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Sucking Pests of Pineapple and their Management- A Review

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Abstract: ***Pineapple herbaceous, perennial plant of the tropical and subtropical area. Pineapples grow as a small shrub and the plant is normally propagated from the offset produced at the top of the fruit or from side shoot. The fruit are eaten fresh where available and in canned form worldwide which is the only source of bromelain, an enzyme used in pharmaceuticals and as meat tenderising agent. Common sucking pests infesting vegetative propagules are mealybugs, scale and pineapple red mites. The successful management of pineapple pests is based on their correct identification and an understanding of how damage occurs. Amongst the sucking pest mealy bugs are the utmost important insect pest of pineapple in many countries while others may reach threshold levels in certain favourable conditions causing serious crop damage.***
Keywords: Pineapple, Sucking Pests, Management

Introduction:

Pineapple (*Ananascomosus*), is self-sterile, herbaceous, monocotyledonous, perennial plant of the family Bromeliaceae. Pineapple is originated in tropical and subtropical America and has been introduced to all other places. Pineapples cultivated as a small shrub; the separate flowers of the unpollinated plant fuse to form a multiple fruit. The plant is normally propagated from the offset produced at the top of the fruit, or from side shoot and typically mature within a year. Since the 1820s, the crop has been commercially grown in protected structures/green houses and many tropical plantations. The fruit are eaten fresh where available and in canned form worldwide. The fruit has developed a characteristic ingredient in the essence, vegetable, fish and rice dishes of what is roughly termed Pan-Asian cuisine. Pineapple grows to 1.0 to 1.5 m (3.3 to 4.9 ft) tall. The plant has a short, sturdy stem with rough, waxy leaves. When producing its fruit, it typically produces up to 200 flowers, though some large-fruited cultivars can exceed this. Once its flowers, the individual fruits of the flowers join together to create a multiple fruit. After 12 - 20 months, the stem

grows into a spike like inflorescence up to 15 cm (6 in) long with over 100 spirally arranged, trimerous flowers, each subtended by a bract.

The ovaries grow into berries, which merge into a large, dense, multiple fruit. The fruit of a pineapple is typically settled in two interlocking spirals, characteristically there are eight in one way and 13 in the other, each being a Fibonacci number. The pineapple is CAM plant, where fixing carbon dioxide at night and storing it as the acid malate, then releasing it during the day aiding photosynthesis. In the wild, pineapples are pollinated primarily by hummingbirds (Stahl *et.al.*, 2012). Bromelain may be dangerous for some users, such as during pregnancy, allergies or anticoagulation therapy.

The main pineapple cultivating countries in the world are Brazil, Thailand, Philippines, Costa Rica, China and India. The total area under pineapple cultivation in the world is 909.84 thousand ha with production around 19412.91 thousand tons (Anonymous, 2011). In India, total area under pineapple production is 88.7 thousand ha and the production are 1415.4 thousand tons. The major pineapple producing states in India are West Bengal, Assam, Karnataka, Meghalaya, Manipur, Arunachal Pradesh, Kerala and Bihar. Maximum area under pineapple cultivation is in Assam (14 thousand ha), but productivity is of medium scale whereas total production and productivity is higher in West Bengal. Productivity is much low in Karnataka, Kerala and Meghalaya states.

Pineapples are attacked by a diversity of insect pests, some of them commonly affect are mealy bugs, scale insects, thrips, fruit borer, bud moths, midgets, fruit flies, white grubs, beetles, weevils, termites and mites. Among the sucking pest mealy bugs are the most important insect pest of pineapple in many countries while others may reach threshold levels in certain favourable situations causing serious crop damage.

Important sucking Insect and mite pests

Common Name	**Scientific Name**	**Family**	**Order**
Mealy bug	*Dysmicoccus brevipes* Cockerell	Pseudococcidae	Hemiptera
Scales	*Diaspis bromeliae* Kerner	Diaspididae	Hemiptera
Thrips	*Holopothrips ananasi* Costa Lima	Phlaeothripidae	Thysanoptera
Red mite	*Dolichotetranychus floridanus* Banks	Tetranychidae	Acarina

1. Pineapple mealybug *Dysmicoccus brevipes* (Cockerell) (Hemiptera: Pseudococcidae)

Dysmicoccus brevipes, usually called the pineapple mealybug, more precisely the pink pineapple mealybug is a universal pest of pineapple crops and a negligible pest of many other crops. Its standing as a crop pest of pineapple is tied powerfully to its capability to spread *Pineapple mealybug wilt* related virus to pineapples. The pests common name is derived from the mealy wax discharge that usually covers their bodies (Kosztarab, 1996).

Distribution:

The pests have been reported worldwide and infestation visible in anywhere pineapple is grown, including many African countries and Australia (Anonymous, 2014). It is believed to have originated in tropical areas in Central and South America (Gonzalez- Hernandez *et al.*, 1999).

Hosts:

The pineapple mealy bug is primarily a pest of pineapple, but due to its polyphagous nature, the mealy bug has been reported on more than 100 plant genera in 53 families. Wide range of other plants viz. avocado, banana, carrot, celery, Citrus, cocoa, coconut, coffee, cotton, *Euphorbia*, ginger, *Gliricidia*, *Hibiscus*, mulberry, orchid pineapple, taro, pumpkin and many perennial grasses (Anonymous, 2014).

Biology:

The pineapple mealybug creates colonies on the lower stem and roots part of pineapple plants, just above ground level. They are less frequently found nourishing on the leaves, fruit and blossom cups. The pineapple mealybug is more solitary than the grey pineapple mealybug, which feeds and resides on the aboveground portions of the plant (Mau and Kessing, 2007). Adult females of the pineapple mealybug replicate parthenogenetically, meaning no males fertilize the eggs. Every egg result in a female mealybug. The species is also ovoviviparous, meaning the eggs hatch within the adult female and she births live, fully-formed larvae (Pandey and Johnson 2007). The lifecycle includes three stages. The normal lifecycle of the pineapple mealybug is 95 days but ranges from 78 to 111 days (Mau and Kessing, 2007).

Eggs are minute (0.3 to 0.4 mm in length) and its development period takes about 3 to 9 days. The Nymphal stage contributes to major dispersal of the nymph bugs because their body is

extensively covered with hairs hence, they are called crawlers. The nymphal period extends up to 40-50 days. The first, second and third nymphal stages last for 10 to 26 days, 6 to 22 days and 7 to 24 days respectively. Adult females having soft, convex, pinkish body and their body are covered by 17 pairs of wax filaments (Tanwar *et al.*, 2007). Like many scale insects, the pineapple mealybug is often tended to by ants, which harvest their honeydew as food. In return, the ant's herd and protect the insects, even occasionally carrying the pineapple mealybugs to new host plants (Jahn and Beardsley, 2000). The ants have symbiotic association with the pineapple mealybug (Petty and Tustin, 1993). The species undergo hibernation in cold period with respect to eggs or other stages, on both host plant and in soil. In warmer climates, the insects remain active and reproduce around the year (Tanwar*et al.*, 2007)

Nature of Damage:

The pineapple mealybug damages pineapple in many ways, all of which reduce the market price of the fruit. The most critical stage of appearance of mealy bugs between six and twelve weeks, when the pineapple "eyes" are open to pests. Direct feeding damages the fruit, causing chlorotic areas (areas that cannot produce enough chlorophyll), rotted bottoms and mealybug stripe (streaks of discoloration with underlying tissue collapse). Sucking by the pineapple mealybug can deteriorate the plant, increasing vulnerability to other pests and diseases. Black spot, produced by a fungus is observed on pineapple fed upon by mealybugs. Black sooty mold and other molds commonly grow in areas exposed to a build-up of honeydew produced by mealybugs.

The uppermost worry for pineapple growers is the pineapple mealybug frequently vectors Pineapple mealybug wilt-associated virus commonly referred to as pineapple wilt, mealybug wilt, or edge-wilt (Sether *et al.*, 1998). Pineapple wilt causes a reddening of leaves and a subsequent pink coloration. The plant loses rigidity and appears wilted. These symptoms may occur rapidly or slowly. The disease primarily attacks the roots of the plant, which in part causes the discoloration and leaf symptoms. Often times, the plants recover and continue growing, but will have reduced weight, leaf size, and root length (Mau and Kessing, 2007).

Management:

Prevention*:* Pre-planting treatments are an effective for controlling pineapple mealy bugs. Selection of healthy suckers is inevitable; avoid planting of five to six years old suckers. Once the suckers are removed, seeds are dried for at least two days upside down on the seed bed (sun based physical control). Before planting, suckers can be dipped in insecticidal solution for about 5- 8 minutes, for example a Diazinon base (900 ml of commercial product/600 liter of water/ha) or botanical extracts (1200 ml/600 liter of water/ha) in organic agriculture (Carillo, 2011).

Cultural Control:

- Avoid using 5-6 years old suckers for planting purpose
- Mealy bug spread can be minimized by destroying ant colonies. If required, ant infestations are treated with such products as hydra methylnon or sodium octaborate but care must be taken against rainwater.
- The mealy bug infested areas must be prepared by eliminating all the plant residues and incinerating them.
- Remove weeds plants in the field as they act as alternate food sources.
- Destruction of alternate hosts such as Hibiscus, custard apple, guava in and around crop field.
- Use sterilized equipment when taking up planting and intercultural operations in an uninfected field.

***Biological Control*:** There are many natural bio-agents for control of mealy bug and they can be introduced to infested fields. Some are discussed here.

- ***Rhino leucophenga*:** A new species of *R. leucophenga*, a potential predator of pineapple mealy bugs (Culik, 2009) was introduced in Brazil. They are larval predators of scale insects (Grimaldi, 1993). *R. leucophenga* species are present in areas such as Espírito Santo and also release eggs or first instar larvae of *Chrysoperla* spp. @ 2-3 grubs/plant.
- ***Cryptolaemus montrouzieri*:** It is commonly called as the ladybird beetle or the mealy bug destroyer. It has been released in Karnataka to decrease large populations of pink mealy bug. The adult lady bird beetle lays egg in between mealy bug egg masses. The

grubs of the beetle grow up to 1.3 cm in length and have wooly appendages of wax making them similar to mealy bugs. The grubs feed on mealy bug eggs and young crawlers. The life span of the *C. montrouzieri* is eight weeks within which they lay up to 400 eggs. It has feeding potential of about 5,000 mealy bugs in various life stages.

- ***Anagyruskamali:*** It is parasitoid, native to China and introduced in Karnataka for the control of pink mealy bugs. It feeds on mealy bug in two ways: (i) the female wasp punctures the bug and sucks the sap and (ii) it lays egg within the bug. When the egg matures it comes out of the bug's body. The entire process takes only half the entire life span of mealy bugs.

- ***Anagyrusananatis****:* It is also a parasitoid and used for controlling of the alarmed mealy bug populations which cause mealy bug wilt associated disease (Gonzalez-Hernandez, 1995).

- ***Verticillium lecanii*****/ *Beauveria bassiana****:* Foliar spray of *Verticillium lecanii*or *Beauveria bassiana*(2 × 108 cfu/ml) at 5 g/ml per litre of water is effective during high humid months in reducing the population of mealy bugs (Tanwar *et al.*, 2007).

C*hemical Control*: Chemical practices are the final attempt for the control of mealy bug and are to be followed as.

- Application of Chlorpyriphos (Hilban 20EC, 2.5 ml/ lit), Imidacloprid (Tatamida 200SL, 0.3 ml/ lit) or Quinalphos (Ekalux 25EC, 2 ml/ lit) @ 500-600 lit/ha.
- Indirect control of mealy bugs can be achieved by drenching soil with Chlorpyriphos 20 EC at 2.5 ml/ lit or apply 5% Malathion dust at 25 kg/ha (Tanwar *et al.*, 2007) to kill the ant colonies.
- Basal portions of the planting materials have to be dipped in 0.02-0.04% Methyl parathion as a prophylactic measure
- Diazinon is applied once or twice to a few fields (2%). Also, a pre-plant dip in Diazinon doubles the shield (Sipes, 2000).

2. Scale Insects: *Diaspis bromeliae* (Kerner) (Hemiptera: Diaspididae)

Distribution and Identification:

It is generally found out on upper leaf surfaces of pineapple and fruit surface of worldwide (Waite, 1993). It has deviating appearance; some are very small tiny (1–2 mm) that grow beneath wax covers, to shiny pearl like objects (about 5 mm), to creatures covered with mealy wax. Adult female scales are most of time immobile and permanently impounded to the plant and they have parasitized. They secrete a waxy coating from the body it acts as defence mechanism; this coating is resembled reptilian scales or fish scales. Yellow spots may develop on leaves when scale densities are low (Waite, 1993). The other scales have been reported infesting pineapple but these are not normally a problematic. The brown/ red pineapple scale, *Melanaspis bromeliae* is similar in appearance to *D. bromeliae* nevertheless it is a chocolate-brown colour with a raised centre. The mealy bugs especially demonstrate high degrees of sexual dimorphism; female scale insects retain the immature external morphology even when sexually mature, a condition known as neoteny. Adult males usually have wings (depending on their species) but never feed and die within a one or two days.

Host Plants:

D. bromeliae is quite polyphagous and was recorded from host plants belonging to 10 plant families (Borchsenius, 1966); however, Miller and Davidson, 1990 attribute it with hosts in 10 genera belonging to two families. Hosts include species of: *Aechmea*, *Agave*, *Ananascomosus, Ananas sativus*, *Anthericum*, *Billbergia*, *Brassia*, *Bromelia*, Bromeliaceae, *Canna*, *Chamaerops*, *Hedera*, *Hibiscus*, *Jodina*, *Nidularium*, *Ocotea*, *Osmanthus*, Palmae, *Phoenix*, *Saccharum* and *Tillandsia*.

Biology:

Scale insects have three distinct life stages (egg, immature, adult) and they complete several generations in a single year. The first larvae of many species of scale insects arise from the egg with functional legs and are casually called "crawlers". They instantly crawl around in hunt of a favourable spot to settle down and feed. There are many differences on such themes, such as scale insects that are related with species of ants that act as herders and carry the young ones to threatened sites to feed. Moreover, in many such types of crawlers when they change their skins lose the use of their legs. Only the males retain their legs and use

them in seeking females for mating. The most of scale insects are hermaphrodites and at least seven forms of parthenogenesis. Adult females produce eggs beneath the scale covering or in a cottony material and in many cases spend the cold winter months in this stage. Minute six legged crawlers develop from the eggs move to newer growth on the plant, insert their mouthparts and begin to feed. Adults scale species are recognized by the colour and shape of the covering. The covering protects scales from predation by other insects and from insecticides. The male scale is frequently having different shape than the female and conclude through a tiny, winged stage. The casual observer seldom sees winged stages. Females are wingless and frequently continue in one place after introducing their mouthparts into plant tissues.

Nature of Damage: The main symptom of an attack is rusty spots. The scale or protective armor is made up partially of a waxy discharge of the insect and moderately of molted skins. The insect itself in the adult phase is fairly well buried underneath the epidermis of the plant and hence there is need of fighting the pest in its early stages. In the areas of large populations some scales become so plentiful that an infested plant tissue is totally encrusted with insects.

Management:

***Chemical Control*:** A light, superior oil/insecticide mixture as soon as applied just as plants begins to grow to control emerging crawlers. The oil should be sprayed before leaves open, yet late sufficient so that this combination will kill the crawlers. The right times to apply any insecticide when the crawlers are present, at this stage does not have a protective covering and is therefore vulnerable to almost any chemical registered for this use. Several conventional insecticides and insecticidal soaps are registered for crawler management. The plant is essentially be covered to kill the crawlers with one application. Systemic insecticides can be sprayed as a foliar spray, can help control adult scale insects during the growing season. Each condition is unique so, it is significant to distinguish which scale species is present overly successful or practical control.

***Biological Control*:** This pest may be biologically controlled by many natural enemies (Waite, 1993). Tiny wasps, including *Aphytis chrysomphali* (Mercet), *Aphytis*

diaspidis(Howard) and *Aspidiotiphagus citrinus*(Craw) (Hymenoptera: Aphelinidae) parasitize the scales, resulting in scale mortality. Lady birds such as *Rhyzobius lophanthae* Blasid and *Telsimisnitida* Chapin (Coleoptera: Coccinellidae) also prey upon the scales (Carter, 1967; Waite, 1993). At the same time, a few of scale insects are considered it as biological control pest agents in their own right such as various species of *Dactylopius*, the cochineal genus, that attack pest species of Opuntia.

3. Thrips: *Holopothrips ananasi* (Thysanoptera: Phlaeothripidae)

Thrips producing serious damages to pineapple (Cavalleri and Kaminski, 2007). As many as 39 species of thrips have been reported worldwide in and around pineapple fields (Petty, 1978). These are small (1.5 mm long), slender, brown insects with pale yellow hind wings appear when the insect is at rest. Adult thrips have characteristic wings; the transparent wings have a fringe of hairs around the outside edge in the same plane as the wing. *Thrips tabaci*, *Frankliniella schultzei* are also measured as significant pests of pineapples. The blossom thrips mainly suck on flowers and its feeding consequences in the development of "dead-eye" in the fruit. Thrips feeding on the top of fruits results in concentric ring patterns developing on crown leaves. Thrips are mobile phase and are able to spread great distances with wind. Abiotic parameters like water and high moisture seem to be very important for thrips multiplication. Thrips are readily move towards moisture and mulched areas. Thrips are remaining active the year around.

Biology

The life cycle of thrips is unique and it reproduces quickly. Females have a saw-like ovipositor that helps for making an incision in plant tissue for egg laying. Usually eggs are laid into incisions in the epidermis of the leaves and stems of young plants. Eggs are elliptical, white in colour, roughly 0.02 cm in length, placed singly, just under the epidermis of succulent leaf, flower, stem or bulb tissue. They are initially deposit whitish colour eggs later it changes to an orange tint as development continues. It will hatch within 4 to 10 days. Young ones will immediately begin to suck sap and fluids containing nutrition from plants. Larvae as well as the adult insects penetrate the leaves and sip the sap. Pupation takes place in the ground. The emerging adult is about 1 mm in length and has a yellow brown colour

with dark cross stripes on the body. There are two larval stages and besides the adults they are the only damaging stages. Larval development is completed in about 9 days. There are two non-feeding stages called the pre-pupa and pupa. Combined pre-pupal and pupal development is completed in 4-7 days. Adults are 0.02 cm long. Their body colour varies from pale yellow to dark brown; wings are un-banded and dirty grey. Males are wingless and exceedingly rare. Females live for an about two to three weeks and each can lay approximate 80 eggs. Mating is not necessary for reproduction. Females produce only female offspring without mating. Females can produce up to 80 eggs, that's why large populations can be generated within a short period. The total life cycle is projected as three weeks producing 5-10 generations in a year.

Nature of Damage:

Thrips suck the plant sap by damaging the leaves. The typical appearance of the damage is a silvery-flecked leaf surface and in severe cases turns brown. Appearance of small black spots on the leaves, the excrements of the insects and sign of thrips infestation. Many thrips rest firmly against leaf veins or in crevices. They are primarily active during the daylight hours. Thrips mainly help in transmission of many fungal and viral diseases in plants. A few species prey upon destructive mites and scale insects, leading to formation of leaf mould. A few others species may assist in the pollination of flowers. These are also preyed upon by many insects (including other thrips), mites, birds, salamanders and lizards. Heavy showers, winds and dust are however possibly as critical to thrips as are predators. Natural parasites are minute parasitic wasps (Eulophidae) which attack on the larval stage. Thrips feed by piercing individual cells and sucking the sap contents. These cells lose their normal colour and when many adjacent cells are damaged, the tissue appears as whitish spots or silvery spots or streaks. In advanced damage the leaves take on a horrible appearance. As is mutual with many thrips species onion thrips deposit small dark fragments of excrement on the surface of tissue where they feed. Considerable damage can be done to young plants particularly to varieties grown in seed beds. Besides direct damage produced by feeding of larvae and adults, this pest is also important as a vector of tomato spotted wilt virus and has been involved in transmitting the disease in pineapple, tomatoes and certain other crops.

Management:

Prevention: Thrips are most infective during drought but not in rainy seasons. Irrigation might reduce thrips population and they move by wind. Establishment of windbreaks reduces thrips population. Suggested economic threshold for small scale growers is when 20% of the plants are attacked with thrips.

***Biological Control*:** Plants that have a natural repellence to thrips are citronella, garlic and pyrethrum. A spraying with garlic and pepper will also control thrips. Two bulbs of garlic and some hot chilli peppers should be blended in some water and after blending the solid parts should be filtered. Add water up to 5 litres and this solution can be applied. Mix 2 kg of fresh plant material of *Andrographis paniculate* with 250 ml of water and grind it well. Add 21 litres of cow urine and 10 g of crushed dried chilli fruits. Add 10 litres of water and leave the solution for some time. Filter the solution and it is ready for spraying. Rinse new roots of *Derris eliptica* and cut them into small pieces of 5 cm length. Add small amount of water and pound the roots until they are finely shredded, filter the solution and dilute with soap and water at a ratio of 1 part soap: 4 parts root solution: 225 parts water. Apply immediately on infested plants.

Cultural Control: Removal of weeds, follow crop rotation, Mulch cropping reduces thrips infestation considerably, Plough deep after harvest to bury the pupae.

***Chemical Control*:** A soap spray will kill thrips which needs to be repeated twice a week.

4. Pineapple Mites, *Dolichotetranychus floridanus* (Acarina: Tenuipalpidae)

The pineapple red mite is the largest mite found on pineapple and bright orange to red colour. The adult mite is approximately 0.3-0.4 mm long and 0.1 mm wide. When present on the plant the mite is always found on the white basal portion of the leaves where it feeds particularly on the crown (Petty, 1978). Individuals are chalky in colour and only have two pairs of legs located near the head. They may be found on detached crowns that are stored for planting. They initiate from previous infestations on the ripe fruit from which the crowns were derived. They usually vanish after the crowns are planted but may be found later on fruit after the flat eye stage of fruit development (Carter, 1967). The pineapple tarsonemid mite *Steneotarsonemus ananas* may be found infesting pineapple later in the plant's phonological cycle.

Distribution:

It is only found in Florida, Cuba, Puerto Rico, Panama, Honduras, Mexico, Central America, Hawaii, the Philippine Islands, Japan, Okinawa, Java, Australia, Brazil, Honduras, Philippines and USA (Jeppson *et al.*, 1975).

Biology:

The tiny epithelium on the palp tarsus has been recorded which is very difficult to see. Eggs are Orange in colour; larvae are pale and almost translucent. They often have three pairs of legs in the larval stage and four pairs of legs in the nymph and adult stages. Adults, nymph and eggs of this species are bright orange in colour when alive.

Nature of Damage:

These cause damage to leaves and fruits. Severe invasions can create large, dark brown lesions that almost cover the basal white tissue which can lead to necrosis and death of the leaves. In pineapple production parts, it may often cause severe injury to recently established plants in the field. Plants that are infested in the initial stages persist small and fruit production is either shortened or non-existent. Deeply infested plants may die before producing fruit (Jeppson *et al.*, 1975). It feeds the epidermal tissue to dry and crack which lets fungus and bacteria to penetrate the plants and cause the tissue rot and scarring and tissue malformation.

Management:

Prevention: Control programs are based on crop monitoring looking for colonies on the basal white tissue of leaves and/or the leaf indentations and "rusty" feeding sites. Three phases in the crop cycle should be watched are planting, flower initiation and near fruit harvest. Timing of treatments is critical for successful control.

***Biological Control*:** The fungus *Hirustella thompsoni* has been effectively used to control this mite.

Cultural Control: The best supervision action is to plant only mite-free seed plant material (Jeppson *et al.*, 1975). Population densities of *D. floridanus* were decreased by routine pesticides and lower or minimal fertilizer treatments.

***Chemical Control*:** Need based recurrent spray application of Dicofol 4 ml/l at 500 l/ha is recommended. At flower introduction, four sprays may be useful at fortnightly intervals.

Some Organic Practices that can be Adapted for Pest Management

- Cow Urine: Dilute one liter of cow urine in ten liters of water and wet the whole plant at the rate of 200-300 l/ha at regular intervals.
- Cow Dung: 12.5 kg of fresh cow dung and 12.5 liters of cow urine are collected in an earthen pot and mixed thoroughly with 12.5 liters of water. The pot is covered and the mixture is allowed to ferment for a week. Occasionally it is stirred with a stick. After a week of fermentation, the mixture is filtered and 100 g of lime is added. The concentration is diluted with water in a 1: 10 ratio and sprayed on the crop at 200-250 l/ha.
- Neem Oil Spray: 2% neem oil is mixed with any detergent powder at 40-50 g/ 100 l and used as a spray solution.
- Neem Seed Kernel Extract (NSKE): It can be used as a prophylactic before the start of pests.
- Chili Garlic Spray: Chili garlic spray is an effective insect repellent.
- Herbal Mixture Spray: About 500 g of tobacco leaves 1 kg of neem kernel, 500 g lime powder, 500 g *Datura* leaves and 500 g pods and seeds of oleander (*Nerium oleander)* are powdered and mixed together, then soaked in 15 liters of water for 15 days. On alternate days the mixture needs to be stirred with a stick. After 15 days one liter of filtrate is mixed in 15 liters of water and sprayed on the crop. It is sufficient for 2.5 ha and is a multi pest repellent.
- Tobacco tea is effective against most pests.

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