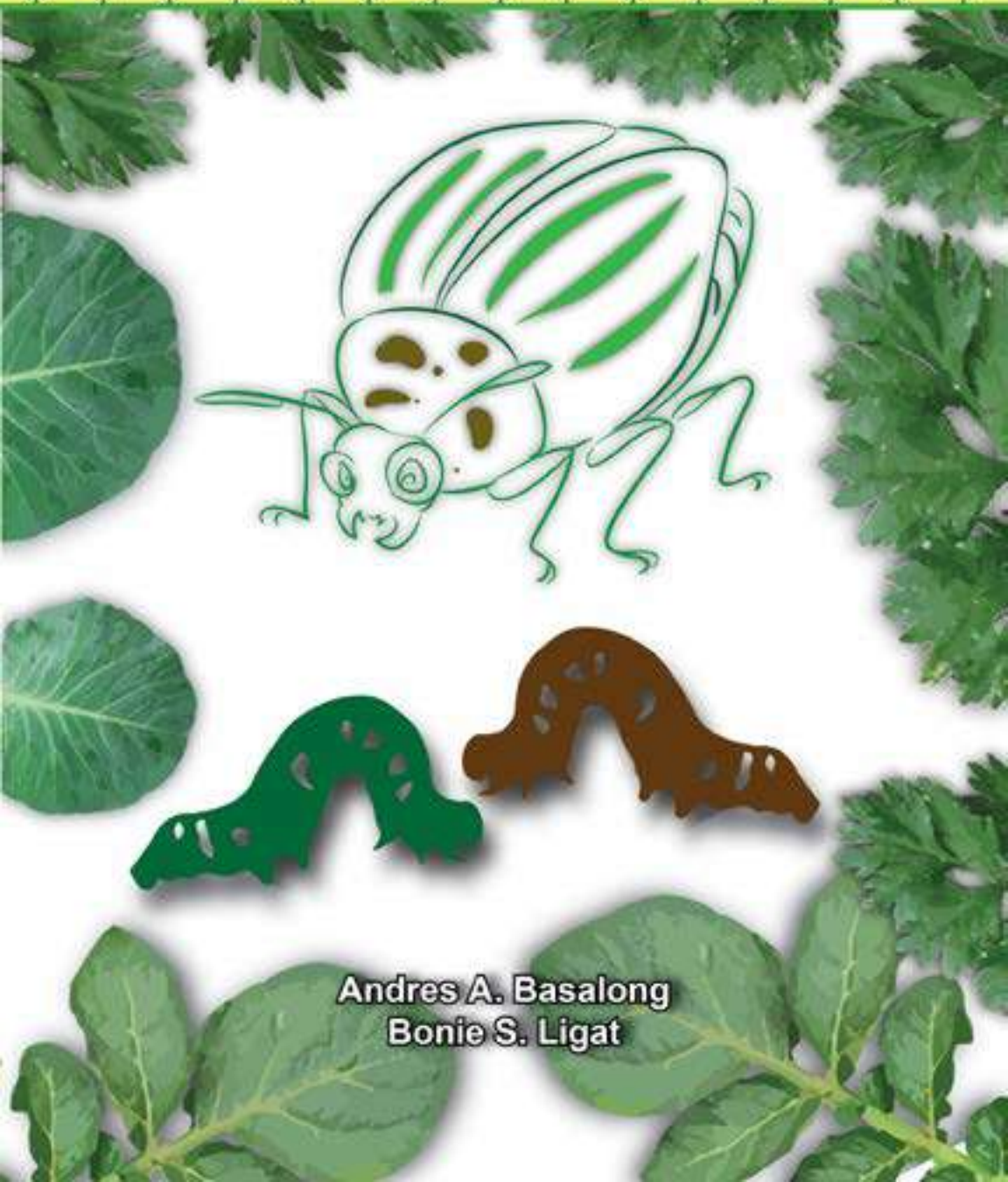
GOOD PRACTICE OPTIONS IN INSECT MANAGEMENT FOR CABBAGE, CARROT AND POTATO

A Supplemental Guide for BSU-Technology and Innovation Menu in Climate Change Mitigation and Adaptation



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GOOD PRACTICE OPTIONS IN INSECT PEST MANAGEMENT FOR CABBAGE, CARROT AND POTATO

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Basic Information on Insect Pest

What are Insects?

Insects are small creatures that belong to the phylum of arthropods. They are characterized by their structure: the head, thorax and the abdomen, two pairs of wings for some insects, pair of antennae, and three pairs of legs.

Insects can be classified into insect pests when they hinder or annoy people, other animals, and damage plants. Some insects can also be classified as beneficial insects because they help farmers and gardeners in pollination such as the honey bees, butterflies, and flies.

What is Pest?

Pests are small destructive organism that destroy crops. They also compete with humans, domestic animals or crops for food and sometimes spreads diseases, viruses and bacteria. Furthermore, they can only be considered as pest if their population increases uncontrollably.

Other Pests

1. Arachnids. These are eight-legged arthropods that has no antennae and wings. They mature through gradual metamorphosis that includes both larval and nymphal stages.

   Mites are one of the arachnids that damage the plant by sucking its fruit, leaves, and shoots resulting into the wrinkling, stunting, and curling of the plants. Mites commonly attack legumes and tuber.

Body Characteristics of Insects
(Cornell University Cooperative Extension, 2012)

Insects can be identified easily by their body characteristics; they have six legs or three pairs of jointed legs, and they have three body regions – the head, thorax, and abdomen.

1. Head. Attached to the insect head are the antennae, eyes, and mouthparts. All of these parts vary in size and shape, and can be helpful in identifying some insect pest.

2. Antennae are paired appendages usually located between or below the eyes. Antennae vary greatly in size and form and are used in classifying and identifying insects. Some of the common antennae types are:

   a. Filiform – threadlike; the segments are nearly uniform in size and shaped like a cylinder (example are ground beetle, cockroach).

Image Credit: Meyer, 2016

   b. Moniliform – looks like a string of beads; the segments are similar in size and round in shape (examples are termites).

Image Credit: Meyer, 2016

   c. Serrate – saw-like; the segments are more or less triangular (example is beetle).

Image Credit: Meyer, 2016

d. Clubbed – segments increase in diameter away from the head (example is Japanese beetle).

Image Credit: Meyer, 2016

e. Plumose – feathery; most segments with whorls of long hair (examples are male mosquito).

Image Credit: Meyer, 2016

3. Mouthparts are different in various insect groups and are often used in classification and identification. The type of mouthpart determines how the insect feeds and what sort of damage it does. Types of insect mouth parts:

a. chewing mouthparts have toothed jaws that bite and tear the food (beetles, cockroaches, ants, caterpillars, and grasshoppers).

b. piercing-sucking mouthparts are usually long slender tubes that are forced into plant or animal tissue to suck out fluids or blood (mosquitoes, aphids).

c. sponging mouthparts are tongue-like structures that have spongy tips to suck up liquids or food that can be made liquid by the insect's vomit (house flies, blow flies).

d. siphoning mouthparts are long tubes used for sucking nectar (butterflies, moths).

4. Thorax. The thorax, or middle body segment, has three pair of legs and sometimes one or two pairs of wings (forewings, hindwings).

5. Legs come in many sizes, shapes, and functions and are helpful in identifying insects. Used for walking, running, jumping and climbing, legs have become very specialized in some insects like the large jumping leg in the grasshopper.

6. Wings. These also vary in size, shape, and texture. The pattern of veins on the wings of an insect are often used to identify insect species. Forewings in some insects are hard and shell-like, as in beetles. The grasshoppers have forewings that are leathery. The forewings of flies are thin, clear, and like membranes. The wings of moths, butterflies, and mosquitoes are membranous and are also covered with scales.

7. Abdomen. The abdomen of the insect is built of segments. Along the side of the segments are openings, called spiracles, which the insect uses to breathe. The abdomen contains digestive and reproductive organs. Parts of the abdomen used in identification include: the ovipositor, male genitalia, and cerci.

Life Cycles of Insect Pests

1. Complete Metamorphosis. It is composed of four stages – the egg, larva, pupa to adult. The larva (or caterpillar) is considered as the most destructive stage because they feed on the plants. Except for some insect pests, when they reach the adult stage, they also feed on the plant such as the beetle. Insect pests that undergo in this life cycle are bees, true flies and beetle.

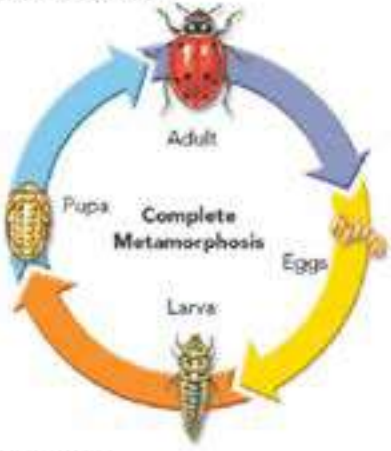

Image Credit: Byrne, 2016

2. Incomplete Metamorphosis. It is composed of three stages – the egg, nymph to adult. This type of life cycle is seen in various insects, including grasshoppers, thrips, and aphids.

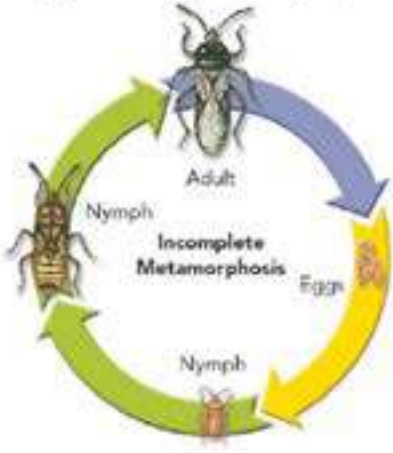

Image Credit: Byrne, 2016

Mode of Damage of Insect Pests to Plants

1. Damage by Chewing

Insect pests can cause damage by creating a tear or cut, then chewing and swallowing the tissue or the leaves of the plant. The leaves may be completely or incompletely eaten by the insect pests resulting into a ragged leaf or lacy appearance. Beetles, caterpillar and grasshopper are several of the insect pests that have chewing mouthparts.

2. Damage by Piercing-Sucking

Insect pest has the ability to pierce and suck. Examples are the aphids that pierce the leaf, flower, roots and stem of the plant. They also have strong mandibles that move laterally, causing yellowing or browning of plants, possible wilting, and stunting.

Piercing-sucking insects may also be a transmitter of most diseases and virus that are very hard to control. Aside from injuring the plant, they also transfer the pathogen to the plant causing it to die or wilt.

3. Mining Insects

The larvae of this group feed within the leaves or middle of the plant resulting into tunneling injuries of the plant. An example of this is the leaf miner.

4. Boring Insects

These are the insects that damage the stems and other parts of the plants by boring. They eat the fruits, stems, leaves and roots of the plant.

Good Management Options in Insect Pest Management

Alternative Environment Friendly Insect Pest Management Strategies

1. Biological control. This pertains to the control of insect pest using organisms, animals or pathogen.

   a. Beneficial insects- this is the use of predators, parasitoids or pathogens to control the attack of insect pests on the plant.

      - *Diadegma semiclausum* (Diadegma). This is a parasitoid wasp that lay its eggs in the developing larvae of the cabbage moth or diamondback moth (DBM). The parasitized DBM becomes mature and they become sluggish and they feed less. However, *Diadegma semiclausum* is commonly abundant in farms not treated with insecticides.

      - Hover-fly. This is a predator that consumes aphids and other soft-bodied insect pests.

      - Ladybug. This is also a predator that consumes aphids, mites, whiteflies and other soft-bodied insects.

   b. Beneficial pathogen against insect pests- these are disease-causing organisms that attack insects.

      - *Beauveria bassiana*. This is a fungus that grows on the soil that also serves as an aggressive parasite of many different insect pest such as aphids, thrips, and beetle.

      - Nuclear Polyhedrosis Virus (NPV). This is a virus being used to attack insect pest. The body of the insect pest becomes flaccid or liquified when they consume NPV.

      - *Metarhizium anisopliae* (Green Muscardine disease) this is a fungus acting as a parasitoid that causes disease in various insects. The fungus attack the insect pest by developing inside their body resulting to death.

- *Bacillus thuringiensis* (Bt). This is a soil-borne bacteria that acts as a stomach poison to insect pests. Bt has a spore that consists of protein crystal serving as the toxin. If the insect pest consumed the toxin, it will eventually die because of being poisoned in the stomach.

2. Cultural control- any agronomic practice done to discourage insect pest in attacking the plants. It is either you will make the environment unfavorable to the insect pest, or the plant grow vigorously with insect pest.

   a. Crop rotation- planting of crops in succession with other families of plants to discourage the attack of pest on the next crop. This is also to remove the continuity of insect pest on the host plants resulting for them to reduce in population. Example of this is planting cabbage after you harvest potato to discourage the attack of diamond backmoth.

   b. Time of planting- this is where you plan your time of planting to avoid the destructive population of insect pest. Try to plant when the population of insect pest is low. Insect have low population during wet season while they are abundant during dry season.

   c. Irrigation- this is one way of dislodging the insect pest from the leaves or other parts of the plants. Flooding type of irrigation suffocates the insects in the soil or killing the larvae. Furthermore, bursting irrigation puts pressure on the canopy of the plants that kill or remove the insects.

   d. Fertilization- this is to make the plant vigorous to become resistant to insect pest so that the plant can cope up with the injury caused by the insect pests.

   e. Multiple cropping- planting of crops side-by-side will produce odor that repels insect or confuse insects in finding their host plants. One example of this is the planting of cabbage and tomato together to discourage the diamond backmoth in attacking the cabbage.

   f. Land preparation and cultivation of the soil- this is to bring out the insect present in the soil. The shelter of the insect pest will be destroyed and the insects will become vulnerable to other predators.

3. Physical control- this pertains to the practice that directly destroys or hinders the insect pest in attacking the crops.

a. Hand-picking- directly getting and crushing the insect pests.

b. Trapping- it is a practice that would attract the insects to the material that would catch them.

1. Colored sticky traps- the color of the trap may vary on different insects depending on their preferred color. The yellow sticky trap can trap aphids, whiteflies, flies, leaf miner, and flea beetle while the blue sticky trap can trap thrips.

Figure 1. Colored sticky traps being practiced at Benguet State University

c. General trap using fermented fruit juice- It traps all flying insects because the odor of the juice attracts them. Once the insect pest started feeding on the juice, their stomach will budge until they cannot fly and they will be submerged on the trap.

Figure 2. General trap using fermented fruit juice to attract flying insects being practiced at Benguet State University

d. Physical barrier using net house- this is the use of insect pest proof nets to prevent entry and contact of insect pest to plants.

Figure 3. Net house as physical barrier being practiced at Taiwan

Observed Insect Pests in Cabbage, Carrot and Potato and their Management Options

For this part of the material, the reference is mainly the results of the insect pest management component of the project funded by the United Nations- World Food Programme through the Benguet State University- Climate Smart Agriculture Center. Below are the key findings of the research titled "Building Farmers' Resilience in Disaster Prone Vegetable Terrace in Atok, Bokod, Buguias, and Kabayan Benguet, Philippines."

A. Insect Pests of Cabbage

Insect pest	Description	Implemented Management Options
a. Diamond backmoth (*Plutella xyllostella*) Local Name: *Tarsan*	Pale green caterpillar with black head and scattered black hairs. It feeds on the underside of the leaves making small holes.  	1. Biological control using *Diadegma semiclausum* and *Bacillus thuringiensis*. 2. Cultural control by crop rotation (planting of cabbage after tomato) and time of planting. 3. Physical control by general trapping and hand-picking.

b. Cabbage looper (*Trichoplusia ni* (Hübner) Local Name: *Kadang-kadang*	Green caterpillar with longitudinal white stripes, long body and tapering toward the head. It consumes tender leaf tissue resulting into ragged leaves because it starts feeding on the leaf margins. 	1. Biological control using Nuclear Polyhedrosis Virus 2. Physical control using general trap for adults
c. Cutworm Local Name: *Limas* or *Dimas*	Fat, basically gray, brown, or black caterpillars that are active at night because they hide during the day in soil burrows at base of plants. They cut the stalks and leaves of the plant.  Image Credit: Hansen, 2018	1. Physical control using general trap for adults and by hand-picking.

d. Flea beetle (*Phyllotreta cruciferae* Goeze) Local Name: *Tiltilang*	These are very small brown to black beetles that may have some yellow markings on their wing covers. The larvae or grubs eat the leaves resulting into the wilting of the seedlings of the plant while the adult or beetle eat the leaves resulting into small or tiny holes. 	1. Cultural control by irrigation 2. Physical control using yellow trap
e. Garden snails (*Corno aspersum*) and gray garden slug	Snails and slugs make irregular holes on the leaves and stem of the plant.  	1. Physical control by trapping • Using a board or a wood where they go and stay. 2. Keeping the surroundings dry because they cannot move faster on dry area.

B. Insect Pests of Carrot

Insect-pest	Description	Implemented Management Options
a. June or May beetle Local Name: *Abal-abal*	Usually brown, rusty or black insect with patterns beneath their bodies. The adult or the beetle makes lacerations on the leaves of the crop when they eat. Furthermore, the larvae or the white grub feeds on the roots of the crop resulting to the yellowing of the leaves, wilting, and stunting of the plant. 	1. Cultural control by cultivation 2. Physical control by general trap
b. Stink bug Local Name: *Taktakba*	These bugs feed on the base of the leaves resulting to the stunting of the leaves. 	1. Physical control by hand-picking

c. Cutworm Local Name: *Limas* or *Dimas*	Green, brown, grey or yellow caterpillars that hide during the day and attack the plant during the night. They cut the stalks of the leaves.  Image Credit: Infonet-Biovision, n.d	1. Physical control by general trap for adults and hand-picking for the caterpillar

C. Insect Pests of Potato

Insect-pest	Description	Implemented Management Options
a. White grub Local Name: *Gagali*	It is a larvae with a C-shaped body, three pairs of brown legs. They feed on the tubers and make holes on the crop. 	1. Physical control by general trap for adults or the May beetle.

Place of Presence of Insect Pests and Other Pests

Insect pest of cabbage, potato and carrot were documented in three demonstration farms in Benguet particularly at Paoay, Atok, Buyacaoan and Lengaoan, Buguias, Benguet.

All the cabbage pests observed were present in Paoay, Atok, while cutworm was not observed in Buyacaoan, Buguias and cabbage looper, cutworm and mollusks (snails and slugs) were not observed in Lengaoan, Buguias.

Beetle larvae or white grubs associated to potato plants were observed in Buyacaoan and Lengaoan, Buguias. It was not observed in Paoay, Atok because harvest sampling was not done during the harvest festival since the potato plants were immature.

Beetle adult and larvae (grubs) associated to carrots were observed in all the three sites. While stink bug and parsley army worm were only observed in Paoay, Atok.

Generally, the occurrence of most of the insect pests and other pests (snails and slugs) were sparsely distributed. Mostly one to two individual of these pests were observed in all the sites, except flea beetle on cabbage which swarms all over the demonstration sites (See Table 1).

Percentage of Insect Pests Damage on Host Plants

Damages inflicted by the observed pests were negligible for potato and carrots. However, cabbage showed prominent leaf lacerations and holes which were associated to pest with chewing mouth parts. Flea beetles were the major cause of the damage as they swarmed around the demonstration sites.

Damage on cabbage leaves were taken in Buyacaoan and Lengaoan, Buguias, no prominent damage on cabbage at Paoay, Atok were observed. The damage was assessed by the count of heads with holes on wrapper leaves per plot. Henceforth, the percentage of damage was computed with this formula:

$$\% \text{ damage} = \frac{\text{Number of plants with damages/plot}}{\text{Total number of plants/plot}} \times 100$$

The data were statistically analyzed in Split plot design. The

cropping systems as the main plot and cabbage cultivars as subplot for both BSU intervention and Farmer's practice. Differences in the means of damages were insignificant (Table 2).

Table 1. Observed insect pests and mollusk in the demonstration sites.

CROP/PEST	FARM LOCATIONS		
	Paoay, Atok	Buyacaoan, Buguias	Lengaoan, Buguias
	Average temperature annually: 20.8°C Average rainfall annually: 2497 mm Elevation: 7,400 ft above sea level	Average temperature annually: 17.5°C Average rainfall annually: 2908 mm Elevation: 200 meters to 2,792 meters above sea level	
CABBAGE			
Diamond backmoth (*Plutella xyllostella*)	+	+	+
Cabbage looper (*Trichoplusia ni* (Hübner)	+	+	-
Cutworm (*Spodoptera litura*)	+	-	-
Flea beatle (*Phyllotreta cruciferae* (Goeze)	+	+	+
Slugs and snails	+	+	-
POTATO			
Beetle larvae or grubs	-	+	+
CARROT			
Beetle adult and larva (grub)	+	+	+
Stink bug (*Chlorochroa sp.*)	+	-	-
Cutworm(*Spodoptera litura*)	-	-	+

Table 2. Percentage of cabbage plants with damaged wrapper leaves.

Cropping system/variety	BSU Intervention		Farmers practice	
	Buyacaoan	Lengaoan	Buyacaoan	Lengaoan
	Average temperature annually: 17.5°C Average rainfall annually: 2908 mm Elevation: 200 meters to 2,792 meters above sea level			
Monocrop				
Scorpio	43.14	38.89	18.95	62.96
Gladiator	49.68	59.26	26.36	40.74
Lucky ball	33.33	38.89	27.78	55.56
Intercrop w/ onion				
Scorpio	35.29	37.04	21.24	55.55
Gladiator	45.75	57.42	22.87	48.15
Lucky ball	32.68	35.18	26.80	59.26
CV(%)	31.71	19.21	26.85	21.81

General Recommendations in Controlling Insect Pests

Green labelled insecticides can also be sprayed on cabbage, carrots and potatoes when necessary to protect them against severe damage caused by flea beetle, semi loopers, thrips and other insect pests.

Another option that can be integrated in disease and insect pests management is the application of biological control agent in the soil in the form of compost that will protect plant roots against soil pathogen infecting plant roots.

Varieties with a certain degree of resistance against diseases and insect pests such as those varieties used in the experiment should be utilized as long as they are available and supplemented with the application of biocontrol agent/s and sanitation practices to keep disease infection and insect infestation at a manageable level. Crop rotation is also encouraged as one option in the management scheme to reduce the build-up of inoculum and reduce insect population. Use of traps and predators should also be a component of the scheme.

Climate Change Impacts on Insect Pests

Based on the research results of the Building Farmers' Resilience in Disaster Prone Vegetable Terrace in Atok, Buguias, Bokod and Kabayan, Benguet, Philippines

A. Rising temperatures affects insects

1. Researchers have shown that increased temperature can potentially affect insect survival, development, geographic range, and population size

   - Insects thrive on 5°- 45°; optimum range for insect survival – 25° C
   - Development Stage - As the temperature increases, the development of insect decreases; as the temperature decreases, the development of insect increases. e.g. Limas – 45-60 days life cycle if 25°C, but if it is colder it will take 90 days.
   - Geographic range – pest in Atok, Benguet is different from the pest in Buguias, Benguet due to the difference in range and altitude.
   - Population size – insect are not always a pest only when they increased in number.
   - 20-40 % of cost production is pest management.

2. Increased temperature will accelerate the development of insects

   - Insects adapts to temperature (Poikilotherm – cold blooded animals). This possibly results in more generations per year. Insects also pass though vulnerable life stages more quickly at higher temperatures, reducing possible exposure for parasitism, and insects have insect enemies. e.g., DBM and diadegma
   - There is a balance in nature (homeostasis). Gender ratios of some pest species such as thrips may change, potentially affecting reproduction rates.

3. Increase temperature could decrease pest insect populations

   - At higher temperatures, aphids have been shown to be less responsive to the aphid alarm pheromone they release when under

attack by insect predators and parasitoids – resulting in the potential for greater predation.

B. Change in Precipitation Affect Insects

1. Some insects are sensitive to precipitation and are killed or removed from crops by heavy rains.

2. Predicted more frequent and intense precipitation events forecasted with climate change negatively impact insect pests in the soil by flooding.

3. Fungal pathogens of insects are favored by high humidity and their incidence would be increased by climate change specifically lengthened period of high humidity.

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About the Author

Andres A. Basalong was born on November 25, 1957 at Sagubo, Kapangan, Benguet. He finished his elementary education at Sagubo Elementary School in 1970 and continued his secondary education at the Mountain State Agricultural College now Benguet State University. He graduated in 1974. He pursued his college degree on the same school where he enrolled in Bachelor of Science in Agriculture major in Plant Pathology. He finished in 1979. To continue his education, he enrolled again and finished his master's degree on plant pathology in 1999.

He assumed various designations at the different offices of Benguet State University particularly in the Research and Extension arm of the University. He was designated as the Assistant Director of the Institute of Highland Farming and Agroforestry, Section Chief of the Agroforestry and Farming Systems R&D, Director of the Climate Smart Agriculture Center, Director of the Northern Philippine Rootcrops Research and Training Center, and currently as the Director of Institute of Highland Farming and Agroforestry.

Prof. Basalong's researches focused on the influence of cropping systems on the severity of arabica diseases; field evaluation of arabica coffee cultivars against foliar pathogens; screening of arabica coffee cultivars at seedling against brown-eye spot; diseases of crops with economic importance in Cordillera particularly coffee and banana; survey, mapping and identification of plant pathogens and alternative weed hosts in the province of Benguet; and the biological agent and cropping systems for the management of major insect pest and diseases of arabica coffee for organic production in Benguet.

Prof. Basalong is constantly being tapped as resource speaker in the production of coffee, anthurium and chayote. He also served as co-author of the Compendium of Disease of Crops with Economic Importance in the Cordillera, Handbook on Vegetable and Weed Diseases in Benguet and the Principles of Crop Protection.

About the Author

Bonie Sacla Ligat was born on May 21, 1956 at Nan-agto, Natubleng, Buguias, Benguet, Philippines. He is the third child among four children of Mr. and Mrs. Leo Ligat. He finished his elementary education at Calasipan Elementary School, Atok, Benguet in 1970. He continued his secondary education at the Mountain State Agricultural College now, Benguet State University in 1974. In the same year, he enrolled Bachelor of Science in Agriculture major in Entomology in the same school where he graduated in 1979. After 5 years, he graduated and earned his Master of Science in Entomology at the University of the Philippines, Los Baños, Laguna. Eventually, he went at Brisbane, Australia to study for his doctorate degree on entomology at the University of Queensland where he earned 48 units in 1988.

He served as project leader on different projects such as Biological Control of Leaf Miner Associated with Highland Vegetables; IPM in Selected Highland Vegetables; Biological Control of Two-Spotted Spider Mites Infesting Strawberry in the Highlands; Survey, Collection, Identification and Management of Major Insect Pests of Arabica Coffee in Benguet; Crop Protection Practices for Organically Grown Crops; and Insect Associated with Cape Gooseberry (Physalis peruviana) in La Trinidad.

Aside from research, Prof. Ligat also authored and co-authored different publication such as: Pre-emptive Management Approach of Coffee Berry Borer (Hypothenemus hampei Ferrari) (Coleoptera: Curculionidae) in Arabica Coffee (Coffea arabica Linnaeus) in Atok, Benguet; Fermented Guava Extract as Fruit fly Attractant; Insect Pest Associated with Yacon Plants in Benguet; Pottential Microorganisms Isolated from Compost Tea Against Cutworms and Mites of Strawberry; Management of Leafminer

(Liriomyza huidobrensis Blanchard) on Selected Highland Vegetables; Simulation of Injury Levels of Leaf miner (Leriomyza huidobrensis) on Potato; and Community- Based Piloting on Rehabilitation of Banana in the Philippines.

His highlight experiences include being a resource person on integrated pest management on organically grown crops, beekeeping for beginners, and management of leaf miner. Professor Ligat is currently a faculty member of the Department of Entomology, College of Agriculture, Benguet State University.

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