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Effect of Neem Extract in Controlling Flea Beetle (*Phyllotreta cruciferae*) in Radish (*Raphanus sativus*) and Other Major Pests of Horticultural Crops

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ABSTRACT

An experiment was conducted to investigate the neem based pesticides and application of neem based pesticides to manage *Phyllotreta cruciferae* population in *Raphanus sativus* and other major pest of horticultural crops. The economic threshold for a foliar application was when an average of 25% of the surface area of cotyledons and first true leaves have been injured and beetles are present. Two neem based pesticides with control were applied as treatments at five day intervals due to the degradation of neem from UV light. A neem seed extract and a leaf extract were investigated to manage flea beetle in radish. Both neem seed extracts and neem leaf extracts, proved to be effective in managing flea beetle in radish. But, neem seed extract was recorded less damage over neem leaf extract. Seed extract and leaf extract were not significantly different in leaf dry weight and tuber dry weight. Hence, the highest leaf and tuber dry weight were recorded in neem seed extract than the neem leaf extract. Although the cost for neem seeds is high in neem seed extract, it can be used to manage flea beetle successfully. Therefore, farmers are advisable to use neem seed extract to manage flea beetle in radish as an environmental friendly management method. Further, neem seed extract can be used to manage scales, thrips, whiteflies and mealy bugs organically than the neem leaf extract.

KEYWORDS: Neem leaf extract, Neem seed extract, *Phyllotreta cruciferae, Raphanus sativus*

INTRODUCTION

Radish (*Raphanus sativus*) belongs to family Brassicaceae is a popular root vegetable grown throughout the year. It can be successfully grown in both tropical and temperate regions. Radish needs light, friable and humid soil. The optimum soil pH should be 5.5-6.8. Radish is rich in vitamin A, B and C (Arya, 2002). Radishes are crops grown for their swollen tap roots which can be globular, tapering or cylindrical in shape. Its entire plant is edible and the tops can be used as a leafy vegetable. Further, radish seeds used to extract radish seed oil (Dixon, 2007).

It is estimated that the world production of radish was seven million t/year, (Kopta and Pokluda, 2013). In Sri Lanka during 2013/2014 *Maha* season the extent of radish cultivation was 1,122 ha and the production was 10,446 mt (Anon, 2014). Further, the major radish cultivating districts were Nuwaraeliya, Badulla, Kaluthara and Galle. Japan ball, *Beeralu raabu*, Table radish are the recommended radish varieties in Sri Lanka (Anon, 2013). Club root, alternaria blight, downey mildew, and black root are some of the common diseases of radish and aphids, cut worms and flea beetles are the major pests of radish (Delahaunt and Newenhouse, 1998). Flea beetle [*Phyllotreta cruciferae* (Coleoptera: Chrysomelidae)] is the most common and destructive pest of radish (Bohinc and Trdan, 2012).

Adult *Phyllotreta cruciferae* feed on cotyledons and developing leaves and stems of seedlings, leading to loss of photosynthetic capability and it leads to plant death (Tangtrakulwanich *et al.*, 2014). Feeding starts at the first two weeks after beetle emergence, and produces a shot-hole appearance and necrosis (Knodel and Olson, 2002). Feeding injury is greatest when it is warm, dry and calm (Soroka and Elliott, 2011). According to Adikari *et al.* (2014), the flea beetle population was high between 9.00 am to 3.00 p.m. during the daytime.

Therefore, application of broad spectrum insecticides was one of the control measures of *Phyllotreta cruciferae* (Mayoori and Mikunthan, 2009). The economic threshold for a foliar application was when an average of 25% of the surface area of cotyledons and first true leaves have been injured and beetles are present (Knodel and Olson, 2002). However, when consuming the radish, there is a chance to consume the chemical residues within inorganic pesticide application.

Application of organic pesticides is an important ecofriendly pest management method. Variety of neem based products are used as insecticide, pesticide, fumigant, fertilizer *etc.* (Lokanadhan *et al.*, 2012).

Further, neem can be more economically viable pest controlling method of family brassicaceae crops (Sow *et al.*, 2013).

Neem pesticides can be extracted from the neem tree (*Azadirachta indica*). Azadirachtin is the most important and active component (Dubhashi *et al.*, 2013).

The most important property of neem is feeding deterrence. If the leaf is treated with a neem product, because of the presence of azadirachtin, there will be an anti-peristaltic wave in the alimentarycanal which produces something similar to a vomiting sensation in the insect. Because of this sensation, the insect does not feed on the neem treated surface. Its ability to swallow is also blocked (Lokanadhan *et al.*, 2012). Since neem is susceptible to UV light it breaks down quickly (Buss and Brown, 2002).

People consume radish in different methods. Therefore, organically flea beetle management is crucial than inorganic management. Therefore, this study was conducted to investigate the neem based pesticides and application of neem based pesticides to manage *P. cruciferae* population in *R. sativus* and other major pests of horticultural crops.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at the Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura situated in the Low country Intermediate Zone (IL_{1a}), at elevation of 30 m from mean sea level. The experiment was carried out from January to April 2016.

The rainfall at Makandura during the experimental period was 1.02 mm, while the relative humidity and temperature were 80%, 35.6 °C respectively.

Land and Bed Preparation

Land was ploughed to 30-40 cm depth. Soil was further prepared to obtain a fine tilth. Fifteen raised beds (2×2 m) were prepared keeping 30 cm row distance.

Crop Establishment and Maintenance

Two days before seeds sowing organic and inorganic fertilizers (Urea, TSP and MOP) were incorporated to soil according to the recommendations of the Department of the Agriculture (DOA; Table1).

Each bed contained six rows and row seeding was practiced (30×10 cm). Thinning out was done twenty days after seed sowing keeping 10 cm gap between two plants.

Table 1. Fertilizer recommendation of radish (kg/ha)

Fertilizer	Urea	TSP	MOP
BD	90	110	65
TD (3 WAS)	90	-	65

TSP-Tri Super Phosphate, MOP- Muriate of Potash, BD-Basal dressing, TD-Top dressing, WAS-Weeks after sowing

Preparation of Neem Pesticides

Neem Seed Extract

Fifty grams of neem seeds were taken and seed coat was removed. Seeds were pounded gently without coming the oil to outside. Neem seed powder was gathered in a muslin pouch and soaked three days in 750 mL of water. The pouch was squeezed and the extract was filtered. The filtered was volume up to 1000 mL. Soap was added as an emulsifier (1 mL emu. / 1 L water; Sridhar and Vijayalakshmi, 2002).

Neem Leaf Extract

Two hundred grams of neem leaves were taken and soaked three days in 750 mL of water. Water soaked leaves were grounded and the extract was filtered and volume up to 1000 mL. Soap water was added as an emulsifier (1 mL of emu. / 1 L of water; Sridhar and Vijayalakshmi, 2002).

Quality Determination of Neem Pesticides

Determination of pH of Neem Extracts

The electrodes were lowered into the neem extract and the pH meter reading was noted (Kovo, 2006).

Determination of Acid Value

Two millilitres of neem extract was dissolved in ethanol and titrated with 0.1 KOH using one millilitre of phenolpthalein indicator (Kovo, 2006).

Determination of Saponification Value

Two millilitres of neem extract was dissolved in 25 mL of alcoholic KOH and it was boiled gently at temperature of 35 °C shacking from time to time for 60 min. One millilitre of the phenolphthalein solution was added to the hot solution and titrated with 0.5 HCl. The blank test was carried out without neem extract following the above procedure (Kovo, 2006).

Management of Common Horticultural Pests by Neem Extracts

Pest samples (Mealy bug, scales, thrips, white fly and flea beetle) were collected to plastic containers and different treatments were applied. Later pest mortality was counted. Each treatment was replicated nine times. Further, each replicate contained five pests except mealy bug. Treatments were sprayed 0.6 m away from pests using hand sprayer.

Damage Severity

To determine the damaged area, the damage severity index was developed. The damage was assessed by measuring the amount of leaf area injured by flea beetle and comparing

with the total leaf surface area in order to calculate the percentage of leaf area damaged on each leaf. The leaf area and damaged area was measured by using grid method (Table 2).

Table 2. Scores for measure the leaf area injured by *Phyllotreta cruciferae*

Score	Leaf damage percentage (%)
1	No visual damage
2	1-10
3	11-20
4	21-30
5	30<

Treatment Application

Two neem based pesticides with control were applied as treatments at 5 day intervals (Table 3).

Table 3. Tested neem pesticides

Treatment	Neem pesticides
T_1	Neem seed extract
T_2	Neem leaf extract
T_3	Control (Tap water)

Data Recording

Before and after applying the neem pesticides, damage severity (Table 2) was detected in 50 randomly selected plants from each treatment.

Further, leaf length, leaf fresh weight, leaf dry weight, tuber length, tuber diameter, tuber fresh weight and tuber dry weight were collected from twenty randomly selected plants from each treatment in each replicate.

Cost Analysis

Cost for neem extract preparation per hectare was calculated.

Statistical Analysis

The data obtained from experiment was statistically analyzed using Minitab 16 software and mean separation was done using turkey t test. The damage severity was statistically analyzed by Kruskal – Wallis test using Minitab 16 software.

RESULTS AND DISCUSSION

Quality Determination of Neem Pesticides

The following quality parameters were recorded in neem seed and neem leaf extract (Table 4).

Table 4. *Quality parameters of neem pesticides*

Parameter	Neem seed extract	Neem leaf extract
pH	5.93	4.22
Acidity	1.40 mL/g	0.84 mL/g
Saponification	192.14 mL/g	187.94 mL/g

Yield

According to the obtained results, no significant differences were observed between and T_1 and T_2 in tuber length, diameter, fresh weight and dry weight. While, there was a significant difference in treatments when compared T_1 and T_2 with control. Further, the highest tuber fresh weight, dry weight and diameter were recorded in neem seed extract treated plants (Table 5).

Table 5. Yield parameters of tubers among tested pesticides

TRT	LEN (cm)	DIA (mm)	FWT (g/plant)	DWT (g/plant)
T_1	12.5^a	16.1^a	23.2^a	1.5^a
T_2	11.1^{ab}	15.1^a	19.1^a	1.3^a
T_3	9.2^b	8.5^b	6.8^b	0.5^b
R-Sq	7.9	16.9	15.9	11.5

Means in a column with same letters are not significantly different at 0.05 level. TRT- Treatment, LEN- Length, DIA- Diameter, FWT- Fresh weight, DWT- Dry weight. T_1- Neem seed extract, T_2- Neem leaf extract, T_3- Control (Tap water)

Further, there were no significant differences were observed in T_1 and T_2 of leaf length, leaf fresh weight and leaf dry weight while, the highest leaf fresh weight and dry weight and length were recorded in neem seed extract treated plants (Table 6).

Table 6. Yield parameters of leaves among tested pesticides

TRT	LEN (cm)	FWT (g/plant)	DWT (g/plant)
T_1	21.3^a	30.6^a	3.4^a
T_2	19.8^a	26.8^a	2.7^a
T_3	13.7^b	13.1^b	1.0^b
R-Sq	34.8	17.5	29.5

Means in a column with same letters are not significantly different at 0.05 level. TRT- Treatments, LEN- Length, FWT- Fresh weight, DWT- Dry weight. T_1- Neem seed extract, T_2- Neem leaf extract, T_3- Control (Tap water)

Damage Severity

When concern about damage severity, significant difference was observed among the treatments (0.05>P). According to the median values both seed extract (T_1) and the leaf extract (T_2) can be used to manage flea beetle population when compare with the control (T_3). But, T_1 recorded the lowest average rank. Therefore, the neem seed extract (T_1) can be used to manage flea beetle successfully than neem leaf extract (T_2; Table 7).

Management of Common Horticultural Pests by Neem Pesticides

All the pests were died less than 15 number of days when compare with control.

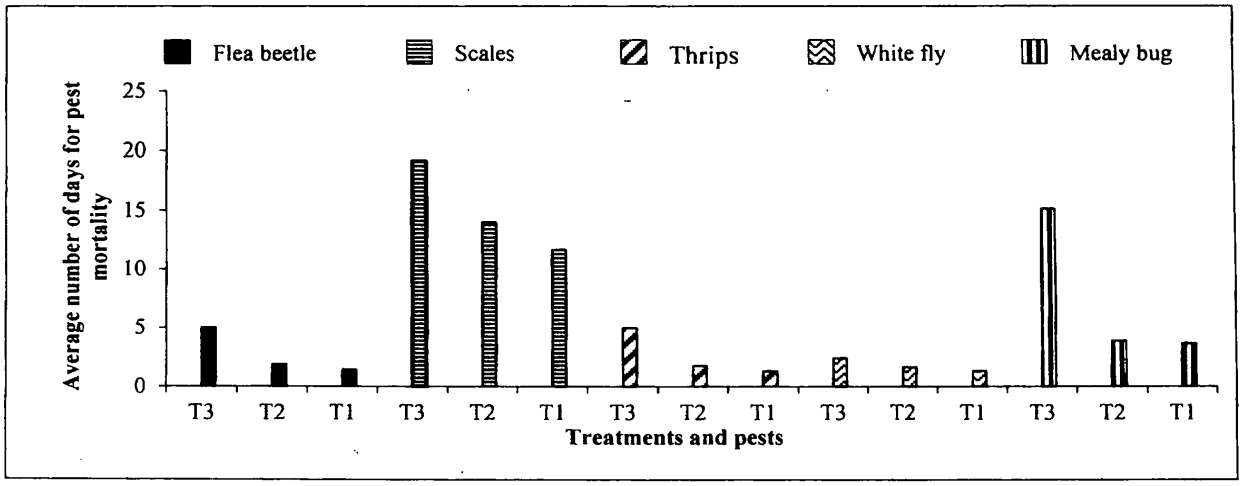

Figure 1. Management of common horticultural pests by neem pesticides
T_1- Neem seed Extract, T_2- Neem leaf extract, T_3- Control (Tap water)

But neem seed extract (T_1) was recorded highest mortality of different pests when compared with control (Figure 1).

Table 7. Damage severity on leaves

Treatment	Median	Ave rank
T_1	0.000	52.4
T_2	0.000	62.8
T_3	1.000	111.3
P value	0.000	

Significantly different at the $p<0.05$level. T_1- Neem seed extract, T_2- Neem leaf extract, T_3- Control (Tap water)

Cost Analysis

According to the cost analysis, cost for neem seed extract was higher than the leaf extract (Table 8).

Table 8. Cost analysis for extracts

Ingredient	Rate (kg/ha)	Cost/ha (Rs.)
Neem seeds	20	4000.00
Neem leaves	30	0000.00

CONCLUSIONS

Neem seed extract can be used to manage scales, thrips, whiteflies and mealy bugs organically by using neem seed extract than the neem leaf extract.

Both neem seed extracts and neem leaf extracts, proved to be effective in managing flea beetle in radish. But neem seed extract recorded less damage over neem leaf extract. Since seed extract and leaf extract were not significantly different for leaf dry weight and tuber dry weight, farmers may be advised to use both extracts. Although the cost for neem seeds is high in neem seed extract, it can be used to manage flea beetle successfully. Therefore, farmers are advisable to use neem seed extract in managing flea beetle in radish as an environmental friendly management method.

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