BIBLIOGRAPHY

DAYAP, ALVIN F. APRIL 2011. Control of the Major Insect Pests of Cabbage (*Brassica oleracea* Linn.) with the Use of Selected Botanical Insecticides. Benguet State University, La Trinidad Benguet.

Adviser: Eulogio V. Cardona Jr., PhD.

ABSTRACT

The study was conducted at the BSU Diadegma Rearing House from December 2010 to March 2011 to record the number of insect pests killed when applied with the different concentration of botanical insecticides, to evaluate the dead insect as affected by the botanical insecticides and to determine the mode of actions of botanical insecticides.

The extracts of yellow ginger, garlic, and chili mixed with water at varying rates were the treatments. The extract and water dilution ratios were as follows: 1:2, 1:4, 1:6, 1:8. Untreated was included as the basis for comparison. The efficacy of the treatments was evaluated against DBM, cabbage butterfly, cutworm and aphids by following the leaf dip and topical method of application. The assessment for the effect of the treatments was done 72 hours after the treatments.

The highest mortality of DBM was 66.67% for the leaf dip method on the dilution ratio of 1:2 for garlic and a very low mortality on the dilution ratio of 1:4, 1:6, and 1:8, Mortality of DBM was not noted in all the treatments of garlic using the topical method. A mortality that was small to negligible was noted from the extract treatments of chili and yellow ginger regardless of the manner of application.

For the control of cabbage butterfly, the treatments of yellow ginger and garlic applied by leaf dip method showed a relative good control. The highest mortality was 73.33% at the dilution ratio of 1:2, 56.67% and 50% for the dilution ratio of 1:4 and 1:6, respectively the mortality ranged from 63.33% to 46.67% for the extract treatments of garlic. Although small, mortality was observed when applied by topical method for chili. The highest was 30%. A very small mortality was observed when applied by leaf dip method.

None of the treatments of yellow ginger, garlic and chili either applied by leaf dip and topical method give a good control of cutworms and aphids.

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INTRODUCTION

Cabbage (*Brassica oleracea* Linn.) is one of the leading crop plants that are grown in the highland areas of the Philippines particularly in Benguet and Mountain Province. Cabbage is popularly grown in the place because of their adaptability to relative cool temperature. Secondly, the demand for cabbage is high and commands a good price. The income generated from the crop however depends on the quality of produce which is usually affected by infestation of insect pests (Otculan, 1989).

The most damaging insects that are pestering the cabbage growers in the province of Benguet are diamondback moth or DBM (*Plutella xylostella* Linn.), cutworms (*Spodoptera litura* Fabr.), aphids (*Brevicoryne brassicae*) and cabbage butterfly (*Pieris rapae*). These insect pests are relatively difficult to control because they easily acquire resistance to insecticides.

At present, the control of insect pests of cabbage and other related plants is still a problem. Several insecticides were proven effective in controlling the pest of cabbage but since there are many drawbacks associated with their use, a better control alternative must be sought.

The importance of the study is to develop locally available botanical insecticides for the control of insect pests of cabbage. The misuse and excessive use of synthetic insecticides may cause some undesirable effects not only to the agricultural ecosystem but to health of humans. Insecticide residue in agricultural products particularly in vegetables and fruit products is a growing concern for producers, traders, and consumers in many parts of the world. One of the efforts is the development of botanical insecticides. Botanical insecticides are safer and are environment friendly.

The study was conducted to:

1. record the number of insect pests killed when applied with the concentration of botanical insecticides.
2. evaluate the dead insect as affected by the botanical insecticides.
3. determine the mode of actions of botanical insecticides.

The experiment was conducted at the Benguet State University Diadegma Rearing House, Balili La Trinidad Benguet from December 2010 to March 2011.

REVIEW OF LITERATURE

Insect Pests of Cabbage

According to Esguera *et al*., (1969), there are about 30 species of insects attacking cruciferous crops like cauliflowers, Chinese cabbage, radish, and cabbage. Among the 30 species, diamondback moth or DBM is the most destructive. In the study of Cardona in 1997, the 5 most destructive insect pests were diamondback moth, cutworms, aphids, flea beetles, and cabbage butterfly.

DBM Nature of Damage

In 1972, Quebral and Caramancion reported that diamondback moth or DBM (*Plutella xylostella*) is known to be the most serious limiting factor for the cultivation of cabbage. The larva feeds on the undersurface of the leaves reducing them into a network of veins with only thin membrane of the upper leaf surface are left.

According to Hines and Hutchison (2001), aphids (*Brevicoryne brassicae*) are small with only 1.6mm to 2.8mm as the biggest, soft bodied having piercing mouthparts but they are prolific and can severely damage crops. The piercing mouthparts are used for feeding by inserting it to the surface of the plants and suck the saps. Keizer and Zuubier (1999) stated that the damage caused by aphids are curling, wrinkling, and stunting of the host plants. In severe cases, the leaves of the plants turns brown dried in appearance followed by death.

The cabbage butterfly larvae (*Pieris rapae*) feed usually on the lower surface of cabbage. They form holes usually with large irregular shape and sizes in the leaves (Metcalf and Flint, 1951).

Most cutworms (*Spodoptera litura*) damage occurs on mostly on early stage vegetables. The damage caused by cutworms occurs when they chew stems of young plants at or slightly above or below the soil line.

Botanical Plants

Ginger *(Zingiber officinale)* is a tuber that is consumed whole as a delicacy, medicine, or herb. It lends its name to its genus and family (Zingiberaceae). Other notable members of this plant family are turmeric, cardamom, and galangal. Ginger cultivation began in South Asia and has since spread to East Africa and the Caribbean. It is sometimes called root ginger to distinguish it from other things that share the name ginger. The oleoresin of ginger is often contained in digestive, antitussive, antiflatulent, laxative, and antacid compounds (Anonymous, 2010).

Garlic (*Allium sativum*) is a species in the onion family Alliaceae. Garlic has been used throughout history for both culinary and medicinal purposes. The garlic plant's bulb is the most commonly used part of the plant. Garlic is a very good all-purpose insect repellent that can be used in several different ways to ward off pests. Garlic in its simplest form is used to keep insects off of several plants. Companion planting or placing plants together for a mutual benefit, works especially well with garlic. When crushed, *Allium sativum* yields allicin, a powerful antibiotic and antifungal compound. It has been claimed that it can be used as a home remedy to help speed recovery from strep throat or other minor ailments because of its antibiotic properties. It also contains the sulfur containing compounds alliin, ajoene, diallylsulfide, dithiin, S-allylcysteine, and enzymes, vitamin B, proteins, minerals, saponins, flavonoids, and maillard reaction products, which are non-sulfur containing compounds (Anonymous, 2010).

Chili (*Capsicum annum*) has been a part of the human diet in the Americas since at least 7500 BC. There is archaeological evidence at sites located in southwestern Ecuador that chili peppers were domesticated more than 6000 years ago, and is one of the first cultivated crops in the Americas that is self-pollinating. The substances that give chili peppers their intensity when ingested or applied topically are capsaicin (8-methyl-*N*-vanillyl-6-nonenamide) and several related chemicals, collectively called *capsaicinoids*. Capsaicin is the primary ingredient in pepper spray (Anonymous, 2010).

MATERIALS AND METHODS

Materials

The materials used were cabbage seedlings, 6 inches diameter clay pots, 8 x 4 plastic container, graduated cylinder, chicken manure, fungicide, shovel, watering can, socks, knife, juicer, 16 celled tray with cover, digital camera, hair brush, garlic gloves, ginger rhizome and ripe chili pepper fruit.

Preparation of the Potted Cabbages

The soil was gathered in the field with the use of shovel, and then placed in the sack. After gathering, the chicken manure was mixed with the soil to enhance the growth of the plants. The cabbage seedlings were transplanted on the 6 inches diameter clay pots. The propagation of cabbages was done inside the green house at the back of BSU Diadegma Rearing House. Except for the application of insecticides, all other cultural requirements of the cabbage plants were provided.

Rearing of Test Insects

Diamondback moth. Cabbage seedlings were planted on the pots with a diameter of 6 inches. Except for the application of insecticides, all the necessary horticulture requirements of the plants were provided. The DBM larvae that was infesting on the plants were collected and serve as the test insects. Plenty of potted cabbages were propagated to come up with plenty of DBM larvae as test insects (Figure 1).

Cabbage butterfly. Larvae that are infesting in cabbage plants for the above study were collected and served as the test insects for the efficacy evaluation of the botanical insecticides (Figure 2).

Figure 1. Cabbage infested with DBM larvae

Figure 2. Field collected cabbage butterfly larvae

Cutworms. Eggs of cutworms were collected in the cabbage field at the BSU Research Station. The eggs that were collected were placed inside the petri dishes. Since an egg mass of cutworms consists of not less than 200 eggs, upon emergence to larvae, they were used as the test insects for the research (Figure 3).

Aphids. Part of the potted cabbages propagated above was used for the infestation of aphids. To enhance aphids buildup, introduction was done by the use of field collected aphids. Insecticides were not applied to enhance aphids' buildup (Figure 4).

Figure 3. Field collected cutworm eggs

Figure 4. Potted cabbages for the rearing of DBM and aphids

Collection and Preparation of the Extracts

The test plants for this research are yellow ginger rhizome, garlic cloves and ripe fruits of chili. These materials were bought from the local market. Prior the extraction, the plants undergoes thorough cleaning. With the use of a knife, the different plants were chopped into smaller pieces. The chopped plants were placed in the juicer for extraction. After extraction, the extract was placed inside the 4x4 inches plastic containers. The extract and water ratio which served as the treatments is shown in Table 1. The experimental design was arranged in Completely Randomized Design (CRD) with 3 replications.

Topical Method of Treatment Application

In this method, the test botanical insecticides were applied by brushing the thorax of the insect by the use of hair's brush that was dipped on the extract (Figures 5 to 9). After the application, the insects were placed immediately on the 16 celled plastic tray containers.

Table 1. Plant extract and dilution ratio

	PLANT EXTRACTS		
DILUTION RATIO	Yellow ginger	Garlic	Chili
Untreated			
T_1-1:2	/	/	/
T_2-1:4	/	/	/
T_3-1:6	/	/	/
T_4-1:8	/	/	/

One insect was placed for each cell. Leaf of cabbage was provided as food and it was covered to prevent the insect to escape. The experiment was stored under laboratory room temperature. The treatments including the untreated were replicated 3 times.

Figure 5. DBM larva topically applied with the extract/toxicant

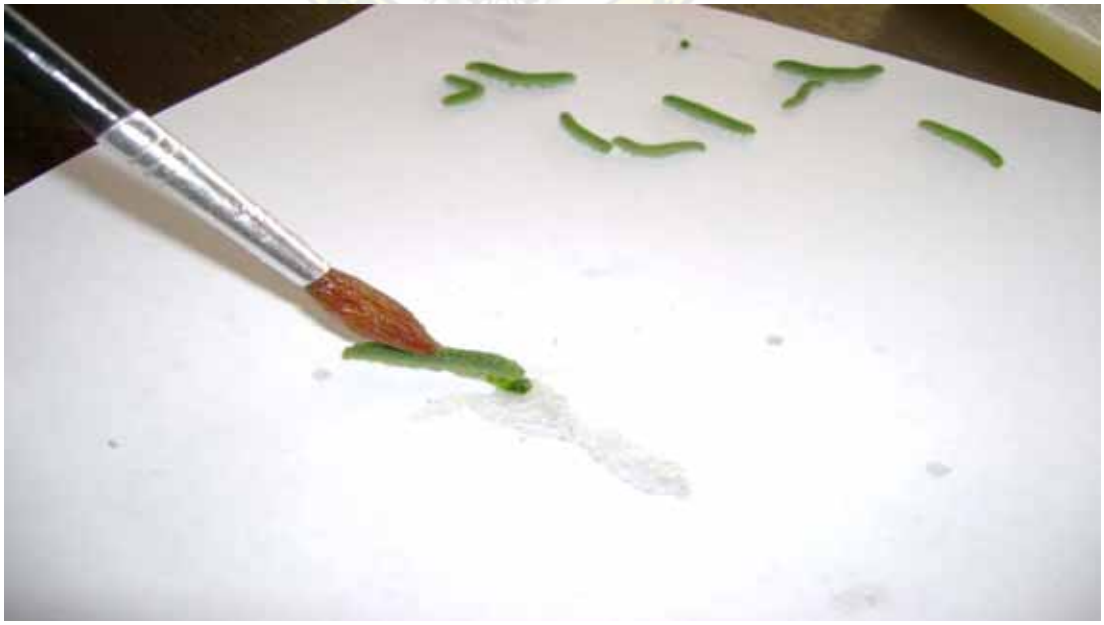

Figure 6. Cabbage butterfly larva topically applied with the extract/toxicant

Figure 7. Cutworm larva topically applied with the extract/toxicant

Figure 8. Aphids topically applied with the extract/toxicant

Figure 9. Leaf of cabbage applied with the extract/toxicant by leaf dip method

Leaf Dip Method of Treatment Application

In this leaf dip method, the cabbage leaves were first dipped into the solution of the treatments and offer to the test insects (Figure 9). The size of the leaves is similar to the size of the tray container. The trays were covered to prevent the insect to escape and it was stored under laboratory condition. The treatments were replicated 3 times.

Evaluation of Dead Insect

The dead insect was evaluated by their size and color of and compared with the live insects.

Mode of Action of the Botanical Insecticides

The mode of action of the botanical insecticides was evaluated as contact and stomach insecticides.

Contact insecticide. The botanical insecticides were a contact insecticide when the insect was found dead after it touches or absorbed the botanical insecticide through the body wall without feeding on the treated leaves.

Stomach insecticide. The botanical insecticides were a stomach insecticide when the insect was found dead after eating the plant that was applied or dipped to the botanical insecticides.

Data Gathered

1. Number of dead insects. Recording of dead insects was done 72 hours after treatments.

2. Evaluation of dead insect. The color and texture of the dead insect were observed.

3. Mode of action. It was evaluated as contact and stomach insecticides.

RESULTS AND DISCUSSION

Mortality of DBM Due to Yellow Ginger, Garlic and Chili

The mortality in percent of DBM larvae after exposure to the treatments of yellow ginger, garlic and chili is shown in Table 2. DBM larvae as affected by the yellow ginger extract on the leaf dip method shows that the dilution ratio of 1:2 has the highest percentage of mortality with a mean of 10.00% followed by dilution ratio of 1:4 and 1 :6 with a mortality of 6.67% and 3.33% respectively. Mortality was not noted from the untreated. A very small to negligible mortality was observed from the treatments of ginger applied by topical method.

The mortality of DBM was highest equivalent to 66.67% from the treatment of garlic with the dilution ratio of 1:2 and applied by leaf dip method. The mortality of DBM significantly declined on the dilution ratio of 1;4, 1:6 and 1:8. Mortality of DBM was not noted in all the treatments of garlic applied by topical method.

A very small to negligible mortality of DBM comparable with the untreated was noted in all the treatments of Chili when applied by leaf dip method and a mortality of 30% which was the highest when applied by topical method with the dilution ratio of 1:2.

Mortality of Cabbage Butterfly Larva Due to Yellow Ginger, Garlic and Chili

The mortality in percent of cabbage butterfly larvae is indicated in Table 3. There are differences of the treatments based on the analysis of variance. Mortality due to yellow ginger was noted on the leaf dip method but not in the topical method. As observed, the highest mortality was 73.33% followed by 56.67% which were due to the

Table 2. Mortality (%) of DBM larvae in cabbage as affected by the different extracts 72 hours after treatment

TREATMENT	YELLOW GINGER		GARLIC		CHILI	
	Leaf dip	Topical	Leaf dip	Topical	Leaf dip	Topical
Untreated	0.00	0.00^{b}	0.00^{d}	0.00^{a}	0.00^{b}	0.00^{b}
T_1-1:2	10.00^{a}	6.67^{a}	66.67^{a}	0.00^{a}	0.00^{b}	30^{a}
T_2-1:4	6.67^{b}	0.00^{b}	16.67^{bc}	0.00^{a}	0.00^{b}	0.00^{b}
T_3-1:6	3.33^{c}	0.00^{b}	10^{bcd}	0.00^{a}	0.00^{b}	3.33^{b}
T_4-1:8	0.00	0.00^{b}	23.33^{b}	0.00^{a}	3.33^{a}	3.33^{b}

*Means followed by a common letter are not significantly different a 5% level by DMRT

dilution ratio of 1:2 and 1:4 respectively. The treatment with the dilution ratio of 1:6 has an equivalent mortality of 50.00% and only 33.33% for the dilution ratio of 1:8. The mortality in all the treatments of yellow ginger was significantly higher in comparison with the untreated.

A relatively high level of mortality was noted in all the treatments of garlic when applied by leaf dip method with a mortality ranging from 63.32 and 46.67% significantly higher than the untreated. Mortality of cabbage butterfly was not noted in all the treatments when applied by topical method.

Although small, a mortality of cabbage butterfly was observed on the treatments of chili for both method of application. In comparison, a relatively higher mortality was observed from the topical method of application. The highest mortality was caused by the highest dilution ratio of 1:2 and 1:4.

Table 3. Mortality (%) of cabbage butterfly larvae in cabbage as affected by the different extracts 72 hours after treatment

TREATMENT	YELLOW GINGER		GARLIC		CHILI	
	Leaf dip	Topical	Leaf dip	Topical	Leaf dip	Topical
Untreated	0.00^{b}	0.00^{a}	0.00	0.00^{b}	0.00^{d}	0.00^{bcd}
T_1-1:2	73.33^{a}	0.00^{a}	56.67^{ab}	0.00^{b}	10.00^{abcd}	30.00^{a}
T_2-1:4	56.67^{a}	0.00^{a}	63.33^{a}	0.00^{b}	20.00^{a}	30.00^{a}
T_3-1:6	50.00^{a}	0.00^{a}	46.67^{abc}	0.00^{b}	13.33^{ab}	13.33^{abcd}
T_4-1:8	33.33^{b}	0.00^{a}	56.67^{ab}	3.33^{a}	13.33^{abc}	23.33^{abc}

*Means followed by a common letter are not significantly different a 5% level by DMRT

Mortality of Cutworm Larva Due to Yellow Ginger, Garlic and Chili

The mortality in percent of cutworm is presented in Table 4. Although small, a mortality of cutworm was noted in all the treatments of yellow ginger applied by leaf dip method. The mortality ranged from 3.33% to 16.67%. Mortality of cutworm was not noted in all the treatments of yellow ginger by topical method.

Mortality of cutworm was almost none in all the treatments of garlic applied by leaf dip and topical method. If there were mortality of cutworm, the mortality was extremely small to negligible.

As for the effect of chili, not any of the treatments have caused a significant mortality of cutworms. This phenomenon was noted in all the treatments either applied by leaf dip method or by topical method.

Table 4. Mortality (%) of cutworm larvae in cabbage as affected by the different extracts 72 hours after treatment

TREATMENT	YELLOW GINGER		GARLIC		CHILI	
	Leaf dip	Topical	Leaf dip	Topical	Leaf dip	Topical
Untreated	0.00[b]	0.00[a]	0.00[b]	0.00[a]	0.00[b]	0.00[b]
T_1-1:2	3.33[b]	0.00[a]	6.67[a]	0.00[a]	0.00[b]	3.33[a]
T_2-1:4	16.67[a]	0.00[a]	0.00[b]	0.00[a]	0.00[b]	3.33[a]
T_3-1:6	6.67[b]	0.00[a]	0.00[b]	0.00[a]	3.33[a]	3.33[a]
T_4-1:8	6.67[b]	0.00[a]	0.00[b]	0.00[a]	3.33[a]	3.33[a]

*Means followed by a common letter are not significantly different a 5% level by DMRT

Mortality of Aphids Due to Yellow Ginger, Garlic and Chili

The effect of the extracts on aphids is presented in Table 5. It is clearly presented in the data table the very small to negligible mortality of aphids in all the treatments of yellow ginger either applied by leaf dip method or by topical method. The mortality was almost insignificant in comparison with the untreated. A much small level of mortality was noted in all the treatment of yellow ginger applied by topical method.

Garlic has a better control of aphids than yellow ginger. This was manifested by the highest mortality of aphids by 40.00% followed by 26.67 and 6.67% due to the dilution ratio of 1:2, 1:4 and 1:6, respectively. The mortality of aphids from the treatments were significantly higher in comparison with the dilution ratio of 1:8 and the untreated. Mortality of aphids was not observed in all the treatments of garlic applied by topical method.

Mortality of aphids was not noted in all the treatments of chili similar with the untreated applied either by leaf dip method or by topical method.

Table 5. Mortality (%) of aphids in cabbage as affected by the different extracts 72 hours after treatment

TREATMENT	YELLOW GINGER		GARLIC		CHILI	
	Leaf dip	Topical	Leaf dip	Topical	Leaf dip	Topical
Untreated	0.00[b]	0.00[a]	0.00[b]	0.00[a]	0.00[a]	0.00[a]
T_1-1:2	6.67[a]	0.00[a]	40.00[a]	0.00[a]	0.00[a]	0.00[a]
T_2-1:4	3.33[b]	0.00[a]	26.67[a]	0.00[a]	0.00[a]	0.00[a]
T_3-1:6	0.00[b]	0.00[a]	6.67[b]	0.00[a]	0.00[a]	0.00[a]
T_4-1:8	0.00[b]	0.00[a]	0.00[b]	0.00[a]	0.00[a]	0.00[a]

*Means followed by a common letter are not significantly different a 5% level by DMRT

Description of Dead Insects Due to Yellow Ginger, Garlic and Chili

The dead DBM larvae due to yellow ginger have a body which was dark yellow to brown in color as shown in Figure 10. The texture of the body was soft. For those dead larva due to garlic and chili, the color of the insect body was yellow to brown as shown in Figures 13 and 16. The texture of the body was soft.

The color of dead cabbage butterfly due to yellow ginger was dark green similar with the dead insects due to garlic. As shown in Figures 11 and 14. For those dead larvas due to chili, discoloration was not noted. Figure 17 shows the body texture of dead larva caused by yellow ginger, garlic and chili are soft.

Unlike the dead cutworms which are dark brown due to yellow ginger (Figures 12, 15 and 18), discoloration was not noted from the dead insects caused by garlic and chili. The body texture was soft.

Dead aphids due to garlic and yellow ginger are dark yellow as shown in Figure 19. Description of aphids due to chili could not be described as none of the insects died after treatment.

Figure 10. Appearance of dead DBM larva due to yellow ginger

Figure 11. Appearance of dead cabbage butterfly larva due to yellow ginger

Figure 12. Appearance of dead cutworm larva due to yellow ginger

Figure 13. Appearance of dead DBM larva due to garlic

Figure 14. Appearance of dead cabbage butterfly larva due to garlic

Figure 15. Appearance of dead cutworm larva due to garlic

Figure 16. Appearance of dead aphid due to garlic

Figure 17. Appearance of dead DBM larva due to chili

Figure 18. Appearance of dead cabbage butterfly larva due to chili

Figure 19. Appearance of dead cutworm larva due to chili

Mode of Action

Mode of action of yellow ginger. The mode of action of the yellow ginger in DBM, cabbage butterfly, cutworm and aphids was stomach type. It was observed in the leaf dip method that there was a high mortality. Secondly, death of insects was observed in all the treatments but not on the treatments by topical method.

Mode of action of garlic. The mode of action of garlic in DBM, cabbage butterfly and aphids was stomach type. Almost all of the treatments of ginger showed a high mortality in DBM, cabbage butterfly and aphids. There was no mortality observed on the topical method in all of the test insects.

Mode of action of chili. The mode of action of chili against cabbage butterfly was either stomach or contact type (Anonymous, 2010). Although mortality was noted in DBM and cutworm, the mortality was small to negligible.

SUMMARY, CONCLUSIONS AND RECOMMENDATION

Summary

This research was conducted at the BSU Diadegma Rearing House from December 2010 to March 2011 to record the number of insect pests of cabbage killed when applied with the different concentrations of botanical insecticides, to evaluate the dead insect as affected by the botanical insecticides and to determine the mode of actions of botanical insecticides

Varying dilution ratio of the extracts with water were the treatments. The extract and water dilutions were as follows: 1:2, 1:4, 1:6, 1:8. Untreated was included as the basis of comparison. The efficacy of the treatments was evaluated against DBM, cabbage butterfly, cutworm and aphids by following the leaf dip and topical method of application. The assessment for the effect of the treatments was done 72 hours after the treatments.

The highest mortality of DBM was 66.67% for the leaf dip method on the dilution rate of 1:2 for garlic and a very low mortality on the dilution rate of 1:4, 1:6, and 1:8, Mortality of DBM was not noted in all the treatments of garlic using the topical method. A mortality that was small to negligible was noted from the extract treatments of chili and yellow ginger regardless of the manner of application.

For the control of cabbage butterfly, the treatments of yellow ginger and garlic applied by leaf dip method showed a relative good control. The highest mortality was 73.33% at the dilution rate of 1:2, 56.67% and 50% for the dilution rate of 1:4 and 1:6. The mortality ranged from 63.33% to 46.67% for the extract treatments of garlic.

Although small, mortality was observed when applied by topical method for chili. The highest was 30%. A very small mortality was observed when applied by leaf dip method.

None of the treatments of yellow ginger, garlic and chili either applied by leaf dip and topical method give a good control of cutworms and aphids.

The dead DBM larvae due to yellow ginger have a body which was dark yellow to brown in color. The texture of the body was soft. For those dead larvas due to garlic and chili, the color of the insect body was yellow to brown. The texture of the body was soft.

The color of dead cabbage butterfly due to yellow ginger was dark green similar with the dead insects due to garlic. For those dead larva due to chili, discoloration was not noted. Body texture of dead larva caused by yellow ginger, garlic and chili are soft.

Unlike the dead cutworms which are dark brown due to yellow ginger, discoloration was not noted from the dead insects caused by garlic and chili. The body texture was soft.

Dead aphids due to garlic and yellow ginger are dark yellow Description of aphids due to chili could not be described as none of the insects died after treatment.

Conclusions

It is concluded that garlic at the highest dilution ratio of 1:2 is best in controlling DBM while the yellow ginger and garlic are least at the dilution ratio of 1:2 and 1;4 for the control of cabbage butterfly. Garlic has the stomach mode of action against DBM. The yellow ginger and garlic are likewise stomach in mode of action against cabbage butterfly. The effect of yellow ginger, garlic and hot pepper on DBM, cutworm and aphids is very small to minimal.

Recommendation

Garlic at the highest dilution ratio of 1:2 is recommended for the control of DBM. Yellow ginger and garlic are recommended for the control of cabbage butterfly.

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APPENDICES

Appendix Table 1. Mortality (%) of DBM larvae as affected by topical method of ginger extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	20	0[b]
T1-1:2	10	10	0	0	6.67[a]
T2-1:4	0	0	0	0	0[b]
T3-1:6	0	0	0	0	0[b]
T4-1:8	0	0	0	0	0[b]
TOTAL	10	10	0	20	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	106.666667	26.6666667	4.00*	0.0343
Error	10	66.6666667	6.66666667		
TOTAL	14	173.333333			

*-significant

Appendix Table 2. Mortality (%) of cabbage butterfly larvae as affected by topical method of ginger extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0[a]
T1-1:2	0	0	0	0	0[a]
T2-1:4	0	0	0	0	0[a]
T3-1:6	0	0	0	0	0[a]
T4-1:8	0	0	0	0	0[a]
TOTAL	0	0	0	0	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	0	0		
Error	10	0	0		
TOTAL	14	0			

[ns]-not significant

Appendix Table 3. Mortality (%) of cutworm larvae as affected by topical method of ginger extract

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
Untreated	0	0	0	0	0[a]
T1-1:2	0	0	0	0	0[a]
T2-1:4	0	0	0	0	0[a]
T3-1:6	0	0	0	0	0[a]
T4-1:8	0	0	0	0	0[a]
TOTAL	0	0	0	0	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	0	0		
Error	10	0	0		
TOTAL	14	0			

[ns]-not significant

Appendix Table 4. Mortality (%) of aphids as affected by topical method of ginger extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0[a]
T1-1:2	0	0	0	0	0[a]
T2-1:4	0	0	0	0	0[a]
T3-1:6	0	0	0	0	0[a]
T4-1:8	0	0	0	0	0[a]
TOTAL	0	0	0	0	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	0	0	0ns	
Error	10	0	0		
TOTAL	14	0			

[ns]-not significant

Appendix Table 5. Mortality (%) of DBM larva as affected by leaf dip method of ginger extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0[d]
T1-1:2	0	10	20	30	10[a]
T2-1:4	0	20	0	20	6.67[b]
T3-1:6	0	0	10	10	3.33[c]
T4-1:8	0	0	0	0	0[d]
TOTAL	0	30	30	60	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	226.666667	56.6666667	1.06ns	0.4240
Error	10	533.333333	53.3333333		
TOTAL	14				

[ns]-not significant

Appendix Table 6. Mortality (%) of cabbage butterfly larvae as affected by leaf dip method of ginger extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0[b]
T1-1:2	70	70	80	220	73.33[a]
T2-1:4	60	60	50	170	56.67[a]
T3-1:6	40	60	50	150	50[a]
T4-1:8	30	40	30	100	33.33[b]
TOTAL	200	230	210	640	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	9933.33333	2483.33333	62.08**	0.0000
Error	10	400	40		
TOTAL	14				

**-highly significant

Appendix Table 7. Mortality (%) of cutworm larvae as affected by leaf dip method of ginger extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0[b]
T1-1:2	10	0	0	10	3.33[b]
T2-1:4	10	20	20	50	16.67[a]
T3-1:6	10	10	0	20	6.67[b]
T4-1:8	10	10	0	20	6.67[b]
TOTAL	40	40	20	100	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	533.333333	133.333333	6.67**	0.0070
Error	10	20	20		
TOTAL	14				

**-highly significant

Appendix Table 8. Mortality (%) of aphids as affected by leaf dip method of ginger extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0[b]
T1-1:2	20	0	0	20	6.67[a]
T2-1:4	10	0	0	10	3.33[b]
T3-1:6	0	0	0	0	0[b]
T4-1:8	0	0	0	0	0[b]
TOTAL					

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	226.666667	56.6666667	2.13ns	0.1522
Error	10	266.666667	26.6666667		
TOTAL	14				

[ns]-not significant

Appendix Table 9. Mortality (%) of DBM larva as affected by topical method of garlic extract

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
Untreated	0	0	0	0	0[a]
T1-1:2	0	0	0	0	0[a]
T2-1:4	0	0	0	0	0[a]
T3-1:6	0	0	0	0	0[a]
T4-1:8	0	0	0	0	0[a]
TOTAL					

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	0	0	0ns	
Error	10	0	0		
TOTAL	14				

[ns]-not significant

Appendix Table 10. Mortality (%) of cabbage butterfly larva as affected by topical method of garlic extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0[b]
T1-1:2	0	0	0	0	0[b]
T2-1:4	0	0	0	0	0[b]
T3-1:6	0	0	0	0	0[b]
T4-1:8	0	0	10	10	0[a]
TOTAL	0	0	10	10	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	26.6666667	6.66666667	1.00ns	0.4516
Error	10	66.6666667	6.66666667		
TOTAL	14				

[ns]-not significant

Appendix Table 11. Mortality (%) of cutworm larvae as affected by topical method of garlic extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0[a]
T1-1:2	0	0	0	0	0[a]
T2-1:4	0	0	0	0	0[a]
T3-1:6	0	0	0	0	0[a]
T4-1:8	0	0	0	0	0[a]
TOTAL	0	0	0	0	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	0	0		
Error	10	0	0		
TOTAL	14				

[ns]-not significant

Appendix Table 12. Mortality (%) of aphids as affected by topical method of garlic extract

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
Untreated	0	0	0	0	0 [a]
T1-1:2	0	0	0	0	0 [a]
T2-1:4	0	0	0	0	0 [a]
T3-1:6	0	0	0	0	0 [a]
T4-1:8	0	0	0	0	0 [a]
TOTAL	0	0	0	0	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	0	0	0ns	
Error	10	0	0		
TOTAL	14				

[ns]-not significant

Appendix Table 13. Mortality (%) of DBM larva as affected by leaf dip method of garlic extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0[d]
T1-1:2	50	80	70	200	66.67[a]
T2-1:4	20	10	20	50	16.67[bc]
T3-1:6	10	10	10	30	10[bcd]
T4-1:8	0	40	30	70	23.33[b]
TOTAL	80	140	130	350	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	8040	2010	27.41**	0.0000
Error	10	733.333333	73.3333333		
TOTAL	14				

**- highly significant

Appendix Table 14. Mortality (%) of cabbage butterfly larvae as affected by leaf dip method of garlic extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0		0^{c}
T1-1:2	50	40	80	170	56.67^{ab}
T2-1:4	50	80	60	190	63.67^{a}
T3-1:6	40	60	40	140	46.67^{abc}
T4-1:8	50	60	60	170	56.67^{ab}
TOTAL	190	240	240	670	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	7906.66667	1976.66667	11.86**	0.0008
Error	10	166.666667	166.666667		
TOTAL	14				

**-highly significant

Appendix Table 15. Mortality (%) of cutworm larvae as affected by leaf dip method of garlic extract

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
Untreated	0	0	0	0	0[b]
T1-1:2	0	20	0	20	6.67[a]
T2-1:4	0	0	0	0	0[b]
T3-1:6	0	0	0	0	0[b]
T4-1:8	0	0	0	0	0[b]
TOTAL	0	20	0	20	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	106.666667	26.6666667	1.00ns	0.4516
Error	10	266.666667	26.6666667		
TOTAL	14				

[ns]-not significant

Appendix Table 16. Mortality (%) of aphids as affected by leaf dip method of garlic extract

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
Untreated	0	0	0	0	0[b]
T1-1:2	30	50	40	120	40.00[a]
T2-1:4	40	10	30	80	26.67[a]
T3-1:6	10	0	10	20	6.67[b]
T4-1:8	0	0	0	0	0[b]
TOTAL	80	60	80	220	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	3840	960	13.09**	0.0006
Error	10	733.333333	73.3333333		
TOTAL	14				

**-highly significant

Appendix Table 17. Mortality (%) of DBM larva as affected by topical method of chili extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0[b]
T1-1:2	20	30	40	90	30[a]
T2-1:4	0	0	0	0	0[b]
T3-1:6	0	10	0	10	3.33[b]
T4-1:8	0	0	10	10	3.33[b]
TOTAL	20	40	50	110	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	1960	490	14.70ns	0.0003
Error	10	1933.33333	33.3333333		
TOTAL	14				

[ns]-not significant

Appendix Table 18. Mortality (%) of cabbage butterfly larva as affected of topical method in chili extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0^{bcd}
T1-1:2	0	50	40	90	30^{a}
T2-1:4	30	30	30	90	30^{ab}
T3-1:6	10	30	0	40	13.33^{abcd}
T4-1:8	20	20	30	70	23.33^{abc}
TOTAL	60	130	100	290	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	1960	490	2.53ns	0.1062
Error	10	1933.33333	193.333333		
TOTAL	14				

^{ns}-not significant

Appendix Table 19. Mortality (%) of cutworm larvae as affected by topical method of chili extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0[b]
T1-1:2	10	0	0	10	3.33[a]
T2-1:4	0	0	10	10	3.33[a]
T3-1:6	10	0	0	10	3.33[a]
T4-1:8	0	10	0	10	3.33[a]
TOTAL	20	10	10	40	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	26.6666667	6.66666667	0.25ns	0.9032
Error	10	266.666667	26.6666667		
TOTAL	14				

[ns]-not significant

Appendix Table 20. Mortality (%) of aphids as affected by topical method of chili extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0[a]
T1-1:2	0	0	0	0	0[a]
T2-1:4	0	0	0	0	0[a]
T3-1:6	0	0	0	0	0[a]
T4-1:8	0	0	0	0	0[a]
TOTAL	0	0	0	0	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	0	0	0ns	
Error	10	0			
TOTAL	14				

[ns]-not significant

Appendix Table 21. Mortality (%) of DBM larva as affected by leaf dip method of chili extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0[b]
T1-1:2	0	0	0	0	0[b]
T2-1:4	0	0	0	0	0[b]
T3-1:6	0	0	0	0	0[b]
T4-1:8	0	0	10	10	3.33[a]
TOTAL	0	0	10	10	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	106.666667	26.6666667	4*	0.0343
Error	10	66.6666667	6.66666667		
TOTAL	14				

*-significant

Appendix Table 22. Mortality (%) of cabbage butterfly larvae as affected by leaf dip method of chili extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0^{d}
T1-1:2	20	0	10	30	10^{abcd}
T2-1:4	20	20	20	60	20^{a}
T3-1:6	10	20	10	40	13.33^{ab}
T4-1:8	10	10	20	40	13.33^{abc}
TOTAL	60	50	60	170	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	640	160	4.80*	0.0202
Error	10	333.333333	33.3333333		
TOTAL	14				

*- significant

Appendix Table 23. Mortality (%) of cutworm larvae as affected by leaf dip method of chili extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0b
T1-1:2	0	0	0	0	0b
T2-1:4	0	0	0	0	0b
T3-1:6	0	10	0	10	3.33a
T4-1:8	10	0	0	10	3.33a
TOTAL	10	10	0	20	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	40	10	0.75ns	0.5801
Error	10	133.333333	13.3333333		
TOTAL	14				

[ns]-not significant

Appendix Table 24. Mortality (%) of aphids as affected by leaf dip method of chili extract

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
Untreated	0	0	0	0	0[a]
T1-1:2	0	0	0	0	0[a]
T2-1:4	0	0	0	0	0[a]
T3-1:6	0	0	0	0	0[a]
T4-1:8	0	0	0	0	0[a]
TOTAL	0	0	0	0	

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	Fc	P>F
Treatment	4	0	0	0ns	
Error	10	0	0		
TOTAL	14				

[ns]-not significant