STUDY ON EFFICACY OF VARIOUS INSECTICIDES AND BOTANICALS AGAINST INSECT PESTS (*Plutella xylostella* L., *Pieris brassicae* L. and *Brevicoryne brassicae* L.) OF OFF-SEASON CABBAGE PRODUCTION IN THE EASTERN HILLS OF NEPAL

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ABSTRACT

Farmers of the eastern hills grow cabbage during off-season (April-October) period to the plains for higher market prices but production during this period is risky with the potential losses to insect pests: cabbage butterfly (Pieris brassicae L.), diamond back moths (Plutella xylostella L.) and aphid (Brevicoryne brassicae L.). Considering this fact, an experiment in RCBD with three replications was conducted to identify suitable chemical and botanical insecticides against cabbage pests; diamond back moth (Plutella xylostella L.), cabbage butterfly (Pieris brassicae L.) and aphid (Brevicoryne brassicae L.) at ARS, Pakhribas (1750 masl) during 2008 and 2009 March-May production with variety, "Green Coronet". Treatments included were Commercial azadirachtin formulation (0.003 %), Aqueous Melia azedarach leaf extract, Aqueous tobacco extract + soap, Aqueous solution Acorus calamus rhizome powder/Deltamethrin 0.003%, Cypermethrin 0.025%, Malathion 0.05%, Endosulfan 0.15%, Dichlorvos 0.075%, combination of botanicals and control. The result showed that diamond back moth had developed resistance to Cypermethrin 0.025% due to its use since a long time in vegetable cultivation. Melia azedarach leaf extract and Acorus calamus rhizome extract are ineffective in controlling insect pests of cabbage. Application of either of commercial azadirachtin formulation (0.003 %), Aqueous tobacco extract + soap, Deltamethrin 0.003%, Malathion 0.05%, Endosulfan 0.15% and Dichlorvos 0.075% twice fortnightly; two weeks after transplanting cabbage seedling provide sufficient protection from diamond back moth, cabbage butterfly and aphid. Alternate use of botanicals (Azadirachtin and tobacco) with chemical pesticides (Deltamethrin, Endosulfan, Malathion and Dichlorovos) could be a better option to reduce selection pressure on DBM larvae.

Key words: *DBM, Cabbage butterfly, aphid*

INTRODUCTION

With increasing development of roads into the hill regions of the country and their concomitant links to the major market/urban centers in the terai and in India, farmers in the hills have begun to capitalize on the comparative advantages offered by the hill agro-ecology. One of the most significant areas is the production diversification by growing high value vegetable crops, particularly cabbage and cauliflower. Production in the hills extends the marketing season in the major marketing centers of the terai by allowing hill farmers to produce early/late season crops which are economically lucrative. Surveys carried out in different semi-commercial vegetable crops growing areas of Ilam, Terhathum, Dhankuta, Makawanpur, Kaski and Parbat districts showed that, farmers of the mid and high hills were only interested to grow the cabbage and cauliflower during off-season (April-October) period to the plains as three to five times higher market prices than winter season production could be fetched (Piya and Khatiwada., 2004a). However, production during this period is risky with the potential for significant losses to insect pests. Cabbage butterflies (*Pieris brassicae*), diamond back moths (*Plutella xylostella*), red ants (*Dorylus orientalis*) and aphids (*Brevicoryne brassicae*) were found as problematic insects in March-May cole crops production in eastern hills of Nepal (Piya and Khatiwada., 2004a). On the basis of literatures, horticulturist consultation, constant farmers' complain and own observation of last few years, diamond back moth (DBM), cabbage butterfly (CB) and aphids are identified as major insects hampering off-season production of cabbage and cauliflower in mid and high hills of eastern Nepal. If the risks due to these insects to vegetable production could be minimized through proper use of insecticide, a larger number of resource-poor farmers would be able to take advantage

of this lucrative enterprise improving their livelihood. On other hand Neupane (2002) reported that diamond back moth has developed resistance against most of the insecticides used in vegetable cultivation. Thus it is also necessary to study efficacy of various chemical and botanical insecticides against these problematic insects.

MATERIALS AND METHODS

An experiment in RCBD with three replications was conducted to identify suitable chemical and botanical pesticide against cabbage pests, DBM, Cabbage butterfly and Aphids at ARS, Pakhribas (1750 masl) during 2008 and 2009 March-May production. Cabbage nursery of "Green Coronet" variety was established on 15th March during the both years. 31 days old seedlings were transplanted to 2.25m X 1.8m sized experimental plots at 45cm X 30 cm spacing. 20 ton per hectare of compost and 100:100:60 kg $N:P_2O_5:K_2O$ in form of Urea, DAP (Diammonium phosphate) and MOP (Murrate of Potash) were applied. The treatments included in the experiments were as follows:

1. Commercial Azadirachtin formulation (0.003 %)
2. Aqueous *Melia azedarach* leaf extract
3. Aqueous tobacco extract + soap
4. Aqueous solution of *Acorus calamus* rhizome powder during 2008 and Deltamethrin 0.003% during 2009
5. Cypermethrin 0.025% (Synthetic pyrethroid)
6. Malathion 0.05% (Organophosphate)
7. Endosulfan 0.15% (Chlorinated hydrocarbon)
8. Dichlorvos 0.075% (Organophaphate with fumigation effect)
9. Combination of treatments 1, 2 and 3 in equal parts
10. Control (water + sticker)

Treatment 4, aqueous solution of *Acorus calamus* was applied in 2008 experiment and replaced with Deltamethrin 0.003 % in 2009. Aquesous *Melia azedarach* leaf extract was prepared with 1 kg fresh leaf soaked overnight in 5 liters of water. Tobacco soap decoction prepared with 1kg of dried tobacco leaf soaked 24 hours in 15 liters of water along with addition of 60g soap. Similarly aqueous *Acorus calamus* solution was prepared with 30g of rhizome powder soaked 24 hours in 4 liters of water.

Treatments were applied fortnightly two weeks after transplanting. Observations on number of DBM larvae, CB larvae and aphids and per cent leaf damage were recorded after twice application of the treatments in 10 sampled plants per plot. Head weight and biomass were recorded at the time of harvesting. Per cent infestations of diseases (Alternaria, Sclerotinia and downy mildew) were also recorded.

RESULTS AND DISCUSSIONS

Mean number of DBM larvae infesting in different treatments during the experimental period in 2008 and 2009 is given in Table 1. Regarding DBM infestation in different treatments; all the treatments except *Melia azedarach* leaf extract, Aqueous solution of *Acorus calamus* rhizome powder and Cypermethrin 0.025 per cent were found significantly effective as compared to control during both years. Deltamethrin, which was replaced against *Acorus calamus* during 2009, was also found significantly effective against DBM. Cypermethrin 0.025 %, a very popular synthetic pyrethroid among eastern hill farmers was found ineffective in controlling diamond back moth during both years experiment. Various workers had reported that, DBM, *Plutella xylostella* L., has an extraordinary propensity to develop resistance to every synthetic insecticide used to control it in cabbage . Efforts to control this pest solely through conventional insecticides led to resistance development to most insecticides. Farmers in the eastern hills are using Cypermethrin for controlling most of the insect pests in vegetable crops since a long time; this could be probable reason behind ineffectiveness of Cypermethrin against DBM

Azadirachtin, Tobacco, Endosulfan, Malathion and Deltamethrin treated cabbage had shown less than 1.67 DBM larvae per plant in both year experiments while control recorded up to 6.33 larvae per plant. Dichlorovos treated cabbage had shown somewhat higher number of DBM larvae up to 2.33 in 2009 experiment.

Table 1. Mean number of DBM larvae in different treatments of March- May cabbage production at ARS, Pakhribas conditions during 2008 and 2009.

SN	Treatments	2008	2009
1	Commercial azadirachtin formulation	1.27(0.341)*	1.00(0.301)
2	Aqueous *Melia azedarach* leaf extract	2.20(0.505)	3.67(0.667)
3	Aqueous tobacco extract + soap	1.20(0.329)	1.67(0.418)
4	Aqueous *Acorus calamus* / Deltamethrin	2.80(0.577)	1.67(0.401)
5	Cypermethrin 0.025%	2.30(0.512)	3.40(0.641)
6	Malathion 0.05%	1.13(0.327)	1.00(0.301)
7	Endosulfan 0.15%	1.27(0.350)	0.67(0.201)
8	Dichlorvos 0.075%	1.20(0.339)	2.33(0.502)
9	Combination of treatments 1,2 and 3	2.13(0.491)	2.00(0.460)
10	Control	4.13(0.706)	6.33(0.859)
	F probability	<0.001	<0.001
	LSD value	0.206	0.219
	CV %	18.6	18.0

*Value within parenthesis are $\log_{(X+1)}$ transformed.

The mean number of Cabbage butterfly larvae in different treatments of March-May cabbage production during 2008 and 2009 is given in Table 2. In 2008 all the treatments except aqueous *Melia azedarach* leaf extract and aqueous solution of *Acorus calamus* were found significantly effective in controlling cabbage butterfly larvae. During 2009 experiment also all the treatments except *Melia azedarach* aqueous solution were found significantly effective against Cabbage butterfly larvae. Deltamethrin which was used against *Acorus calamus* aqueous solution was also found significantly effective in reducing CB larvae population compared to control. University of Florida, Department of Entomology and Nematology has also reported that cabbage butterfly larvae are readily killed by foliar application of any insecticide and botanical insecticides are fairly effective.

Table 2. Mean number of Cabbage butterfly larvae in different treatments of March- May cabbage production at ARS, Pakhribas conditions during 2008 and 2009.

SN	Treatments	2008	2009
1	Commercial azadirachtin formulation	0.80(0.241)*	4.33(0.719)
2	Aqueous *Melia azedarach* leaf extract	4.20(0.715)	6.33(0.864)
3	Aqueous tobacco extract + soap	0.53(0.180)	4.33(0.725)
4	Aqueous *Acorus calamus* / Deltamethrin	2.20(0.496)	3.33(0.634)
5	Cypermethrin 0.025%	0.27(0.085)	3.33(0.619)
6	Malathion 0.05%	0.60(0.195)	3.00(0.593)
7	Endosulfan 0.15%	0.20(0.075)	4.33(0.719)
8	Dichlorvos 0.075%	0.67(0.221)	4.67(0.748)
9	Combination of treatments 1,2 and 3	1.47(0.386)	3.67(0.661)
10	Control	4.87(0.763)	9.33(1.006)
	F probability	<0.001	<0.001
	lSD value	0.285	0.147
	CV %	19.2	11.8

*value within parenthesis are $\log_{(X+1)}$ transformed.

Mean number of Aphids in different treatments in the experimentals seasons are given in table 3. During 2008 experiment, aqueous solution of *Melia azedarach*, aqueous solution of *Acorus calamus* and treatment with combination of Azadirachtin, *Melia azedarach* and tobacco were not effective in controlling aphid

population. However during 2009 experiment, all the treatments except *Melia azedarach* leaf extract were found effective in controlling aphid. Similar finding was also reported by Paneru *et al.* (2004) where neem products, chinaberry seed extract, tobacco and endosulfan were found effective in controlling *Brevicoryne brassicae* in cauliflower. Leaves of Melia *azedarach* contain less amount of Meliantriol as compared to seed (Neupane, 2002), which could be the probable reason behind ineffectiveness of aqueous solution of it in present experiment.

Combination of Azadirachtin, *Melia azedarach* and tobacco extracts in equal parts had shown highest number of DBM, CB and aphid infestation after control (Table 1, 2 and 3) as effects of Azadirachtin and tobacco are diluted by aqueous solution of *Melia azedarach*, which was ineffective in controlling cabbages pests.

Table 3. Mean number of Aphids in different treatments of March- May cabbage production at ARS, Pakhribas conditions during 2008 and 2009.

SN	Treatments	2008	2009
1	Commercial azadirachtin formulation	9.00(0.975)*	30.00(1.473)
2	Aqueous *Melia azedarach* leaf extract	14.20(1.167)	45.00(1.652)
3	Aqueous tobacco extract + soap	5.33(0.778)	20.00(1.292)
4	Aqueous *Acorus calamus* /Deltamethrin	15.33(1.170)	20.00(1.292)
5	Cypermethrin 0.025%	1.00(0.201)	23.00(1.352)
6	Malathion 0.05%	6.00(0.842)	30.00(1.473)
7	Endosulfan 0.15%	2.67(0.441)	13.33(1.117)
8	Dichlorvos 0.075%	1.93(0.450)	30.00(1.473)
9	Combination of treatments 1,2 and 3	18.00(1.232)	28.33(1.441)
10	Control	35.87(1.561)	50.00(1.695)
	F probability	<0.001	<0.001
	l.SD. value	0.4047	0.1487
	CV %	15.7	6.1

*value wihtin parenthesis are $\log_{(X+1)}$ transformed.

Farmers in the eastern hills are not aware of DBM infestation in cabbage due to hidden larvae, small size and green color which matches with cabbage. They always feel only CB and aphid are pests of cabbage as they are easily visible. Cypermethrin which is ineffective in controlling DBM larvae showed better performance in controlling CB and aphid. This could be probable reason behind farmers' preference on Cypermethrin as best insecticide for cabbage cultivation.

Head weight and biomass produced per plant in kg 2008 and 2009 is given in Table 4.The head weight per plant and biomass per plant were not found significantly different with the control during both the years. But reduced aesthetic value with more infestation would be problem in marketing cabbage.

Table 4. Average head weight and biomass produced in different treatments of March- May cabbage production at ARS, Pakhribas conditions during 2008 and 2009.

SN	Treatments	Head wt. (kg/plant)		Biomass (kg/plant)	
		2008	2009	2008	2009
1	Commercial azadirachtin formulation	1.31	1.05	2.01	1.30
2	Aqueous *Melia azedarach* leaf extract	1.17	1.12	1.82	1.32
3	Aqueous tobacco extract + soap	1.17	1.09	1.88	1.23
4	Aqueous *Acorus calamus* /Deltamethrin	1.46	1.44	2.24	1.56
5	Cypermethrin	1.63	1.27	2.53	1.52
6	Malathion 0.05%	1.24	1.16	2.00	1.31
7	Endosulfan 0.15%	1.37	1.33	2.27	1.60
8	Dichlorvos 0.075%	1.35	1.10	2.19	1.35
9	Combination of treatments 1,2 and 3	1.20	1.22	1.94	1.39
10	Control	1.35	1.50	2.26	1.61
	F –test	Ns	ns	ns	ns

Infestation of various diseases during 2008 and 2009 experiments are given in table 5. Though various workers had reported fungicidal properties in Azadirachtin, *Melia azedarch* and Tobacco, but none of the botanicals were capable of reducing Alternaria, Sclerotinia and downy mildew infestation in the cabbage crop.

Table 5. Per cent infestation of alternaria, sclerotinia and downy mildew in different treatments of March-May cabbage production at ARS, Pakhribas conditions during 2008 and 2009.

SN	Treatments	Alternaria %		Sclerotinia % (2008)	Downy mildew % (2009)
		2008	2009		
1	Commercial azadirachtin formulation	7.3	20.0	33.3	10
2	Aqueous *Melia azedarach* leaf extract	3.8	16.7	40.0	20
3	Aqueous tobacco extract + soap	3.1	21.7	30.0	8.3
4	Aqueous *Acorus calamus*/Deltamethrin 0.003 %	2.8	18.3	26.7	10
5	Cypermethrin	3.0	15.0	31.7	10
6	Malathion 0.05%	2.7	18.3	30.0	11.7
7	Endosulfan 0.15%	2.5	21.7	35.0	11.7
8	Dichlorvos 0.075%	3.2	13.3	30.0	8.3
9	Combination of treatments 1,2 and 3	3.8	18.3	26.6	8.3
10	Control	3.8	25	35.0	13.3
	F test	Ns	ns	ns	ns

CONCLUSIONS

Application of either of Commercial Azadirachtin formulation (0.003 %), aqueous tobacco extract + soap, Deltamethrin 0.003%, Malathion 0.05%, Endosulfan 0.15% and Dichlorvos 0.075% in week interval after two weeks of seedling transplanting provide sufficient protection from diamond back moth, cabbage butterfly and phids. Further continuous use of Cypermethrin in cabbage cultivation in the eastern hills should be avoided as DBM had shown resistance against it. Alternate use of botanicals (Azadirachtin and tobacco) with chemical pesticides (Deltamethrin, Endosulfan, Malathion and Dichlorovos) could be a better option to reduce selection pressure on DBM larvae.

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