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Management Strategies Against Flea Beetle (*Phyllotreta cruciferae* Goeze) Infesting Pechay (*Brassica rapa* L.) in La Trinidad, Benguet

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Abstract

The study evaluated five management strategies against flea beetle infesting pechay varieties in terms of population, degree of crop injury, yield, and yield loss, determined the degree of efficacy and contribution of the treatments against flea beetle, and compared the return on investment (ROI) of the different management strategies employed. The study was conducted in La Trinidad, Benguet in 2021. Results revealed that while management strategies have a significant influence on the degree of injury by flea beetles (23% or slight in Black Behi and 30% or moderate in Cherokee), no positive interaction was traced in all major parameters used. Untreated plants showed even comparable injuries with those installed with physical barriers such as sticky traps, row covers, and sweeping. Insecticide spraying gave the greatest contribution as a single management strategy in both Black Behi and Cherokee varieties; however, netting gave the highest control contribution. For combination treatments, sweeping + netting gave the highest contribution of control but sweeping + row cover contributed the least to flea beetle pest control. Further, netting gave the highest ROI in Black Behi followed by sweeping + netting, while insecticide use resulted in the lowest gain. On the other hand, Cherokee had the highest ROI under sweeping + netting, closely followed by netting, while the lowest ROI was obtained from sweeping + row cover. Netting has contributed much in decreasing the insect population and degree of injury regardless of variety; however, the use of Black Behi without any applied treatments is still the most practical way in pechay production.

Introduction

Flea beetle, *Phyllotreta cruciferae* Goeze (Coleopteran: Chrysomelidae), is one of the most common and destructive pests of Brassicaceae crops. It was first introduced in North America in the 1920s and is now distributed all over the world. Flea beetle has one generation per year. They are very active early in the growing season, especially during periods of dry sunny weather wherein they can seriously damage seedlings and transplants including pechay by chewing small pinholes through the leaves. The larvae live in the soil and feed on small roots or root hairs while adults feed on the surface of leaves and stems. Intensive feeding damage can kill plants, especially young seedlings, and moderate damage can reduce plant size, delay maturity, reduce yield, or render

crops unmarketable due to numerous small holes, or 'shot-hole' on leaves and stems (Jimenez et al., 2000; Hazzard et al., 2003).

Pechay (*Brassica rapa* L.), which belongs to the Brassicaceae family, plays an important role in the economy and nutrition of the Filipino people and is one of the most known vegetables in the Philippines. It is used mainly for its immature but fully expanded tender leaves. Succulent petioles are often preferred as the main ingredient for soup and stir-fried dishes. It is also added to Filipino stews such as *nilagang baka* (boiled beef) or *bulalo* (boiled beef shank). People who choose to eat it raw can enjoy it tossed in a salad mixed with other greens (Pinoy Entrepreneur, 2010).

Pechay is one of the crops attacked by flea beetles. In Benguet, pechay is commonly cultivated because of the demand and maturity takes about 35 to 45 days. According to pechay growers in La Trinidad, the crop can incur losses of about 50 to 60% if flea beetle is not controlled at an early stage (T. Mangili, personal communication, April 20, 2017). Accordingly, all pechay varieties especially those with succulent leaves can be attacked by the flea beetle known locally as *Timel*.

Current control options for flea beetles consist primarily of foliage application of broad-spectrum insecticides, which may create several environmental and health hazards (Mikunthan, 2009). The effects of insecticides on human health are risky because of their exposure either directly or indirectly. Ansari et al. (2014) reported that more than 26 million people suffer from pesticide poisoning, with nearly 220,000 deaths yearly. According to them, hundreds of millions of people are exposed to pesticides every year, primarily through agriculture. Globally, 36% of agricultural workers are exposed; which is rising by 50% in Southeast Asia and the Pacific and 66% in sub-Saharan Africa. Global pesticide use reached record sales of Php1.78 trillion in 2008 primarily through agriculture.

Insecticides are widely used and have negative impacts such as toxic residues in food, water, air, and soil. Dissolved compounds may move with runoff in the water or attach to soil particles that can pollute streams, ponds, lakes, and wells and may harm plants and animals and contaminate groundwater (British Colombia Ministry of Agriculture, 2017). Worldwide, more than 500 species of insects, mites, and spiders have developed some level of insecticide resistance due to injudicious spraying of insecticides (Michigan State University, n.d). About 7,470 cases of resistance have been reported in insects to a particular insecticide; 16 species of arthropods accounted for 3,237 (43%) (Ansari et al., 2014). These situations create a demand for alternative control methods, including physical control (Vincent et al., 2003).

The need to reduce the negative impacts of pest control on the environment is important. Increased concerns about the potential effects of pesticides on health, the reduction in arable land per capita, and the evolution of pest complexes likely to be accelerated by climate changes also contribute to changes in plant protection practices.

Findings from this study will guide organic pechay producers to attain better yield and income through the best management options where farmers' labor and farm inputs in controlling flea beetles will be reduced.

The study was therefore conducted using other management strategies against the flea beetle which include: row covering, sticky trapping, insect netting, and sweeping to enhance the diversity of the farm system. The study 1) evaluated the different management strategies against flea beetle infesting pechay varieties, in terms of population, degree of crop injury, yield, and yield loss; 2) determined the degree of efficacy and contribution of the treatments against flea beetle using pechay varieties; and 3) compared the economic analysis of the different management strategies employed.

Methodology

Design and Treatments

The experimental area of 520 sqm. was laid out in a Randomized Complete Block Design (RCBD) factorial with four blocks corresponding to the number of replications. Each block contained 26 plots corresponding to 13 treatments for each of the two varieties evaluated: Black Behi and Cherokee. The distance between the plots and blocks is 0.5m.

The treatments were as follows:

Factor A	Variety
V1	Black Behi
V2	Cherokee

Factor B	Management Strategy
T1	Untreated
T2	Insecticide treated
T3	Row cover
T4	Sweeping
T5	Sticky Trap
T6	Netting
T7	Sweeping + Sticky Trap
T8	Sweeping + Row Cover
T9	Sweeping + Netting
T10	Sticky Trap + Row Cover
T11	Sticky Trap + Netting
T12	Netting + Row Cover
T13	Row Cover + Sticky Trap + Netting + Sweeping

Layout, Fabrication, and Installation of Physical Barriers

Sticky Trap

Recycled empty plastic bottles (1.5 Li cap.) were used as traps. These bottles were spray painted with chrome yellow color all over the surface and after drying was applied with adequate Marfak grease as a trap. Five sticky trap bottles lined side by side vertically were installed.

Row Cover

A row cover was installed using UV-treated polyethylene plastic, nylon rope, and steel bars. Light-weight row covers were used to allow about 90% of light to pass through to the plants. Clear polyethylene plastic measuring 1.5m x 5m was used. First, four steel hoops per plot were placed at a distance of 1.25m. The three-meter hoops were staked into the soil, having both ends at a depth of 25cm into the ground. The polyethylene was placed over the steel hoops. This polyethylene plastic was secured using soil as weights at each side to hold the polyethylene in place and prevent the entry of pests. Both ends of the row cover were covered with a mesh net to allow ventilation among the plants.

Insect Netting

A thin fabric mesh with a thickness of 0.2mm was laid directly on the plot after the seeds were sown. The fabric mesh is adjusted as the plants grow taller to provide enough space. The edges of the fabric mesh were sealed with sandbags or soil with row cover clips. Before crop emergence, the fabric mesh was put in place so that insects could not establish inside the nets.

Sweepnets and Sweeping

A lightweight aluminum frame with a wooden handle and a soft mesh with a diameter of 35cm with a curved tip was used to help prevent insects caught from escaping.

Untreated

Pechay plants were not applied with any treatment but crop management practices such as watering, weeding, and fertilization for proper crop growth and development were properly observed.

Insecticide Application

The pechay plants were sprayed with insecticide Profenofos at the recommended rate at 7 days intervals 2 weeks after planting until a month before harvest.

All cultural management practices in the maintenance of pechay were followed for the vigor growth of the plant.

Collection of Flea Beetle Population

Sticky Trap Treatment

Flea beetles that were trapped were counted manually and placed in plastic containers at weekly intervals for 4 successive weeks clearing and reapplying grease after each counting period.

Row Cover/Insect Netting/ Insecticide-treated and Untreated

The quadrat method was used in sampling the flea beetle population. A 32cm x 32cm square made up of thin wire was constructed, and five of these were placed randomly in each plot, serving as a sampling area within the plot. Counting and collecting the insects in the quadrats was done once a week.

Sweeping

Sweeping was done at 9:00 a.m. and 2:00 p.m. on the second and fifth day of the week for four weeks. Swept insects were soaked in water with a 25% soap solution to prevent them from escaping during counting. The immobilized insects were

transferred into microwavable plastic for ease of counting.

Data Gathered

Population

The number of flea beetles collected regardless of growth stage at weekly intervals for 4 successive weeks in each treatment starting at 2 weeks after planting.

Degree of Injury

This was determined by estimating the percentage of damage inflicted by flea beetles feeding on the leaves of pechay. One hundred sample plants were randomly selected from each plot. The rating index used to assess the degree of injury is based on Faroden (2003) as follows:

RATING	DESCRIPTION
Sound	No injury
Slight	1-25% injury on leaves
Moderate	26-50% injury on leaves
Slightly severe	51-75% injury on leaves
Severe	76-100% injury on leaves

Yield and Yield Component

The harvest in kilogram produced in each treatment per variety. Yield was determined by weighing 100 randomly collected samples from each treatment.

Degree of Damage

The yield loss is caused by flea beetle infestation at harvest.

Yield Loss

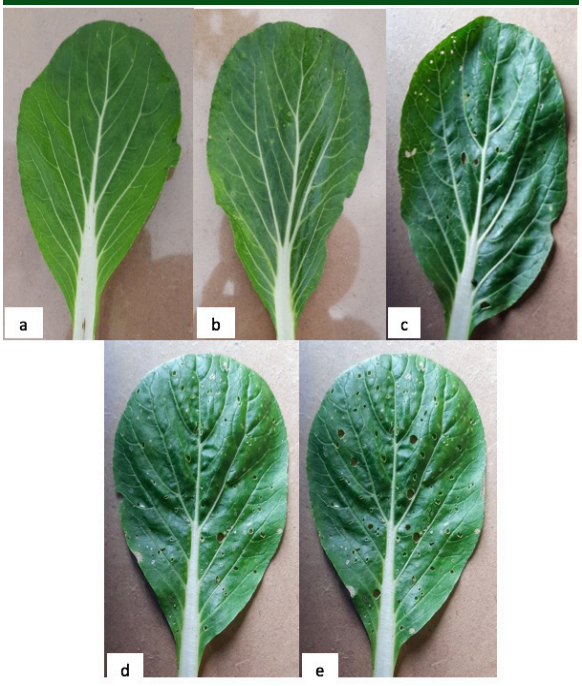
This was computed by subtracting the weight of the two variety treatment samples from the insecticide-treated samples. The yield loss was computed using the formula below:

Yield Loss = Mean weight of insecticide in treated samples – Mean weight of samples from different/other treatments/management strategies

Return on Investment (ROI). This was computed after attaining the total expenses and total sales in the production for each treatment. The total

Figure 1

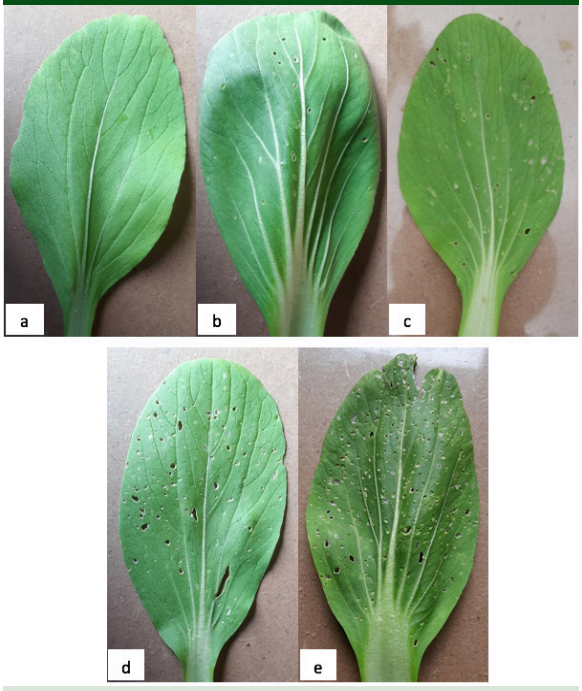
Appearance on the Degree of Injury on Black Behi



(a) sound degree of injury (b) slight degree of injury (c) moderate degree of injury (d) slightly severe degree of injury (e) severe degree of injury

Figure 2

Appearance on the Degree of Injury on Cherokee



(a) sound degree of injury (b) slight degree of injury (c) moderate degree of injury (d) slightly severe degree of injury (e) severe degree of injury

sales were computed based on the selling price of organic pechay at the BSU Marketing Center, which is 70 per kilogram. The ROI was computed using this formula:

$$ROI = \frac{\text{Net Profit}}{\text{Investment Cost}} \times 100$$

Degree of Efficacy of Management Strategies. This is the correlation on the yield of pechay between insecticide-treated and engineering management strategies.

$$\text{Degree of Efficacy of Treatments} = \frac{\text{Treatment}}{\text{Insecticide Treated}} \times 100$$

Degree of Contribution of Treatments. This was determined by using the equation:

Efficacy of Treatments – Untreated

Treatment of Data

Data were analyzed using Analysis of Variance (ANOVA).

Results and Discussion

Population of Flea Beetles

Influence of Varieties

The flea beetle mean population collected from the first to the last assessment period was almost similar in both varieties of pechay (Table 1).

Influence of Management Strategies

Regardless of variety, the management strategies had a significant impact on the mean population of flea beetles. The use of a sticky trap with a mean population of 74.03 showed the highest insect population collected comparable to sticky trap combined with sweeping (62.54) and when combined with row cover (54.84) respectively. The rest of the management strategies used had lower insect counts collected comparable with the untreated (Table 2). Further, netting the plants and netting + row cover and treatment combination of row cover + sticky trap + netting + sweeping also did not allow build-up of target pest population which could be due to the physical barriers installed however their numerical differences were insignificant.

Table 1

Mean Population of Flea Beetle on the Two Varieties of Pechay/Plot

Variety	Mean
Black Behi	20.39
Cherokee	27.29

The results imply that the management strategy using sticky traps on the two varieties lowered the population of flea beetles. This finding aligns with Demirel and Cranshaw's 2006 study on spring canola, which indicated that yellow sticky traps were attractive to flea beetle species due to the visual stimuli released by plant foliage in the green-yellow region of the spectrum. Thus, flea beetles may similarly prefer this color range to stimulate food and host-finding behavior.

Influence of the Varieties and Management Strategies

As presented in Table 3, there was no positive

Table 2

Mean Population of Flea Beetles/Plot on Pechay Varieties as Affected by the Different Treatments

Management Strategy	Mean
Untreated	28.00[b]
Insecticide-treated	2.78[b]
Row cover	3.88[b]
Sweeping	18.12[b]
Sticky Trap	74.03[a]
Netting	1.91[b]
Sweeping + Sticky Trap	62.54[a]
Sweeping + Row Cover	28.33[b]
Sweeping + Netting	4.53[b]
Sticky Trap + Row Cover	54.84[a]
Sticky Trap + Netting	27.19[b]
Netting + Row Cover	1.75[b]
Row Cover + Sticky Trap + Netting + Sweeping	2.07[b]

Means with the same letter are not significantly different at 5% level (DMRT)

Table 3

Interaction Effect on the Population of Flea Beetle/ Plot with Different Treatments and Pechay Varieties

Management Strategy	Mean Population	
	Black Behi	Cherokee
Untreated	19.44	36.56
Insecticide-treated	2.00	3.56
Row cover	3.81	3.94
Sweeping	16.36	19.88
Sticky Trap	65.63	82.44
Netting	1.19	2.63
Sweeping + Sticky Trap	51.31	73.77
Sweeping + Row Cover	21.75	34.91
Sweeping + Netting	3.20	5.86
Sticky Trap + Row Cover	53.81	55.88
Sticky Trap + Netting	23.50	30.88
Netting + Row Cover	1.13	2.38
Row Cover + Sticky Trap + Netting + Sweeping	1.98	2.16

interaction between varieties of pechay and any of the treatments or management strategies employed.

Degree of Injury

Influence of Varieties

As to the degree of injury inflicted by flea beetles on the varieties, Black Behi showed significantly lower damage with a mean of 23% described as slight, whereas Cherokee had 30% assessed damage equivalent to moderate from the scale used (Table 4). This result implies that the flea beetle has a higher feeding preference for the Cherokee regardless of treatments employed.

Table 4

Mean Degree of Injury (%) of Flea Beetles on Two Varieties of Pechay/Plot

Variety	Mean
Black Behi	22.94^{b}
Cherokee	30.01^{a}

Means with the same letter are not significantly different at 5% level (DMRT)

Influence of Management Strategies

Based on the findings, management strategies had significant influences on the degree of injury by flea beetles regardless of the variety used. This was shown in the mean degree of injury recorded where, comparable effects of management such as netting, insecticide spraying, netting + row cover, sweeping + netting, sticky trap + netting, and a combination of the four treatment strategies could protect the plants from severe injuries due to the target insect with means of 0.33, 0.37, 0.41, 0.49, 0.52, and 0.13, respectively. The mean of the combination of row cover + sticky trap + netting + sweeping showed the most protection from insect damage compared to the rest of the treatments of management strategies applied singly. The row cover and sticky trap which gave mean injuries of 62.57 and 60.33 equivalent to slightly severe injury based on rating scale used even higher than the untreated plants (42.48) as presented in Table 5.

The results align with the study of Martin et al. (2006) indicating that netting significantly lowers populations of lepidopteran larvae and diamondback moths on cabbage, while the Bockmann (2022) study on leek and cabbage

Table 5

Mean Population of Flea Beetles/Plot on Pechay Varieties as Affected by the Different Treatments

Management Strategy	Mean (%)
Untreated	42.48^{bc}
Insecticide-treated	0.37^{d}
Row cover	62.57^{a}
Sweeping	47.24^{abc}
Sticky Trap	60.33^{a}
Netting	0.33^{d}
Sweeping + Sticky Trap	36.26^{c}
Sweeping + Row Cover	56.67^{ab}
Sweeping + Netting	0.49^{d}
Sticky Trap + Row Cover	36.38^{c}
Sticky Trap + Netting	0.52^{d}
Netting + Row Cover	0.41^{d}
Row Cover + Sticky Trap + Netting + Sweeping	0.13^{d}

Means with the same letter are not significantly different at 5% level (DMRT)

further supports the effectiveness of net covers, especially with a 0.8mm mesh size, in protecting crops from pests compared to cautious insecticide use.

On the contrary, row cover had the highest leaf injury attributed to the unforeseen entry of flea beetles during routine activities like watering, weeding, and fertilizer application. This damage confirmed the reproduction of flea beetles, influenced by the elevated temperature within the row cover, aligning with the statement and observation of Ngumbi (2020) that rising temperatures accelerate insect metabolism, leading to increased energy consumption, faster and larger development, reduced mortality, faster reproduction, and higher egg-laying rates, ultimately resulting in elevated pest populations and subsequent crop damage.

Influence of Varieties and Management Strategies

The lowest percentage on the degree of injury on a single treatment were from Cherokee using netting, Cherokee treated with insecticide, Black Behi with netting, and insecticide-treated mean values ranging from 0.28% to 0.42% which were not significant. However, these were not significant from combined treatments on Black Behi using netting + row cover, Cherokee on netting + row cover, Black Behi and Cherokee using sweeping + netting, and Black Behi and Cherokee with sticky trap + netting ranging from 0.38% to 0.53%.

Combined management practices row cover + sticky trap + netting + sweeping on Black Behi had the lowest degree of leaf injury with a mean of 0.10%, followed by Cherokee with 0.15%. Insecticide treatment on Cherokee and Black Behi recorded corresponding means of 0.33% and 0.45%, while untreated Cherokee and Black behi varieties showed 45.62% and 39.35%, respectively.

The highest degree of injury from a single treatment was from Cherokee installed with row cover, with a mean of 71.05% followed by Cherokee using sticky trap and row cover and Black Behi on row cover 69.91%, 54.57% and 54.09%, respectively (Table 6). However, these were comparable to sweeping + row cover with Cherokee and Black Behi varieties with means of 58.34% and 55.00%.

Although the degree of injury by flea beetles had no significant interactive effect between the varieties and any of the treatments used, combining four of the strategies showed the least injury (Row cover + sticky trap +netting + sweeping) and the plant protection provided was even better than the use of insecticide which is more hazardous to both human and environment (Table 6).

Table 6

Interaction Effect of Degree of Injury of Flea Beetle with Different Treatments and Pechay Varieties

Management Strategy	Mean Degree (%)	
	Black Behi	Cherokee
Untreated	39.35	45.62
Insecticide-treated	0.42	0.33
Row cover	54.09	71.05
Sweeping	39.91	54.57
Sticky Trap	50.76	69.91
Netting	0.38	0.28
Sweeping + Sticky Trap	25.79	46.73
Sweeping + Row Cover	55.00	58.34
Sweeping + Netting	0.48	0.50
Sticky Trap + Row Cover	31.02	41.74
Sticky Trap + Netting	0.52	0.53
Netting + Row Cover	0.38	0.44
Row Cover + Sticky Trap + Netting + Sweeping	0.10	0.15

Yield

Influence of Variety

Results showed that although moderate plant damage was recorded on the Cherokee variety compared to Black Behi with only slight damage, they have comparable yield based on the rounded-off mean of total yield by weight at 4 kg/plot (Table 7).

Table 7

Mean Yield on the Two Varieties of Pechay at Harvest

Variety	Mean (kg/plot)
Black Behi	3.96
Cherokee	3.95

Means with the same letter are not significantly different at 5% level (DMRT)

Influence of Management Strategies

Based on data presented in Table 8, among the management strategies against flea beetle evaluated, insecticide spraying exhibited significantly the highest mean yield (5.50kg) without particular regard for the variety, followed by netting and sweeping + netting strategies with mean yields of 4.63kg and 4.53kg respectively. These latter two management options with combinations applied however are more of creating physical barriers to prevent or minimize the attack of flea beetles. The rest of the management approaches used gave lower mean yield but generally had comparable effects. It was sweeping + row cover (2.94kg) that was significantly least effective in protecting the plants from insect attack or it could be that the row cover somehow affected the photosynthetic activities of the plants being covered right from seedling emergence.

The study results indicate that using insecticide on growing pechay is more effective than various engineering management strategies. Selectron spraying proved successful in controlling flea beetles, minimizing disturbances to pechay plant growth. On the other hand, row cover methods, such as sweeping + row cover and sticky trap + row cover, did not yield well due to increased temperatures inside the cover causing heat stress. High temperatures can negatively impact plant photosynthesis, transpiration efficiency, and root development, leading to reduced yield. This decline is often attributed to lower internal CO_2 levels, inhibition of photosynthetic enzymes, and reduced ATP synthesis, which is essential for regulating plant biochemical reactions (Traunfeld, 2021; Irmak, 2016).

Table 8

Mean Yield of Pechay Varieties as Affected by Different Treatments

Management Strategy	Mean Yield (kg)
Untreated	3.85^{cd}
Insecticide-treated	5.50^{a}
Row cover	3.45^{de}
Sweeping	3.66^{cd}
Sticky Trap	3.48^{de}
Netting	4.63^{b}
Sweeping + Sticky Trap	3.88^{cd}
Sweeping + Row Cover	2.94^{e}
Sweeping + Netting	4.53^{b}
Sticky Trap + Row Cover	$3.45d^{e}$
Sticky Trap + Netting	4.16^{bc}
Netting + Row Cover	3.83^{cd}
Row Cover + Sticky Trap + Netting + Sweeping	4.05^{bcd}

Means with the same letter are not significantly different at 5% level (DMRT)

Influence of Varieties and Management Strategies

Based on the statistical analysis used, there was no clear interaction between the varieties and any of the management approaches evaluated as to their effect on the mean yield of pechay (Table 9).

Both varieties of pechay used, Black Behi and Cherokee, were hybrids that are commercially available varieties. In addition, the flea beetle mean population collected from both varieties is almost similar (Table 1). Furthermore, the different management strategies employed did not allow the build-up of flea beetle population although there is a difference in numerical count but insignificant.

Table 9

Interaction Effect on Yield (kg) as Affected by Treatment and Varieties of Pechay

Management Strategy	Mean Yield	
	Black Behi	Cherokee
Untreated	3.76	3.95
Insecticide-treated	5.34	5.66
Row cover	3.74	3.17
Sweeping	3.67	3.64
Sticky Trap	3.50	3.46
Netting	4.38	4.88
Sweeping + Sticky Trap	3.88	3.88
Sweeping + Row Cover	2.99	2.90
Sweeping + Netting	4.42	4.64
Sticky Trap + Row Cover	3.50	3.40
Sticky Trap + Netting	4.06	4.27
Netting + Row Cover	4.10	3.56
Row Cover + Sticky Trap + Netting + Sweeping	4.21	3.89

Yield Loss

Influence of Variety

Consistent with the data on crop injury inflicted by flea beetles, a significantly higher yield loss was displayed by Cherokee with almost 2kg on its total weight over the Black Behi variety with 1.3kg having only slight injury due to insect infestation (Table 10).

Table 10

Mean Yield Loss on Two Varieties of Pechay

Variety	Mean (kg)
Black Behi	1.30[b]
Cherokee	1.76[a]

Means with the same letter are not significantly different at 5% level (DMRT)

Influence of Management Strategies

Among the management strategies evaluated, plants sprayed with insecticide significantly outranked all treatments with their zero-yield loss, closely followed by netting (0.40kg). The rest of the treatments had yield loss ranging from 1.33kg to 2.11kg. However, sweeping + row cover significantly stands out in its ineffectiveness due to having the highest yield loss (2.68kg.) recorded (Table 11), consistent with its least mean yield as presented in Table 8.

On two combined treatments, sweeping + netting recorded the least yield loss, with a mean of 0.97kg followed by sticky trap + netting (1.33kg), sweeping + sticky trap (1.62kg), and netting + row cover (1.67kg). The highest was on sweeping + row cover, with a mean of 2.68kg. On the other hand, row cover + sticky trap + netting + sweeping recorded lower yield loss than untreated, with corresponding means of 1.45kg and 1.77kg, respectively.

Influence of Varieties and Management Strategies

Results showed that neither of the varieties nor any of the management strategies employed showed a positive relationship about the mean yield loss obtained from this study (Table 12).

Table 11

Mean Yield Loss of the Two Varieties of Pechay with Different Management Strategies

Management Strategy	Mean Yield Loss
Untreated	1.77[bc]
Insecticide-treated	0.00[f]
Row cover	2.05[ab]
Sweeping	1.84[bc]
Sticky Trap	2.02[bc]
Netting	0.40[ef]
Sweeping + Sticky Trap	1.62[bcd]
Sweeping + Row Cover	2.68[a]
Sweeping + Netting	0.97[de]
Sticky Trap + Row Cover	2.11[ab]
Sticky Trap + Netting	1.33[cd]
Netting + Row Cover	1.67[bc]
Row Cover + Sticky Trap + Netting + Sweeping	1.45[bcd]

Means with the same letter are not significantly different at 5% level (DMRT)

Table 12

Interaction Effect on the Mean Yield Loss with Different Treatments and Varieties of Pechay

Management Strategy	Mean Yield Loss	
	Black Behi	Cherokee
Untreated	1.58	1.96
Insecticide-treated	0.00	0.00
Row cover	1.60	2.50
Sweeping	1.66	2.02
Sticky Trap	1.84	2.20
Netting	0.01	0.78
Sweeping + Sticky Trap	1.45	1.78
Sweeping + Row Cover	2.35	3.02
Sweeping + Netting	0.91	1.02
Sticky Trap + Row Cover	1.84	2.38
Sticky Trap + Netting	1.27	1.39
Netting + Row Cover	1.24	2.10
Row Cover + Sticky Trap + Netting + Sweeping	1.13	1.78

Degree of Efficacy and Contribution of Treatments

Degree of Efficacy of Treatments Compared to Insecticide-treated

Table 13 shows no positive relationship in the interaction between varieties and management strategies as to the degree of efficacy. Results revealed that netting integrate in its designs were effective as suppression of flea beetles before using insecticides as final control measure. This means that such treatments could be used as component of pest management of flea beetles.

Degree of Contribution of Treatments Compared to Untreated

Cherokee variety on insecticide-treated plants recorded the highest degree of contribution. This was followed by insecticide-treated Black Behi, Cherokee on netting, and netting alone on Black Behi garnered respective means of 11.61%, 29.59%, 16.43%, and 30.21% (Table 14).

Table 13

Degree of Efficacy (%) of Pechay Varieties as Affected by Different Treatments

Management Strategy	Degree of Efficacy of Treatments	
	Black Behi	Cherokee
Untreated	70.41	69.79
Insecticide-treated	100.00	100.00
Row cover	70.04	56.00
Sweeping	68.73	68.16
Sticky Trap	65.54	61.13
Netting	82.02	86.22
Sweeping + Sticky Trap	72.66	68.55
Sweeping + Row Cover	56.00	51.24
Sweeping + Netting	82.77	81.98
Sticky Trap + Row Cover	65.54	60.07
Sticky Trap + Netting	76.03	75.44
Netting + Row Cover	76.78	62.90
Row Cover + Sticky Trap + Netting + Sweeping	78.84	68.73

Table 14

Degree of Contribution (%) of Different Treatments to Pechay Varieties

Management Strategy	Degree of Contribution of Treatments	
	Black Behi	Cherokee
Untreated	70.41	69.79
Insecticide-treated	29.59	30.21
Row cover	-0.37	-13.79
Sweeping	-1.68	-1.63
Sticky Trap	-4.87	-8.66
Netting	11.61	16.43
Sweeping + Sticky Trap	2.25	-1.24
Sweeping + Row Cover	-14.41	-18.55
Sweeping + Netting	12.36	12.19
Sticky Trap + Row Cover	-4.87	-9.72
Sticky Trap + Netting	5.62	5.65
Netting + Row Cover	6.47	-6.89
Row Cover + Sticky Trap + Netting + Sweeping	8.43	-1.06

The different pest management strategies employed have varied degrees of contribution compared to the untreated against flea beetle regardless of the variety. Compared to the untreated plants, the different treatments generally reduced pest population and damage by the insect pest.

Among the five single strategies evaluated, insecticide spraying gave the greatest (39%) contribution as a management strategy in both Black Behi and Cherokee varieties. However, netting gave the highest control contribution (12-16%) among the single physical protective measures employed. As to the treatments with a combination of strategies, sweeping + netting gave the highest contribution of control (12%) but sweeping + row cover had the most negative impact in contributing to pest control (-14 to -18%). Nevertheless, in both pechay varieties, leaving the plants unsprayed or without any strategies applied, the plants can withstand insect damage and still produce a yield that is even organic and with a considerably high ROI (Table 15). Most people are aware that pechay is a

short-maturing crop, needs no pesticide, and is a common vegetable on every family table.

Return of Investments

Among the management approaches evaluated, netting gave the highest ROI in the Black Behi variety with 675.68%, followed by sweeping + netting (556.97%). The lowest was gained from the use of insecticide to protect plants from flea beetle attacks. In the case of variety Cherokee, however, sweeping + netting gave the highest ROI, closely followed by netting. Under this variety, the lowest ROI was obtained from sweeping + row cover. In the organic outlets, products sprayed with pesticide command very low prices, which affect the ROI, and therefore organically grown crops paid with higher prices eventually increase their ROI. Also, the cost of materials and labor used in managing the major insect pests may have contributed more to lowering profit gained or ROI.

Table 15

Return of Investment on Pechay Varieties as Affected by Different Treatments

Management Strategy	Return on Investment (%)	
	Black Behi	Cherokee
Untreated	508.91	452.05
Insecticide-treated	312.81	308.34
Row cover	458.89	338.05
Sweeping	474.35	425.42
Sticky Trap	396.78	357.17
Netting	675.68	558.61
Sweeping + Sticky Trap	434.72	452.04
Sweeping + Row Cover	355.84	295.10
Sweeping + Netting	556.97	576.21
Sticky Trap + Row Cover	363.21	304.89
Sticky Trap + Netting	425.08	296.28
Netting + Row Cover	462.02	349.40
Row Cover + Sticky Trap + Netting + Sweeping	410.13	430.31

1/Current Price: Organic – P70.00 GAP – P40.00

Conclusions

Results indicate that the use of netting alone, netting + row cover, and row cover + sticky trap + netting + sweeping effectively reduced the population of flea beetles infesting the two pechay varieties as compared to insecticide-treated and untreated. The same above treatments also recorded the lowest percentage of leaf injury, equivalent to sound or no injury than insecticide-treated and untreated. The highest yield, however, was produced from insecticide-treated pechay, followed by netting alone and netting combined with other treatments but not significant from untreated. The lowest yield loss was recorded from insecticide treatment and sweeping + netting treatment.

Black Behi performed better in controlling flea beetle populations in terms of variety. Meanwhile, the highest degree of efficacy was recorded on the Cherokee variety treated with netting, Black Behi with sweeping + netting, and Black Behi with row cover + sticky trap + netting + sweeping. The highest degree of contribution was from Cherokee treated with insecticide and Black Behi with sweeping + netting. Treatment using row cover + sticky trap + netting + sweeping on Black Behi recorded significantly lower than insecticide-treated. The highest ROI was from Black Behi using netting alone, Black Behi with sweeping + netting and row cover + sticky trap + netting + sweeping compared to insecticide-treated.

Recommendations

Based on the results, netting as a management strategy can be effectively used to control flea beetle infestation, either single or with combinations. In terms of variety, Black Behi performed better in terms of flea beetle population, degree of injury and yield loss, and higher yield and return on investment.

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