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The Effectiveness of Home Made Organic Pesticides Derived from Wild Plants (*Solanum pindiriforme* and *Lippia javanica*), Garlic (*Allium sativum*) and Tobacco (*Nicotiana tobacum*) on Aphid (*Brevicoryne brassica*) Mortality on Rape (*Brassica napus*) Plants

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Abstract: A trial was carried out at the Horticulture Research Centre, Marondera, Zimbabwe in 2007 to find out the effect of organic pesticides derived from 2 local plants (*Solanum pindiriforme* and *Lippia javanica*), garlic (*Allium sativum*) and tobacco (*Nicotiana tobacum*) on aphid mortality on a rape (*Brassica napus*) crop. Rape seedlings were raised in a screen house in potting media made from pine bark and vlei soil. Seedlings were transplanted into the field at seven weeks after planting. The design of the experiment was a randomised complete block (RCBD) replicated three times. Rape plants were infested with 10-12 aphids per plant at three weeks after transplanting. Organic pesticides prepared from *Solanum* (spray and buttermilk), *Lippia* (spray), garlic (buttermilk, garlic and chilli spray) and tobacco (spray) were sprayed on selected plants that were highly infested with aphids at 10 weeks after aphid infestation. The control was unsprayed infested plants. Buttermilk was mixed with paraffin. The results of aphid mortality obtained at 12 days after spraying indicated that plants sprayed with *Solanum* (spray and buttermilk), and garlic buttermilk had 100% mortality, *Lippia* spray, garlic and chilli spray and tobacco spray had 77, 70 and 10% aphid mortality, respectively. The control plants had 0% mortality. This shows that local wild plants (*Solanum* and *Lippia*) and garlic can be prepared into formulations that can control aphids on rape plants and therefore can be used as organic pesticides.

Key words: Aphid mortality, buttermilk spray, organic pesticides, phytotoxic, rape

INTRODUCTION

Rape (*Brassica napus*) is a popular vegetable grown in Zimbabwe for home consumption and market gardening. Some smallholder farmers make a living from the crop in most areas of Mashonaland (Jackson 1997). The farmers supply the vegetables to urban markets; however some grow the vegetables exclusively for home consumption.

Being a non-indigenous vegetable rape is vulnerable to attack by a number of insect pests that include aphids, bagrada bugs, diamond back moth, cutworms, white grubs and several other insect pests. Aphids are considered by most farmers in Zimbabwe as the most common pest of rape (Turner and Chivinge, 1999). The most common species that attack rape plants is the cabbage aphid (*Brevicoryne brassica*). The aphids feed by sucking the sap from the plants and if in large numbers they remove sufficient sap to kill the leaves and the growing tip. Infested seedlings become stunted and distorted. Continued feeding on mature plants causes wilting, yellowing and general plant stunting (Hill, 1983). Affected leaves wrap or curl inwards (Dube *et al*., 1999). The cabbage aphid is a vector of 23 virus diseases of cruciferous plants (Kessing and Mau, 1991). Some of the most important diseases transmitted are turnip mosaic virus and cauliflower mosaic virus. Some smallholder farmers predominantly use synthetic pesticides to control aphids (Turner and Chivinge, 1999; Sibanda *et al*., 2000; Obopile *et al*., 2008). The most widely used chemical to control aphids in Zimbabwe is dimethoate, an organophosphate which is locally known by the trade name *rogor*. The decision to apply the pesticide is mostly based on noticing the presence of a pest on the plant (Obopile *et al*., 2008). Some farmers, especially those who grow vegetables for home consumption, fail to secure the commercial chemicals due to their high costs, unavailability in local shops and ignorance of chemical control methods (Turner and Chivinge, 1999) and end up loosing their vegetables to insects and virus diseases. Those who afford synthetic pesticides face challenges of accessing appropriate chemical applicators and end up using some less orthodox application methods (Sibanda *et al*., 2000).

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There are concerns about the risks of chemicals to the vegetable producer; consumer and the environment. Chemicals are expensive and harmful to both man and the environment. The risks emanate from shortcomings in chemical handling practises, likely large deviations from recommended chemical doses, and chemical drift to non targets and run off into the soil and ground water (Sibanda *et al*., 2000; Williamson *et al*., 2008). Furthermore, agronomists are facing challenges of build up of resistance to some of the pesticides in target pest populations (Gerhandson, 2002). It is within this challenge that it becomes imperative to explore possible utilisation of relatively cheaper, accessible, safer and environment friendly alternatives, to the presently dominating synthetic pesticides. These include organic pesticides and diatomaceous earth.

Organic pesticides can be home made, they are less expensive, easy to use and are not harmful. They have little impact on natural enemies of pests (Schmutterer, 1997); hence can be used in the development of integrated pest management systems (Charleston *et al*., 2005). Organic pesticides extracted and derived from naturally occurring bioactive plant compounds are called botanical insecticides. They are based on a variety of plants that include garlic, onion, chillies, neem, tobacco, pyrethrum (Nayar *et al*., 1990; Defago *et al*., 2006) and some weeds like S*olanum pandiriforme* (*nhundurwa*), *Bidens pilosa* (black jack) and *Lippia javanica* (fever tea, *zumbani*) (Municipal development partnership in Eastern and Southern Africa, MDP, 2006).

Neem extracts adversely affect the development of a number of insects when applied to plant foliage or incorporated into a diet (Kumar, 1986). Neem products are approved for organic farming. Neem pesticides provide good control of the turnip aphid and other aphids and fair to poor control of the green peach aphid. *Lippia* seems to repel antestia bugs (Kutywayo, 1999) Tobacco leaves are useful in the control of thrips and aphids (Nayar *et al*., 1990). Nicotine is the toxicant derived from tobacco thus organic insecticides from tobacco are normally called nicotines. Nicotine in tobacco is very low (2-5%) and sometimes negligible in other parts. The efficiency of using tobacco as an organic pesticide therefore depends on quality of the leaves used. Garlic is a broad spectrum insecticide. It is effective against a wide range of diseases and insects at different developmental stages (egg, larvae and adults). Garlic effectiveness has been recorded with pests such as aphids, ants, armyworms, caterpillars, diamond back moth, white pulse beetle, whitefly, wire worm, false codling moth, termites, mice, mites, moles, bacteria and fungi. It can be crushed dry and the powder can be applied directly onto plants or mixed with water. The amount of water used depends on the strength of the garlic. Garlic spray is useful against mildew, bean rust and tomato blight. Garlic can be intercropped with other vegetables as an insect repellent to control aphids, ants and nematodes (MDP, 2006). When intercropped with cabbage garlic deters diamond back moth and repels shootfly in sorghum. Garlic is planted around fruit trees to repel aphids, fruit tree borer, termites, mice and other pests. Water, paraffin and liquid soap are added to organic pesticides to improve efficacy of the chemicals. Soap acts as a surfactant without which the spray will drain off the leaf surface, paraffin acts as a solvent. Organic pesticides have been used to control bugs, mites, slugs, snails and boll worms (West, 2002).

Table 1: Characteristics of some insecticides

		Mode of entry				
Group	Insecticide	Contact	Stomach	Fumigant	Residual and action persistence	Mammalian toxicity
Plant origin						
	Nicotine (Alkaloid from tobacco)	x	x	x	None	High
	Pyrethrum (From *Chrysanthemum* flowers)	x	-	-	None	Slight
	Rotenone (From roots of certain *Derris* and *Lonchocarpus* spp	x	-	-	Low persistence	Relatively harmless to most mammals
	Sabadilla (Alkaloid from seeds of *Schoenocaulon officinale*)	x	-	-	None	None
	Rhyanodine (Alkaloid from stem wood of *Rhyania speciosa*	x	-	-	Low	Slightly irritant to mammals
Chlorinated hydrocarbons Organo phosphates Carbamates						
	DDT	x	x	-	High persistence	Moderate
	Dieldrin	x	x	-	Persistent	High
	Toxaphene	x	x	-	Persistent	Pronounced
	Diazinon	x	-	x	-	Low
	Malathion	x	-	-	-	Moderate
	Parathion	x	x	-	-	Very high
	Carbaryl (Sevin)	x	-	-	-	Low
	Carbofuran (Furadan)	x	-	-	-	Low

Kumar (1986)

Organic pesticides are mostly contact insecticides (Nayar *et al*., 1990; Kumar, 1986.) Contact insecticides kill the insect by contact and entry into the body through the vulnerable sites found on its body. It may be applied directly onto the body of the insect in spray or dust. Contact insecticides are particularly effective against sucking insects like aphids. Organic pesticides have limited residual action and are biodegradable therefore less harmful to the environment. Table 1 shows characteristics of some organic pesticides compared to inorganic pesticides.

It is important to gather and document knowledge on natural pest control. Scientific investigations should be carried out to improve applicability and effectiveness of organic pesticides (Mbwile, 1999; Kutywayo, 1999). In South Africa, work is being carried out on the potential of indigenous plants as sources of botanical pesticides and this includes a thorough investigation of the plants in the field and in the laboratory (Wright, 1999).

This research was conducted to determine the potential of organic pesticides derived from two local plants (*Solanum pindiriforme* and *Lippia javanica*), tobacco trash and garlic in controlling aphids on rape. Organic pesticides are relatively cheaper, safe to handle, environmentally friendly and easily accessible. Garlic can be produced from the garden, tobacco trash can be obtained from tobacco farmers and *Solanum* and *Lippia* can be easily collected from the wild.

Objective: To determine the effect of organic pesticides from garlic, tobacco, *Solanum pindiriforme* and *Lippia javanica* on aphid mortality on rape plants.

MATERIALS AND METHODS

Study site: The trial was carried out at the Horticulture Research Centre in Marondera, Zimbabwe (altitude 1630 m, latitude 18º11′S, longitude 11º33′E), between June and September, 2007. Rape seeds were sown in speedling trays with potting media made from pine bark, vlei soil and compound fertiliser (8% N : 14% P_2O_5 : 7 K_2O). Seedling production was carried out in a screen house. The seedlings were transplanted to the field after seven weeks. The plot size was 3.6 m × 3 m, rows were spaced 60 cm apart and plant spacing was 30 cm within the rows. The experimental design was a randomised complete block (RCBD) replicated three times. At two weeks after transplanting the rape plants were infested with 10-12 aphids per plant collected from nearby infested mustard (*Brassicae rapa*) plants. At 12 weeks after infestation three plants per plot with high aphid populations were selected and scored before spraying with the organic insecticides (Table 2). Spraying was done weekly for two weeks using a hand sprayer. Data were collected on aphid mortality per plant based on the score before spraying at 1, 4, 8 and 12 days after spraying.

Table 2: Aphid infestation score before spraying

Score	Aphid infestation description
1	Low infestation, growing point infested with few aphids
2	Mild infestation, few leaves infested
3	High infestation, half of the leaves on the plants are infested
4	Very high infestation, most of the leaves infested
5	Severe infestation, leaves are curly and plant is stunted

Treatments: A total of six treatments comprising the following six organic pesticide sprays were used, the control was no spraying. Buttermilk was used to describe sprays that had paraffin added to them.

Garlic and chilli spray: 1 garlic bulb, 1 quart (946 mL) water, 1 medium onion, 1 table spoon cayenne pepper, 1 table spoon liquid dish soap.

Crush garlic finely. Add finely chopped onion to the mixture and rest of ingredients except soap. Wait for 1 hour before adding the soap to the mixture. The spicy ingredients must sort of stew or steep almost like tea.

Add the soap, the non-toxic spray is ready to use. Spray can be stored in the fridge for a week.

Garlic Buttermilk spray: 1 pint (568 mL) water, ¼ cup dish liquid, 2 teaspoons paraffin, 6 table spoons chopped garlic.

Soak whole garlic in liquid paraffin for at least 24 h. After a day finely chop the garlic, add dish liquid and water. Shake very well and strain the mixture. Store in a glass jar lasts around a week.

Tobacco spray: 1 cup tobacco trash, 1 gallon (4.5L) water put tobacco in a container of water. Allow mixture to set for 24 h. It should have a colour of weak tea. If too dark dilute with water. Spray should not to be used on peppers, egg plant, tomato or any S*olanaceous* plants.

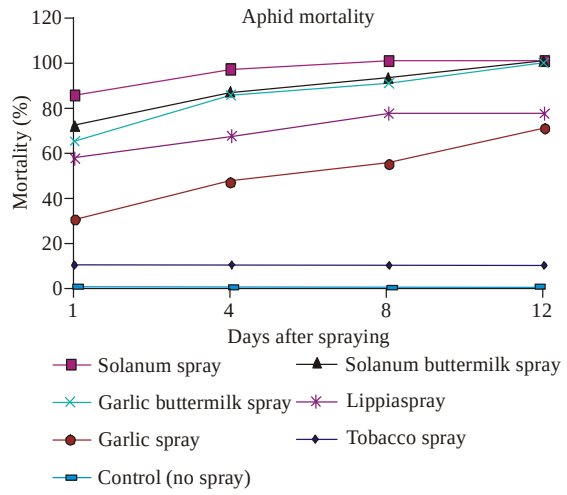
***Solanum* spray:** 10 Solanum fruits, 1 quart (946 mL) water, 1 table spoon liquid dish soap

Chop *Solanum* fruits and put in container. Add water and allow mixture to set for 24 h. After a day strain, add liquid soap. Spray can be stored in a glass jar in the fridge for about a week.

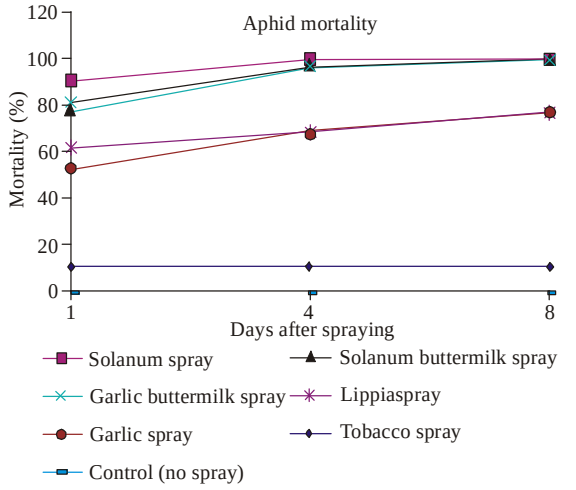
***Solanum* buttermilk spray:** 1 pint (568 mL) water, ¼ cup dish liquid, 2 teaspoons paraffin, 6 table spoons chopped *Solanum* fruits

Soak whole *Solanum* fruits in liquid paraffin for at least 24 h. After a day finely chop the *Solanum*, add dish liquid and water. Shake very well and strain the mixture. Store in a glass jar lasts around a week.

***Lippia* spray:** 2 cups (500 mL) fresh *Lippia* leaves and tips, 1 quart (946 mL) boiling water, 1 table spoon liquid dish soap.



(a) week 1



(b) week 2

Fig. 1: Effect of organic pesticides on aphid mortality

Mix boiling water and *Lippia*. Allow mixture to completely cool. Add liquid soap and spray.

Data analysis: Data were analysed using MSTAT-C version 2.10 (Nissen, 1989).

RESULTS AND DISCUSSION

The results obtained in both week 1 and week 2 sprayings are shown in Fig. 1. The results indicate that garlic; *Solanum* and *Lippia* have pesticidal effects on aphids. Garlic buttermilk which was sprayed on plants that had severe aphid infestation had more than half of the aphids dead on the following day. All the aphids had died after 12 days. The plants that were sprayed with *Solanum* spray and *Solanum* buttermilk spray with very high to severe aphid infestation also had more than half of the aphids dead on the following day. There was 100% mortality after 12 days. The plants that were sprayed with *Lippia* and garlic and chilli sprays had very high aphid infestation, half to less than half of the aphids were dead on the following day. Plants sprayed with tobacco spray had very low aphid mortality. Most of the aphids were active on the following day and even after 12 days. The plants that were used as control with no spraying had very high aphid infestation, the aphids were active on the following day and through out the observation period. The plants became severely infested after 12 days.

The leaf edges of the plants sprayed with buttermilk (both garlic and *Solanum*) and *Lippia* were burnt. This is because the mode of action of organic pesticides is mostly contact, most contact insecticides are phytotoxic on plants especially at higher dosages (Nayar *et. al.*, 1990). In this study the organic pesticides were sprayed without dilution after preparation and were therefore at high doses. The paraffin added to the buttermilk is also phytotoxic. Further observations on new leaves did not show signs of burning.

There were significant ($p<0.001$) differences among the pesticides for aphid mortality at 1, 4, 8 and 12 days after spraying (Table 3 and 4). *Solanum* was the most effective pesticide with the highest percent of dead aphids when sprayed both as a simple spray and as buttermilk. This was indicated by the highest mortality rates as from day 1 after spraying and total mortality of the aphids after 12 days. Adding paraffin to *Solanum* fruits did not improve effectiveness on aphid mortality. Garlic buttermilk was also effective; it had a high mortality rate 4 days after spraying. Garlic and chilli spray had

Table 3: Mean aphid mortality for week 1

Treatment	1 DAS mortality (%)	4 DAS mortality (%)	8 DAS mortality (%)	12 DAS mortality (%)
Solanum spray	85.00 a	96.67 a	100.0 a	100.0 a
Solanum buttermilk spray	71.67 b	86.67 a	93.33 ab	100.0 a
Garlic buttermilk spray	65.00 bc	85.00 a	90.00 ab	100. 0 a
Lippia spray	56.70 c	66.67 b	76.67 b	76.67 ab
Garlic and chilli spray	30.00 d	46.67 c	55.00 c	70.00 b
Tobacco spray	10.00 e	10.00 d	10. 00 d	10.00 c
Control (No spray)	0.00 e	0.00 d	0.00 d	0. 00 c
LSD	10.661	13.57	18.752	24.705
CV %	13.18	13.65	17.36	21.29
Probability	0.0000 ***	0.0000***	0.0000 ***	0.0000***

Treatments with same letter are not significantly different at *** p>0.01

Table 4: Mean aphid mortality for week 2

Treatment	1 DAS mortality (%)	4 DAS mortality (%)	8 DAS mortality (%)
Solanum spray	90.00 a	100.0 a	100.0 a
Solanum buttermilk spray	78.33 b	96.67 a	100.0 a
Garlic buttermilk spray	81.67 b	96.67 a	100.0 a
Lippia spray	61.67 c	68.33 b	76.67 b
Garlic and chilli spray	53.33 d	68.33 b	76.67 b
Tobacco spray	10.00 e	10.00 c	10.00 c
Control (No spray)	0.00 f	0.00 d	0.00 d
LSD	5.374	6.035	6.035
CV %	5.64	5.46	5.13
Probability	0.0000***	0.0000***	0.0000***

Treatments with same letter are not significantly different at *** p>0.01

significantly lower aphid mortality than the garlic buttermilk spray. The paraffin that was added to the garlic buttermilk improved the effectiveness of the garlic. The mortality from *Lippia* spraying varied for week 1 and week 2. In week 1 it was not significantly different from *Solanum* spray, in week 2 it was significantly lower than *Solanum* spray. Effects of *Lippia* are inconsistent. Katsvangwa and Chigwaza (2004) found high mortality with *Lippia* powder spraying at 1:1 dilution and negligible effects at 1: 2 dilution. The aphid mortality on plants that were sprayed with tobacco was not significantly different from the mortality on plants that had no spraying. The tobacco spray was ineffective. This could be due to the fact that the concentration of nicotine in the tobacco trash used was too low or it required soap to be added. Adding soap to the tobacco infusion improves the wetting, spreading and killing properties of nicotine (Nayar *et al*., 1990).

CONCLUSION

The results showed that *Solanum* and garlic are effective organic pesticides against aphids on rape plants. Adding paraffin to the organic pesticides increased the mortality rate of the aphids. Tobacco spray was not effective; it resulted in the least mortality. Effectiveness of *Lippia* spray was relatively lower and varied.

RECOMMENDATION

- Organic pesticides prepared from *Solanum pindiriforme*, garlic (*Allium sativum)* and *Lippia javanica* are effective and can be used to control aphids in rape.
- Tobacco trash leaves and stems high in nicotine should be used to formulate pesticides. Addition of liquid soap is recommended to improve the effectiveness of the pesticides.
- There is need to carry out more research on home made organic pesticides to come up with information on the chemistry and toxicology of the pesticides.
- More research has to be carried out to test other known plants with pesticidal effects and to identify new plants with pesticidal properties in different areas.

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