STUDY ON SOME ORGANIC PRODUCTS AGAINST THE INSECT PESTS OF CAULIFLOWER AND BRINJAL

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ABSTRACT

Three trials, two in cauliflower (one off-season during spring and one main season) and one in brinjal were conducted at HIRI Agriculture Farm, Budhanilkantha, Kathmandu in 2004. The objective of these trials was to assess the effectiveness of the following botanicals and other organic products against the pest insects of the above crops: neem (Azadirachta indica) (Multineem® @ 2 ml/l of water), tobacco (Nicotiana tabacum) (30 g of dried leaves /l of water), ginger (Zingiber officinale) (70g rhizome/l of water), garlic (Allium sativum) (70g cloves/l of water), turmeric (Curcuma domestica) (30g powder/l of water), mug-wort (Artemisia indica) (200g fresh leaves & shoots/l of water); crofton weed (Eupatorium adenophorum) (200g fresh leaves & shoots/l of water), ageratum (Ageratum houstonianum) (200g fresh leaves & shoots/l of water), cow urine (200 ml/l of water) and monocrotophos (Monocil-36 EC® @ 1 ml/l of water). The treatments, at an interval of the week, were applied four times to off-season cauliflower, five times to main season cauliflower and 10 times to brinjal. Insect populations and their damages on crops were recorded periodically. Most of the insects of cauliflower including the diamondback moth (DBM) (Plutella xylostella) and the cabbage butterfly (CB) (Pieris brassicae nepalensis) were observed in the off-season cauliflower. Neem, garlic and turmeric reduced the larval populations of DBM and CB by over 50 % while tobacco and ginger showed only little effect on them. The treatments did not show any impact on the curd yield of cauliflower. In the main season cauliflower both DBM and CB were absent and other insects had very low populations. Hence the treatments: neem, mug-wort, crofton weed, ageratum, cow urine and monocrotophos could not show any impact on the pest insects as well as on the yield of cauliflower. Neem, ginger, mug-wort, crofton weed, and monocrotophos did not control the damage of the shoot and fruit borer (Leucinodes orbonalis) in brinjal. The infestation on shoots was as high as 20 % and on fruits it was 64 % by number and 61 % by weight. All the infested shoots were dead and the fruits were unfit for human consumption.

Key words: botanicals, cauliflower, brinjal, cow urine, insect pests

INTRODUCTION

Synthetic organic pesticides entered into Nepal during 1955-56. DDT, the first insecticide imported through USAID grant for malaria eradication was used for several years. Later on it was followed by several hydrochlorine compounds (aldrin, dieldrin, chlordane, endrin, heptachlor, endosulfan, etc.), organophospatic compounds (parathion, methyl parathion, diazinon, malathion, demeton-s-methyl, fenitrothion, phorate, dimethoate, etc.), carbamate compounds (carbaryl, carbofuran, aldicarb, etc.) and synthetic pyrothroids (deltamethrin, cypermethrin, fenvalerate, etc.). Hydrochlorine compounds except endosulfan have been banned all over the world due to their persistent nature in the environment. Most of the above insecticides are in use in the present day. Commercialization of agriculture has boosted the use

of pesticides. The commodities such as cotton, tea and vegetables come in the top list of pesticide consumers (Neupane, 2001).

Commercial vegetable production has come up rapidly in many districts of Nepal especially near the road heads and urban areas. Vegetables are very delicate commodities and suffer a lot from various pests (insects, fungi, bacteria, nematodes, etc.). There are cases of overuse and misuse of pesticides in these crops. There is a great possibility of the presence of illegal residues of pesticides on most of the vegetables being sold in our daily markets and consumed by majority of the households. Most of the knowledgeable consumers are now scared to consume the fresh vegetables. It is really a confusing situation now.

Crucifers (cauliflower, cabbage, broccoli, knolkhol, broadleaf mustard, radish, turnip, etc.) are very important vegetables, which are being cultivated commercially in various parts of the country. These crops suffer from a large number of insect pests (for example: diamondback moth, cabbage aphid, mustard aphid, cabbage butterfly), which cause significant economic losses (Neupane, 2003).

Brinjal is also popular both in hilly region and Tarai. It has also several insect pests. Of them, the shoot and fruit borer is very serious and a tough pest that has not been controlled by chemical pesticides (Neupane, 2002).

There is an immediate need to replace the synthetic chemical pesticides with safer products such as botanicals, microbial products (*Bacillus thuringiensis* (BT), nuclear polyhedrosis viruses (NPV) and effective parasitoids and predators. Even cow urine has been reported to be effective against certain diseases and insects. But there are no authentic data on these organic compounds related to their make up, mode of action, methods of application and effective doses.

There are over 2400 plant species reported to have pesticide properties around the world (Grainge, 1988). Over 300 species of these botanicals are found in Nepal including about two dozens having better performance against insect pests and diseases of several crops (Neupane, 2000). The status of botanical pesticides in Nepal has been reviewed by Neupane (2003 a). Paneru and Giri (2003) have summarized the research findings of organic pest management on vegetable crops in Nepal, and Neupane (2003) has presented a mini review on organic pest management in Nepal. SSMP (2003) has published a document on organic pest management on vegetable crops in Nepal.

Formulations of neem are easily available in the market. But the efficacy of these products against vegetable insects has not been tested and ascertained in Nepal.

Farmers have tried mixtures of various pesticidal plants and cow urine, and have reported encouraging results on vegetable crops (SSMP, 2059, 2003; Devkota & Gurung, 2003). However, data on such investigations are lacking. It is therefore very imperative that some organizations come forward for verifying the farmers' observations as well as start new research in this area.

In urban areas a large number of people are demanding pesticide free agricultural products for consumption. Nepal has joined WTO recently. There is a good scope of exporting organically produced products to other countries. This may help to increase our economy.

As studies in this area of organic pest management are lacking in Nepal, this study was conducted at the HIRI Agriculture Farm located at the premise of the Budhanilkantha School, Kathmandu during 2004 with an objective of identifying the efficacies of some botanical and other organic products against the insect pests of crucifers and brinjal.

MATRIALS AND METHODS

A. CAULIFLOWER

Experiments in cauliflower (*Brassica campestris* var. *botrytis*) were done during the spring (January to May) and autumn seasons of 2004. For this crop the former season is known as off-season and the latter season as the main season.

Spring Season Crop

Variety and Planting

Cauliflower variety "Sweta" was choosen for this study. The seeds were sown on 20th January and transplanted on 16th February. Individual plot size was 6 X 1.2m. Plant to plant and row-to-row distance was maintained at 60cm. There were 20 plants per plot. Basal dozes of manures and fertilizers were applied as follows per plant: Farmyard manure (FYM): 1.5 kg, Urea: 10g, Diamonium phosphate: 10g, Muriate of Potash: 5g. Topdressing was done after 45 days of transplanting with chicken manure @ 50g and urea @ 5g per plant. Intercultural operations and irrigation were done as per need.

Treatments and Their Applications

There were seven treatments: neem (*Azadirachta india*), tobacco (*Nicotiana tabacum*), ginger (*Zingiber officinale*), garlic (*Allium sativum*), turmeric (*Curcuma domestica*), soap and an untreated check. Their details are presented in Table 1.

The final spray solutions of each treatment were applied during afternoon on cauliflower plants with the help of a hand compression sprayer having a medium volume nozzle (@ 500l/ha). The treatments were applied thrice at an interval of one week.

Data Recording and Analysis

Insect pests attacking the experimental plants were recorded one day before and two days after each treatment. For this purpose 5 plants from each plot were selected randomly. Different stages (egg, larva, pupa and adult) of insects, found in these sample plants were recorded. In case of low infestation of insects qualitative record (such as low number observed, slightly affected/infected, etc.) was maintained. But in case of high infestation, the intensity of insects was recorded quantitatively. The effectiveness of each treatment was assessed on the basis of population decrease of insects after the treatment. The mean values of each treatment were separated with the help of Duncan's Multiple Range Test.

Table 1: Various treatments used in the experiment and their details

Treatment	Form used	Dose	Method of preparation
1. Neem	Commercial formulation (liquid)	0.00006%	2 ml of Mulineem (0.03) was mixed up with 1 litre of water.
2. Tobacco	Dry leaves	30g/litre of water	The dry leaves were put into a cotton bag and soaked in water for 18 hours. The bag was then squeezed several times in water. Finally the required amount of water was added and liquid soap mixed @ 1g/litre of water before application in the field.
3. Ginger	Rhizome (fresh)	70g/litre of water	The rhizomes were converted into a thick paste, put into a thin cotton bag and soaked in water for 18 hours. The remaining procedure was as described under tobacco.
4. Garlic	Cloves (fresh)	70g/litre of water	The cloves were converted into thick paste and the remaining procedure was as described above.
5. Turmeric	Rhizome powder	30g/litre of water	The powder was put into a cloth bag and the same procedure was followed as described above.
6. Soap	Liquid	1g/litre of water	The liquid soap was mixed with water at the time of application.
7.Untreated check			

Autumn Season Crop

Variety and Planting

Cauliflower variety Jyapu 3 was chosen for this study. The seeds were sown on 29th August and transplanted on 24th September. Individual plot size was $5m^2$. Plant and row-to-row distance was maintained at 50X50 cm. There were 20 plants per plot. Basal doses of manures and fertilizers per plant were applied as follows: Chicken manure: 150g, Urea 10g, Diammonium phosphate 10g, Muriate of potash 5g and Biozyme 2g.

Topdressing was done after 45 ays of transplanting with chicken manure @ 150 and urea @ 5g per plant. Intercultural operations were done as per need.

Treatments and Their Applications

Seven treatments, neem, mug-wort (*Artemisia indica*), crofton weed (*Eupatorium adenophorum*), ageratum (*Ageratum houstonianum*), cow urine, monocrotophos (contact-cum-systemic insecticide) and an untreated control, were replicated thrice in a randomized complete block design. Details of the treatments are presented in Table 2.

Table 2: Various treatments used in the experiment and their preparations

Treatment	Form used	Dose	Method of preparation
1. Neem	Commercial formulation (liquid)	0.00006% (azadirachtin)	2 ml of Multineem (0.03%) was mixed up with one litre of water.
2. Mug-wort	Fresh young shoots & leaves	200g/litre of water	Young shoots and leaves of these species were crushed separately in the form of a thick paste with the help of an iron mortar and soaked in water for 18 hours. Then the mixtures were stirred well and filtered with a fine cotton cloth. Powder soap @ 1g/litre of the final mixtures was mixed before application.
3. Crofton weed	Fresh young shoots & leaves	200g/litre of water	
4. Ageratum	Fresh young shoots & leaves	200g/litre of water	
5. Cow urine	Diluted with water	200 ml/litre	The urine was diluted just before application.
6. Monocrotophos	Emulsifiable concentrate	0.05% (a.i.)	1 ml of Monocil 36% EC was diluted just before application.
7. Untreated check			

All the treatments were applied during the afternoon with a hand compression sprayer. Applications were repeated at an interval of one week. In total five applications were made.

Data Recording and Analysis

Data recording and analysis were done as described under spring season cauliflower.

B. BRINJAL

Variety and Planting

Brinjal variety BE-706 was choosen for this study. The seeds were sown on 18th May and the seedlings were transplanted on 20th June. Individual plot was 6.48m^2. Plant to plant and row-to-row distance was maintained at 60cm. There were 18 plants per plot. Basal doses of manures and fertilizers were applied as follows per plant: Chicken manure: 150g, Urea 10g, Diammonium phosphate 10g, Muriate of potash 5g and Biozyme 2g.

Topdressing was done after 45 days of transplanting with chicken manure @ 75g per plant. Intercultural operations and irrigations were done as per need.

Treatments and Their Applications

Six treatments; neem, ginger, mug-wort, crofton weed, monocrotophos and untreated check, replicated thrice, were applied 10 times at an interval of one week. The details are presented in Table 3.

Table 3: Various treatments used in the experiment and their preparations

Treatment	Form used	Dose	Method of preparation
1. Neem	Commercial formulation	0.00006% (azadirachtin)	As in Table 1
2. Ginger	Rhizome	70g/litre of water	As in Table 1
3. Mug-wort	Young shoots & leaves	200g/litre of water	As in Table 2
4. Crofton weed	Young shoots & leaves	200g/litre of water	As in Table 2
5. Monocrotophos	Commercial formulation	0.05% (a.i.)	As in table 2
6. Control			

Data Recording and Analysis

The insect pests were observed one day before and two days after each application of the treatments. In case of brinjal shoot and fruit borer, the infected shoots were counted and their percentage of infestations were calculated for each observation. The fruits were harvested twice, and percentages of infested fruits were calculated in terms of number and weight of fruits.

The percentage figures were transformed into are sine values before analyzing the data. The treatment means were separated with the help of Duncan's Multiple Range test.

RESULTS

A. CAULIFLOWER

Spring Season Crop

Insect Pests Recorded

Most of the insect pests of crucifers have been observed in this trail (Table 4). Of them, the diamondback moth (DBM) and cabbage butterfly (CB) emerged in large numbers during April. Rest of the insects had scanty populations.

Table 4: Insect pests recorded in cauliflower trial plots during the spring season at HIRI Agriculture Farm, Budhanilkantha, Kathmandu, 2004

English name	Scientific name	Infestation level
	LEPIDOPTERA	
Leaf webber	*Crocidolomia binotalis*	Low
Chickpea podborer	*Helicoverpa armigera*	Low
Cabbage butterfly	*Pieris brassicae*	High
Cabbage butterfly	*nepalensis*	Low
Diamondback moth	*Pieris canidia*	High
Semilooper	*Plutella xylostella*	Low
Tortrix moth	*Thysanoplusia orichalcea*	Low
	HOMOPTERA	
Cabbage aphid	*Brevicoryne brassicae*	High
Mustard aphid	*Lipaphis erysimi*	Low
	HEMIPTERA	
Painted bug	*Bagrada hiliris*	Low
	COLEOPTERA	
Flea beetle	*Phyllotreta* sp.	Low
	ORTHOPTERA	
Grasshopper	*Atrctomrpha crenulata*	Low
	DIPTERA	
Leaf miner	*Phytomyza horticola*	Low

Effect of Treatments on Pests Insects

The effects of the treatments on cauliflower pests are summarized below.

Neem: It reduced the larval population of DBM by 83.3% and that of CB by 56% (Table 5). It also reduced the populations of cabbage aphid (CA) and mustard aphid (MA) only on the upper surfaces of cauliflower leaves. Aphids on the lower surfaces of leaves were unaffected. Neem is mostly effective on lepidopterous larvae and least effective against aphids and other sucking insects (Schmutterer & Hellpap, 1989). It also reduced the populations of other minor pests.

Tobacco: Low reduction of DBM (27.3%) and CB (33.3%) was observed in this treatment. It reduced the populations of CA on the upper surfaces of leaves (Table 5).

Ginger: CB was controlled on the upper surfaces of leaves. Low reduction of DBM (33.0%) and CB (44.7%) was noticed.

Garlic: It provided high reduction of DBM (64.7%) and CB (73.0%) and CA on the upper surfaces of leaves.

Turmeric: Both DBM and CB were reduced by 50%. Aphids were also reduced on the upper surfaces of leaves.

Soap: It reduced DBM by 13.8% and CB by 50.6 %. Also, the aphids on the upper surfaces were reduced.

Table 5. Effect of treatments on diamondback moth and cabbage butterfly larvae in cauliflower during the spring season, 2004, HIRI Agriculture Farm, Budhanilkantha, Kathmandu

Treatment	% Reduction in number after 48 hour of treatment	
	DBM	CB
1. Neem	83.3	56.0
2. Tobacco	27.3	33.3
3. Ginger	33.0	44.7
4. Garlic	64.7	73.0
5. Turmeric	52.0	51.0
6. Soap	13.8	15.6
7. Untreated check	9.00	00

Effect of Treatments on the Yield of Cauliflower

The mean curd yield of cauliflower per plant for each treatment has been presented in Table 6. Since this trial was not replicated, the difference between two means could not be workedout.

Table 6. Effect of treatments on curd yield of cauliflower

Treatment	Mean yield/plant (g)*
1. Neem	643
2. Tobacco	653
3. Ginger	610
4. Garlic	590
5. Turmeric	600
6. Soap	595
7. Untreated check	605

* means of 15 plants

CAULIFLOWER

Autumn Season Crop

Insect Pests Recorded

Almost all of the insect pests recorded under this trial were the same as reported under spring season cauliflower (Table 4). Their details are presented in Table 7. It is observed that all the recorded insects had very low level of infestation.

Table 7: Insect pests observed in cauliflower trial plots during the autumn season at HIRI Agriculture Farm, Budhanilkantha, Kathmandu, 2004

English name	Scientific name	Infestation level
	LEPIDOPTERA	
Tobacco caterpillar	*Spodoptera litura*	Very low
Soybean hairy caterpillar	*Spilarctia casigneta*	Very low
Hairy caterpillar	*Orgyia* sp.	Very low
Semilooper	*Thysanoplusia orichalcea*	Very low
	HOMOPTERA	
Cabbage aphid	*Brevicoryne brassicae*	Very low
Mustard aphid	*Lipaphis erysimi*	Very low
	COLEOPTERA	
White spotted flea beetle	*Monolepta signata*	Very low
	ORTHOPTERA	
Short horned grasshopper	*Atractomorpha crenulata*	Very low
Short horned grasshopper	*Oxya* sp.	Very low

Effect of Treatments on Pest Insects

Since the infestation levels of the pest insects were very low, the treatments could not show any significant effect on them.

Effect of Treatments on the Yield of Cauliflower

The means of biomass (above ground, curd plus leaves and stems) yields of different treatments did not differ significantly among themselves (Table 8).

Table 8: Effect of treatments on biomass yields of cauliflower

Treatment	Mean yield / plant (kg)
1. Neem	1.21
2. Mug-wort	1.16
3. Crofton weed	1.26
4. Ageratum	1.18
5. Cow urine	1.25
6. Monocrotophos	1.16
7. Untreated control	1.14
F test: Not significant	

B. BRINJAL

Insect Pests Recorded

Of the insects recorded in brinjal, the brinjal shoor and fruit borer was very serious. The epilachna beetle, which feeds on, leaves caused medium level infestation (Table 9).

Table 9: Insect pests observed in brinjal trial plots during the summer season at HIRI Agriculture Farm at Budhanilkantha, Kathmandu, 2004

English name	Scientific name	Infestation level
	LEPIDOPTERA	
Brinjal leaf roller	*Eublemma olivacea*	Low
Brinjal leaf webber	*Herpetogramma bipunctalis*	Very low
Brinjal shoot & fruit borer	*Leucinodes orbonalis*	High
	COLEOPTERA	
Epilachna beetle	*Epilachna vigintioctopunctata*	Medium
Flea beetle		Very low
	HOMOPTERA	
Cotton aphid	*Aphis gossypii*	Low
Planthopper	*Empoasca* sp.	Low
	ORTHOPTERA	
Green grasshopper		Very low
Grey grasshopper		Very low

Effect of Treatments on Pest Insects

The infestation of brinjal shoots by the borer has been shown in Table 10. This insect remained active in brinjal from July to October. Hundred percent of the plants were infested and the level of infested (dead) shoots ranged from 7 to 20% during the above period. None of the treatments showed any control on shoot infestation by the borer.

Table 10: Effect of treatments on shoot and fruit borer in relation to brinjal shoot infestation, HIRI Agriculture Farm, Budhanilkantha, Kathmandu, 2004

Treatment	Mean % infested shoots on various dates								
	6/8/'04	17/8/'04	25/8/'04	1/9/'04	8/9/'04	15/9/'04	24/9/'04	2/10/'04	Mean
1. Neem	11.6	8.4	10.0	10.0	11.3	16.6	14.7	13.5	12.0
2. Ginger	14.4	8.8	7.6	8.5	10.4	13.8	15.7	10.3	11.2
3. Mug-wort	11.7	8.1	9.1	9.8	13.6	14.1	15.8	18.4	13.5
4. Crofton-weed	11.9	8.3	8.0	10.3	12.2	13.9	14.4	20.0	12.4
5. Monocrotophos	14.0	7.0	9.0	10.0	10.8	10.8	11.3	12.0	10.5
6. Untreated check	13.8	10.5	7.2	9.2	12.5	10.3	12.2	13.4	11.1

Effect of the treatments on shoot and fruit borer in relation to brinjal fruit infestation has been presented in Table 11. Mean number of fruits per plot showed significant differences among the treatments - untreated check produced the lowest number of fruits (104.7) and differed significantly from ginger (140) and neem (136.7) while rest of the treatments were at per to each other. Similar results were found with percent infested fruits by number. Mean weight of total fruits and percentage of infested fruits per plot also did not differ significantly among the treatments.

Table 11: Effect of treatments on shoot and fruit borer in relation to brinjal fruit infestation, HIRI Agriculture Farm, Budhanilkantha, Kathmandu, 2004

Treatment	Mean no. of fruits per plot	Mean weight of fruits per plot (kg)	% Infested fruits	
			by number	by weight (kg)
1. Neem	136.7 A	11.83 A	50.63 D	53.13 A
2. Ginger	140.0 A	13.23 A	52.93 D	58.33 A
3. Mug-wort	127.7 AB	10.90 A	56.10 BCD	56.23 A
4. Crofton weed	126.3 AB	11.27 A	57.47 ABC	54.17 A
5. Monocrotophos	110.3 AB	9.600 A	59.77 AB	53.87 A
6. Untreated check	104.7 A	9.233 A	63.63 A	60.77 A

In a column means followed by the same letter are not significantly different at 0.05 level of significance by Duncan's Multiple Range Test.

DISCUSSION

In Nepal, Cole crops are mainly grown during the winter season as a result the pest insects cannot do much damage. Now a days, they are also grown as off-season crops, which are very susceptible to pest attack. In the latter category DBM, CB, cabbage aphid and mustard aphid are serious pests, which cause significant damage to the crops. Hence for their management farmers mostly rely on chemical pesticides. The botanicals tested on the spring season cauliflower have given some positive impact against DBM and CB. The commercial formulation of neem was expected to perform better than what has been found out. The defect with neem formulations is that their storage life is short (Rembold, 1966). Ofcourse, only one formulation was available in Nepal. Fresh stock would be better for research work. It would be better to repeat the off-season cauliflower trial in the coming season so that replicated experiments could be done for more realistic data. The main season cauliflower was almost free from insect attack. Hence the treatments could not show any impact. This experiment may not be repeated for next season.

Brinjal shoot and fruit borer is the must serious pest of brinjal in all the southern Asian countries where this crop is grown. This pest cannot be controlled with any chemical pesticides (Neupane, 2002). In the past almost all the pesticides were tested against it and none of them gave positive results. Hence some good alternatives to chemical pesticides are needed for its management. Our findings showed that there is high loss of brinjal (20 % shoot damage and 63 % fruit damage) from this pest and none of the treatments that we tested gave any positive result inspite of their 10 applications in a season.

The botanicals mostly act as feeding deterrents to pest insects. We have used only a eight species of plants in the trials. A large number of potential botanicals may be tested in the future so that a few of them could be selected for future experiments.

CONCLUSION

The insect pests of cauliflower are not serious during the main season (September-December) as compared to the off-season (February-May). Hence pest management research activities should be conducted during the summer and rainy seasons.

Before conducting field trails, the botanicals should be tested first thoroughly in the laboratory and green houses.

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REFERENCES

Devkota, K. and D. Gutung. 2003. Tarkari Balima Lagne Rog/ Kira Byawasthapan Ka Lagi Krishakharule Prayog Gardai Ayeka Kehi Mukhya Banaspatik Bishadhiharu (Some Important Botanicals Used by Farmers for Managing Vegetable Crops in Nepal). In: *Organic Pest Management on Vegetable Crops in Nepal* (SSMP Document No. 94). Sustainable Soil Management Program, Bakhundole, Lalitpur, Nepal. (in Nepali).

Neupane, F.P. 2000. Jadibutidwara Kira Niyantran (Insect Control by Botanicals). Sajha Prakashan, Pulchowk, Lalitpur. (In Nepali).

Neupane, F.P. 2001. Synopsis of Use and Economic Value of Pesticides and Chances for Reduced Application Rates at Different Scales in Hindu Kush Region. Centre for Environmental and Agricultural Policy Research, Extension and Development, Shanti Basti, Lalitpur, Nepal.

Neupane, F.P. 2002. Integrated Management of Vegetable Insects. Published by Sushila Neupane, Arun Tol, Sat Dobato, Lalitpur. (In Nepali).

Neupane, F.P. 2003. Balibiruwaka Shatru Ra Tinko Roktham (Crop Pests and Their Control), Sajha Prakashan, Pulchowk, Lalitpur. (In Nepali).

Paneru, R.B. and Y.P. Giri. 2003. Some research findings related organic pest management on vegetable crops in Nepal. In: Organic Pest Management on Vegetable Crops in Nepal (SSMP Document No. 94). Sustainable Soil Management Program, Bakhundole, Lalitpur, Nepal. pp. 12-16.

Rembold, H. 1996. Neem and its general development for pest control. In: Neem and Environment, vol. I (S. Singh, M.S. Chari, W. Raheja and W. Kraus, eds.). Oxford IBH Publishing Co. Pvt. Ltd., India. pp. 1-10.

Schmutterer, H. and C. Hellpab. 1989. Effects of neem on pests of vegetables and fruit trees. In: 1988 Focus on Phytochemical Pesticides, Vol. I – The Neem Tree (M. Jacobson, ed). CRC Press, Inc., Boca Raton, Florida. pp. 69-86

SSMP. 2059 (B.S.). Banaspatik Bishadiko Prayogdwara Tarkari Tatha Phalphul Balika Rog-Kira Byawasthapan: Kisanka Anubhavko Sangalo, (Management of diseases and insects of vegetable and fruit crops by botanical pesticides: Compilation of farmers' experiences) Document No. 84. Sustainable Soil Management Program, Bakhundole, Lalitpur, Nepal.

SSMP. 2002. Rato Kamila Ra Khumre Kirako Lagi Jaibik Bishadiko Prayog. Krishakako Anubhav-3. (Use of Organic Pesticides against the Red Ants and the White Grubs: Farmers Experience). Sustainable Soil Management Program, Bakhundole, Lalitpur, Nepal.