

Organic and biological approaches to manage pests of banana

Conventional chemical control measures have failed to control the pest adequately which resulted in severe yield losses. Banana cultivation can be made more profitable in a long run through sustainable management of pests. This article aims to create awareness among all the stakeholders including scientists, researchers, farmers, students and common people regarding different options of organic management of banana pests with special reference to biological control.

INDIA is the largest producer of banana (*Musa* sp. Family- Musaceae) in the world (27.8%) followed by China and Philippines. According to the production, banana is the major fruit crop in India contributing 33.4% followed by mango (20.7%) and citrus (12.5%). In India, banana has a total area of 0.88 million hectare and total production is 30.81 million tonnes with a yield of 34,850 kg/ha. Major banana growing states are Maharashtra, Gujarat, Tamil Nadu, Andhra Pradesh, Assam, Bihar, Karnataka, Kerala, Odisha and West Bengal.

Satyagopal listed 9 species of insect pests having national significance and 4 species having regional significance. Insect pests of banana can cause significant damage to fruits (e.g. Scarring beetle, Banana Rust thrips, flower thrips, Fruit fly, moths/caterpillars, scales), leaves (e.g., cyclamen mite, Banana lacewing bug, leaf thrips, Banana leaf eating caterpillar, Bag worm), corms and pseudostems (e.g., Banana rhizome weevil, Banana pseudostem weevil), and can transmit important plant pathogens (e.g., Banana aphid). Though many options are available for the management of these insect pests, farmers of our country mostly use synthetic chemicals because of their quick effect with or without knowing the ill effects of these chemicals. However, these conventional chemical control measures failed to adequately control this pest resulting in severe yield losses. Sustainable management of pest is the part of sustainable agriculture which makes the banana cultivation more profitable in long term basis with a sustainable way.

MAJOR PESTS AND THEIR SUSTAINABLE MANAGEMENT

Banana pseudostem weevil [*Odoiporus longicollis*, Curculinidae, Coleoptera]

Damage symptoms: Infestation generally starts in 5 months old crop. Pinhead size hole on the stem shows early symptom of infestation. Jelly exudation on the stem from the bore hole is the initial symptom of damage. Chewed up material will be pushed out from the bore hole. Rotting due to secondary pathogen infection and a

foul smell is emitted.

Sustainable management:

- Follow clean cultivation, and uproot and burn infested plant.
- Remove the dead and old leaves.
- After harvesting, remove the bunch and destroy the pseudostem from ground level so as to avoid it serving as a breeding site for the pest.
- Use healthy and pest free suckers to check the incidence.
- Prune the side suckers every month up to 8 months to prevent harbouring of adult weevil.
- Use clean planting materials from tissue culture, or plant vigorous healthy suckers from weevil free plants.
- Avoid mattocking (leaving the plant after bunch harvest for recycling of nutrients) in weevil endemic areas.
- Do not dump infested materials into manure pit.
- Apply mud slurry mixed with neem oil 5% on the pseudostem at five month after planting in heavily infested areas to prevent oviposition.
- Closely monitor the plants for the detection of oviposition punctures.
- Cowdung ash slurry can be plastered on the pseudostem.
- Use of pheromone trap for monitoring and trapping by using 2 methyl 4 heptanol with host plant extract from banana pseudostem.
- Control by using mechanical trap at 5 months stage by using longitudinal split pseudostem trap where longitudinal splits of pseudostem of 30 cm length can be made at the banana gardens @ 20 for 350 plants (10-15 traps/acre). The split portion should face the ground, after one week, collect the trapped weevil and kill. Renew the trap material weekly.
- Another method is Disc-on stump trapping where the pseudostem is cut one foot above the ground level and a pseudostem disc is kept over the stump cut portion. Few pebbles are kept in between so that entryway is made for weevil. This trap attracts both banana stem

weevil as well as banana corm weevil. This trap works for monitoring as well as for trapping.

- Use of some resistant variety-Synthetic diploids (AA) and cv. Sanna Chenkadali (AA), Anaikomban and kunnan groups (AB), Poovan, kadali, chitti, basrai, poomkali, sawaii etc.
- Dipping the suckers in 20% neem seed solution at planting.
- Administer stem injection of neem Azal at 4:4 with water, swabbing with neem Azal 4%, can be recommended for the effective pest management.
- Fill the leaf axils with neem seed kernel powder @ 50 g per plant when the plant attains 135 days after planting.
- Nanma and Menma (a tapioca leaf based organic pesticide) developed by CTCRI is very effective in managing the pest. Spray Nanma 5 % (50 ml/l) covering leaf axil and pseudostem when the plant attains 4-5 months after planting. Nearly 100 ml of spray fluid will be required per plant. Before spraying, the pseudostem of the dried and drooping leaves should be cleaned. Once the infestation is noticed, undiluted Menma is injected just below the bore hole made by the weevil. Injections are to be made at 3 locations around the pseudostem near the infestation point @ 5 ml per injection.
- Swab the cut surface of the longitudinal split traps with 20g of *Beauveria bassiana* fungus or *Heterorhabditis indica* nematode and the weevils die on their own due to infection.
- Swab the cut surface of the longitudinal split traps with 20 g of the formulation either entomopathogenic fungus, *Beauveria bassiana*, *Metarrhizium anisopliae* or entomopathogenic nematode, *Heterorhabditis indica* (1×10^8 spores/mg) and keep the split traps near the banana plant facing cut surface to soil.
- Padmanaban and Sathiamoorthy isolated a good number of fungal pathogens viz. *Fusarium solani*, *Mucor heimalis*, *Aspergillus niger* and *Scopulariopsis bevicaulis* from field population of *O. longicollis*, which may be effective in managing this pest.
- Padmanaban reported that *Beauveria bassiana* and *Metarrhizium anisopliae* have shown efficacy as control agent of the pest. Spray either of this at 20 g per lit of water or 5 ml/l covering the leaf axil and pseudostem at 5 months after planting.
- *Beauveria bassiana* (1×10^7 spores/ml) spray at 5th, 6th and 7th month after planting + stem trapping shows better results against banana stem weevil.
- Predatory ants such as big headed ant and *Tetramorium spp.* are important predators of the banana weevil.



Adult Rhizome weevil

Tunneling and rotting of pseudostem due to pseudostem weevil

Scarring beetle damage on tender leaf and whorl

- Two species of earwigs feeding on larvae and pupae are reported from China. There is a report of an acarine mite parasitizing larvae and adults. Release of an ectoparasitic mite, *Uropodia* sp. on adult weevil had been tried for its control with limited success.

Banana corm weevil [*Cosmopolites sordidus*, Curculinidae, Coleoptera]

Damage symptoms: Newly planted banana fields are easily susceptible to infestation. Infestation begins at the base of the outermost leaf-sheath and in injured tissues at the lower part of the pseudostem. Initially the young grubs make several longitudinal tunnels in the surface tissue until they are able to penetrate to adjacent inner leaf-sheaths. Then they bore into the pseudostem base and rhizome/corm, but also into the base of suckers and into roots. The young grub tunnels into the base of suckers, roots and rhizome/corm. Infested plant shows yellowing and withering of leaves, slowed plant growth, root destruction, reduced fruit production. Young infested suckers often wither and fail to develop.

Sustainable management:

- Use clean planting material. This can be done by selecting vigorous healthy planting material from weevil free plants or from tissue culture.
- Suckers should be pruned periodically and infested pseudostems must be removed from the field and destroyed.
- Banana stumps kept in the field after harvest must be removed and destroyed as they serve as weevil refuges and breeding sites.
- Pare (trim) dead parts from the corm and remove outer leaf sheaths. Immerse suckers in hot water (54°C) for 20 min or dip suckers in 20% neem solution overnight and plant as soon as possible.
- Hot water treatment of corms at 52 to 55°C for 15 to 27 minutes.
- Deep plant suckers (45-60 cm) in fertile soils at recommended spacing to delay infestation.
- Dig out and remove old corms, weeds and trash around banana stools to reduce weevil sheltering sites.
- Spread mulch away from banana stool leaving about 60 cm ring from the stool to prevent the roots growing towards the surface where they can be attacked by weevils.
- Ensure proper fertilization and free from weeds at all times.
- Crop rotation with non host crops like paddy and sugarcane.
- Cut and remove the outer layers of rhizome and sundry for 3-4 days after smearing it with cow dung slurry and ash.
- Avoid growing Robusta, Karpooruvally, Malbhog, Champa and Adukkar and grow less susceptible varieties like Poovan, Kadali, Kunnan, Poomkali.
- Cut slices of banana trunk 7-10 cm thick, place them around the stool on the ground covered by banana leaves to trap and then kill banana weevils mechanically.

- Disc-on-stump traps can be used for trapping weevils. Disc-on-stump traps consist of corm slices placed on top of harvested plants cut at the rhizome. Adult weevils are attracted to the cut stems or corms for shelter, to feed and to lay eggs. The weevils can be collected by hand and destroyed. The efficiency of the traps depends on their numbers and frequency of trapping.
- Cosmolure (an aggregation pheromone) can be set at the rate of 4 traps/ha. The pheromone will last for 2-3 months. Pit fall trap is a metal basin of 15 cm diameter and 12 cm height filled with detergent water up to 3 cm level from the bottom. This is placed in such a way that the brim of the basin is at the ground level and the remaining part inside a pit. A small wooden stand is kept at the middle of the basin on which cosmolure is suspended. The trap should be placed on a 20 × 100 m grid throughout the area. After a month, the trap is moved to 20 m thereby the whole area will be covered with in a cropping season at 4 traps/ha.
- Apply castor cake @ 250 g per pit before planting also prevents infestation.
- Application of 60 to 100 g of neem seed powder or neem cake at planting and then at four months intervals significantly diminished pest damage and increased yields. Application of over 100 g of neem oil was phytotoxic (harmful to plants) and uneconomical.
- Apply 50 g of powdered neem seed kernel per plant in the baby pits in which suckers are planted, apply one kg of neem cake in two equal split doses at one and two month after planting, apply 50-100 g neem seed powder around each stool at 4 months interval (applying higher rates will harm the plant) and apply neem leaf mulch around the base of the plant (1 kg per plant).
- Extracts of *M. azedarach*, *Tagetes* spp and *R. communis* could possibly control the weevil through affecting oviposition.
- Regular monitoring of weevil by keeping banana traps viz. (i) longitudinal cut stem trap of 30 cm size @ 10-15/acre. In case once weevil is attracted to the laid traps, place longitudinal split banana traps @ 100 ha with bio control agents like *Beauveria bassiana* or *Heterorhabditis indica* @ 20 g/trap. These bio control agents have to be swabbed on the cut surface of the stem traps and keep the cut surface facing the ground.
- Apply biocontrol agents like *Beauveria bassiana* and *Metarhizium anisopliae* in the banana fields and it causes more than 90% mortality of the weevils
- Dip suckers in *Beauveria bassiana* @ 20 g/l for 30 minute before planting.
- Predatory ants such as the big headed ant (*Pheidole megacephala*) and *Tetramorium* spp feed the eggs, grubs and pupae of weevils.
- Some endophytic non pathogenic *Fusarium* spp. cause egg mortality of rhizome weevil.

Banana aphid [*Pentalonia nigronervosa*, Aphididae, Hemiptera]

Damage symptoms: The nymphs and adults congregate under the outer base of the pseudostem.

Aphids always accompanied by ants, which act as dispersing agents of nymph. Honey dew secretion appears on the plants which attracts the ants. The aphids suck the sap of the plant and reduce the growth and vigour. They also act as a vector of Banana Bunchy Top Virus (BBTV).

Sustainable management:

- Ensure clean cultivation.
- Use healthy and pest free suckers to check the pest incidence.
- Rogue out the affected plants.
- Ratoon and inter crops should not be taken up.
- Collect planting materials from healthy plants.
- Before planting, spread lemon grass in the pit (if available).
- Drench the petioles, furled leaves, whorls or young suckers with soapy water or insecticidal soap.
- Destruction of weeds and alternate hosts.
- Use yellow pan water trap/ sticky trap @ 4-5/acre.
- Immersing flowers and foliage in hot water at 49°C for 10 minutes kills banana aphids.
- Apply neem cake @ 1 kg in two equal splits at one and two months after planting.
- Spray 2% neem oil garlic emulsion directing the spray on leaf axil and base of the plant.
- Spray *Verticillium lecanii* to control aphid vectors @ 20 g or 5 ml /l at 25, 65 and 165 days after planting. Where ever synthetic chemical insecticides are applied 10 days gap should be given for bio-control.
- Apply bio-control agents like *Beauveria bassiana* in the banana fields.
- *Endaphis fugitiva* Gagné and Muratori, *E. aphidimyza* found to parasitize the banana aphid, *Pentalonia nigronervosa* Coquerel, the vector of banana bunchy top virus.
- Introduction braconid wasps, *Lysiphlebius testaceipes* as parasitoid to parasitize the aphids.
- Predators of banana aphids include lady bird beetles (*Symnus nubilus*, *Pseudaspindimerus circumflexa*, *Micraspes crocea*, *Menochilus sexmaculatus*), Lace wing (*Chrysoperla* sp.), Syrphids (*Paragus serratus*, *Ascarina* sp.) and a Hemerobid. Protect these natural enemies.

Leaf and fruit scarring beetle [*Basilepta subcostata* (= *Nodostoma viridipennis*, *N. subcostatum*), Chrysomelidae, Coleoptera]

Damage symptoms: Adult beetles feed on tender unfolded leaves and fruits. They remain hidden under unfolded leaves. The leaves of central whirl are worst affected with perforation. The beetles scratch epicarp of the tender fruits, blemish them by scarring the surface and render unmarketable. The scars on leaves as well as fruits turn brownish later.

Sustainable management:

- Follow clean cultivation and sanitation in the orchards.
- Weed control, mainly grass in ditches. Weeding effectively reduced the infestation of *N. viridipennis*.
- Exposing immature insects to environmental conditions, predators and parasites.
- Bagging of immature bunch using net bags or

poly propylene bags with perforation preferably three weekly rounds. Bunch cover treatments with polyethylene were effective and economic for controlling damage caused by *Nodostoma subcostatum*. Bunch covering with Decis impregnated nylon net protected the banana completely from the attack of banana leaf and fruit beetle.

- Leaf extract of *Sapindus saponaria* (Monisal) has the most effective insecticidal activity to reduce the *N. subcostatum* followed by *Azadirachta indica* (Neem) and *Nyctanthes arbortristis* (Sewali). Thus, there is the possibility of developing a source of alternate insecticidal agent for sustainable management of insect pests of the banana.
- Soil application of *Beauveria bassiana* and *Metarhizium anisopliae* fungi has shown to be significantly effective to control this pest.
- Among the treatments including one entomopathogenic fungus (*Beauveria bassiana*) and three neem products tested against banana scarring beetle, *B. bassiana* (5g/L) and azadirachtin (5ml/L) are highly effective.

Banana red rust thrips [*Chaetanophothrips signipennis*, Thripidae, Thysanoptera]

Damage symptoms: The early symptoms appear as water-soaked smoky areas where the colonies congregate to feed and oviposit between touching or adjacent fruit. These areas then develop the typical rusty-red to dark brown-black discolouration. Further rusty growth of the fruit and yellowing of leaves may be observed. While the taste and texture of the fruit within these peels remains unaffected, the exterior discolouration reduces the marketability of affected fruit. In severe cases, the skin develops longitudinal cracks and sometimes fruit may split and exposed flesh quickly discolours.

Sustainable management:

- Use thrips-free planting material or tissue-cultured bananas and, if possible, hot water treatment prior to planting.
- Destroy all the volunteer plants that could act as a source of thrips to spread to other plantings.
- Bunch covers (which cover the full length of the bunch) do provide some protection if applied very early.
- Regular checking of fruit under the bunch covers is essential to ensure that damage is not occurring.
- At the time of shooting, cover the bunch firmly (without any space between polythene cover and bunch) with 100 gauge thickness polythene sleeve having 6 to 10% holes.
- Remove the male flower buds after opening of all hands.
- Use blue pan water sticky trap @ 4-5/acre.
- *Verticillium lecanii* (2×10^8 cfu/g) @ 3g/lit + 1ml Milk + 1ml sticker or NSKE 5% + sticker can be taken up as second spray.
- Predators: Lacewings, ladybird beetles, syrphid fly, minute pirate bug, predatory thrips, spiders, damselfly. Parasitoid: *Ceranisus menes*.

Tingid or lace wing bug [*Stephanitis typicus*]

Damage symptoms: Nymphs and adults are seen in colonies on the lower surface of leaves. Due to draining of sap by the insect, numerous pin point spots develop on both surface of leaves and the areas where the insects colonize turn yellowish in colour. The symptom of damage is visible from a distance. Yellowing of one outer whorl of leaf associated with the presence of the pest or its feeding punctures. Premature withering of more than one outer whorl of leaves associated with feeding punctures or presence of pests. Withering of all outer whorls of leaves followed by yellowing of one inner whorl of leaf associated with feeding punctures or presence of pest.

Sustainable management:

- Cut and burn the firstly infested outer whorl of leaves.
- Collect and destroy the damaged leaves, flowers and fruits along with life stages.
- Spray 2% neem oil garlic emulsion.
- Use yellow sticky trap @ 15/ha.
- Predatory mirid bug *Stethoconus praefectus* (Distant) predate on this pest and two egg parasitoid *Erythmelus panis* and *Anagrus* spp. parasitize the eggs.

Banana leaf eating caterpillars

Sustainable management:

- Hand-pick and destroy the caterpillar.
- Collect and destroy the damaged plant parts.
- Summer ploughing to expose to the pupae.
- Use light trap @ 1/ha.
- Remove half opened spindle leaves which are suspected to harbour the caterpillars during day time.
- Remove and destroy the rolled leaves with larvae and pupae of leaf rollers.
- Use burning torch to kill the congregating larvae.
- Grow repellent plants: Ocimum/basil.
- In severe infestation: spot application of *Bt*.
- Spray hot chilli cow urine mixture diluted in water directing the spray inside the partially opened spindle leaf, leaf axil and both the surfaces of leaves and at the base of the plant. (The mixture can be prepared by mixing one litre of cow urine in 10 litre of water and then adding 30 g well crushed green hot chilli. Filter and spray).
- Field release of entomopathogenic fungus, *Nomuraea rileyi*.
- Field release of egg parasitoids such as *Telenomus spodopterae*, *T. remus*.
- Encourage the activity of larval parasitoids *Ichneumon promissorius*, *Carcelia* spp., *Campoletis chlorideae*.
- Pupal parasitoids such as *Ichneumon* sp etc., predators such as *Chrysoperla zastrowi sillemi*, Coccinellids, King crow, Braconid wasp, dragonfly, spider, robber fly, reduviid bug, praying mantis, red ants.
- Conserve nematode such as *Ovomeris albicans*.

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