

Field Guide to
**Non-chemical
Pest Management**



**in Cassava
Production**



Field Guide to

Non-chemical Pest Management in Cassava Production

**for small scale farming in
the Tropics and Sub-tropics**



**Pesticide Action Network (PAN) Germany
Hamburg, 2009**

Pesticide Action Network (PAN)

Founded in 1982, the Pesticide Action Network is an international coalition of over 600 citizens groups in more than 60 countries, working to oppose the misuse of pesticides and to promote sustainable agriculture and ecologically sound pest management.

PAN Germany was established in 1984 as part of this global network and has continually been involved in initiatives to reduce the use of hazardous pesticides and to promote sustainable pest management systems on national, European and global levels.

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Prologue

Pesticides worth more than 38 billion US dollar are intentionally released into the global environment every year. A high proportion of these is highly toxic and has immediate adverse effects on human health, wildlife, local food sources such as cattle or fish, beneficial insects and biodiversity. Some of them have chronic effects including cancers, reproductive problems, birth defects, hormonal disruption and damage to the immune system. Impacts come from direct exposure in use, spray drift, washing work clothes used while spraying, home pesticide storage, pesticide dumps, and persistence in the environment.

Overall aim of the international *Pesticide Action Network (PAN)* is to eliminate the use of hazardous pesticides, reduce overall use, risk and dependence on pesticides, and increase support for community-based control over a sustainably produced food supply. PAN is committed, in its projects, strategies and campaigns to place pesticide concerns in the broad political and economic context in ways that will advance the fight against rural poverty and enhance pro-poor development and ethical trade. PAN aims to help local communities use the initiatives to benefit their day-to-day lives.

PAN Germany is part of the international Pesticide Action Network. It is supporting non-chemical pest management on tropical crops that are commonly grown by small landholder farmers through the project:

Online Information Service for Non-chemical Pest Management in the Tropics, OISAT (www.oisat.org).

OISAT is a web-based information system to distribute information on non-chemical pest management in the tropics and sub-tropics that is easy to read and easy to understand. Information provided via www.oisat.org is relevant to small-scale farmers who intend to produce crops using safer and more affordable non-chemical pest management practices. It provides varied information on how to lower the cost of production based on recommended insect/mites pests, disease, and weeds control methods.

The 'Field guide to Non-chemical Pest Management in Cassava Production' is an excerpt taken from the website, www.oisat.org. It enables to provide farmers with practical guides and alternatives to eliminate the use and their dependence on synthetic pesticides for the management of cassava pests. The recommended practices are safer, more affordable, and easy to follow. Most of the farm practices, the farmers can do by themselves and the materials that are needed are found in their backyards or in their kitchens or can be purchased in the local agricultural suppliers.

Carina Weber
(Executive Director PAN Germany)



How to use this field guide

This field guide is designed to let you grow cassava as easy as possible.

It provides you the suggested appropriate management practices on how to grow cassava. In the pest pages, each pest has a brief description of its lifecycle, damage it causes, and its control measures. It is very important to know how the insect/mite pest develops because the adult does not always cause the damage and sometimes it is not even found where the damage occurred. Included in the control measures are cultural practices, physical control, plant extracts, other homemade solutions, and other practical methods. Also, as not to confuse you with the beneficial insects, a separate page with photos of them and their conservation and management are included.

For example, you notice that the cassava leaves are having brown spots when you're out in the field. What would you do? First, have a closer and careful examination of your plant. If you find the pest and can't identify it, turn the following

pages and look at the illustration of an insect and/or the damage or symptom in each pest entry. Once you have identified the pest, look into the corresponding control measures on how to eliminate and/or lessen its population density. You have various options like: cultural practices (e.g. removal of weeds); physical control (e.g. handpicking); plant extract (e.g. neem spray); other homemade solution (e.g. soap spray); other method (use of baits).

However, with every effort made to provide you with complete information on the pest control in cassava growing, the recommendations may vary from every location. It is highly recommended that you have to try the various control practices in small scale especially for the plant extracts and other homemade solutions, in order to make adjustments that are adaptable to your local farm conditions before going into large scale application.

Fill up the forms at the end of this manual to have a record of activities each time you grow cassava.



Recommended practices

Throughout this field guide you will find suggestions for stopping or lessening the pests' population before they have control over your cassava field. To make a plan for you to grow a healthy crop, the following tips are the steps you ought to take:

1. Learn to identify the pests and other causal agents and the natural enemies
2. Select the proper cassava variety that is well adapted to your local conditions
3. Always select good and diseased-free planting materials
4. Have a healthy soil, but always keep in mind that over-fertilizing isn't necessarily better
5. Practice crop rotation by planting on the next cropping season- crops of different family group
6. If possible practice intercropping to improve the field's diversity and to encourage natural enemies
7. Follow the recommended planting distances
8. Prepare the soil thoroughly by appropriate tillage
9. Always practice proper field sanitation by removing and pruning infested plant parts, keeping the area free of weeds and other plant residues, and cleaning regularly all farm tools and implements
10. Monitor your plants regularly
11. When in doubt, always ask for assistance from your local agriculturists

When controlling pests using the plant extracts and other homemade solutions, the following are the standard procedures for their preparation and application;

1. Select plants/plant parts that are pests-free.
2. When storing the plants/plant parts for future usage, make sure that they are properly dried and are stored in an airy container (never use plastic container), away from direct sunlight and moisture. Make sure that they are free from molds before using them.
3. Use utensils for the extract preparation that are not used for your food preparation and for drinking and cooking water containers. Clean properly all the utensils every time after using them.
4. Do not have a direct contact with the crude extract while in the process of the preparation and during the application.
5. Make sure that you place the plant extract out of reach of children and house pets while leaving it overnight.
6. Always test the plant extract formulation on a few infested plants first before going into large scale spraying.
7. Wear protective clothing while applying the extract.
8. Wash your hands after handling the plant extract.

I. Introduction

About Cassava

Scientific name: *Manihot esculenta*
 Family: Spurge Family (*Euphorbiaceae*)
 Other names: Maniok, Casava, Yuca

Uses

Cassava is grown mainly for food. The roots can be prepared in various ways, much like potato and sweet potato. The young shoots are used as vegetables. It is also grown as animal feeds and for industrial uses such as bio-fuel, bio-ethanol, alcohol, etc.

II. Climatic and soil requirement

Temperature: 20 - 30°C is the required daily temperature for adequate growth and development

Soil pH: 4.6 - 8 is the average soil pH requirement but 5.5 - 7.5 is ideal.

Rain: 1000 - 1500 mm/year of rain is needed for adequate growth and development. Cassava can tolerate a dry climatic condition once established.

III. Selection of planting materials

Cassava is grown from stem cuttings.

Selection of the planting materials should be taken from 8 - 10 months old, healthy cassava plants. The cassava stems should be about 20 - 25 mm in diameter.

To prepare the planting materials, take cuttings from the middle of the stem, cut into pieces of about 20 - 30 cm long with a minimum of 3 - 4 buds.

The stem cuttings must be planted immediately, although the whole stems can be stored under a shaded area to prevent from drying. The stems are still viable sources of cuttings until 3 months when properly kept.

The selection process of the planting materials is done usually during harvesting.

IV. Planting materials requirement

10,000 - 15,000 cuttings are needed for a hectare in monocropping and a lesser plant density in intercropping. The number of plants in a given area depends upon the planting distances.

V. Land preparation

Conservation and conventional tillage are both appropriate land preparation methods.

Ridge tillage is highly recommended. Planting along the ridges helps reduced soil erosion and makes harvesting easier.

Farmers who practice shifting and slash and burn cultivations do not till the soil at all. This is still a recurring practice in the upland areas.

VI. Method of planting

Cassava is planted either vertically or erect. Under a dry condition, cuttings are planted vertically almost entirely covered with soil. When planted erect, they are placed deeper into the soil.

Cuttings should not be planted upside down, as this drastically reduces yield.

The distance between plants depends on the selected cultivars and the fertility of the soil. When the soil is fertile, a closer planting distance is recommended.

Recommended planting distances: in between plants and in between furrows 0.8 x 1.2m, 0.8 x 1.5m, 1.0 x 1.0m, 0.5 x 1.0m.

VII. Plant establishment

Planting is done manually usually at the beginning of the rainy season.

Various cropping patterns and rotations suit cassava production. Cassava grows well with intercrops such as corn, groundnut, cowpea and other legumes. It grows well as an alternative intercrop for coffee, coconut, banana, some fruit trees, and some forest trees.

A common practice done by small scale landholder farmers in the tropics is the continuous planting of cassava on the same land which reduces yield and lessens further the soil productivity.

To help improved the soil condition, plant canavalia or crotalaria (legumes) as cassava intercrop. Sow one row of canavalia or crotalaria between rows of cassava immediately after planting. Let them grow

until cassava is harvested. Cut and plow them under to be incorporated into the soil.

VIII. Fertilizer requirements

Apply 5 - 7 tons of manure in a hectare. Cassava grows well when farm manure is applied.

A ton of whole plants removes 4.9 kg N; 1.1 kg P; 5.8 kg K; and 1.8 kg Ca. The nutrient removal by 1 t of the fresh tubers is: 2.3 kg N; 0.5 kg P; 4.1 kg K; and 0.6 kg Ca (CABI, 2004).

Soil analysis provides the very best chance of getting the right amount of fertilizer without over or under fertilizing. Ask for assistance from your local agriculturist office for soil sampling and soil analysis procedures.

IX. Pest management

Refer to insect/mites, diseases, natural enemies information

X. Weed management

Hand weeding at least twice is necessary; one month after planting and when the plants are about 2 - 3 months old.

XI. Harvesting

The leaves can be harvested 50-70 days after planting.

Harvesting of tubers begins 8-4 months after planting depending on the variety. During harvest, the entire plant is being uprooted by hand and/or by cutting first the top part of the stem and then uproot the remaining part. In the process, care must be taken to minimize damage of the tubers, as this greatly affects the shelf life.

Small scale farmers harvest cassava in time for marketing and/or for home consumption. This harvesting method provides fresh produce and at the same time increases the size of the tubers when left growing in the field.

Cassava is a perennial crop so that it can be left in the field for more than one cropping season. However, the tubers become rough and hard when left too long in the field.

XII. Yield

The yield of fresh tubers ranges from 7 - 30 t/ha. The yield is dependent on the climate, cultivars, soil fertility, and the other necessary farm inputs.

XIII. Handling and storage

The cassava tubers have a few days shelf life. Once harvested, tubers must be cooked or marketed, and/or processed within a couple of days.

Cassava plant has toxic compounds, cyanogenic glucosides (cyanogens) in its tubers and leaves. Boiling and drying make cassava safe for consumption.

Grating, fermenting, and sun-drying are other effective storage methods.

Insects/Mites

Cassava green mites

Damage

Generally, mites feed on the undersides of leaves. They use their sucking mouthparts to remove plant saps. The upper leaf surface has a speckled or mottled appearance while the underneath appears tan or yellow and has a crusty texture. Infested leaves may turn yellow, dry up, and drop in a few weeks. Mites produce large amount of webbing. Heavy infestation will result in a fine cobwebby appearance on the leaves. Plants die when infestation is severe.

Description

Eggs are tiny, spherical, pale-white, and are laid on the undersides of leaves often under the webbings. Eggs hatch in 4 or 5 days.

Nymph looks similar to the adult but is only the size of an egg. It has only 6 legs. It molts 3 times before becoming an adult.

The adult is also very tiny, maybe yellowish, greenish, pinkish, or reddish depending on the species. It looks like a tiny moving dot. It has an oval body with 8 legs and with 2 red eyespots near the head of the body. The male is smaller than the female with a more pointed abdomen. A female usually has a large, dark blotch on each side with numerous bristles covering her legs and body.

Control measures

Cultural practices

Plant on the onset of the rainy season to encourage vigorous growth

Horizontal planting of cuttings is recommended rather than the slanting position

Intercrop cassava with pigeon pea in triple and double rows

Cowpea or peanut are also good cassava intercrops and in addition, apply 5-7 tons of manure in a hectare, to maintain the soil fertility.

Canavalia or crotalaria are good companion crops. Sow 1 row of Canavalia or crotalaria between rows of cassava immediately after planting cassava. Let these grow until harvest. Plow under them to incorporate into the soil.

Natural enemies

Predatory mites

Predatory mites control cassava green mites. They can reduce the green mite population and can increase cassava yield by 1/3. The good thing is that predatory mites do not require mass breeding in rearing station. They can be transferred to new

locations on cassava shoot tips where mites are present. They can spread easily when introduced into cassava fields because of the many food sources such as mites, white flies, corn pollens, and honey dews. But in order to reproduce, they require mite preys. In the absence of mites, predatory mites disperse or die so that they cause no harm to the environment.

Cassava hornworm

Damage

Larvae generally eat the younger leaves of cassava, often stripping the growing shoots. In severe attacks, the whole plant and/or the entire field can be defoliated.

Description

The eggs are very tiny, shiny black, and are found in the crevices of bud, stems, and barks of the plant.

A newly hatched larva is pale green with a black horn and is about 6 mm long.

The matured larva is whitish-green with yellowish body spots and more pronounced black and red spot on its abdominal segment. The thoracic-feet are pinkish, and thrice annulated with black. The abdominal feet are pale reddish with a black band and whitish claspers. A larva can reach a length of 8-10 cm.

The pupa is shiny and has pale-orange streaks on the wing cases, feet, and around each abdominal segment. There is also a curved line of the same color at the rear of the thorax. It is usually found on the ground among plant residues.

An adult female has pale-gray forewings while those of male are darker. Both hindwings are red with dark-gray marginal bands. The adults fly only at night time and they tend to migrate in swarms and lay eggs in masse.

Control measures

Pathogen in pest control

Hornworm baculovirus

Baculovirus erinnyis is a hornworm larva virus. The larvae are collected in the field, liquefied in blenders and mixed with water. The same mixture is then sprayed to the infested plants. Upon application, the virus can kill 90-100% hornworm larvae. This virus is used to control cassava hornworm larvae in Latin America.

Bacillus thuringiensis

Spray plants thoroughly with BT when larvae are less than 5 mm long. The larvae are not killed instantly. The pests have to ingest BT first. It takes about 2-3 days for the pests to die.

In the hot tropics, it is more effective to spray BT in the late afternoon as there are longer and cooler hours ahead. BT remains longer on the leaves' surfaces and survives better in cooler temperature. Spraying in the morning provides a shorter and hotter environment. Do not spray BT on wet days. Keep BT formulations in cool storage places. Ask for assistance from your local agriculturist when using BT for the first time.

Cassava mealy bug



Damage

Leaves are distorted (rolled or folded), stunted, and yellow. Attacked fruits and pod drop prematurely. Like the other sap-feeding insects, mealybugs excrete (eliminate) large quantities of honeydews, which promote sooty mold that caused blackened-malformed leaves and stems.

Description

Eggs are oblong, golden-yellow and enclosed in woolly ovisacs located at the posterior end of the adult females. The eggs may hatch as soon as they are laid, giving the impression that young are born rather than hatched. The crawlers are flattened, oval, light yellow, six-legged insects, and with smooth bodies. Soon after feeding, they emit a white-waxy covering over their bodies giving them a mealy appearance. The female body is oval, rose-pink, and covered with white waxy filaments. The tiny-winged male is needed for reproduction but only lives for a few days.

Control measures

Cultural practices

1. Plant flowering herbs as intercrop and or perimeter crops help build-up the population of natural enemies.
2. Control ants as they tend the mealybugs to have access to the plant hosts.

Termites



Damage

Initial damage is wilting when the termites attack the roots of seedling and/or older plant. A plant dies when they tunnel inside the taproot, stem, and branches because they disrupt the distribution and movement of nutrients in the plant's vascular system.

Description

In a new established colony, the queen lays about five eggs. When these hatched, the larvae are fed by the gastric juices of the queen. As the colony expands, the eggs are laid singly or in double rows of 16 - 24 eggs glued together by a gelatinous secretion, depending on the species. Incubation takes from 24 - 90 days depending on the climatic conditions.

The larva undergoes seven nymphal instars but this again varies according to their species and the environmental conditions. These are fed and cared for by the workers. They mature over a period of 2 - 6 months, depending on their species.

Adult termites are small, 4 -15 mm long, and vary in color from white to tan and even black, depending on the species.

Termites can be identified according to the caste they belong. There are four castes in the colony namely; the queen, king, soldier, and the worker. The queen is the largest termite in the colony. Her role is to lay eggs to increase the size of the colony. She can lay a thousand of eggs in a day. The king is always beside her ready to mate her. The soldiers have large onion-like heads and powerful jaws. They emit liquid when disturbed. The workers are the majority in a termite colony. They gather the food, feed the queen, take care of and feed the larvae, as well as build and maintain the nest. Unlike ants, the male and female termites can be workers. The nymphs with fully developed wings will be the future kings or queens.

To distinguish a termite from an ant, the former has a straight antenna, broad waist and if wings are present, these are of the same sizes and have many veins.

Control measures

Plant extract

Spanish needle seed extract (Bidens pilosa)

Bring to boil 1 teacup of mature seeds for 5 minutes. Cool and then strain to get a clear filtrate. Add 1 liter of water.

Physical control

Burning plant residues on top of termites' mound would suffocate them.

Destroy the termites' nest, locate and kill the queen, and pour boiling water or burn dried grass straws (any plant debris) to kill the rest.

For the 'worker termites', locate their soil runways/tunnels and destroy these either by hand tilling or by flooding.

Whiteflies



Damage

Whiteflies, both the larvae and adults, pierce and suck the sap of the leaves. This causes the weakening and early wilting of the plant resulting in reduced plant growth. Their feeding may also cause yellowing, drying, premature dropping of leaves that result in plant death.

Whitefly produces honeydews that serve as the substrates for the growth of black sooty molds on leaves and fruit. The mold reduces photosynthesis causing the poor plant growth of the plant. Whitefly is the most important carrier of plant viruses that causes diseases of fiber crops, vegetables, fruit trees, and ornamentals.

Description

Eggs are tiny, oval-shaped, about 0.25 mm in diameter, and stand vertically on the leaf surface. Newly laid eggs are white then turn brownish. They are deposited on the underside of leaves, sometimes in a circle or oval-shaped patterns.

Larvae are transparent, ovate, and about 0.3 to 0.7 mm in size and they move around on the plants looking for a feeding site upon hatching.

Pupae are dirty white and surrounded by wax and honeydews. During this stage, the red eyes of the emerging adults are visible.

Adults are about 1mm long with two pairs of white wings and light yellow bodies. Their bodies are covered with waxy powdery materials. They are found feeding on top of the plants. A female can produce as many as 200 eggs in her lifetime and mating is not necessary. It takes about 40 days to develop from egg to adult.

Control measures

Plant extract

Neem leaf extract

Pound 1-2 kg of neem leaves gently. Place in a pot. Add 2-4 liters of water.

Cover the mouth of the pot securely with the cloth and leave it as such for 3 days. Strain to get clear extract. Dilute 1 liter of neem leaf extract with 9 liters of water. Add 100 ml of soap. Stir well.

Neem oil extract

Put 5 kg of finely ground seeds into a basin. Add hot water little by little until it is possible to knead the mixture. Knead and press the mixture to get the oil. Approximately 650-750 ml oil is extracted from this mixture.

For the spray material, add 15 ml of neem oil to 1 liter of water and 5 ml of soap.

Neem seed powder extract

Remove shells and pulps from dried and matured. Pound the seeds gently in such a way that no oil comes out. Once done, add 50 grams of powder in a pail of 1 liter of water. Stir well for about 10 minutes and steep for at least 6 hours but not more than 16 hrs. Stir it again for another 10 minutes. Strain. Add 5 ml of soap. Stir well.

Physical control

Yellow sticky boards

To use, place 1 to 4 yellow sticky cards per 300 square meter field area. Replace traps at least once a week. It is difficult to determine the population of newly trapped whiteflies on a sticky card to those previously trapped ones.

To make your own sticky trap, spread petroleum jelly or used motor oil on yellow painted plywood, 6 cm x 15 cm in size or above. Place traps near the plants, preferably 25 cm away from the plant to ensure that the leaves will not stick to the board. Alternatively, the traps can be hung and positioned at 61 cm zone above the plants.

Add 15 ml of neem oil into 1 liter of soapy water. Constantly shake the container or stir the extract while in the process of application to prevent oil from separating.

Diseases

Bacterial soft rot

Symptoms

An infested stem rots internally resulting in the wilting of young shoots which is then followed by tip collapse and dieback.

Prevention and control

Mint leaf spray

Grind 250 grams of leaves to make into a paste. Add 2 liters of water. Stir well and ready for use or strain it to have a clear extract.

Cassava bacterial blight

Symptoms

Infested leaf has angular watersoaked spots along its veins, margin, and tip. The infected leaf blade turns brown with the typical watersoaked symptom at the leading edge of the brown patch. As the disease further develops, the spots join together into large patches killing the leaf blade as they expand. The leaf eventually dries and falls down.

Prevention and control

Mint leaf spray

Grind 250 grams of leaves to make into a paste. Add 2 liters of water. Stir well and ready for use or strain it to have a clear extract.

Cassava leaf spot

Symptoms

The damage is similar to cassava leaf blight wherein infected leaf has watersoaked angular leaf spots that often extend along the veins but without the formation of the small secondary spots progressing into the blighted areas. Larger dead tissues only develop on the leaf blade when several angular spots joined together. As the bacteria mature, the center of the spot turns dark-brown covered with small yellow discharges and becomes surrounded by a narrow watersoaked line and a yellow ring.

Prevention and control

Mint leaf spray

Grind 250 grams of leaves to make into a paste. Add 2 liters of water. Stir well and ready for use or strain it to have a clear extract.

Cassava mosaic virus



Symptoms

An infected leaf has white or pale-yellow or pale-green spots. It is often twisted, distorted, and stunted. The leaflets have uniformed or localized mosaic pattern. Heavily infested plant is distorted, retarded, and stunted.

Prevention and control

Control whiteflies as they are the carriers of the disease.

Beneficial Insects

The following are some beneficial insects that are indigenous on your fields and gardens or can be introduced for the control of pests.



Ground beetle



Lacewings



Ladybird beetles



Mealy bug destroyer



Spiders

Conservation of the beneficial insects

1. Provide hiding sites and alternative habitats such as mulches and other ground covers.
2. Plant small flowering plants on borders, hedges, and other perennial habitats as source of food and shelter
3. No indiscriminate use of synthetic pesticides.



Ground beetle



Hosts

Slugs, snails, cutworms, cabbage root maggots, grubs and insect pupae, and small caterpillars

Description

Eggs are normally laid singly in the soil.

Larva is elongated and tapered toward the end, worm-like in appearance and have a large head directed forward.

Pupa is brownish black, small and found in the soil.

Adult ground beetles or Carabids are about 2-6cm long, dark shiny brown to metallic black, blue, green, purple, or multi-colored. They vary in shapes, - from elongated to heavy-bodied, - tapered head end with threadlike antennae, and have a ringed wing cover. Their heads are usually smaller than their thorax. Both adults and larvae have strong pincher-like mandibles. They have prominent long legs, which make them fast moving insects. Most species are nocturnal and they hide during the day in soil crevices, under rocks and stones, decaying logs, leaf litter, or composting materials.

When disturbed or when other vertebrates prey upon them, they emit an odor or gas, as a type of defense mechanism, preventing them from being eaten by other predators. Ground beetles live on or below the ground, hence the name. Development from the egg to the adult stage takes about a year, although adults may live 2 to 3 years or longer.

Conservation

1. Practice mulching in some sections of your field to provide a habitat for the ground beetles.
2. Provide permanent beds and perennial plantings to protect population.
3. Plant white clover and/or amaranth as ground covers.

Lacewing



Hosts

Aphids, leafminer, mealybugs, thrips, whitefly, armyworms, bollworms, cabbage worm, codling moths, corn borer, cutworm, DBM, fruitworm, leafhopper nymphs and eggs, potato beetle, scale insects, spider mites, and caterpillars of most pest moths. If given the chance, they can also prey on adult pests.

Description

Eggs are found on slender stalks or on the underside of leaves. Each egg is attached to the top of a hair-like filament. Eggs are pale green in color.

Larvae are known as aphid lions. Newly hatched, they are grayish-brown in color. Upon emerging, larvae immediately look for food. They grow to about 1 cm in length. They attack their prey by taking them with their large sucking jaws and injecting paralyzing poison, and then sucking out the body fluids of the pest. A larva can eat 200 or more pests or pest eggs a week. An older larva can consume 30-50 aphids per day. It can consume more than 400 aphids during its development. The larvae resemble alligators with pincers like jaw. However, they become cannibalistic if no other prey is available. They feed for 3 to 4 weeks and molt three times before pupation. They cover their bodies with prey debris.

Pupae are cocoons with silken threads. These are found in cracks and crevices. The pupal stage lasts for approximately 5 days.

Adults are green to yellowish-green with four, delicate transparent wings that have many veins and cross veins. Adults are about 18 mm long, with long hair-like antennae and red-gold eyes. Each adult female may deposit more than 100 eggs. Many species of adult lacewings do not prey on pests. They feed on nectar, pollen, and honeydew. An adult will live for about four to six weeks depending on the climatic conditions.

Conservation

Flowering plants such as dill, cosmos, sunflower, carrots, and dandelions are good source of pollen and nectar for adults. Provide source of water during dry season.

Ladybird beetles



Hosts

Aphids, mealybugs, scale insects, spider mites, whiteflies

Description

Eggs are yellow to orange in color, football-shaped, and are laid in circular clusters of 10 -50 eggs on the underside of leaves or near the aphid colony.

Newly hatched larvae are gray or black and less than 4 mm long. They emerge as dark alligator-like flightless creatures with orange spots. Adult larvae can be gray, black, or blue with bright yellow or orange markings on the body. The larvae are elongate and slightly oblong in shape. They undergo four instars before pupating.

The pupae are usually brightly patterned and can be found attached to the leaves and stems of plants where larvae have fed and developed.

Adults are oval to hemispherical and strongly convex with short legs and antennae. Most species are brightly colored. Body length ranges from 0.8-16 mm. Their colors tell other predators that they are tasteless and toxic. When disturbed, some of them emit a strong smelling yellow liquid as a protection against other predators. Their colors vary from red, orange, steel blue, yellow-brown, or yellow elytra, frequently spotted or striped with black. They feed on pollen, nectar, water, and honeydew but aphids or other prey are necessary for egg production. They are the best-known predators of aphids and are capable of eating up to 50-60 per day and about 5000 aphids in their lifetime.

Conservation

Lady bird beetles are found in most agricultural and garden habitats. Their presence indicates that natural biological control is occurring. It is important to maintain habitats planted with several flowering crops. These give the ladybird beetles varied food sources. When food is not available, they tend to eat each other. Their beneficial predatory behavior and activities are continuous when there is no indiscriminate use of synthetic pesticides.

Mealybug destroyer



Hosts

Mealybugs

Description

Eggs are yellow and are laid among the cottony egg sack produced by the mother mealybugs. The eggs develop into larvae in about 5 days.

The larva looks like mealybug. It has woolly appendages of wax but is twice as big as the adult mealybug. It grows up to 1.3 cm in length. It undergoes three larval stages, which lasted for about 12-17 days. The larva feeds on mealybug eggs, young crawlers, and the honeydew produced by mealybugs. It can consume up to 250 mealy-bugs.

The pupa is found in sheltered stems. The pupal stage lasts for about 7-10 days.

Adult mealybug destroyer is dark brown or blackish beetle. It has orangish head with reddish abdomen. It is small, about 3-4 mm long. A female can lay up to 10 eggs a day in a mealybug colony or in a group of mealybug eggs. It may live up to 2 months.

Conservation

Mealybug destroyers only thrive when there are mealybugs. They feed on mealybugs, which are necessary for their reproduction. Members of carrot (fennel, dill, angelica, tansy) and sunflower families (goldenrod, coreopsis, sunflower, and yarrow) are good habitats for adult mealybug destroyers.

Spider



Hosts

Moths and caterpillars

Description

Some spiders' eggs are laid in a cluster in silken sacs, while some species lay their egg masses covered with silks within folded leaves. Some of these sacs are attached to the mother spiders or mothers stay nearby to guard their egg sacs. Eggs usually hatch into spiderlings within three weeks. The spiderlings may remain attached to the mother for several days on

some species, but for some species they are left on their own.

Spiders are not insects. They have 8 legs, while insects have 6. They do not have wings whereas insects do. They have two body sections; a united head and thorax and abdomen, while insects have three; head, thorax, and abdomen.

A female can produce 200-400 eggs but only 60-80 spiderlings can hatch from these. Females can survive 2-3 months. In some species, females die after laying eggs.

All spiders are poisonous to insects but only a few species are poisonous to humans, like the Black widow and the Brown recluse.

Conservation

Mulching along some sections in dikes of rice paddies, in field corners, or a portion of the fields can increase the number of spiders. They can hide in the layer of mulch that serves as their alternate habitat. They can also prey on other small insects inside the mulch.

Remember, that the more food the spiders can eat, the faster their population build-up will become. Cover crops are also important to provide over-wintering sites of spiders' sacs.

A spider population depends on the availability of food, the habitat, and the environmental conditions. Avoid use of pesticides as much as possible, for broad-spectrum insecticides can easily kill them.

Photo credits

page

- 01 Cassava tubers. Jewel Bissdorf.
- 12 Cassava mealybug. CGIAR.
<http://www.cgiar.org/images/iita30.gif>
- 12 Termite. ARS, USDA.
- 13 Whiteflies. Photo courtesy of Clemsom University - Department of Entomology
- 14 Cassava mosaic virus. FAO
- 15 + 16 Ground beetle. IRRI & Queensland University. IRRI, Los Banos, Philippines
- 15 + 16 Lacewing. Photo courtesy of Clemsom University - Department of Entomology
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Tables

Table 2. Monthly cropping calendar of activities

Management practices	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Preparation of stem cuttings												
Land preparation												
Fertilization												
Irrigation												
Pests monitoring												
Pests control												
Harvesting												
Post harvest												



Table 3. Weekly activities

Field activities	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Care of stem cuttings																				
Land preparation																				
Fertilizer application																				
Cultivation																				
Irrigation																				
Weeding																				
Control of insect pests and diseases																				
Harvesting																				

Table 4. Crop lifecycle

Growth stages	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Early growth stage												
Vegetative												
Maturation												





**For more information
on non-chemical pest management see:**

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