Efficacy of the Botanical Pesticides, *Derris elliptica*, *Capsicum frutescens* and *Tagetes minuta* for the Control of *Brevicoryne brassicae* in Vegetables

Moyo M., Nyakudya I.W., Katsvanga C.A.T. and Tafirei R.

Abstract

In order to evaluate the efficacy of natural botanical pesticides used by low-income farmers, an experiment was carried out to determine the optimum extraction temperature and effective dilutions of Derris elliptica, Capsicum frutescens and Tagetes minuta for the control of Brevicoryne brassicae in vegetables. Vegetable beds were prepared and planted to Brassica napus cv giant rape in winter, and the plants were infected with the aphid, Brevicoryne brassicae. The aphids were left to multiply for two weeks before the application of the botanical pesticides. Three temperatures 50^{0}C, 60^{0}C and 65^{0}C were used in the extraction of the botanical pesticides using a water bath. Dilutions of 1:1, 1:2 and 1:3 were used for each botanical pesticide extract. A significantly higher percentage reduction of aphids ($p < 0,001$) was observed with the extraction temperature of 60 ^{0}C as compared to both 50 ^{0}C and 65 ^{0}C for the three species, Derris elliptica, Capsicum frutescens and Tagetes minuta. The dilution of 1:1 did not show significant differences compared to 1:2 for all the three plant species. Foliage damage was noted when 1:1 was used for Derris elliptica and Capsicum frutescens. The three botanical pesticides were equally effective.

Key words: Botanical pesticide, Brevicoryne brassicae, extraction temperature

Introduction

Sustainable pest management is a prerequisite to farming in semi-arid environments of Africa fraught with economic risks and uncertainties. According to Schwarb et al. (1995), given the conditions of climate and poverty in developing countries, these risks are many times higher than in industrialized countries. Reliance on synthetic chemicals to control pests has also given rise to a number of problems such as destruction of beneficial non-target organisms (parasitoids and predators) thereby affecting the food chain and impacting on biological diversity.

The injudicious use of synthetic pesticides can lead to secondary outbreaks of pests that are normally under natural control resulting in their rapid proliferation. There have also been cases of pests becoming tolerant to insecticides, resulting in the use of double and triple application rates (Stoll 2000). In addition, due to other problems such as health hazards, undesirable side effects and environmental pollution caused by the continuous use of synthetic chemical pesticides (Nas 2004), there is renewed interest in the application of botanical pesticides for crop protection. Scientists are now experimenting and working to protect insect infestation by indigenous plant materials (Roy et al. 2005). The use of such plant extracts to control pests is not a new innovation, as it has been widely used by small-scale subsistence farmers. According to Roy et al. (2005) the use of locally available plants in the control of pests is an ancient technology in many parts of the world. Most of these botanical pesticides are non-selective poisons that target a broad range of pests.

Botanical pesticides are biodegradable (Devlin and Zettel 1999) and their use in crop protection is a practical sustainable alternative. It maintains biological diversity of predators (Grange and Ahmed 1988), and reduces environmental contamination and human health hazards. Research on the active ingredients, pesticide preparations, application rates and environmental impact of botanical pesticides are a prerequisite (Buss and Park - Brown 2002) for sustainable agriculture. Botanical pesticides are unique because they can be produced easily by farmers and small industries (Roy et al. 2005).

As consumer demand for organically produced foods increase, scientific research on the use of botanical pesticides is now gaining momentum (Nas 2004). The objective of this research was to determine the optimum extraction temperature and efficacy of three plant species, Derris elliptica, Capsicum frutescens and Tagetes minuta as botanical insecticides against the aphid, Brevicoryne brassicae on the vegetable, Brassica napus cv giant rape.

Materials and Methods

During the winter period (May - July), botanical pesticides were each extracted at 50^0C, 60^0C and 65^0C and diluted in the ratio 1:1, 1:2 and 1:3 by volume. For D. elliptica, roots weighing 1kg were cut and pounded together with 2,5g neutral soap in 1litre of water. Neutral soap facilitates the solubility of the active ingredient and acts as a sticking agent (Nhachi and Kasilo 1996). The liquid was filtered and then diluted for application. The fruits of C. frutescens with a mass of 1kg were finely pulverized in a mortar and vigorously shaken with 1litre of water and filtered then the concentrate was diluted for application. Freshly cut T. minuta roots of mass 1kg were pounded into a pulp then mixed with 1litre of water and 2,5g neutral soap and also diluted. Bexadust "L" was used as control and applied to the vegetables at a rate of 2,5g per square metre (as per instructions on the label). The active ingredient in Bexadust "L" is Gamma B. H. C-0.6%.

Vegetable beds were prepared and arranged in a randomized block design with seven treatments replicated five times. Each bed was planted with 5 B. napus seedlings. To cater for the differences in dilution and temperatures, distances of 2m were left between the beds. Other cultural practices were uniformly applied to all the plants.

Wingless female aphids were inoculated 3 weeks from the time of seedling transplanting. Ten aphids were introduced to each plant and left for 14 days to allow them to multiply following the aphid complete life cycle of approximately 14 days (Dixon 1995). Liquid extracts were sprayed on the leaves as soon as the aphid population started to increase.

Enumeration of aphids was done using hand lenses and a pair of clippers. This was done daily until the active period of the pesticides expired. The active period was determined by checking the aphid population until it became constant or started to increase. The average percentage reduction of aphid population was calculated for the control, each botanical pesticide, extraction temperature and dilution.

Differences in aphid population reduction were analyzed for the botanical pesticides using a one-way analysis of variance (ANOVA) in a randomized design. Multiple comparisons of means were done using Least Significant Differences (LSD) test.

Results

A significantly higher percentage reduction of aphids ($p < 0,001$) was observed with the extraction temperature of 60 ^{0}C as compared to both 50 ^{0}C and 65 ^{0}C for the three species, Derris elliptica, Capsicum frutescens and Tagetes minuta.

Table 1: Effect of extraction temperature and dilution on aphids for the three species

Measured Parameters		**Percentage aphid reduction (Mean+SE)**		
Synthetic pesticide as control		96.68±0.213		
Organic pesticides		**D. elliptica**	**C. frutescens**	**T. minuta**
Dilution	1:1	38.709±1.807	38.493±1.619	36.052±1.407
	1:2	38.453±1.807	37.6±1.619	34.404±1.423
	1:3	31.116±1.807	30.745±1.602	34.760±1.423
Extraction Temperature	50^{0}C	37.642±1.807	40.293±1.619	45.131±1.423
	60^{0}C	53.473±1.807	55.909±1.619	53.100±1.423
	65^{0}C	17.162±1.807	10.636±1.602	6.985±1.407
Significance	Dilution	**	**	N.S
	Extraction temperature	***	***	***

***, ** Denote Significant Difference at 0.01 and 0.05; and NS Non-significant Difference at 0.05

The mean percentage aphid population decrease was significantly different ($P<0.004$) between the dilutions of 1:1 and 1:3, and 1:2 and 1:3 for D. elliptica. For the same plant species, the mean percentage reduction of 38.709±1.807 at a dilution of 1:1 and 38.453±1.807 at 1:2 were not significantly different. The mean percentage aphid decrease was also significantly different ($P<0.000$) between the dilutions of 1:1 and 1:3, and 1:2 and 1:3 for C. frutescens. The mean percentage reduction of 38.493±1.619 and 37.600±1.619 for the dilution of 1:1 and 1:2 respectively were not significantly for C. frutescens. T. minuta showed no significant difference at the three dilution levels. The dilution of 1:1 caused leaf discoloration following the use of C. frutescens and D. elliptica. The leaves curled and dried after three days of application. Comparison of the mean percentage aphid mortality across the different dilution levels of 1:1, 1:2 and 1:3 for the three species, Derris elliptica, Capsicum frutescens and Tagetes minuta exhibited no significant difference.

Discussion

The three botanical pesticides reduced B. brassicae population on B. napus at dilution levels of 1:1 and 1:2. Except for T. minuta, dilution in the ratio 1:3 had no significant effect on the aphids with average mortality percentages of 31±1.807 and 30.745±1.602 for D. elliptica and C. frutescens. In related experiments, Roy et al. (2005) demonstrated the effectiveness of a botanical leaf extract of Blumea lacera Dc. against the lesser grain borer, obtaining the highest repellency percentage of 57.41% at 3% extract concentration. These results indicate the potential for on-farm cultivation, extraction, formulation and use of botanical extracts in crop protection within the framework of sustainable pest management. However, though the results are indicative of the potential of botanical pesticides, further research is needed to determine the efficacy levels of the extracts on a wide range of common crop pests, and the modes of action of the active ingredients.

Extraction temperature has an effect on the efficacy of the active ingredients of botanical pesticides. The use of 65^0C in the extraction process resulted in reduced efficacy of all the three botanical pesticides. High temperature extraction at 65^0C could have resulted in the degradation of the active ingredients, giving low effectiveness of the extracts even at dilutions of 1: and 1:2.

Low temperature extraction at 50^0C produced extracts with low efficacy. Significant aphid reduction was obtained when an extraction temperature of 60^0C was used for all the plant species. High botanical pesticide efficacy was obtained at an extraction temperature of 60^0C giving average mortality percentages of 53.473±1.807, 55.909±1.619 and 53.100±1.423, for Derris elliptica, Capsicum frutescens and Tagetes minuta respectively.

Commercialization of botanical pesticides may not necessarily benefit the financially constrained subsistence farmers since the cost of the products may still render it inaccessible. A challenge that needs to be tackled is dose standardization due to regional and seasonal variations in plant constitutions and different concentrations of the active ingredients (Brazier 1995). In addition, although botanical pesticides are obtained locally, there is a danger of genetic erosion when plants are harvested from the wild (Devlin and Zettel 1999). Though this can be averted through the use of biotechnology, in particular, micropropagation of planting materials, this technology may still be an expensive option for most developing countries. Despite these challenges, this experiment is suggestible to the use of botanical pesticides by farmers, especially with the increased interest in the consumption of organic food products.

Conclusion

In conclusion, the three botanical pesticides were effective in the control of aphids, though they do not match the effectiveness of the synthetic pesticide. These botanical pesticides are affordable to low-income farmers. These natural pesticides have the potential for use in agriculture, especially with the dramatic increase towards the consumption of organically produced plants.

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