SUSCEPTIBILITIES OF THE CABAGE APHID, *BREVICORYNE BRASSICAE* (LINNAEUS) TO SELECTED ORGANOPHOSPOROUS INSECTICIDES

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ABSTRACT: In this study the effect of three insecticides including Trichlorophen, chlorpyriphos-methyl and Oxydemton-methyl on *Brevicoryne brassicae* in a leaf dip assay was investigated. At the highest and the lowest concentrations of Oxydemton-methyl 91.16 and 25 % mortality was achieved, respectively. Fifty percent mortality (LC_{50}) was recorded at 19.62 ppm with fudicial limit of 11.41 and 30.73 ppm. Also, LC_{10} and LC_{90} were estimated to be 1.08 and 356.27 ppm. When different concentrations of Trichlorophen was used at the lowest and the highest concentrations about 21.27 and 87.23 % mortality was achieved, respectively which correspond to 30 and 480 ppm of the insecticide doses. Lethal concentration of 10, 50 and 90% was calculated using probit analysis and estimated LC_{10}, LC_{50} and LC_{90} were 14.30, 95.96 and 643.89 ppms, respectively. Estimated lethal concentration of 10, 50 and 90 for chlorpyriphos-methyl were equal to 14.06, 59.65 and 253.10 ppm, respectively. Results showed that the most effective insecticide was Oxydemton-methyl with the LC_{50} value of 19.62 ppm followed by chlorpyriphos methyl with the LC_{50} value of 59.65 ppm and Trichlorophen with the LC_{50} value of 95.96 ppm. Therefore, Oxydemton-methyl act on insect through contact and systemic action that is major reason why this insecticide has low LC50 and is more effective than the other two insecticides which are contact and stomach insecticides.

KEY WORDS: Cabbage aphid, Oxydemton-methyl, Chlorpyriphos methyl, Trichlorophen.

The cabbage aphid *(Brevicoryne brassicae* L.) is a widely distributed and severe pest of horticultural and oil-seed brassica crops. The aphid first indentified in Europe, but now its distribution is worldwide especially in most countries with a temperate climate (Ellis & Singh, 1993; Singh & Ellis, 1993).

This aphid feeds exclusively on all cultivated and wild cruciferous plants. The aphid major plant hosts include: broccoli, Brussels sprouts, cauliflower, and head cabbage. It also feeds on the other species of the family Cruciferae, however, damage is usually less severe than on cabbage. Cabbage aphid populations, if not controlled, often build to very high densities. Heavily infested plants acquire a grayish appearance due to the mass of aphid bodies on the foliage.

Aphids feed by sucking sap from their hosts. Infested seedlings may become stunted and distorted. Continued feeding on mature plants causes wilting, yellowing and general stunting of the plants. Honeydew and sooty mold are often evident. High densities also cause the leaves to wrinkle and curl, usually cupping downward. Under dry conditions, aphids cause the plants to wilt, and leaf tissue that has been fed upon may turn yellow. Cabbage aphid prefers the youngest tissue and highest portions of the plant, but may occur on both the upper and lower surface of foliage. Flower heads of seed crops may be attacked, reducing the setting of seed. Contamination of the plants with honeydew and aphids can cause considerable loss (Trumble, 1982; Pickel et al., 1983).

In addition to the direct effects of feeding by aphids on plant growth, and the damage caused by aphid contamination of foliage, cabbage aphid can also be a vector of plant viruses. Over 30 viruses are known to be transmitted by *B. brassica*. Cauliflower mosaic and cabbage ring spot virus transmission were studied by Broadbent (1954). Cabbage aphid transmits cauliflower mosaic more effectively because this virus concentrates in the young tissue of the plant, which is the preferred feeding site of the aphid.

In warm climates aphid colonies consist completely of females. Reproduction does not involve mating or egg laying. Females give birth to live female nymphs. In temperate climates, aphids reproduce as above during the warmer periods of the year. In the fall, the reproduction changes. Males are produced in response to a decrease in photoperiod or temperature (Blackman & Eastop, 1984). Mating occurs and females lay eggs. Aphids overwinter in the egg stage. Life cycle duration ranges from 16 - 50 days and is greatly influenced by temperature. The life cycle is shortened at higher temperatures.

Naturally occurring parasites and predators are important factors in regulating population densities. Syrphid fly maggots and lady beetles are efficient predators of aphids. There are many insecticides that are effective against this aphid. Because of the waxy nature of the pest and crop, care must be taken that sprays provide good wetting of the crop. Proper rates of surfactants in combination with well adjusted spray equipment are important to achieve control with minimum effort. So, aim of the current study was to evaluate susceptibilities of cabbage aphid population to insecticides used for control of this aphid species in Iran. These insecticides include Trichlorophen, oxydemeton- methyl, and chlorpyriphos methyl. So, the efficacy of these insecticides on *Brevicoryne brassicae* was investigated to determine these insecticides effectiveness on the aphid. Bioassays using treated leaf disks were used to determine dose response curves for all insecticides used.

MATERIALS AND METHODS

Insect rearing

Brevicoryne brassicae used in these experiments were collected from rape field of Saveh and transferred to laboratory. The aphid was reared on rape var. Havila in greenhouse at 22 ± 2 °C, a 12 h light: 12 h dark cycle, and relative humidity of 70 ± 5%. These colonies were kept on each rearing plants for several generations. Every week (5-7 days) plants were replaced with new ones in order to keep colonies alive. Apterous adults from these colonies were used in this study. Seedlings used for aphids culturing as well as producing leaf disks for insecticide bioassays were grown in plastic pots in above mentioned conditions.

Toxicity bioassay

Three insecticides used in this experiment were Trichlorophen (Diptrex®), chlorpyriphos (Reldan®) and Oxydemton-methyl (Metasystox-R®) 25% EC (German's Bayer Company). Leaf dip assays were performed according to the procedures described by Lowery et al. (2005). Initially, for each insecticide on each population, bracketing test was done to determine doses that produce satisfactory range (10% - 90% mortality). The concentrations used for Trichlorophen were 0 (control), 30, 60, 120, 240, and 480 ppm. The concentrations used for Oxydemton-methyl were 0 (control), 3, 10, 30, 100, and 300 ppm and for chlorpyriphos were 0 (control), 20, 40, 80, 160 and 320 p pm.

All three insecticides were diluted with distilled water and each assay consisted of 25 apterous adult per treatment (each dose) and each treatment replicated 5 times. Plant leaf was cut (three weeks old seedlings leaf) and dipped into insecticide solution for 10 seconds and allowed to dry for 30 minutes before exposing the insects to it. For controls plant leaves were treated with distilled water alone.

Mortality was assessed after 24 hours. Mortality data were corrected with Abbott's formula (Abbot, 1925).

Data Analysis

In these experiments concentration-mortality regression for the adult from each bioassay was evaluated statistically using probit analysis (Polo-PC Probit and Logit analysis; LeOra Software 1997) to determine the lethal concentrations (LC_{50}s). Differences in toxicity were considered significant when 95 % Fiducial Limit (FL) did not overlap (Adams et al., 1990).

RESULTS

Toxicity of Oxydemton-methyl

In this experiment 5 doses of pesticide including 0 (control), 3, 10, 30, 100 and 300 ppm were used. At the highest and the lowest concentrations 91.16 and 25 % mortality was achieved, respectively. Fifty percent mortality (LC_{50}) was recorded at 19.62 ppm which fudicial limit was 11.41 and 30.73. Also, LC_{10} and LC_{90} were estimated to be 1.08 and 356.27 ppm, respectively (Table 1). Figure 1 shows regression line of effect of Oxydemton-methyl against *B. brassicae.*

Toxicity of Trichlorophen

Six concentrations including 0 (control), 30, 60, 120, 240 and 480 ppm of this insecticide were used in bioassay against *B. brassicae*. The lowest and the highest mortality obtained were 21.27 and 87.23 %, respectively which correspond to 30 and 480 ppm used doses of the insecticide.

Lethal concentration of 10, 50 and 90% was calculated using probit analysis and estimated LC_{10}, LC_{50} and LC_{90} were 14.30, 95.96 and 643.89 ppms, respectively (Table 1).

Figure 2 shows regression line of effect of Trichlorophen against B. brassicae.

Toxicity of chlorpyriphos methyl

In the bioassay of chlorpyriphos methyl against *B. brassicae* six concentrations including 0 (control), 20, 40, 80, 160, and 320 ppm were used. The highest and the lowest mortality obtained were 20.83 and 93.75 % which correspond to 20 and 320 ppm insecticide concentrations.

Estimated lethal concentration of 10, 50 and 90 were equal to 14.06, 59.65 and 253.10 ppm (Table 1). Figure 3 shows regression line of chlorpyriphos methyl against *B. brassicae.*

DISCUSSIONS

In this study the effect of three insecticides including Trichlorophen, chlorpyriphos methyl and Oxydemton-methyl on B. brassicae in a leaf dip assay was investigated. Results showed that the most effective insecticide was Oxydemton-methyl with the LC_{50} value of 19.62 ppm followed by chlorpyriphos methyl with the LC_{50} value of 59.65 ppm and Trichlorophen with the LC_{50} value of

95.96 ppm. Also there are significant differences between their toxicity toward the aphid since there are not overlap between upper and lower limit of LC_{50}s.

Although all these insecticide are from organsophosphate group that inhibits acetylcholinesterase enzyme so that disrupt nervous system, they have different toxicity toward cabbage aphid. Oxydemton-methyl is used for effective control of pest by contact and systemic action. It is used to control many destructive pests that attack certain vegetable, fruit, and field crops as well as ornamental flowers, shrubs, and trees. Primarily it is effective against aphids, mites, thrips, and sawflies.

Chlorpyrifos methyl is an organsophosphate insecticide, too and its popular trade names are Dursban, Empire and Lorsban. Chlorpyrifos is moderately toxic and chronic exposure has been linked to neurological effects, developmental disorders, and autoimmune disorders.

Chlorpyrifos methyl is used for control of pest in homes and gardens. However, since 2000 Chlorpyrifos methyl has been banned for use in homes and home garden because of health concerns in the area where it was being extensively used (Milne, 1995).

Chlorpyrifos methyl is "one of the most widely used organophosphate insecticides," according to the United States Environmental Protection Agency (EPA). The crops with the most intense chlorpyrifos methyl use are cotton, corn, almonds, and fruit trees including oranges and apples.

Trichlorfon is an organophosphate insecticide used to work both by contact and stomach poison action. It is used for vegetable, fruit and field crops. It is also used for control of insect on livestock, ornamental and forestry plantings (Simon, 2008).

Interestingly, when compare these insecticides slope it can be observed that Oxydemton-methyl, Trichlorfon and chlorpyrifos methyl have slope of equal to 1.01, 1.55 and 2.04, respectively.

Therefore, Oxydemton-methyl act on insect through contact and systemic action that is major reason why this insecticide has low LC50 and is more effective than the other two insecticides which are contact and stomach insecticides.

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Table 1. Estimation of LC_{10}, LC_{50}, and LC_{90} of oxydemeton-methyl, Trichlorophen and chlorpyriphos methyl against *Brevicoryne brassicae*.

Pesticides	LC_{10} (Fudicial limit)	LC_{50} (Fudicial limit)	LC_{90} (Fudicial limit)	X^2	df	Slope
oxydemeton-methyl	1.08 (0.25-2.50)	19.62 (11.41-30.73)	356.27 (184.69-1034.72)	1.40	3	1.01 ± 0.14
Trichlorophen	14.32 (5.10-25.57)	95.96 (66.58-129.56)	643.89 409.13-1391.91)	0.35	3	1.55 ± 0.23
chlorpyriphos methyl	14.06 (7.14-21.43)	59.65 (44.94-75.53)	253.10 (184.97-406.607)	2.45	3	2.04 ± 0.27

Units LC_{10}, LC_{50} and LC_{90} (PPM) estimated 24 h post application using probit analysis.

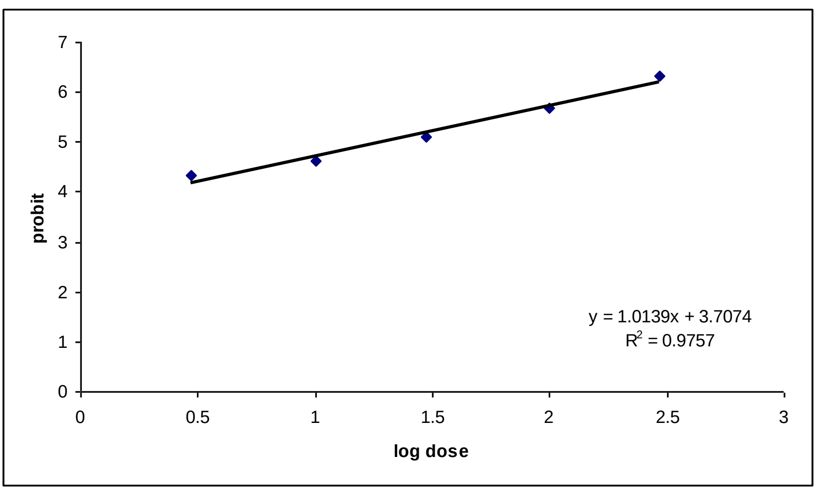

Figure 1. Regression line of effect of oxydemeton-methyl on *Brevicoryne brassicae*.

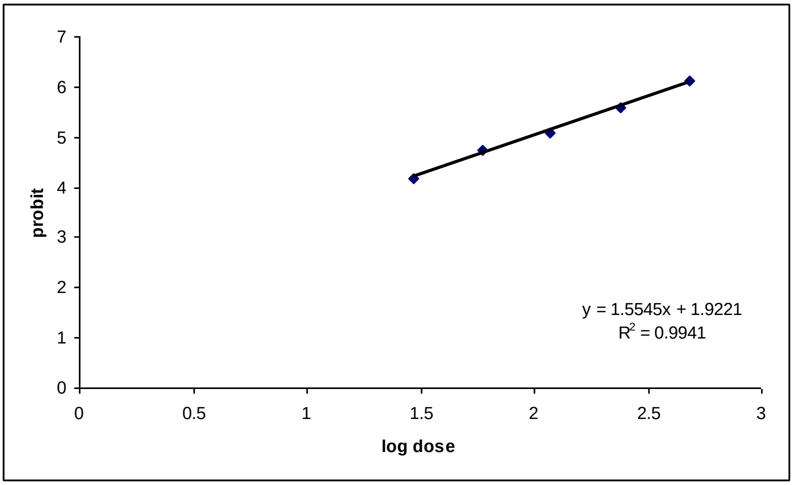

Figure 2. Regression line of effect of Trichlorophen on *Brevicoryne brassicae*.

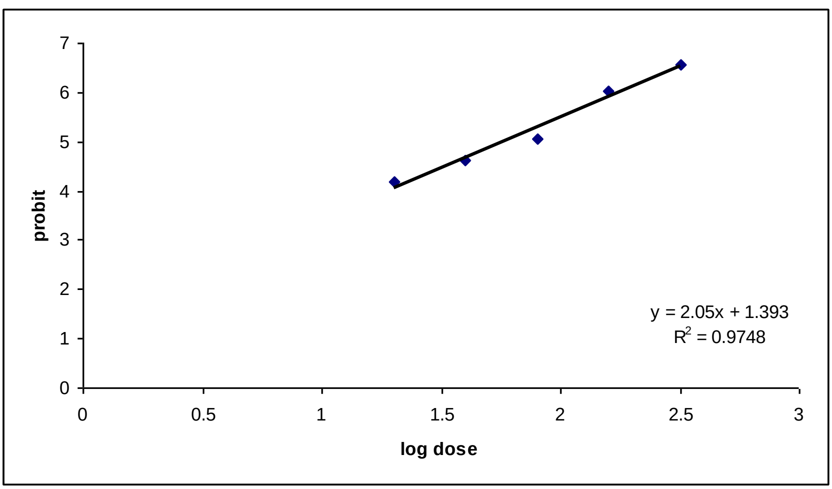

Figure 3. Regression line of effect of chlorpyriphos methyl on *Brevicoryne brassicae*.