more Images

Papaya
Scientific name: *Carica papaya*
Order/Family: Violales: Caricaceae
Local names: Pawpaw, papayu (Swahili)
Pests and Diseases: Aphids Broad mite Damping-off and root rot False spider mite Fruit flies Mealybugs Papaya ringspot potyvirus Powdery mildew Ripe fruit rots Root-knot nematodes Snails (Giant East African Snail) Spider mites Systates weevil Whiteflies
Anthracnose, Black spot, Black rust, Leaf spot, Stem rot, Mealybugs

General Information and Agronomic Aspects
Information on Diseases
Information on Pests
Information Source Links

General Information and Agronomic Aspects

Papaya is a widely cultivated fruit tree in the tropics and subtropics. It is a popular fruit in Kenya. Ripe papaya is a favourite breakfast and dessert fruit that is available year-round. It can be used to make fruit salads, refreshing drinks, jam, jelly, marmalade, candies and crystallized fruits. Green fruits are pickled or cooked as a vegetable. Young leaves are sometimes eaten. In some countries, seeds are used as vermifuge and to

Geographical Distribution of Papaya in Africa

induce abortion (abortifacient).

Carpaine, an alkaloid present in papaya, can be used as a heart depressant, amoebicide and diuretic. In some countries papaya is grown in sizeable plantations for the extraction of papain, an enzyme present in the latex, collected mainly from the green fruit. Papain has varied uses in the beverage, food and pharmaceutical industries: in chill-proofing beer, tenderizing meat, drug preparations for digestive ailments and treatment of gangrenous wounds. It is also used in treating hides, degumming silk and softening wool.

There are 3 groups of papayas distinguished on the basis of their flowers: Female (pistillate), male (staminate) and hermaphrodite (bear both male and female flowers). These groups are only distinguishable at flowering stage. Fruits from female flowered trees are usually sweeter and of more round shape than fruits from hermaphrodite trees.

Climate conditions, soil and water management

Papaya thrives in warm areas with adequate rainfall and a temperature range of 21-33°C. Its altitude range is similar to that of the banana, from sea level to elevations at which frosts occur (often around 1600 m). However they grow best in areas below 1000 m. The quality and yield are low at higher altitudes. Frost can kill the plant, and cool and overcast weather delays fruit ripening and depresses fruit quality. Fruit tastes much better when grown during a warm sunny season. Evenly distributed annual rainfall of 1200 mm is sufficient if water conservation practices are employed. Plantations should be in sheltered locations or surrounded by windbreaks; strong winds are detrimental, particularly on sandy soils, as they cannot make up for large transpiration losses.

Papaya grows best in light, well-drained soils rich in organic matter with soil pH of 6.0-6.5. It can tolerate any kind of soil provided it is well-drained and not too dry. The roots are very sensitive to waterlogging and even short periods of flooding can kill the plants.

- Teff
- Tomato
- Wheat
- Yam
- Zucchini/Courgette

- Pests/ diseases/ weeds
- Medicinal plants
- Fruit and vegetable processing
- Natural pest control
- Cultural practices

Propagation and planting

Papaya is propagated by seed. To reproduce the desired characteristics it is best to get seeds through controlled pollination. The fleshy outer layer of the seed coat (sarcotesta) enveloping the seed is removed because it inhibits germination. This is achieved by rubbing the seed together against a fine-meshed screen under running water. Thoroughly dried seeds stored in air-tight containers remain viable for several years. Seeds are sown in small containers (tin cans, plastic bags or paper cups) at the rate of 3-4 seeds per container. Use of sterilized soil minimizes losses resulting from nematodes and damping-off fungi. Germination takes 2-3 weeks. Another practice is to sow the seeds in sterilized nursery beds and to prick out at the 2-3-leaf stage, transferring 3-4 seedlings to each container. Seedlings are transplanted about 2 months after sowing when they reach the 3-4-leaf stage or 20 cm height, preferably at the onset of the rainy season. During transplanting, take care not to disturb the roots. Older seedlings recover poorly after planting out.

Papaya needs adequate drainage and is often planted on mounds or ridges. Transplants must be watered regularly until they are established. Field spacings are in the order of 3 x 2 m to 2.50 x 1.60 m, giving densities of 1667 and 2500 plants/ha respectively. The same densities are obtained by planting in double rows spaced (3.25+1.75) x 2.40 m or (2.50+1.50) x 2 m. Thinning to one female or one hermaphrodite plant per hill is done when the plants reach the flowering stage. In the absence of hermaphrodite plants, 1 male plant per 25-100 female plants is retained as pollinator.

Papaya plants grown from seed produce fruits of different shapes, sizes, colour and even taste. Vegetative propagation of papaya provides a solution to most of these problems. The clone is selected for higher productivity and good quality fruits besides agronomic qualities such as dwarfness for easy harvesting and good resistance to diseases. Propagation of papaya using

tissue culture is fast gaining popularity, mainly because tissue culture has numerous advantages over other conventional methods of propagation. Tissue culture facilitates rapid production of disease free plants. In Kenya such plants are available from Kenya Agriculture Research Institute, Thika as well as several private companies.

Planting holes of 60 x 60 cm and at least 50 cm deep are prepared with 1 bucket of compost and a handful of rock phosphate is mixed in with the dug out soil and returned around the plant. Firm the soil and water liberally, then add mulch around the young plant.

Major varieties include:

- **'Honey Dew'. This is an Indian variety of medium height that produces oval juicy medium size fruit.**
- **'Kiru'. Is a Tanzanian variety that produces large fruits. It is a high yielder of papain.**
- **'Mountain'. originally the name for a variety grown at high altitudes with very small fruits only suitable for jam and preserves. Now the name is also used for a medium size variety with good fresh consumption qualities such as firm sweet tasting yellow flesh.**
- **'Solo'. Is a Hawaiian variety that produces small round very sweet fruits with uniform size and shape. It is hermaphroditic.**
- **'Sunrise Solo'. Hawaiin variety that produces smooth pear shaped fruit of high quality, weighing 400 to 650 g. The flesh is reddish orange. This variety is high yielding.**
- **'Sunset': Hawaiian variety with red flesh and having same characteristics as 'Solo'**
- **'Waimanalo'. another Hawaiian variety that produces smooth, shiny round fruits with short neck and is of high quality. The flesh is orange yellow, thick, sweet and firm.**

Most of commercial varieties grown in Kenya are derived from Hawaii. A few are from India and some known as 'Mountain varieties' whose origin / source is a rather not explained. None of these have been reported to have resistance to *P. palmivora*. However, information available claims that Hawaiian lines such as 'Waimanalo 23', 'Waimanalo 24' and 'Line 40' exhibit

resistance to *P. palmivora*.

Another serious disease problem with papaya is papaya ring spot virus. However, according to a recent report by PIP COLEACP (www.coleacp.org/en), there are no commercial papaya varieties, except for transgenic, which are tolerant or resistant to papaya ring spot virus or bunchy top.

Intercropping

Papaya grows best when planted in full sunlight. However, it can be planted as an intercrop under coconut, or as a cash crop between young fruit trees such as mango or citrus. Low growing annual crops such as capsicums, beans, onions and cabbages are suitable good intercrops.

Husbandry

Clean cultivation is standard practice and weed control, particularly around the small plants, is very important. If weeds are only slashed - resulting in a grassy weed cover - papaya plants suffer severe competition. Experimental work shows a very good response to mulching. Irrigation is needed to minimize the abortion of flowers and maintain growth during the dry season. Watering once a week is recommended. Papaya is a fast-growing crop that requires a lot of nutrients. The use of manure and mulch steadies the release of nutrients. Calcium deficiency depresses growth and fruit set and enhances fruit drop; liming (to a pH of about 6) is the remedy.

Harvesting

The stage of physiological development at the time of harvest determines the flavour and taste of the ripened fruit.

The appearance of traces of yellow colour on the fruit indicates that it is ready for harvesting. Fruits harvested too early have longer post harvest life, but give abnormal taste and flavour. The fruits also tend to shrivel and suffer chilling injuries when refrigerated. The fruit is twisted until the stalk snaps off or cut with a sharp knife. Yields per tree vary from 30 to 150 fruits annually, giving 35 to 50 tons of fruit per ha per year. A papaya plantation can be productive for over 10 years but the economical period is only the first 3 to 4 years. It is therefore advisable to renew the plantation every 4 years.

For papain production, latex is collected by tapping the green unripe fruit. Four longitudinal incisions, skin-deep and 2 to 3 cm apart are made with a sharp, non-corrosive rod (glass, plastic or horn). Latex is collected in a clean glass or porcelain container and dried, or a canvas covered tray fixed onto the trunk of the tree. The latex is later scraped off the canvas with a wooden scraper and dried. Fruits may be tapped once a week, until they show signs of ripening. The operation is best done early in the morning (before 10:00) because the latex flows slowly in hot weather. Tapping results in ugly scars on the fruit, although quality is unaffected. Tapped fruit can be processed or used as animal feed. The papain producing trees are productive for 2 to 3 years, with the first 2 years being the most productive. If kept longer production is uneconomical.

back to Index

Information on Pests

Fruit flies

Two species of fruit flies have been recorded from papaya in East Africa, namely *Bactrocera invadens* and *Ceratitis rosa*

(personal communication S. Ekesi, AFFI, *icipe*). The flies usually deposit their eggs in ripe fruit. Some fruit flies lay eggs on green pawpaw, but most of the eggs die due to the latex secreted when fruits are punctured by females while laying eggs. Developing larvae cause rotting of ripening fruits. Fruit flies are a major concern of papaya-importing countries.

What to do:

- **Fruit should be harvested at the mature green stage.**
- **Over-ripe and infested fruit should be buried.**

Fruit fly
Natal fruit fly (*Ceratitis rosa*), wing length 4-6 mm.

More Information on Fruit flies

Spider mites

Several species of mites damage papaya:
*** Spider mites (Tetranychus spp., Eutetranychus spp. and Oligonychus gossypii)**
*** The false spider mite (Brevipalpus phoenicis)**
*** The broad mite (Polyphagotarsonemus latus)**

(personal communication, M. Knapp, ICIPE).

Spider mites
Two-spotted spider mite. The adult female is 0.6 mm

The Spider mites suck the plant sap, leading to poor plant growth

and blemishes on the fruit. Infested leaves show yellow patches on the upper surface, particularly between main veins and midrib. Feeding by mites causes scarring and discoloration of fruit, and reduced fruit size affecting its market value. Infestations usually begin on the older leaves and the spreads to the younger growth. Serious infestations occur during long dry periods. Broad mites attack mainly the terminal buds; they feed on the young leaves as they emerge from the growing point. Affected leaves are thick and brittle, with down curled edges. Severe infestations inhibit new stem growth, with consequent reduction in fruit production.

long. The male is smaller.

More Information on Spider mites

The false spider mite (*Brevipalpus phoenicis*)

It usually feeds on the trunk below the level where the bottom whorl of leaves is attached. The mites move upward on the trunk and outward onto the leaves and fruit as the population increases, leaving a large, conspicuous, damaged area behind them. The affected area becomes raised and blister-like. Later the affected tissue dries up, dies and becomes discoloured, forming a large and continuous callous area, light brown and scaly and/or scabby.
Damage by feeding on young papaya fruits is manifested by sunken areas. Sometimes feeding by the mite causes a copious outflow of a milky white liquid that mars the appearance of the fruits. Under heavy mite infestations, the papaya stem, which normally remains green for a long time, becomes brownish and corky in appearance, and has a spindly growth (Martin Kessing and Mau, 1992; CABI Compendium, 2000).

Size is tiny, about 0.1mm.

What to do:

- **Natural enemies, like predatory mites, often provide adequate control of the false spider mite.**
- **Wettable sulphur sprays can be used in case of heavy infestations (Sulphur has phytotoxic effects when used during hot weather).**

The broad mite (*Polyphagotarsonemus latus*)

Broad mites are tiny (0.1-0.2 mm long) and cannot be seen with the naked eye, and are even difficult to detect with a hand lens. In addition, they have often disappeared before the damage is noticed. Therefore an attack by broad mites is usually detected by the symptoms of damage. Broad mite attacks mainly the growing point and the underside of young leaves causing hardening and distortion. Severe infestations inhibit new stem growth, with consequent reduction in fruit production. Broad mite damage may be confused with injury caused by some herbicides because in both cases the leaves become claw-like with prominent veins. Grey or bronze scar tissue between the veins on the underside of the leaves distinguishes mite from herbicide damage. For early detection of damage inspect the growing point of the tree regularly. This is important to allow control the pest before serious distortion of terminal growth occurs.

Broad mite
Broad mite damage (here on chili)

What to do:

- **Natural enemies, in particular predatory mites often provide adequate control of mites. Therefore, the use of acaricides or insecticides that also kill mites should be restricted.**

- **Sulphur, insecticidal oils or soaps are effective against mites. However, sulphur is reported to be toxic to predatory mites.**

The cotton aphid (*Aphis gossypii*) and the green peach aphid (*Myzus persicae*)

These are the most important aphids in papaya growing. These insects suck sap from young leaves and flowers and may weaken the plants. However, this type of damage is usually of little importance. Their importance as pests is mainly due to their ability to transmit virus diseases, for instance the papaya ring spot virus and the papaya mosaic virus. Few aphids are enough to transmit mosaic virus. These aphids are also found on other crops such as cucurbits, potatoes and tobacco.

What to do:

- **Avoid planting these crops near papaya fields.**
- **Removing alternative hosts and the presence of natural predators can effectively reduce aphid populations**
- **Monitoring and control of aphids in the nursery is important.**

Cotton aphid
Cotton aphid (*Aphis gossypii*) is a small aphid. Adults range from just under 1-1.5 mm in body length.

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Cotton aph... **Green peac...**

More Information on Aphids

The systates weevil (*Systates* spp.)

This is a very common weevil in East Africa. It attacks many crops and ornamental plants. The adult is a black weevil, about 12 mm long with a swollen, rounded abdomen, and long, thin, elbowed antenna. It is active at night, feeding on the edges of leaves producing a characteristic indentations. During the day it hides in the mulch, at the base of plants or in loose soil near plants. They feed on a wide range of crops and wild plants. They can be a problem to young papaya plants when present in large numbers.

What to do:

- **Hand picking and destruction is possible.**

Systates weevil
The systates weevil (*Systates* spp.) on papaya. The weevil feeds on leaves, making characteristic notch-like indentations to the leaf margin

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Root-knot nematodes (*Meloidogyne incognita*)

These infest papaya. Feeding nematodes cause root swellings or root galls, resulting in yellowing and premature abscission of the leaves. Infestation by nematodes reduces growth and yield. In nurseries, severely infested seedlings wilt and die.

What to do:

- **It is important to use clean land, and not to replant papaya in**

Root-knot nematodes
Root-knot nematode galls

the same field.

(here on tomato roots). Affected plants are normally stunted and eventually wilt and die. The most characteristic symptom is formation of root galls (knots) and these can be seen with the naked eye. Affected roots rot.

© Bridge J., IIP. Courtesy of Ecoport (www.ecoport.org)
More Information on Root-knot nematodes

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back to Index

Information on Diseases

Damping-off and root rot

These are caused by the soil-borne fungi *Phytophthora parasitica, P. palmivora* and *Pythium aphanidermatum*. *Phytophthora* and *Pythium* also occur in the orchard, causing root rot.

Stem and fruit rots are produced on papaya. Infected young

Fruit rot

fruits develop water-soaked lesions that exude milky latex. These fruits may eventually shrivel and fall off the trunk. Infected trees show yellowing of leaves, which later collapse and hang limply around the trunk before falling. Small roots are generally absent and large ones show a soft, wet decay extending towards the trunk. At that stage, the lateral roots and taproots are entirely destroyed and a foul odour often emanates from diseased trees. Stem cankers, which develop most frequently in the top of the stem where the fruit is borne, induce fruit and leaf fall. These fungi may also cause trunk rot of mature trees. Infected trees eventually die.

Plants are susceptible at all ages but roots of young seedlings are most susceptible.

What to do:

- **Good soil aeration**
- **Good drainage and hygiene are important to control these fungi in the orchard as well as in the nursery.**
- **If possible do not replant pawpaw on the same land.**
- **Copper based fungicide treatments at the very beginning of first symptoms can reduce fruit rots. However, it is very sentive to copper fungicides. For more information on copper click here.**

White fungal crusts of white mycelium associated with fruit rot of papaya (*Phytophthora palmivora*).

Ripe fruit rots

Several fungal pathogens are involved in fruit decay. They include *Colletotrichum gloeosporioides* (*Glomorella cingulata*), *Alternaria tenuis*, *Phomopsis caricae-papayae* and *Ascochyta caricae*.
Symptoms first appear as brown, superficial discolourations of the skin. These develop into circular, more or less sunken spots and tend to occur in a group on the outer exposed side of the fruit and often join to form a large rotted area extending deep into the flesh. The fungi causing ripe fruit rots live on dying leaf stalks and produce spores, which spread to the fruit particularly during wet weather.
Several of these fungi, especially, *Colletotrichum gloeosporioides*, may infect green fruit and remain dormant in the tissues until ripening when they develop rapidly. They constitute a big post-harvest problem especially during transport and storage.

Ripe fruit rot
Ripe fruit rot on Papaya

What to do:

- **A 20-minute hot-water dip at 45°C reduces post-harvest decay.**
- **Spray fruit with hot water at 54°C for 3 minutes**
- **Destroy rotten fruit**
- **Practise early harvesting**

Powdery mildew (*Oidium caricae*; *Sphaerotheca humili*)

Young crown leaves show light green patches covered by a

white powdery growth. Fruits develop circular, white patches on the surface. As the fruits develop, the white mould disappears leaving grey-scarred areas. The disease is particularly severe on immature tissue. The white mildew produced on leaves and fruits, contains large numbers of spores, which are spread to adjacent trees by wind and rain.

What to do:

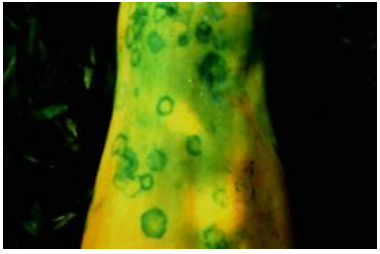
- **Collect and destroy fallen diseased leaves**
- **Spray wettable sulphur. However, sulphur should not be applied when it is very hot as it may cause leaf scorch. Alternatives to the use of sulphur are baking powder, neem extracts and white mineral oil plus soap solution**

Powdery mildew
Powdery mildew (here on upper surface of an okra leaf).

More Information on Powdery mildew

Papaya ringspot potyvirus

It is a devastating virus disease. In Africa, it occurs in Kenya, Nigeria, Tanzania and Uganda. Initially, the disease appears as oil streaks on stems and petioles and as it progresses, mottling of leaves becomes evident. Severely infected plants do not flower and die young. Infected fruits develop characteristic line patterns, which form rings and remain green when fruits ripen. The virus is spread by aphids and it is also mechanically transmitted.



Papaya ringspot potyvirus
Papaya ringspot potyvirus (PRSV) on papaya fruit

What to do:

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- **Plant in isolation**
- **Remove and destroy infected plants**
- **Avoid interplanting with cucurbits, which are also a host of PRSV**
- **Use tolerant cultivars.**
- **Papaya mosaic potexvirus is another virus disease transmitted by aphids. Therefore, control aphids as soon as they are visible with soap sprays, neem or pyrethrum.**

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back to Index

Information Source Links

- **AIC (2003). Fruits and Vegetables Technical handbook. Ministry of Agriculture and Livestock**
- **Beije, C., Kanyagia, S. T., Muriuki, S. J., Otieno, E. A., Seif, A. A., Whittle. A. M. (1984). Horticultural Crops Protection Handbook. National Horticultural Research Station, Thika, Kenya.**
- **CABI (2005). Crop ProtectionCompendium, 2005 Edition. © CAB International Publishing. http://www.cabi.org/**
- **De Villiers, E. A. (1999). The cultivation of Papaya. Institute for Tropical and Subtropical Crops. Published ARC.LNR. South Africa.**
- **De Villiers, E. A., Willers, P. (1995). Papaya pests. In Papaya. Institute for Tropical and Subtropical Crops. Published by the ARC. South Africa.**
- **EcoPort: Information on Ethnobotany: http://ecoport.org**
- **GTZ-Integration of Tree Crops into Farming Systems Project (2000). Tree Crop Propagation and Management - A Farmer Trainer Training Manual. BMZ/GTZ/ UNEP/ Ministry of Agriculture and Rural Development Kenya.**
- **Griesbach, J. (1992). A guide to propagation and cultivation of fruit trees in Kenya. GTZ.**

Germany. Schriftenreihe der GTZ, No. 230. ISBN 3-88085-482-3.

- Horticultural crops protection handbook. National Horticultural Research Station, Thika. Keny170 pp.
- Kessing, J.L.M. and Mau, R.E.L. (1992). *Brevipalpus phoenicis* (Geijskes), Red and Black Flat Mite. Crop Knowledge Master. Department of Entomology. Honolulu, Hawaii. http://www.extento.hawaii.edu
- PIP Technical Itinerary Papaya. www.coleacp.org/en
- Papaya. Export Manual. Tropical fruits and Vegetables. Protrade, GTZ
- Pests of papaya. Broad mite in papaya. Department of Primary Industries and Fisheries. Queensland. David Astridge,. Last updated: December 2003. www2.dpi.qld.gov.au

back to Index

Crops/ fruits/ vegetables

African Nightshade
Amaranth
Avocados
Bananas

more Images

Sugarcane
Scientific name: *Saccharum officinarum* L.
Order/Family: Monocotyledonae: Poaceae
Local names: Miwa (Swahili)
Pests and Diseases: African armyworm Gummosis Leaf scald Mealybugs Pineapple disease Purple witchweed Ratoon stunting disease Rats Red rot of sugarcane Stemborers

Beans
Cabbage/Kale, Brassicas
Carrot
Cashew
Cassava
Citrus plants
Cocoa
Coconut
Coffee
Cotton
Cowpea
Cucumber
Eggplant
Green gram
Groundnut
Maize
Mango
Millet
Okra
Onion
Papaya
Passion fruit
Peas
Peppers
Pigeon pea

Sugarcane common rust Sugarcane mosaic potyvirus
Sugarcane scale Sugarcane smut Termites Couch grass, Witchweed

General Information and Agronomic Aspects Information on Diseases
Information on Pests Information Source Links

General Information and Agronomic Aspects

Geographical Distribution of Sugarcane in Africa

Sugarcane provides over 50% of the worlds sugar requirements as it can grow in any country where it is not exposed to frost. The main product of sugarcane is sucrose, constituting about 10% of the crop. Sucrose is a highly valued food and sweetener but also serves as a preservative for other foods. Moreover, it provides the basis for various food products and beverages.

Sugarcane is chewed in all of the producing countries because of its sweet cell juice. Sugarcane juice is obtained by pressing the sugarcanes, and is mostly used to sweeten foodstuffs, but can also be consumed as fresh or fermented juice. The byproduct of sugar production - molasses - is used in distilling alcohol and as an important cattle feed additive. Sugarcane can even be produced to provide motor fuel alcohol or ethanol as is the case in Brazil. Presently, the worldwide theme is on biofuels, and sugarcane is one of the major contenders. Cane tops can be used as livestock feed.

Organic sugar cane is mostly cultivated on small farms of 0.1-3 ha. The work is carried out manually, or with the help of animals. Only ripe sugarcane is cut down during the harvest. Cut off leaves and unripe plants are left on the plot. In this way, the field is never cleared, and the soil is constantly covered by a thick layer of mulch. Such systems make sustainable cultivation of sugarcane

- Pineapple
- Potato
- Pumpkin
- Rice
- Sesame
- Sorghum
- Soybean
- Spider plant
- Spinach
- Sugarcane
- Sweet potato
- Tea
- Teff
- Tomato
- Wheat
- Yam
- Zucchini/Courgette
- Pests/ diseases/ weeds
- Medicinal plants
- Fruit and vegetable processing

possible, also on relatively sloping ground.

Total area in Kenya under sugarcane production in 2005 was 144,765 hectares with a total production of sugar of 488,997 tonnes , and a national consumption of 695,622 tonnes, so Kenya has a national shortage in sugar production. However, the deficiency in Kenya, is primarily, due to old technology used in sugarcane companies resulting in high cost of production, and that is why Kenya cannot compete with Sudan. Sudan is one of the biggest sugarcane producers in world and number one in Africa.

Climate conditions, soil and water management

Good site conditions are necessary for successful organic cultivation. Under natural conditions, the plant seeks its place in an eco-system amongst the canopy, and therefore needs to reach above the additional crops. Relatively wet conditions tend to cause more difficulties in an organic cultivation system than do sites that are too dry. This is due to a more involved mechanical tilling of weeds, and also to the difficulties the shoots have in developing. Altitudes of 0-1700 m and pH of 5.0-7.0 are suitable.

Ideal site conditions are met with average temperatures of 20 to 28ºC and little fluctuation between night and day. The ideal amount of rainfall is around 1500-1700 mm annually, with a drought occurring during harvesting. Harvesting during wet conditions gives a lot of transport problems. The soil should be deep, humus-rich, well aerated and drained. On black cotton soils cambered beds and ditches may be necessary.

Propagation and Planting

Generally, sugarcane is vegetatively propagated with cuttings of mature stalks, and true seed is only used for breeding of new cultivars. Each cutting or seed sett usually has 2-3 buds. The

Natural pest control

Cultural practices

cuttings are put down horizontally and covered with a thin layer of soil. The leaves and top ends of seed cane can also be removed in the field, the buds are then allowed to germinate on the standing cane stalk. When the new shoots have reached a certain length, the cane is cut into setts and planted. These pre-germinated setts are excellent planting material, but vulnerable during handling and transport and very labour intensive to produce.

Crop rotation / Intercropping

In contrast to perennial field cultivation of sugarcane, the nursery fields need to follow a strict regime of crop rotation, in order to prevent infestation by soilborne diseases and pests, such as, e.g., nematodes, sugarcane smut (*Ustilago scitaminea*) and red rot of sugarcane (*Glomerella tucumanensis*). In problem cases, treatment of the seedlings with hot water can be effective. Sugarcane smut (*Ustilago scitaminea*), black rot (*Ceratocystis paradoxa*) and nematodes can be successfully managed with a 20 to 30 minute hot water treatment at 52°C, although this temperature may not be exceeded. Hot water treatment is only economically feasible for nursery stock. Heat treatment even when well done reduces germination percentage and the reduction depends on the variety being treated. Heat treated cane cannot be planted straight into commercial fields for two reasons: its germination is likely to be poor and so much cane would be involved that the treatment would be prohibitively expensive. Heat treated setts are therefore planted in nurseries which are harvested about a year later to provide planting material for the commercial fields.

The seedlings are planted in rows in pre-prepared furrows (furrow depth ca. 40 cm). On conventional sugarcane cultivations, the average distance between the rows is 150 cm (120 cm - 180 cm). On organic sugarcane cultivations, the best results have been achieved with double rows (40-50 cm gap between two single rows and 110-180 cm distance to the next double row). It is necessary to plant legumes on newly developing organic plantations.

Every new plantation should be fertilised with organic material. The organic fertiliser must be well decomposed, so that no fires can be caused by it. It should be spread as near to the plants

as possible, so that all nutrients that are released are immediately available to the plants' roots. The broad middle gap between the rows of new plantations is for the sowing of legumes. On farms with enough labour available for the manual harvest, these can be common bean or in drier areas cowpea or other *Vigna* species.Alternatively white clover is an excellent fixer of nitrogen and covers the soil very well, smothering most other weeds.

The beans do not only supply nitrogen, but are also an important source of food, and therefore useful to the economics of the plantation. Foliage of beans or legumes should be incorporated into the soil surface for best nitrogen effect.

Seed setts are planted in a narrow planting furrow, which should have good tillage. They are covered with a thin layer of soil from the inter-row. These planting furrows can be made on flat land or on the bottom of an irrigation/drainage furrow. In wet sites, planting may be on the top of the ridge between the furrows. Irrigation water is usually applied before or immediately after planting. A nursery of one ha is needed to plant 8 to 10 ha of cane.

Recommended varieties for Kenya by zone:

Nyanza sugar belt		Awendo/Trans Mara		Mumias/Nzoia/Busia	
Variety	Yield potential T cane/ha	Variety	Yield Potential T cane/ha	Variety	Yield Potential T cane/ha
CO 421	87.3	CO 421	32.2	CO 945	114
CO 331	93	CO 331		NCO 376	103.4
CO 617	102.7	CO 617	180	CO 421	103.1
CO 945	100	EAK 70-97	156	EAK 69-47	94.9

EAK 70-97	**109.2**	**CO 945**	**97.5**		
EAK 71-402	**89.4**				
EAK 69-47	**100**				

Husbandry

Weed control is carried out manually. Where sufficient labour is available, weeding is carried out at 3-4-week intervals with 3-4 weedings per season.

As sugarcane is a heavy producer of plant material, the soil under continuous ratoon crops need heavy fertilisation in order for yields not to decrease. Phosphorus in the form of rock phosphate or SSP should be applied in heavy doses at planting (40-50 bags/ha) and same amount again for each new crop. In organic systems, nitrogen has to come from natural nitrogen fixation of legumes or in the form of compost/manure/ slurry, which then also is needed in heavy applications.

Irrigation water, if necessary, is supplied every 2-4 weeks to the cane rows in the case of furrow irrigation, and to the cane on flat land or in small furrows in the case of sprinkler irrigation. When the cane grows taller, more water has to be applied, but intervals between the applications need not always be shortened.
In most cane fields the cane rows are earthed up 1-2 times by hand. In the end the cane stands on ridges separated by furrows. This practice stimulates root growth, consolidates the cane stools and improves drainage on the heavy clay soils. On the lighter textured soils it helps against early lodging of cane and can prevent erosion (if the direction of the furrows is along the contours of the land).

Diversification strategies

The ideal method is to cultivate sugarcane in a crop rotation system, yet for economical reasons, this is often difficult. Therefore, the good self-tolerance of sugarcane, the planting of legumes, the creation of sufficient compensatory tracts and niches, as well as a comprehensive fertilisation management system all have to help replace a lack of crop rotation on organic cultivations.

Green manure plants in existing sugarcane crops

On older plantations, a covering layer of legumes can quickly be obtained by sowing directly after the harvest. The seeds and re-growing sugar cane will form a compact, green mass that can be lightly worked into the soil after 3 months, before the seedbed is prepared for the new sugar cane. At sites with a strong growth of weeds, it may be worthwhile planting a second type of fast growing green manure plant. For sowing it may help to break over the sugar cane and afterwards apply one or two sowings of green manure plants. The green manure plants should be competitive, and able to suppress any weeds that may appear. They should be non-climbing varieties, as these would be harmful to the sugarcane.

Sowing legumes in the middle rows

Directly following the harvest, rapid-growing legumes can be sown in between rows. These will die off after the sugarcanes has appeared.
In areas with light soils and sufficient irrigation water, cane is intercropped, for example, with maize, groundnut or soybean. In such cases, the intercrops are planted on the ridges and the cane is planted 3-4 weeks later in the furrows. If required, irrigation furrows with a depth of 25-30 cm and a spacing of 1.10-1.30 m are made for hand-cultivated cane.

Harvesting

In Kenya the planted sugarcane crop is ready for harvest at the age of 14 (coast) - 22 months (higher altitudes) and the ratoon crop at the age of 12 (coast) - 18 (higher altitude) months. Cut the cane as near o the ground as possible as the butt is the sugar-richest portion. To prepare

for a ratoon crop, the stems will have to be trimmed down to ground level in order for new shoots to form well from their own roots.
The cane is cut and loaded manually, hand cut and grab-loaded or loaded in bundles by chains pulled by a tractor. Because the sucrose is being decomposed quickly inside the sugarcane, it must be processed relatively quickly after harvesting.

In many sugarcane growing regions, a controlled burning-off of the sugarcane fields is practised. Before the actual harvest, the foliage of the sugarcanes is set alight. Quite often, the sugarcane is again burned down after the harvest, in order to make the field easier to work. However if the fire gets out of control, the problem of too much cane being ready for the factory will occur, as it needs to reach the factory within 72 hours after harvest.
Advocates of burning-off argue that: a) an increase in efficiency of sugarcane cutting of around 30% (the work is usually carried out by casual labourers at piece rates).
b) non-burnt sugar cane contains more foreign substances, making sugar processing less efficient.
c) working the soil is not hampered by the mulch layer. The mulch layer hinders the shoots, especially in wet climates.
d) pests and diseases are destroyed by the fire.
e) nutrients in the ash are made easily available.

A 'green harvest' of sugarcane on the contrary is to harvest the cane without burning-off, which is practised in some sugarcane cultivation regions. Organic sugarcane cultivation consciously rejects the burning-off method in favour of a "green harvest" for the following reasons:
a) the sugar cane biomass remaining after harvesting is the basis for long-term sugar cane cultivation.
b) mulch encourages nitrogen fixing.
c) mulch suppresses unwanted growth.
d) in combination with the measures outlined above, this method helps to improve the humus

content and the structure of the soil.
e) the burning-off method causes a high loss of nutrients and energy that is caused by carbon and nitrogen compound gases escaping.

back to Index

Information on Pests

African armyworm (*Spodoptera exempta*)

The African armyworm can cause serious crop losses. Armyworms may cause indirect injury to the taproot by cutting stems and/or consuming foliage above ground.

What to do:

- **Monitor regularly field margins, low areas where plants have lodged, beneath plant debris around the base of plants, on the ground, and underneath the plant leaves. Check daily young crops if conditions are known to be favourable to the pest.**
- **Spray Bt or botanicals such as neem and pyrethrum extracts. Spray when caterpillars are small. Once caterpillars are mature (about 3 to 3.5 cm long) they may have cause serious damage and it may no longer be economical to treat the crop. For more information on (neem click here, for pyrethrum click here and for Bt click here)**

Armyworm caterpillar African armyworm. Mature larvae measure up to 4 cm long and are generally black, heads faintly mottled with dark brown spots, and with light yellow stripes at their backs. They are characterized by the presence of C-shaped dark spots along their backs

- **Conserve and encourage natural enemies. For more information on natural enemies click here**
- **Practise field sanitation. For more information on field sanitation click here**

(IRRI, 2001).

© University of Arkansas
More Information on African armyworm

Stemborers

Stemborers are the most important pests of sugarcane. Several species of stemborers attack sugarcane. The most important is the African stemborer.

1) The African sugarcane stalkborer (*Eldana saccharina*) The adult moth has a wingspan of 30 to 40 mm. It has elongated, pale brown forewings, each with two small spots in the centre, and whitish hind wings with a short fringe. Adult moths congregate on the cane canopy at night, they are attracted to light and so populations can be sampled using light traps. Female moths lay batches of yellow, oval eggs behind the leaf sheath or in folds of dead leaves. Eggs become pink before hatching. Young caterpillars feed on the leaves eating away the upper layers of the tissue; this damage is known as windowing. Later, they penetrate into the stalks. Caterpillars usually burrow into single internodes. When burrowing in the stem, caterpillars push their excrement outside.

Large amounts of frass are often hanging from the exit hole

Sugarcane borer
Damage of the African sugarcane borer, (*Eldana saccharina*) in the stalk.

© Courtesy of CIMMYT/www.agricomseeds.net




Sugarc… **African su…** **African su…** **African su…**

made by caterpillars prior to pupation. Caterpillars are light brown to dark grey coloured with brown with very small dark coloured spots. Pupation takes place in the plants, in the stem or on the leaf sheath. At emergence, the moth leaves a large emergence hole in the stalk. Attacked plants are stunted; in severe attacks they may dry up and die. When very young plants are attacked "deadheart" results, followed by tillering of the plant.

Older plants or ratoon cane have internodes bored. Crop losses are hard to assess because they vary with the age of the cane. In unstressed, maturing cane, quite high numbers of borers may be present without serious crop loss, but where infested, stressed cane is left to stand from one season to the next, the loss may be total. This stemborer also attacks maize and sorghum.

2) The spotted cane borer (*Chilo sacchariphagus*)
It is a serious pest of sugarcane in the Indian Ocean Islands (Mauritius and Reunion), and also attacking sugarcane in Mozambique and South Africa.

What to do:

- **Adjustments to crop management are the most effective measures in the control of African sugarcane borer.**
- **Use borer-free planting material (setts).**
- **Check planting material for signs of stem boring, which may indicate the presence of caterpillar and/or pupae.**

African su...

More Information on Stemborers

- **Avoid plant stress, such as drought, since stressed crops are more prone to stemborer attack.**
- **Cut older canes out, as soon as possible after 12 months, because the numbers of borers accumulate as cane ages, especially after about nine months.**
- **Do not leave tops of plants in fields; in East Africa caterpillars of the African cane borer are largely found on the upper part of the plant, and these residue will maintain carryover population for the next growing season.**
- **Proper fertilization is important; in particular nitrogenous fertilizers have shown to influence stemborer attack. In South Africa, where the African sugarcane borer is a problem, a reduction in nitrogen fertilisation rate from 50 kg to 30 kg per hectare is recommended. However, the yield outcome should be considered when deciding in reducing nitrogen input, though nitrogen fertilisation enhances borer development it also enhances the plant's tolerance to borer attack, and the outcome in terms of yield may be positive.**
- **Trashing has been recommended for control of stemborers. De-trashing sugarcane crops during the fifth, seventh and ninth month of growth has been recommended in India for control of the spotted cane borer. Pre-trashing of mature cane reportedly reduces numbers of the African sugarcane borer by 30% or more (Carnegie, 1991).**
- **Burning attacked fields at harvest or burning of residual cane is sometimes suggested, as it is more likely to destroy the pests than trashing, However, there are**

concerns that it may do more harm than good by destroying natural enemies.

- **Parasitic wasps and predators attack caterpillars of the African sugarcane borer. In particular Cotesia sesamiae is widespread. The introduced spotted cane borer is attacked by the parasitic wasp Cotesia flavipes introduced in the region for control of the spotted stemborer Chilo partellus. In Madagascar, parasitism of 60% of caterpillars of the spotted cane borer by this parasitic wasp has been reported (Kfir et al, 2002).**

Sugarcane scale (*Aulacaspis tegalensis*)

The adult scales are pear-shaped (females) to elongated (males). The scale mainly attacks stalks and leaf sheaths but can also be found on leaves as a result of crowding on the stalks. In the case of severe infestation, the cane stalks are almost entirely covered by scales. When gravid, the female's body is 1.8 mm long and 0.9 mm wide. After egg-laying, the female shrinks and loses her pink coloration. Eggs are laid under the females scale. Upon hatching the crawlers (young immature mobile stage) wander looking for a feeding site. They insert their needle-like mouthparts and suck plant sap and do not move again. They then develop a thick, waxy scale cover.

Crawlers can be dispersed considerable distances by wind or movement of vegetation by field workers and transport. This scale is a serious pest of sugarcane causing yield loss (both of canes and sugar content) and making extensive replanting necessary. Yields

Scale
Round female scale and elongate immature males on a leaf (here the related Mango scale, *Aulacspis tubercularis*). Its 1.5 to 2mm long.

© Bedford ECG, de

losses of over 30% percent have been reported in Tanzania (Bohlen, 1973).

Villiers EA. Courtesy of www.ecoport.org

What to do:

- **Use of clean planting material will delay scale population build-up. Washing or hot-water treatment kills the scales.**
- **Practice plant sanitation in pruning infested plants. In many cases, the crawler stage (dissemination life stage) can be spread from plant to plant by pruning equipment or by infested clippings that are not discarded properly. A good practice is to clean pruning equipment before moving to new plants and to destroy infested clippings. Uproot and burn heavily infested sugarcane plants.**
- **Scales are usually attacked by parasitic wasps; leave alternate infested plants to allow this wasps to survive and to built-up.**
- **Spray of white oils (foliage and truncs) is effective against young scales. However, care should be taken, since mineral oils may be phytotoxic.**

Pink sugarcane mealybug (*Saccharicoccus sacchari*)

The adult female is pinkish and it is elongated, oval to round in shape, and about 7 mm long. This mealybug is usually found in colonies on the stem beneath the sheath but is sometimes found on the stem just below ground level, on the root crowns, on the stem buds, and underneath the leaves. The leaves often turn red at the bases as a result of mealybug attack. Sooty moulds often

develop in severe infestations and ants feed on honey dew excreted by the mealybugs. This mealybug is often present in very large numbers, which excrete a considerable amount of honeydew.

Damage is partially caused by the insect sucking the plant sap, which may lead to stunting and yellowing, thin canes, death of young shoots and impaired growth when mealybugs are present in high numbers, but direct damage rarely causes yield loss in sugarcane. Most damage is caused by honeydew excreted by the mealybugs and the gums exuded from the wounded parts, which interfere with the synthesis of raw sugar juice leading to filtration and clarification problems, lower quality of the syrup and reduced crystallisation. Severe attacks decrease the general vitality of the plants, which become more susceptible to diseases.

What to do:

- **Cultural methods such as destruction of crop residues and trash; clean cultivation; and use of uninfested planting material is the best way of controlling this pest.**

Mealybugs
Here a related species of the sugarcane mealybug (on the image see the cassava mealybug (*Phenacoccus manihoti*). Female mealybugs are 0.5 -1.4 mm long and their body is usually covered with a waxy secretion.

© G. Goergen, Courtesy of Ecoport (www.ecoport.org).
More Information on Mealybugs

Termites (*Amitermes* spp., *Pseudacanthotermes* spp., *Macrotermes*spp., *Odontotermes* spp., *Microtermes* spp. and *Ancistrotermes* spp.)

Occasionally termites can be a problem by attacking the seed

pieces or the roots and stems of established plants. Yield losses can be very high. In Sudan losses of 18 per cent have been recorded and in Central Africa losses of 5-10 per cent are common. In Nigeria plant germination failure of up to 28 per cent has been reported. The most common damage to sugar cane is the destruction of the planting material (setts).

Termites
Termites (*Coptotermes formosanus*)

© Scott Bauer, USDA Agricultural Research Service, Bugwood.org
More Information on Termites

What to do:

- **Deep plow or tillage to expose termites to desiccation and to predators, thus reducing their number in the crops. Pre-planting tillage also destroys the tunnels built by termites and restricts their foraging activities.**
- **Dig mounds and destroy the queen.**
- **Destroy mounds. Mounds may also be flooded or burnt with straw to suffocate and kill the colony.**
- **Spray plant extracts, such as those of neem, wild tobacco and dried chili.**
- **Conserve natural enemies. Ants are important termite predators. Attract ants to the field by placing protein-based baits in the field near the plants.**
- **Remove residues of previous cereal crops (sorghum, millet and maize). Plant residues left in the field serve as food for termites, which may infest the new crop.**

Rats (*Rattus* spp.)

Every 5-6 years there are explosions in rat population size, mainly attacking food crops and

sugarcane.

What to do:

- **Do not kill mongoose, snakes, owls and other birds as they are very good predators of rats.**

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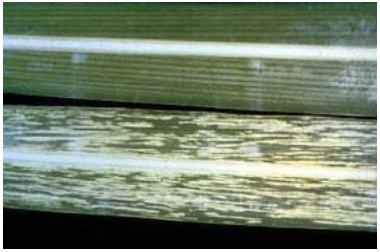
back to Index

Information on Diseases

The sugarcane mosaic potyvirus (also called mosaic of abaca) (SCMV)

It causes systemic infection of the sugarcane plant: the whole plant, including roots, contains virus. The symptoms (mosaic and/or necrosis) are observed on the leaves and sometimes the stems. Sometimes the whole plant is stunted. The classical symptoms are contrasting shades of green on a background of paler green to yellow chlorotic areas. It is aphid transmitted and also through infected planting material.



Sugarcane mosaic virus Severely strains of sugarcane mosaic virus infection on sugarcane compared to a healthy leaf.

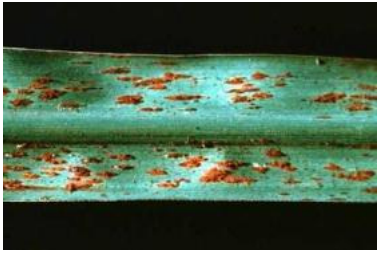
What to do:

- **Attempts to eradicate SCMV by rouging infected plants have rarely been successful. Rouging by digging out may be useful in maintaining mosaic-free seed plots of cane if the level of infection is lower than 5%.**

- **A close relationship exists between ants and aphid vectors of sugarcane mosaic virus. Ants can carry the aphids from one sugarcane plant to another, from grass to cane and from cane to grass. Presumably, ants also reduce natural predators and parasitoids of aphids, which would exert better control.**
- **Because aphids which transmit sugarcane mosaic virus come from outside as well as inside the sugarcane crop, take care to reduce the build up of the vector species in the vicinity. Crops of maize and sorghum are hosts of vectors and should not be grown near infected sugarcane crops.**
- **Alter the times of planting and harvesting so that they do not coincide with high aphid vector populations.**

Sugarcane common rust (*Puccinia melanocephala*)

Initial symptoms of sugarcane common rust are elongate yellowish leaf spots, 1-4 mm long. On susceptible plants, the spots increase in size with a reddish-brown change in colour. Typical rust pustules form on the leaves. The elongate pustules are parallel to the venation of the leaf and measure 2-20 mm by 1-4 mm. Multiple pustules on leaves give a reddish appearance to plants from a distance.



Common rust
Sugarcane common rust (*Puccinia melanocephala*)

What to do:

- **Control of sugarcane rust relies on planting resistant cultivars. Fungicides are neither practical nor economical for rust control.**

Red rot of sugarcane (*Glomerella tucumanensis* / *Colletotrichum falcatum*)

The fungus may infect any part of the sugarcane plant. It is most destructive as a rot of the stalk of standing cane, seed cuttings and/or stubble pieces remaining in the ground after the cane has been harvested. It produces long lesions on the leaf midribs. The lesions on the leaf midribs are dark or red. They may be short and discontinuous or long extending the length of the leaf. The centres become straw-coloured with age and are later covered with black powdery mass of spores of the fungus. However, the leaf lesions cause no serious injury to the plant but are important in the life cycle of the disease because they are sources of the spores that cause infection of the stalk.

Affected plants turn yellow, shrivel and the upper leaves die. On splitting the stalk or seed cutting, the normally white or creamy-white internal tissues are reddened and the reddened area is cross-barred with white or light patches. Any sort of wounding causes a reddening of the stalk tissues next to the wound, but when diseased the characteristic red discolouration extends beyond the point of the wound. In advanced stages of rotting, the interior of the stalk darkens and the tissues shrink, leaving a cavity, which may be filled with mycelium (growth) of the fungus.

The disease is spread by wind and rain. It is also spread by planting infected seed cuttings and it is enhanced by injuries by sugarcane borers and sugarcane weevils.

Red rot of sugarcane Sugarcane red rot (*Glomerella tucumanensis*) - Red spots on the midrib of the upper leaf surface develop pale yellow to white centres, merging to cover the length of the leaf. Similar spots also occur on the leaf blades.

What to do:

- **Disease management consists of planting disease-free cuttings, resistant varieties and minimizing hazards of injury by borers.**
- **Treatment of the seedlings with a 20-30 minute hot water treatment at 52°C can be effective, although this temperature should not be exceeded.**
  For more information on hot-water treatment click here.

Pineapple disease (*Ceratocystis paradoxa*)

It is called pineapple disease because of the characteristic odour of the rotting cuttings, which is like that of decaying pineapples. The interior of affected seed pieces becomes sooty black. Eventually the vascular bundles (tissues conducting fluids in the plant) become fibrous strands in hollow blackened core.

In contrast to red rot (which is favoured by excessive soil moisture), pineapple disease is most destructive when cane is planted in dry soil. Another major difference is that the red rot fungus is not soil-borne and infection occurs before planting, whereas pineapple disease fungus lives in the soil.

What to do:

- **Best management options include planting resistant varieties and rotation.**

Pineapple disease Reddening, followed by black areas of rot, on stems of sugarcane with pineapple disease caused by *Ceratocystis paradoxa*.

© Bureau of Sugar Experiment Stations, Queensland. Courtesy of www.ecoport.org

Sugarcane smut (*Ustilago scitaminea*)

he main symptom of smut is a long whip-like shoot covered with black spores contained in a silver coloured membrane. It emerges at the top of the stem in place of the inflorescence. Other symptoms include stunting and production of thin horizontal leaves. Smut is spread by infected cuttings and spores released from the whip-like shoot. Infection takes place through seed pieces and through axillary buds of the growing plant.

What to do:

- **Management measures consist of planting resistant varieties and hot water treatment of planting setts (50°C for 2 hours or 52°C for 20 minutes).**

Sugar cane smut
Sugar cane smut *Ustilago scitaminea*

© J. Kranz. Courtesy of www.ecoport.org

Ratoon stunting disease (*Clavibacter xyli* subsp. *xyli*)

This disease does have overt symptoms: There is a decrease in plant vigour and decline in yields, both of which are noticeable in ratoon crops. Red spots can sometimes be seen in vascular tissues, especially in the nodes. It can be spread by infected planting material and also through mechanical operations.

What to do:

- **Its management involves planting resistant varieties and also hot water treatment of planting material (50°C for 2 hours or**

Ratoon stunting disease
Discolouration of the nodal and internodal regions of sugarcane stem due to

52°C for 20 minutes). Heat-treated cane cannot be planted straight into commercial fields because its germination is likely to be poor. Secondly, for direct planting under commercial scenario, treatment of cane would be prohibitively expensive. Heat-treated setts are therefore planted in nurseries and harvested about a year later to provide planting material for commercial fields.

ratoon stunting disease (RSD).

Gummosis (*Xanthomonas campestris* pv. *vasculorum*)

It is a primarily a disease of the vascular system. It got its name from slimy gum that oozes from cut ends of infected stalks. Yellowish streaks, usually dotted with red or brownish spots are produced on the leaves near the tips. These spots often widen to a V-shape towards the leaf tip. Top rotting may result when the terminal bud is attacked resulting to shooting of the lateral buds. The disease is transmitted in infected cuttings used for seed, knife cuts and other means of physical contacts.

What to do:

- **Management measures consist of use of disease-free planting material, resistant varieties and sterilization of cutting tools.**

Leaf scald (*Xanthomonas albilineans*)

It is a vascular disease but differs from gummosis in that there is no oozing of gum from cut ends. Also leaf streaks due to leaf scald are different: they begin as sharply defined, narrow, white pencil stripes, which may extend the entire leaf length.

As the leaves grow older, the streaks tend to broaden and become more diffuse. There may be only one or several streaks on a leaf. Sometimes, instead of definite streaks, the entire shoot is chlorotic to nearly white. Affected plants become stunted and in advanced disease stage some shoots or the entire stool may suddenly wilt and die.

What to do:

- **Disease management measures for gummosis are applicable for leaf scald. Also heat treatment of planting for 3 hours at 50°C provides effective control.**

Leaf scald
Typical white streaking of the leaves found on sugaracane plants with leaf scald *Xanthomonas albilineans*

back to Index

Information Source Links

- **Acland J.D. (1980). East African Crops. An introduction to the production of field and plantation crops in Kenya, Tanzania and Uganda. FAO/Longman. ISBN: 0 582 60301 3.**
- **Agricultural Information Center, Nairobi (2002). Field Crops Technical Handbook**
- **Bohlen, E. (1973). Crop pests in Tanzania and their control. Federal Agency for Economic Cooperation (bfe). ISBN: 3-489-64826-9.**
- **CAB International (2005). Crop Protection Compendium, 2005 edition. Wallingford, UK www.cabi.org**

- **Carnegie, A. J. M. (1991). Cane borers in Africa and recent work on *Eldana saccharina*. Paper presented to International Society of Sugarcane Technologists Entomology Workshop, West Palm Beach, Florida, USA, 11-15 March, 1991. In: Polszek A, ed. 1998. African Cereal Stem Borers: Economic importance, taxonomy, natural enemies and control. Wallingford, UK: CAB International.**
- **Dick J, (1969). The mealybugs of sugarcane. In: Williams JR, Metcalfe JR, Mungomery RW, Mathes R, eds. Pests of Sugarcane. Amsterdam, Netherlands: Elsevier, 343-365.**
- **Hill, D. S. (1983). Agricultural insect pests of the tropics and their control. Second edition. ISBN: 0-521-24638-5.**
- **Kfir, R., Overholt, W. A., Khan, Z. R. and Polaszek, A. (2002). Biology and Management of Economically Important Lepidopteran Cereal Stem Borers in Africa. Annual Review of Entomology. 47: 701-731.**
- **Naturland e.V. www.naturland.de**
- **OISAT: Organisation for Non-Chemical Pest Management in the Tropics. www.oisat.org**
- **Republic of Kenya, Ministry of Agriculture: Economic Review of Agriculture 2006.**
- **UNEP (2006). TERMITES THREATEN INFRASTRUCTURE AND FOOD SECURITY. www.unep.org/dewa/Africa/publications/AEO-2/content/186.htm**
- **University of Florida IFAS Extension: Diseases in Sugarcane. edis.ifas.ufl.edu/TOPIC_Sugarcane_Diseases**

back to Index

Print

Crops/ fruits/ vegetables

African Nightshade
Amaranth
Avocados
Bananas
Beans
Cabbage/Kale, Brassicas
Carrot
Cashew
Cassava
Citrus plants
Cocoa
Coconut
Coffee
Cotton
Cowpea
Cucumber
Eggplant
Green gram
Groundnut
Maize
Mango

more Images

Cotton
Scientific name: *Gossypium* spp.
Order/Family: Malvales: Malvaceae
Local names: Pamba (Swahili)
Pests and Diseases: African bollworm African cotton mosaic disease Anthracnose Aphids Ascochyta blight Bacterial blight Cotton leaf curl bigeminivirus Cotton leaf roller Cotton stainers Cutworms Damping-off diseases Fusarium wilt Helopeltis bugs Leafhoppers or jassids Other bugs Root-knot nematodes Spider mites Whiteflies Cotton semi-looper

General Information and Agronomic Aspects
Biological methods of plant protection
Information on Pests
Information on Diseases
Information Source Links

General Information and Agronomic Aspects

Geographical Distribution of

Cotton in Africa

Introduction

The cotton plant belongs to the Malvaceae family. Over 30 species have been discovered (among others: *Gossypium hirsutum L., G. barbadense L., G. arboreum L.).* Cotton as a tropical crop originates from several locations (southern Africa, south-east Asia and Peru). There are annual and two-year species, as well as perennial varieties. It produces a yellow, white and purple-red blossom, and is a hermaphrodite.

Varieties and countries of origin

World wide there are ca. 33 mill. hectares of cotton crops. Economically, the most important varieties are *Gossypium hirsutum* and *Gossypium barbadense*.

G. hirsutum:
- Upland cotton
- 80-90% of world market
- short to medium fibres (2-3 cm; middle stapled variety)

G. barbadense:
- Sea Island cotton
- 10-20% of global market
- high-quality, long to very long fibres (3-4 cm; long stapled variety)

In addition, the annual *G. herbaceum* or the hardy cotton bush *G. arboreum* produces fibres with a length of 1.8-2.2 cm. Long stapled varieties are cultivated mostly in Egypt and Peru. The middle stapled varieties from the USA, short stapled varieties in Asia *G. barbadense* is more susceptible to pests due to its long vegetation period *G. hirsutum*, that ripens far quicker (some varieties after only 150 days).

Pests/ diseases/ weeds

Medicinal plants

Fruit and vegetable processing

Natural pest control

Cultural practices

All of the cotton varieties with coloured fibres, formed from crossings between wild varieties (from Peru) and crops, have provoked a certain interest in the natural textile processing industry. Until now, mostly brown, green and beige varieties had been cultivated.

Organic cotton production is most widely spread in the USA (ca. 4000 ha). Yet ecological cotton projects also exist in Egypt, Argentina, Brazil, Greece, India, Mali, Nicaragua, Paraguay, Peru, Tanzania, Turkey and Uganda.

Uses and contents

Cotton can be seen as a classic dual purpose plant (fibres and oil). A harvest yielding 1000 kg of cotton/ha can be broken down thus:

- **ca. 320 - 420 kg fibres (raw cotton)**
- **ca. 200 - 250 kg seed cakes or flour**
- **ca. 100 - 150 kg oil**
- **ca. 200 kg shells**
- **ca. 20 kg retained seeds**
- **ca. 40 kg dirt**

The fibres (lint-fibres, lint) are used in the production of materials (threads, fabrics, etc.), whilst the linters (fluff separated from the cotton seeds) are used to produce cellulose fibres and other cellulose products, thick threads and stuffing materials, as well as being used for the production of paper.

Oil produced from the seeds can be used as edible oil, among other things. When oil is produced from the cotton seeds and pelleted feed used as fodder, care must be taken to remove the Gossypol that forms in the oil/cakes by heating it. Gossypol is poisonous to humans and animals with normal stomachs (e.g. pigs), only ruminants (e.g. cattle) can digest

cakes containing Gossypol without a problem. The seed shells can be used as raw fodder for animals, as straw, dung or as fuel.

Low-grade oil is used in the manufacture of soap, lubricants, sulphonated oils and protective coatings. The seed cakes are used as fodder and manure. The seed shells can be used as raw fodder for animals, as straw, or as fuel.

Climate conditions, soil and water management

Cotton performs best in desert climates, under irrigation. It grows on lowland below 1000 m. The optimum temperature for germination is 34°C, for the growth of seedlings 24-29°C, and for later continuous growth 34°C. Low temperature increases the production of vegetative branches and extends the cropping period. Cotton is susceptible to frost. High temperature increases the number of fruiting branches and reduces the cropping period. Cotton is a sun-loving plant and cannot tolerate shade, particularly in the seedling stage. Reduced light intensity, caused by long-lasting overcast weather, shading from interplanted crops or too dense a stand, retards flowering and fruiting and increases boll shedding. Shedding of over 50% of squares, flowers or young bolls, due to early bollworm attack, drought or waterlogging, is normal. Upland cottons are day-neutral.

The crop will not tolerate very heavy rainfall and, where grown as a rain-fed crop, the average rainfall is usually 800-1200 mm. Adequate, but not excessive, moisture is required for early vegetative growth. The first flowering period requires relative dryness to speed up formation of fruiting branches. An increase in moisture is required for boll setting and renewed growth, followed by dry weather for ripening and harvest. Sufficient soil moisture is essential during the flowering period.
In the tropics most cotton is grown by smallholders who sell their seed cotton to the ginners. Ginneries may be privately, cooperatively or state owned.

Cotton can be grown on a variety of soils from light sandy soils to heavy alluvium and calcareous clays. Soils must be permeable to water and to roots to a depth of at least 100 cm, preferably over 150 cm, with pH 5.5-8.5. Cotton is one of the salt-tolerant crops.

Propagation and Planting

Site requirements

In its early stages of growth, cotton requires an arid climate with a plentiful supply of water. Afterwards, the weather needs to be dry, especially after the capsules have opened, for if rain can enter at this stage it will have a detrimental effect on the quality. The vegetation period generally lasts around 180-220 days (varieties such as *G. hirsutum* that mature rapidly can be harvested after only 150 days). Very high yields have been reported from the arid areas of the CIS and in Egypt using irrigation.

Because cotton loves the heat, yet is also highly susceptible to frost, temperatures of around 26-28°C are ideal for its development. Lots of sun has a very positive effect during the blossoming and fruit setting periods, in cases of 50% and more cloud during the vegetation period it makes little sense to plant cotton. Cotton cannot withstand shade. Cotton is also a short-day plant, and such conditions will accelerate its growth. The correct climatic conditions are generally found between the 28° northern and 47° southern latitudes.

A strong wind can suck the fibres out of the capsules and blow them away. Today's varieties are tolerant with regard to salinity (up to a salinity of 0.5-0.6%). The soil's pH value should be between 6 and 8. In addition, cotton also requires deep, well-drained and ventilated soil, in order to properly develop its system of tap-roots (resistance to drought).

The site's elevation plays a large role when planting coloured varieties of cotton, because the intensity of the sun's rays has a strong effect. At least the green varieties tend to bleaching

when the intensity increases too much (Peru).

Seeds and shoots

The fertilisation process is generative. Most wild Gossypium varieties are perennial. Annual varieties are most generally used for cultivation, which conclude their development cycle during one single vegetation period. Local and regionally produced seeds should be used, which will have developed a tolerance or resistance against the pests most commonly found in the region. Because the sale of seeds is usually controlled by government authorities, it is important to try to acquire untreated seeds of the desired variety early enough.

During the last few years, hybrid seeds have been developed that provide high yields. Yet this method makes it impossible to use self-produced seeds from the crop, and a new supply of seeds must be bought for the next season.

Because cotton can be affected by various root and dumping off diseases, in certain cases, it is worthwhile considering pre-treating the seeds. In contrast to conventional cotton crops, only micro-organisms, which work antagonistically, are used. In Egypt, for example, the seeds are treated with Bacillus subtilis, Gliocladium penicilloides and/or a suspension of trichoderma. In order to improve the nutrient availability for the young plants in India, the seeds are additionally treated with azotobacter and bacteria strains capable of breaking down phosphorous.

Sowing methods

If the cotton is to be planted by machines, then the seeds need to be rid of the fluff that surrounds them (otherwise the seeds stick together). This is not necessary when the seeds are sown by hand. The temperature should not fall below 18°C. Temperature of 35°C is optimal. The seeds should be sown at a depth of maximum 5 cm.

The density depends upon the method utilised (manual or by machine). Bio-dynamic farmers in Egypt sow several seeds by hand every 20 cm into the prepared planting rows (distances

between the rows 60-70 cm). Between three and four weeks later, the plants are inspected and all but the two strongest specimens removed. The plant population of rain-fed cotton of small-scale farmers in Tanzania is much lower. The farmers sow cotton by broadcasting the seeds on the flat land or in rows at a spacing of 90 cm between and 30 ? 50 cm in the rows. Some farmers sow also on ridges with the same spacing.

Mechanical methods usually leave 70 cm (50-120 cm) between the rows and 20 cm (20-60 cm) distance between the seeds. When the harvest is done mechanically, varieties such as G. hirsutum that produce few branches are sown every 8-10 cm with a distance between the rows of 15-20 cm.

Cotton is either planted on flat soil, ridges or in furrows. Furrow drilling is employed mainly as a protection against quicksand. Ridges are used in soils, which are difficult to drain, and in regions with little rainfall, as this eases irrigation and facilitate the seeping in of the water into the soil. Its disadvantages are more difficult sowing and tilling of weeds. The cotton is sown in the lower third of a ridge in high-content soils and the upper third for low content soils. The seeds should be watered as soon as possible after sowing.

During the first 3 weeks, the shoots can offer little resistance against weeds, but this improves until the thick crop growth has no more problems in the area. For this reason, a suitable position in the crop rotation, suitable soil cultivation method and preparation of the seed beds should be taken care of to prevent an excessive growth of weeds during the early growth phases. On irrigated soils, irrigation is carried out prior to sowing in order that the weed seeds germinate and grow. The resulting growth of weeds can then be easily removed by appropriately cultivating the soil, before the cotton is sowed. The final soil treatment before planting should include the spreading of compost.

For cultivation done using animal-drawn (oxen or water-buffaloes) implements time requirements are: 15 animal days and person-days/ha, or by hand: 50 person-days/ha. By two

or four-wheeled tractors (150 kWh/ha).

The land should be prepared early and to a depth of at least 15 cm. To maintain soil organic matter, liberally apply or incorporate plant residues and animal manure during land preparation. Planting should be early, as soon as rainfall is adequate for the germination and growth of the crop. Cotton grown by smallholders is commonly planted with a delay, because the food crops are given priority. In hand planting, cotton is usually sown at a seed rate of 11-14 kg/ha and at a depth of about 25 mm with 3-6 seeds per hole in rows or ridges. Ridges are an advantage as they can be tied to conserve water under dry conditions and aid drainage under wet conditions. Thinning is done when the plants are 6-10 cm high, and two plants per hill are usually left. The optimum spacing depends on the size and fruitfulness of the plant permitted by local conditions. It also depends on the interactions between variety, soil and climate. The optimum spacing ranges from 80-20 to 100-40 cm, with one or two plants per hill. Plant densities may vary between 40,000 and 100,000 plants per ha, but are generally between 50,000 and 60,000 plants per ha.

Husbandry

Cotton seedlings are sensitive to competition from weeds. Weeds should be controlled early to prevent damage to the crop. Control weeds against the first flush of weeds before sowing and plant the seeds closely. Weed early and frequently. Place manure some 6 weeks after sowing. These measures help to reduce hand weeding to some 15 person-days (work of one person done per day) per ha. It also helps to reduce attack by pests harboured by weeds.

Irrigation

Intervals between irrigation should be 2-3 weeks on deep permeable sandy loams to heavy clays and less for very light, very heavy and shallow soils. The irrigation period should be 19 weeks.

Excessive irrigation besides being a waste of water increases risk of disease incidence. Most irrigation is by gravity using furrows. Water saving is possible by alternate furrow irrigation or by handwatering with a hosepipe.

Nutrients and organic fertilisation strategies

Compost, decomposed animal dung and mulching material are used to supply the soil with sufficient organic material. This supports the cotton's growth. Potassium can be supplied by spreading wood ashes, and phosphorous by adding rock phosphate. Usually, the soil is prepared before the cotton is sown by spreading compost that is mixed with ashes and rock phosphate. In some areas, animal manure that has been composted is used for fertilisation. It should be applied inside the furrow close to the plant lines or in each plant hole. The above is only applicable to smallholder farmers. It is not practicable where cotton is a plantation crop as in Egypt, Sudan and Tanzania.

Crop rotation and intercropping

Cotton should not be grown for more than 3 years on the same field. It is important that cotton is grown in rotation with other crops. This helps to improve and maintain soil fertility. Crop rotation and mixed cropping help prevent build-up of pest population, diseases and weeds. Cotton grows well in rotation with cereals, tobacco and legumes. Particularly good yields can be achieved when cotton is grown after pulses (soybean, chickpea, pigeon pea, groundnut etc.), horticultural crops like chillies or vegetables, and after sugarcane and wheat.
Cotton intercrops such as maize, sorghum, beans, and peanut create a natural balance of pests, natural enemies, and weeds in the cotton field environment. Maize or tobacco planted in every 20 rows of cotton attracts African bollworm. Sunflower or cowpea sown in every 5 rows of cotton attracts moths when planted as trap crops. Castor bean (*Ricinus communis*) attracts caterpillars. Rice when rotated with mungbean and cotton disrupts the life cycles of pests

attacking these crops. However, the timing of planting of intercrops, trap crops, and border crops should be planned to flower at the same time with cotton.

Harvesting

In Africa generally, cotton is hand picked. This creates work for farmers' families or village labourers, usually women. It also produces clean seed cotton that can be ginned easily and cheaply in low-cost ginneries. One picker can harvest 25-40 kg of seed cotton per day depending on the availability of open bolls. Picking is very laborious. It should be done every 3-4 weeks, so that open cotton is not left in the field for too long which may result in a change of the colour and reduced the quality of the lint. It is then sorted into clean and stained cotton before marketing. Harvesting begins about 4 months after sowing, lasts for 2 months and 2-3 pickings are usually done.

back to Index

Biological methods of plant protection

Preventative or combating methods are already known for all of the important pests and diseases that can occur on organic cotton plantations. In the long-term, it is safe to presume that a high level of pest and diseases will significantly diminish following the introduction of an organic cultivation system.

Yet this requires a successful plant protection management system. The farmer should inform himself in time:

- **Which important infection agents are present in the region,**
- **Which preventative strategies he wishes to implement against them on his site,**

- **Which combating measures exist against a heavy infestation,**
- **Which permitted resources are available for organic systems,**
- **How these are applied**
- **When it is correct time to apply them**
- **Whom he can turn to in an emergency (advice).**

The following preventative measures should thereby be strictly adhered to:

Selecting crop rotation
As cotton is not well compatible with itself, it is not advisable to have a larger ratio than 1/3 in the crop rotation. Other mallow plants (e.g. hibiscus) must be excluded from the rotation, or at least not planted on the same soil. It is also important to check that no cotton is grown on any of the neighbouring plots. On the whole, a diversified crop rotation works best.

Mixed crops with plants that act as a repellent
Mixed or strip cultivation with onions, garlic, chillies, chrysanthemums or hot peppers have proved their worth because of their repellent effect against, among others, bugs, white fly and cotton leafworm (*Alabama argillacea*). Rotted liquid manure can also act as a repellent (and be simultaneously used as a fertiliser).

Cultivation of trap crops
Trap crops manage to keep pests away from the cotton by offering a more attractive source of food. Strip cropping using lucerne (*Medicago sativa L.*) within the cotton plants is, for example, practised in the USA and Paraguay, in order to keep pests such as different bug species (*Dysdercus* spp., *Lygus* spp.), *Helicoverpa* spp., *Spodoptera littoralis, Platyedra gossypiella* and aphids away from the cotton.
Sowing sorgo before the cotton (on neighbouring plots) can help to build up a population of useful insects, which can then combat cotton pests when they appear at an early stage (e.g.

aphids).

A similar strategy can be followed by planting *Hibiscus esculentus* against the pest *Podagrica* spp., planting *Lablab niger L.* against the pests *Helicoverpa* spp., *Spodoptera littoralis* and *Bemisia tabaci*, or nasturtium against *Tetranychus cinnabarinus* (these are based on experiences culled from Turkey and in Sudan). During 9 years of organic cotton growing in Tanzania the experiences have shown that the most important cotton pest *Helicoverpa* spp. can be controlled with sunflower as trap crop to such an extend that the threshold for an economic application of insecticides is not reached in most cases. The recommended practice is to sow one row of sunflower around the cotton plot as a living fence and one row of sunflower all 10 meters in the plot. The sowing time has to be very close to the cotton sowing so that the sunflower will be in the flowering stage when the infestation period starts. The sunflowers attract the moths of *Helicoverpa* spp. to lay their eggs. The caterpillars are feeding on the sunflower however without destroying the production of sunflower seeds. So the farmers can get an additional income from the sunflower seeds.

The caterpillars on the sunflowers show also the phenomenon of cannibalism so that they reduce their number itself (Source: Dr. Braun, gtz-IPM project, personal communication, 1997).

The positive effects of sunflowers are also shown in the results of a study that was carried out by an entomologist on behalf of the GTZ-IPM project in Shinyanga. The researcher found out that in organic cotton plots with sunflowers were up to ten times more useful ants compared with cotton plots without sunflower. It is known that these ants are reducing the eggs and larvae of the African bollworm (*Helicoverpa armigera*). (Source: Varela, Ana (1996) "Ants as mortality factors of the African bollworm *Helicoverpa armigera* in smallholder cotton fields in Tanzania"). A booklet about the natural enemies of the African bollworm names especially the ant species *Myrmicaria* and *Pheidole* as important. 'On sunflower, ants were observed to reduce bollworms by as much as 85%.' (Source: van den Berg, H. + Cook, M.J.W., (1993) 'African bollworm and its natural enemies in Kenya', P. 33, CAB International + NRI, International

Institute of Biological Control, Kenya Station). Many contracted smallholders in Tanzania confirm the positive effects on the cotton yield by cultivating sunflower as trap crop and even many conventional neighbours in the region started copying this cheap and easy method of preventive pest control.

Pigeon peas (*Cajanus cajan*) can also be a useful trap crop for pests like *Helicoverpa* spp. but it is not so easy to synchronise the flowering stage of the trap crop with the infestation period of the pest. The local pigeon pea varieties in Tanzania start the flowering too late to be an efficient trap crop. Early maturing varieties or sowing of pigeon peas in the previous year could resolve this problem. In the bioRe India project the pigeon peas are successfully use as trap crop in cotton.

Trap crops planted in autumn (e.g. maize) can be used in combination with a pheromone against hibernating boll weevils.

Leaving a strip of natural vegetation around the cotton plot can be useful against aphids and other pests.

Choosing a site
Cotton should be planted in healthy soil wherever possible. In principle, sites that are infested with weeds should not be sown with cotton, but first cultivated with an appropriate rotation crop in order to prepare it. Care should be taken that no cotton is planted in the neighbouring plots. Sowing time
The choice of when to sow plays an important role. Cotton sown too early will possibly become infested by the pest population that has already developed there. In Tanzania the late sown cotton is often attacked by African bollworm (*Helicoverpa armigera*) that developed on maize or sorghum plots. At the end of the season the risk of the late season pest cotton stainers (*Dysdercus* spp). is higher on late sown cotton while it is a minor problem on early sown cotton.

Mulching of harvest residues
Careful mulching of the remains of a cotton harvest can help prevent the survival of pests (e.g. *P.gossypiella* in seeds and boll weevil, *Anthonomus grandis*). In the case of heavy infestations with wilting diseases, such as bacterial blight (*Xanthomonas malvacearum*), Anthracnose (*Glomerella gossypii*), verticillium-wilt (*Verticillium alboatrum*) or fusarium-wilt (*Fusarium oxysporum*) it is recommended to remove the residue and then apply for composting.

Sufficient, balanced supply of nutrients
A plant that receives balanced nutrients is more vigorous, and therefore less susceptible to infestation. As already mentioned, supplying too much nitrogen will lead to an infestation by pests.

Choosing a variety
It is hereby important to choose varieties adapted to the site conditions, and that are resistant to, or can tolerate, the main pests. In addition, general varieties have proven their worth that matures quicker, thereby shortening the time span they can be infested. Gossypol-free are not so well suited to organic plantations because Gossypol (just like other terpenoide chemical compounds) has a repellent effect on certain insects (e.g. against *Helicoverpa* spp., *Spodoptera* spp. and *Pectinophora* spp.).
How easy or difficult it is to choose a suitable variety show the examples from Tanzania and India.
While in Tanzania there is only 1 cotton variety per production zone the bioRe farmers in India use 9 out of more than 50 different varieties according to their specific needs and preferences. It follows a list with the advantages and disadvantages of the varieties used in India, which shows the different aspects that can be important for the decision.

Planting of boundary areas
Planting 2-3 rows of trees or hedges along the boundaries provides a habitat for birds, improves climatic conditions and reduces the amount of water needed for cotton.

Checking the infestation level of cotton pests
In Tanzania the gtz-IPM project has developed a method to check the infestation level of the key pest *Helicoverpa armigera*. The method is called 'scouting' and it works by counting the squared buds on 30 plants of 1 acre. If the number of squared buds comes up to 15 the economic threshold is reached and the farmers are advised to spray an insecticide. The organic farmers then apply an oily formulation of neem. This 'scouting' method works much faster than looking for the pests itself and helps to avoid many applications of insecticide (in organic and in conventional farming).

Light traps allow seeing the start of pests moving into the cotton plot and at the same time reducing the number of moths laying eggs on the cotton plant. In Tanzania the the fields at rate of one per acre for about two hours after sunset. The reduction of moths can help to reduce the number of sprayings.

Direct combating measures
Direct methods of combating pests are also available for organic plantations, yet are only to be used in emergencies (and not as preventatives). It is necessary that the cotton, and any pests which may eventually develop, should be regularly inspected in order to be able to decide whether a direct method is to be used or not (see chapter above).

If the critical threshold is reached and there is an immediate threat for the cotton harvest the organic farmers need to have insecticides available that are allowed in organic farming. There are several botanical insecticides, which proofed to be efficient against important cotton pests.

In India the bioRe farmers can choose among 3 commercial neem formulations and the self-made preparations made with crushed neem seeds. In Tanzania the farmers can get one neem formulation imported from Kenya and another from India to control *Helicoverpa armigera*. Against the late season pest *Dysdercus* spp. the farmers use a locally formulated Pyrethrum

preparation with black wattle extract (*Acacia mearnsii*) as UV-light stabilisator.

Beside the neem products there are also some other plants that can be useful to produce botanical insecticides. In Tanzania the Ukiriguru Research Institute tested with promising results an emulsion of *Jatropha curcas* oil against *Helicoverpa armigera*. In Mali it has been tested against Sorghum pests and a report from Malawi states: 'The oil and aqueous extract from oil (active principle probably phorbol ester) has potential as an insecticide, for instance in the control of 4 insect pests of cotton including cotton bollworm (Solsoloy 1995) and on pests of pulses, potato and corn.' (Malawi Agroforestry Extension Project Marketing & Enterprise Program Main Report, Publication No. 47, page 46, July 2002).

In West African countries like Bénin and Mali the farmers are experimenting with mixtures of plant extracts and other ingredients. Experiences from Bénin give the following recommendations for 1 ha:

3 sprayings during early season with a preparation of
1.5 kg pounded neem seeds in water, fermenting over night and then filtered
1 litre cow urine
20 papaya leaves
local soap diluted in water
total of 10 litres

Then later in the season the following preparation without cow urine in order to avoid excessive vegetative growth:
2 kg pounded neem seeds in water, fermenting over night and then filtered
5 cloves of garlic
20 papaya leaves
local soap diluted in water
total of 10 litres

Since 1999 organic cotton growers in Mali use a mixture of neem and 'Npeku' oil (*Lannea microcarpa*) as botanical insecticide. The preparation for 1 ha is done as follows:
- 500 g grounded neem seeds in 10 litres of water for 3 to 5 days and then filtered
- Add 40 to 160 ml of 'Npeku' oil (according to plant stage, see table below) and mix well to get an emulsion

Instead of the 'Npeku' oil the organic cotton farmers in Mali take also the oil of 'KOBI' (Carapa procera) in the same way.

Yellow traps, pyrethrum and also sulphur extracts do not work specifically enough (useful insects are also affected). For this reason, these preparations should only be used when absolutely necessary, and when no other alternatives are available.

back to Index

Information on Pests

General Information

Preventative or combating methods are already known for all of the important pests and diseases that can occur on organic cotton plantations. In the long-term, it is safe to presume that a high level of pest and diseases will significantly diminish following the introduction of an organic cultivation system.

Direct methods of combating pests are also available for organic plantations, yet are only to be used in emergencies (and not as preventatives). It is necessary that the cotton, and any pests which may eventually develop, should be regularly inspected in order to be able to decide whether a direct method is to be used or not (see chapter above).

Examples of Cotton Pests and Organic Control Methods

Root-knot nematodes *(Meloidogyne* spp.)

Several species of root-knot nematodes attack cotton roots. Infested plants are often stunted and leaves yellow. Galls or knots are formed on the roots. Infestation can be particularly serious in light soils. Nematode infestation predisposes plants to *Fusarium* wilt infection.

What to do:

- **Practice crop rotation with crops not related to cotton (e.g. cereals) whereby cotton is cropped once every 3 or more years.**

Root-knot nematodes
Root-knot nematodes (*Meloidogyne incognita*) affected plants are normally stunted and eventually wilt and die. The most characteristic symptom is formation of root galls (knots) and these can be seen with the naked eye. Affected roots rot.

More Information on Root-knot nematodes

Helopeltis bugs (*Helopeltis schoutedeni* and *H. anacardii*)

Other bugs feeding on cotton include Helopeltis bugs, blue bugs and cotton lygus and the cotton seed bug.

Cotton Helopeltis (*Helopeltis schoutedeni*)
Helopeltis bugs are up to 10mm long and have very long antennae. They are bright red (females) or yellowish-red (males) in colour. The bugs prefer to feed on young plant tissue of leaves, shoots, peduncles and petioles. The toxic saliva injected during sucking causes pale brown necrotic patches. The leaves and the stems of the plants are twisted. The lesions on the leaves often drop out leaving holes as if attacked by chewing insects. The green boll wall is also attacked showing dark, circular, sunken lesion.

Helopeltis bug
Helopeltis bug. Real size: 6 to 10 mm long.


Helope Helope

What to do:

- **Bugs, in particular adults are difficult to control since they can readily move from neighbouring crops or wild plants into the cotton crop.**
- **Do not interplant cotton with crops that are host for Helopeltis bugs, such as cashew, tea, sweet potato, guava and mango.**
- **Monitor the crop regularly. Helopeltis attack occurs very suddenly and great vigilance is very important to control this pest, particularly during the rainy season or when water is available leading to flushing (production of young shoots) when Helopeltis populations normally build up.**
- **Natural enemies are important in the control of bugs.**

Conserve natural enemies. Weaver ants build nests on cashew trees providing good protection against this and other bug pests. The most important are parasitic wasps attacking bug eggs; ants, which feed on eggs and nymphs; and various predacious bugs, spiders, birds and parasitic flies.

- **Neem products reportedly reduce feeding by some bugs.**
- **Since bugs are late season pests early sowing and picking is recommended to reduce bug attack.**

Bugs (Blue bug, cotton lygus, cotton seed bug)

Other bugs feeding on cotton include blue bugs and cotton lygus and the cotton seed bug.
Blue bugs (*Calidea degrii*, *Calidea bohemani*)
The adults are large bugs, 8 to 17 mm long by 4-8 mm broad, and strikingly coloured, with red or orange underneath and the upper surface bright metallic blue or green with black spots. They suck the seeds of unopened bolls causing staining of the cotton lint in a similar way as stainer bugs; as a result the development ceases and the boll aborts.
Blue bugs seldom breed on cotton; they usually invade cotton when the bolls are well formed, from other host plants, for instance sorghum, sunflower, castor and many wild hosts such as crotalaria and hibiscus.
Cotton lygus (*Taylorilygus vosseleri*)
The adult bugs are up to 5mm long and pale green to light brown in colour. The nymphs are green. Adults and nymphs prefer to suck young leaf buds, flower buds and bolls. The toxic saliva

Cotton seed bugs
Cotton seed bugs(*Oxycarenus hyalinipennis*) (here on okra)

© A. M. Varela, icipe

causes the flower buds to turn yellow and drop off. Leaves, which have been attacked in the bud stage, later show a ragged appearance with many irregular holes. The cotton lygus is an early season pest.

Cotton seed bug (*Oxycarenus hyalinipennis*)
These bugs are small (4 to 6 mm), and blackish in colour. Their wings are transparent. They attack open or damaged pods mainly at the end of the growing season. It is a late season pest, which mainly appears when the bolls have opened. Nymphs and adults suck the seeds. Feeding by large numbers of bugs reduces considerable the germination rate, seed weight and oil quality. The lint is not affected.

What to do:

- **Bugs, in particular adults are difficult to control since they can readily move from neighbouring crops or wild plants into the cotton crop.**
- **Natural enemies are important in the control of bugs; the most important are parasitic wasps attacking bug eggs; ants, which feed on eggs and nymphs; and various predacious bugs, spiders, birds and parasitic flies.**
- **If heavy outbreaks of the cottonseed bug occur, the cotton should be picked as soon as the cotton bolls mature.**
- **Neem products reportedly reduce feeding by some bugs.**
- **Since bugs are late season pests early sowing and picking is recommended to reduce bug attack.**
- **Tanzania: Pyrethrum formulation with black wattle extract as**

UV light stabilisator

Cutworms (*Agrotis segetum* and the cotton leafworm, *Spodoptera littoralis*)

Caterpillars cut seedlings at ground level. They can be found in the soil up to a depth of about 5cm around the plant host. Caterpillars of the cotton leafworm are up to 45 mm long. Their colour varies from yellowish white to bluish grey and greyish brown. On the dorsal side of the caterpillars there are usually two rows of triangular black spots. These spots can be absent with the exception of those at the fore and hind part of the body. Although the caterpillars feed mainly on leaves, they occasionally cut plants and attack fruits.

What to do:

- **Remove weeds in and around the fields as a preventive measure to reduce the number of sites where the moths can lay eggs. Do this at least 2-3 weeks before planting.**
- **Plough and harrow fields properly before planting to destroy eggs and expose caterpillars to birds, ants and other predators.**
- **Apply neem cake or de-oiled castor cake before sowing.**
- **Encourage the presence of birds with trees and hedges. Also promote natural enemies like spiders, ground beetles and lacewing.**
- **Interplant with onion, garlic, peppermint or coriander, this will act as a repellent to cutworms.**

Cutworms
Black cutworm (*Agrotis ipsilon*). Early instars are about 7 to 12 mm long. Fully grown caterpillars are 35 to 50 mm long.

© Ooi P., Courtesy of Ecoport (www.ecoport.org)
More Information on Cutworms

- **Sunflowers can be planted as trap crops.**

The cotton aphid (*Aphis gossypii*)

Cotton aphids are about 1-3 mm long, and variable in colour from yellow to yellowish green or very dark (almost black) with two cornicles (projections) on the rear end and long antennae. They suck sap preferably from tender shoots and the underside of young leaves. Feeding by aphids may result in crinkling and cupping of leaves, defoliation, square and boll shedding and stunted growth.

Honeydew (a sugary liquid) excreted by aphids accumulates on the upper surface of leaves and sooty mould develops. Honeydew can contaminate the fibre if the bolls are open, causing problems in processing the lint.

What to do:

- **The cotton aphid is attacked by a range of natural enemies; the most important are ladybird beetles, hoverflies, lacewings and parasitic wasps. They usually keep aphids under control.**
- **Healthy cotton plants can tolerate a fairly high number of aphids.**
- **Avoid plant stress by giving neither too little nor too much manure. Avoid water stress and water logging.**
- **Intercrop cotton with maize or sorghum to create a natural balance of pests and natural enemies.**

The cotton aphid
Cotton aphid (*Aphis gossypii*) on the underside of a cotton plant.

© Ronald Smith (Courtesy of EcoPort, www.ecoport.org)
More Information on Aphids

- **Use yellow water or sticky traps.**
- **Spraying maybe necessary in the case of high aphid infestation or if the honeydew affects the lint in open bolls. If this is the case, use plant extracts such as neem leaf and seed extracts, ginger rhizome extract, and custard apple leaf extract for control of aphids.**
- **3% potassium soap in acute cases; ii extreme cases nicotine extract, neem, chilli, garlic, Lantana camara**

Whiteflies (*Bemisia tabaci*)

Whiteflies (*Bemisia tabaci*) suck the sap of leaves. Feeding weakens plants and may lead to yellowing and wilting, premature leaf shed and reduced plant growth, affecting the quality and quantity of yield. Severe attack may kill young plants. Honeydew excreted by whiteflies and sooty mould that develops subsequently can affect the fibre quality considerably and cause problems in processing the lint.

The whitefly is a vector of important virus diseases on various crops including cotton. It transmits the cotton leaf curl virus and the African cotton mosaic disease. Attacks are common during the dry season, and usually recede with the onset of rains.

What to do:

- **Whiteflies are attacked by parasitic wasps and predators. Conservation of these natural enemies is important.**

Whiteflies
Whiteflies (*Bemisia tabaci*) under leaf. Adult whiteflies are about 1mm long.

© Clemson University, Department of Entomology
More Information on Whiteflies

- **Yellow sticky traps are useful for monitoring whiteflies, and may help to control low populations.**
- **3% potassium soap in acute cases**
- **Plant traps: Lablab niger; Trichogramma chilonis Ishii; Brinckochrysa scelestes**

Leafhoppers or Jassids (*Empoasca* spp)

Adult leafhoppers are small (2 to 3 mm long), long and thin. The wings are held roof like over the abdomen. They are pale green to yellowish green in colour, shiny and more or less transparent. The legs are slender with bristles. The nymphs resemble the adults but are smaller and do not have fully developed wings. Adults and nymphs suck sap from the leaves, remaining on the underside during the day, but also moving to the upper surface during the evening; when disturbed they run sideways rapidly to reach a shady part of the host plant.

Leafhoppers Leafhopper. Adults are small, about 2.5 mm long. Picture shows *Empoasca fabae*.

© Steve L. Brown, University of Georgia, Bugwood.org

Feeding by leafhoppers causes discolouration, and leaf curl, the outer zone of the leaf turn yellow to reddish and whiter later. Heavy leafhopper infestation may retard plant growth and cause severe yield losses. Cotton fields attacked by leafhoppers are easily recognisable form some distance, owing to their reddish or purple colour ("hopperburn").

What to do:

- **Use resistant varieties. A number of very hairy varieties have been bred, which are considerable less prone to leafhopper**

attack than those varieties whose leaves are not or only sparingly covered with hairs. By planting such resistant varieties damage by leafhoppers can be avoided to large extent. In Tanzania, the release of the Ukiriguru varieties resistant to leafhoppers and to bacterial blight played a major role in the increase in annual crop production.

- **Early sowing helps if the cotton plants have past the most susceptible plant stage during the period after the rainy season, when leafhopper population is at its peak.**
- **Repellent plant extracts from: neem, chilli, garlic and Lantana camara**

The cotton leaf roller (*Haritalodes (Sylepta) derogata*)

The moths are about 15 mm long with a wingspan of 25-30 mm. They are yellowish-white with black and brown spots on the head and thorax and a series of dark-brown wavy lines on the wings. Caterpillars are dirty pale green and semi translucent and up to 30 mm long when fully grown. Moths lay eggs on the underside of leaves. Young caterpillars feed initially on the underside of leaves, but older caterpillars spin or roll leaves together, and eat the leaf margins, causing the leaves to curl and droop. They pupate in the leaf roll or in debris on the ground.

The leaf roller is a common pest, which may cause considerable local damage. In extremes cases, the cotton plants may be almost completely defoliated, as a result the growth of the plants is stunted, and the bolls ripe prematurely leading to yield

Leaf roller
Caterpillar of the leaf roller (*Haritalodes derogata*)

reduction.

What to do:

- **The leaf roller is usually controlled by natural enemies, particularly parasitic wasps, spiders and praying mantis.**
- **Removal and destruction of eggs, caterpillars, pupae and rolled leaves help to reduce damage.**

Spider mites (*Tetranychus* spp; cotton red mite *Oligonychus gossypii*)

Spider mites feed on the lower surface of leaves. Adults are about 0.6mm long. As a result the leaf surface appears tan or yellow and the upper surface has a speckle or mottled appearance. A close inspection of the lower leaf surface shows the mites as tiny moving greenish or reddish speckles. Heavily infested leaves turn yellow, curl up, dry and are shed. Mites produce large amount of webbing. In heavy infestations a fine web may cover the leaves. Plants may die when infestation is severe, particularly in hot dry conditions.

What to do:

- **Provide good plant growing conditions, in particular enough water; water stressed plants are prone to mite damage.**
- **Avoid the use of broad-spectrum pesticides, which kill natural enemies and may result in outbreaks.**
- **Avoid planting next to infested fields.**

Spider mites
Spider mites *Tetranychus* spp; cotton red mite *Oligonychus gossypii*) on cotton leaf. Adults are about 0.6mm long.

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More Information on Spider mites

- **Sulphur preparations**

Bollworms (*Helicoverpa armigera*, *Earias spp* and *Pectinophora gossypiella*)

Bollworms are among the most serious cotton pests. They feed in the bolls, damaging lint and seed and causing considerable reduction in yield and quality. The main bollworms are the African bollworm (*Helicoverpa armigera*), spiny bollworms (*Earias* spp) and the pink bollworm (*Pectinophora gossypiella*). Caterpillars of the false codling moth (*Cryptophlebia leucotreta*) are sometimes found boring in the bolls.

The African bollworm (*Helicoverpa armigera*) bores into the boll often with the hind part of the body exposed outside the boll. If younger bolls are attacked they normally show a yellowish colour and the bracteoles open out (flared square). One caterpillar can damage a number of bolls and buds by moving from one to the other. Infested bolls and buds drop prematurely.

2) Spiny bollworms (*Earias biplaga* / *Earias insulana*)
The adults are moth, about 12 mm long with a wingspan of about 20-22. The forewings are white, peach, metallic green to straw yellow in colour according to the species. Fully-grown caterpillars are up to 18 mm long. Their body bears numerous fleshy spines. Caterpillars vary in colour from brown and deep orange to grey and yellow. Caterpillars bore into flower buds, young shoots and maturing bolls. Hollowed tender shoots

African bollworm
Larvae of African bollworm (*Helicoverpa zea*) feeding on cotton.

© Clemson University, www.insectimages.org



African bo... **Spiny boll...** **Pink bollw...**

More Information on African bollworm

whither and die.

3) The pink bollworm (*Pectinophora gossypiella*)
The moths are small (about 8-9 mm long) with grey brown or brown forewings covered with dark spots. The hind wings are whitish, broader than the fore wings, and have a long fringe on the posterior margin. The pink caterpillars are up to 15 mm long and have two broken transverse red bands on each segment of the body. This is usually a late season pest.
The caterpillars bore into the flower buds and young bolls causing shedding. Caterpillars feeding on flowers spin the petals together, causing the formation of what is called "rosette flowers" which do not open up. The bolls open prematurely and may also rot or drop to the ground. The most important damage is caused by caterpillars penetrating bolls, where they feed on the seeds and soil the lint with frass and excrements. The pest is carried over to the next season and crop as a diapause-caterpillar mainly within the cottonseeds.

What to do:

- **Practise field hygiene. Remove and destroy old crops and plant debris after harvesting or let cattle graze in the field after the picking is over.**
- **Crop rotation with plants not related to cotton (avoid kenaf, okra, abutilon and other malvaceas) may help to reduce attack by the pink bollworms and the spiny bollworm, but it is unlikely to be effective against the African bollworm, since this pest feed on many different plants.**

- **Mixed cropping helps to reduce attack by bollworms; plant composition and combinations are important to optimise the benefits. Some plants may act as trap crops and/or may attract natural enemies that will then predate on bollworms.**
- **In Tanzania, early sowing of Ukiriguru varieties is strongly recommended. These varieties have the ability to compensate for early crop loss of fruiting points caused by either physiological stress or by the African bollworm, provided soil moisture and nutrients are not limiting. Thus, the early sown cotton (sown between the end of November and end of December) may lose its bottom crop, but can compensate later by producing a crop during the main rains in March-April. If bollworms attack later, then the early sown crop would have set its main crop and will therefore escape damage (Nyambo et al., 2003).**
- **Encourage natural enemies like ladybird beetles, lacewings, spiders etc.**
- **Direct control measures are spraying with neem spray or a garlic-chilli-onion-repellent and Bt. For more information on neem click here. For information on Bt click here**
- **In Malawi and Zimbabwe, thresholds based on egg numbers have been used successfully in cotton since 1961. Spraying was recommended at an average of one egg per two plants in twice-weekly counts. In the Sudan Gezira, over two eggs or caterpillar per 18 plants, and in Australia two eggs per metre of row were used as thresholds (CABI, 2000). It has been argued that control thresholds based on damage are easier to use and more economical than those based on pest density. In the case of cotton, damaged buds are easier to detect and**

sample than either eggs or small caterpillars. Studies in Tanzania indicate that spraying at damage threshold of 10 to 20% would give adequate protection to the crop. Further fine-tuning of damage thresholds should be concentrated during the first four weeks of flowering when most of the damage by this pest occurs. (Kabissa, 1989).

- **Bollworms can also be removed by hand picking. This helps when their numbers are low and in small fields.**

Cotton stainers (*Dysdercus* spp.)

Several types of bugs attack cotton. They are late season pests; they usually attack during the flowering and fruiting stages of the crop. The most important are the cotton stainers.

Stainer bugs are between 14 and 24 mm long. They are bright red, yellow or light grey with an orange tinge depending on the species, and with black bands. Stainer bugs are late season pests; they appear when the bolls are ripening. Female lay whitish yellow eggs in moist soil or in crevices in the ground. They hatch to produce reddish-orange nymphs. Initially the nymphs are wingless, but wings develop gradually as the nymphs grow.
The nymphs are found together in the area where the eggs have been laid and later disperse to look for food. Both nymphs and adults feed on the bolls, but adults cause the most serious damage. They pierce through the boll and suck the seeds reducing germination capability and the quality of the seed oil

Cotton stainer
Cotton stainer (*Dysdercus* spp.) nymphs (two to the left) and an adult cotton stainer.

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and the cake.

Furthermore, they cause severe indirect damage by transmission of a fungus (*Nematospora* sp.), which leads to internal boll rot and stain of the lint with typical yellow colour, hence the name 'cotton stainers'. The nymphs feed mainly on seeds in open bolls reducing the seeds's oil content and their germination capacity. Severe bug attack affects yield, oil content and the marketability of the crop.

What to do:

- **Cotton stainers are attacked by a range of natural enemies; the most important are assassin bugs, ants, spiders, birds and parasitic flies.**
- **Caging chickens in cotton plots using chicken wire may control cotton stainers; about 15 birds will keep about 0.1 ha free of stainer bugs. This is a good option for small plots grown next to the homestead.**
- **Preventive control measures are sanitation; remove cotton plants and all its debris as well as ratoon cotton as soon as harvesting is over. Keep stores clean. Cotton should be grown strictly as an annual with a close (dead) season. Hand pick and destroy the bugs, this is feasible in small plots and at the beginning of infestations, and will help to reduce population density.**
- **Custard apple leaf extract is recommended for control of these bugs (PAN).**
- **The baobab tree is one of the main host plants of stainer**

bugs. If cotton is grown where baobab occurs, the soil and trunk of the baobab tree should be sprayed to kill the nymphs hatching from eggs laid around the stem.

- **Tanzania: Pyrethrum formulation with black wattle extract as UV light stabilisator**

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back to Index

Information on Diseases

General Information

Diseases in cotton are of less importance than pests. The most common diseases are bacterial blight (*Xanthomonas axonopodis* pv. *malvacearum*) and *Fusarium* wilt (*Fusarium oxysporum* f.sp. *vasinfectum*).

Examples of Cotton Diseases and Organic Control Methods

Bacterial blight (*Xanthomonas axonopodis* pv. *malvacearum*)

Bacterial blight

The disease attacks seedlings, leaves, stems and bolls. Seedling attack, usually called seedling blight, results in small, round, water-soaked spots on the cotyledons as they emerge from the seed coat. The spots furnish inoculum (disease source) for the developing true leaves. Leaf spots are translucent, water-soaked, angular and bordered by veins. Affected leaves become browned and blackened. Spread of the bacteria along leaf veins is

commonly called vein blight. Affected veins appear black. Younger leaves are more susceptible to vein blight than mature, old leaves.

In older plants black lesions may develop on the stems. These lesions girdle the stem and may cause breaking of the stem when windy. This symptom is known as black arm. Infected bolls have round, shiny lesions, which later become sunken, browned and finally blackened. Infected bolls become deformed and open prematurely. Fibre in diseased bolls is usually stained.

The disease is carried over season to season on infected crop debris and diseased seeds. Spread of the disease is through use of infected seeds and in the field by wind-blown rain water.

What to do:

- **Plant resistant varieties (e.g. Albar 51; Albar G501; BPA; BP 52; SATU; S 2950)**
- **Use disease-free seeds**
- **Practise crop rotation of at least 3 years with cereals or legumes**
- **Practise good field sanitation**

Bacterial blight blackening of veins (here on okra)

Fusarium Wilt (*Fusarium oxysporum* f.sp. *vasinfectum*)

The earliest symptoms on seedlings and young plants are the yellowing and browning of cotyledons and leaves. The affected

parts finally die and fall off. The bare stem blackens and dies.

In older plants symptoms are stunting, followed by leaf yellowing, wilting and dropping of most of the leaves. A characteristic symptom is the browning and blackening of the woody tissue below the bark. When a stem or branch is cut crosswise, brown discolouration is usually seen in a ring just beneath the bark. The wilt fungus survives in the soil and it is also seed-borne. Infection is often associated with nematodes.

What to do:

- **Plant resistant varieties (e.g. UK 61; UK 77; UK 91)**
- **Use disease-free seeds**
- **Liming of the soil may help to reduce wilt incidence**
- **Crop rotation is not effective in controlling Fusarium wilt but it may reduce nematode population in the field. Nematodes are associated with Fusarium wilt as they cause injury to the roots and therefore facilitate Fusarium infection.**

Fusarium wilt
Wilting (here of okra plant) due to Fusarium wilt

More Information on Fusarium wilt

Anthracnose (*Glomerella gossypii*)

It is caused by the fungus *Glomerella* (*Colletotrichum gossypii*). It is the primary cause of seedling blight, boll rot and fibre deterioration (staining) in all humid cotton growing areas. Seedlings affected by blight are killed before or after they emerge (damping-off).
Symptoms of seedling blight on cotyledons are usually diseased

areas on margins or small reddish or light coloured spots. Diseased seedlings show reddish-brown lesions below ground. The lesions may be on one side of the stem or they may surround it and extend down the root. On the bolls the disease appears as small, round, water-soaked spots, which enlarge, become sunken and brownish in colour. In wet weather, the spots are covered with a sticky mass of fungal spores pinkish in colour.
Boll infection is often associated with wounds made by boll weevils. The lint and seeds are rapidly invaded once the disease gets through the husk of the boll. Affected lint is stained.
The disease survives on old rotten bolls, crop refuse in the field and on the seeds. It is spread on diseased seeds. Infection is favoured by moderate temperatures and high moisture.

Anthracnose
Anthracnose (*Glomerella gossypii*) on cotton bolls (*Gossypium hirsutum*)

© Jürgen Kranz (Courtesy of EcoPort, www.ecoport.org)
More Information on Anthracnose

What to do:

- **Use disease-free seeds**
- **Practise crop rotation**
- **Practise good field hygiene**

Ascochyta blight (*Ascochyta gossypii*)

The disease is caused by fungus *Ascochyta gossypii*. It may manifest as seedling blight, a leaf spot, a stem canker, and as a boll spot. The first symptoms are small, round, white, purple-ringed spots on the cotyledons and lower leaves. The spots become somewhat elongated and raised on the upper surface.

Later they change to a light brown, the purple ring around the outside disappears, and the diseased tissue often falls out. The upper small leaves, petioles and buds are often infected, and the plant dies. The almost bare stems, with a few small leaves at the tip, are characteristic of the disease at the later growth stages.

Stem infection, which occurs only during consecutive days of cloudy, wet weather, leads to the formation of lesions, which may reach several centimetres in length, with cracks and ragged edges. The centre of these lesions becomes pale, liver-coloured and covered with tiny black dots (bodies of fungal spores, conidiomata). Cankers may encircle the stem and kill the distal parts. Flowers are not attacked, but mature lint can be destroyed. Lint may show a grey discolouration with conidiomata in half-opened bolls.

The disease is favoured by long periods of rain and cool weather. It is also seed-borne.

Ascochyta blight
Ascochyta spots (here on snowpea leaves)

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What to do:

- **Use disease-free seeds**
- **Practise crop rotation with crops non-related to cotton (e.g. cereals)**
- **Practise good field sanitation and cultivation practices which destroy drop residues are also recommended**

Damping-off diseases

Cotton seedlings are subject to attack by several fungal and bacterial diseases. These include the anthracnose fungus (*C. gossypii*), Ascochyta blight (*A. gossypii*), wilt fungus (*F. o.* f.sp. *vasinfectum*), bacterial blight (*X. a.* pv. *malvacearum*), *Pythium* spp. and *Rhizoctonia solani*.

More Information on Damping-off diseases

The latter is particularly serious where soil temperatures are low and wet weather prevails at planting.
***Rhizoctonia solani* causes sore shin disease of cotton seedlings. Attacked seedlings develop dark to reddish-brown cankers on the stems near the soil line. The cankers encircle the stems or penetrate so deeply that the plants fall over and die.**

What to do:

- **Use disease-free seeds**
- **Avoid planting during cold, wet weather**

African cotton mosaic disease

The disease causative agent is still unknown but it is associated to whitefly-transmitted geminiviruses, based on symptomatology typical of begomoviruses and the demonstration of its transmissibility by the whitefly *Bemisia tabaci*. The disease is widespread in Africa south of the Sahara. Disease symptoms include irregular leaf mottling (chlorotic patches), reduced flower production, boll shedding and stunting of infected plants.

What to do:

- **As with most insect-vectored plant viruses, the disease pressure may be reduced by**

routine sanitation practices.

- **Also remove infected residues; this helps to reduce disease inoculum (source) and assists in lowering vector populations**
- **Remove seasonal weeds adjacent to cotton fields and ditch banks in irrigated areas**

Cotton leaf curl bigeminivirus

Leaves of infected cotton curl upward or downward often accompanied by foliar discoloration and mosaic. These leaves may bear leaf-like enations (growth) on the underside along with vein thickening. Plants infected early in the season are stunted and yield is reduced drastically. The virus is transmitted by whiteflies (*Bemisia tabaci*).

What to do:

- **Plant resistant varieties (e.g. B6L; L1530; XL1; X1730A)**
- **Eliminate weeds in and near cotton fields. This may have some advantage in reducing virus and insect vector reservoirs**

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back to Index

Information Source Links

- **Acland, J.D. (1980). East African Crops. An introduction to the production of field and plantation crops in Kenya, Tanzania and Uganda. FAO/Longman Publication. ISBN: 0 582 60301 3.**
- **Bohlen, E. (1973). Crop pests in Tanzania and their control. Verlag Paul Parey. Federal Agency for Economic Cooperation. ISBN: 3-489-64826-9.**
- **CAB International (2006). Crop Protection Compendium, 2006 Edition. Wallingford, UK**

www.cabi.org
- Eyhorn, F., Ratter, S.G., Ramakrishnan, M. (2005). Organic Cotton Crop Guide - A manual for practitioners in the tropics. Research Institute of Organic Agriculture (FibL). www.fibl.org
- Kabissa JCB, 1989. Evaluation of damage thresholds for insecticidal control of *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) on cotton in eastern Tanzania. Bulletin of Entomological Research, 79(1):95-98.
- Naturland e.V. (2004). Organic Farming in the Tropics and Subtropics. Exemplary description of 20 crops. Cotton. www.naturland.de
- Nyambo, B. T., Varela, A. M., Seguni, Z., and Kirenga G. (2003). Integrated Pest Management in Tanzania. In Integrated Pest Management in the Global Arena. Eds. K. M. Maredia, D. Dakouo and D. Mota-Sanchez. Chapter 13. PP. 145-155. ISBN: 0-85199-652-3.
- Online Information Service for Non-Chemical Pest Management in the Tropics (OISAT) www.oisat.org
- Puri, S. N., Sharma, O. P. Murthy, K. S. and Raj, Sheo. (1998). Hand Book on Diagnosis and Integrated Pest Management of Cotton Pests. National Centre for Integrated Pest Management, Pusa Campus, New Delhi, India. NCIPM.
- Schmutterer, H. (1978). Cotton pests in the Philippines. GTZ. ISBN: 3-88085-064-X.

back to Index

---

vegetables
African Nightshade
Amaranth
Avocados
Bananas
Beans
Cabbage/Kale, Brassicas
Carrot
Cashew
Cassava
Citrus plants
Cocoa
Coconut
Coffee
Cotton
Cowpea
Cucumber
Eggplant
Green gram
Groundnut
Maize
Mango
Millet
Okra

more Images

Rice
Scientific name: *Oryza sativa*
Order/Family: Cyperales: Poaceae
Local names: Swahili: mchele / mpunga (upland rice)
Pests and Diseases: African armyworm African gall midge Bacterial leaf blight Blast Brown leaf spot Case worm Damping-off diseases Flea beetles Hispid beetles Leafmining flies (leafminers) Purple witchweed Rice sucking bugs Rice whorl maggots and leafminers Rice yellow mottle virus Root-knot nematodes Spotted stemborer Stalk-eyed shoot flies Storage pests Termites White tip nematode

General Information and Agronomic Aspects Information on Diseases
Information on Pests Information Source Links

General Information and Agronomic Aspects

Geographical Distribution of Rice in Africa

The cultivated rice is an annual grass. Depending on the degree of sensitivity to light its growth duration may range from 60 to more than 200 days. Cultivated rice belongs to two species, *Oryza sativa* (which is more widely used) and *Oryza glaberrima* - an African rice. Rice is grown in four ecosystems, which are broadly defined on the basis water regimes. The ecosystems are irrigated, rain-fed lowland and upland, and flood prone.

- Onion
- Papaya
- Passion fruit
- Peas
- Peppers
- Pigeon pea
- Pineapple
- Potato
- Pumpkin
- Rice
- Sesame
- Sorghum
- Soybean
- Spider plant
- Spinach
- Sugarcane
- Sweet potato
- Tea
- Teff
- Tomato
- Wheat
- Yam
- Zucchini/Courgette

- Pests/ diseases/ weeds

Uses

Rice is cultivated primarily for the grain, which is a main staple food in many countries, especially in Asia. In Kenya it is becoming increasingly popular, especially in urban centres. Kenya has a yearly production of about 100,000 metric tons. In 2003, this amount made up 60% of rice consumption in Kenya, in 2006 same amount of rice only covered about 30 % of consumption. This increase in demand and the development of new upland varieties have created an oppurtunity for farmers to venture into rice growing.

Rice will give the same or better yield as maize and fetch the double price on the market at harvest time. Grains are quite nutritious when not polished. Common or starchy types are used in various dishes, cakes, soups, pastries, breakfast foods, and starch pastes; glutinous types, containing a sugary material instead of starch, are used in the Orient for special purposes as sweetmeats. Grain is also used to make rice wine, Saki, much consumed in Japan. Rice hulls are sometimes used in the production of purified alpha cellulose and furfural (an industrial chemical derived from a variety of agricultural by-products, and commonly used as a solvent). Rice straw is used as roofing and packing material, feed, fertiliser, and fuel.

Climate conditions, soil and water management

Rice thrives on land that is water saturated or even submerged during part or all of its growth. Optimal temperatures for rice growing are 20 to 37.7°C, and no growth occurs below 10ºC. Optimal pH is between five and seven, though rice has been grown in fields with pH between three and ten. Rice will grow in altitudes ranging from 0 to 2500 m above sea level, but world wide is mostly grown on the humid coastal lowlands and deltas. Aquatic rice may require a dependable supply of fresh, slowly moving water, at temperature of 21 to 29°C. Rain fed rice requires an average of 800 to 2000 mm of rainfall well distributed over the growing season. If rainfall is less than 1250 mm annually, irrigation is used to make up deficit. The crop is salt tolerant at some stages of growth; during germination but not seedling stages and has even been grown to reclaim salty soils. Terrain should be level enough to permit flooding, yet sloped enough to drain readily. The soils on which rice can grow are as varied as the climatic regime it

Medicinal plants
Fruit and vegetable processing
Natural pest control
Cultural practices

tolerates, but ideally it prefers a friable loam overlying heavy clay, as in many coastal and delta areas.

Propagation and planting

Seedling production. Steps for producing healthy seedlings:

1. Seed selection. Select plump and healthy seeds.

2. Seed pre treatment. This is practised in order to secure better germination of seeds and better growth of seedlings. It involves:

- **Seed disinfection. Hot water treatment is effective in destroying the nematode *Aphelenchoides besseyi*, which causes the white tip disease. For more information on hot-water treatment click here**
- **Seed soaking. To supply the required moisture for germination, to shorten germination period and reduce seed rotting. During the soaking period change water to remove poisonous substances and allow entry of fresh air.**
- **Pre-sprouting. The seeds are drained and covered with grass for 24 to 48 hours. This ensures uniform seed germination, avoids over sprouting and allows air circulation for germination**

3. Sowing:

- **Sowing 80 to100g/m² is normal practice**
- **Broadcast seed uniformly**
- **Do not submerge the nursery bed after sowing**
- **Use a seed rate of about 20kg/acre**

4. Seed bed preparation (nursery):

- **Plough at least two weeks before sowing and flood**
- **Puddle one week before sowing and prepare raised nursery bed**
- **Drain the nursery bed the day before sowing to stabilize the surface of the soil**
- **If the soil covering the nursery bed is too soft, sown grains are buried into the soil resulting in poor establishment**
- **For one ha of transplanted rice, a nursery of about 350 m² is required**
- **Irrigate a few days after sowing so that the surface is kept moist, and as the seedlings emerge keep submerged conditions with water controlled at 1 to 3 cm according to growth of seedling.**
- **Raise the water level to 10 cm one day before uprooting to ease washing off of soil that sticks to roots. This will make transplanting easy.**

Main land preparation

a) Under Irrigation: Land preparation is carried out by flooding the fields to a depth of 10 cm) and then cultivating them by use of tractor (40 to 75hp) equipped with rotavators. Good timing and quality of land preparation will influence the growth of rice. Poor and untimely land preparation will cause serious weed problems and expose plants to harmful substances such as carbon dioxide and butyric acid, released by decaying organic matter in the soil.

It is recommended that land should be tilled and immediately flooded at least 15 days before transplanting or direct sowing. The purposes of this are:

- **To save the seedling from the effect of high concentration of harmful substances generated by decomposing organic matter rotated into flooded soils.**
- **To prevent loss of nitrogen released by decomposing organic matter through denitrification. The ammonia released during decomposing of organic matter is conserved because ammonia is not converted to nitrate due to the absence of oxygen in the soil. This ammonia is later utilized by the rice plant.**

b) Under rainfed situation: Land should be ploughed twice and harrowed once.

Transplanting
It is important to transplant from the nursery as soon as the seedlings are big enough. Seedlings are said to be ready for transplanting after a period of between three to four weeks depending on daylight, temperatures and the variety. "Basmati 217" will be ready for transplanting 25 days after sowing (4.5 to 5 leaf stage); "BW 196" and others at 28 to 30 days after sowing (5 to 5.5 leaf number).

Spacing: Seedlings are spaced according to the tillering ability of a variety. "Basmati 217" should be planted at 20 cm x 10 cm, "BW 196" and others at 20 x 20 cm.
Seedling number per hill: Two to three for "Basmati" and other low tillering varieties. For "BW 196" one to two seedlings per hill are more suitable for good rooting and tillering. Higher seedling rates increase competition for the available nutrients, hence should be discouraged.

Planting depth: Practice shallow planting of about three cm depth for vigorous initial growth will result in good rooting and tillering. Deep transplanting delays and reduces tillering resulting in a non uniform crop growth and ripening, consequently resulting in yield losses.

Seedlings should be transplanted in an upright position to allow correct tillering and rooting.

Direct sowing method: Trials have been done on direct sowing and have showed that the same level of yields performance as those of transplanting system can be obtained. This method saves substantially on labour input. However it has some disadvantages such as uneven germination rate and more weeding work in the paddy field.

Planting under rainfed conditions: Planting should be done before the onset of the long rains. Farmers are advised to use certified seed and appropriate variety for the region. Drill seed in

rows at the rate of 50 kg/ha with a spacing of 25 cm for short varieties and 35 cm for tall varieties. In case of broadcasting, 75 kg/ha is often used.

Main field water management

Water is applied to the rice field for the use of the rice plant and also for suppressing weed growth. For this reason, it is important to practice appropriate water management throughout the growing period of a rice crop.

In lowland rice fields, water comes from rainfall and irrigation. Water is lost by transpiration, evaporation, seepage and percolation. Prevent water loss by:

- **Repairing levees to minimise seepage**
- **Removal of weeds to avoid competition with rice plants for water**
- **increasing the height of levees to prevent surface run-off water**

Critical stages when water is required in large quantities are:

- **For a period of three to seven days after transplanting cover the crop up to 80% of its height. This reduces transpiration and gives the plants a chance to re-establish their roots to be able to take up enough water from the soil**
- **From the stage of booting to 14 days after heading, more water is required because the shedding of pollen and the process of fertilization requires very high moisture content in the air. Low moisture content in the air leads to sterile spikelets.**

Seven to ten days before harvesting, drain the field to harden the soil for good harvesting and also to hasten the drying and ripening of the rice grains.

Varieties in Kenya

"Sindano", highly susceptible to Rice Yellow Mottle Virus (RYMV) and Basmati 217 highly susceptible to blast have been grown since the 1960s. Since then alternative varieties of both irigated rice and rain fed rice have been identified.

Varieties of irrigated rice and their characteristics:

Variety	Height in cm	Maturity days	Yield t/ha	Cooking quality	RYMW2	Blast
"Basmati 217"	118	122	4.6	Very good	Resistant	Susceptible
"Basmati 370"	118	122	5.3	Very good	Resistant	Susceptible
"IR 2035-25-2"	86.2	128	5.5	Good	Moderately susceptible	Moderately resistant
"IR 2793-80-1"	89	142	6.4	Good	Susceptible	
"BW 96"	68	135	9.0	fair	Susceptible	Moderately resistant
"UP 254"	84.2	124	6.4	Good	Moderatley susceptible	Moderately resistant
"AD 9246"	78.2	128	5.1	Good	Moderately resistant	Moderately suscepbible
"IR 19090"	96.6	122	5.8	Good	Moderately susceptible	Moderately resistant

Varieties for lowland (swampy) zones	Varieties for Upland (dry land) zones
"Ci cong Ai"	"Dourado Precose"
"TGR 78"	"2051 A 233/79"

"IR 2793-80-1"	"TGR 94"
"BW 196"	"WAB 181-18"
"WaBis 675"	"Nam ROO"
	"Nerica" (New Rice for Africa)

The upland variety "Nerica" was developed by IRRI. It is resistant to Blast, RYMV stemborers and leafminers. It is high yielding and is doing well from West Africa to Uganda. It is now also being promoted by NIB (National Irrigation Board), Kenya, KARI and JICA. In Kenya it has great potential for medium altitudes with high rainfall or possibility for irrigation. "Nerica" can be planted as other small grains, but does need irrigation especially during flowering, and fertilisation.

Husbandry

Crop rotation

Continuous rice monoculture systems results in decline in soil fertility due to over dependence on chemical fertiliser, and deterioration in physical properties of the soil like texture and microbial existence.

To improve the situation, trials have been carried out on many potential rotation systems. Soybeans and green grams have shown a lot of potential in alleviating the problem. Such legumes can be cultivated during off-season at the time the land used to lie fallow. Crop rotation with bananas or sugarcane is another possibility.

Natural fertilisers commonly used in rice production are rice straw, rice ash, stable manure, buffalo dung, green manure, natural manure, rock phosphate, gypsum etc. The needs of nitrogen varies with varieties. In Kenya, commonly about 80kg N/ha is recommended, along with 58 kg P2O5 (Mwea irrigation scheme). However, the National Irrigation Board (NIB) has found that planting soybean or green gram in the fallow season can halve the need for nitrogen. They further recommend composting of rice straw and manure to further cut down on chemical fertilisers. In organic growing, phosphorous can be applied as rock phosphate, and nitrogen

through green manure legumes, which fix the nitrogen from the atmosphere.
See also Mwea Rice Production Manual available from NIB.

Harvesting

Time from planting to harvesting varies between four to six months. Rice is cut, swathed and threshed from windrow. In the tropics it is essential to harvest the crop on time, otherwise grain losses may result from feeding by rats, birds, insects and from shattering and lodging. The crop should be ready to harvest when 80% of the panicles are straw dust coloured and the grain in the lower portion are in the hard dough stage. In a well-grown crop the grain matures evenly and can be harvested in one operation. Cutting can be done with a sickle. The cut stems are bundled for transport to the threshing place, where final drying to around 12% moisture takes place before threshing and storage.

back to Index

Information on Pests

The African gall midge (*Orseolia oryzivora*)

It is a small reddish-brown midge (similar to a mosquito) 4 to 5 mm long. Females lay up to 300 eggs on rice leaf sheaths. Upon hatching, the small maggots wiggle down to the leaf blade and move between the leaf sheath and the stem until the growing points where they feed for 2 to 3 weeks. Larval feeding induces development of light swellings or galls, which are inconspicuous until larvae are ready to pupate. The galls are long cylindrical,

African gall midge
African gall midge (*Orseolia*

about 3 mm in diameter and from a few cm up to 1 to 1.5 m long. They are often silvery white and resemble an onion leaf, hence they are generally known as 'silver shoots' or 'onion leaf galls'.

Galls generally appear about 20 to 40 days after the crop has been transplanted. Gall midges can cause serious damage from the seedling stage to panicle initiation. Attacked tillers do not produce panicles. Galled plants may tiller profusely to compensate for loss of growing points. A serious attack results in stunted plant growth and poor yields. Gall midges do not attack rice plants that have matured beyond tillering stage. These midges spent some generations on wild grasses and then move to attack young rice plants. They are pests during the rainy season, and are most serious on rainfed lowland and irrigated rice.

What to do:

- **Destroy alternative host plants such as rice ratoon crop, volunteers and wild red rice or longstamen rice (Oryza longistaminata)**
- **Destroy stubble after harvest**
- **Plant resistant and early maturing varieties. Varieties tolerant to the rice gall midge released in West Africa include "Cisadane", "BW 348-1" and "Leizhung". "NERICA L-25" was found to be moderately resistant to this pest in Nigeria. The Oryza sativa japonica sub-species "TOS 14519" has shown moderately resistant to the gall midge across West Africa (WARDA). Embark on early and synchronised planting. Rice**

***oryzivora*), onion shoot galls on rice.**

fields planted early are less likely to suffer serious damage than those planted late

- **Avoid close spacing since it provides a suitable micro-environment for the survival of this pest.**
- **Conserve natural enemies. Parasitic wasps (Aprostocetus procerae and Platygaster diplosisae) are very important in the natural control of the African rice gall midge. These wasps provided an important check to pest populations, especially late in the season. However, the wasp populations usually build up too late to prevent heavy gall midge infestation.**
- **Habitat manipulation such as dry-season cultivation to encourage Paspalum grass (Paspalum scrobiculatum) abundance early in the wet season is suggested as a way of improving the natural biological control of the rice gall midge. Paspalum grass is attacked by a different gall midge, which does not attack rice but is an alternative host for the parasitic wasps. The carry-over of parasitic wasps from gall midges attacking Paspalum grass to the rice field early in the season, could improve the natural control of the rice gall midge. The combination of growing gall midge tolerant varieties with Paspalum grass management at the edge of rice fields had significantly increased farmers? yields (WARDA)**

Rice-sucking bugs, stink bugs (*Aspavia* spp, *Nezera viridula*), and Alydid bugs (*Mirperus* spp.and *Riptortus* spp.)

Stink bugs produce a strong odour when disturbed. Adult Aspavia bugs are brown bugs with a large triangular shield on the

back having three yellow spots and a spine at each side of the thorax. *Nezera viridula* is green and about 1.2 cm long. Alydid bugs have a long slender body and lack a triangular shield on the back. Riptortus is stout and varies from light to dark brown; the hind legs are enlarged.

Both nymphs and adult bugs feed sucking rice grains in the milky stage. When grains have ripened the bugs feed on panicle stalks and pedicels. Riptortus bugs also feed on hard dough rice grains. Bug feeding causes pecky rice that is partially or wholly stained due to infections with bacteria and fungi. The glumes change colour first to light brown, then darker and may turn grey in severe cases. Damage grains are shrivelled and unfilled. Severity of the damage depends on the stage of grain development and on the number of punctures in the grain.

Green stink bug
Green stink bug (nymphs and adults). Adults are about 1.2cm long. (Host: Pearl Millet)

© Russ Ottens, University of Georgia, Bugwood.org

What to do:

- **If necessary spray plant extracts. A number of plants (lantana, garlic, oleander, African marigold, blackjack, goat weed, wormseed, among others) are reported as effective against various species of bugs (Elwell and Maas, 1995).**
  Pyrethrins are recommended for control of sucking bugs in organic production in USA (Layton, 2004).

Storage pests (*Sitophilus oryzae*, *Rhyzopertha dominica*

The most serious pests of stored rice are the rice weevil

(*Sitophilus oryzae*) and the lesser grain-borer (*Rhyzopertha dominica*). Good store hygiene plays an important role in limiting infestation by rice weevil.

What to do:

- **Remove infested residues from last season's harvest**

Rice weevil
Rice weevil (*Sitophilus oryzae*)

More Information on Storage pests

Rice root-knot nematode (*Meloidogyne graminicola*)

Symptoms consist of characteristic hooked-like galls on roots, newly emerged leaves appear distorted and crinkled along the margins, and infested plants are stunted and yellow. Heavily infested plants flower and mature early. The rice root-knot nematode is a damaging parasite on upland, lowland and deepwater rice. It is well adapted to flooded conditions and can survive in waterlogged soil as eggs in egg-masses or as

Root-knot nematodes

juveniles for long periods.

Numbers of nematodes decline rapidly after four months but some egg masses can remain viable for at least 14 months in waterlogged soil. This root-knot nematode can also survive in soil flooded to a depth of one m for at least five months. It cannot invade rice in flooded conditions but quickly invades when infested soils are drained. It can survive in roots of infected plants. It prefers soil moisture of 32%. It develops best in moisture of 20% to 30% and soil dryness at rice tillering and panicle initiation. Its population increases with the growth of susceptible rice plants.

What to do:

- **Practice crop rotation with crops that are resistant or poor hosts of the rice root-knot nematode (e.g. castor, cauliflowers, cowpea, common beans, groundnut, maize, onion, sesame, soybeans, sunflower and sweet potatoes). Long rotations, greater than 12 months, will be needed to reduce nematode soil populations to low levels. Rotation crops like marigold (Tagetes sp.) are also effective in lowering root knot nematode populations because of its nematicidal properties.**
- **Amend soil. Experiments with organic soil amendments such as leaves of chrysanthemum, neem and marigold, and oil cakes of sesame, neem and coconut oil cakes, incorporated at the rate of 0.12%, 0.50% and 1.00% (w/w), showed that these amendments decreased root knot severity, caused**

Root-knot nematode (*Meloidogyne graminicola*) infestation in rice field

© Roger Lopez-Chaves, Universidad de Costa Rica, Bugwood.org


Root-knot ... **Root-knot ...**

More Information on Root-knot nematodes

reduction in nematode populations and increased seedling growth (Hossain et al.1999).

- **Introducing a fallow into the rotation will also give control of the nematodes but, to be effective, it needs to be a bare fallow free of weed hosts and is therefore impractical. However, the weed, false daisy (Eclipta alba), is toxic to the rice root-knot nematodes and could be grown and incorporated into the field soil to kill the nematodes (CABI, 2000).**
- **Water management. Continuous flooding and raising rice seedlings in flooded soils will help prevent root invasion by the nematodes.**
- **Soil solarisation and planting cover crops such as sesame and cowpea has been reported to decrease nematodes. For more information on solarisation click here**

White tip nematode (*Aphelenchoides besseyi*)

Rice is the most important host worldwide. Host plants include; strawberry, onion, garlic, sweet corn, sweet potato, soybean, sugar cane, horseradish, lettuce, millet, many grasses, orchids, chrysanthemum, marigold, Mexican sunflower, African violets, and rubber plant (*Hibiscus brachenridgii*). Feeding of the nematodes at leaf tips in rice results in whitening of the top 3 to 5 cm of the leaf leading to necrosis (described as "White Tip" of rice). There is also distortion of the flag leaf that encloses the panicle. Diseased plants are stunted, lack vigour and produce small panicles. Affected panicles show high sterility, distorted

White tip nematode
White tip nematode (*Aphelenchoides besseyi*). Left: Characteristic 'white

glumes and small and distorted kernels.

What to do:

- **Plant nematode-free seeds**
- **Plant in nematode-free areas**
- **Plant resistant rice varieties if available**
- **Treat seed with hot water. Hot water treatment of seed can be used to destroy this nematode infecting the seeds. Thermal wet treatment was the most effective at 55-60°C for 15 minutes. For more information on hot-water treatment click here.**

tip' symptom on rice leaf. Right: Necrotic patches and crinkled rice leaves.

The African armyworm (*Spodoptera exempta*)

Armyworms may cause severe defoliation in upland rice plants leaving only the stem. Armyworms are regarded as occasional pests, but during an outbreak they devastate rice crops.

What to do:

- **Monitor regularly the crop to detect small caterpillars before they cause serious damage. Look in field margins, low areas where plants have lodged, beneath plant debris around the base of plants, on the ground, and underneath the plant leaves**
- **Spray Bt or botanicals such as neem and pyrethrum extracts. Spray when caterpillars are small. Once caterpillars are mature (about 3 to 3.5 cm long) they may have cause serious**

African armyworm African armyworm (*Spodotera exempta*). Mature caterpillars measure up to 4 cm.

damage and it may no longer be economical to treat the crop. For more information on (neem click here, for pyrethrum click here and for Bt click here)

- Conserve and encourage natural enemies. For more information on natural enemies click here
- Practise field sanitation. For more information on field sanitation click here

More Information on African armyworm

Stalk-eyed shoot flies (*Diopsis* spp.)

Stalk-eyed shoot fly
Stalk-eyed shoot fly (*Diopsis* spp.). It is about 8mm long.

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The dark brown flies are about 8 mm in length, and have the eyes situated on two long stalks projecting from both sides of the head. Flies lay eggs singly on the upper surface of young leaves, or on the leaf sheath of older plants. The whitish maggots that hatch from the eggs penetrate into the growing zone (heart) of the plant. As a result of maggot feeding the central whorl does not open, but dries-up and dies, producing what is commonly known as "dead heart".

Maggots move readily from one tiller to another. One maggot can destroy up to 10 neighbouring tillers. Later generations feed on the developing flower head. Pupation normally occurs in the first three leaf sheath of healthy tillers, generally one pupa per tiller. A severe attack is likely to occur when water levels are low. Such attacks reduce yields of rice plants. Shoot fly attack rice plants early in the crop growth stage, shortly after emergence in direct-seeded fields or shortly after transplanting. They are present throughout the crop growth period, although infestation is low in

the flowering-ripening stages.

What to do:

- **Practice early and synchronised planting**
- **Manage plant spacing. There are indications that damage increase with an increase in plant density (Heinrich and Barrion, 2004).**
- **Apply calcium silicate to strengthen stem tissues.**
- **Avoid panicle harvesting (leaving tall stems) and destroy stubbles after harvest.**
- **Water management: keep basis of stems always under water.**
- **Conserve natural enemies. Spiders are the main natural enemies of these flies.**
- **The cultivars "WAB 1159-2-12-11-6-9-1-2" has been reported in Uganda to trap Diopsis thoracica larvae with their highly hairy leaves (WARDA)**

Stemborers: Spotted stemborer (*Chilo partellus*)

Several species of stemborers attack rice. The more important are the striped borer (*Chilo partellus*), *Chilo zacconius, Chilo orichalcocilielus*, the white rice borer (*Maliarpha separatella*), the yellow borer (*Scirpophaga* sp.) and the pink stemborer (*Sesamia calamistis*).
The caterpillars bore into the stem of rice plants. Caterpillars of the yellow borer bore into the stem below the growing point, destroying tillers. The white borer and the pink stemborer attack

Spotted stemborer
Spotted stemborer (*Chilo*

rice at full tillering stage preventing grains from filling up and ripening. This damage results in empty panicles known as "whiteheads". The striped borer feeding on rice plants at all stages. Young caterpillars cause "dead hearts".

What to do:

- **Practice field sanitation. Burn or feed debris to livestock after harvest.**
- **Plough and flood after harvest. These practices destroy diapausing stemborer caterpillars**
- **Practice early and synchronised planting. Synchronised planting over a large area allows the most susceptible stage of rice to escape from stemborer damage.**
- **Practice proper water management**
- **Conserve natural enemies. Wasps that parasitise eggs and caterpillars, and predators such as ants, dragonflies, assassin bugs, carabid beetles and spiders are important natural enemies of stemborers.**
- **The following cultivars are reported to be resistant to stemborers: Oryza sativa japonica sub-species: "LAC 23", "ITA 121", "TOS 4153", and upland "NERICA"s ("NERICA 1", "NERICA 2", "NERICA 4", "NERICA 5", and "NERICA 7") (WARDA).**

***partellus*)**

More Information on Spotted stemborer

The case worm (*Nymphula depunctalis / Parapoynx stagnalis*)

The case worm is a common pest on wetland rice. Moths are small (1 to 1.2 cm in wingspan)

with white markings and black specks on the wings. Females lay eggs in small batches (about 20) on the lower side of leaves that are floating on the water surface. Upon hatching caterpillars are yellow to green with light brown heads. They climb onto a leaf and begin feeding by scrapping the leaf surface causing linear grazing of leaves giving the leaf tissue a ladder-like appearance. Later caterpillars cut a piece of rice leaf, roll it up into a case and seal the edges with silk material leaving the interior end open. The cut near the tip of a leaf is characteristic.

At all times the caterpillar is likely to be partly or wholly enclosed in its portable leaf case. The caterpillar attacks the food plant only in the vegetative stage, during the first four weeks after transplanting. Caterpillars of the case worm are semi-aquatic, ascending the plants at night to feed. Heavy infestation on small seedlings may completely destroy a rice crop. Damaged plants may recover but crop maturation may be delayed about a week. Yield loss may occur when the caseworm occurs in combination with other non-defoliating insects such as whorl maggots and stemborers. Damaged plants are stunted and produce fewer tillers.

What to do:

- **Practice field sanitation (burning debris or feeding of debris to livestock after harvest.**
- **Practice early and synchronised planting.**
- **Manage plant density. A study in West Africa showed that defoliation due to the caseworm ranged from 16% in seedlings transplanted at a wide spacing (40 X40 cm) to 68% at a spacing of 10 X 10 cm (WARDA).**
- **Practice proper water management. Ensure good drainage for three days, since larvae cannot survive without water.**
- **Handpick and destroy rolled leaves in the nursery.**

Termites (*Microtermes* spp., *Ancistrotermes* spp.,

***Trinervitermes* spp., *Macrotermes* spp., and *Odontotermes* spp.).**

Termites, also known as white ants are common pests of upland rice in West Africa where they may cause serious damage during dry periods. They may also occur in lowland areas in light texture soils. They generally attack plants in their later growth stage by hollowing out their root system and filling it with soil resulting in the lodging of the rice plants. The attacked plants are then predisposed to further damage by ground-dwelling pests such as rodents, ants, and secondary infection by fungi and bacteria. Damaged plants can easily be pulled up by hand because the roots are severed

Termites
Termites (*Coptotermes formosanus*)

© Scott Bauer, USDA Agricultural Research Service, Bugwood.org
More Information on Termites

What to do:

- **Plant resistant varieties whenever available. "LAC 23", "NERICA 1", "NERICA 5" and "NERICA 14" are resistant to termites. In experiments in Nigeria "NERICA"s 5 and 1 had lower levels of termite attack than other rice varieties tested ("NERICA"s 2,3,4, 6 and 7, "LAC 23" and "OS 6"). "NERICA"s 2 and 3 showed some levels of tolerance (WARDA; Nwilene et al., 2008)**
- **Use neem products. They provide effective control of termites on rice fields. In experiments in Nigeria two litres of neem seed oil (Cobeneem) mixed with one litre of water and 10 g of detergent soap (OMO) applied in an area of 900 m2 gave the best protection against termite attack, followed by neem powder (800 kg per ha). Applications were done close to the rice hills along the rows (Nwilene et al., 2008). For more**

information on neem click here

- **The application of red palm oil mixed with pawpaw is an indigenous control practice. The mixture attracts soldier ants that attack and drive away the termites.**

Hispid beetles (*Trichispa* spp., *Dicladispa viridicyanea, Dactylispa bayoni*)

Hispid beetles are serious pests of rice in some countries in Africa, causing severe defoliation and as vectors of the Rice Yellow Mottle Virus. Adult beetles have numerous spines on thorax and abdomen. *Trichispa sericea* is the most common of the hispid beetles. The adult is a dark grey beetle covered with spines, and about 3 to 4 mm long. Females lay eggs singly in slits made under the epidermis of the upper portion of the leaf. Eggs are white, boat-shaped and about one mm long. Upon hatching, the grubs (larvae) mine within the leaf. Grubs are slender, yellow and about six mm long. They pupate in the mine. When infested leaves are held against the light, the grub or pupa may be seen as a dark spot in the mine. Hispid beetles attack the crop in the early growth stages. Larval feeding occurs during the tillering stage. The first attack in a field is highly localised, but the infested area spreads rapidly.

Feeding by adults on the leaves causes characteristic narrow white streaks or feeding scars that run along the long axis of the leaf. Mining by grubs within the leaf shows as irregular pale brown blister-like patches. Feeding results in loss of chlorophyll and the plants wither and die. The most serious damage occurs in nurseries, which may be completely destroyed. Severe infestations sporadically occur on transplanted rice and can kill the plant. When the plants survive, they usually recuperate and produce some grain. However, damaged plants often mature late. Hispid beetles are prevalent in wetland environments, especially irrigated lowland fields. They are generally most abundant during the rainy season.

What to do:

- **Use close spacing. Populations of adult hispid (T. sericea) are affected by the spacing of transplanted seedlings. Studies in West Africa have shown that population of this hispid beetle were higher in close spacing of 10 x 10 cm) than in wider spacing of 20 x 20cm (WARDA).**
- **Keep bunds and surroundings free of grass weeds.**
- **Destroy stubbles and avoid ratooning.**
- **Ensure balanced nutrition. Avoid excessive nitrogen application.**

Flea beetles (*Chaetocnema* spp.)

Flea beetles make small holes in the leaf when feeding, however, this damage is considered minor. Most important, these beetles are potential vectors of the Rice Yellow Mottle Virus. Flea beetles are small, and have enlarged hind legs and jump when disturbed.

Flea beetle
Flea beetle feeding on young okra pod

© A.M. Varela, icipe

What to do:

- **Use close spacing. Populations of flea beetles are affected by the spacing of transplanted seedlings. Studies in West Africa have shown that population of this hispid beetle were higher in close spacing of 10 x 10 cm) than in wider spacing of 20 x 20cm (WARDA).**
- **Keep bunds and surroundings free of grass weeds.**
- **Destroy stubbles and avoid ratooning.**
- **Ensure balanced nutrition. Avoid excessive nitrogen application.**

Rice whorl maggots and rice leafminers (*Hydrellia* spp)

The rice whorl maggot (*Hydrellia prosternalis*) has been reported from West Africa. Another species *Hydrellia* sp. has been reported in Kenya (NIB, 1995). Adults of the rice whorl maggot and rice leafminers are small flies (1.5 to 3 mm long), grey to black in colour with silvery white or golden brown markings on the lower part of the head. They lay white cigar-shaped eggs on the leaves. Upon hatching the maggots of the leafminers penetrate the leaf tissue and feed in between the two layers of the leaf causing mines parallel to the veins. Maggots may pupate in an existing mine or migrate to a different leaf to form a new mine. High humidity (80-100% relative humidity) is required for leafminer development, therefore, mines are typically observed in leaves close or lying on the water surface. Whorl maggots start feeding on the leaf margins causing large scarred areas giving the leaf a ragged appearance and causing eventual leaf collapse. Eventually the maggots enter the whorl and tunnel the plant's developing stem.

Feeding damage by leafminers retards plant development, reduces plant vigour and renders infested plants less competitive with weeds. Plant vigour and weather conditions affect the extent and seriousness of the damage caused by the rice leafminer. Damage extent is closely related to the speed the plant growths erect and out of the water. Any factor affecting plant growth, which increases the number of leaves remaining lying on the water, or the length of time they are fully in contact with water will increase damage. The plant is usually able to produce

Rice leafminer
Hydrella rice miner damage to rice

additional leaves, but continued mining can result in reduced tillering, greater susceptibility to later pest attack, delayed maturity, or death of the plant. Once leaves start growing upright above the water, the rice leafminer does not cause economic damage. Attack by the whorl maggot may kill young plants (2 to 6 weeks after emergence) depending on the severity of the damage. Plants that survived damage are eventually drowned by the flood, or plant stands get so thinned that are easily overwhelmed by weeds.
Other leaf-mining fly (*Creodont orbiting*) has been reported as a minor pest in West Africa. This leaf-mining fly is widely spread in the rice-growing region in Ghana, but it is of no apparent economic importance. The adult is a small fly (about 1.6 mm long). Females lay eggs into the leaf tissue, and the maggots feed forming mine towards the leaf tip. Maggots pupate within the mine. Symptoms of damage are the transparent, light brown mines that are elongated along one side of the midrib reaching up to 6 cm in length.

What to do:

- **The rice leafminer can be controlled by managing the water level**
- **Avoid leaf contact with water. However, this practice seems to intensify the whorl maggot problem. Field observations in Louisiana, USA showed that by draining fields, the maggot enters the plant whorl and stems without being drowned (LSU AgCenter).**
- **Drain the water at intervals of 3 to 4 days during the first 30**

days after transplanting reduces egg laying as the adult flies are more attracted to standing water.

- **To reduce the potential for damage by the rice leafminer encourage the rice to emerge quickly and grow erect.**
- **Level the field as accurately as possible and start the crop in 7-10 cm of water. Increase the water depth slowly after the leaves begin to grow upright.**
- **Monitor for rice leafminers to determine the need to lower the water level. Begin monitoring two to four weeks after planting, just after most of the rice plants have emerged from beneath the water and the leaves are lying on the water surface (UC Pest Management Guidelines).**
- **Crop establishment methods that enable the plants to cover the water surface most rapidly usually result in insignificant damage.Thus, close planting has been shown to decrease egg laying and subsequent damage by leafminers in several countries in Asia and South America.**

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back to Index

Information on Diseases

The most serious diseases of rice are: Rice blast disease (*Magnaporthe grisea*) and Bacterial leaf blight (*Xanthomonas oryzae* pv. *oryzae*).

Other diseases of economic importance include Brown Leaf Spot (*Bipolaris oryzae*), Rice Yellow Mottle Virus (Sobemovirus) and White Tip Disease (nematode - *Aphelenchoides besseyi*).

Examples of Rice Diseases and Organic Control Methods

Damping-off diseases

Damping-off
Damping-off on rice

More Information on Damping-off diseases

Failure of seedlings to emerge is the most obvious symptom of seed rot and pre-emergence damping off. Examination may reveal a cottony growth of mycelium (mould) in and around seed coats and the emerging seedlings, indicating attack by water mould(s). The growing point or root of germinated seedlings has a dark brown discolouration or rot. The base of the leaf sheath and the roots of emerged seedlings have a similar dark brown or reddish-brown rot. Affected seedlings appear stunted and yellow and may soon wither and die (seedling blight). Water moulds are particularly severe in water-seeded rice culture. In areas where fields are frequently water-seeded, it has become difficult to obtain adequately dense and uniform stands. Seed rots caused by the water moulds *Pythium* and *Achlya*, and to a lesser extent by the fungus *Fusarium*, have been identified as the causes of the problem. These fungi often act as a complex within affected fields.

Symptoms of water mould can be observed through the flood water as balls of fungal strands radiating from seeds on the soil surface. When the flood is removed using the critical point method of water-seeding, affected seeds are surrounded by a mass of fungal strands. This results in circular, copper brown or dark green spots on the soil surface, about the size of a quarter, with the rotted seed at the centre. The colours of the spots are

the result of bacterial and algal growth. Seed rot by water moulds is favoured when the water temperature is unusually high or low. If seedlings are attacked after germination at pegging, seedlings become yellow and stunted and grow poorly.

What to do:

- **Use certified disease-free seeds for planting**

Bacterial leaf blight (*Xanthomonas oryza* pv. *oryza*)

The first symptom of the disease is a water soaked lesion on the edges of the leaf blades near the leaf tip. The lesions expand and turn yellowish and eventually greyish-white and the leaf dries up. High rainfall with strong winds provides conditions for the bacteria to multiply and enter the leaf through injured tissue.

What to do:

- **Plant resistant varieties if available**
- **Use certified disease-free seeds**
- **Practice rotation**
- **Practice good field sanitation. Plough or roll the stubble to hasten decay of the rice debris; this helps to manage the disease by destroying the tissue in which the bacterium is maintained**

Bacterial leaf blight
Bacterial leaf blight (*Xanthomonas oryzae* pv. *oryzae*) on mature rice plants. Lesions begins as water-soaked stripes on the leaf blades and eventually would increase in length and width becoming yellow to grayish-white until the entire leaf dries up.

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Bacteri... Bacteri...

Blast (*Pyricularia oryzae* (*Magnaporthe grisea*)

This disease can cause serious losses to susceptible varieties during periods of blast favourable weather. Depending on the part of the plant affected, the disease is often called leaf blast, rotten neck, or panicle blast. The fungus produces spots or lesions on leaves, nodes, panicles, and collar of the flag leaves. Leaf lesions range from somewhat diamond-shaped to elongated with tapered, pointed ends. The centre of the spot is usually grey and the margin brown or reddish-brown. Both the shape and colour of the spots may vary and resemble those of the brown leaf spot disease. Blast differs from brown leaf spot in that it causes longer lesions and develops more rapidly.

The blast fungus frequently attacks the node at the base of the panicle and the branches of the panicle. If the panicle is attacked early in its development, the grain on the lower portion of the panicle may be blank giving the head a bleached whitish colour,

Blast
Dried rice tassels caused by rice blast disease (*Magnaporthe grisea*)

© Jan Breithaupt (Courtesy of EcoPort, www.ecoport.org)

giving the name "blasted" head or rice "blast". If the node at the base of the panicle is infected, the panicle breaks causing the "rotten neck" condition. In addition, the fungus may also attack the nodes or joints of the stem. When a node is infected, the sheath tissue rots and the part of the stem above the point of infection often is killed. In some cases, the node is weakened to the extent that the stem will break causing extensive lodging. Blast generally occurs scattered throughout a field rather than in a localised area of the field. Late planting, frequent showers, overcast skies, and warm weather favour development of blast. Spores of the fungus are produced in great abundance on blast lesions and can become airborne, disseminating the fungus a considerable distance. High nitrogen fertilization should be avoided in areas that have a history of blast.

What to do:

- **Plant early**
- **Avoid excessive or high levels of nitrogen**
- **Proper flood management**
- **Plant resistant varieties (e.g. "Nerica". This is the most effective method of controlling rice blast.**

Brown leaf spot (*Bipolaris oryzae*)

This disease was previously called Helminthosporium leaf spot. Most conspicuous symptoms of the disease occur on leaves and glumes of maturing plants. Symptoms also appear on young

seedlings and the panicle branches in older plants. Brown leaf spot is a seed-borne disease. Leaf spots may be evident shortly after seedling emergence and continue to develop until maturity.

Leaf spots vary in size and are circular to oval in shape. The smaller spots are dark brown to reddish brown, and the larger spots have a dark-brown margin and reddish brown to grey centres. Damage from brown spot is particularly noticeable when the crop is produced in nutritionally deficient or otherwise unfavourable soil conditions. Significant development of brown spot is often indicative of a soil fertility problem.

What to do:

- **Plant resistant varieties**
- **Use certified high quality disease-free seeds**
- **Ensure balanced fertilisation**
- **Practice crop rotation**

Brown leaf spot
Brown leaf spot on rice. Symptoms on leaves


Brown leaf...


Brown leaf...

Rice Yellow Mottle Virus (RYMV) (Sobemovirus)

Rice yellow mottle virus is endemic in Africa, was first reported in Kenya in 1966, but is now known to occur in almost all irrigated

rice growing areas in Africa. This disease can cause up to 92% yield loss on "super", the most popular rice variety in Tanzania.

RYMV causes severe infections mainly in irrigated rice and is transmitted by beetles (*Sesselia pusilla*, *Chaetocnema pulla*, *Trichispa sericea* and *Dicladispa viridicyanea*) and mechanically. It is not seed transmitted.

Major symptoms of the disease are yellowing of leaves, stunting of affected plants, reduced tillering of the affected plants and sterility of the seed/grain.

What to do:

- **Plant resistant varieties. The following cultivars are reported as resistant to RYMV: Oryza sativa japonica sub-species: 'LAC 23', 'Moroberekan', 'IR 47686-1-1' for direct seeded rainfed lowlands, and Oryza sativa indica sub-species: "WITA 9", "WITA 11" and "Gigante" (tete) for irrigated lowlands (WARDA)**
- **Avoid / minimise mechanical injuries**
- **Avoid exposing healthy seedlings and plants to virus contaminated and infected material (water, soil, cattle faeces and plants)**
- **Control insect vectors (see above under pests Hispid beetle and Flea beetle)**
- **Transplant early before the outbreak of Hispid beetles occur. Trichispa sericea, with reduction in spacing of plants**
- **Destroy crop residues after harvest and ratoons that harbour the virus and insect vectors.**

Rice yellow mottle virus Typical symptoms of rice yellow mottle virus: yellow mottle or orange colouration, depending on the genotype.

- **Synchronous planting. Wide range and non-synchronous planting dates increases the risks of RYMV outbreaks.**
- **Plant diverse varieties on a single plot**
- **Change of site for nurseries**
- **Rough infected plants**
- **Reduce fertiliser application on attacked plots**
- **Weed timely. Early and double weeding helps reduce the weed reservoir of the virus and insect vectors**
- **Withhold irrigation water between plantings to provide a rice free period and so restrict the build-up of the virus and insect population**

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back to Index

Information Source Links

- **AIC (2002). Field Crops Technical Handbook.**
- **Acland J.D. (1980). East African Crops. An introduction to the production of field and plantation crops in Kenya, Tanzania and Uganda. FAO/Longman. ISBN: 0 582 60301 3.**
- **Anthony Youdeowei (2002). Integrated Pest Management Practices for the Production of Cereals and Pulses. Integrated Pest Management Extension Guide 2. Ministry of Food and Agriculture (MOFA) Plant Protection and Regulatory Services Directorate (PPRSD), Ghana, with German Development Cooperation (GTZ). ISBN: 9988 0 1086 9.**
- **Bohlen, E. (1973). Crop pests in Tanzania and their control. Federal Agency for Economic Cooperation (bfe). Verlag Paul Parey. ISBN: 3-489-64826-9.**
- **Brunt, A.A., Crabtree, K., Dallwitz, M.J., Gibbs, A.J., Watson, L., Zurcher, E.J. (eds.) (1996 onwards). Plant Viruses Online: Descriptions and Lists from the VIDE Database. Version: 20th August 1996. http://micronet.im.ac.cn/vide/sppindex.htm**

- **Bèye, A. M. and Guei, R. G. (2001). Rice Seed Production by Farmers: A Practical Guide. ISBN: 92-9113212-8. www.warda.org**
- **CAB International (2005). Crop Protection Compendium, 2005 edition. Wallingford, UK www.cabi.org**
- **Elwell, H, Maas, A. (1995). Natural Pest & Disease Control. Natural Farming network, Zimbabwe. The Plant Protection Improvement Programme and The Natural Farming Network.**
- **Heinrich, E. A., Barrion, A. T. (2004). Rice-feeding insects and selected natural enemies in West Africa: biology, ecology and identification. Los Baños (Philippines): International Rice Research Institute (IRRI), and Adbijan (Côte d'Ivoire) WARDA- The Africa Rice Center. ISBN 971-22-0190-2.**
- **Hossain, S. M. M., Mian, I. H., Islam, A. T. M. S. and Haque, M. M. (1999). Organic amendments of soil to control rice root-knot nematode (Meloidogyne graminicola). Bangladesh journal of scientific and industrial research. vol. 34, no3-4, pp. 385-390 . ISSN 0304-9809 . INIST-CNRS, Cote INIST : 13166, 35400012026135.0140**
- **International Rice Research Institute (2006). Biological control of rice insect pests: www.knowledgebank.irri.org/IPM/biocontrol/**
- **International Rice Research Institute (2006). www.knowledgebank.irri.org**
- **LSU AgCenter. First Report of Whorl Maggots in Rice. February 2, 2005, SPDN Network News. By Boris Castro.**
- **Layton B. (2004). Bug Wise. http://msucares.com/newsletters/pests/bugwise/2004/bw1804.pdf**
- **Mississippi State University Extension Service (2001): Rice diseases. http://msucares.com/pubs/publications/p1840.htm**
- **NEMAPLEX (2007). *Aphelenchoides besseyi*. http://plpnemweb.ucdavis.edu/nemaplex/Taxadata/G011s1.htm#Hosts**
- **NIB (1995). Mwea Rice Production Manual.**
- **Nwilene, F.E.; Nwanze, K.F. and Okhidievbie, O. (2006). African Rice Gall Midge: Biology, Ecology and Control. Africa Rice Center (WARDA) ISBN 92 9113 236 5 (PDF); ISBN 92 9113 255 1 (print) www.warda.org**

- **Nwilene, F.E; Agunbiade, T.A.; Togola, M.A. and Youm, O. (2008). Efficacy of traditional practices and botanicals for the control of termites on rice at Ikenne, southwest Nigeria. International Journal of Tropical Insect Science Vol. 28, No. 1, pp. 37-44. journals.cambridge.org/download.php?file=%2FJTI%2FJTI28_01%2FS1742758408944386a.pdf&code=b1ab0e235f5250dec3e652438a6bb**
- **Nyambo, B. (2001). Integrated Pest Management Plan for SOFRAIP. Soil Fertility Recapitalization and Agricultural Intensification Project. SOFRAIP. Ministry of Agriculture and Food Security, Tanzania.**
- **OISAT: Organisation for Non-Chemical Pest Management in the Tropics. www.oisat.org**
- **Oduro K.A. (2000). Checklist of Plant Diseases in Ghana. Vol. 1: Diseases. Ministry of Food and Agriculture. Plant Protection & regulatory Services Directorate, Ghana**
- **Texas A & M University (1996). Texas Plant Disease Handbook**
- **UC IPM Online. Statewide Integrated Pest Management Program. How to manage pests, UC Pest Management Guidelines. Rice leafminer. http://www.ipm.ucdavis.edu/PMG/r682300211.html**
- **WARDA: www.warda.cgiar.org**

back to Index

Soybean

African Nightshade
Amaranth
Avocados
Bananas
Beans
Cabbage/Kale, Brassicas
Carrot
Cashew
Cassava
Citrus plants
Cocoa
Coconut
Coffee
Cotton
Cowpea
Cucumber
Eggplant
Green gram
Groundnut
Maize
Mango
Millet
Okra
Onion

more Images

Scientific name: *Glycine max*
Order/Family: Fabales: Fabaceae
Pests and Diseases: Anthracnose Aphids Bacterial pustule Bean flies Bean yellow mosaic virus Bugs Cowpea seed beetle Downy mildew Leaf-feeding caterpillars Leafmining caterpillars Pod and stem blight Pod borers Purple seed stain Root-knot nematodes Soybean bacterial blight Soybean mosaic potyvirus Soybean rust Storage moths and bruchid beetles Storage pests White mould Wildfire disease Couch grass, Leafhoppers

General Information and Agronomic Aspects
Information on Diseases
Information on Pests
Information Source Links

General Information and Agronomic Aspects

Geographical Distribution of Soybean in Africa

Soybean is the world's most important legume in terms of production and trade due to its high content of protein (35-40 %) and oil (15-22 %). Soybean products are rich in essential amino acids, vitamins and minerals. Soybeans are used in the preparation of a variety of fresh, fermented and dried food products like milk, tofu, soya sauce and bean sprouts. Soybeans are used not only for food but they serve also as a cure for various diseases and body ailments. Soybeans (preferably black ones) are included in medicines to improve the action of the heart, liver, kidneys, stomach and bowels. They are also processed to extract oil for food and for numerous industrial purposes. As edible oil, it enters the market as salad oil, cooking oil, margarine and shortening. Soybean meal is extensively used as an ingredient in livestock feed.
Soybean is also one of the crops where many varieties are now genetically modified - especially in the American market.

Papaya
Passion fruit
Peas
Peppers
Pigeon pea
Pineapple
Potato
Pumpkin
Rice
Sesame
Sorghum
Soybean
Spider plant
Spinach
Sugarcane
Sweet potato
Tea
Teff
Tomato
Wheat
Yam
Zucchini/Courgette

Pests/ diseases/ weeds

In sub-Saharan African soybean is mostly grown by small-scale farmers either as a sole crop or mixed with sorghum, maize or cassava.

Climate conditions, soil and water management

Soybean is grown from the Equator to latitude 55°N or 55°S, and from below sea level to altitudes close to 2000 m. Above 2000 m the late maturing varieties take as long as 180 days (6 months) but they out-yield the early maturing varieties. Soybean is a short-day plant. In Kenya, soybeans are grown in the maize growing areas, mainly by small-scale farmers.

Temperatures below 21°C and above 32°C can reduce floral initiation and pod set. Extreme temperatures above 40°C are detrimental for seed production.

If water is available, soybeans can be grown throughout the year in the tropics and subtropics. Soybean requires 400 to 500 mm in a season for a good crop. High moisture requirement is critical at the time of germination, flowering and pod forming stage. However dry weather is necessary for ripening. Soybeans can tolerate brief waterlogging but weathering of seed is a serious problem in the rainy season.

Soybeans are sensitive to low pH. In acid soils, liming is essential to raise the pH to 6.0 or 6.5 and to obtain optimum yield. Mn, Fe and Al toxicity is common with low pH, and deficiency in Mn and Fe with high pH. Cultivars tolerant to iron deficiency are available.

Propagation and planting

Soybeans are propagated by seed. However soybean seed loose viability within 6-10 months depending on the variety and the environmental conditions, especially under hot and damp conditions. Test seed for viability before planting: Take 100 seeds from about 3 places in the seed lot, put each lot of 100 seed in a glass of water for 24 hours, then drain off the water and replace with damp cotton wool or a damp cloth. Keep cloth damp - after 3-4 days young sprouts

Medicinal plants
Fruit and vegetable processing
Natural pest control
Cultural practices

will have formed on all viable seed, and it is easy to count how many out of the 100 that has germinated (Germination %). They are grown on paddy-rice bunds too. Soybeans are sown without tillage in rice stubble after each harvest in rows with a spacing of 25 x 25 or 20 x 20 cm. In tilled fields, soybeans are sown in rows 40-50 cm apart and within rows the seeds are either drilled or planted 10 cm apart. Seed rate is 60-70 kg / ha. Broadcasting of seed after the rice harvest is also practised.

Examples of different varieties grown in Kenya and their parameters:

Characteristics	"Hill"	"Perry-41"	"Black hawk"	"Red-Tanner"	"Composite"	"Duicker"
Days to flowering	76	61	81	65	62	84
Days to physiological maturity	147	131	151	138	131	180
Plant height (cm)	60	48	60	70	35	43
Seed yield kg/ha	2000	1800	1300	1800	700	1000
Oil content (%)	17	18	16	18	14	16
Protein content(%)	33	35	35	35	37	34

Recommended soybean varieties for different agro ecological zones in Kenya:

Description	Area in Kenya	Varieties
Warm Temperature sites	Homa Bay	"Duicker", "EAI 3600" and "Nyala"
Moderate temperature sites	Bukura, Kakamega, Manor House, Embu	"SCS I", "Duicker", "Nyala" and "Gazelle"
Cool temperature sites	Bahati, Baraton, LH2, Menengai	"Sable", "SCS I", "Nyala" and

		"Gazelle"
Marginal rainfall sites	**Matayos, Gachoka, Makueni, Ol Rongai**	**"Gazelle", "EAI 3600", "Nyala" and "Sable"**

Intercropping

Soybeans are cultivated both as a sole crop and in various intercropping systems with maize, cassava, sorghum, banana, sugar-cane, rubber, oil palm, coconut and fruit-trees. In maize and sorghum, soybeans can be intercropped with two rows.
Intercropping soybean with maize attracts parasitic wasps that control African bollworm (*Helicoverpa armigera*) and at the same time serves as weed cover. Soybeans should not be grown on the same site for more than two years to prevent a build-up of soil-borne diseases. Practice crop rotation of 3 to 4 years as a part of disease control. The plant grows best in a rotation after maize or small grains but should not follow edible beans, rape, or sunflowers because white mould disease can be carried over.

Husbandry

Weed control is essential. Early seed bed preparation with removal of couch and watergrass is the first step to good yields. Irrigation at flowering and during seed filling when rain is failing is essential to gain optimum yield. More frequent irrigation is needed in sandy, well-drained soils than in heavy clay soils. Favourable effects of soybeans are improved soil structure and fertility due to its nitrogen fixing capacity. Soybeans can obtain all of their nitrogen needs from the air when nitrogen-fixing-rhizobia (bacteria) are present in the soil. Nitrogen fixation is a result of the symbiotic relationship of rhizobia and the plants. Where soybeans have not been grown before it may be beneficial to treat the seed with soybean inoculum (*Rhizobium japonicum*, available from University of Nairobi - Kabete campus, Dept. of Soil Science) at a rate of 100g/15kg seed before planting to allow maximum nitrogen fixing throughout the growing season. A well-nodulated plant should have around 5-7 nodules on the primary root. When

plants have fewer nodules, monitor the field carefully to determine if the nodule numbers increase. Nitrogen deficiency results in reduced chlorophyll development and a pale-green leaf colour. Do not add nitrogen to well-nodulated soybeans. It is just a waste of time and money. Nitrogen added during planting delays nodulation and when applied during the vegetative stage results in poor nodule formation in proportion to the rates applied. However phosphorus in the form of rock phosphate at a rate of about 100-150 kg/ha is very beneficial for good root formation.

Harvesting

Early-maturing cultivars can be harvested for grain 70 days after planting and late maturing cultivars need up to 180 days. The plants are cut near the ground or pulled with their roots at physiological maturity when most leaves have aged and turned yellow, and at least one pod per plant have turned brown or black. Vegetable soybeans are harvested when the pods are still green but when the seeds have filled the pod. Most small scale farmers achieve yields of about 500-1000 kg/ha, though 3000 kg/ha is possible with good husbandry practices and recommended varieties.

Soybeans can be harvested by hand or by combine harvesters (this only at full maturity or after windrowing - cutting plants and leaving them in rows for wind and sun to dry properly). Once threshed, dry the soybeans to below 12 % moisture content before storing. Keep in a clean store and prevent weevil attack by any of the means described under storage pests. Seeds meant for seed should not be stored for longer than 1 year due to rapid loss of germination capability. For more information on storage pests click here

back to Index

Information on Pests

Root-knot nematodes (*Meloidogyne* spp.)

Field symptoms are typically of stunted, poorly growing plants with yellowing leaves. They may cause also wilting and death of plants particularly in hot weather. Roots of affected plants are distorted, swollen and show characteristic knots or galls.

What to do:

- **Plant resistant varieties, where available.**
- **Rotate for at least 3 to 4 years with cereals.**
- **Use bio-products (e.g. neem extracts). Some are commercially available for nematode control.**

Root-knot nematodes
Root-knot nematodes (*Meloidogyne* spp.)

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More Information on Root-knot nematodes

Beanflies (*Ophiomyia centrosematis* and *O. phaseoli*)

Bean flies are tiny (about 2mm long) flies, shiny black-bluish in colour. Female flies lay eggs on young leaves, piercing the leaves and sucking the exuding sap resulting in yellow blotches on the leaves, which are the first signs of bean fly attack and are useful for early detection of this pest. Maggots mine their way from the leaves down to the base of the stem, where they complete their development. Maggot feeding destroys the tissue causing the steam to swell and split and reducing formation of lateral roots.

Bean fly
Bean fly maggot (*Ophiomyia* spp.) in

Young seedlings and plants under stress wilt and die when attacked by bean flies. Older or vigorous plants may tolerate bean fly attack, but their leaves turn yellow, their growth is stunted and their yield reduced. Damage is more severe in plants growing under poor conditions such as infertile soils and drought. Under good conditions, Soybean, however, can compensate for minor stand reductions; thus, small gaps dispersed in a field normally are filled by adjacent plants and no yield reductions are detected.

a french bean stem

© A.M. Varela, icipe

Bean fly

Bean fly

What to do:

- **Plant early in the season. Bean fly numbers tend to be low during the early stages of the growing season and increase with time.**
- **Provide favourable growing conditions to improve plant vigour and to enhance tolerance to bean fly attack.**
- **Avoid planting beans near cowpea, beans and other leguminous crops, that may be the source of bean flies.**
- **Remove and destroy crop residues and all plant parts with symptoms of damage by bean flies.**
- **Monitor the field shortly after emergence.**
- **Ridge the crop 2-3 weeks after germination. This helps to cover the adventitious roots, which are produced by plants damaged by bean flies. The soil support prevents lodging and improves the survival of the damaged plants.**
- **If necessary, spray neem extracts. Frequent foliar applications of neem extract give satisfactory control of bean flies on beans.**

The cotton aphid (*Aphis gossypii*)

It is a major pest of soybeans. Adults range from just under 1 to 1.5 mm in body length. Aphids are found in clusters (colonies) on stems, young shoots and pods and underside of leaves. They transmit the Bean Yellow Mosaic Virus on soybeans.

What to do:

- **Monitor regularly build-up of aphid population and natural enemies.**
- **When necessary use neem seed or leaf extracts for control. For further information on neem click here..**

Cotton aphid
Cotton aphid (*Aphis gossypii*) is a small aphid. Adults range from just under 1-1.5 mm in body length.

© Mississippi State University Archive, Mississippi State University, Bugwood.org
More Information on Aphids

Leaf-feeding caterpillars

Leaf-feeding caterpillars such as the cotton leafworm (*Spodoptera littoralis*), the beet armyworm (*S. exigua*) and the tomato looper (*Chrysodeixis chalcites*) are generally of minor economic importance, but serious outbreaks occasionally occur. In particular, *S. littoralis* often causes extensive damage to soybeans.

The bean webworm (*Lamprosema indicata*) feeds on leaves, which are spooned together, causing characteristic windowing as the upper epidermis of leaves remain untouched. This caterpillar may cause considerable damage in soybeans. Natural enemies are important to keep populations at low level.

What to do:

- **Conserve natural enemies. Caterpillars have a wide range of natural enemies (parasitic wasps, predators and pathogens) that are important in their natural control.**
- **Monitor the crop regularly.**
- **Hand pick eggs and caterpillars.**
- **Use botanicals (e. g. neem extracts) and biopesticides (e.g. Bt).**

Damage by beet armyworm
Damage by the beet armyworm (*Spodoptera exigua*) on garden peas, it is about about 2-3cm long.

© A.M. Varela, icipe

The groundnut leafminer (*Aproaerema modicella*)

The adult is a small greyish moth, with a full wing span of up to 18mm. Eggs are laid singly on the underside of the leaves of groundnut, soybean and other leguminous plants. Caterpillars are 6 mm long at the time of pupation, and rarely exceed 8 mm in length. Young caterpillars mine the leaves; later as caterpillars get older they exit the mine to web together several leaflets.

Damaged leaves become brownish, rolled and desiccated, which results in early defoliation and affects the growth and yield of the

Leafmining caterpillar
Leafmining caterpillar (*Aproaerema modicella*) on

plants.

This leafmining caterpillar is a pest of groundnut and soybean in South and Southeast Asia and has recently invaded Africa. It has become a major pest of groundnuts in several African countries and has also been reported causing damage to soybeans in Uganda. Some farmers have reported a 30% yield loss.

What to do:

- Plant during the first short rains when normally the miner population is low
- Avoid drought stress by irrigating or sowing so as to avoid periods when drought is likely. Plants that are drought stressed are much more susceptible to leafminer attack than irrigated plants.
- Monitor plants regularly, particularly when intercropped with or planted near groundnuts. In India, soybean plants have been recommended as trap crops to divert these leafminers from groundnuts
- Treat with neem products as soon as infestation is detected. Early applications of neem products have been effective in India and Uganda

groundnut. They are grey-green with a shiny black head. Caterpillars are 6 mm long at the time of pupation, and rarely exceed 8 mm in length.

Bugs

Sucking bugs are major soybean pests. They feed on pods and soft growing plant parts. While feeding they inject toxins into

pods/seeds causing necrosis.

The most important are stink bugs (e.g. *Nezara viridula*, and *Piezodorus hybneri*), Riptortus bugs (*Riptortus dentipes), Mirperus jaculus*, giant coreid bugs (*Anoplocnemis curvipes*), and spiny brown bugs (*Clavigralla* spp.).

Extensive stink bugs feeding may result in pod abortion and the destruction of seeds. Severe pod abortion may induce such plants to remain in the vegetative stage, causing foliar retention, which poses problems at harvest. The green stink bug (*Nezara viridula*) also injects a fungus (*Nematospora coryli*) into the developing seeds, which is the casual agent of the yeast spot disease. A single stink bug puncture may result in the loss of seed germination. Direct pod and seed injury may result in yield loss and decrease in seed quality due to microorganisms, even if plants compensate for considerable injury that occurs during early pod-set. Damage at the end of the seed- development will result in yield loss.

Sucking bugs are difficult to control since they are very mobile and can infest the crop from neighbouring crops.

What to do:

- **Sucking bugs are attacked by parasitic wasps and assassin bugs. In Ghana a threshold of 2-bugs/metre row is suggested.**
- **Control strategies should be related to the stage of pod development. It has been shown that early pod fill is the most**

Stink bug
Green stink bug (*Nezara viridula*) on soybean. Adults are about 1.2cm long.

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Stink bug **Tip wilter..** **Spiny brow...** **Riptort ...**

sensitive stage to attack by green stink bugs (N. viridula), and the only one in which yield, seed weight and oil content was significantly reduced. Bugs should be controlled before this stage is reached, i.e. towards the end of pod elongation. Once pod fill is completed, soybeans are not at risk and control is not warranted unless planting seed or edible seed is being grown (CABI, 2005).

- **Research in Indonesia has shown that Sesbania rostrata is an effective trap crop, for managing stink bugs and Riptortus bugs on soybeans (Naito, 1981, 1996). Sesbania rostrata is taller than soybean, and since it takes longer to mature, it can also attract stink bugs over a longer period. In addition to attracting adults of N. viridula, it helps to reduce their numbers, since it is not a suitable food plant for nymphal development. Sesbania is usually planted on two opposite sides of a soybean field.**
- **Spraying with aromatic plants (e.g. gums, lantana, khaki weed,etc.) has been suggested to repel bugs (Elwell and Mass, 1995).**
- **Neem-based pesticides reportedly reduce feeding by green shield bugs.**

Pod borers (*Maruca vitrata, Etiella zinckenella, Helicoverpa armigera*)

The legume pod borer (*Maruca vitrata*), the lima bean pod borer (*Etiella zinckenella*) and the African bollworm (*Helicoverpa armigera*) are major pests of soybeans. The adults are small

moths. They are nocturnal and seldom seen in the field at daytime. Caterpillars of these moths feed on the floral parts and pods of legume plants, rendering them unmarketable. They scrape or bore through pod walls into the developing seeds.

For more information on African bollworm click here.

What to do:

- **Monitor the crop regularly.**
- **Spray with Bt o neem extracts or other plant extracts. It is very important to apply them before the young caterpillars enter into the pods. Once the caterpillars have entered the pods they are difficult to control and by then they have caused damage. Since the period between hatching to entering the pods is very short it is very important to monitor the crop frequently.**

Legume pod borer
Legume pod borer (*Maruca vitrata*)

© Ooi P. Courtesy of EcoPort, www.ecoport.org



Legum pod... **Lima bean ...** **African bo...**

Storage moths and bruchid beetles

Larva of storage moths (*Ephestia cautella, Corcyra cephalonica*) and bruchid beetles (*Callosobruchus* spp.) cause extensive damage to soybean grains. The forewings of the adult moth *E. cautella* are greyish-brown with an indistinct pattern. The wing span is 1-2 cm.

What to do:

- **Rice husk ash was found to be effective against bruchid beetles (Callosobruchus analis) in Indonesia. Fresh, dry ash should be used, at a rate of around 1% of the seed weight. The rice husk ash should be spread by hand over well-dried soybean seeds stored in a can with a capacity of 6 - 18 litres. The ash should be gently mixed with the seed by hand, and the lid placed tightly on the can. The can should be kept in a cool, dark place (Naito, 1981).**

Bean bruchid
Bean bruchid (*Acanthoscelides obtectus*) on soybean. Adults are 3-4.5mm long, grey-brown.

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Bean bruch.. **Cowpe see…** **Storag mo…**

More Information on Storage moths and bruchid beetles

back to Index

Information on Diseases

Among the diseases, Soybean rust caused by Phakopsora pachyrhizi can reduce yields by as much as 90%.
Other serious diseases are: Bacterial pustule (Xanthomonas axonopodis pv. glycines) /Soybean bacterial blight (Pseudomonas savastonoi pv. glycinea), Soybean downy mildew (Peronospora manshurica), Anthracnose (Colletotrichum truncatum and Glomerella glycines), Purple seed stain (Cercospora kikuchii), Pod and stem blight (Diaporthe phaseolorum var. sojae), Soybean mosaic potyvirus, Bean yellow mosaic virus and various seedling diseases.

Soybean rust (*Phakopsora pachyrhizi*)

The most common symptoms are grey green, tan to dark brown or reddish brown lesions particularly on the undersides of the leaflets. These lesions are called uredia and they contain spores of the fungus. The spores from uredia are called urediniospores. Lesions tend to be angular, are restricted by leaf veins, and reach 2-5 mm in diameter. Lesions may also appear on petioles, pods, and stems. With time uredia turn black and at this stage they are called telia and the spores they contain are called teliaspores.
Lesions are frequently associated with leaf chlorosis, and high lesion densities result in premature defoliation and early maturity. During the early stages of development before the onset of sporulation, rust lesions may be confused with bacterial pustules (see bacterial pustule/bean blight). However, the symptoms of the two diseases can be differentiated by the presence of multiple uredia in the rust lesion and by the irregular cracks that usually appear in host tissue with a bacterial pustule lesion. Rust epidemics are most severe during long periods of leaf wetness

Soybean rust
Soybean rust (*Phakopsora pachyrhizi*) symptoms on lower leaf surface

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when the mean daily temperature is less than 28°C. Urediniospores are the primary means of disease spread. Soybean is susceptible at any stage of development, but symptoms usually appear from the middle to late in the season because a prolonged wet, cool period is required for infection and sporulation. Spread of urediniospores is by windblown rain. The pathogen is not seed-borne in soybean.

What to do:

- **Plant resistant varieties, if available.**

Soybean mosaic potyvirus (SMV)

Soybean mosaic potyvirus
Soybean mosaic potyvirus

© Mike Pearson (Courtesy of EcoPort, www.ecoport.org)

Symptoms vary with host, virus strain, plant age at infection, and environment. Most infected cultivars are slightly stunted with fewer pods that are sometimes dwarfed and flattened, without hairs, and without seeds. Trifoliolate leaves have a mosaic of light and dark green areas that may later become raised or blistered, particularly along the main veins. Primary leaves of some cultivars may show necrotic local lesions, which merge, into veinal necrosis followed by yellowing and leaf abscission. Seeds from infected plants may be mottled brown or black, depending on hilum colour. Seeds may be smaller and germination reduced as compared to seed from noninfected plants. Mottling does not indicate that the virus is present in seeds as not all mottled seeds contain virus and not all seeds from virus-infected plants are mottled. SMV is sap and graft-

transmissible. At least 32 aphid species, belonging to 15 different genera, transmit the SMV in a non-persistent manner. Virus isolates may show some vector specificity. Infected plants resulting from transmission through seed play an important role in SMV epidemiology. Such plants are sources for primary inoculum of SMV. In most cultivars, seed transmission is less than 5%, but no transmission occurs in some cultivars while others can have levels as high as 75%.

What to do:

- **Use certified disease-free seeds.**
- **Practise aphid control to reduce the spread of virus.**
- **Plant resistant cultivars, if availale.**

Bean yellow mosaic virus (BYMV)

Leaves of infected plants are not distorted as in SMV. The younger leaves show a yellow mottling scattered in random areas over the leaflets or sometimes an indefinite yellow band along major veins. Rusty necrotic spots develop in the yellowed areas as the leaves mature. Infected plants are not noticeably stunted. The disease is transmitted by aphids and infected seeds.

What to do:

- **Use certified disease-free seeds.**
- **Control aphids. For more information on aphid control click here.**

Soybean bacterial blight (*Pseudomonas savastonoi* pv. *glycinea*)

Blight lesions are most conspicuous on leaves but also occur on stems, petioles, and pods. Small, angular, translucent, water-soaked, yellow to light brown spots appear on leaves. The centres soon dry out, turn reddish brown to black, and are surrounded by a water-soaked margin bordered by a yellowish green halo. Young leaves are most susceptible. Infected young leaves are distorted, stunted, and chlorotic. The angular lesions enlarge in cool, rainy weather and merge to produce large, irregular dead areas. *P. savastonoi* pv. *glycinea* over seasons in surface crop residue and in seeds. Seeds can be infected through the pods during the growing season, or they may be invaded during harvesting. Primary infections on cotyledons often result in secondary lesions on seedlings. The bacterium is spread during windy rainstorms and during cultivation while the foliage is wet. It is seed-borne.

Bacterial blight
Soybean bacterial blight

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What to do:

- **Use certified disease-free seeds.**
- **Plant resistant varieties, if available.**
- **Practise proper field sanitation.**

Bacterial pustule (*Xanthomonas axonopodis* pv. *glycines*)

The symptoms are much like those of bacterial blight. At first they appear as small, yellow-green spots with reddish-brown

centres, more conspicuous on the upper surface of the leaf. A small, raised pustule usually develops at the centre of the lesion, especially on the lower leaf surface. This is the stage at which the disease is most readily distinguished from bacterial blight. The pustule and the absence of water soaking serve to distinguish bacterial pustule from bacterial blight. The latter shows water soaking at the centre or the margin of the dead area in the early stages of infection. In bacterial pustule, small infections may run together and cause large, irregular brown areas surrounded by a yellow margin. Parts of the brown dead areas may crack, giving the leaf a ragged appearance. The bacteria causing bacterial pustule over-season in diseased leaves and are seed-borne. Some strains infect common bean and cowpea.

Bacterial pustule
Soybean bacterial pustules caused by *Xanthomonas axonopodis* pv. *glycines*.

What to do:

- **Disease management is the same as in the case for bacterial blight.**

Wildfire disease of soybeans (*Pseudomonas syringae* pv. *tabaci*)

Symptoms consist of light-brown necrotic spots of variable size, surrounded by broad yellow halos on the leaves. In damp weather the spots enlarge forming large dead areas on the leaf. Wildfire disease is commonly associated with bacterial blight and bacterial pustule infections. The bacteria causing wildfire are seed-borne and also are carried over in crop debris.

What to do:

- **Disease management is the same as in the case for bacterial blight and bacterial pustule.**

Wildfire disease
Wildfire disease (*Pseudomonas syringae* pv. *glycinea*) symptoms.

Soybean downy mildew (*Peronospora manshurica*)

Early stages of the disease are characterised by indefinite yellowish-green areas on the upper surface of the leaves. As the disease progresses, those infected areas become greyish brown or dark brown and have yellowish-green margins. Severely infected leaves fall off prematurely. A greyish mould-like growth develops on the under surface of the spots when weather is wet and temperatures are cool. The disease also attacks the pods and infects the seeds. The disease is favoured by cool temperatures and wet conditions.

Downy mildew
Soybean downy mildew (*Peronospora manshurica*)

More Information on Downy mildew

What to do:

- **Plant certified disease-free seeds.**
- **Use resistant varieties, if available.**

Pod and stem blight (*Diaporthe phaseolorum* pv. *sojae*)

It kills the plants in the later stages of crop development. Stems, petioles, pods, seed and less frequently leaf blades may be infected. It can be easily identified by the numerous, small, black fugal fruiting bodies (pycnidia) that appear on the stems and pods of infected plants. On the pods, the pycnidia are scattered while on the stems they are usually arranged in rows. The disease is favoured by wet weather. The disease is seed-borne and can over-season on diseased stems in the field.

What to do:

- **Use certified disease-free seeds.**
- **Use resistant varieties, if available.**
- **Practise sanitation.**
- **Practise crop rotation with non-legumes.**

Pod and stem blight
Pod and stem blight on soybean (*Diaporthe phaseolorum*)

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White mould (*Sclerotinia sclerotiorum*)

It is characterised by a rot at the base of the plant stem. The rot is covered by a cottony, fungal (mycelial) growth on which black irregularly shaped fungal bodies (sclerotia) are produced. Size of sclerotia varies from 2 to 22 mm in diameter. The disease infects the stem and pods. Large, black, round to irregularly-shaped sclerotia of varying size form on stems, which are partially covered with dense white mycelium. Sclerotia are also formed in the stem pith and are conspicuous when the stem is opened.

White mould
White mould on bean pods

Seeds may become infected within diseased pods. If infected early, seeds are flattened and shrivelled and sometimes replaced by black sclerotia. Attacked plants die prematurely, sometimes before seeds have formed. Infection occurs at flowering. Moderate air temperatures and frequent rains just prior to flowering to the pod development stage of growth favour the disease.

What to do:

- **Use certified disease-free seeds.**
- **Plant resistant varieties, if available. Early maturing cultivars tend to escape infection because of their usually short stature and early flowering. In contrast, late maturity cultivars are believed to have more disease because of lush vegetative growth and later flowering.**
- **Avoid planting soybean directly after common bean, sunflower and rape.**
- **Avoid planting highly susceptible cultivars if row spacing is less than 76 cm in fields with a history of the disease.**
- **Avoid excessive irrigation until flowering has ceased.**
- **Use good weed control practices.**

(*Sclerotinia sclerotiorum*).

Damping-off diseases and Anthracnose (*Colletotrichum truncatum* and *Glomerella glycines*)

They are caused by an array of fungi including *Colletotrichum truncatum* and *Glomerella glycines* (cause of anthracnose). The

diseases cause rotting of seeds before emergence from the soil or death of seedlings after emergence.

The two species of fungi produce similar symptoms on the petioles, stems and pods particularly when plants are nearing maturity. Diseased areas have dark sunken lesions. Under moist weather the lesions become covered with a pink spore mass. The disease is seed-borne. When infected soybean seeds are planted, many of the seeds rot in the soil. Those that emerge from the soil often have brown, sunken cankers on the cotyledons (seedling leaves). The fungi may grow from them into the young stems. The damping-off seedling losses are probably more serious phases of soybean anthracnose than symptoms on older plants. The disease is favoured by cool wet weather.

What to do:

- **Use certified disease-free seeds.**
- **Plant resistant varieties, if available.**
- **Practise crop rotation with non-legumes.**
- **Practise proper water management.**

Anthracnose
Anthracnose on soybean

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Anthra Brown blot...

More Information on Anthracnose

Purple seed stain (*Cercospora kikuchii*)

Symptoms of purple stain are most evident on the seeds, but the fungus also attacks leaves, stems and pods. On the seeds, discolouration varies from pink or light purple to dark purple and ranges from a small spot to the entire seed coat. Cracks often

occur on the discoloured areas giving the seed coat a rough, dull appearance. When infected seeds are planted, the fungus grows from the seed coats into the cotyledons (seedling leaves) and into the hypocotyls (seedling stem). The fungus produces spores abundantly on infected seedlings and these spores serve as source of infection to leaves, stems and pods. The spores are spread by wind and rain splash.

What to do:

- **Use certified disease-free seeds.**
- **Plant resistant varieties, if available.**
- **Avoid overhead irrigation.**

Purple seed stain
Purple seed stain (*Cercospora kikuchii*) on soybean

back to Index

Information Source Links

- **AIC (2002). Field Crops Technical Handbook. Nairobi**
- **Blay, E., Cudjoe, A. R., Braun, M. (eds) (2000). Handbook of crop protection recommendations in Ghana: An IPM approach Vol:1 Cereals and pulses. Plant Protection & Regulatory Services Directorate and Integrated Crop Protection Project (ICP) German Development Co-operation (GTZ/PPRSD.**
- **Bohlen, E. (1973). Crop pests in Tanzania and their control. Federal Agency for Economic Cooperation (bfe). Verlag Paul Parey. ISBN: 3-489-64826-9.**
- **Brier H.B. and Rogers, D.J. (1991). Susceptibility of soybeans to damage by *Nezara viridula***

(L.) (Hemiptera: Pentatomidae) and *Riptortus serripes* (F.) (Hemiptera: Alydidae) during three stages of pod development. Journal of the Australian Entomological Society, 30(2):123-128.

- **CABI. (2005). Crop Protection Compendium, 2005 Edition. © CAB International Publishing. Wallingford, UK. www.cabi.org**
- **Major Soybean Pests of the World. www.nsrl.uiuc.edu/news/nsrl_pubs/insectbooks/guidelines/sectionIII.pdf**
- **Naito, A. (1981). Low-Cost Technology for Controlling soybean insect pests in Indonesia. Association for International Cooperation of Agriculture and Forestry (AICAF). http://www.agnet.org. African Entomology. 102: 97-99. IITA. 1981.**
- **Naito, A. (1996). Insect pest control through use of trap crops. Agrochemicals Japan, 68, 9-11.**
- **Participatory evaluation of the distribution, status and management of the groundnut leafminers in the Teso and Lango farming systems. Final technical report. NARO/DFIFD COARD Project. October 2004. By George Epieru Naro Saari.**
- **Paulraj, M.P. and S. Ignacimuthu. (2006). Integrated control of groundnut leaf miner. Entomology Research Institute Loyola College, Chennai. www.thehindu.com**
- **Suzuki N, Hokyo N, Kiritani K. (1991). Analysis of injury timing and compensatory reaction of soybean to feeding of the southern green stink bug and the bean bug. Applied Entomology and Zoology, 26(3):279-287.**
- **The New Vision (2004). Uganda's leadings website. http://www.newvision.co.ug**
- **Todd J.W. (1989). Ecology and behavior of *Nezara viridula* Annual Review of Entomology, 34:273-292.**
- **University of Illinois National Soybean Research Centre: www.soydiseases.uiuc.edu**

back to Index

Crops/ fruits/ vegetables
African Nightshade
Amaranth
Avocados
Bananas
Beans
Cabbage/Kale, Brassicas
Carrot
Cashew
Cassava
Citrus plants
Cocoa
Coconut
Coffee
Cotton
Cowpea
Cucumber
Eggplant

more Images

Cucumber
Scientific name: *Cucumis sativus*
Order/Family: Violales: Cucurbitaceae
Pests and Diseases: Angular leaf spots Anthracnose Aphids Damping-off diseases Downy mildew Epilachna beetles Flea beetles Fruit flies Fruit rot Fusarium wilt Powdery mildew Root-knot nematodes Scab Spider mites Virus diseases Whiteflies Leafminer

General Information and Agronomic Aspects
Information on Pests
Information on Diseases
Information Source Links
Contact Links

General Information and Agronomic Aspects

Cucumber is a member of the Cucurbitaceae family, which includes pumpkins, squash, gourds and zucchini. Cucumber is grown for the immature fruits, which are eaten fresh (slicing cucumber), or used for pickles (pickling cucumber) . The slicing cucumbers are peeled, sliced and served with vinegar or dressing, or as an ingredient of salads. The large, yellow, round types are boiled and eaten as an ingredient of stews. Pickling cucumbers are preserved or marinated with vinegar, salt, or spices. They can also be used fresh. Cucumbers are a good source of Vitamin C.

- Green gram
- Groundnut
- Maize
- Mango
- Millet
- Okra
- Onion
- Papaya
- Passion fruit
- Peas
- Peppers
- Pigeon pea
- Pineapple
- Potato
- Pumpkin
- Rice
- Sesame
- Sorghum
- Soybean
- Spider plant
- Spinach
- Sugarcane
- Sweet potato
- Tea
- Teff
- Tomato

Geographical Distribution of Cucumber in Africa

Nutritive Value per 100 g of edible Portion

Raw Vegetable	Food Energy (Calories)	Protein (g)	Carbohydrates (g)	Ash (g)	Calcium (g)	Phosphorus (mg)	Iron (mg)	Potassium (mg)	Vitamin A (I.U)	
Cucumber	15	0.9	3.4	0.5	25	27	1.1	160	250	

Climatic conditions, soil and water management

Cucumber requires a warm climate. The optimum temperature for growth is about 30°C and the optimum night temperature 18-21°C. In the tropics, elevations up to 1700 m appear to be suitable for cucumber cultivation. A lot of light tends to increase the number of staminate (male) flowers. Cucumbers need a fair amount of water but they cannot stand waterlogging. High relative humidity encourages downy mildew. The soil should preferably be fertile and well-drained, with a pH of 6.5-7.5. Long and medium long slicing cucumber varieties are grown in greenhouses where climate and other growing conditions can be controlled.

Wheat
Yam
Zucchini/Courgette
Pests/ diseases/ weeds
Medicinal plants
Fruit and vegetable processing
Natural pest control
Cultural practices

Propagation and planting

Cucumber is propagated by seed. Soil preparation requires generous incorporation of well rotted manure. About 30 t/ha or 15 tons/ha should be applied inside the planting holes together with a spoonful of rock phosphate (3 tea spoons) for each planting hole. Sowing is done directly in the field with several seeds per hill, 90-120 cm apart, then thinned to 2-3 plants per hill, or seeds are sown in nursery beds and seedlings transplanted to the field at the 2-true-leaf stage at 30-40 cm within and 1-2 m between the rows. Sowing rates per ha are about 2.5-3 kg for direct seeding and 1 kg when transplanted. Cucumber cultivated for pickles is planted closer, up to 250,000 plants/ha. For greenhouse varieties plants are started in individual pots and transplanted to permanent position when they have 2-3 permanent leaves.

Cucumber varieties are categorised into four types on basis of fruit length:

- **Long cucumbers: Fruit length over 30 cm. Examples: Berlin RZ / Bologna RZ / Cumlande RZ / Myrthos RZ / Pluto RZ / Virginia RZ)**
- **Midi cucumbers: Fruit length between 18 -24 cm Examples: Media RZ**
- **Mini cucumbers: Fruit length between 15 -19 cm. Examples: Khassib RZ / Gianco RZ**
- **Cocktail cucumbers: Less than 15 cm. Examples: Rania RZ**

Other varieties include:

- **Ashley**
- **Poinsett. Poinsett is a variety with a very high yield potential, good disease and heat resistance.**
- **Long Fellow**
- **Hybrid Victory**
- **Kande (new variety produced in Tanzania)**

Because varieties change all the time, please ask your local seed company to give information about the available varieties.

Marketable cucumbers: The two long varieties shown on the left are green house types that need protected environment and careful staking so as not to damage fruits. The two short types on the right can be grown in open fields and without staking. Pickling varieties are even smaller, but also baby fruits of the two field varieties are good for pickling.

Husbandry

Weed control is necessary until the plants cover the soil entirely. Support (stakes) should be provided for some cultivars, and the tip of the main stem can be nipped off to encourage branching. Irrigate at frequent intervals, and maintain a high level of soil moisture throughout the growing period. Lateral shoots can be pruned after the first fruits have formed to limit leaf and flower production. Greenhouse varieties are staked according to preferred practices, usually by means of twisting the growing stem around a string attached to an overhead strong wire. There are indications that irrigation water containing applications of effective micro-organisms (EM) can prevent damping off and early attacks of diseases on leaves. Irrigation should preferably be applied in the form of drip irrigation in order to prevent water splashes and spread of diseases. Staked cucumbers are very susceptible to wind, so if grown in open land should be carefully protected from wind.

Harvesting

Cucumbers for fresh consumption are harvested before they are fully mature, usually starting about 50- 60 days after planting, and thereafter every few days. For pickling, immature fruits of several stages are harvested. Only for seed production are cucumbers allowed to mature on the plant. Cucumbers should be handled with care as they get damaged easily during transport. Depending on variety one plant may yield up to 10 fruits, and total yields with good plant care can easily reach 50 tons/ ha of the larger fruit types. More common yields are 25-30 tonnes/ha. Fruits should not be left to ripen on the vines as the plants will cease to bear. The marketed fruit must be firm, green and the size typical of the cultivar.
Some of the long slicing cultivars of cucumber are packed individually before marketing and cooled.

back to Index

Information on Pests

Aphids (*Aphis gossypii*)

The cotton aphid (*Aphis gossypii*) is common on cucurbits, including cucumber. Colonies of green to blackish aphids are found on tender shoots, mainly on the lower leaf surface, where they suck sap. The growth of the attacked shoots is stunted and the leaves are curled and twisted. Aphids excrete honeydew, which leads to growth of sooty mould, and may attract fruit flies. Aphids, in particular winged aphids, transmit virus diseases (e.g. cucumber mosaic virus) when moving from plant to plant.

Aphids
The cotton aphid (*Aphis gossypii*) is a small aphid.

What to do:

- **Plant barrier crops**
- **Apply sticky traps**
- **Use botanicals (e.g. neem extracts)**
- **Use reflective mulch (e.g a polyethylene sheet covered with a thin layer of aluminium that is spread out on the growing bed at planting time). Covering the ground with a material like aluminium foil repel winged aphids, delay aphid colonisation and may delay virus infection**

Adults range from just under 1-1.5 mm in body length.

More Information on Aphids

Fruit flies (*Bactrocera cucurbitae*, *Dacus* spp and *Ceratitis capitata*)

Fruit flies are important pests of cucumber and other cucurbits.

Fruit flies are about 4-7mm long, they pierce the fruits and lay eggs in fruits. The fruit fly maggots feed inside the fruit causing sunken, discoloured patches, distortions and open cracks. These cracks serve as entry points for fungi and bacteria, causing fruit rot.

Fruit fly maggots
Fruit fly maggots in watermelon fruit, the larvae are about 1cm long


Fruit

Fruit

Fruit

Fruit

What to do:

- **Avoid continuous cultivation of cucumbers at the same place since this may lead to fruit fly outbreaks.**
- **Destroy all infested fruit**
- **In small plots, wrap individual fruits or bag them with newspaper or paper bags to prevent fruit flies from laying**

eggs fruits. Wrapping or bagging should be started shortly after fruit set.

- **Spray with a pyrethrum solution in the evenings after the bees are mostly back in their hives (after 6 pm). There is a product commercially available called Flower-DS, made of natural pyrethrum and acceptable in Organic certified systems (see Hygrotech Company, contact-addresses below).**
  - Precautions: Be careful to spray late in the evening, follow the spraying instructions. Wear masks and skin protection. All insect poisons are also poisonous to humans even if coming from natural sources.
  - Frequency of spraying: start shortly after beginning of flowering, and repeat approx every 5 days or according to counts.
- **Frequent applications of neem can keep fruit fly attack to a minimum.**
  For more information on neem click here.

fly ... **fly ...** **fly ...** **fly ...**

More Information on Fruit flies

Whiteflies (*Bemisia tabaci*)

They suck plant sap and excrete honeydew where moulds grow, which may affect plant growth and vigour. The tobacco whitefly is considered a major pest due to its ability to vector various virus diseases, which cause considerable damage to cucurbits. (*Bemisia tabaci*)

What to do:

Whiteflies
Whiteflies (*Bemisia tabaci*)

- **Conserve natural enemies. Parasitic wasps are important in natural control of whiteflies**
- **Use reflective mulches (see aphids). Reflective mulch repels whitefly adults in pumpkin, cucumber and zucchini squash, resulting in delayed and reduced attack by this pest with consequent reduction in damage as shown in experiments in USA. Whitefly density on pumpkins and cucumbers plants growing over reflective mulch was reduced 10- to 14-fold as compared to plants growing on bare soil. This was reflected in significantly higher yields in plants grown over reflective mulch than in those grown over unmulched soil. (UCANR, 2003; Summers & Stapleton 2002)**
- **Whenever necessary spray crop with neem products. Neem-based pesticides are reported to inhibit growth and development of immature stages, and to reduce egg laying by adult whiteflies**

under leaf. Adult whiteflies are about 1mm long.

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More Information on Whiteflies

Epilachna beetles (*Epilachna chrysomelina*)

Adults of this beetle, also known as the African melon ladybird, are 6-8 mm long, reddish in colour with a number of black spots on the wing cases. The larvae are 7-9 mm in length, soft and covered with dark coloured spines. Adults and larvae feed on leaves leaving a fine net of veins. Damaged leaves shrivel and dry up. Young plants can be entirely destroyed. Older plants can tolerate considerable leaf damage. This beetle is a vector of squash mosaic virus. Epilachna beetles attack all cucurbits.

Epilachna beetle Larvae of Epilachna beetle (*Epilachna chrysomelina*) and damage caused (here

What to do:

- **Spray neem extracts. Simple neem-based pesticides have given control of this pest in Togo. Thus, feeding by Epilachna beetles in squash and cucumber could be reduced significantly by weekly applications of aqueous neem kernel extracts at concentrations of 25, 50 and 100 g/l and neem oil applied with an ultra-low-volume (ULV) sprayer at 10 and 20 l/ha (Ostermann and Dreyer, 1995).**

on water melon).

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Epilach Epilach ...

Flea beetles (*Podagrica* spp)

They are tiny to small (1.5 to 3 mm) long leaf beetles with well-developed hind legs. They are named for their habit of jumping like fleas when they are disturbed. The colour of the adult beetles varies from black, brown, black and yellow striped or metallic blue-green depending on the species. Adult flea beetles chew small round holes (shot holes) in leaves, giving them a sieve like appearance. On rare occasions, they may feed directly on ripe fruit, just below the calyx. This damage is usually seen only in plants that show extreme foliar stress resulting from lack of water or powdery mildew. The larvae of flea beetles live in the soil and feed on roots, but the damage caused is not of economic importance. Adult flea beetles can be particularly damaging to young plants. Seedlings are most vulnerable to flea beetle feeding when stressed, particularly by inadequate moisture. Older plants can withstand considerable leaf perforation.

Flea beetle
Flea beetle (*Podagrica* spp) feeding on young okra pod

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What to do:

- **Monitor the crop frequently, particularly during the first stages of the crop. Even a small flea beetle population can cause significant damage to a crop in the cotyledon or first-leaf stages**
- **Provide good nutrition and favourable growing conditions. This helps to avoid plant stress from diseases and moisture, and helps plants survive flea-beetle attack.**
- **Weed in and around fields. This may help to eliminate flea beetle shelter and breeding grounds, reducing crop damage.**
- **Keep plant diversity in the farm. Living mulches or polycultures are known to reduce flea-beetle damage. Diversity in the farm support populations of natural enemies.**
- **When necessary spray botanicals or other alternative products. Extracts of neem, rotenone, pyrethrin, sabadilla, garlic, onion and mint alone or in combination have been recommended for control of flea beetles. Insecticidal soap is reported to give partial control of flea beetles. However, sprays combining rotenone with insecticidal soap are considered very effective. Diatomaceous earth and rock powders have been observed to reduce flea-beetle populations but applications must be renewed regularly after rainfalls.**

Red spider mites (*Tetranychus* spp.)

Red spider mites attack leaves of cucumber. Adults are about 0.6 mm long. Attacked leaves have a stippled appearance, turn

yellowish to whitish and dry up. Often young plants are entirely destroyed. In older plants growth can be severely stunted and the fruit set considerable reduced. Spider mites can be a problem in dry and hot conditions. Plants under water stress (drought) are more likely to suffer damage by spider mite.

What to do:

- **Conserve natural enemies. Predatory mites and anthocorid bugs are important in natural control of mites**
- **Avoid use of broad-spectrum pesticides. They may kill natural enemies and may lead to mite outbreaks**
- **Provide good growing conditions for plants. Healthy plants are more likely to withstand mite attack. Adequate irrigation is particularly important. Apply mulch and incorporate organic matter into the soil to improve the water holding capacity and reduce evaporation**

Spider mites
Spider mites (here on tomato). Note the mites and their webbing visible beetween the leaves.

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Spider mit… **Spider mit…**

More Information on Spider mites

Root-knot nematodes (*Meloidogyne* spp.)

Symptoms of infestation by root-knot nematodes are similar in

all crops: wilting of plants and if infested plants are pulled from the soil the roots can be seen to be distorted, swollen and bearing knots. The infested roots eventually rot and affected plants die.
(*Meloidogyne* spp.)

What to do:

- **Use resistant varieties, if available**
- **Practice mixed cropping. Mixed cropping with African marigold (Tagetes spp.) minimise root-knot nematode damage. Intercrop with different mustards (e.g. Brassica juncea var. integrifolia or Brassica juncea var. juncea) on infested fields. As soon as mustards are flowering they are mulched and incorporated into the soil. While incorporated plant parts are decomposing in a moist soil, nematicidal compounds of this decomposing process kill nematodes. Two weeks after incorporating plant material into the soil a new crop can be planted or sown (phytotoxic effects are usual if the crop is planted before two weeks).**
- **Maintain high levels of organic matter in the soil (manure or compost)**
- **Use biofumigation where possible (biofumigation involves incorporation into the soil of crop residues of crucifers, resulting in high levels of organic matter).**
- **Use neem extracts**

Root-knot nematodes
Root-knot nematode (*Meloidogyne* spp.) galls (here on tomato roots). Root-knot nematodes affected plants are normally stunted and eventually wilt and die. The most characteristic symptom is formation of root galls (knots) and these can be seen with the naked eye. Affected roots rot.

More Information on Root-knot nematodes

back to Index

Information on Diseases

General Information

Many viruses affect the cucumber family. The important viruses include cucumber mosaic virus, watermelon mosaic virus and squash mosaic virus. Field symptoms of these three diseases are similar and therefore it is very difficult to separate them by symptoms alone. Leaf symptoms include a prominent light and green mosaic pattern, mottling (yellow with green islands or blisters), and in severe cases, leaf distortion whereby affected leaves appear fern-like. Diseased fruits are malformed (slightly to severely misshaped with wart-like lumps).

Examples of Cucumber Diseases and Organic Control Methods

Damping-off disease

Damping-off disease - *Phytium* sp. on Cucumber

Damping-off disease - *Phytium* sp. on Cucumber

More Information on Damping-off diseases

Downy mildew (*Pseudoperonospora cubensis*)

Symptoms on leaves appear as small, pale-yellow areas on upper leaf surface. Under humid conditions, a purplish, grey whitish growth may be seen on the underside of the yellowish spots. Affected leaves curl, shrivel and die.

Most downy mildew fungi require cool weather for reproduction and development. This is not true of the cucurbit downy mildew fungus. Optimum temperature for infection is at 16 to 22º C. It can survive when temperatures are over 37.8º C. The most critical factor for infection is a film of moisture and / or long dew periods on leaves. Disease spread is primarily through wind and rain splash. The fungus attacks only members of the cucumber family, mostly those that are cultivated, although it can infect wild cucumber and a few other weed hosts.

Downy mildew on cucumber Downy mildew (*Peronospora* sp.) attacking the upper leaf face

More Information on Downy mildew

What to do:

- **Use resistant varieties, if available**
- **Leave wide spacing between plants**
- **Avoid overlap cucumber plantings**
- **Copper fungicides at 0.1% can provide control**

Powdery mildew (*Sphaerotheca fuliginea* and *Erysiphe cichoracearum*)

Symptoms first develop as a whitish talcum-like powdery growth on lower leaf surface. The powdery growth is composed of fungal spore mass. These areas covered by white powdery growth may enlarge and join up to cover both lower and upper leaf surfaces. Severely affected leaves dry, turn brown and become brittle. Vines can be also attacked. Secondary effects of the disease include sun-burning and premature ripening of fruits.

Powdery mildew affects cucumber, gourd, muskmelon, pumpkin, squash and watermelon. Other hosts include African violets and pawpaws. The powdery mildew fungi are influenced by plant age, humidity and temperature. Foliage is most susceptible 16 to 23 days after unfolding. The fungi reproduce under dry conditions. Infection increases as humidity increases, but does not occur when leaf surface is wet. Optimum temperature for infection is about 27.4º C. However, infection can take place at a temperature as high as 32º C and relative humidity as low as 46%.

Powdery mildew
Severe powdery mildew attack (*Sphaerotheca fuligenea*) on cucumber

© Jürgen Kranz Courtesy of EcoPort

More Information on Powdery mildew

What to do:

- **Use resistant varieties, if available**
- **Spray with sulphur based fungicides, which provide good control**
- **Destroy weeds belonging to the cucurbit family**

Angular leaf spot (*Pseudomonas syringae* pv. *lachrymans*)

Spots on leaves angular in shape and variable in size due to leaf veins that limit their enlargement. Initially, spots are water-soaked. In moist weather, bacteria ooze from the spots in tear-like droplets, which dry making the tissue white. Affected leaf dries and shrinks, and it may tear away from the healthy portion leaving irregular holes. Leaves approaching maturity are more susceptible than older leaves. Fruits may also be attacked. Fruit spots are small, nearly circular and superficial. The bacteria survive in association with seed. When infected cucumbers are used for seed extraction, the seed can be contaminated during fermentation process.

Angular leaf spot
Angular leaf spot (*Pseudomonas syringae* pv. *lachrymans*) on cucumber

© A. A. Seif

The bacteria can also survive in soil or infected crop debris. Drainage water can spread the bacteria in the soil. Angular leaf spot disease is favoured by wet conditions, frequently associated with rainfall and overhead irrigation. Optimum temperature for disease development is 23.9 to 27.8º C. The disease attacks gherkin, muskmelon, pumpkin, squash, vegetable marrow and watermelon.

What to do:

- **Use resistant varieties, if available**
- **Use disease-free seed**
- **Practice crop rotation. A crop rotation of 1 to 2 years is recommended**

- **Avoid run-off water from nearby cucurbit fields and overhead irrigation**

Anthracnose (*Colletotrichum orbiculare*)

The fungus can attack all the above-ground plant parts. Cotyledons (seed leaves) of affected seedlings droop and wilt. Lesions (elongated spots) may form on stems of affected seedlings near the ground. Spots on leaves start as small yellowish areas that enlarge and turn brown. The affected tissue dries, breaks and the whole leaf dies. On vines, the spots are elongated and may kill the vines.

Symptoms are most noticeable on fruits. Spots on fruits are circular, black, and sunken. When wet, the centres of the spots become salmon coloured due to a mass of fungal spores. Affected fruits can be destroyed by secondary soft-rot organisms, which enter through broken rind. The fungus is seed-borne. It can survive in crop debris and in weeds belonging to the cucurbit family. Fungal development is promoted by wet conditions, high relative humidity and moderate temperatures (20 to 23.9º C). Its host range includes cucumber, gherkin, gourd, muskmelon, and watermelon. Cucurbit weeds can also be attacked.

Anthracnose
Anthracnose (*Colletotrichum orbiculare*) damage to pumpkin leaf (*Cucumis sativus*).

© Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org
More Information on Anthracnose

What to do:

- **Use resistant varieties, if available**
- **Use disease-free seeds**

- **Practice crop rotation**
- **Destroy volunteer cucurbits and weeds**

Fusarium wilt (*Fusarium oxysporium* f.sp. *cucumerinum*)

In seedlings, the cotyledons lose their healthy look (luster) and wilt. This is followed by complete collapse of the plants. Older plants initially exhibit wilting and yellowing of leaves near the crown. Later individual vines and then the whole plant wilt and dies. If the taproot and stem are split open, an orange-brown discolouration of the water conducting tissues will be seen. Fruits from affected vines are small with poor flavour and colour.

The fungus is a soil inhabitant. It enters the roots and grows in the water conducting tissues thereby blocking water movement. The fungus is also carried on the seeds and in soil adhering to farm implements. It can persist in soil for long periods. The disease is favoured by warm weather (optimum soil temperature for infection is about 27.8º C) and air humidity of more than 80% over a long period.

Fusarium wilt
Wilting (here of okra plant) due to fusarium wilt

© A.M. Varela & A.A.Seif, icipe
More Information on Fusarium wilt

What to do:

- **Use resistant varieties, if available**
- **Use disease-free seeds**
- **Avoid spread of the fungus through contaminated farm implements and furrow irrigated water**

Fruit rot

Fruit rots are of minor importance in Africa; they are primarily post-harvest problems during storage. In most African countries, cucumbers are sold fresh from farm, consumed and are hardly stored for long (exception could be supermarkets in urban areas where fruits are kept on shelves).

What to do:

- **Avoid injuries during harvesting**
- **Store fruits properly after harvest**

Mosaic Virus diseases

Cucumber mosaic virus
It is not seed transmitted except through seed of perennial wild cucumber (*Echinocytis lobata*) and chickweed (*Stellaria media*). It is mechanically transmitted and in nature it is spread by various species of aphids. It has a very extensive host range including such varied species as bananas, carrots, cowpeas, lupine, lilies, onions, passion fruit, potatoes and tomatoes.

Watermelon mosaic virus
This virus is mechanically transmitted and also spread by several species of aphids. It is not seed transmitted. Its host range is primarily restricted to cucurbits although one of its strains infects peas.

Squash mosaic virus

Virus diseases
Virus on cucumber leaf

© A.A. Seif, icipe


Virus dise... **Virus dise...**

It is mechanically transmitted. It is transmitted through seeds of melons and squash. It is also transmitted by spotted, striped and banded cucumber beetles, which attack cucumbers in the Americas. The Epilachna beetle (*Epilachna chrysomelina*) a pest of cucumber in Africa, is also vector of squash mosaic virus. Its host range includes cucurbits, peas, coriander, and salad chervil.

What to do:

- **Use tolerant / resistant varieties if available**
- **Remove infected plants (disinfect hands and tools with 70% alcohol after contact with infected plants)**
- **Do proper weeding**
- **Control insect vectors. A sustainable approach of controlling aphids is important to prevent aphids reaching the crops and transmitting virus.**
- **In case of squash mosaic virus use disease-free seeds**

Scab (*Cladosporium cucumerinum*)

It attacks all aboveground plant parts. Initial symptoms on leaves appear as light water-soaked or pale green spots. The spots are numerous and can appear on and between veins. Elongate spots may develop on petioles and stems. The spots later turn grey to white and become angular. The fine veinlets in the spots may be brown and are distinct against a white background. Dead leaf tissue cracks and breaks away until the whole leaf is ragged. Fruits can be attacked at all stages of growth. However, young

Scab
Scab (here on citrus leaf) symtoms on leaf

fruits are most susceptible. Plant tissue near the spots may produce sap, initially watery but later becomes gummy to hard.

The fruit spots are cankerous and with time become darker, sunken until a pronounced cavity is formed. Under moist weather, a dark-green velvety layer of fungal growth appears on the cavities. The fungus survives in crop debris, soil and on seed. It is spread by insects, farm tools and wind. The disease is most severe at 100% relative humidity and at relatively cool temperatures (21-25ºC). Its host range includes cantaloupe, gherkin, muskmelon, pumpkin, squash and watermelon.

What to do:

- **Use resistant varieties, if available**
- **Use disease-free seeds**
- **Practice crop rotation with nonrelated crops**

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back to Index

Information Source Links

- **AIC, Nairobi (2003). Fruits and Vegetables Technical Handbook**
- **AVRDC International Cooperators' Factsheet on Cucurbits www.avrdc.org/LC/cucurbits/publications.html**
- **Beije, C.M., Kanyangia, S.T., Muriuki, S.J.N., Otieno, E.A., Seif, A.A., Whittle, A.M. (1984). Horticultural Crops Protection Handbook.National Horticultural Research Station, Thika KEN/75/028 and KEN/80/017/**
- **Blay, E., Cudjoe, A. R., Braun, M. (editors) (2000). Handbook of crop protection**

recommendations in Ghana: An IPM approach. Vol 2; vegetables. Plant Protection & Regulatory Services Directorate (PPRSD) and the Integrated Crop Protection Project, German Development Cooperation (GTZ).

- **Bohlen, E. (1973). Crop pest in Tanzania and their control. Federal Agency for Economic Cooperation (BFE). Veralgh Paul Parey. ISBN 3-489-64826-9.**
- **CAB International (2005). Crop Protection Compendium, 2005 edition. Wallingford, UK www.cabi.org**
- **Ekesi, S., Billah, M.K. (Eds) (2006). A field guide to the management of economically important tephritid fruit flies in Africa. ICIPE. ISBN: 92-9064-179-7.**
- **Kuepper, G. (2003). Flea Beetle: Organic Control Options. NCAT Agriculture Specialist. Published ATTRA Publication #CT114. National Sustainable Agriculture Information Service.**
- **Ministry of Agriculture and Rural Development (Kenya) (MoARD) & Japan International Cooperation Agency (JICA) (2000). Local and Export Vegetables Growing Manual. Reprinted by Agricultural Information Resource Centre, Nairobi, Kenya. 274 pp.**
- **Ostermann, H., Dreyer, M. (1995). Vegetables and grain legumes. In ?The Neem tree *Azadirachta indica* A. Juss. and other meliaceous plants sources of unique natural products for integrated pest management, industry and other purposes?. Edited by H. Schmutterer in collaboration with K. R. S. Ascher, M. B. Isman, M. Jacobson, C. M. Ketkar, W. Kraus, H. Rembolt, and R.C. Saxena. VCH. pp. 392-403. ISBN: 3-527-30054-6**
- **Sherf, A.F., Macnab, A.A.(1986). Vegetable Diseases and Their Control. 2nd. Edition. John Wiley & Sons Inc. USA. ISBN: 0-471-05860-2**
- **Summers, C.G. and Stapleton, J. J. (2002). Use of UV reflective mulch to delay the colonization and reduce the severity of *Bemisia argentifolii* (Homoptera: Aleyrodidae) infestations in cucurbits. Crop Protection. Volume 21. Pages 921-928. www.sciencedirect.com**
- **UCANR. UC helps pumpkin farmers produce pumpkins without pesticides. October 2003. www.ucanr.org**
- **East African Seed Co. Ltd. Africa's Best Grower?s Guide www.easeed.com**

back to Index

Contact Links

- **For information on small scale farming techniques, seeds, equipment and insecticides(e.g. pyrethrum solution).**

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back to Index

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