



Extension Bulletin No. 2

PEST MANAGEMENT IN GRAPES



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PEST MANAGEMENT IN GRAPES

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Correct citation :

Mani, M., Kulkarni, N. S., Banerjee, K. and Adsule, P. G.
2008. Pest management in grapes. National Research
Centre Grapes, Extension Bulletin No. 2, 44 p.

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Extension Bulletin No. 2

July 2008

Price Rs.50/-

Published by :

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National Research Centre for Grapes
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Printed at :

Flamingo Business System,
19 Laxminagar Commercial Complex No. 1
Shahu College Road, Pune - 411 009
Tel. : 020-24214636 • Email : flaminbs@vsnl.com

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PREFACE

Grape cultivation in India faces serious threat from several pests and diseases. The pests covered in this bulletin are insects, mites, nematodes, bats and birds. Among them, thrips, mealybugs, stem borer and mites are considered to cause serious losses in various regions, if adequate and timely preventive and curative measures are not taken. As much as 80% yield loss is reported on grapes due to insect pests in India. Generally, chemicals are used to manage the insects, mites and other pests on grapes. Indiscriminate use of these chemicals pesticides not only add to the cost of production significantly, but also results in these chemical residues in final produce and also in soil, water and air. Use of appropriate pesticides in right dose at right time holds the key for effective pest management and therefore the usage of chemicals alone does not solve pest problem completely in many cases. Many a time, the integration of cultural, mechanical, chemical with biopesticides helps to manage the pests effectively.

This extension bulletin covers the grape pest species with photographs for identification, life cycle, seasonal development, list of effective chemicals and biopesticides besides various other practices which will be highly useful for the effective pest management.

The bulletin will serve as a guide for grape growers, State govt. officials and other stake holders industry, besides researchers and students engaged in grape research and development activities.

Date : July 2008
Place : Pune

(Dr. P. G. Adsule)
Director



1. INTRODUCTION

Grapevine (*Vitis vinifera* L.) is one of the important commercial crops grown in temperate zone of the world. In India, it is grown in tropical peninsular states like Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu and also in subtropical states like Punjab, Haryana, Rajasthan, Delhi and Western Uttar Pradesh. It covers a total area of 64,300 hectares with annual production of 1.6 million tons. Pests and diseases are the major limiting factors in grape production. The pests covered in this bulletin are insects, mites, nematodes, birds and bats. Extensive and intensive cultivation of grapes tend to attract various kinds of pests to vineyards. As many as 100 insect and mite pests have been reported to damage various parts of grapevine from different grape growing states of India. Of these, only 15-20 species are considered to cause serious losses in various regions, if adequate and timely preventive and curative measures are not taken. Among them, thrips, mealy bugs, stem borer, mites, flea beetle, leaf and bunch eating caterpillars are important occurring year after year while other pests like leaf roller, chafer beetles, stem girdler and leafhoppers occur sporadically, and are less important. As much as 80% economic yield loss is reported on grapes due to pests in India.

2. PESTS

2.1. INSECTS

2.1.1. THRIPS

Thrips pose an increasing threat to grape cultivation in all the grape growing areas in India by causing scab formation on berries and resulting in heavy loss in the field.

Species : Three species namely *Scirtothrips dorsalis*, *Thrips hawaiiensis* and *Rhipiphorothrips cruentatus* are found causing damage to grapevine.

Status : It is a major pest in all the grape growing areas

Identification : *Scirtothrips dorsalis* is yellowish white, *T. hawaiiensis* and *R. cruentatus* are reddish to dark brown in colour.



S. dorsalis



R. cruentatus



T. hawaiiensis



Life cycle : The adults are small, elongated and fast moving approximately 2 mm in length with four narrow fringed wings. The female thrips produces 50-100 eggs. Eggs are very small and inserted in the tender tissue on the underside of the leaves. Hatching takes place in 5-8 days. Life cycle of thrips comprises of four immature stages namely first instar and second instar larvae (Nymphs), pre-pupa and pupa. Nymphs move down to the soil and pupate in the top 8-18 cm. The life cycle is completed in about 15 days. Nymphs are similar to adults but are without wings. Adult thrips live for about 10 days.



Eggs

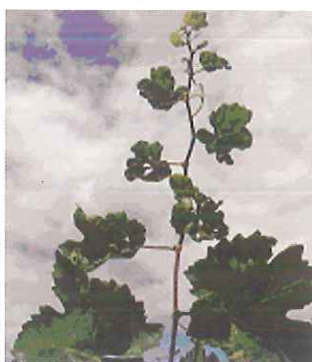


Nymph

Damage : Damage is caused both by nymphs and adults by rasping the lower surface of the leaf with their stylets and sucking the oozing cell sap. The injured surface is marked by the number of minute spots thereby producing a speckled silvery effect, which can be detected from a distance. They feed in groups, generally on the undersurface of the leaves. Curling of leaves is observed in case of heavy incidence. The leaves may dry up and drop off the vine due to severe thrips attack.



Fruits scarring by thrips



Thrips affected leaves



Rhipiphorothrips damage

The thrips also attack blossoms and developing berries. Fruit setting is poor and yield is considerably reduced. The thrips are also responsible for the scab formation on the berries. The affected berries develop a corky layer and become brown. Fruits obtained from seriously attacked plants are of poor quality and fetch low price.

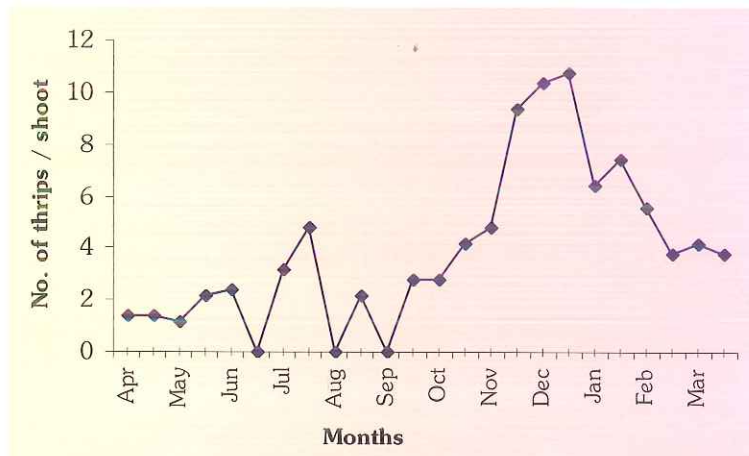


Berry damage by thrips



Thrips on berry

Seasonal incidence : Thrips population is observed throughout the year. They cause the damage to the new leaves in any part of the year. A maximum population of 8-10 thrips/shoot is observed in November and December months coinciding with flowering. Temperature and relative humidity are negatively correlated with thrips population.



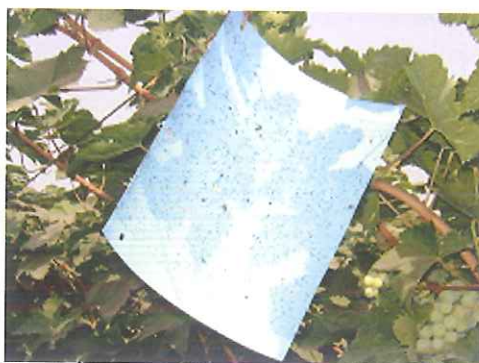
Seasonal incidence of thrips

Crop scouting and Trapping : Regular scouting is necessary to detect early infestations and also monitor the efficacy of control measures. A crop scouting program includes both sticky trap cards and visual inspection. Scouting should be done once in a week. A hand lens is a useful tool to detect thrips on leaves. Light tapping of the blossoms and growing points aids in visual inspection. Yellow or blue sticky traps can be placed 1 to 2 inches above the crop canopy

so that the bottom of the trap is just above the crop, at the rate of one or two per 1,000 square feet.



Yellow sticky trap



Blue sticky trap

Management

Sanitation : Sanitation is to be maintained for eliminating the sources of the thrips infestation. Weeds and alternate host plants inside and near the outside the vineyard should be removed. Plant debris from previous crops is also a source of both immature and adult thrips and they should be destroyed.

Cultural method : Deep ploughing in summer or exposure / raking of soil in vineyards helps to destroy its pupal stages and minimizing the incidence.

Biological Control : The green lacewing *Chrysoperla carnea* is commonly associated predator with insect pests in the vineyards. Spraying of fungal pathogens namely *Verticillium lecanii* or *Beauveria bassiana* @ 5 ml or 5g/L helps in reducing thrips population in cold and humid climate especially when the temperatures are between 20-25°C and humidity of above 70%.



Thrips infected with *V. lecanii*



Eggs of *Chrysopa*



Adult *Chrysopa*

Botanical pesticides : Different neem formulations (EC based) depending upon the strength of botanical viz., 1% @ 2.5 mL and 5% @ 0.5 mL/L can be sprayed like insecticide @ 400 litre spray solution per acre.

Chemical Control : Effective management of thrips on grapes relies primarily on the use of insecticides. The chemicals should be applied at critical growth stages like new flush, flowering and berry developing stages. Indiscriminate use of chemicals leads to pesticide residue problem in the fruits and Pre harvest interval (PHI) should be taken into consideration before spraying these insecticides.

Table 1. List of insecticides recommended to control thrips

Insecticide	Dose	Pre Harvest Interval (PHI)
Dimethoate 30 EC	1.00 mL/L	100 days
Imidacloprid 200 SL	0.30 mL/L	60 days
Clothianidin 50% WDG	0.12 g/L	40 days
Thiamethoxam 25 WG	0.25 g/L	40 days
Lambda-cyhalothrin 5EC/CS	0.50 mL/L	30 days
Spinosad 45 SC	0.25 mL/L	28 days
Emamectin benzoate 05 SG	0.20 g/mL/L	25 days

Foliar application of fipronil 80 WG (0.5 g/L) and 5 SC (0.8 mL/L) is also found to be effective against thrips.

2.1.2 LEAFHOPPERS

Species : *Arbordia vinifera*, *Typhalo* sp., *Empoasca* sp., *Chlorota lybica*

Identification : The adult is a small, wedge-shaped insect, measuring 3mm in length and is yellowish green in colour with black and red markings. The newly emerged adults are pale yellow in colour.



Egg



Nymph



Adult



National Research Centre for Grapes

Status : It is a destructive pest in north India and also certain pockets in South India.

Biology : Eggs are laid singly into the leaf tissue. They are minute measuring 0.8 mm long. Hatching takes place in 10-14 days. There are five nymphal instars lasting for 20 days. The life cycle is completed in 30-35 days.

Damage : Nymphs and adults feed on the under surface of the leaves. They suck the sap from the leaves. The damage first appears as a scattering of small white spots. With severe infestation and continuous feeding, the entire leaf turns yellow, finally brown, dries up and drops off.



Hopper damage on leaf



Severe hopper damage on leaf

Management : The chemicals recommended for thrips take care of hoppers also.

2.1.3. MEALYBUGS

In recent years, mealybugs have become an increasing threat to grapevine in peninsular India causing heavy loss in the field.

Status : It is a major pest in the major growing states namely Maharashtra, Andhra Pradesh, Karnataka and also Tamil Nadu.

Identification : The adult female mealybugs are pinkish (*Maconellicoccus hirsutus*) or yellowish white (*Planococcus citri*) and sparsely covered with white wax. These eggs are orange in colour (*M. hirsutus*) or yellowish white (*P. citri*).



Eggs of pink mealybug



Adult female pink mealybug



Male mealybug

Mealybug Species : Among the mealybug species infesting grapes in India, the pink mealybug *M. hirsutus*, citrus mealybug *P. citri*, spherical mealybug *Nipaecoccus viridis* and striped mealybug *Ferrisia virgata* are found causing severe loss in many grape growing areas of Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu.



P. citri adult ♀



P. citri eggs



F. virgata ♀



N. viridis ♀

Damage : Nymphs and adult mealybugs suck the sap from the trunk, cordons, buds, spurs, aerial roots, leaves, shoots, nodes, flower panicles and bunches. Infestation of the growing point especially with the pink mealybug results in malformation of leaves and shoot tips. Honeydew excreted by mealybug nymphs and adults, supports the growth of sooty mould on leaves, shoots and bunches. Sooty and sticky bunches harbouring



Pink mealybugs under bark



Spherical mealybug eggs on trunk



Pink mealybug affected shoot



P. citri leaf damage

mealybugs and their white cottony wax masses are unfit for marketing as table grapes. The pest attack weakens the grownup vines. In case of severe mealybug infestation, young vines often die. The grape mealybug causes losses up to 100 per cent in severe cases in the vineyard.

Biology : The adult female mealybug deposits 350-500 eggs in a loose cottony terminal ovisac during a week's time. The eggs hatch in about 5 days. The first instar nymphs are also called as crawlers, which are mobile. They settle on the plants, start sucking the sap and form the colonies. Crawlers are orange in colour (*M. hirsutus*) or yellowish white (*P. citri*). The male and female mealybugs are similar in early stages. The female passes through three nymphal instars while male passes through four



Mealybugs on nodes



Mealybugs on aerial root



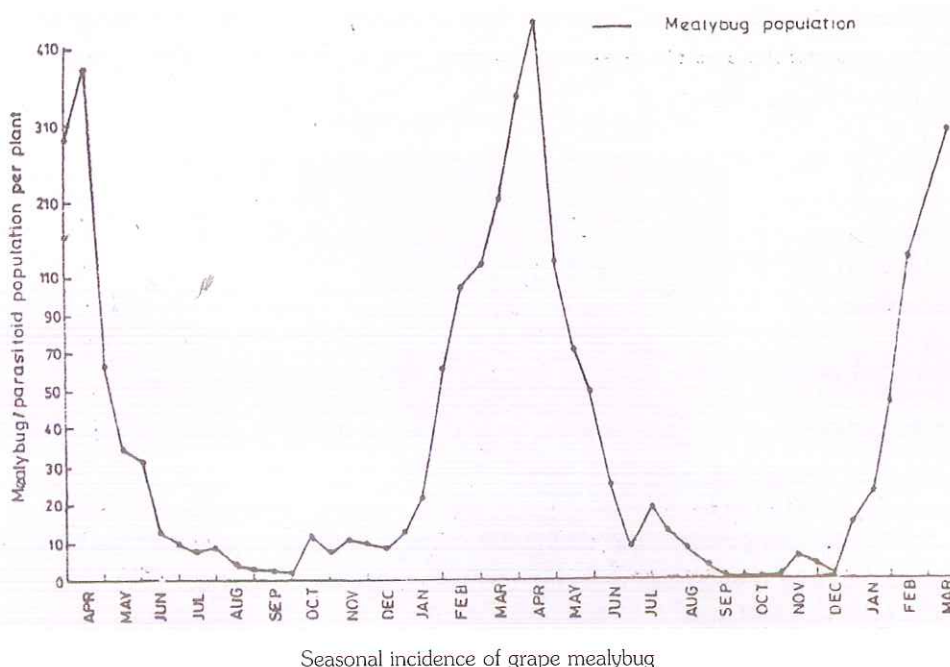
Bunches covered with mealybugs and sooty mold



Honeydew on berries

nymphal instars. The total nymphal period is 19 days for male and 21 days for female. The male nymph forms a cottony cocoon in which the pupal stage is found mainly in the winter season. The adult male has a pair of wings and a pair of halteres. All the stages of the female mealybug are similar. Males are very rare and female mealybugs are commonly found causing the damage in the field. Mealybug completes the life cycle in about 30 days. Without mating, they are known to reproduce partheno-genetically throughout the year.

Seasonal Development : The mealybug occurs on the grapevine throughout the year. After the harvesting, the mealybug population is confined to vegetative parts. The grapevine is pruned usually in April-May (Foundation pruning). Grape mealybugs remain on the leaves, stem and trunk from April to September.



The mealybug population is usually low from June to September. In the absence of rains, there is sudden spurt in the mealybug population in July-August also. Otherwise, the mealybugs remain low on the trunk, cordons and stem up to the first fortnight of December.

The mealybug population starts increasing from mid December onwards. During January, they migrate from the trunk, cordons and shoots to developing berries. It attains peak population before harvesting of bunches during March-April. Early pruned crop usually escapes from the mealybug attack as compared to late pruned crop. Heavy sporadic rains and cool temperatures of less than 20°C result in temporary reduction in the mealybug population. The pest population buildup coincides with high temperature of 30-40°C, low humidity (less than 40%) and berry development. The population is low in winter and rainy seasons and higher in summer months.

Management : Prevention is better than cure. This principle is highly applicable in the management of grape mealybug. Mealybugs are hard to kill pests on several crop plants. They form colonies in protected areas like cracks and crevices. All the stages of the mealybugs are covered with waxy coating and therefore it is difficult to control the mealybugs with



conventional insecticides. Cultural, mechanical, biological and chemical methods of control have to be adopted throughout the year to contain the mealybug population thus preventing the loss caused by the mealybugs.

1. Collection and destruction of the mealybug - infested bunches at the time of harvesting in March-April.
2. Collection and destruction of all the pruned material from mealybug infested gardens in April/May.
3. Removal of loose bark and destruction of the debarked material in April/May.
4. Removal of weeds and alternate host plants harbouring the mealybugs in and around the vineyards throughout the year.
5. Locating the ant colonies and destroying them with drenching of chlorpyrifos 20 EC @ 2.5 mL/L or dusting with malathion 5%, since the ants are associated with the buildup of mealybug population.
6. Swabbing/washing of trunk and cordons with 2 mL of dichlorvos 76 EC + 2 g of fish oil rosin soap in a litre of water in April -May.
7. Soil drenching with imidacloprid 200 SL @ in the basins around the trunk through drip irrigation @ 400 mL/ac in April-May.
8. Foliar spray with buprofezin @1.25g/L after 30 days of soil drenching.
9. Releasing the Australian ladybird beetle (*Cryptolaemus montrouzieri*) @ 5000/ha. in August-September to clear the mealybug population present on the plants.
10. Alternatively, two to three foliar sprays of *Verticillium lecanii* / *Beauveria bassiana* (2×10^8 cfu/mL/g) @ 5 g/L at 15 days interval in the rainy season (July-August) can be given.

After fruit pruning : Steps No. 1-8 to be followed after foundation pruning should be repeated in October-November also besides the following steps.

11. Monitoring and destroying the mealybug colonies as and when seen on the trunk, stem, etc. from November to February.



12. Foliar spray of the following chemicals depending on the incidence of the mealybugs is recommended to keep the mealybug population under check.

Table 2. List of insecticides recommended to control mealybugs

Insecticide	Dose	Pre Harvest Interval
Methomyl 40 SP	1.00 g/L	61 days
Buprofezin 25 SC	1.25 mL/L	40 days
Chlorpyrifos 20 EC	2.00 mL/L	40 days
Dichlorvos 76 EC	2.00 mL/L	20 days
Azadirachtin 1%	2.00 mL/L	3 days

13. Releasing the Australian ladybird beetle (*Cryptolaemus montrouzieri*) @ 5000/ha. during mid December - first fortnight of January.
14. One or two applications of dichlorvos 76% EC (2 mL/L) from mid February to the first week of March, if necessary, depending upon the incidence of mealybugs and time of harvesting.
15. One jet spray of water can be given on the bunches if the mealybugs are still present just prior to harvest to dislodge the mealybugs.

Mealybug management in nursery : Planting material is the major source of mealybug infestation. Therefore mealybug management in the nursery is very important to prevent further spread in the main field. The above steps No. 7 and 8 or 9 can be followed to control the mealybugs in the nursery.

Biological control of Mealybugs : They are called "hard to kill pests of fruit trees". There are several reasons which may account for this fact. Perhaps the most important factor is the habitat of the mealybug. Mealybugs live in protected areas such as cracks and crevices of bark, at bases of leaf petioles, on the undersides of leaves and inside the fruit bunch. Eggs of the mealybugs, protected by waxy filamentous secretions of ovisac are almost impossible to reach with insecticides. Late instar nymphs and adult female mealybugs are not affected by foliar application of insecticides since they are covered with waxy coating. Many of the insecticides have failed to check the mealybug damage. On the other hand, mealybugs being sessile insects

are more amenable to biological control in which parasitoids and predators effectively reduce the mealybug population. Among them, *Anagyrus dactylopii* and *Scymnus coccivora* are the major natural enemies for the pink hibiscus mealybug and *Leptomastix dactylopii* for citrus mealybug. Even though many indigenous natural enemies are available, biological control using the Australian ladybird beetle *Cryptolaemus montrouzieri* is found practicable to check the mealybug menace.



A. dactylopii



L. dactylopii



S. coccivora

a) Production and use of Australian ladybird beetle

The Australian ladybird beetle *C. montrouzieri* has often provided spectacular control of heavy infestations of mealybugs. The coccinellid beetle *C. montrouzieri* was first discovered in Eastern Australia. Following the success obtained in the control of *Planococcus citri* in California and other countries, the Australian ladybird beetle was introduced into more than 40 countries. Introduction of *C. montrouzieri* into India was done in 1898 to control the coffee mealybugs and scale insects.

Biology : Adult female beetle lays eggs either singly or in groups of 2-6 in the mealybug colonies. Freshly laid egg is pale yellowish white, smooth and cylindrical both ends being smoothly rounded. Incubation period varies from 4 to 6 days but extended at lower temperatures. Viability of eggs varies from 86-100%. Newly hatched larva becomes active after 3 to 4 h. The tiny larva is smooth and pale greyish, and white wax strands develop on the body after 24 h of hatching. There are four larval instars. The duration of first, second, third and fourth larval instars are 3.5, 2.5, 4.10 and 4.95 days respectively. The larval stage is completed in about 15 days. Pre-pupal period is about 2 days and the pupal period varies from 7 to 9 days. Emergence takes place normally between 8 A.M. and 11 A.M. The life cycle is usually completed in about 30 days under normal conditions.

Life stages of Australian ladybird beetle



Eggs



Larva



Pupa



Adult beetle

Adult is a black beetle measuring about 4 mm long with an orange head. In males, the first pair of legs is brown and the other two pairs are black, whereas in the female all the three pairs are black. Generally the male to female ratio is found to be equal. The pre-mating period varies from 4 to 7 days and the pre-oviposition and oviposition period range from 5 to 7 days and 45 to 68 days respectively. A single adult female lays about 200 eggs. The longevity of adult varies from 50 to 80 days.

Predatory potential : Both adults and larvae feed extensively on all stages of mealybugs and the eggs and crawlers of some scale insects. But the larvae are more voracious feeders than the adult beetles. A single larva is known to consume 2000-3000 mealybug eggs. It also feeds about 300 mealybug nymphs. A single larva requires 30 female mealybugs to complete its development.

Mass production : To release the predator in large numbers in the field, mass culture of *Cryptolaemus* is a pre-requisite. *Cryptolaemus* is easily cultured on a large scale on the mealybugs

Mealybug production :

Pumpkins : In the large scale production of mealybugs, ripe pumpkins are used in the laboratory. *Planococcus citri* and *Maconellicoccus hirsutus* are the ideal laboratory hosts for the culturing *C. montrouzieri*. The pumpkins are selected with ridges and grooves with a small stalk which makes them handling very easy. They are cleaned with water to get rid of any dust on them. Ovisacs of the mealybug are placed over the pumpkin for about 48 hours. Mealybug infested pumpkins are kept on a plastic stand in wooden cages, with glass sliding front and cloth on other sides. In due course, crawlers emerged from ovisacs, settle on all sides of



pumpkin and develop into fully mature mealybugs in 30 to 40 days. The mealybug infested pumpkins can also be arranged in steel racks.

Culturing of Australian ladybird beetle



Eggs on the pumpkin



Young mealybugs on pumpkin



Fully matured mealybugs on pumpkin

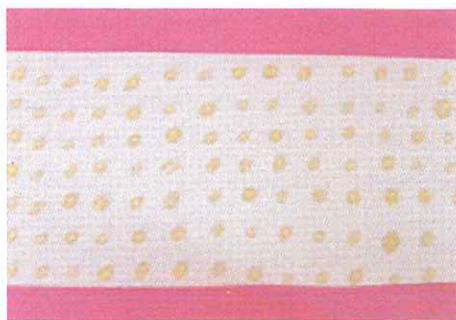


Mealybug infested pumpkins in the rack

Potato sprouts : The mealybugs can also be cultured on potato sprouts. Planting trays are made of wood (45 x 45 x 10). Soil to be used is sandy silt. Approximately 3 months after harvest or when sprouts begin to appear the tubers are ready for planting. Whole potatoes are used and 25 to 36 tubers are placed about $\frac{1}{2}$ " apart on a $\frac{1}{2}$ " layer of soil in the tray and covered with slightly moist soil. These trays are kept in racks in the production room and watered. Temperature of 25 to 27°C appears to be optimum for facilitating sprout growth. The time from planting until infesting with the mealybugs is usually 20 days in summer and 30 days in winter. Stock from one mealybug tray is sufficient to infest 20-25 trays of sprouts.

Beetle production : In about 20-25 days after the mealybug infestation on the pumpkins, *Cryptolaemus* adults are released into the cage through its sleeve. The adult beetles, besides feeding on the mealybugs, lay their eggs singly or in groups of 4-12 near the mealybug colonies. The larvae are visible in about a week's time. Initially, they feed on the eggs of mealybugs and smaller nymphs, and later they feed on all stages of the mealybug. Cannibalism is observed when the mealybug population is low. The fully grown larvae pupate on the pumpkin or anywhere inside the breeding cage. The first beetle emerges in about 30 days time from the date of exposure of the mealybugs to the beetles. The beetles continue to emerge for another 5-10 days. The beetles are collected in glass vials using the aspirator. Each breeding cage yields 100 to 200 beetles. They are fed with honey solution (50%) and honey-agar in the laboratory. In about 10-15 days, when the adult beetles complete the mating and pre-oviposition, they are ready for field release. Adult feeding with 50% honey solution is supplemented with the diet containing agar-agar and honey.

Preparation of honey-agar medium : The diet is prepared by boiling sugar 20g in 70cc of water, 1g agar agar powder and 40cc honey in 30cc of water. The hot liquid is dropped on small white plastic cards in the form of droplets which solidifies on cooling. The diet can also be stored in refrigerator 2-3 weeks.



Honey agar medium on paper card

Storage : Pupae of *C. montrouzieri* could be stored for a period of 20 days after subjecting the five day old pupae at 10°C for 3 weeks without having any adverse effect on the fecundity.

Use of Australian ladybird beetle

Monitoring of ants : Ants are known to attack the predators of scales and mealybugs while attending the pests. Hence, it is necessary to check the activity of ants prior to the release of *Cryptolaemus*. General ant control measures like destruction of ant holes and ant nests, application of sticky bands around the tree trunk and chlorpyrifos 0.05% into the ant-hills are to be adopted to suppress the activity of the ants. After the patrolling (up and down) of ants on the trunk is stopped, the beetles are to be released.



Ants attending the mealybug colonies

Stage to be released : Adult beetles and larvae can be released in the field for the suppression of pests. Adults upon release soon produce sufficient offspring to clear the mealybugs. However, the release of larvae is preferred to adults when the mealybug infestation is confined to few plants.

Time of release : Usually the releases are made between 8.00 AM and 10.00 AM and 3 PM and 5 PM.



Release of *Cryptolaemus* larvae



Number to be released : Depending upon the severity of infestation, the beetles have to be released. A release rate of 5000 beetles/ha is recommended to suppress the pest population. Two to three releases are to be made annually depending upon the severity of pest infestation. The releases have to be made early in the season. The first generation develops from the released beetles. The second generation definitely brings down the pest population. As a pre-requisite for release, spraying of insecticides has to be discontinued for two to three weeks prior to the release of the predator.

Target pests :

- (1) **Green shield scales :** It has given very good control of green shield scales belonging to the genus *Choropulvinaria* on guava, mango, coffee and ornamental plants.
- (2) **Mealybugs :** It has given good control of mealybugs infesting citrus, grapes, mango, custard apple pomegranate, pineapple, ber, passion fruit, avocado, coffee, brinjal, beans, ornamentals, tobacco, sugarcane etc

Integration with chemicals : The pesticides often interfere with the activity of the predatory beetle. The pesticides are known to cause mortality of different stages of the beetle. Commonly used fungicides and acaricides namely copper oxychloride, mancozeb, sulphur, captafol, carbendazim, bordeaux mixture, dicofol, abamectin etc. are found to be very safe to *C. montrouzieri*. Dichlorvos, chlorpyrifos and buprofezin are found harmless to the ladybird beetle. These pesticides can be applied safely without affecting the activity of the beetle. Fish oil rosin soap and most of the botanical origin pesticides are also found to be very safe to the ladybird beetle.

Problems of control with the ladybird beetle

1. Many of the growers are not aware of the potential of the ladybird beetle in controlling the mealybugs and scale insects. Hence awareness about the effectiveness of ladybird beetle is to be created among the farmers, and confidence building measures are to be taken.
2. Only very few commercial insectaries are producing ladybird beetle on a limited scale which is totally inadequate to meet the demands of the farmers in time. Hence many agencies including KVK should come forward to produce and supply the beetle to the growers on payment basis.



3. Many of the pesticides are broad spectrum, and kill the parasites and predators including Australian ladybird beetle. Some of them are reported very safe to the beetle. The safer chemicals can be applied when the predator is used to control the mealybugs and scale insects.
4. Time of release and stage of the crop are very important. Releasing the beetle at very late stage does not help to control the pests. i.e. Some farmers release the ladybird beetle just few days before harvesting to control the mealybugs and scale insects. The ladybird beetle requires at least two months time to give good control.
5. Many a time, the growers release only very few numbers not proportionate to the area under cultivation. At least, a release rate of 5000 beetles per hectare is to be followed.
6. In certain areas, very large area is under cultivation of a particular crop. If only a portion of the area under cultivation is covered, it is not possible to get adequate control of the mealybugs and scale insects. The ladybird beetle has to be released to cover the entire area under cultivation for getting adequate control.
7. Planning of releasing the beetle has to be done in advance. If the particular area is affected in the previous season/crop, the indent for the purchase of ladybird beetle has to be given well in advance so that the beetle will be available in time to control the mealybugs in time.

b) Production and use of *Verticillium lecanii*

Verticillium lecanii was isolated from whiteflies and developed as biopesticide named as Phule bugicide at Mahatma Phule Krishi Vidyapeeth (Rahuri, Maharashtra) for the control of sucking pests including thrips and mealybugs. A rate of 20gm formulated material/10 lit of water is recommended to control the mealybugs. Two to three sprays at 15 days interval in rainy season are needed. Addition of milk powder 5gm/10 lit water helps to improve the control of mealybugs.



2.1.4. STEM BORER

Species : *Coelosterna scabrator*

Status : It becomes a serious pest in old and neglected gardens. It is also serious on the grafted plants than on own roots.

Life stages of stem borer



Egg



Larva



Pupa



Adult

Damage : These beetles are active in the night and they start laying eggs especially during the onset of monsoon. The adult beetle makes conspicuous slit on the bark of the trunk and arms, and lay eggs. The eggs hatch in a fortnight and the young grubs enter directly into the stem and tunnel inside the main stem and arms very close to it. A number of holes on the stem and arms, and fine wood power similar to saw-dust can be noticed on the ground in severe incidence of the pest. The affected plant shows yellowing of leaves followed by drying and leading to dieback symptoms. The affected branches are exposed to secondary infection leading to slow death of the plant. Generally the beetles keep emerging from first summer shower in May-June till October-November. The adults feed for nearly two months on dead wood and also gnaws the green bark of shoots.



Stem borer tunnel



Gummosis



Fallen floss from
damaged trunk



Hole caused by stem
borer



Trunk damaged by stem
borer

Management

1. Removal of loose bark and pasting the bark with IIHR mixture (1 ml of Neem oil + 1ml of gum + 6 gm carbaryl + 10 gm of copper oxychloride).
2. Insertion of 1 tablet of aluminium phosphide in each hole is found to kill the larvae inside the stem.
3. Injection of 1ml of petrol or carbon disulphide or methyl bromide at 1ml/hole is also found to be effective in killing the borer. The hole made by the stem-borer can be located by the oozing of resinous substance from the hole. The dried resinous material will be sticking on the stem over the hole. It can also be located by the presence of small conical pile of dust on the ground shoved out of the hole. The resinous mass is removed, the hole is made little wider with a sharp needle and then the tablet or chemical is pushed inside. The hole is plugged with mud paste or soap, so that the fumes emitting from the injected chemical do not escape out through the hole.
4. Injecting dichlorvos 2 mL/hole into the stem kills the stem borer.
5. Keeping the vineyard and its surrounding clean helps to minimize the incidence of stem borer.
6. Wherever drip irrigation is followed, in such orchards care should be taken to avoid the bark get wetted by water.
7. Setting up of light traps to attract and kill the adult beetles in the affected garden.
8. If incidence of stem borer is more than 60 %, then replanting of vineyard is advised.



Light trap

2.1.5. SHOT-HOLE BORER

Species : *Xyleborus crassiusculus*

Status : It is a sporadic pest in certain pockets of grape growing areas in South India.

Damage : Shot hole borer is becoming a serious pest on grapes in parts of Karnataka and A.P. The beetle mainly attacks the main trunk, starting from the base of the plant. It is the nest building activity of the beetle on the main trunk that actually damages the vine. The fore-most symptom of the pest is the 'pinhole' on main trunks, more conspicuous if the loose barks are removed. Powdery wastes due to the tunneling can be seen falling from the holes. As infestation progresses, regularly gummy exudates can be seen along the trunk. Severely affected plants show wilting and yellowing.



Shot hole borer damage

Gradually the plant begins to dry from most affected side. It takes almost 15-20 months to cause total mortality of the vine. Towards the terminal stage of infestation, even secondaries are affected, as insects would have completely exhausted the main trunk. Once secondary branches are affected, the vine mortality is imminent.

Management

Preventive treatment : Shot hole borer infestation can be prevented, if regular removal of loose barks and swabbing of main trunk with IIHR swab mixture (Carbaryl 6 g + Copper oxychloride 10 g + (Neem oil 1 ml + Kerosene oil 1 ml + Sticker 1 ml) per litre) at least twice a year preferably after each pruning after removing loose barks. Periodic examination for holes and powdery or gummy exudates should be carried out. Usually infestation takes several months to spread, and the affected plants should be immediately treated.

Curative Treatment :

- Remove loose bark and scrape gently gummy exudates using a knife.
- Spray dichlorvos 0.25% on main trunk (not on the leaves and vines); inject using a disposable syringe, if the holes are only few in numbers.
- Band loosely using ribbons of plastic/polythene or synthetic gunny bags for 3-5 days the sprayed trunks immediately after the above treatment.

- Remove the bands and swab with the above IHR mixture.
- Remove castor plants growing adjacent to the orchards.
- If serious, repeat the above treatment after a month.

2.1.6. FLEA BEETLES

Species : *Scelodonta strigicollis* and *Oides scutellata*

Status : *Scelodonta strigicollis* is a regular and serious pest in some grape growing areas in India.

Identification : Adults are small measuring 3-5 mm long. They are shiny, coppery brown on emergence and metallic bronze subsequently with 6 dark spots on the elytra. Grubs are small and dirty white/light brownish in colour.



Adult



Healthy bud



Damaged bud



Leaf damage (close up)

Life cycle : Adult female beetle lays eggs in groups of 20-40 from mid March to mid October mainly below the bark or crevices of vines and under bark. Adult beetle feeds on the leaves and live for 8-12 months laying 220-550 eggs. Incubation period is 4-8 days. Grub period is 35-45 days, and are seen in the soil up to 18 cm. The grubs feed on cortical portion of roots and pupate in the soil up to 6-8 cm deep in earthen cells and the pupal period is 7-10 days. Adult beetles are nocturnal in habits, and many growers fail to detect the presence of the flea beetles on grapevine plants. They hibernate under the bark from November to March.

Damage : Adult beetles cause severe damage to buds and tender shoots. They scrap the sprouting buds or eat them completely. Damaged buds fail to sprout and dry up. They also feed on tender shoots and tendrils. The damaged tender shoots wither and drop down. Adult beetles



also feed on the new flush in October and April -May after pruning. Later they also feed on mature leaves giving shot hole appearance or create elongated holes on the leaves. The damage usually extends from 10 to 30%. The loss goes up to 55%, and even it is very high when the sprouting buds are damaged particularly after October pruning. Instances of total failure of crop are also reported in some grape gardens. Grubs feed on roots but do not cause severe damage. Adults are more destructive than the grubs.

Seasonal incidence or development : Adult beetles hibernate from December to March under the bark of the vine, and crevices. Accordingly the eggs are found from mid March to mid October and larvae from May to November. Adult populations reach peak numbers in October - November. Adults become very active and cause damage to the plants immediately after pruning in October. Adults are seen throughout the year. They also become active in April -May and cause damage. Among the weather factors, morning relative humidity is positively correlated with the incidence of flea beetle.

***Oides scutellata* :** The grubs of *Oides scutellata* feed upon the leaves by scrapping the green chlorophyll leaving behind the net work of veins intact.

Management

Cultural and mechanical :

1. Collection and destruction of dried and fallen leaves.
2. Raking the soil to expose the grubs and pupae to sunlight.
3. Keep the bundles of dry shreds of banana on the pruned end of the vines in the evening. Beetles, which take shelter on these banana shreds at night, can be shaken and collected in the morning. Similarly, bundles of dry banana leaves can be tied around the stem of the vines or the vines can be shaken and the beetles are to be collected in an inverted umbrella or on a sheet of cloth spread under the vines. Putting them in buckets containing water mixed with kerosene oil can then kill the beetles.
4. Removal of loose bark after April and October pruning and paste the trunk with a mixture of copper oxychloride 0.20% and carbaryl 0.20% reduce the different stages of the flea beetle.

Chemical : It is easy and practical to control the flea beetles with chemicals. Spray application of dichlorvos 0.20%/chlorpyrifos 0.05%/carbaryl 0.20% / fenvalerate 0.02%/cypermethrin 0.02% twice at weekly intervals seven days after pruning is recommended.

Biological : Soil drenching of entomopathogenic nematode (EPN) *Heterorhabditis indicus* @ 1-2 lakh infective juveniles (IJS) and irrigation of vines before and after the treatment and also once in a week thereafter results in significant reduction in the grub population and also adult emergence of grape flea beetle.

2.1.7. LEPIDOPTERANS

Species : *Sylepta lunalis*, *Helicoverpa armigera*, *Spodoptera litura*, *Adoxophyes prevatana* and *Conogethes punctiferalis*.

Several lepidopteran caterpillars are known to damage leaves and also bunches. They are sporadic but cause heavy losses in peninsular India in a short span of time.

i) Gram caterpillar - *Helicoverpa armigera*

H. armigera is reported in Andhra Pradesh and Karnataka on grapevine. They feed by boring into the berries causing up to 15% loss. Application of Nuclear polyhedrosis virus and *Bacillus thuriangiensis* is recommended against *Helicoverpa* attacking grapes. Insecticides viz., phosalone, chlorpyrifos, methomyl and spinosad can also be used keeping the PHI in mind. These insecticides have to be applied on the appearance of the pest. It is very difficult to control these caterpillars in the later stage.



Spodoptera leaf damage



Spodoptera damage to bunch



Helicoverpa feeding on bunch



Helicoverpa damage to bunch

ii) Tobacco caterpillar- *Spodoptera litura*

Spodoptera litura causes heavy losses at times in Karnataka, Tamil Nadu and Andhra Pradesh. The larvae feed on the leaves, inflorescence, rachis and berries causing up to 10% loss. Application of Nuclear polyhedrosis virus and *Bacillus thuringiensis* is recommended against *S. litura* on several crops. Insecticides viz., phosalone, chlorpyrifos, methomyl and spinosad can also be used keeping the PHI in mind. These insecticides have to be applied on the appearance of the pest. It is very difficult to control these caterpillars in the later stage.

iii) Leaf roller/folder - *Sylepta lunalis*

It has been reported as a pest of grapes in Tamil Nadu, Andhra Pradesh and Punjab. The yellowish green caterpillars with dark brown head roll the leaves from edges towards the midrib and feed inside the rolled leaves. Two parasitoids *Apanteles dita* and *Cardiochiles fulous* are found attacking the leaf roller. *Bacillus thuringiensis* is found to be effective against the grape leaf rollers. Insecticides recommended for *H. armigera* and *S. litura* will also take care of the leaf roller.



Leaf roller damage



Leaf roller larve

2.1.8. DEFOLIATING BEETLES

Species : *Holotrichia serrata* and *Adoretus bengalensis*

Damage : Adult beetles defoliate leaves especially after the first few rains



Adoretus



Holotrichia



Larva



Leaf damage

Management : Management includes erecting light traps and a single spray of fenvalerate 0.005% or deltamethrin 0.0028%.

2.1.9. SCALE INSECTS

Species : Several species of scale insects have been reported in different parts of India but are rarely of economic importance in major grape growing areas. They include *Hemiberlesia lataniae*, *Kerria lacca*, *Aspidiotus lataniae*, *A. cydoniae*, *Lecanium longulum*, *Pulvinaria maxima* and *Ceroplastis actiniformis*. *Aspidiotus* spp. are commonly found in Punjab.

Damage : These scale insects suck the sap from leaves, petioles, shoots and also bunches. In case of severe attack of scale insects, the vines become weak resulting in death of arms and decline of plants.



Scale insects on trunk



L. longulum



H. lataniae



H. lataniae



C. actiniformis

Management : The control of scale insects becomes difficult because they are covered with protective covering and they also take shelter under bark. Removal of loose bark and spraying with systemic insecticides reduces the intensity of scale attack. Scale insect free planting material should be used for establishment of new vineyards. The coccinellid predators like *Chilocorus nigrita* for hard scales and *Cryptolaemus montrouzieri* for soft scales can be released for the suppression on long term basis. Ants attending the scales should be checked as in the case of mealybug control with bioagents.

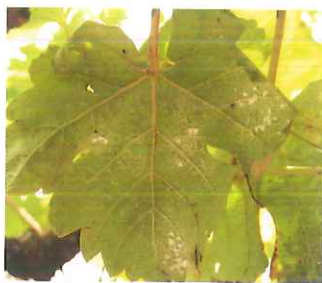
2.1.10. OTHER INSECT PESTS

Spiralling whitefly - *Aleurodicus dispersus*

Aleurodicus dispersus, native to Caribbean islands and Central America, is reported to occur on grapevine in India. Nymphs and adults suck the sap from the leaves. Eggs are laid singly at right angles to the leaf veins in association with irregularly spiralling deposits of waxy white flocculences from which the whitefly derives its common name.



Adult whitefly



Whitefly infested leaf



E. guadeloupae

Management

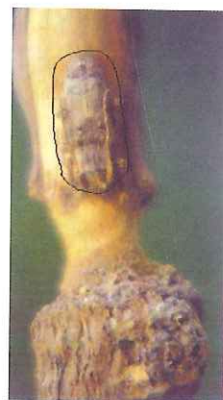
The aphelinid parasitoids *Encarsia haitiensis* and *Encarsia guadeloupae* give excellent control of spiralling whitefly.

Stem girdler - *Sthenias grisator*

It is reported in Punjab and Andhra Pradesh. Adult beetles girdle around the main stem 15 cm above ground level at night. They also girdle the young green bunches, which later dry up. The adult beetle lays eggs in the girdled portion. After hatching, the grubs tunnel into the wood. During day time, the adults hide on the lower side of the leaves or under the forking of branches but actively move at night.

Management

1. Hand picking of the adults at night with the help of torch light.
2. Collection and burning of dried twigs prevent further buildup of the pest.
3. Spraying of chlorpyrifos 0.05% is recommended.



Stem girdler damage with adult beetle



Sphingid caterpillar

Sphingid caterpillar - *Hippotion celerio*

The larvae of *H. celerio* feed extensively on leaves.*

2.2. MITES

Mites pose an increasing threat to grape cultivation in certain grape growing areas in India causing heavy loss in the field.

Mite Species : Six species viz., *Tetranychus urticae*, *T. cinnabarinus*, *T. neocledonicus*, *Oligonychus angiferus*, *O. punicae* and *Eutetranychus orientalis* are found causing damage to grapevine in India. Among them, the two spotted red spider mite *T. urticae* causes severe loss in Maharahtara and Andhra Pradesh.

Life cycle : Mites pass through egg, larval, protonymph and deutonymph stages. Female mites begin to lay eggs after 1-2 days singly on the under surface of leaves, particularly along the midrib and veins. Eggs are found on the upper surface of the leaves when the population levels are high. Eggs are also laid in its webbing. Freshly laid eggs are minute measuring 0.1mm white, spherical, transparent and appear like a water droplet. Later they change into dull white, gradually turn brown and then become transparent along sides with red spot visible before



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hatching. The female mite lays 30-50 eggs. Hatching takes place in 4-6 days. The newly hatched translucent larva has six legs. Dark spots appear soon after feeding on the dorsal side. The protonymph and deutonymphal stage have eight legs. The deutonymph stage is similar in appearance to an adult female but smaller. Nymphal period is 6-8 days. Life cycle is completed in 10-14 days depending on weather conditions. Freshly emerged adult females are 0.5mm long and devoid of spots but as the feeding begins, the spots become more distinct. Usually two large, diffuse spots appear forward. Adult spider mite females are reddish. Their pointed abdomens and smaller size easily recognize males. Adult mites live for about 15 days. Breeding is rapid in summer months. Development is greatly retarded in winter months. There are overlapping generations throughout the year.



Eggs



Nymphs



Adult mites

Nature of damage : Both nymphs and adults suck the cell sap from lower surface of tender leaves causing the cells to collapse and die. This damage is usually most conspicuous as pale colour spotting visible on the upper surface of the leaves. The infested leaves turn yellowish. In heavy infestations, the mites remove chlorophyll up to 70% leading into development of brown burnt patches on the infested leaves, which wither and finally dry. Discoloration of leaves leads to reduction in photosynthesis thereby affecting the vigour of the plants. Mites secrete very fine, silk-like webbing which is usually obvious over the drying leaves, and later the mites move away to feed on growing shoots. Heavy leaf fall due to mite infestation causes berry ambering of such table grapes as



Mites on the lower surface of leaves



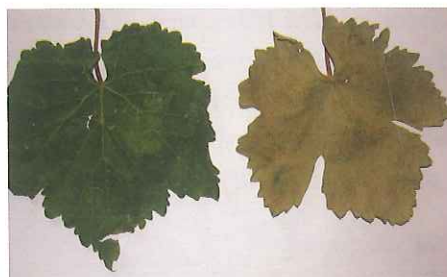
Yellowing of leaves due to mite attack



Webbing by mites



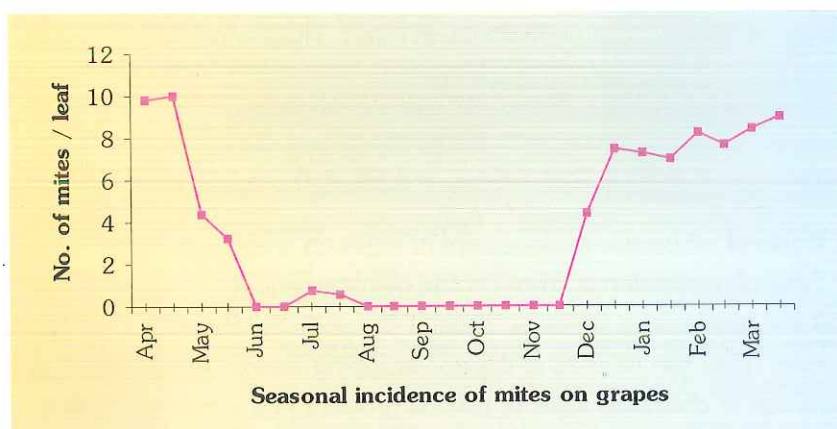
Browning of leaves due to mite attack



Healthy and mite infested leaf

Thompson seedless, because of exposure of bunches to sunlight. Severe infestation of spider mites results in delay in maturing of canes and ripening of bunches and reduction in sugar content thereby affecting the quality of grapes.

Seasonal development : The mites become more active in December and the mite infestation reaches peak in April. Mite population is negatively correlated with the minimum temperature and relative humidity. Watering practices affect the development of mite populations. Drought stressed plants are most prone to mite outbreaks. Pest is highly active during summer months. There is outbreak of mites in hot dry conditions. High humidity and rainfall reduce mite numbers. Wind is an important agent of mite dispersal.



Monitoring : Regular scouting is necessary to detect early infestations and also monitor the efficacy of control measures. Mites are small and difficult to see with naked eye. A crop scouting program includes the visual inspection. A 10x hand lens is a useful tool to detect mites



on leaves. The mites, eggs and cast skins can be best seen by examining the under surface of the leaves. Appearance of yellow spots on the upper surface of the leaves is also the indication of mite incidence. Mites can also be sampled using the beat method whereby plant parts are beaten onto a white piece of paper or card. The dislodged mites from beaten plant parts can be seen then readily crawling on the paper.

Management

Cultural method : Sanitation is to be maintained for eliminating the sources of the mite infestation. Plant debris after pruning is also a source of both immature and adult mites and they should be destroyed. Weedy vineyards are most likely to contain more mites. Hence weeds and alternate host plants inside and nearby outside the vineyard should be removed. Spider mite outbreaks frequently occur where vines are dusty or stressed. Proper irrigation scheduling reduces the water stress and also increases the humidity thereby reducing the mite population. High volume with high pressure water sprays helps to reduce the dust and water stress, increases the humidity in vineyard and also dislodges the mites from foliage thereby temporarily reducing the mite populations.

Biological Control : Although some predators are found in nature, they do not play significant role in keeping the heavy mite population buildup under check on grapes. The fungi *Beauveria bassiana*, *Verticillium lecanii*, *Hirsutella thompsonii* and *Pacilomyces fumosoroseus* are known to cause mortality in mites. These fungal pathogens can be used in the management of spider mites on grapevine.

Botanical pesticides : Different neem formulations containing azadirachtin depending upon the strength of botanical viz., 1% @ 2.0 mL and 5% @ 0.5 mL/L can be sprayed.

Chemical Control : Effective management of mites on grapes relies primarily on the use of chemicals. Time of application is crucial in the management of mites. First application should be made on the appearance of mites. Several old and new molecules are available for the control of mites. They can be used in the non-cropping season. In the export grape gardens, indiscriminate use of chemicals leads to residue problem in the fruits and pre harvest interval (PHI) should be taken into consideration before spraying these chemicals on the exportable grapes.

Table 3. List of chemicals recommended to control mites

Insecticide	Dose	Pre Harvest Interval (PHI)
Dicofol 18.5 EC	2.50 mL/L	100 days
Fenpyroximate 5 SC	1.00 mL/L	60 days
Difenthurion 50 SC	0.80 mL/L	45 days
Sulphur 80 WP	2.00 gm/L	15 days
Abamectin 1.9 EC	0.30 mL/L	7 days
Azadirachtin 1%	2.00 mL/L	3 days

2.3. NEMATODES

Species : Several nematode species are known to be associated with grapes but the major ones belong to the genera *Meloidogyne*, *Pratylenchus* and *Xiphinema*.

Root-knot nematode - *Meloidogyne* spp.

Three species of root-knot nematodes namely *M. javanica*, *M. incognita* and *M. arenaria* are known to cause economic damage. Patches of poorly branched vines with scant foliage, pale and small leaves, and poor bearing are the indications of root-knot nematode damage. In young



Root galls by *Meloidogyne*

plants, premature decline and weak vegetative growth are commonly associated with nematode attack. But the

confirmation of nematode attack is possible by assaying soil and roots samples. The root system shows typical localized swellings/galls particularly on feeder roots and young secondary roots. *Meloidogyne incognita* has been reported to stimulate the production of many new, fine rootlets above the site of nematode infection resulting in "hairy root" condition.



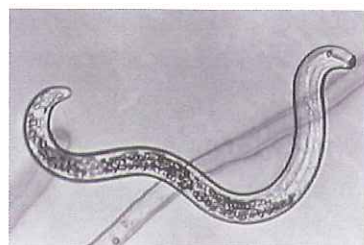
Meloidogyne

Root-lesion nematode - *Pratylenchus* spp.

Pratylenchys vulnus is also economically important particularly in heavier soils. Plants infested with *P. vulnus* show loss of vigour and reduction in fruit production. Infested young vines remain very weak, often fail to establish root system and eventually die. Below ground symptoms on roots distinctly shows lesions, which are initially brown and later turn black. In severe infection, black lesions combine and griddle the roots. Nematodes infested plants have generally reduced root system resulting in reduction in potassium and zinc uptake.



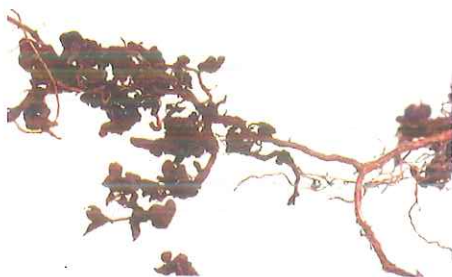
Root damage by
Pratylenchus



Pratylenchus

Dagger nematode - *Xiphinema* spp.

Dagger nematodes are ectoparasites and feed on succulent tissues of young roots. *X. index* and *X. americanum* have been found pathogenic on grapes. Dagger nematode feeding on roots results in terminal swelling, cessation of root elongation, distortion due to malformation of rootless and also stunting of vine shoot and root. Discoloration, decay of roots and death of growing points of feeder roots occur at a later stage. *X. index* is known to transmit the fan leaf yellow mosaic vein banding virus (GVFVGVYMV) disease of grape.



Root damage by *Xiphinema*



Xiphinema



Management of nematodes

1. Use of nematode free planting material is one of the most important cultural practices adopted to avoid nematode infection. *Tagetes patula* used as intercrop, reduces 39-44% nematode population and significantly increases the yield.
2. Hot water treatment has been used to disinfect plant material but accurate timing and suitable uniform temperature (52°C) are very important for obtaining good results.
3. Use of nematode resistant root-stocks has an added advantage over other methods of control. The cost factor is reduced to minimum. Dogridge (*Vitis champini*), Salt creek (*V. chmpini*), 1613 (*V. sonalis* X *Othello*), Harmony (1613 X Dogridge), St. George (*V. rupestris*), A X R1 (Aroman X Ganzin1), Lake Emerald, Tompa, Banquabad, Cardinal, Early Muscat, Jasbeli, Loose Perlette and Reisling have been recognized as resistant rootstocks.
4. Soil fumigants 1, 3 dichloropropene (1,3D) at 60-170 gallons per acre, and methyl bromide (MBr) at 60-170 gallons per acre and 450-560 Kg/ha at 60-100 cm depth have been used to clean field soil before planting vines. Application of carbofuran, benfurocarb or phorate at 6Kg ai/ha in *M. javanica* infested vineyard gives about 70% nematode reduction and improves yield (120%). Carbofuran at 13g/sq. m. at bud breaking stage is recommended for controlling *M. javanica*.
5. Application of 2 kg of farm yard manure enriched with *Trichoderma harzianum* + *Paecilomyces lilacinus* at the time of planting and also subsequently add the same dosage of bio-agent enriched FYM once in every six months interval.
6. **Enrichment of farm yard manure (FYM) with bio-agents** : One kg of *Trichoderma harzianum* + 1 kg of *Paecilomyces lilacinus* can be used to enrich 1 ton of farm yard manure. It is advisable to add 50 kg of neem cake per ton of FYM for faster enrichment. Farm yard manure added with these bio-agents and neem cake should be left under shade for a period of 15 days. In between, it is also advisable to mix FYM thoroughly at an interval of 5 days to enrich FYM with the bio-agents.

2.4. Bats and Birds

Bat

Species : *Cynopterus sphinx*

Damage : It plucks the berries from the bunches and suck the juice from berries. It is nocturnal in habit. Hanging half naked bunches and littered ground in the vineyard are the evidences of bat damage.



Bat



Bat damage to bunches

Birds

Species : Jungle crow - *Corvus macrorhynchos*

House crow - *C. splendens*

Bank myna : *Acridotheres ginginianus*

Indian myna : *A. tristis*

Parrots and sparrows are also common pests of grapes.



House crow



Jungle crow



Indian myna

Damage : They feed and damage the bunches directly causing very heavy loss at times. Fruit loss goes up to 40%.



Birds on vineyard



Bird damage to bunch

Management : The management strategy consists of netting all around the orchard covering canopy gaps with twigs and berries beginning at fruit maturity.



III. GENERAL PRECAUTIONS

- Right type of chemical for a particular pest has to be chosen for application
- Correct time of application of pest management practices is necessary to prevent the pest build-up.
- Late application of any practice results in wasteful expenditure without any control
- All the doses mentioned above are for high volume sprayer, where normal spray volume is 1000 litres/ha.
- The integration of biopesticides with chemicals has to be done on the basis of the safety of chemicals to the key natural enemies.
- Recommendation of chemicals for the management of pests along with dose and PHI are of advisory nature for the good viticulture practices and therefore, not covered under any legal scrutiny.
- Recommended chemicals with their MRL and PHI are subjected to change due to export-import regulations. Readers are requested to check the current pesticide recommendation list from NRC for Grapes, Pune.
- In foliar application, insecticides should not be mixed with fungicides.

ACKNOWLEDGEMENTS

Additional photographic help by Dr. S. D. Sawant, Principal Scientist (Plant Pathology), Dr. J. Sharma, Senior Scientist (Soil Science), Mr. P. B. Taware (Technical Officer) from NRCG, Pune and supplementary information by Dr. M. S. Rao, Principal Scientist (Nematology) IIHR, Bangalore are gratefully acknowledged.



ANNEXURE

(Updated on : 9th July 2008)*

Pesticides recommended for the control of various insect pests based on the studies at NRC for Grapes and AICRP on Grapes of ICAR (2008-2009).

Sr. No.	Pesticide recommended for major disease and pest	Nature of pesticide	Dose on formulation basis	MRL (mg/kg)	Pre-harvest Interval (PHI in days)
I FLEA BEETLES					
1	Carbaryl 50 WP	NS	2.00 g/L	0.05	42
2	Imidacloprid 200 SL	S	0.30 mL/L	1.0	60
3	Thiamethoxam 25 WG	S	0.25 g/L	0.5	40
4	Lambda-cyhalothrin 05 EC/CS	NS	0.50 mL/L	0.2	30
5	Clothianidin 50 WDG	S	0.12 g/L	0.01	40
II THRIPS and JASSIDS					
3a	Thiamethoxam 25 WG	S	0.25 g/L	0.5	40
6	Spinosad 45 SC	NS	0.25 mL/L	0.5	28
7	Emamectin benzoate 05 SG	NS	0.22 g/mL/L	0.01	25
8	Difenthiuron 50 SC	S	0.80 g/mL/L	0.01	45
9	Dimethoate 30 EC	S	1.00 mL/L	0.02	100
10	Endosulfan 35 EC	NS	2.00 mL/L	0.5	65
11	Azadirachtin 1% and 5% (Neemazal T/S 1%, Neemazal F 5%, Econeem plus 1%, Ozoneem Thrishul 1%)	Neem based EC formulation	1% & 5% @ 2.00 & 1.00 mL/L	1.0	3
4a	Lambda-cyhalothrin 05 EC/CS	NS	0.50 mL/L	0.2	30
2a	Imidacloprid 200 SL	S	0.30 mL/L	1.0	60
5a	Clothianidin 50 % WDG	S	0.12 g/L	0.01	40
III MEALYBUGS					
12	Chlorpyrifos 20 EC	NS	2.00 mL/L	0.5	40
13	Malathion 50 EC	NS	2.00 mL/L	0.01	40
14	Phosalone 35 EC	NS	2.00 mL/L	0.01	40
15	Methomyl 40 SP	S	1.00 g/L	0.05	61
16	Dichlorvos 76 EC	NS	1.00 mL/L	0.01	20

*Recommendation of pesticides for the management of various insect pests along with their dose, PHI and MRL values are of advisory nature for the good viticulture practices and therefore, not covered under any legal scrutiny.



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Sr. No.	Pesticide recommended for major disease and pest	Nature of pesticide	Dose on formulation basis	MRL (mg/kg)	Pre-harvest Interval (PHI in days)
17	Cartap Hydrochloride 50 SP	S	2.00 g/L	0.01	15
18	Buprofezin 25 SC	NS	1.25 mL/L	1.0	40
2b	Imidacloprid 200 SL	S	1.50 mL/L/vine as soil drench	1.0	60
2c	Imidacloprid 70 WG	S	0.45 g/L/vine as soil drench	1.0	60
11a	Azadirachtin 1% and 5% (Neemazal T/S 1%, Neemazal F 5%, Econeem plus 1%, Ozoneem Thrishul 1%)	Neem based EC formulations	1% & 5% @ 2.00 & 1.00 mL/L	1.0	3
IV CATERPILLARS					
14a	Phosalone 35 EC	NS	2.00 mL/L	0.01	40
12a	Chlorpyrifos 20 EC	NS	2.00 mL/L	0.5	40
15a	Methomyl 40 SP	S	1.00 g/L	0.05	61
6a	Spinosad 45 SC	NS	0.25 mL/L	0.5	28
4b	Lambda-cyhalothrin 05 EC/CS	NS	0.50 mL/L	0.2	30
11b	Azadirachtin 1% and 5%	Neem based EC formulations	1% & 5% @ 2.00 & 1.00 mL/L	1.0	3
V MITES					
19	Dicofol 18.5 EC	NS	1.00 mL/L	2.0	100
20	Abamectin 1.9 EC	NS	0.50 mL/L	0.01	7
8a	Difenthiuron 50 SC	S	0.80 mL/L	0.01	45
11c	Azadirachtin 1% and 5 % (Neemazal T/S 1%, Neemazal F 5%, Econeem plus 1%, Ozoneem Thrishul 1%)	Neem based EC formulations	1% & 5% @ 2.00 & 1.00 mL/L	1.0	3

NS= Non systemic, S= Systemic

Note :

- All the doses mentioned above are for high volume sprayers, where normal spray volume is 1000 L/ha. Spray volume can however, be changed as per the efficiency of sprayers used. However, the amount of each pesticide (active ingredient) recommended for 1 ha on the basis of 1000 L spray solution per ha should be strictly maintained to minimize pesticide residues.
- Recommended PHI will be valid only if maximum 2 sprays are applied per fruiting season at 7-15 days interval at recommended doses.
- All MRL and PHI are subjected to change due to export - import regulations.



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