rapidly defoliate and kill plants. Some species also are vectors of serious diseases such as potato blight and bacterial wilt of corn. Certain flea beetles are considered polyphagous, though many of them attack only one or few closely related plant species (Metcalf et al. 1993).

The farmers use chemical insecticides to mitigate the yield losses by the beetles without considering economic injury level. However, the chemical control is not only expensive but also there is a risk of residues on the product but also in the soil that have become a matter of great concern of human health and environmental pollution (Rikabdar 2000). Apart from chemical control, there are several other methods that help to combat flea beetles of cabbage comprising cultural, mechanical and biological as well as planting less susceptible varieties.

Amongst them the latter is also one of the most important techniques to manage the infestation of different pests because it does not require the elimination of the pest. Bok et al. (2006) reported that the cabbage cultivars such as Big Cropper, Cape Spitz, Copenhagen Market, Conquistador, Drumhead, Giant Drumhead, Glory of Enkhuizen, Grandslam and Hercules were found to be resistant to different insect pests. Development of a resistant variety, however, is a long term strategy and currently the resources available in this regard seem to be inadequate. Many cabbage varieties have been released by different research organizations as well as imported by traders. However, their rate of resistance to flea beetles and other insect pests have not been tested under field conditions. Considering the above situation and aiming to a more effective control of that pest, this study has been undertaken to record the infestation status of flea beetles and to evaluate the different cabbage varieties/genotypes resistance against them.

Materials and Methods

The experiment was conducted at the Research farm of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207 during September 2007 to February 2008. The experiment was carried out in a Randomized Complete Block Design (RCBD). The entire experimental field was divided into three blocks. Then, each block was divided into seven plots. Each experimental plot was 3 × 3m and two adjacent unit plots and blocks were separately by 50cm and 1 m apart, respectively. Seven different varieties/genotypes of cabbage were tested (Table 1).

Seeds of each variety were sown on 22 September. Shading was given by bamboo mat (chatai) over the seedbed to protect the young seedling from scorching sunlight and rainfall.

The plots were raised by 10cm from the soil surface keeping the drain around the plots. Manures and fertilizers were provided

with the appropriate doses and methods of application. Healthy, 28 days old uniform sized seedlings were transplanted in the experimental plots. A total of 10 seedlings were transplanted in each plot. The spacing was followed by 60cm between rows and 40cm between plants on the row.

The following parameters were considered for evaluating the varietal performance: incidence of adult flea beetles (No./plant), percent leaf and plant infestation caused by flea beetle per plot and yield (weight of cabbage head). Data were recorded twice a week starting from 10 days after transplantation.

The percent infestation of leaves or plants was calculated with the following equqtions:

$$\% \text{ Infested leaves} = \frac{\text{Number of infested leaves}}{\text{Total number of leaves}} \text{ X } 100$$

$$\% \text{ Infested plant} = \frac{\text{Number of infested plant per plot}}{\text{Total number of plant per plot}} \text{ X } 100$$

The recorded data were compiled and tabulated for statistical analysis. Analysis of variance was done using MSTAT-C statistical software (Gomez and Gomez 1976). The treatment means were separated by Duncan's Multiple Range Test (DMRT).

Results and Discussion

During the study period - November 2007 to February 2008 (winter season) - the occurrence of flea beetles and the other parameters were recorded in each of the seven cabbage varieties.

Incidence of adult flea beetles on different cabbage varieties

Significant variation of the incidence of adult flea beetles was recorded at different growth stages of the seven cabbage varieties (Table 2). At 15 DAT (Days After Transplanting), the highest number (0.93 adults/plant) of flea beetles was recorded in V_3, which was statistically similar with V_2 (0.87 adults/plant) and V_7 (0.80 adults/plant). On the contrary, none of flea beetles was recorded in V_5 followed by V_4 and V_6. More or less similar trends of the incidence of flea beetles were recorded at 22 DAT, 29 DAT and 36 DAT. But the rate of adult flea beetles incidence was decreasing with the increase of the age of the cabbage plants and no flea beetles were recorded at mature stage (43 DAT). In case of mean incidence, more or less similar trend of flea beetles incidence was also observed and the highest number (0.55 adults/plant) of flea beetles was recorded in V_3, which was statistically different from all other varieties followed by V_2, V_7 and V_1. On the other hand, no flea beetles were recorded in V_5 followed by V_6 and V_4.

According to the results, it was revealed that the incidence of adult flea beetles in the early stage of cabbage was highest in Atlas-70 (V_3), and lowest in Tropical queen (V_5) following the order $V_3 > V_2 = V_7 = V_1 > V_4 > V_6 > V_5$.

Infestation Level

Significant variation in the incidence of adult flea beetles infested leaves and plants was recorded at different growth stages of cabbage varieties evaluated in the present study (Table 3,4).

Infestation of leaves

Among the seven cabbage varieties/ genotypes, the highest incidence (26.53%) of adult flea beetles infested leaves was recorded in V_3 which was statistically different from all other varieties followed by V_2 and V_7 (Table 3) at 15 DAT. On the other hand, no incidence of flea beetles infested leaves was recorded in V_5 followed by V_6 (11.94%) and V_1 (15.27%). More or less similar trends of the incidence of flea beetles infested leaves were recorded at 22 DAT, 29 DAT and 36 DAT. However the rate of incidence of flea beetles infested leaves was decreased with the age of the cabbage plants and no flea beetles infested leaves was

observed at 43 DAT, because the leaves that were infested at early stage of the plant growth were dropped off at the later stage and no fresh damage at that time. In case of

TABLE 1. Different treatments (varieties) and their source of availability.

Treatments	Varieties	Sources of availability
V_1	BARI badhakopi-1/Provati	BARI*
V_2	BARI badhakopi-2/Agrodot	BARI*
V_3	Atlas-70	Local market
V_4	Autumn queen	Local market
V_5	Tropical queen	Local market
V_6	T-776	Local market
V_7	Seisho YR	Local market

*BARI= Bangladesh Agricultural Research Institute.

TABLE 2. Incidence of adult flea beetles (adults/plant) on different cabbage varieties grown in winter 2007-2008.

Varieties	Incidence of adult flea beetles					Mean
	15 DAT	22 DAT	29 DAT	36 DAT	43 DAT	
V_1=BARI badhakopi-1	0.73 b	0.53 ab	0.33 b	0.00 c	0	0.33 b
V_2=BARI badhakopi- 2	0.87 ab	0.4 bc	0.00 d	0.40 b	0	0.33 b
V_3= Atlas-70	0.93 a	0.67 a	0.60 a	0.53 a	0	0.55 a
V_4= Autumn queen	0.47 c	0.47 ab	0.33 b	0.00 c	0	0.25 c
V_5=Tropical queen	0.00 d	0.00 d	0.00 d	0.00 c	0	0.00 e
V_6= T-776	0. 53 c	0.27 c	0.00 d	0.00 c	0	0.16 d
V_7= Seisho YR	0.80 ab	0.67 a	0.20 c	0.00 c	0	0.33 b
LSD $_{(0.01)}$	0.17	0.19	0.11	0.08	0	0.04
CV (%)	15.23	24.6	30.66	32.73	0	6.28

Within columns, means followed by same letter(s) do not differ significantly at 1% level by DMRT. Values are the means of three replications. DAT= Days After Transplanting, LSD=Least Significant Difference, CV= Coefficient of Variation.

mean incidence, more or less similar trend of flea beetles infested leaves was observed, and the highest incidence (10.85%) of infested leaves was recorded in V_3 which was statistically different from all other varieties followed by V_2 (8.69%) and V_7 (8.09%). On the contrary, the lowest incidence (0.87%) of flea beetles infested leaves were recorded in V_5 followed by V_6 (4.83%) and V_4 (6.86%).

From the above, it was revealed that, the percent leaf infestation caused by flea beetles was the highest in Atlas-70 variety and lowest in Tropical queen. The order of trends in terms of mean incidence of flea beetles infested leaves was $V_3 > V_2 > V_7 > V_1 = V_4 > V_6 > V_5$.

TABLE 3. Cummulative incidence of adult flea beetles infested leaves (%) on different cabbage varieties grown in winter 2007-2008.

Varieties	Percent leaf infestation caused by flea beetles					
	15 DAT	22 DAT	29 DAT	36 DAT	43 DAT	Mean
V_1= BARI badhakopi-1	11.94 e	14.16 a	7.58 b	0.00 c	0	6.74 d
V_2= BARI badhakopi-2	22.67 b	12.31 b	3.03 d	5.45 a	0	8.69 b
V_3= Atlas-70	26.53 a	15.61 a	8.92 a	3.17 b	0	10.85 a
V_4= Autumn queen	17.10 d	10.02 c	7.17 b	0.00 c	0	6.86 d
V_5=Tropical queen	0.00 f	4.33 d	0.00 e	0.00 c	0	0.87 f
V_6 = T-776	15.27 d	5.56 d	3.33 d	0.00 c	0	4.83 e
V_7= Seisho YR	20.68 c	14.39 a	5.42 c	0.00 c	0	8.09 c
$LSD_{(0.01)}$	1.95	1.45	0.77	0.39	0	0.62
CV (%)	6.71	7.46	8.52	16.70	0	4.16

Within columns, means followed by same letter(s) do not differ significantly at 1% level by DMRT. Values are the means of three replications. DAT= Days After Transplanting.

Infestation of plants

The highest incidence (66.67%) of infested plants among the seven cabbage varieties was recorded in V_3. At 15 DAT, its value was statistically different from all other varieties followed by V_2, V_7 and V_1 (Table 4). On the other hand, a lower incidence of infested plants was recorded in V_4 (36.67) and V_6 (30.00%) and no incidence in V_5. More or less similar trends of the incidence of flea beetles infested plants were recorded at 22 DAT, 29 DAT and 36 DAT. The rate of incidence of flea beetles infested plants was decreased with the age of the cabbage plants and no infested plants was recorded at 43 DAT. The mean incidence followed a similar trend. The highest incidence (35.33%) of infested plants was recorded in the variety V_3, which was statistically different from all other varieties followed by V_2 (29.13%) and V_7 (24.83%). On the contrary, the lowest incidence (2.00%) of flea beetles infested plants was recorded in V_5 followed by V_4 and V_6. As a result, the order of trends in terms of mean incidence of flea beetles infested plants was $V_3 > V_2 > V_7 > V_1 > V_4 = V_6 > V_5$.

Thus, among the varieties, V_3 (Atlas-70) was the most suitable host for adult flea beetles in respect of the number of adults (0.55 adults/plant), infested leaves (10.85%) and infested plants (35.33%). Conversely, V_5 (Tropical queen) was the least preferred. In a similar work Wang et al. (2006) observed that the flea beetles were serious pests of crucifers and infestation was high in Atlas-70 when they fed on the mature leaves of cabbage than when feeding on young leaves.

Yield of different cabbage varieties

The highest yield of cabbage head (14.77 kg/plot and 16.41 ton/ha) was recorded in V_2 (BARI badhakopi-2), which was statistically similar with 13.73, 13.53, 13.37, 13.27 kg per plot and 15.26, 15.04, 14.85 14.74 ton per ha in V_3, V_1, V_6 and V_5, respectively (Table 5). On the other hand, the lowest yield of cabbage head (6.33 kg per plot and 7.04 ton per ha) was recorded in V_7 (Seisho YR) followed by 9.93 kg per plot and 11.04 ton per ha in V_4.

TABLE 4. Incidence of adult flea beetles infested plants on different cabbage varieties grown in winter 2007-2008.

Varieties	Percent plant infestation by flea beetles per plot					
	15 DAT	22 DAT	29 DAT	36 DAT	43 DAT	Mean
V_1=BARI badhakopi-1	46.67 b	33.33 bc	20.00 d	3.50 d	0	20.70 d
V_2=BARI badhakopi-2	53.33 b	40.00 ab	36.67 b	15.67 b	0	29.13 b
V_3 = Atlas-70	66.67 a	46.67 a	43.33 a	20.00 a	0	35.33 a
V_4 = Autumn queen	36.67 c	20.00 d	10.00 e	0.00 e	0	13.33 e
V_5 =Tropical queen	0.00 d	10.00 e	0.00 f	0.00 e	0	2.00 f
V_6 = T-776	30.00 c	26.67 cd	10.00 e	0.00 e	0	13.33 e
V_7 = Seisho YR	53.33 b	36.67 b	26.67 c	7.50 c	0	24.83 c
LSD $_{(0.01)}$	8.39	8.24	6.54	3.88	0	4.21
CV (%)	11.51	15.19	17.53	32.73	0	9.56

Within columns, means followed by same letter(s) do not differ significantly at 1% level by DMRT. Values are the means of three replications. DAT= Days After Transplanting.

Table 5. Comparison of yield among seven cabbage varieties grown in winter 2007-2008.

Varieties	**Yield**	
	Kg plot^{-1}	**Ton ha^{-1}**
V_1=BARI badhakopi-1	13.53a	15.04 a
V_2=BARI badhakopi-2	14.77a	16.41 a
V_3 = Atlas-70	13.73 a	15.26 a
V_4 = Autumn queen	9.93 b	11.04 b
V_5 =Tropical queen	13.27 a	14.74 a
V_6 = T-776	13.37 a	14.85 a
V_7 = Seisho YR	6.33 c	7.04 c
LSD $_{(0.01)}$	2.06	2.293
CV (%)	9.56	9.56

Within columns, means followed by same letter(s) do not differ significantly at 1% level by DMRT. Values are the means of three replications. DAT= Days After Transplanting.

From the above mentioned findings it was revealed that the V_2 performed as the best variety in terms of yield of cabbage which was very close to V_3 and V_1. On the other hand, V_7 was the least performer in terms of yield.

It is evident that the variety plays an important role for higher yield in having sufficient genetic variation, head size, shape, firmness, maturity and resistance to insect pests and diseases. In respect of factors, although V_2 (BARI badhakopi-2) gave the highest yield it was statistically similar with

V_3, V_1, V_6 and V_5. However, V_5 (Tropical queen) was the best performer in terms of flea beetles infestation. Moreover, consumer prefers fresh cabbage without infestation by any pests. Therefore considering market demands, V_5 (Tropical queen) variety is recommended against flea beetles infestation.

Effect of flea beetles on the percent plant infection and yield of cabbage

The graph (Fig. 1) represents the relationship among percent leaf infestation, percent plant infestation and yield of cabbage during the varietal screening of cabbage. The yield of cabbage increased with decreasing percent of flea beetles infested leaf and plant; conversely it decreased with increasing of the flea beetles infested leaf and plant.

Conclusively, this study depicted that among seven cabbage varieties, V_3 (Atlas-70) was the most suitable host for adult flea beetles in respect of incidence of adult flea beetles (0.55 adults/plant), infested leaves (10.85%) and infested plants (35.33%). Conversely, V_5 (Tropical queen) was the least preferred host for adult flea beetles (0.00 adult/plant), infested leaves (0.87%) and plants (2.00%). The rate of incidence of adult flea beetles, infested leaves and plants were decreased with increasing the age of cabbage plants and no incidence of adult flea beetles, infested leaves and plants was observed at the later stage (43 DAT) of the crop growth.

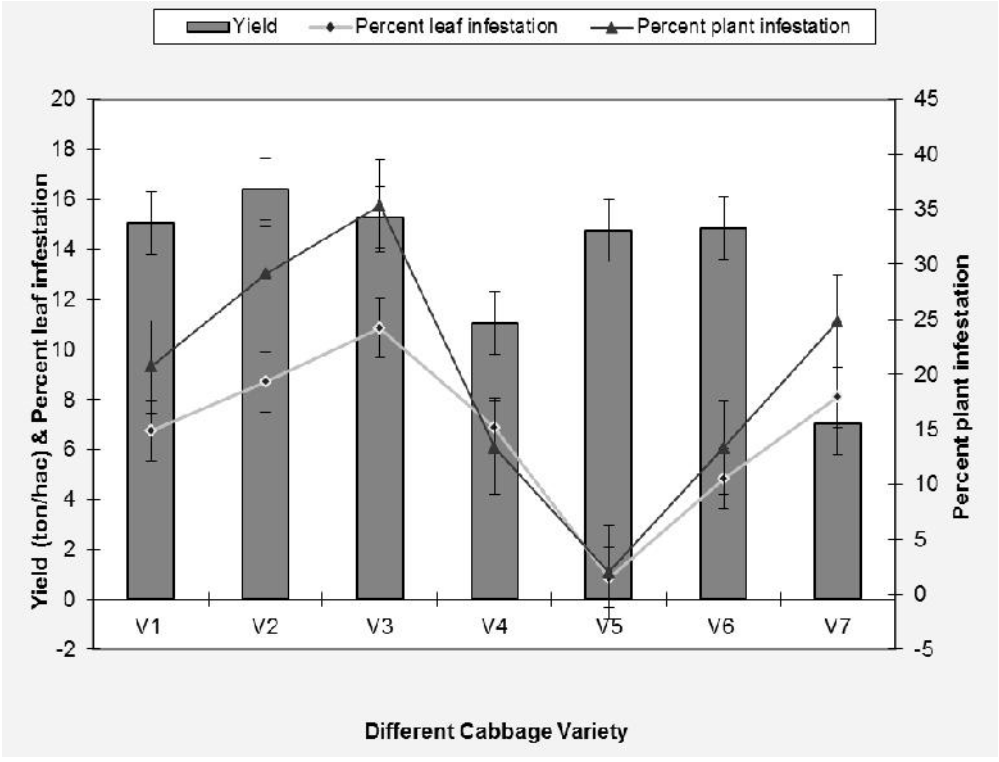

FIG. 1. Relationship among percent leaf infestation, percent plant infestation and yield of cabbage (V1: BARI badhakopi-1/Provati, V2: BARI badhakopi-2/Agrodot, V3: Atlas-70, V4: Autumn queen, V5: Tropical queen, V6: T-776, V7: Seisho YR).

Thus, V_5 (Tropical queen) variety could be recommended against flea beetles infestation. However, further investigations are needed including biotic and abiotic factors on the performance of the selected cabbage varieties against infestation of flea beetles.

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Συγκριτική μελέτη της επίδρασης φυλλοφάγων κολεοπτέρων *Phyllotreta* spp. σε ποικιλίες λαχάνου

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ΠΕΡΙΛΗΨΗ

Κατά τη διάρκεια Σεπτεμβρίου 2007 - Φεβρουαρίου 2008 διεξήχθη πειραματισμός στο Γεωπονικό Πανεπιστήμιο Sher-e-Bangla (Μπαγκλαντές) για την αξιολόγηση της επίδρασης των φυλλοφάγων κολεοπτέρων εντόμων *Phyllotreta* spp. σε επτά ποικιλίες λαχάνου. Δοκιμάστηκαν οι ποικιλίες V_1: BARI badhakopi-1/Provati, V_2: BARI badhakopi-2/Agrodot, V_3: Atlas-70, V_4: Autumn queen, V_5: Tropical queen, V_6: T-776 και V_7: Seisho YR. Η ποικιλία V_5 αποδείχθηκε ως η λιγότρο ευπαθής όσον αφορά στην παρουσία σκαθαριών (μέσος όρος: 0,00 ακμαία/φυτό), στο ποσοστό προσβεβλημένων φύλλων (0.87 %) και στο ποσοστό των προσβεβλημένων φυτών (2,00 %). Η εργασία αυτή προσφέρει στοιχεία χρήσιμα για την πιθανή αντιμετώπιση αυτών των εντόμων σε καλλιέργειες λαχάνου με την χρήση λιγότερο ευαίσθητων ποικιλιών.