GEORGIAN ACADEMY OF AGRICULTURAL SCIENCES

Guram Aleksidze

GRAPE PEST MANAGEMENT IN GEORGIA

Tbilisi

Georgian Academy of Agricultural Sciences

Guram Aleksidze

Grape Pest Management in Georgia

Publishing House "Agro"

Tbilisi 2023

UDC 634.8..632
5 - 483

A special thanks to my colleagues for contribution of some materials:
Z. Khidasheli, PhD;
N. Meskhi, PhD;
D. Maghradze, PhD;
Ts. Tegetashvili (Common technical issues).

Editor: T. Epitashvili, PhD.

Technical editor: I. Bakhtadze, PhD.

Reviewers: Shakro Kanchaveli, Professor, Doctor of Agricultural Sciences.

ISBN 978 – 9941 – 8 – 5175 – 9

The book is published by financial support of Shota Rustaveli National Science Foundation of Georgia (SRNSFG) (Grant #SP-22-959, "Grape Pest Management in Georgia")

The book "Grape Pest Management in Georgia" is reviewed and recommended for publication by the Scientific Council of Georgian Academy of Agricultural Sciences (Protocol #3 31.05.2022).

The book is dedicated to the memory of Professor Niko Aleksidze, who devoted his whole life to the study of grapevine pests. For 40 years he directed the Plant Protection Department at the Research Institute of Horticulture, Viticulture and Winemaking of Georgia.

Agricultural farms play a significant role in satisfying the demand population for food of Georgia. They produce almost all agricultural crops, the share of grape in which is very important, however, the farmers` products get today would be much more if not the numerous pests and diseases, which in some cases destroy 80-90% of the crop.

The book discusses the main pests and diseases of grapes common in different agro-climatic zones of Georgia; also the dates of their appearance, symptoms of damage, the periods of harm, effective chemical and biological measures to be taken against them, as well as the conditions of their safe use. The recommended measures are designed to minimize the frequency of chemical treatments and increase the share of biological and other non-chemical measures to protect consumers and produce ecologically pure product.

The research data, analysis and results provided in the present publication are based on many years of testing in the vineyard condition.

The book is intended for those working in the field of plant growing, for the specialists, viticulturists and agronomists, also for university students, and for all who realize the value of cultivation and preservation of this very important crop.

Georgian man has maintained grape for 8 thousand years; He endured countless hardships to bring this century-old treasure unchanged till present. There is no other country in the world which can be proud having more than 500 local cultural vine varieties and more than 300 their wild relatives.

CONTENTS

Instead of Introduction

Plant protection has a special place in the technologies of growing agricultural crops. Specialists of FAO estimate that despite the measures taken, crop losses in the field exceed 30% annually, plus 10% losses in storage conditions, and sometimes the plants and yield are completely destroyed.

A good example of this is that in recent years, leaf chewing insects have spread in the regions of Kartli, and their massive damage has nearly brought agricultural crops to the extinction.

The situation was similar in the regions of western Georgia (Guria, Adjara, Samegrelo), where farmers suffered heavy losses due to the massive spread of the Web worm (American white butterfly).

It is noteworthy, that the Brown marmorated stink bug (Asian bug), which spread massively under the same conditions, significantly destroyed not only hazelnut, but also other very important agricultural crops, including grapes.

Locusts spread in Kakheti districts destroyed agricultural crops, including vines.

Significant losses are caused annually by Grape berry moth, Mites, Grape mildew, Oidium and others. Plant protection is a complex ecological problem and involves the integrated use of control measures, which include the integration of agro-technical, physical-mechanical, chemical, biological, microbiological, biotechnical and other methods, the basic principle of which is to protect the plants and get ecologically pure product.

Plant protection measures involve active human intervention in biocenosis, and if we do not know what basic component we are dealing with and do not determine in advance what kind of changes are expected - the result can be disastrous. Humanity has many examples of this. There is an example of this in Georgia as well, during the unsystematic, and in some cases reckless use of pesticides, the beneficial entomo-fauna, common in vines, which regulate the reproduction of pests, have been almost completely destroyed; large amounts of persistent pesticides have been also observed in soil and groundwater. All above said has rather negative effect on humans, worsening their health conditions. A good example of this was the

existence of large amount of copper in the soils of Kakheti vineyards, which was later detected in wine. The reason was the overuse of pesticides, in particular Bordeaux mixture in tripled doses, and the complete disregard for agro-regulations.

Early, in the 1990s, when Georgia gained independence, a new movement started which expressed its objections against the use of pesticides and against their import in the country. Four agricultural regions of Georgia were declared as pesticide-free zones; unfortunately, the devastating results of this policy were clearly seen on the examples of the heavily damaged vineyards in Kartli and Kakheti.

During the same period, a kind of illegal traders appeared, selling all sorts of expired substances. Years ago, in the vineyards of western Georgia, the farmers used Defoliant which is applied for cotton crops, thus completely destroying the vine in that area. A similar case was reported in Kakheti and Kartli. Expired or already banned pesticides were imported to Georgia from neighboring countries.

The question is whether the use of pesticides can only have some disastrous results. This is not the case at all, first of all, it is necessary to accurately follow the plant treatment regulations when applying them; furthermore, in the result of scientific advancement, a new group of pesticides is being created that are relatively more adaptive (labil) to the environment and highly efficient.

Today, pyretroides are used in practice, using 10 times less concentration than previously widely used phosphororganic compounds.

Fungicides of the triazole group are used against fungal diseases at 10-15 times lower concentrations when the effectiveness is greater than that of previously used fungicides. Noteworthy are the fourth generation pesticides (biologically active substances), which are characterized by high selectivity and environmental safety. All these pesticides are imported into our country and used in practise.

The biological methods of pest control are successesfull, such as Cryptolaemus, Metaseiulus and others *being used against some harmful species of grape pests. Over the years, bio-laboratories in Sokhumi, Batumi, Zugdidi, Gori and Gurjaani propagated artificially using 5 species of beneficial insects, mites and entomophoric fungi. Today, these labs has stopped functioning.*

Over the years, 30 species of beneficial insects and entomopathogenic fungi, which have acclimatized, have been introduced to Georgia from different countries, but additional species need to be introduced, which will significantly enhance the overall role of the biological control.

Currently, a biological enemy of Web worm – Americal white butterfly (Hyphantria cunea) parasite (Chouioia cunea Yang*) was introduced by us and Professor Yang (China), which were multiplied in biological control center of Batumi. The multiplication of parasites and their release into the environment significantly limits the spread of this highly dangerous pest.*

A microbiological method of control occupies an important place in the pest control. Currently bacterial preparations: Dendrobacillin, Lepidocide, Bitoxibacillin and others are successfuly used against leaf chewing pests, including grape pests. In the past years, we received those quite expensive pesticides from Russia; today our country has already started to produce these pesticides, which is a very positive initiative.

The use of biologically active substances in an integrated pest control system is becoming increasingly promising. For the last two decates, the Institute of Plant Protection, as well as the Institute of Horticulture, Viticulture and Winemaking, have developed the technology and methods of application of promising pheromones. Some necessary recommendations are drawn up for their implementation.

For many years, according to the recommendations of the research institutes, Grape berry moth pheromones were used on thousands of hectares, which gave significant benefits to our country, saving expenses significantly. As we can see, biological protection is one of the most important factors in the fight against pests. However, much remains to be done for its effective use.

First of all, it needs to be given the status of priority development to get target funding, also, training of relevant specialists in the centers abroad should be supported to create a strong material and technical base.

A selective method of pest control, which mainly envisages the use of pest-resistant varieties and hybrids, has great prospects. It should be

noted, that Georgian vine varieties are characterized by good resistance to diseases, which is widely used by breeders.

Genetic engineering plays an important role in the fight against pests. Unfortunately, working in this direction in our country is proceeding at a very slow pace while its prospects are very large, and especially after the discovery of "CRISPR-Cas" technology. Many species of agricultural crops, including vine, which are characterized by high yields, can be distinguished by high resistance to pests and diseases and to stressful conditions in general.

An important direction is also the use of plant pesticides, which are used on a small scale, but the prospects are important because they give farmers a high effect even in primitive conditions. There are currently some promising plants in the world used for this purpose, including Azadirachta indica, *which is distinguished by its insecticidal and repellent properties. Seed powder solution protects many plants from insect damage by spraying, as evidenced by our experiments with the webworm. It is good that pesticides made from this plant are currently widely used in plant protection and in Georgia as well.*

Finally, integrated plant protection is the only correct way to control pests, using all of the above-mentioned measures, the basic principle of which is to minimize the use of pesticides at the expense of biological and other non-chemical methods.

Chapter I. Brief Information about Georgia

Geography of Georgia

Georgia is a country in the Caucasus region, on the coast of the Black Sea. It occupies the central and western parts of South Caucasus and is bordered to the north Russia, to the south by Turkey and Armenia, and to the southeast by Azerbaijan.

Total area is 69,700 km^2, population is approximately 4 million. The terrain of the country is mostly rugged and mountainous. Georgia occupies the south slopes of the western and central parts of the Greater Caucasus and the northern part of Lesser Caucasus. Altitudes in the country vary from 0 m at the Black Sea coast up to 5,201 meters on the top of the Shkhara Mountain.

Climatic condition

Georgia is very diverse climatically. It varies from very severe, with permanent snow in the high mountains, to humid and warm subtropical at the Black Sea coast and semi-arid in the East Georgia.

The climate of the lowlands of the West Georgia (Colchis lowland) is humid subtropical. The annual temperature at the Black Sea cost is about 13-15^{0}C. Annual precipitation at the Black Seas coast exceeds 1,200 mm. In foothills of Adjara as much as 3000 - 3500 mm have been recorded in some years.

The climate of the lowlands of East Georgia is more continental. In contrast to West, the East Georgia is drier. Annual precipitation varies from 350 to 650 mm and most of it falls during the warm season.

Soil condition

The soils of Georgia are also very diverse, which reflects the variability of geology, orography and climate. The most widespread types of soil in the West Georgia are podzolic, red, yellow and yellow-brown soils, which have mainly acid reaction. Grey, black, and chernozem soils are widespread in the lowlands of Eastern Georgia and are characterized with neutral reaction.

Forestry

Forest is main type of vegetation and occupies 40% of the country's total area. Swamp forests occupy the Colchic lowland with its mainly damp and poorly drained soils.

The largest areas of forests are found in the mountains.

Agriculture

The Georgians have been cultivating land since the ancient times. The diversity of the climate and the rich soils supported a great variability of crop production. The area of arable land is about 790 thousand ha (11.5%), while the crops cover about 268 thousand ha (3.8%). Hay meadows spread over 142 thousand ha, while the pastures occupy 1800 thousand ha.

Large areas of tea, citruses, subtropical fruits and nuts are located in the humid subtropical lowlands of West Georgia. It is also rich in rare grape varieties, which are used for the production of expensive wines. Chestnut is harvested in significant amounts in native forests of West Georgia. Among the annual crops in the West, maize is the most widespread and there are a number of local maize food varieties cultivated across the lowlands, foothills and mountains.

Most of the seed and stone fruit, and grape plantations are located in East Georgia. The major field crops of East Georgia are winter wheat and sunflower, which are cultivated in the dryland areas. Maize for feed, beans and alfalfa are sown frequently in irrigated areas. Potato and barley are important crops in the mountain areas of West, East and South Georgia. The irrigated part of Southeast Georgia is specialized in early vegetables and early potato growing.

The fruit production is less than half of that what had been in the end of 1980-s and before disruption of the ties with the traditional markets. At present, grape production is a third, citruses one eighth, while tea is one twentieth of the level of that in the late eighties. The area of grapes has reduced from 117.7 ha to 37.7 thousand ha, citrus from 27.1 ha to 8.7 thousand ha and tea plantations from 65 ha to 11.5 thousand ha.

Map of Georgia

The share of small farms that used less than 1 ha of agricultural land was as much as 75%. About 23% of farms owned from 1 to 5 ha land. Only 2% of farms use more than 5 ha land in agricultural production.

Genetic Resources

The diversity of the genetic resources of Georgia provides sustainable basis for food security and agricultural production in the country. According to the recent edition of *Flora of Georgia*, about 4200 plant varieties have been registered in Georgia.

Georgian flora is rich in economically important plant species. According to N. Vavilov, Georgia is a part of the West Asian center of origin of the cultural plants. West Asia is considered as the major center of domestication of barley, wheat, pea, lentil, vetch, grapevine and numerous fruit trees.

More than 2000 species of the Georgian flora have direct economic importance for food, timber, fruits and nuts, forage and fodder, medicine, industry and essential oil production. In addition, there are many traditional varieties and wild relatives of cultivated

species. A variety of crops, such as cereals (wheat, barley, rye, sorghum, millet), legumes (faba bean, grass pea, chickpea, lentil, cowpea), also flax, onion, garlic, and various fruits (grape, apple, pear, quince, medlar, peach, apricot, plum, cherry, cornelian cherry, etc) have been cultivated here since the ancient times. Starting from the 17th century, many American crops have been introduced in the country, such as maize, potato, tomato, tobacco and later followed by the citruses and tea in the 19th century and kiwifruit in 20th century.

Grape Varieties

Grapevine has been cultivated in Georgia since the time immemorial. Georgia is considered as one of the places of grapevine domestication. The oldest seeds of cultivated vines (*Vitis vinifera*) were found in Georgia and dating back to the period of 6000 BC. The mountainous countryside and isolated villages have preserved our unique heritage - about 525 indigenous grape varieties. The most distinguished ones are: Rkatsiteli, Saperavi, Khikhvi, Khisi, Budeshuri, Aladasturi, Kakhuri Mtsvane, Alexandrouli, Goruli Mtsvane, Ojaleshi, Krakhuna, Chkhaveri, Tsitska, Usakhelouri, Chinuri, Khvantchkara, MujureTuli, Tsolikouri, Kharistvala, and other varieties. Also, 400 forms of wild relatives of grapevine have been recorded in Georgia.

Georgian aboriginal grape species, according to their morphological - biological characteristics, belong to the Black Sea (*Convar pontie* Negr.) basin, and Georgian (*Sub.convar Georgica* Negr.) region sub-group. The majority of grapevine species of Western Georgian and some of Eastern Georgia, such as: Kachichi, Tsolikouri, Tsitska, Krakhuna, Otskhanuri Sapere, Chkhaveri, Rkatsiteli, Saperavi, and others belong to this sub-group. Some grape vine species of Easter Georgia belong to Eastern Asia ecological- geographical zone group (*Convar orientalis* Negr.) and Caspian Sea (*Sub.convar Caspica* Negr.) group. For example,Tavkveri and Shavkapito.

In Georgia, mainly two geographical locations: Kolkheti and Alaznis Veli are identified as the places of birth of Georgian grapevine species. Georgian species are endemic and are located in historical places of their ethnical-Geographical places: in Kakheti about 90 species; in kartli region about 72 species; in Imereti region more than 70 species; in Lechxumi region: In Guria region about 60 species; in

Achara region about 50 species; in Samegrelo region about 60 species; in Abkhazia region about 50 species, and in Meskheti more than 25.

Chapter II. The Main Pests and Diseases

II.1. Brief Description

Insects. The body of an insect is made up of segments and is divided into three parts: head, thorax and abdomen, while its outside part is covered with cuticule. Attached to the lower side of the thorax are three pairs of legs, which in turn are made up of separate parts, while the upper side has two or more pairs of wings. Antennas, mouth organs and eyes are located on the head.

Insects by mouth part are mainly divided in two types: one with piercing-sucking and the other chewing. Insects with piercing-sucking mouth parts have a thin stalk through which they pierce plant tissue and suck into cell sap. They include aphids, bugs, trips, scale insects, mites, etc.

Other insects are equipped with a chewing-type mouth with cool jaws that chewing leaves, fruits, branches and other parts of the plant. Chewing insects include beetles and their larvae, caterpillars, etc. Some insects, such as flies, have a licking type of mouth. The structure of the oral apparatus and the feeding type of insects are of great importance for the selection of chemical measures to control them.

Insects breathe through respiratory organs which are located on the sides of the body and cover the tracheal system, which in turn consists of numerous respiratory holes.

Various appendages are located in the last part of the abdomen: ovipositor, copulatory organs, pricking, and others.

Insects have a well-developed nervous system, which is located inside the body, in the form of nerve nodes and chains on the abdomen. Nervous system of bees, cockroaches, ants, beetles, butterflies and their larvae are particularly developed. Most insects reproduced in a sexual way. Their descendants are derived from fertilized egg. There are insects that reproduce from infertile eggs

through parthenogenesis. There are insects in which sexual and asexual reproduction alternate (many species of aphids). Most insects are highly fertile. In different species of insects, the number of eggs laid by one female varies from one - to one hundred thousand.

Worms are hatched from the eggs laid by females which feed on plants, gradually grow, change their skin, move to different ages and nest. Complicated changes occur in the shells, and then they become adult insects. Such development is called a complete transformation. It is characterized by butterflies, beetles, flies and some other insects.

Some insects, such as aphids, do not have a pupal stage. They are insects of incomplete transformation. Worms of such insects develop wing and are called nymphs.

Insect larvae, which is completely transformed during development, can be easily distinguished by the following signs: Butterfly caterpilars have 5 or 8 pairs of legs, 3 pairs of breasts and 2 to 5 pairs of bellies, which are called claspers. The head is well observed on worms.

Most bugs have a well-defined head, but number of breast legs does not exceed three pairs, and have no abdomen legs. Worms of flies have neither legs nor a clearly pointed head.

The development from the egg phase - to the adult insect is called generation. Some insects give one generation per year, some produce several. There are species whose development of one generation takes 3-4 years. The number of generations depends on the location and weather conditions.

Insects develop and multiply only during the warm period of the year (spring, autumn). In winter their development is suspended. Insects mostly overwinter in the egg, during larval or pupal stage. In spring, as soon as it warms up, the pests begin to overwinter and further develop.

Mites. Plant mites belong to the class of Arachnid. Unlike insects, their body is not dissected and contains 2 parts: chest and abdomen. They do not have antennas. The body shape of araneidan mites is flat-oval or convex-oval, while some mites is a worm-like. Adult mites have 4 pairs of legs, while anothers have 3 pairs. Gale-forming mites have 2 pairs of legs on the chest.

The mites have a spinous- pircing-sucking mouth apparatus. They breathe through the body surface and the small tracheal system. They

have a weakly developed nervous system. Gale-producing mites have no respiratory or visual organs at all. Like some insects, mites undergo an incomplete transformation during their development. Mites multiply by laying eggs, from which tiny worms are born. The worms change their skin, turning first into nymphs and then into adult mites. All stages of development are preceded by a short resting period.

The most mites overwinter in the egg phase and some - in the adult state. The number of generations depends on weather conditions.

Diseases. Plants are infected with fungi, bacteria, viruses and phytoplasmas, which belong to the group of parasitic diseases. Non-parasitic lesions include disorders in the plant caused by soil, climate and by the influence of other unfavorable factors.

Fungal diseases are the most widespread group of plant diseases. Almost every plant has its own fungal parasites. They belong to the lowest plants` genera and do not have green color and not contain chlorophyll; has no root, stem or leaf. Nutrition can be made at the expense of the prepared product. Such parasitic fungi lives at the expense of the green plant and profiteers that inhabit the dead parts of the plant. There is also a transitional form of fungi - semi-parasites, or facultative profits which first develop on living tissues and then on dead parts of plants.

Fungi that damage plants are very similar in structure to the well-known edible and non-edible fungi. They have mycelium - thin filaments that develop inside or on the surface of damaged plant tissue. The mycelium is well visible under a microscope, through which the fungus spreads to the plant and feeds on it. Spores are formed on the mycelium. When they reach the plant, the spores grow, invade the tissues or develop mycelium on the plant surface. Every fungus has its own characteristic, a spore-forming type. Spores can develop directly on the mycelium, or on the fruit body: pycnidia, perithecias, etc.

Fertility of the fungus is a reliable sign to determine without error which fungus is causing this or that plant disease.

Bacterial diseases. They are a less common group compared to fungi. Bacterial diseases (bacterioses) are caused by bacteria, single-celled organisms from the lowest plant group. They dig into the plant in a natural way or through wounds.

Bacteria multiply mainly by simple division. Under favorable conditions this process proceeds very quickly. Most bacteria have a sticky shape, a significant portion of which is motile. Consequently, they are quickly planted in vines and other crops, causing dampness, drought, the formation of increments, etc.

Viral diseases. The reason for causing diseases is viruses. It is a special protein compound that is produced in the cell sap of a damaged plant. Viral disease is spread by the juice of an infected plant. This disease is mainly transmitted by insects and mites, that inhabit the diseased and healthy plant. The virus can be spread during pruning, grafting and other operations. Externally viral diseases change the color of infected organs, the shape of leaves and flowers.

Phytoplasmic diseases. They are a specific group of pathogenic organisms that are in transition between viruses and bacteria. In terms of the form and the nature of the harmfulness, phytoplasmal diseases are similar to viral diseases and in terms of body structure and form of reproduction – to bacteria. Characteristic signs of the disease are stunted growth, deformation of plant multiplication and reproductive organs, discoloration, etc. The disease is spread by viruses, mainly insects with piercing-sucking mouthparts. The human factor is also important.

Non-parasitic diseases. These diseases are most common in perennial crops, caused by improper plant nutrition, water supply disruption, and adverse climate conditions.

II.2. List of Main Harmful Insects, Mites, their Bioecology and Control Measures

Grape entomofauna and mycoflora are diverse in Georgia, which is mainly caused by natural-climatic conditions that are very favorable for spread and development of pests. It is also noteworthy that the area of pests and disease zones has changed significantly in recent decades. If some pests have lost their previous aggression, some of them, for example, grape moths, scales, mites, downy mildew, powdery mildew, viral and phytoplasmal diseases cause great damage every year. Often,

ignorance of the mechanism of pests and damage symptoms leads to an underestimation of their aggressiveness, which is why grape harvest losses are still large.

Amateur growers, farmers who want to care of vines should be well aware of the symptoms of pest damage, against which some measures should be taken. The viticulturist should determine according to the symptoms of injury, the type of disease and pest, and choose how to control them and not harm the beneficial organisms and the environment.

II.2.1. List of Main Hurmfull Insects and Mites

Grape is damaged by up to 100 species of pests in Georgia which are divided into two groups: Pests of root system and pests of vegetative organs. Some of those are listed below:

1. Auger beetle - *Bostrychus capucius* L.
2. Apple blossom beetle - *Tropinota hirta spp suturalis* Poda.
3. Beet armyworm - *Spodoptera exigua* Hb.
4. Brown marmorated stink bug - *Halyomorpha halys* Stal.
5. Beet armyworm – *Spodoptera exigua* Hbb.
6. Cottony maple scale -*Pulvinaria innumerabilis* Rathvon.
7. Common click beetle - *Agriotes sputator* L.
8. Carpenter moth - *Cossus cossus* L.
9. Comb – clawed beetle – *Omophles pruinosus* Rttr.
10. Common wasp - *Vespa vulgaris* L.
11. Common cockchafer - *Mololontha pectoralis* F.
12. Dune chafer - *Anamola dubai Scop subsp abchasica* Mot.
13. European mole cricket, - *Gryllotalpa gryllotalpa* L.
14. European fruit lecanium - *Parthenolecanium corni* Bouche.
15. European chinoceros beetle - *Oryetes nosicornis* L.
16. European rose chafer - *Cetonia aurata* L.
17. Flower scarab chafer - *Oxythyrea cinctella* Shaum.
18. Grape bud mite – *Colomerus vitis*
19. Grape bud worm – *Theresimima ampelophaga* Bayle.
20. Grape berry moth – *Lobisia botrana* Den et Schiff.

21. Grape mealybug – *Pseudococcus maritimus* Ehrhorn.
22. Grape phylloxera - *Daktulosphaira vitifoliae* Fitch.
23. Grape spider mite -*Eotetranychus pruni* Oud.
24. Grape gall mite - *Eriophyes vitis* Pagal.
25. Grape miner moth – *Antispilla rivillei* Stt.
26. Grape cottony scale – *Pulvinaria vitis* L.
27. Grape leaf mite – *Phyllocoptis vitis* Hal.
28. Grape thrips - *Drepanothrips reuteri* Uzel
29. Georgian steppe click beetle - *Agriotes gurgistanus* Fold.
30. Hazel leaf roller – *Byctiscus betilea* L.
31. Kaziel leaf roller - *Byctiscus tulea* L.
32. Livornic sphinx - *Celerio livornica* F.
33. Leopard moth - *Zeuzera pyrina* L.
34. Long-palped fordrix - *Tortrix pillerians* Sh.
35. Mediterranean spatled chafer - *Oxythyrea funsta* Pods.
36. Oriental hornet - *Vespa Orientalis* L.
37. Shamyl`s ghost moth - *Zenophassus shamyl* Chr.
38. Scariba beetle - *Polyphilla aspera* Mot.
39. Scarab beetle - *Anomala aene*
40. Spotted - wing drosophila - *Drosophilla suzukii* Mats.
41. Transcaucasus marmorated Beetle - *Polyphylla olevieri* Gach.
42. Turnip moth - *Agrotis segetum* Schiff.
43. Turnip moth – *Agriofis segefum* Schiff.
44. Tornip moth - *Leaxoa segetum* Sch.
45. Vine borer - *Sinoxylon perforans* Sch.
46. Web worm – *Hyphantria cunea* Drury.
47. White line Dast - *Leaxoa tritisi* L.
48. White line sphinx - *Celerio Lineata* Esp.
49. Weird beetle - *Phyllon thus silenus* F.
50. Zlephant hawk moth - *Pergesa elpenor* L.

Among the above listed pests, we selected some of them which are most dengareous in Georgian conditions.

II. 2.2. Biology of Main Hurmfull Insects, Mites and their Control Measures

2.2.1. Pests of Root System

Grape Phylloxera (*Daktulosphaira vitifoliae* Fitch.) is a very dangerous pest of the vine root system. It was spread from America and destroyed 70% of vineyards in Europe; Grape Phylloxera has been observed in Georgia since 1881. It is a monophagous insect, has a sucking mouth organ and damages the root system of the vine, as a result of which the food supply to the plant is interrupted and its growth and development is weakened. Such plants often dries out.

There are two types of phylloxera - root and leaf. The root phylloxera damages the roots, while the leaf phylloxera destroys leaves and young shoots.

When young roots are damaged, nodositates develop on it. It turns yellow at first, then turns brown, and finally dies. In the result of such injury, the growing roots die in 10-15 days. In case of damage to larger roots, tuberositates appear, which in case of strong damage covers the entire roots, and then causes the death of the plant.

Phylloxera is an egg-laying insect. In its full development it comes in 4 forms: 1. Root phylloxera; 2. Winged (spreader); 3. Sexual; and 4. Leaf-maker or galles. It is characterized by parthenogenetic reproduction. Sexual form includes females and males. The female lays a fertilized egg in winter after mating.

Root phylloxera begins to produce nymphs on the roots from the second generation. These nymphs then transform into wings (spreaders) and lay eggs from which the females and males are hatched. In spring, leaf phylloxera (April 10-25) settles on the upper side of the leaf and damages it, causing galls. In 2-8 days, the second generation phylloxera is excreted hatched. It can give 5-9 generations. Two types of phylloxera are hatched from eggs - brushy, short and long-stemmed. The first remains on the leaf, the second moves to the roots and the next generation of pests hatches.

II. 2.2. Biology of Main Hurmfull Insects, Mites and their Control Measures

2.2.1. Pests of Root System

Grape Phylloxera (*Daktulosphaira vitifoliae* Fitch.) is a very dangerous pest of the vine root system. It was spread from America and destroyed 70% of vineyards in Europe; Grape Phylloxera has been observed in Georgia since 1881. It is a monophagous insect, has a sucking mouth organ and damages the root system of the vine, as a result of which the food supply to the plant is interrupted and its growth and development is weakened. Such plants often dries out.

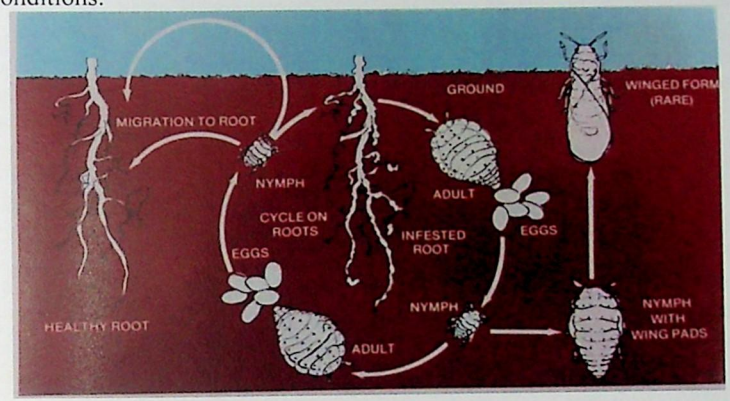
There are two types of phylloxera - root and leaf. The root phylloxera damages the roots, while the leaf phylloxera destroys leaves and young shoots.

When young roots are damaged, nodositates develop on it. It turns yellow at first, then turns brown, and finally dies. In the result of such injury, the growing roots die in 10-15 days. In case of damage to larger roots, tuberositates appear, which in case of strong damage covers the entire roots, and then causes the death of the plant.

Phylloxera is an egg-laying insect. In its full development it comes in 4 forms: 1. Root phylloxera; 2. Winged (spreader); 3. Sexual; and 4. Leaf-maker or galles. It is characterized by parthenogenetic reproduction. Sexual form includes females and males. The female lays a fertilized egg in winter after mating.

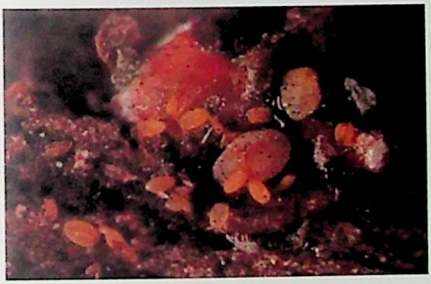
Root phylloxera begins to produce nymphs on the roots from the second generation. These nymphs then transform into wings (spreaders) and lay eggs from which the females and males are hatched. In spring, leaf phylloxera (April 10-25) settles on the upper side of the leaf and damages it, causing galls. In 2-8 days, the second generation phylloxera is excreted hatched. It can give 5-9 generations. Two types of phylloxera are hatched from eggs - brushy, short and long-stemmed. The first remains on the leaf, the second moves to the roots and the next generation of pests hatches.

In the lowlands of Georgia Root phylloxera gives 7-8 generations a year. The development cycle lasts 13-33 days, depending on climatic conditions.



Life cycle of phylloxera in grape roots[1]

Both European (including Georgian) and American vine varieties are not equally resistant to this pest. The most resistant vine varieties from USA are *Berlandier* X *riparia*, 420a and 420b, and from Georgian, relatively - Tsitska, Chinuri, Rkatsiteli and Mtsvane. On the other hand, Saperavi, Krakhuna and others have weak resistance.



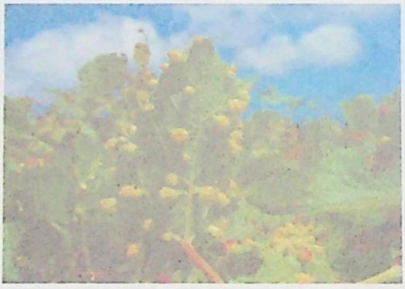
Root Phylloxera

[1] Source: Grape Pest Management. University of California. 1992.

Control measures: The fight against phylloxera is conducted in different ways. For example, in order to protect the root from phylloxera, a phylloxera-resistant vine rootstock is used, on which European grape shoots are grafted. The grafted vines prove the resilience of American vine roots and European vine leaf phylloxera. Therefore, the lower part of the graft, the root, is American, and the upper part, the crop - is European. Therefore, it is understandable that grafting protects vine from both forms of phylloxera.

Among the existing phylloxera-resistant vine varieties the following are used: *Riparia* X *Rupestre* 101-14, 3306 and 3309; *Berlandier* X *Riparia Kober* 5 BB; 420-a, *Berlandier* X *riparia Kober* 5 bb; *Shasla* X *Berlandier* 41 b. It should be noted, however, that the above-mentioned varieties of *Riparia* X *Rupestre* and *Rupester* X *Dulo* are not tolerant to limy soils and become damage with chlorosis. Other varieties tolerate soil moisture much better.

The application of the agro-technical method of control is as follows: in Mother plantations of rootstocks are necessary to earth them up and make hilling up to 12 - 15 cm height. This process should be done in fall or in early spring, before starting vegetation and bud break. If hilling is done in autumn, in spring more soil should be added because during autumn-winter period soil can be compacted and collapsed. This measure should be carried out in such a way that no vine is left without hilling, because on such vine the first leaf phylloxera appears in spring, which then multiplies and spreads to the whole mother plantations of rootstocks.



Leaf Phylloxera

Pesticides against leaf phylloxera are used in the mother plantations of rootstocks: among them B-58 top 0.1-0.2%, Karate 0.03-0.04% or other contact or systemic pesticides.

Transcaucasus Marmorated Beetle - (*Polyphylla olivieri* Gast.) is spread in both eastern and western Georgia. The Polyphagous pest does a lot of damage to the vines, especially in nurseries and young vineyards. More than 50% of the vine in Georgia is damaged by its worms. Worms live in the soil and infect both young and old roots and when it damages the main root - the plant dies.

The beetle is 33 mm long. Has fan-like antennas, colore - black, with marbled spots.

The length of the newly hatched worm is 12-13 mm. At the end of growth, it reaches 8 cm. The worm is yellowish and ellipsoid.

The pupa of the beetle is yellow. The egg is first white, then brown, 4.5-5 cm long. It spends winter period in soil at the depth of 25-30 cm. It comes out at 10-12°C from the winter period. At a temperature of 15-18°C it begins intensive feeding, after changing the skin three times, the worms move into the pupal stage (June, 1st decade). It takes 3 years for worm to reach its full development, sometimes even 4-5 years. The development of the shell requires a certain temperature, according to which the flight of beetles begins in late June - late August. The mass flights take place in July, mainly in the evening and early morning. Its flight radius is 20 m, duration does not exceed 15-45 minutes.

Transcaucasian Marmorated Beetle

It takes 37 days for worms to hatch at a temperature of 22-29°C. The worms feed on the roots in the soil until the temperature drops to 10-12°C. Then they move to deep into 25-30 cm the soil and overwinter.

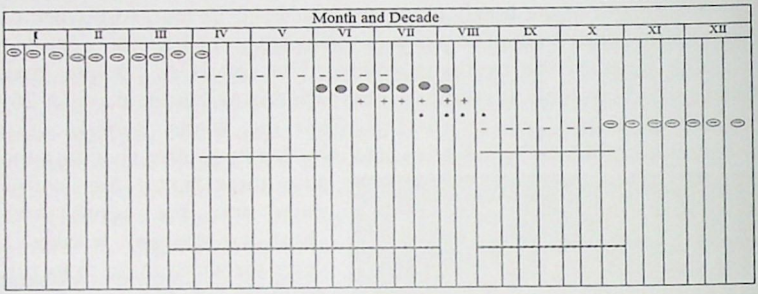
Their natural enemies are rooks (*Corvus frugilegus*) and other birds and wasps - in small numbers.

Control measures: Since larvae of the beetle are widespread in loamy soils, both nurseries and vineyards need eradicated before planting, in addition to collecting and destroying pupas during plowing,

mulching and cultivation. Good effect if we hold this event in April-May (sometimes in the second half of March, if it warms up early), as the worms are close to the soil surface at this time; Also, during the mass spread period larvae and pupae must be collected and destroyed. The granular pesticides used against them also effective.

Transcaucasus marmorated Beetle

Phenocalendar



Symbols: • Egg; — Worm; ⬬ Cocoon; ⊖ Wintering worm; + Imago; —— Injury period; ..... Control period

Click Beetles or Wire Worms. In Georgia, grapes are mainly damaged by two species of Click beetles: Georgian Steppe Click Beetle (*Agriotes gurgistanus* Fald.) and Common click beetle (*Agriotes sputator* L.). Georgian wireworms are more important. It is highly harmful in nurseries and newly planted vineyards, where it often destroys 80-85% of the plants.

The bug is 8-13 mm long; Dark chestnut, furry; Covered with dots. The upper wings have grooves.

The biology of Georgian and Common click beetle differ from each other. Georgian wireworms overwinter in the worm phase, while sown wireworms - in both the worm and imago phases, at a depth of 25-70 cm in soil. Georgian worms hatch in March and April. In the beginning, they feed on the remains of herbaceous plants, and after transplanting vines, they first damage the buds in the soil, and then - the

young yellow twigs. So they continue to live for 3 years. The skin is changed 8 times. After the end of growth, they dig to a depth of 8-15 cm (August). This phase lasts 14 days for Georgian wire worms, and 7-9 days for Common wire worms. Its full development takes 4 years.

Control measures: To control the wire worms, we should use granular contact pesticides in the newly planted vineyards. Granular Actara in the soil, at 400 grams/ha or using Nuprid.

Georgian steppe click beetle

Moths. The grape is damaged by the Turnip moth– *Agrotis segetum* Schiff, and Beet armyworm - *Spodoptera exigua* Hb.

The worm is 30-45 mm with outstretched wings. Forewings are grayish-yellowish gray, sometimes black; egg is yellowish-white, worm-grayish-bluish, 4-5 cm long, with 5 false legs in front of the abdomen.

Beet worm

All species of moth overwinters in the stage of worms, caradrina - in the form of pupa. The worms emerge from the soil only at night and damage the upper parts of the grape. While at day time – it damages

the roots and underground twigs, after which the vine in the nursery completely dies.

The moth, depending on the species, gives different generations per year: in our conditions the Turnip moth gives 2-3 generations, and the Beet armyworm - one. The first one lays up to 1300 eggs.

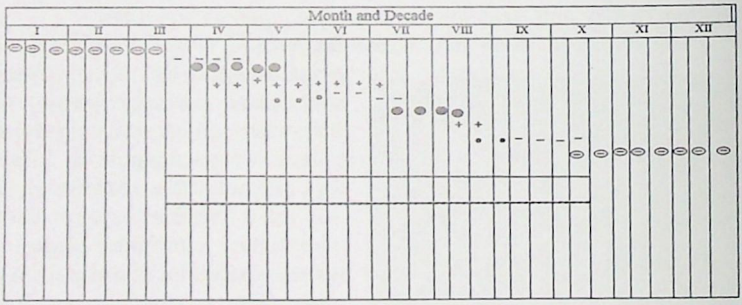
Turnip moth

The imago of this species is active only at night, but during the day they are passive. Under the grasses or leaf. Their active action (feeding, flying, multiplying) begins in the evening and lasts until morning. As a specific of feeding, the worm develops, changes the skin 5 times and burrows into the soil, the so-called cradle. The number of these pests is reduced by parasites, unfavorable weather conditions - frequent rains or prolonged drought.

Control measures: Same as on wireworms.

Turnip moth

Phenocalendar



Symbols: • Egg; — Worm; ⬬ Cocoon; ⊖ Wintering worm; + Imago; —— Injury period; ..... Control period

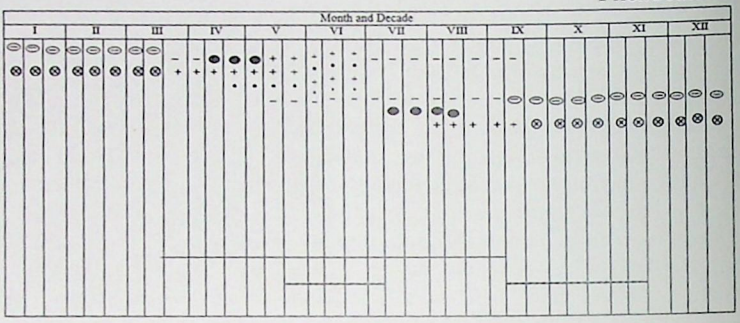
European Mole Cricket (*Gryllotalpa gryllotalpa* L.) is a polyphagous pest, severely damaging vines in both nurseries and newly planted vineyards. It destroys the buds in the soil, the root system, the root collar, also the young shoots. The length of the adult is 35-37 mm. The top is brown and the bottom is yellow. The upper wings are short, brown, and the lower ones are well developed. The egg is oval, 3-3.5 mm long. The European mole cricket overwinters in the worm and imago stages at different depths in the soil. At a temperature above 12°C. It overwinters, and after feeding begins to mate. Spawning takes place in late May and the first decade of June. Before laying eggs, it makes a nest in the soil at different depths. The hatched worms emerge from the left hole. Its sexual output varies between 14-400 eggs; the hatching process takes 7-28 days. The hatched worms feed first on the shell and then on the plant. During the day it spends time in the soil, at night it comes out on the surface of the soil. It cannot stand the drought. Vertebrates play a big role in regulating the number of mares: Grey crow, Rook, Jaybird, Stork, Seagull, Sow thistle, Owl, Bee-eater, Black kite, Buteo, Coral, Cuckoo, Hen, Turkey, etc.

Control measures: The fight against European mole cricket control measures are carried out mainly by mechanical and chemical methods. The mechanical method involves destroying the nests before hatching eggs. Granular contact pesticides also gives good results.

European Mole Cricket

European mole cricket

Phenocalendar



Symbols: • Egg; — Worm; ⬬ Cocoon; ⊖ Wintering cocoon; + Imago; —— Injury period; ..... Control period; ⊗ Wintering Imago

Schamyl's ghost moth (*Phassus schamyl* Chr.). This pest is considered to be an endemic species of the West Caucasus. It is spread in West Georgia and local varieties of grape.

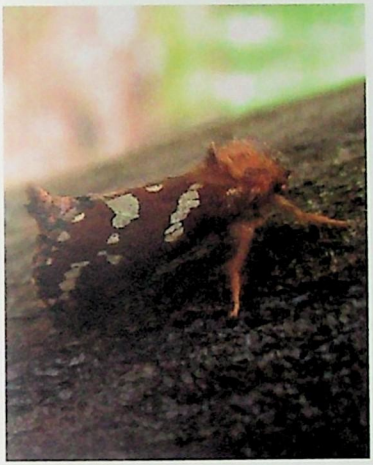
The width of the butterfly of the Schamyl's grost moth is 9.5 cm with the wings spread out and the length of the body is 3.5 cm. The female is a brown butterfly, while the male is purple. The hind wings are brown, with a pink tip and a hind shoulder. Butterfly`s antennas are extremely short. A sitting butterfly looks like a dried, curled leaf. The newlaid egg is yellow, which in 24 hours becomes glittery black in color and resembles poppy seeds. The newly hatched worms are silvery-gray, while the shield and fern are brown. A darker colored stripe is well visible along the body. Adult worms are white-yellowish, the head is brown and have well-defined hooks. The length of worm is 6-7 cm, the shell is brown-yellow with a length of 4-5 cm. The pest first dig out of the underground stem of the vine irregularly or in a ring, and then dig into the heart of the plant stem and makes holes, the length of which in some cases reaches 17-24 cm. The worms widen the holes for

the butterfly to fly, which is why the vine stem breaks easily in this very place.

Schamyl's grost moth mostly damages new vineyards, rarely – old grapes. Grape leaves damaged by the pest begin to turn yellow in May-June during the second year of vegetation, and wither in summer in July-August.

In addition to vines, larvae of Schamyl's grost moth feed on the roots of hazelnuts, blackberries and other shrubs.

Schamyl's grost moth has a one-year generation. In the second half of October, the 2-3 instar worms stop feeding, dig holes in the heart of the underground stem of vines and other shrubs and overwinter. In the spring, March-April, they continue feeding again, which lasts until the end of July. In early August, the larvae nest where they feed, and in rare cases - in the soil, at a depth of 5 cm. The pupal stage lasts 14-17 days depending on the climatic conditions. The butterfly begins to fly along the canals and crevices in the second decade of August. At this time, it is possible to see it after sunset, until complete eclipse. Butterflies fly and lay their eggs mainly in the ground near the vine stem or directly on the plant stem. The butterfly lays on average 700-750 eggs. 10-14 days after hatching, the worms hatch, which enter the soil and begin feeding on the underground organs of the vine.



Schamyl`s ghost moth

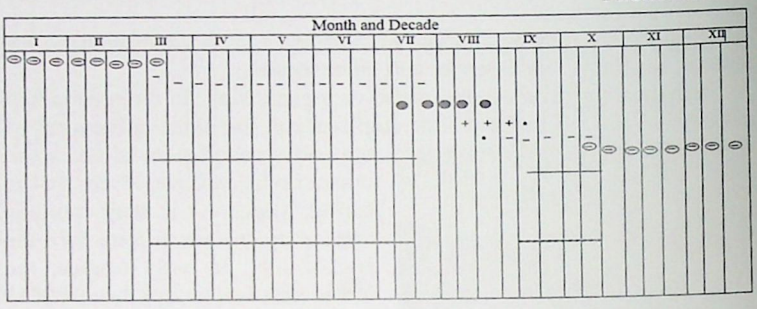
The larvae of the pest are particularly damaging to vineyards planted in loamy soils. Soil moisture is of particular importance for pest development. In dry soils it dies. Therefore, the area of Schamyle's ghost moth is limited.

Control measures: When planting vines, carefully inspect the shrubs around the plot, and when pests are found on them, destroy them. In the spring (April-May), it is effective to apply 12% granulated

Nurel-des to the soil at a depth of 12-15 cm in the spring (April-May), used norms - 15-20 kg. per hectare.

Shamyl`s ghost moth

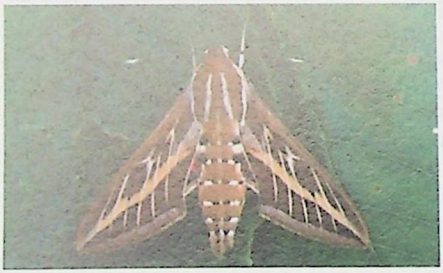
Phenocalendar



Symbols: ∘ Egg; — Worm; ⬬ Cocoon; ⊖ Wintering worm; + Imago; —— Injury period; ..... Control period.

II.2.2.2. Pests of Vegetative Organs

Livornic sphinx (*Celerio livornica* F.) is spread almost everywhere in Georgia. During the years of mass damage the vine sometimes remains completely leafless and the grapes can not ripen. The sphinx mainly damages leaves, sprouts and buds.



Livornic sphinx, imago

This butterfly with wingspan is 65-90 mm. Its upper wings are brown with a broad white stripe. The lower wings are pink with a black base. Each segment of the abdomen is separated by

a white stripe. The end of its mustache antenna is white.

The egg is rounded-oval, 1-2 mm long. In the beginning, the egg is green, but then becomes white.

The newly hatched larva is 3-4 mm long, with a white-black head, legs and shoots, located at the bottom of the abdomen, on the side of the spine. After feeding, the worm turns green and reaches a length of 7-8 cm. The pupa is 35-40 mm long. First the color is yellowish-lettuce, then brown. It has a spot at the bottom.

Livornic sphinx, worm

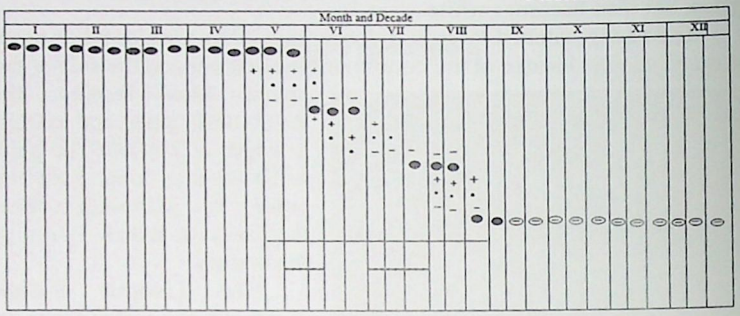
The Livornic Sphinx overwinters in the form of pupa in the soil. Butterflies emerge from the shell in the first days of May-June. Ovulation begins 2-3 days later on the underside of the leaf, on the leaf stalk or in the soil. Products reach 225 eggs. Worms hatch at 16°C in 10 days and at 28°C in 3 days. The worms change the skin 5 times. The Sphinx population has reduced with many viral disease - polyhedrosis. The Sphinx produces 3 generations per year.

Control measures: The larvae of the Livornic sphinx I and II instar are carried out by chemical methods, and the following treatment can be used: 0.2% B-58 top, or 0.04% Karate zeon, or 0.15% Actellic.

The first treatment should be carried out in mid-May, and the second treatment, if necessary, in early August.

Livornic sphinx

Phenocalendar



Symbols: • Egg; — Worm; ⬬ Cocoon; ⊖ Wintering cocoon; + Imago; —— Injury period; ..... Control period.

Grape bud worm - (*Theresimima ampelophaga* Bayle.) is widespread in western Georgia, and less in the east part of the country. It damages both European and American vines as it feeds on their buds and leaves. In particular, it damages the bud from the outside and then enters inside it. Such a bud has a red hole on the outside. After completion of germination, it moves to other buds and begins to damage them again. During mass propagation of Grape bud worm, up to 50% of the buds in the vineyard are damaged.

Grape bud worm, imago

The butterfly of the pest the outstretched wings of which equals to 22-25 mm. has upper body which is glitter blue, wings are dark brown with a bronze tinge and it has a comb-type antennas.

The egg is 0.7 mm long and 0.5 mm wide, yellowish, with a mesh structure on the outside.

The worm is initially has a light color (yellowish), with a black back and head. It then takes on a greenish color, with 3 red lines on the back and 2 on the sides. The back is red, the body is covered with light colored hairs. The adult worm is 14-15 mm. The shell is yellow with black dots and stripes.

The pest overwinters in phase 2-4 instar of the worm, both on the above-ground living vegetative organs of the vine (stem, shoots), as well as in the dormant and rotten areas of the support bark, in white, thin, dense parks, from where it overwinters in March-April, budding early. They take 12-14 days to emerge (in windy conditions). Newborn worms feed on buds and then on leaves. They change their skin 6 times and grow on vine stems, leaves, reflective material, soil-covered areas, etc. The worm phase in western Georgia begins in May and lasts until June (15-20 days).

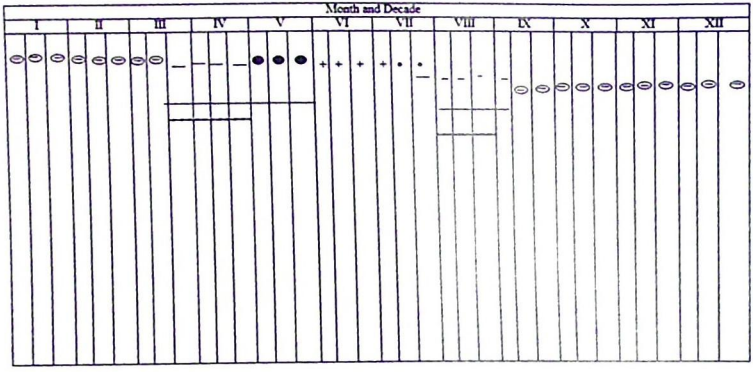
Grape bud worm, worm

The butterflies are active in the morning and evening. Eggs are mainly laid on the backside of the leaf, from the last decade of June, and in the second decade of July. Sex production are 100-300 eggs. The newly hatched larvae stay there for a day, then move to the leaves and start to live separately.

Control measures: The fight against bud worm is carried out by chemical methods, using any phosphororganic (B-58 top) or pyrethroid pesticides (Fastak, Karate). Spraying is done from all sides to completely cover the buds and leaves with the mixture. We should try to keep the back side of the leaf well moistened, as most of the bud worms sit on this side. The first treatment is carried out at the beginning of bud germination, in late March or mid-April, the second treatment - at the end of budding, the third - in July, when the new generation of worms are hatched.

Grape bud worm

Phenocalendar



Symbols: • Egg; — Worm; ● Cocoon; ⊖ Wintering worm; + Imago; —— Injury period; ..... Control period.

Grape berry moth (*Lobesia botrana* Den et Schiff.). This moth causes great damage in the viticulture areas of Kakheti, rarely in Imereti. The first generation worm damages the flowers, wrapping them in a web of thin abalone. After flowering, the worm also wraps the newly hatched fruit in the abalone network and feeds on it.

Grape berry moth, Imago

The top of the butterfly is brownish grey, the underside and sides are light grey. Grey, yellowish, bluish spots appear on the front wings. The winged butterfly is 4-5 mm long and 10-13 mm wide.

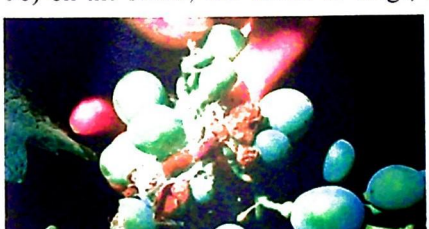
The egg is whitish at first, then whitish-yellowish, and finally yellowish-green. The head and neck shield are initially black, then - gray. He has gray warts all over his body, and one fur on each wart. The

length of an adult worm is 10 mm. The pupa is brown, with a greenish tinge at the bottom, with three hook-shaped bristles on each side. He has his whole body covered with short brushes, which is located in white park.

In early July, the first generation worm develops, which feeds on green berries. It moves from one to another, sometimes damaging the entire cluster. Heavily damaged berries fall, partially damaged reach maturity, fungal organisms inhabit it and alpine, which is reflected in the secondary damage of the worm. It should be noted that in case of strong spread of the pest 50-60% of the crop dies.

The grape worm overwinters in the stage of pupe on the vine stem, under the cracked bark, rarely - on the stems, from which butterflies fly in the spring. They fly in the evening and in the morning, and during the day - hiding in the leaves.

The butterflies emerging from the pupa are sexually immature. After a few days of feeding, they mate and after 1-2 days lay eggs (30-90) on the stems, leaf stalks or twigs, from which after 8-10 days the worms hatch, which move to different stalks and develop at the end of flowering. Some even continue feeding on fresh fruit. It takes about 38 days for the worm to fully develop. After that it changes the skin 4 times and cuts the leaves in the middle or in clusters. The pupal stage takes 12-15 days. The butterflies lay their eggs on the berries, from which the second-generation worms emerge, enter and begin to damage the berries. The second-generation worms nest when they have finished growing and usually nest in damaged and wilted berries. Butterflies will fly in the second half of August. We find the spawning of these butterflies already in the period of maturity, in the second half of August and the beginning of September. The indirect damage caused by them is also noticeable here, as mechanically damaged berries begin to rot.



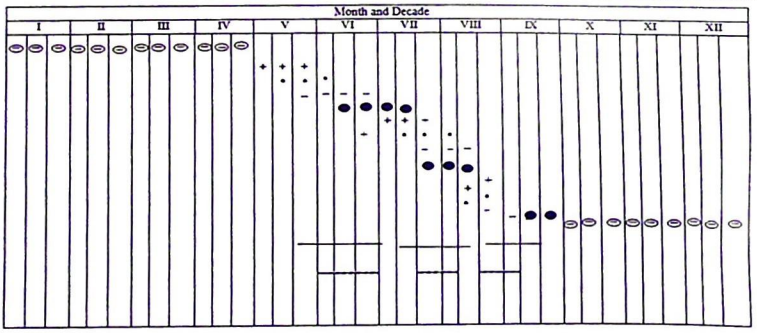
Grape berry moth, damage

Various parasites significantly reduce the number of the Grape berry moth. In Kakheti vineyards alone, 16 species of insects are registered, through which the number of worms is reduced by 25-54% under favorable conditions. Among them are important may be *Ichneumonidae* and *Chalcidoides*.

Control measures: Timely spraying of vines. From chemical preparations 0.03-0.04% pyrethroides (Karate, Karate zeon) are used. 1% Bitoxybacillin or Lepidocide gives good results from microbiological pesticides. The first two generations are treated with chemicals, and the third generation - with biological preparations. The first treatment is carried out when the clusters are in the cockles, the second - at the end of flowering, and the third - before ripening, when counting the grains. The use of pheromone catchers also gives good results.

Grape berry moth

Phenocalendar



Symbols: • Egg; — Worm; ● Cocoon; ⊖ Wintering cocoon; + Imago; —— Injury period; ..... Control period.

Grape Mealybug - (*Pseudococcus maritimus* Ehrhorn.) is distributed in eastern and western Georgia. It damages all the above-ground plant organs, especially leaves. The damaged leaf turns yellow, the clusters wither and fall off. It is also distinguished by indirect damage, as its sweet excrements are inhabited by fungi of the genus *Capnodium* and covered with black mulch, which adversely affects the quality of the grapes and then the wine. Damaged grapes sometimes reduces yields by 70-75%. Particularly it is dangerous in late June and the first and second decade of July.

Grape mealybug, Imago

The average length of an adult is 4 mm, width - 2.5-0.8 mm. It has an oval shape. Its pink or greenish body is covered with a white, floury snowflake, hence its name.

Females and males of mealy bugs differ from each other. Males are elongated and winged, while females are wingless, oval, yellow or pink, with waxy flakes. The eggs are small, yellow, covered with waxy snowflakes.

Grape mealybug on berries

The mealybug overwinters at different ages on the stem, pole, under the exposed bark. It grows, changes the skin several times and enters the adult phase. It lays its eggs in the waxy threads it separates, on the stem, under the exposed bark, and in later generations - on the leaves and their stems, as well as at the base of the twig, and most of the last generation - on the clusters. They are

negatively affected by winter frosts, and even more so by parasites and predatory insects that destroy them in summer, sometimes by up to 80%. The spread of the pest is facilitated by winds, transportation of nursery materials and grapes.

Control measures: 1. From July 15 to the end of the month on B-58 top 0.2%, Aktelic 0.2%, or 0.03-0.04% pyrethroid pesticides (Karate zeon or Fastak) and spray twice on the leaves. The pest should be wetted carefully during spraying; otherwise, the pesticide will not have any affect. Due to the settlement of sedges on the leaves, spraying should be done from the bottom. 2. A good result is provided by the predatory beetle *Cryptolaemus*, which is multiplied by a large number of production bio-laboratories. Beetles should be released in early August - 10 thousand pieces per hectare.

Cottony maple scale (*Neopulvinaria innumerabilis* Rathvon.). This pest is widespread in viticulture areas of both eastern and western Georgia. It damages the above-ground organs of the plant by murmuring, inhabiting both sides of the grape leaf, on the stalk, as well as on the green twigs of the stalk. The pest is very similar to the grapes with the powdery mildew, but there is one essential difference between them: it is characterized by one-year generation.

An adult, sexually mature female is 5-11 mm, is oblong-oval, and reddish brown. Before the egg hatch, it is light in color, with a dark convex longitudinal stripe on the dorsal side, in the middle. When the egg is laid, its body is brown or yellowish. The eggs are white oval. It is placed in a wax bag. Its length is 0.19-0.3 mm.

Cottony maple scale on twigs

It overwinters in the worm stage of

different instar, on shoots and stems. Comes out of the winter in April and starts feeding. In the first decade of May, they start laying eggs in bags (2000-3000). After 14-10 days, the worms hatch, which are placed on different organs of grape and start feeding; the skin is changed several times, in October-November they switch to wintering.

Control measures: B-58 top 0.2%, or their substitutes, or any of the pyrethroid preparations, 0.03-0.04%, in the period of mass hatching of worms from eggs, twice, at intervals of 7-10 days. Mechanical control is also effective during ovulation.

European fruit scale (*Parthenolecanium corni* Bouche.). The pest is widespread in Georgia and causes great damage to vineyards. In addition to direct crop loss, damage adversely affects grape quality. The pest is polyphagous and is found on many plants. It damages young shoots, stems, leaves and clusters; it secretes a sweet juice, which is inhabited by fungi from the genus *Capnodium*. This fungus multiplies rapidly and spreads widly. At this time the function of the leaf is weakened, as a result of which, in case of mass damage of the pest, the twigs, leaves and bunch of grapes die.

European fruit scale on twigs

The first age of larvae of the scale insect is elliptical in shape; flat, segmented, with well-developed antenna and legs. Male insect is much smaller than female, its front wings are large, broad, rounded at the bottom, long on the body, without the hind wings. Females have no wings. An adult insect is 3.5-6.4 mm long and 2-4 mm wide, yellow in color. Its eggs are white and oval, length varies between 0.26-0.3 mm.

The pest overwinters on the grape stem, in the second instar worm phase. The scale insects that grow from the forest thrive well on twigs and leaves. They reach adulthood, mature sexually and give fertile offspring. In October-November they settle on the stem and shoots, where they overwinter. They emerge from winter in the third decade of March or the first decade of April. Upon completion of female development, it lays up to 2000 eggs and dies. The period of laying eggs varies according to the years and climatic conditions: 12, 15 or sometimes even 20 days. The second generation of worm hatch at different times, mainly in the first half of August. Newly hatched worms begin active moving on various organs of grape. Eggs are laid in the adult phase - placed under the body. Their embryonic development depends on environmental conditions. Worms do not hatch at temperatures below 10. Optimal is 27-29 C^0. In this case, they hatch in 9-10 days. The worms change their skin and overwinters.

Control measures: Same as for other scale insects.

Grape spider mite (*Eotetranychus pruni* Oud.). Mites are the most important pests in Georgia. It is widespread in all viticulture districts of Georgia. It does a lot of damage throughout years.

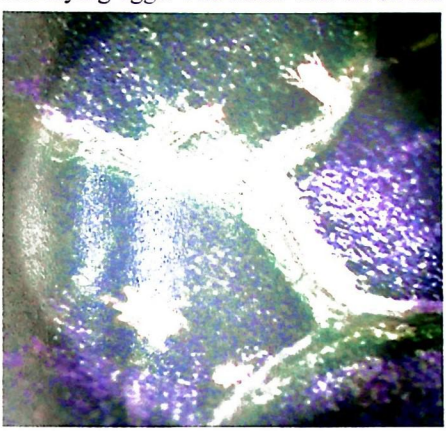
The pest mainly damages the leaves, but the damage starts from the newly sprouted buds and then spreads to the twigs and leaves. Chlorophyll spots are well noticeable in the swollen areas along the veins. Damaged twigs turn black. Damaged leaves deform, sound and fall off. Due to the decrease in the activity of the enzyme catalase, the ability of sugar to accumulate in grapes decreases, while the yield is reduced sometimes by 20%.

The grape spider mite infects different varieties of grapes in different ways. For example: Rkatsiteli, Mtsvane, Cabernet, Shasla, Muscat varieties, Tsitska, Saperavi are heavily damaged and other are slightly, such as Budeshuri black, Kharistvala black, Dondghlabi, Chinuri and others.

The mites are very small. Males do not exceed 0.25-0.35 mm, while females do not exceed 0.4-0.5 mm. Before the first skin-change, it has 3 pairs of legs, then 1 pair is added. It has small black dots on both the back and the sides, and thick brushes on the body and legs.

Moth is yellowish-green in color. The egg is round, 118.8 microns in diameter, at first watery color, then it turns dark.

The grape spider mite overwinter on different parts of the vine (stem, shoots, buds, as well as on grafting material). Its emergence from the winter coincides with the phase of unfolding of the grape buds. They move to the newly emerged leaves and immediately begin feeding and laying eggs. The mites first sit on the young leaves from the upper side, and as the leaves grow, they settle on its lower part, mainly along the veins. The development of its one generation, depending on air temperature, takes 9-29 days. For example, at 9-10^{0}C embryo development takes 19 days, at 10^{0}C - 6, at 25^{0}C - 4 and at 30^{0}C - 4-6 days. Thus, the optimum temperature for its development is 25^{0}C. When the temperature is more or less what is indicated above, the rate of embrio development slows down, then completely ceases and the pest dies.



Grape spider mite

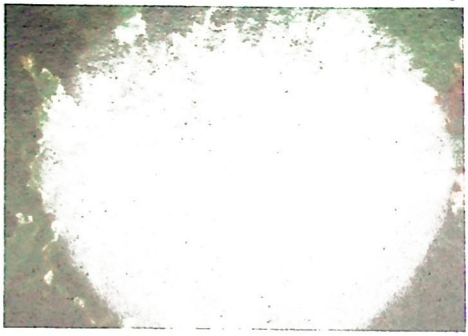
Under favorable conditions, the total number of eggs reaches 108, while the daily number reaches 14. Under optimal conditions (25^{0}C) gives up to 9 generations of vegetation. Its number is significantly reduced by predatory mites.

Control measures: The use of specific acaricides such as 0.2%, Fastak gives good results against the spider mite, which acts on all stages of the mite (egg, worm, nymph, imago). It should be sprayed well on the leaves from the bottom. The first spraying is carried out by removing 3-4 leaves on the twigs, the second - 10 days after these application. If necessary, another with plant pesticides. Potato, Onion or Grandfather tinctures can also be used against mites. The fight

against them is carried out if the number of pests is more than 3 per leaf.

Grape gall mite (*Eriophyes vitis* Pagst.). This mite is widespread in all viticulture regions of Georgia. It is very small in size. The length of the female is 0.16 mm, the width is 0.032 mm, and that of the male is 0.14-0.33 mm.

The mites spend winter mainly in the grape buds, under the bark. Overwinters coincides with the bud burst phase. At this time it settles on the young leaves and begins to damage them. As a result of feeding, protrusions appear on the upper side of the leaf, and on the lower side - in the curved areas, fur-like intertwined hairs. During the period of mass propagation they also damage the buds, as a result of which the buds die and the twigs develop poorly. In case of drought, severely damaged leaves wither and fall off. In the beginning of summer, spots first turn light yellow, whitish, and then turn brown. Mites live in the lower part of the leaf, in galleys, and give birth to 6-7 generations per year.



Damage from Grape gall mite

Control measures: 0.2% B-58 top, or piretroid pesticides (0.04%) gives good results against mites. The first treatment is carried out during the germination of buds, repeated - immediately after flowering.

Grape bud mite (*Colomerus vitis*). Grape bud mites are tiny (0.1 to 0.2 mm long), wormlike, and whitish yellow with two pairs of legs near the head. They can only be seen at magnification of 45 X or higher under a microscope, and the damage they cause is usually the first indication of their presence. The grape bud mite resides within the

bud and causes damage by feeding on the preformed stem, leaf and flower primordia that exist within the bud. In spring, there may be no growth at all from damaged buds, or only weak shoots may grow from less damaged parts of the compound bud. Vines infested with bud mites may exhibit erratic budbreak, stunted shoots, malformed basal leaves, and have reduced number of flower clusters. Stunted shoots may have arrested development and fail to grow beyond. Damage is most visible on tissues rapidly growing during budbreak. Symptoms observed from mite feeding should not be confused with symptoms of nutrient deficiency (boron or zinc), low reserve carbohydrates, herbicide damage, frost, or thrips damage. This pest mostly distributed in vineyards of East Georgia and some years gives significant damage.

Grape bud mite

Grape bud mites overwinter as adults inside buds where they feed on bud tissues and may kill the tissues within the overwintering bud. When buds begin to swell in spring, mites migrate to newly developing tissues where they feed and lay eggs. Eggs hatch and develop into adults. Bud mites move to the newly forming buds in the axils of the leaf petiole where they reside until budbreak the following year. During the next growing season, once the growth commences, mites within the inner scales are distributed along the shoot length as the shoot develops.

Control measures. Dormant - season oils used for other pests may also control this mite.

The emergence of these mite species of vineyards may be related to a general sulfur use to manage disease. Sulfur continues to be used by organic growers and in many other vineyards as an economical way to control powdery mildew. Sulfur is effective to control pest populations of rust and erineum (blister) mites but may cause a decline in predatory mites when over-used. Chemical management of pest

mites should be based on properly timed applications of sulfur. Acaricides used for mites control also this one.

Brown marmorated stink bug (*Halyomorpha halys* Stal.) is an invasive bug first identified in Georgia 2016 in the West part, 90% of hazelnut been destroid in 2017 in Mengrelia (Georgia), the bug has emerged as a major pest of tree fruits and vegetables, causing thousand of dollars' worth of crop damage and control costs each year. The bug has also become a nuisance to homeowners due to its use houses, as overwintering sites.

The eggs of the bug are of a light green or light blue color, 1 mm in diameter, and approximately 28 eggs are laid in clutches. Eggs are usually located on the inner side of leaves of host plants. As embryo develops, it may become visible through an egg with the eyes appearing as two red spots. The first instar nymphs are approximately 2.4 mm in length, with a black head and thorax and an orange-red abdomen. Following the transition to the second instar, the nymphs lose a majority of their orange-red coloring. Second instar nymphs appear dark, with rough spiny projections along the lateral edge of the thorax. Wing buds begin to develop with each successive molt. Later, instars have a black to gray base coloration with noticeable spines along the shoulder, as well as white bands on the legs and antennae.

Brown marmorated stink bug

Adult bugs are larger than those of most native stink bug species, ranging from 12 to 17 mm. in length. The base color is a mixture of brown, dark red and black on the dorsal surface, with a beige or cream-colored ventral surface with some metallic green markings on the ventral thorax. Key features for identification of the adult include white bands on antennae and legs, and alternating dark and light bands on the margin of the abdomen.

Brown marmorated stink bug, like all stink bugs, is a hemimetabolous insect. Development from egg to adult takes approximately from 40 to 60 days, depending on temperature and photoperiod. After hatching, first instar nymphs may aggregate around the egg clutch before molting and dispersing to feed. Adult bug can produce multiple egg clutches throughout their lifespan. Winter diapause is a crucial component of the brown marmorated stink bug life cycle. Brown marmorated stink bugs respond to shortening the length of day during fall by entering into diapause. During this period, adult reproductive activity ceases as the stink bugs conserve resources to survive in winter. Only adults enter diapause and survive throughout winter. Increased temperature and daylength in spring signal an end to the dormant period and adult bugs will leave their overwintering sites in search of food. In warmer climate, several generations can be produced per year in Georgian grapes; though in most of North American species, the brown marmorated stink bug produce one to two generations per year.

Control measures. Management of the brown marmorated stink bug in agricultural settings has primarily relied on the use of broad-spectrum insecticides. Excessive chemical control has interrupted established IPM programs for several crops. For the reason that the pesticides that are most effective against the brown marmorated stink bug are often toxic to natural enemies, pollinators and other beneficial insects, strategies to reduce the amount of pesticides used for control have been developed. Among these is the use of border sprays, which take advantage of the increased pest densities observed on border rows of crops, especially when borders are adjacent to forested areas.

The discovery of the aggregation pheromone has allowed researchers to design lures which attract the stink bug to the vicinity of the lure location. When combined with traps, including black pyramid traps and sticky traps, the lures can allow growers to determine when stink bug populations are at levels that demand pesticide applications. Additionally, an attract-and-kill approach has developed, which aims to use the pheromone lure to attract stink bugs to specific trees which are then sprayed with pesticides. Native natural enemies have not been effective at controlling populations of the brown marmorated stink bug in its invasive range. Predators have been observed feeding on the stink

bug, however, low rates of control have been reported, generally below 10%. In its native range, the stink bug experiences upwards of 70% parasitism from a number of hymenopteran egg parasitoids, however the parasitism rate in the West Georgia is significantly lower.

Spotted Wing Drosophila (*Drosophila Suzuki* M.). Drosophila belongs to small fruit flies, called also vinegar flies, which is included in genus *Drosophila.* It is a fly that targets many host plants and harms to them, but their preference is different according to of the host plants. In Georgia it was recorded in the last 2-3 years.

Spotted wing drosophila. It is a small fly that has length of 2 to 4 mm. but spotted wing fly is different in color, compared to most of the flies, spotted wing drosophila is colored yellowish to brown, has dark colored band on the abdomen and multiple red eyes. Spotted wing drosophila by appearance resembles other fruit flies, but not to flies in general, therefore it can be hard to distinguish this species from other representatives of the same class.

Spotted wing drosophila has male and also female representatives of the species. Male flies have spotted dark wings, thus the name of the flies. Spots are located near veins, at the tip of the both wings. As of females, they also have clear wings, but significant difference between males and females is that females don't have dark spots on the wings. Females can also be identified by their saw-like ovipositor, which is allows females to lay eggs in the berries and not on the surface of a plant. We can't detect this organ by simply looking at the fly. It needs to be magnified and observed in this manner.

Spotted Wing Drosophila

Fly turns into a larvae at some point, therefore it is a part of the life cycle of the fly. Larvaes of the flies are white with cylindrical body that tapers on one end. This maggot does not have legs or relatively

distinguishable head. They are small insects and it is sometimes difficult to spot this worm.

Flies start to appear in summer, during late June or early jule. And during middle of the summer their population starts to increase rapidly. Peak of poplation reaches in august. To follow step by step to the life cycle of the insect, we can say that in summer, when flies start to emerge, they start planting eggs in the berries of the fruit. Fruits can be: grapevine, raspberries, blueberries and other ones. larvae develops in the fruit, which leaves fruit damaging it. After leaving the fruit larvae undergoes pupation, from which adult flies emerge. As we can see, spotted wing drosophila has really low duration of the life cycle that can last as short period of time as one week. Therefore in one year many generations of fruit drosophila can emerge on host plant. August and sometimes September are the months when the highest number of the population is achieved. These flies cannot resist harsh cold of winter, because of this they do not hibernate and prefere to migrate to warmer environment.

Drosophila harms not yet ripened, slowly growing fruits of grapevines. In case of raspberries, damage goes to harvest fruits. These flies feed on skins of the fruits (at this time grapevine berries have much thiner skin). Therefore they damage berries such as: strawberries, raspberries, blackberries, blueberries, cherries and plums.

Control measures: There are several methods to control spotted wing drosophila, though it is difficult to take control measures since drosophila attacks fruit from summer through the beginning of autumn when harvest of the grape is most active. Therefore, combinaton of management, chemicals, other preventative and integrated control techniques should be considered to maximize effects of control.

Since drosophila is a fly, it is easy to find catcher mechanism against them. For example commercial traps, such as soap and water can easily trap these pests. Vinegar, especially apple cider vinegar seems to be effective for trapping flies. After implementing, the traps should be checked 1-2 times per week. So called yellow sticky traps can also be used against drosophila.

It is also important to sanitize tools that we use in the vineyard. Flies or larvae can adhere to the tools, such as scissors, boots, canes and

etc., therefore, sterilization in alcoholic solutions eliminates propagation of drosophila.

Chemical insecticides can be used only on adults, since none of them are effective against resistant eggs. Consequently, before using insecticides we should consider stage of drosophila development.

Fall webworm (*Hyphantria cunea* Drury.). This insect first time was recorded, in Samtredia in 1976, in mulberry trees. Soon after it was spread all over West Georgia and damaged many agricultural and Forest trees, among them grape vine. Its presence is indicated by loosely woven, dirty white webs enclosing the foliage on the ends of the branches. Several branches are sometimes covered by one of those webs. The webs enclose many pale- yellow, black-spotted, very hairy caterpillars which feed upon the surface of the leaves. These webs contain a quantity of black pellets of excrements from worms. The fall webworm worm has been found feeding on more than 300 fruit, shade, and woodland trees. It does not attack evergreens.

Fall webworm, imago

This insect passes the winter in the form of brown pupae, enclosed in lightly woven, silken cocoons. These cocoons will be found under trash on the ground or sometimes under the bark of trees. The moths begin emerging during the spring and continue to come out over a long period. Both sexes are winged, satiny white, sometimes with brown or black spots. They lay their eggs on the leaves, in masses, partly covered with white hairs, and the caterpillars

Fall webworm, worms

hatching from these eggs construct webs over the leaves inside of which they feed. They continue feeding for about 1 month to 6 weeks, upon becoming full-grown, crawl down the tree, and construct the cocoons in which they pupate. The adults emerge late in the summer and lay eggs for a second generation of the worms in early fall, which, upon becoming full-grown, spin the cocoons in which they pass the winter as pupae.

Control Measures. Sprays for grape worms usually control the webworms also. From pesticides, pyretroides and phosphororganics are more effective. Good results also give microbiological pesticides.

II.3. List of Main Diseases, their Bioecology and Control Measures

II.3.1. List of Main Diseases

Georgia is rich with grape diseases; among them, the following are more important:

1. Grape downy mildew - *Plasmopara viticola* Berl. & De Toni.
2. Grape powdery mildew - *Uncinula necator* Burr.
3. Grape grey rot - *Botrytis cinerea* Pers.
4. Grape white rot - *Coniella diplodiella* (Speg.) Petr. & Syd., sinonim *Coniothyrium diplodiella* (Speg.) Sacc.
5. Grape black rot - *Guignardia bidwellii* Ellis) Viala & Ravaz.
6. Grape anthracnose (Grape birds eyes) - *Gloeosporium ampelophagum* (Pass.) Sacc.
7. Grape black spot - *Phomopsis viticola* (Red) Coin.
8. Grape summer rot – *Stereum hirsitum* (wild) Fr.
9. Grape armilaria – *Armillariela mellea* (Vahl.) Karsten.
10. Root rot – *Rosellinia necafix* (Hart) Berl.
11. Grape cercospora – *Cercospora roeseleri* (Catt) Sacc.
12. Grape alternaria - *Alternaria vitis* Cavara.
13. Grape phyllosticta – *Phyllosticta viticola* Sacc.
14. Grape phyllosticta – *Phyllosticta vitis* Sacc.
15. Grape ascochita – *Ascochita ampelina* Sacc.

16. Grape spot necroses – *Rhacodiella vitis* Sterenb.
17. Grape redness – *Pseudopeziza tracheiphila* Mull. – Thurg.
18. Grape sour rot - Summer Bunch Rot (Sour Rot) – *Alternaria, Aspergilus, Botrytis*, etc.
19. Grapevine Fleck Virus – GFKV
20. Grapevine Fanleaf Virus - GFLV
21. GLRV-1 - Grapevine leafroll virus 1;
22. GLRV-2 - Grapevine leafroll virus 2;
23. GLRV-3 - Grapevine leafroll virus 3;
24. GFkV - Grapevine fleck virus;
25. GFLV - Grapevine fanleaf virus;
26. GVA - Grapevine virus A;
27. ArMV - Arabis mosaic virus;
28. Grapevine B virus
29. FD - Grapevine flavescence dorée phytoplasma - Grape golden yellow phytoplasma
30. BN - Grapevine Bois Noir phytoplasma - Grapevine Bois noir phytoplasma.

Among them, some fungal, bacterial, virus and phytoplasma diseases are spread each year and need to be controlled regularly; otherwise the damage will be very significant.

II.3.2. Main Fungal Diseases and their Control Measures

Grape Downy Mildew - (Plasmopara viticola Berl. Et de Toni) is a widespread disease in Georgia. The damage caused by it is extremely large. The disease has found very favorable conditions for its development in our country. All organs of grapes are affected by the downy mildew, especially the leaves, flowers and fresh fruit. The first signs of the mildew are more often observed on the leaf. Yellowish-green crystalline spots of various sizes appear on the upper side of the leaves. Under favorable conditions, the spot is covered with white

snowflakes from the bottom. The diseased part of the leaf gradually changes color, turns brown and finally dries. When a spot covers more than two-thirds of a leaf, such a leaf dries/fades, shrinks and falls down.

In case of flower disease, they are covered with white snowflake. The flowers sound and fall down. During fetal disease, a spot appears on the stalk of the berry, which then spreads to the whole closter berries, causing it to crack and sound.

The Ripe fruits rarely get sick. If it gets sick, a bluish spot appears on the crack. Snowflake does not even develop. Severely diseased berries soften, turn brown and fall off easily.

The process of fetal disease varies according to the phase: a white snowflake appears on a newly infected fetus. The fruit dries and falls on the ground. Too often Downy mildew cannot be selected from the Powdery mildew patient. They can be distinguished as follows: on the surface of infected berry by Downy powdery mildew develops a thin abalone-like layer of grayish-white threads, covered with a dusty mass of the same color which arises from the spores of conidia.

Grape downy mildew

In case of Downy mildew, under favorable conditions, a snowflake rises in groups on the surface of the berry, which is relatively white. In dry weather, the diseased berries are dark brown and remain almost undeveloped.

As the berry grows, disease decreases because the berry is covered with a changeable membrane, the buds shrink, and the spores are difficult to dig into. In this case, the berry disease often starts from the place of attachment of the grape, on which the concave bluish-colored spots develop and gradually spread to the whole berry. Relatively diseased berries soften, turn brown and fall easily from the stalk, while

weakly diseased berries turn gray, crack and sound on the bunch of grapes.

Snowflakes never develop on diseased fruit during maturity. Diseased grains sometimes take on the appearance of wet rot, and sometimes dry out and look like black rot. His characteristic black flesh, obviously, does not develop.

Wine made from grapes suffering from this disease is of poor quality and less stable, contains less sugar and alcohol and is characterized by weak coloration and unpleasant taste. The Downy mildew shoots do not reach maturity and die easily from winter frost. Next year's fruiting buds can not form well on a weakened plant. This has a significant impact on the development of grape in the following years and its yield.

The mildew overwinters in the fall in the leaf tissue of grape in the form of oospores. It has a thickened membrane. Fallen leaves of oospores released by rot and decay of their tissue remain in the soil. In spring, when air temperature reaches 11-15^{0}C, and air humidity maximum rises to 90-100%, oospores form microconidia. Zoospores later emerge from the microconidium. Oospora develops into the leaves through the stoma and causes infection. This process often takes place at night. After invading the plant, the fungus gives rise to mycelium, which develops between cells. At first, the disease goes unnoticed, but after a while its signs become visible. This latent period is called the incubation period.

According to the low temperature development curve of Downy mildew, 12^{0}C is considered. The plant is inoculated even at lower temperature, although rarely. Even at high temperatures, which stop the development of mildew, 30^{0}C is considered. With the rise of temperature, the length of the incubation period also increases. At the end of this period, signs of the disease appear and snowflakes develop on the underside of the leaf. Snowflake development starts from 15^{0}C on Rkatsiteli grape variety. The optimum temperature for the appearance of powder is 22-24^{0}C. For fungal growth it is necessary that the green parts of the vine are often exposed to raindrops. The less rainfall is, the less powder develops; and vice versa - in rainy areas its development reaches a maximum. The development of Downy mildew

is hindered by wind, as the wind dries the wet leaves quickly. Therefore Downy mildew is relatively rare in dry and windy areas.

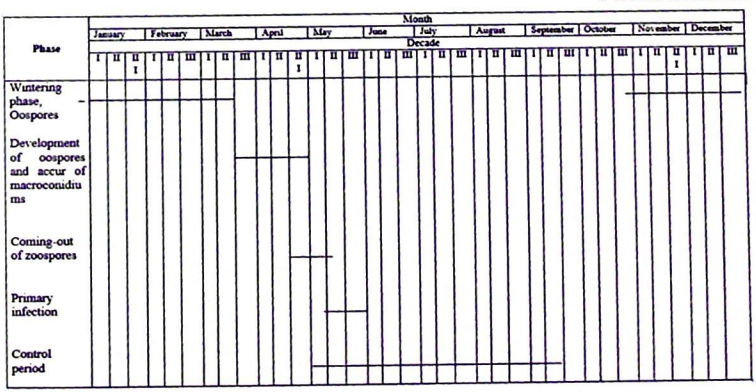
The negative impact of Downy mildew on vines can be significantly reduced by timely and the quality of agro-technical operations in the vineyard.

Control measures: The first treatment against Downy mildew is mostly carried out during the period of separation of buds, the second treatment - before flowering, and the third one - after flowering, and etc. The first and the last sprays are mostly applied with the following contact fungicides: 0.2% Polyram, 0.5% Delan, 0.3% Cauryl or any other copper-containing fungicides.

If it is a particularly epiphyotic year, and the conditions are perfectly favorable for the development of Downy mildew, even a second, third, fourth and fifth cure is possible. At this time we turn to the use of different systemic fungicides in turns. These are: 0.25% Ridomyl gold, 0.2% Cabrio top. It should be noted that Cabrio top affects almost all major diseases of the vine, such as Downy mildew, Powdery mildew, etc. It has gained great popularity in the viticulture regions of Europe and America, as well as in Georgia as a unique fungicide.

Grape downy mildew

Phenocalendar



Grape powdery mildew (*Uncinula necator* Burr.) is a disease of all the parts of grape. It spreads all over the Georgia. The diseased part is covered with a white lacquered snowflake which can be easily removed by hand. Its name is originated from here.

At first, white spots appear on the leaves. They gradually merge and may cover the entire leaf. Such leaves no longer develop; turn yellow and fall off earlier. Young shoots are also covered with snowflakes, as a result of which they slow down their growth and no longer mature.

Grape powdery mildew

The emergence of Powdery mildew is more dangerous on co-flowers and berries. The diseased co-flower fades, takes on a blue color and falls off. Berries get sick at all stages of development - from hatching to counting. Depending on at what stage berries develop, the Powdery mildew appear and the symptoms of the disease are different. The Powdery mildew developed on the berries irritates the skin, causing the stopage of growing of the skin cells; the juice clogs the skin and breaks down the berries. The berry cracking is often so strong that even its grains appear at times. In the translucent berries, they crack and fall off as a result of drying of the juice.

In the form of mycelium of Powdery mildew, it overwinters on the shoots, stem and buds, and on fallen leaves - with cleissocarpiums. The wintering mycelium membrane is thickened, which is the reason it tolerates unfavorable conditions well. The wintering mycelium in the buds is relatively thin. In spring, the mycelium produces conidia which is a primary source of disease.

Cleistocarpis initially light brown. They have developed spiral appendages. The intensity of Powdery mildew development depends on environmental conditions. The mildew develops from a maximum of

22C^0 to 25 C^0, and ceases to give fertility only at 30 C^0. The mycelium of the fungus can withstand 37 C^0 heat and die at higher temperatures.

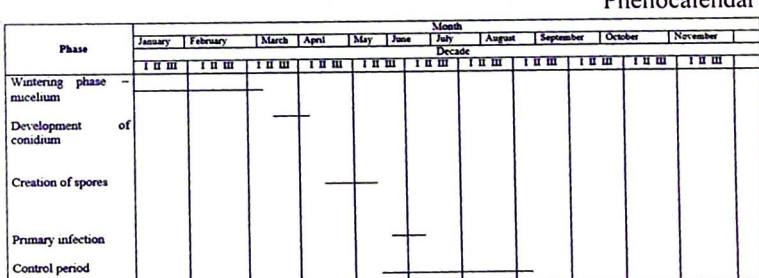
Humidity in relation to air is crucial for the development of Powdery mildew along with temperature. The formation of its conidia is quite active under conditions of 100% humidity, but can't develop below 25% humidity. The optimum humidity for spore formation is 50-100%.

When developing Powdery mildew, we must pay attention to two factors: temperature and humidity. If any of these are missing, the growth of fungal organisms is inhibited.

Control measures: Contact and systemic fungicides are used against Powdery mildew. At the beginning and end of the vegetation, we use contact fungicides such as: 0.5% ; Thiovit jet or sulfur fungicides 3-4 times. Systemic fungicides are used, such as 0.04% Topaz, 0.02% Strobe, and 0.06% Quadis max.

Grape powdery mildew

Phenocalendar



Grape grey rot (*Botrytis cinerea* Pers.). This type of diseases spread quickly in warm, humid areas. It is especially common in western Georgia, eastern Georgia - mostly in Inner Kakheti on the Alazani valley, in the lowlands and irrigated areas.

The vine gets sick with Gray mold in almost all stages. In case of leaf disease with this fungus, various black spots appear on it which cover the whole leaf. The diseased leaf sounds and falls to the ground;

the flower is covered with white, gray snowflakes in high humidity conditions, causing the flowers to fade, sound and fall en masse. It gives a very negative result when the berry is in the growth stage. At this time, the grape berry becomes dark brown, wrinkle, sound and remain on the shoots for very long.

The Grey rot can cause the most damage during the grape ripening period. Brown spots appear on the berry, which are then applied to the whole berry and cover with a light brown airy snowflake. Strong disease starts when the amount of sugar in the berry is 10% and more. In dry weather the diseased berries are crushed, the sugar content of the grape juice increases, the composition of acids, nitrogen, tannins and other substances also changes. The sprout when infected by the disease is covered with a characteristic snowflake of this fungus and then gradually dries. One of the contributing factors to the development of the disease is high humidity. For example, after prolonged droughts, if the grape ripening coincides with rainy days, the grey rot due to the intensification of juice movement and fungus, develops en masse in a short time in the cracked areas. The disease is exacerbated by irregular irrigation. In case of lack of water, the skin of the grain thickens and becomes rough. Excessive watering also causes the grains to crack quickly and the best conditions for the development of grey rot are created. Its development is facilitated by hail, some pests and other diseases, such as Berry moth, Grape powdery mildew, Grape downy mildew, etc.

Grape grey rot

The fungus that causes bunch gray mold is easily found on both living and dead cells. It develops conidia - sclerosis and fertility - apothecia. Sclerotia develops on fallen leaves and berries in the fall, as well as on the cut shoots in the form of small black round bumps on

storage. Fungus spends the winter this way. In spring, when the temperature reaches 10-12C^0, Conidia are formed from sclerotia with conidia, just like in summer, and re-infection begins.

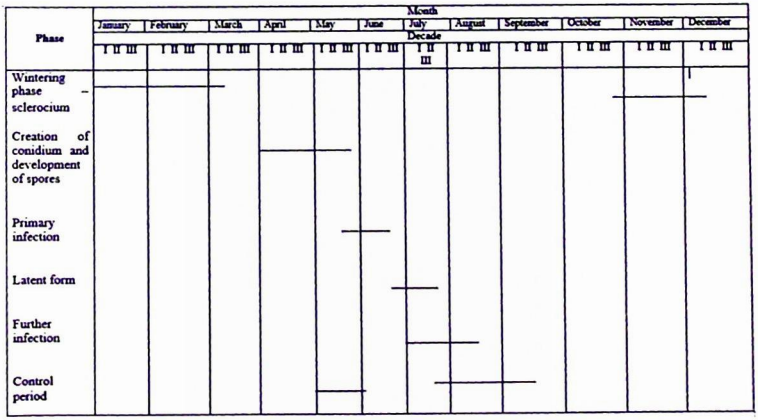
There has been various opinions among the researchers as to which phase of the grapes become damaged with Grey rot. Some believe that the vine is diseased in all phases of the disease, while others believed that it is diseased in the phases of maturity and flowering.

The research has shown that the gray matter's inoculum begins in the flowering phase, followed by latents, remains inside the grape seed, and then emerges from the ripening of the grapes when the conditions are right for its development and multiplication - substrate in the form of grape juice, moisture and temperature. In some cases, the first infection occurs after the onset of grape ripening.

Control measures: The first treatment is carried out before flowering with 0.02% Strobe, or 0.03% Topaz, etc. The second - at the beginning of maturation process with only 2% Bordeaux mixture. For this period it is necessary to thin the leaves in the cluster zone.

Grape grey rot

Phenocalendar



Grape white rot (*Coniothyrium diplodiella* (Speg.) Sacc.) is found in almost all viticulture zones, especially in Telavi, Gurjaani, Sighnaghi, Sagarejo, Gardabani, Zestaponi, Baghdati, Vani and Sokhumi regions. This disease primarily affects vine leaves, clusters and twigs, mechanically damaging or by pests. Dark green spots appear on the leaf, which soon disappear; Whitish spots also appear on the twigs. The disease manifests itself after more hail, as a result of which the laryngeal cells begin to disintegrate from the injured area, the movement of the juice ceases, and the bud begins to swell. The dried branch is easily broken by touch or wind or remains dry on the plant. Twig disease is common in the vine stem, especially on cultivated plots. The twig has large white spots clearly visible in different places, surrounded by reddish streaks. When these spots unite, the upper part of the twig begins to wither.

Grape white rot

Damage to the bunch of grapes more often starts from the period of entering maturity stage. This is important for the location of the infection. If the disease starts from the stalk, then the whole cluster dies, and the diseased berry eventually dries out and stays on the cluster for a long time. White warts – Pycnidia are observed on the surface of the berries. Conidia are densely located in the Picnicidae.

The fungus spends the winter in the Pycnidia, in the form of a mycelium developed inside the cuticule. The optimum temperature for fungal growth is 25-27^{0}C heat and 90-100% humidity. White rot spores maintain viability for a long time under normal soil moisture conditions.

Control measures: Collect and burn diseased parts. Crush the debris on the knee as the fungus invades the wound. From fungicides, all which act on Grey rot - are used.

Grape black rot (*Guignardia bacae* Cav. Jacz) is found in Kakheti and Kvemo Kartli viticulture districts. However, it can't cause much harm, as its annual measure against the Powdery mildew severely limits its development.

Grape black rot

Grape black rot causes disease of leaves, berries, rarely twigs. Small elongated green spots appear on young leaves. The signs of berry disease are as follows: at the beginning of the disease berry develops small concave dark blue spots that adhere to the whole berry in 2-3 days. Berries are softened, crushed, mummified and remain as such on the clusters. Black dots - pycnidia appear on it, which are the fertility of fungus. As the pycnidia ripen, the conidia emerge, move to other organs of the vine, and infect them.

The fungus that causes Black rot is propagated by conidia throughout summer. For winter, bags develop in the same picnics, which turn into a perithecium. The spores placed in the bag are released in spring and cause a new infection.

Control measures: The same pesticides are used against black rot, in the same time as for Grape downy mildew.

Grape anthracnose (*Gloesporium ampelophagum* (Pass.) Sacc.). This disease is found in almost all areas of viticulture. Anthracnose infects vine leaves, twigs, flowers and berries. It forms brown spots surrounded by thin, reddish streaks on the leaves. During severe damage the spots sound, the leaf is flattened. On the sprout this disease arises in the form of deep dark spots. The spots enlarge and take on an elliptical or slightly angular shape. If anthracnose has developed during the flowering period, reddish spots appear on the co-flower with black patches around it. Diseased flowers begin to fall.

Anthracnose on the berry is visible for its round brown or black concave spots with red patches. The spots unite and swell. When anthracnose appears on both sides of berry it cracks and falls down. The fungus overwinters in plant tissue in a form of sclerotia, like pycnidium and mycelium. Mycelium in plant tissue maintains viability for 3-5 years. In warm and rainy weather in spring, at 13-14 C^0 heat and 75-85% humidity, the first infection of the disease begins, causing disease of young shoots.

Grape anthracnose

Control measures: It is necessary to use 0.2% Polyram, or other copper-containing fungicides as soon as the leaves appear, and systemic fungicides, such as Acrobat, Ridomyl gold, Cabrio top, Strobe, etc.

Grape black spots (*Phomopsis viticola* (Red.) Coin.). It is spread almost everywhere and causes great damage. It affects all the surface organs of the vine: shoots, twigs, leaves, antennas, flowers, clusters. Diseased twigs are darkened, blackened, the intervertebral discs shortened and the skin becomes dull, the antenna is more curled and blackened.

The diseased sprouts are clearly observed from normal berries. In many cases, black spots on the twigs resemble of bacterial cancer with external symptoms.

The surface of the diseased shoots is covered with black dots that are clearly visible to the eye and which represent the fertility of the fungus (pycnidia). The disease is not only noticeable on the outside of the plant, but it also develops in the shoot tissue, fungal mycelium is observed in the vessels and around the heart. However, the rays of the

heart are browned. The pen material made from diseased shoot is the main source of Black spot spread.

Phomopsis affects all surface organs of the vine. The leaves have dark brown, often scattered spots with small black dots - pycnidia, in which single-celled colorless elongated spores are located. The sites of injury rot, sound and fall on the diseased berry. Especially during the ripening period, pycnidia are formed in the form of concentrated rings, after which the berry strats to rot. Damaged berries turn blue on white varieties and brown on colored varieties. Most damaging grapevine varieties are: Khikhvi, Tsitska, Kharistvala, Goruli Mtsvane, Pino, Rkatsiteli.

Grape black spots

Control measures: Same as against Downy mildew. In case of its wide spread, it is necessary to use 0.2% Polymer as soon as the leaves appear in spring, and then 0.2% Cabrio top.

II.3.3. Bacterial Diseases and their Control Measures

Grape crown gall (*Agrobacterium tumefaciens* Sm. Et T.) affects vines at all stages, but is especially prevalent in the elderly stage. The disease starts from the stem, but is also found on the shoots, twigs and roots. Vine cancer is a bacterial disease. Its causative bacterium penerates into mechanically damaged vine organs, begins to develop, and causes cancer-like damage.

Grape crown gall is widespread in lowland and humid areas, especially in alkaline soils. Abnormal conditions of the vine, wounds on its body, mechanical injuries, cracks caused by frost contribute to the spread of the bacterium. At the site of cancer, a small tumor appears on

the vine for the first time, which is soft and green at the beginning. As it grows, the appearance of the tumor changes, the surface cracks, darkens, hardens, and takes on the characteristic color of a vine stem.

Grape crown gall

The cancerous growth does not last long, its tissue collapses, turns black, futurizes and easily extends beyond the vine. Heavily damaged vines die. The cancer-causing bacterium has been found widespread in nature and infects many plants. The bacterium is motile, present in large number in diseased intercellular cells of the plant. The disease spreads from one plant species to another. It grows best in the dark, its development is inhibited by the sun's scattered radiation, and it ceases completely during direct exposure to the sun's rays, although it retains its viability.

Grape crown gall's bacterial disease which develops from 5^0C. Optimal is 26-27^0C. But above 30^0C, its development is limited. 100% relative humidity is also optimal. Moisture reduction is directly proportional to the growth of the bacterium.

Control measures: In early spring the stem should be cleaned of exposed bark, tumors, collected and burned. The vine should be pruned below the damaged area - where tumors are observed. Soil drainage should be carried out in the vineyard, if necessary. Diseased vines should be treated with 4% Bordeaux mixture and then with a combined solution of 0.2% Polyram and 0.02% Strobe before the buds start to germinate.

II.3.4. Major Viral Diseases

For vegetative propagated crops, the plant infected with the virus is an important source of infection. Latent forms of infectious agents are common which adversely affect not only the current, but also next year's crop. In the absence of symptoms of the disease it is often neglected. As a result, the plant becomes infected with better adapted forms of viral disease. The use of infected planting material even causes disastrous results and artificially contributes to the widespread of the disease.

Vines are damaged by many viral diseases that spread during grafting. At the same time, various viruses have been isolated from damaged plants, although they are rarely identified as causing disease with typical symptoms. Damage caused by viruses during severe wetting is very significant. Some viral diseases cause plant death. In swollen clusters, the content of pectin, reduced sugar and juice in acidic clusters, as well as acidity is increased. The quality of wine made from grapes of diseased vine plants is significantly lower.

Among the common viral diseases of vines the following can be identified:

1. **Nepoviruses.** This group of viruses includes 13 different viruses that infest vines. They are transmitted mainly by nematodes and by mechanical damage:

Grapevine fanleaf virus (GFLV) or short kneecap causes leaf rot. It is the most characteristic virus among vine viruses, manifested in the form of leaf degeneration in infected plants. It is naturally distributed all over the world.

Leaf marasmus is one of the major problems for vines. Diseased plants give small number of fruits, which, in turn, lead to reduced yields. Losses are sometimes as high as 80% for some varieties. Symptoms include fan-shaped deformed leaves and yellowish chlorosis, like ring spots, the appearance of rings on the veins, are spots or mosaic edges. The virus is transmitted through the nematode Xiphinema index and infects all species of vines.

Tomato ringspot virus (ToRSV) or Grape Arabic mosaic virus causes jaundice of vine veins. The disease is transmitted by nematodes of different species (*X. americanum, X. californium*). Symptoms of both

diseases are berry blight, stopping the growth of twigs. The symptoms of vascular jaundice are similar to the symptoms of leaf rot. Thus, mixing them is very easy.

Grape Arabic mosaic virus or viral mosaic is widespread in Europe. The symptoms of the disease are similar to the symptoms of leaf rot and these two viruses are presented as a mixed infection. Viral degeneration of vines is common to many species of nematodes, although the most notable is the species *Xiphinema diversicaudatum* Micoletzky.

Rupestris stem pitting associated virus (RSPaV) or stem porosity virus is usually insignificant. Loss caused by this disease is not recorded. It spreads naturally.

2. **Vitiviruses (GVA, GVB, GVß, GVD, GVE, GVF)** – Grape *Vitovirus A*, grape *Vitovirus B*, etc. - On a diseased plant, at the site of grafting, it is manifested by symptoms of a tumor. Grafted vines also get infected with the virus, but there are no symptoms.

3. **Grapevine fleck virus (GFKV)** causes vine fleck. The symptoms of this disease are manifested only on *V. rupestris*. In other vine species the disease is asymptomatic. Symptoms: Local spots develop on the veins of young leaves. Symptoms of the disease on adult leaves are manifested in the form of a mosaic. The leaves are wrinkled and curled upwards. In mild climates the symptoms are actively manifested and disappear as the temperature rises.

4. **Grape leafroll virus** causes the leaves to curl. This group includes at least seven distinct viruses that infect all areas of the vine. Symptoms: The disease manifests itself in the form of twisting of the lower tier leaves. The color of the leaves fades, the surface roughens, and twists down along the main vein. The fruits are weakly developed in color and their ripening is slowed down. Yield loss is 10-20%. Infections mixed with more than one virus can severely weaken the vine and eventually kill it. When grafted onto phylloxera-resistant rootstocks, this virus becomes more dangerous. The vine form *Vitis vinifera* shows no symptoms of the disease if it is grafted on an American rootstock. The disease is also called red leaf or white emperor. The small leaves of black grapes turn red in September-October. At this time white grape leaves are only yellow. The rest of the

symptoms, including leaf fall, appear in the spring. Yellow chlorosis develops on the leaf before redness starts.

1. **Viral short kneecap**

2. **Tomato ringspot virus**

3. **Virus mosaic**

4. **Virus spotish**

II.3.5. Non-Infectious Diseases

The violation of vital processes in the vine due to adverse effects on the environment belongs to non-infectious diseases. These processes can be caused by various environmental conditions, such as: atmospheric (hail, wind, drought, insufficient heat, frost, etc.) and soil factors (poor food layer, poor water and air permeability, excessive acidity or alkalinity, salinity, etc.), nutrient deficiencies (nitrogen, phosphorus, calcium, magnesium, boron, zinc, etc.), phytotoxic emissions, plant protection means (including herbicides), etc. Symptoms vary, for example: growth retardation, interstitial constriction, thinning, discoloration, asymmetry, spots, necrosis, nasal and berry loss, berry scaling, darkening of the berry, and other.

Non-infectious diseases dramatically reduce the physiological processes taking place in the vine, metabolism, contribute to the invasion of infection in the plant and often destroy them. More common are: berry loss, reddening of leaves, darkening, or yellowing. Berry loss is caused by incomplete flower formation, which is caused by intense rains during the flowering period, especially during cold weather, lack of boron in the soil, etc. The reason for the wilting of the main stalk of bunch of grapes and fruit loss is often the lack of magnesium in the soil, the violation of the correct ratios between nutrients, etc. The cause of redness or redness between the leaf veins is a lack of potassium in the soil. The reasons for the appearance of dark spots on the upper side of the leaf are also often the result of insufficient content of potassium in the soil. Vine chlorosis is often observed for the same reason. Non-infectious necrosis of vines is very common, the causes of which are as follows:

- Small amount of nutrients in the soil;
- In the case of potassium necrotic spots of interstitial pulp;
- In the case of magnesium, necrotic spots on the edges of leaves;
- Paralysis of the stalk during water balance disorders;
- During the action of harmful poisonous emissions, for example, in case of chlorine - burn necrosis of the lower part of the plant;
- During fluoride content - decomposition of plant tissue;

- Various stress meteorological factors (low temperature, hail) can also cause necrosis.

Nitrogen deficiency is mainly observed in humus-less sandy soils where the chemical substances are easily released. Throughout the vegetation. Symptoms on such soils appear at the very beginning of vegetation under conditions of intensive plant growth, especially after rains, when the plant rapidly depletes the remaining supply of nitrogen. As a result, the growth is reduced, and the leaf looses its normal color and manifests itself in the form of chlorosis. The reddish color of the leaf stalk is also characteristic. The main veins at this time retain their green color for a long time. The diseased plant stays small and the grains are also small size.

In case of nitrogen deficiency, the plant should be fed early with organic fertilizer or nitrogen fertilizers (before the beginning of vegetation).

Potassium deficiency is mainly observed in acidic sandy soils or soils with high calcium and magnesium content. The veins of the vine leaf remain light green and are well distinguished from the intervertebral discs, in the result of which the leaf takes on a marble color. Potassium fertilizers are used to prevent such diseases, and organic fertilizers are applied in sandy soils.

The symptoms of magnesium deficiency occur mainly on soils that are characterized by a mildly acid reaction, where acidic fertilizers have been applied. The disease is also found on loamy soils. The disease occurs in the form of chlorosis on grape leaves, starting from the lower tiers or necrotic spots on the leaves of the upper tier. In case of such symptoms, it is necessary to spray the grape with a solution of 1-2% magnesium sulfuric acid. In such situation, it is good to use magnesium-containing fertilizers.

1

2

3

4

5

Microelements deficiency: 1- Potassium, 2 - Boron, 3 - Nitrogen, 4 - Magnesium, 5 – Iron

Boron deficiency, especially during drought, occurs after cracking on carbonate soils or acidic soils. Boron is an essential trace element for the plant, especially for generating organs. In case of boron insufficiency on the vine, necrotic spots are observed between the vessels, which then merge and form a single chlorotic area. In this type of soil, the vine should be fed with mineral fertilizers containing boron.

Iron deficiency is often observed in soils, although iron is quite abundant. It is especially noted in fertile soils that contain large amounts of calcium. The disease first appears on young leaves and begins with yellowing. It then moves on to longer leaves that turn completely or partially yellow.

Such plants should be sprayed with iron-containing substances.

In addition, grape is severely damaged by adverse climatic conditions and often by improper measures taken by humans.

Unfavorable climatic conditions in spring period sometimes cause freezing of vine shoots, and due to the action of high temperatures - the fruit burns. Hail causes significant damage to vines and often leaves the farmer without a crop. Often misused pesticides or the adverse climatic conditions attached to them (high temperatures, etc.) significantly reduce not only the yield but also its quality.

Early autumn rains during the grape ripening period often lead to an increase in turgor in the fruit and grain scab, followed by the invasion of fungal infections and by the rot of the bunch. The vine is also negatively affected by strong drought at the same time as the berry wilting starts and early wilting begins. High temperatures (maximum 38^0C) cause the unripe grains to brown and then dry out. Such symptoms are easily noticeable in the vineyard. Yellowing of young leaves, yellow lines between the veins and necrotic spots are frequent after spring frosts. Depending on the season, the hail will significantly damage the leaves, twigs (spring), fruit (autumn). Fungal diseases spread to deciduous clusters, which completely destroy the crop.

Grape berries are often marked by pesticide-induced spots caused by wetting powders. This in turn significantly reduces its commodity value. Herbicides do more harm than good if used incorrectly. For example, Simazin causes intravascular chlorosis on leaves, 2,4 D - leaf deformity resembling viral disease, Glyphosate - (Roundup) intravascular chlorosis, shortening of intercostals, and more.

Chlorosis is spread everywhere, in both herbaceous and perennial woody fruits. Chlorosis is caused by various parasitic organisms (fungi, bacteria, viruses). If the disease is caused by soil, temperature, water regime or plant nutritional conditions, then we are dealing with functional chlorosis. Chlorosis causes quite severe economic damage to our viticulture. The diseased vine eventually withers and the vineyard becomes so stagnant that it often becomes completely uprooted. Chlorosis is mainly found in eastern Georgia, but is slightly less common in western Georgia. Chlorosis occurs periodically. It can be disguised for years and then revealed again.

Functional chlorosis is characterized by the following external signs: In the beginning, thin, slightly yellowed areas are observed on the leaf plate of the upper part of the grape shoot. It occurs in late spring or early summer. The spots coalesce and the leaf gradually turns yellow. Jaundice develops between the leaf veins. On moderately damaged leaves, the greenery is preserved only along the veins. As time goes on, the leaf becomes thinner and turns completely yellow. Occasionally there is a whitish tinge. Eventually, the vine develops so many thin yellowed branches as if the vine had developed into a broom. Such a vine is doomed to death, if it does not wither before autumn, it freezes in winter.

Chlorosis has a very strong effect on the cluster. The number of clusters is reduced. If detected during the flowering or budding phase, it causes the flower cockles and new shoots to fall off.

There are many causes of chlorosis vine disease. Of these, great importance is attached to soil conditions, as well as weather, humidity and temperature conditions. Poor result is followed by violation of agro-technical measures. What matters is the variety of vines, the durability of the root vines and more. Chlorosis is common on black soils and generally on good soils. It is also found in soils that contain nitrates. Lack of micronutrients is observed in chlorinated plots. There is always an excess of water in them. Chlorosis predominates in acidic soils, but is rarely found in alkaline soils. Also important is the resistance of the vines to the disease, and for grafting - the resistance of the roots.

Control measures: Selection of resistant varieties to alkaline soils - such as Rkatsiteli, Chinuri, Tsolikauri, Tsitska, Goruli mtsvane and

others. Chelating compounds are also good, spraying and incorporating them into the soil.

Hail often damages the vineyards of Kakheti and Kartli, and rarely Imereti. Kakheti is especially affected by hail. It often leaves entire vineyards leafless and barren, sometimes completely destroying the vineyards.

Damaged by hail

Damage from vine hail is expected during all periods of active vegetation - from the appearance of the first leaves on the shoots until the end of the vintage, so the measures to be taken after the hail are determined by the period of vegetation and the degree of damage to the vine.

If the hail came to bloom with such force that it damaged the native twigs in continuous strips and completely destroyed more than two thirds of the green mass of all kinds, in this case the vine will be uprooted immediately. The twigs are cut completely or cut by leaving the base at the knee. If the green bodies of the vine have survived at least halfway, then no other is needed. We will remove such vines only from broken parts. In both cases there is an urgent need for hail-damaged vineyards. It is primarily directed against fungal organisms spread on the wound, such as rottenness of white, black and grey molds, as well as powdery mildew.

After hail, a treatment is carried out with increased concentrations of fungicides - treatment with 0.6% Copper chloride or 0.4% Euparen, 0.6% Couproxate and / or 2% Bordeaux mixture. After 8-10 days we should spray one of the above mentioned fungicides again. The next treatment should be continued within the usual time frame.

During the flowering or the period of pea - sized berries - before starting the ripening of the grapes, we should avoid intensive pruning of canes. Remove only the damaged parts and immediately spray the solution or its substitutes with a combination of 0.2% Polyram and 0.02% Stroma. In the absence of the listed preparations, the treatment

will be provided with 1% Bordeaux mixture and colloidal sulfur. Subsequent medications will be provided after 8–10 days, but not at increased concentrations. The rest of the treatments will usually be done on time with a combination of the recommended fungicides.

If the vineyard is damaged during the ripening period, the treatment should be provided with 0.5% Delan or 0.02% Strobe. In the absence of these fungicides, spray 2% Bordeaux mixture no later than 20 days before harvesting is good.

1

2

3

4

Grape damages by climatic conditions: 1- damaged by high temperature; 2- damaged by water deficit; 3- damaged by autumn raining; 4-damaged by freezing

Chepter III – Beneficial Insects and Mites

III.1. Predators

It has been known that some species of insects feed on other species -predators. The information which date back to 900-1200 AD, this useful property of insects was already used in different countries. Chinese citrus growers have been especially collected ants since ancient times and brought to gardens. The similar method was used by the Arabs, who used predatory ants against the pests of the date palm.

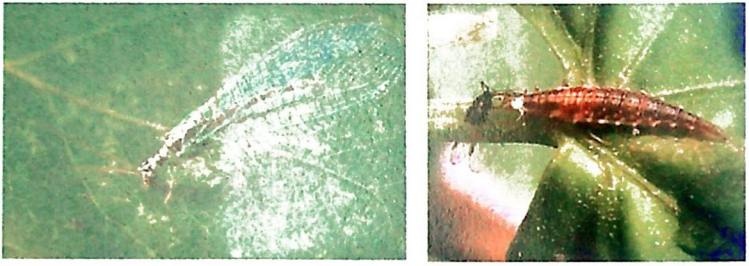
Predation in insects is more common than parasitism, although the proportions of both groups are equal and both provide important services to humans.

Lacewings (*Chrysopidae*). The neuropterous is very rich in species of beneficial insects. It includes 19 families, most of which show predatory traits in the worm phase. Of this detachment, the Lacewings' family should be especially mentioned, some species of which are so widespread that they fully control the spread of aphids and mites under favorable conditions.

Common Green Lacewing (*Chrysopa carnea* Step.). This species is widespread in the world. It is of great importance in Uzbekistan, where it destroys almost 90% of cotton mites. The worm eats up to 1000 mites during its development and gives up to 5 generations per year. This predator moved to Comstok Mealy bug in Eastern Georgia, thus doing a very useful job. Another Lacewing with seven-spotted (*Chrysopa septempunctata*) has a great importance in orchards and vineyards of Georgia, where it feeds mainly on aphids and mites.

The Common green lacewings lay eggs on leaves, at the end of 4-8 mm long fur. This method of laying eggs also has a justification - this protects it from attacks of predatory insects. Eggs are usually laid on the leaf from the bottom, more often - in groups, in the amount of 4-50 pieces. This place is close to the acorn colony. One female usually lays 100-200 eggs. The newly hatched worm sits motionless on the egg shell once (for several hours), then comes down and looks for food.

In the absence of food and in unfavorable climatic conditions the worm dies after 1-2 days. The worm's body is covered by the skin of an death aphid, which acts as a kind of disguise. The newly hatched worm eats 8-10 aphids a day. With the growth of the worm, the appetite increases and already adult worm destroys 60-70 aphids. It should be noted that the digestive system of young worms is closed at the bottom, so the excrement is secreted only by an adult insect. The worm phase lasts 8-15 days under optimal conditions. The larva of the last age reaches the adult form, seeks a hidden place and nests. The pupa is housed in a white, round silk sac, which is separated from the anal hole by a worm. The duration of the pupal stage is equal to 10-15 days. Imago is active during the day and in the evening. It begins to mate and lay eggs as soon as it emerges, producing 4-5 generations per year.



Common green lacewing, imago and larva

Coccinellidaes or Ladybirds (*Coccinellidae*) are also very important useful insects in vineyards, the beetles and worms eat a large number of mites, aphids, aleuroides, various butterfly worms, etc.

Cryptolaemus (*Cryptolaemus montrouzieri* Muls.). The beetle is considered to be the enemy of citrus and vine pests, grape mealy bug and grape scales. Ladybird was first introduced to California in 1892 from Australia and bred and then successfully introduced to other regions of the United States, including Israel and others. *Cryptolaemus* was introduced to Georgia in 1932 on the Black Sea coast. The beetle is very sensitive to frost, so its acclimatization in Abkhazia, Adjara and Kakheti is associated with significant difficulties.

It is necessary to artificially propagate the beetle in insectariums and then launch it into the field. This method was justified in the fight against the mealy bugs.

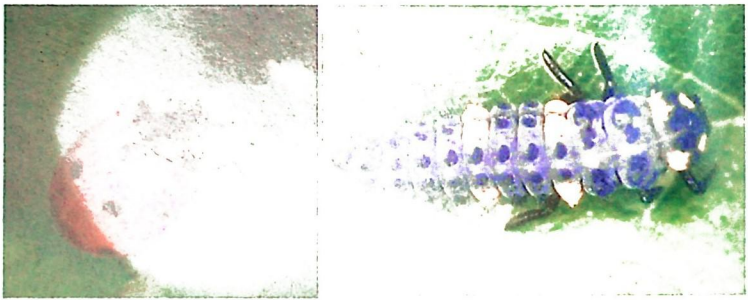
In 1962, a total of 500,000 *Cryptolaemus* bugs were released into the field in Georgia, which proved to be very useful. Experiments have shown scientists that running 25-100 beetles on a damaged tree completely cleans it of pests.

Cryptolaemus destroys mealy bug's eggs and worms. The worm can eat up to 30 worms in a lifetime. There are usually 70-2000 eggs in each park. It overwinters in the beetle and pupal stage in Georgia. Overwintering beetles lay eggs in the second half of April or early May. The female lays up to 1000 eggs in optimal conditions. Embryonic development under favorable conditions lasts 7 days, the worm phase in summer - 10-11 days. The worms of *Cryptolaemus* burrow into their own skin. Cuts take place in cozy places, under the bark of a tree, etc. It is noteworthy that the laying of eggs by overwintering beetles coincides with the laying of eggs by beetles. So, it lays eggs in the pest's nests. On the Black Sea coast *Cryptolaemus* gives 3-4 generations.

Cryptolaemus, beetle and larva

Seven-spotted ladybirds (*Coccinella septempunctata* L.). The beetle is widespread in Georgia. Its main habitat is steppe, field, and vegetable crops, relatively rare in parks, gardens and vineyards. The bug winds its way under the dead cover of the windbreak. There is massive overwintering in the mountains of Central Asia at 2700 m

above sea level, and in Crimea at 1500 m above sea level. In early spring, with the onset of warm weather, the beetles emerge from the winter and begin to climb the ground and trees. Such wintering takes place in the first decade of April in the vicinity of Tbilisi. Overwintering beetles are found in large numbers in gardens, where they feed on aphids. During this period, the beetle can eat 1200 aphids in 15 days. After complementary feeding, the beetles lay their eggs in the colonies of aphids growing on vegetable crops and weeds. Thus, from May, 7-spotted coccinella completely pass through gardens and vineyards, so they are less involved in reducing aphids, as they already start migrating to the wintering place from July-August. In our conditions, 7-point ladybird gives 2 generations in our condition.



Seven-spotted Ladybird, imago and larva

Two-spotted ladybird (*Adalia bipunctata* L.). This ladybird is a typical insect in the garden and vineyard and plays an important role in reducing fruit pests. Ladybird spends the winter under the dead cover of a windbreak. In some cases it bears warm and covered places and even winters in the windows of the house.

In spring, with the onset of warm weather, the beetles emerge from the winter solstice. Such wintering takes place near Tbilisi in the first decade of April, when the average air temperature rises to 8^0C. Overwintered ones require additional feeding, and about 10 days after the second half of April, copulation begins. Mass spawning takes place in late April - early May. The beetle lays its eggs in groups at the top

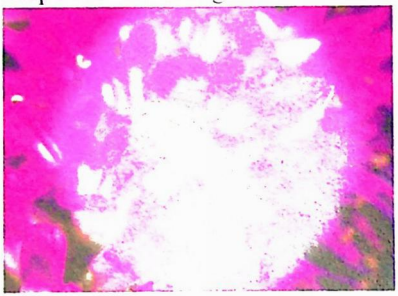
and bottom of the leaf, in exceptional cases - in units as well. The total number of eggs in the group is 14-16, with a maximum number of 50. The egg is orange. 4-5 days after laying eggs, small (1.7-1.9 mm) worms hatch and immediately start looking for food. The newly hatched worm eats an average of 4-6 aphids per day. Appetite also increases with age, and finally, the third- to fourth-aged worm already eats up to 50-60 aphids. The adult larva hatches, which lasts for two days and then hatches. The larvae development cycle which lasts 12-13 days; destroys up to 400 prays during this time. The worm of ladybird can be found in gardens and vineyards until the end of May. During the same period there is a mass spawning and flight of beetles. The pupas phase lasts 6-8 days in summer. At the end of May, the 2-point ladybird completes its development on the orchards, where it gives birth to a second generation by mid-July. The second-generation beetles then prepare for wintering.

Due to the mass use of modern pesticides, this beneficial insect dies in large numbers. To prevent this event it is necessary to select the optimal periods for the pesticide, which will allow us to save the useful beetle from destruction.

Two-spotted ladybird, imago and larva

Predatory Flies (*Syrphidae*). The flies are characterized by a large number of predatory species. In the territory of the former Soviet Union alone, it counts about 700 species. The adult fly feeds on flower nectar. Predatory life is carried out only by worms. It feeds on aphids, cermets, coccidia, aleuroids, thrips,

and butterfly worms. The female fly lays her eggs in the aphid colonies. Almost a few hundred eggs. The Syrphids destroys up to 2000 aphids in a lifetime. The worm does not choose much food and eats eggs, different types of worms, often - even their own. Usually, the big one eats the little one. Adult worm has the shape of an elongated water drop. Usually, pupa or worms overwinter, and in some species – even imago does.



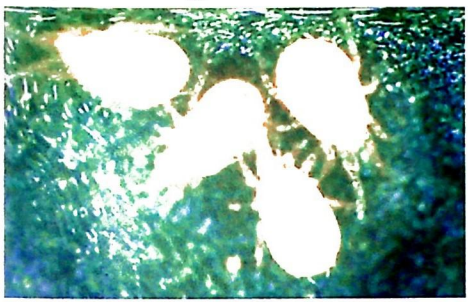
Predatory flies, Syrphidae

Syrphus balteatus De Geer. and *Eupeedeos corollae* Falr. are widespread in our conditions. Both especially destroy aphids. One adult worm eats up to 200 aphids a day. The worm phase lasts for 20 days. If we recalculate, the benefits brought by the worm will become clear. In order to increase the concentration of syrups, it is of great importance to cultivate nectar-bearing plants (mustard).

Predatory mite (*Metaseiulus occidentalis* Rev.) was introduced from the United States to the Russian Federation and Ukraine in 1976 by well-known specialists Begliarov and Fadeev. This fact is interesting in that these populations of metacellus are characterized by resistance to phosphorous pesticides. In 1979, these varieties of mites by Ts. Chubinishvili was introduced to Georgia, where it was mass-propagated and released into vine and fruit agrocenoses at the Gori Bio-Laboratory. The result was positive. The same scientist developed an integrated vine protection system against spider mites, which provided the double release of predatory mites, the first - in the 3-5 leaf phase, and the second at the end of flowering - in the amount of 2500 pieces per hectare. This dosing is important in the overall protection system of the vine, as we are dealing with a

significant reduction in the use of acaricides which allows to get an ecologically pure crop and not pollute the environment with pesticides.

The female of *M. occidentalis* is usually found along leaf veins or wedged in vein angles where she prefers to lay her eggs in a loose grouping. After hatching, the larva wanders awkwardly in search of food; after feeding, it becomes more active. The larval stage attacks all stages of prey, but prefers spider mite eggs. Before molting to the protonymph stage, it passes a short resting period.



Metaseiulus, imago

The protonymph moves quickly while searching for prey, successfully attacking all stages of prey, although it may not eat the entire adult. More than one predator is sometimes seen feeding on the same prey. The protonymph stops moving for a short time before molting to the deutonymph stage. The deutonymph is similar to the protonymph in habits and activity.

Unlike the protonymph and deutonymph, the adult female, if not hungry, is less active, spending considerable time in protected angles of leaf veins. The male adult, which resembles the nymphal stages, often attends the female deutonymph while she is inactive and ready to molt. Mating occurs after the adult female emerges. With prey available and favorable conditions, *M. occidentalis* is capable of developing from egg to egg-laying female in 5 days.

Metaseiulus occidentalis overwinters primarily under the buds of grapevines as a mated, adult female. As with spider mites, diapause for overwintering survival is induced by short day lengths and cool temperatures in fall. Prey must be available for these predators in fall; without food, reproduction stops and the predator population cases to produce the proper state for diapause induction that occurs during immature stages.

The diapausing female remains inactive until cooler weather under bud scales. There she remains until the following spring. In spring the emerging female searches expanding foliage for prey and begins laying eggs, the number depending upon availability of prey. When a well-distributed population of predators successfully overwinters in a vineyard, spider mites are generally controlled, unless subsequent pesticide treatments disrupt predation.

III.2. Parasitoides

In addition to the predatory properties of insects, their parasitic properties are also very important. Parasitism is a form of symbiosis that feeds on a single symbiont at any stage of development at the expense of the host and is biologically related to it. During a parasitic union, the host insect lives until the parasite has finished developing.

Parasitic insects are mainly characterized by two types of nature. In one case they live outside the host's body and feed on it (ectoparasitism). In the second case the parasite lives and feeds inside the host body and only comes out after the end of any phase of development (endoparasitism).

During the parasitic life, the insect feeds on the host's body tissue, hemolymph, fatty body, weakens it and often causes its death.

Tachinid Flies (*Tachinidae*). The family of tachinid flies is numerous in number. The body of the fly is covered with fur, it feeds on flower juice, nectar and various sweet secretions. Tachinid flies are parasitic on butterfly larvae, on bug imago and worm, fly worm, etc. The worm is usually an endoparasite.

The vast majority of *tachinid flies* are egg-laying, although live births are also found. Egg and worm larvae are divided into different groups. Eggs are laid on the host's body, soil or any other substrateb - leaves or stem; Larvae are born on the host's body.

The European species of tachinid fly *Sturmia* is important (*Sturmia scutellata*), which overwinters in the soil, inside the pupa. In early spring, flies emerge from the nest and lay up to 5,000 small eggs on the leaves, which are swallowed by non-silkworms with food. In the

digestive system, a small worm of the parasite hatches, which burrows in the gastrointestinal tract, attaches to the inner tissue and feeds. At the end of the growth, the worm leaves the host's body, runs to the ground and pupated.

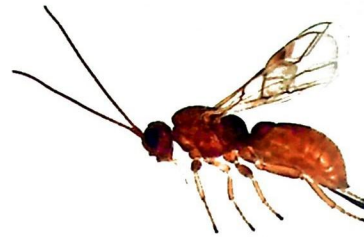
The characteristic of the harmful butterfly parasite of tachinid fly *Compsilura concinnata* Maig. young worm of which overwinters in the host's body is characterized by beneficial action. In spring, adult worms emerge and nest there. Flying flies give birth to worms a few days after copulation - an average of 100-125. The fly places the worm directly in the host's body where the worm feeds on the inside of the host. After the growth is completed, the worm sometimes hatches inside the host body and sometimes outside it.

Hymenoptera. The family *Ichneumonoidae* is quite rich in parasitic species. Their specific gravity is also very important in reducing pests. It includes the following families: *Braconidae* and *Ichneumonidae*.

In terms of yield, the *Braconidae* family is more important. Its species parasitize butterflies, beetles, bugs, garden beetles, etc. *Braconides* can be both ecto and endoparasites. During ectoparasitism, poachers first paralyze the insect and then lay eggs. Endo-parasites penetrate directly into the host cuticule with long ovaries and lay eggs inside. Egg production is very high, with one female laying an average of 1000 eggs, in some cases as many as 2000.

The *Chalcidoidea* superfamily is characterized by the largest number of species, numbering several thousand. Usually, they are small insects. They make a great contribution to the reduction of pests, parasitizing all phases: eggs, worms, pupa and sometimes even imagos. Both ecto and endoparasitic species are observed in them. The host organisms of the *Chalcidoides* are: butterflies, flies, thrips, bugs and etc.

Chalcidoidea



Braconidae

Chapter IV. Control Systems

At the present stage, plant protection is not a single method taken separately. It involves integration of different methods combined with agro-technical, mechanical, physical, selective, biological, biotechnical, and chemical methods known as integrated control.

Agro-technical control is a set of preventive measures against pests. Its purpose is to create unfavorable conditions for the pests and pathogens, and conducive to the development of a protected plant. This method generally does not require additional costs and special technical equipment. Apparatus and tools commonly used in agriculture are sufficient.

When planning the organizational-economic measures of agricultural works, the composition of pests of this or that crop should be taken into account, and those agro-technical methods which actively affect on the main pests and diseases and significantly limit their reproduction should be selected.

The great importance from the multiplication agro-technical methods are soil cultivation, timely and quality irrigation, use of fertilizers, eradication of weeds, strict observance of harvest dates, eradication of post-harvest residues, etc.

These methods are important tools in the fight against pests of agricultural crops and often play a crucial role in reducing their damage.

Selection methods depends on the resistance of agricultural plant varieties to pests. It can be manifested in tolerance of the plant to the damage caused by this or that pest, and in changing the morphological-anatomical structure in such a way as to interfere with the feeding of the pest or the settlement of the pathogen, their negative effects, among others.

The European grapevine (*Vitis Vinifera*) cultivated worldwide for high-quality wine production is extremely susceptible of downy mildew (*Plasmopara viticola*). The cultivation of resistant varieties would be a sustainable way to reduce the damage caused by the pathogen and the impact of disease management, which involves the economic, health and environment costs of frequent fungicide application. Study of Italian and Georgian scientists shows, that *V. vinifera cv. Mgaloblishvili* native to Georgia, exhibits unique resistant traits against downy mildew. Its defense response, leading to a limitation of disease growth and sporulation is determinated by the over-expression of genes related to pathogen recognition, the ethylane signaling patwey, synthesis of antimicrobial compounds and enzymes, and the development of structural barriers. The unique resistant traits found in *Mgaloblishvili* highlight the presence of a rare defence system in *V. Vinifera* against *P. viticola*, which promises opportunities for grapevine future genetic improvement.

Also, the group of scientists from Italy and Georgia established that some Georgian grape varieties have resistant genes against Phytoplasma diseases - Bois noir (BH) which is spread in Georgia.

Breeding and propagation of varieties resistant to pests, especially fungal, bacterial and viral diseases of agricultural crops is an effective and promising method of plant protection.

Mechanical control involves the use of various insect repellents, the destruction of the habitat of pests and diseases, the cutting of diseased and dried branches, the pruning of stems, filling of holes and so on.

Currently, farmers unfortunately rarely use this mechanical method to control the pests and diseases. However, as a means of sanitary-hygienic protection, it still plays an important role in the fight against grape pests.

Biophysical control is one of the oldest methods of plant protection along with the mechanical method; however, advances in modern physics make it possible for this method to play a more important role in the fight against vine pests.

From the physical methods, attracting insects with artificial light or ultraviolet radiation with combined electric lamps are also important. Radiation is applied for male sterilization of pests.

Biological control is based on the use of natural enemies of pests - parasites and predators, microorganisms (bacteria, fungi, viruses), insects, birds and animals. It is now widely used against pests, lesser - against diseases.

Seasonal colonization, which involves the artificial reproduction of beneficial organisms and their release into the field for a period, is common. An example of seasonal colonization is the parasitic *Trichogramma*, for the reproduction of which bio-factories have been established in many countries. *Trichogramma* is effective against moth and some another species. The method of seasonal colonization, in order to fight against Grape mealy bug *Cryptolaemus* is widely used in Georgia.

Intra-area habitat is also widely used, during which beneficial organisms move from old places to new ones where they have not yet managed to accumulate in adequate amounts.

It is important to promote the beneficial action of local parasites and predators. First of all, it is recommended to use pesticides in periods when they are less dangerous for entomophagous and acariphagous. It is also good to plant indoor flowering plants in the plots, so that the entomophagous get extra food.

A microbiological method of controlling pests involves the use of bacteria, viruses and fungi. Bacteria are currently the most widely used, based on which highly effective preparations against chewing insects, such as: Dendrobacillin, Bitoxibacillin, Lepidocid and others.

The properties of fungal antagonism and parasitism have been used to control plant diseases by biological methods. More important of these is the antagonism found predominantly among soil-born fungi. For example, the activity of pathogenic fungi - *Rhizoctonia* and *Fusarium* - is significantly reduced by the soil fungus *Trichoderma*.

Biotechnical control involves the use of means that do not even directly kill the pests, but also help to reduce their harm. The natural and synthetic chemical compounds used, with some exceptions, are less dangerous for humans and people in general, less harmful to the environment, do not adversely affect beneficial organisms and so on.

One of the biotechnical methods is chemical sterilization. Its advantage is that it is not necessary to multiply pests (insects and mites) and release them into the field. It is enough to use a pre-tested sterilizer with pheromones.

An important measure is the use of pesticides, the purpose of which is, on the one hand, to determine the species composition and number of pests, and, on the other hand, to combine with insecticides to attract and eradicate pests on the treated area. Close to the attractants are pheromones, also called mass attractants, because they attract one of the sexes (male or female).

Repellents are used against insects. Polychlorinate and Toxafen scare away rodents and birds. Insect and mites repellents are few and are mainly used to protect humans and animals. The group of antifungals is very promising. It is true that they do not kill insects and mites, but they do deprive them of their nutritional ability and thus reduce the harm. None of the antifungals are widely used yet, but many insects completely stop or significantly reduce feeding when fungicides - Tsiram and Copper chloride, as well as some herbicides of the Triazine group - are used. The great advantage of antifungals is that they do not kill pest parasites and predators and even leave the pests alive, thus not reducing the conditions for feeding and reproduction of beneficial organisms. In addition, antifungals are not toxic to humans.

No less important and promising are the Juvenile hormone-type preparations, which are practically less used so far. Hormones are isolated from the insect organisms themselves. In case of insignificant contact with the worm skin, the insects stop developing and die. Juvenile hormones_prevent the worm from entering into the pupa and the pupa into the imago stage.

Thus, the biotechnical method of controlling pests of agricultural plants combines many promising means, but so far their practical use (except for pheromones) is less.

Integrated control. Simultaneous use of different methods of pest control is known as integrated control, which primarily involves the use of pesticides in such a way to allow the natural enemies of pests to maximize their beneficial effects. Pesticides are used only at economic injury level. The integrated control also includes selective, agro-technical, biological and biotechnical measures that reduce the number of pests and ensure the intake of healthy plants. Integrated method is different for different crops. However, the basic principles set forth remain the same. The frequency and scale of pesticide use during integrated control is significantly reduced, thus reducing the risk of environmental pollution and the amount of residues of chemical compounds (pesticides or their decomposition products) harmful to human health in plant products.

The basic principle of integrated protection of grape (as well as other crops) is based on two main principles: the first, Chemical control measures are carried out when the amount of damage incurred by vine pests exceeds the economic injure level, i.e. when the use of chemical measures is economically justified, and the second, when the optimal balance between harmful and beneficial insects (or mites) is disturbed, which means that above this number, beneficial insects (mites) can no longer control the number of harmful species. These two basic principles indicate that in vine agrocenoses we should not cause the total destruction of pests, but rather, a certain amount should be needed to feed and develop beneficial insects or mites.

In doing so, we are implementing the basic principle of ecological demand - not to completely destroy harmful species, but to regulate them. This will allow us to protect the agrocenosis of the vine from destruction, and at the same time, get an ecologically clean product: wine, "chacha", sweet juice, "churchkhela", and cognac.

Generally, we have the measures of integrated grape protection in order to reduce the use of highly toxic chemicals and use another nonchemical methods. For example, against root pests are a number of agro-technical measures, deep plowing of the soil, and flooding with water, also some physical-mechanical measures, such as, correct pruning, trank cleaning, light insect catcheres, burning of the residue after pruning, and other ones; Selection measures including induction-resistance (chemical which could increase the resistant feature of

grape), also use of resistant varieties against diseases; use of pheromones and lures for male elimination; microbiological pesticides; Reproduction and use of beneficial insects and mites, as well as the use of other non-chemical measures.

Chemical control. Pesticides widely used in plant protection are divided into insecticides (against insects), acaricides (mites), fungicides (fungi), zoocides (rodents) and herbicides (weeds) according to the existing objects against what they are used for.

Insecticides are divided according to the mechanism of action: internal, contact, systemic and fumigants action.

Internal pesticides are used against chewing mouth part insects such are butterflies, beetles, their worms and etc. In this case the insect eats poisonous leaves, fruits or sprouts and is poisoned from inside.

Contact pesticides are used against all kinds of pests having chewing or sucking mouth part (aphids, mites, mealy bugs etc.). They also characterized by systemic, contact or fumigating action. Such properties are characterized for the phosphororganic, chlororganic, pyrethroid groups. Systemic preparations are also used against the same group of insects which kill the insects by moving them to the plant and by cell juice, which are also characterized by direct contact action.

Fumigants act on the respiratory system of insects and are used against both sucking and chewing -type insects. Fungicides are divided into two groups according to the nature of action: prophylactic and exterminating (crushing) fungicides. Protective fungicides are substances that, by pre-treatment, protect the plant from disease by phytopathogenic organisms, but do not have the ability to cure the disease. Protective or prophylactic fungicides, in turn, can be contact and systemic. Contact fungicides act on the plant surface during direct contact with the fungus, but can not dig deeply into the plant. A systemic fungicide can move the juice in a plant at a safe concentration for the plant and protect it from potential diseases or increase the plant's resistance to disease by interacting with the physiological-biochemical processes of the protected plant.

Exterminating fungicides are substances that have the ability to kill pathogenic fungi. They are also divided into contact and systemic. Destructive-contact fungicide kills an already developed pathogen, but its action is local and does not extend deeply into the tissues. The

property of exterminating systemic fungicides is to penetrate into the tissues of the plant at a concentration harmless to it, to move and destroy the already invaded pathogen or to stop its development. Such fungicides can also be called therapeutic. Fungicides can be characterized by fungistatic or genostatic action in addition to cyclic action. A fungistatic action is when a certain concentration of a fungicide causes the spores to germinate and the mycelium to stop growing.

Genostatic is an action in which a certain concentration of a fungicide inhibits the activity of fungal generative organs and thus limits fungal reproduction.

The methods of application of plant protection chemicals are: spraying, dusting, fumigation.

Spraying is a drip form of poison, which is obtained by special spraying machines. Solutions, emulsions and suspensions are used for spraying. Solutions are monotonous forms of liquid in which substances are characterized by the same physicochemical properties and which are impossible to separate. An emulsion is a liquid form consisting of two, intermingled liquids (e.g., oil is dispersed in water in the form of small droplets). In order to get a stable emulsion, special emulsifiers and stabilizers are added - soap, clay. Suspension is a form of liquid in which solid particles are immersed in water. To prevent these properties, suspensions are added to sulfate alkali.

Dusting is a form of poison application that is applied to the surface of a protected plant in the form of a powder. In this case, more poison is consumed compared to spraying. Instead, more space can be processed over a period of time. Dusting is used if the wind speed does not exceed 3 m/s. Otherwise the distribution of powder on the surface will be uneven. Dusting is recommended in the morning.

Fumigation - This is the saturation of air with poison. In this case, the insect is poisoned during respiration. Fumigation is used in protected buildings, under special aps. In the soil the latter is very effective against root phylloxera.

Complex control measures reduce the frequency of pesticides and the risk of environmental pollution.

If a chemical or microbiological agent is recommended as a plant protection product, it must meet certain requirements, the most

important of which are: high toxicity to pests, safety to plant, low toxicity to warm-blooded animals, and in this way, there is less possibility of polluting nature, also, a rapid loss of toxicity to natural enemies of pests (entomophagous, acariphagous, entomopathogenic fungi, bacteria and viruses).

In addition, the recommended pesticides and microbiological preparations should be of some degree of universality, standard, portability, availability, do not cause corrosion of metals and spoilage of other materials. In terms of dangerous fires, etc.

In recent times, special attention has been paid to the hygienic evaluation of pesticides and microbiological preparations. They should not be highly toxic to humans and warm-blooded animals resistant to environmental conditions (do not decompose into non-toxic components for two years or more), should not accumulate in living organisms, should not have carcinogenic and allergic properties.

Pesticides and microbiological preparations are divided into the following groups in terms of toxicity to humans and the environment: the first group includes pesticides with an LD -50 (lethal dose - 50) does not exceed 50 mg/kg (strong toxic), the second group with an LD-50 ranges from 50-200 Between mg/kg (highly toxic), in the third group - between 200-1000 mg / kg (moderately toxic), and in the fourth group LD -50 is more than 1000 mg/kg (low-toxic).

According to volatility, pesticides are divided into highly dangerous, dangerous and less dangerous groups, depending on how toxic the concentration that saturates the environment is.

The resistance of pesticides is determined by the amount of time during which the pesticides decompose into non-toxic components. If this time is more than 2 years, the pesticide belongs to the strongly resistant group, if it ranges between 0.5-2 years - stable, and when this time does not exceed 1-6 months - less stable.

IV.1. Pheromones

Use of pheromones is considered to be one of the most important non-chemical control measures against grape pests. These substances are divided into three groups: 1. Attracting substances for insect-feeding; 2. Insect attraction at the site of egg laying; 3. Sex Attractants. Such a division is conditional, since often the same substance has different actions and it is difficult to attribute it to this or that group. Synthesized pheromones are divided into the following groups:

- Sex pheromones, when a compound of the same species of the opposite sex is attracted to fertilization;
- Alarm pheromones, through which insects sense the approach of danger, move from the danger zone to the safe zone;
- Aggregate pheromones help insects search for egg lies substrate, search for food, overcome resistance, crossbreed, find shelter, search for a host plant, etc.;
- Trace pheromones characterize ants and termites, helping them to find nests and obtain food;
- Pheromones of social cognition and regulation characterize, for example, bees, act within a colony or within a family, and participate in the regulation of reproduction.

The use of pheromones has partially changed the concept of mass use of a wide range of insecticides, thus reducing their negative impact on the environment and weakening the production of insect resistance to the insecticides themselves. However, the development of insect resistance or other adaptive ability to pheromones themselves has not been reported anywhere. Pheromones are used in small concentrations and norms, and they are rapidly volatile substances, so they cannot pollute the environment and generally change the agrobiocenosis with the corresponding negative consequences.

Pheromones are one of the largest groups of biologically active substances. Insects are known to secrete odorous substances from special glands - pheromones, which are released into the environment through the air stream and cause reactions in individuals of the same species. There are several types of pheromones: sex, aggregate, tracer finder, food finder, alarm, egg laying substrate finder and so on.

Among the pheromones listed is the sex pheromone, which is quite widely used in the fight against pests. Insecticides released by insects are potent and specific in that they attract insects of their own species from quite a long distance. What is specific is that crossbreeding takes place between individuals of only one species.

Through a joint effort of biologists and chemists, the chemical composition of 700-800 species of insect sex pheromones has already been deciphered, based on which similar compounds have been synthesized, which are practically used in the fight against pests.

Successful use of pheromones is based on the amount of pheromone evaporated from the substrate impregnated with the odorous substance (rubber tube). A pheromone-impregnated rubber tube is placed in a paper towel that is evenly distributed in vineyard. Pheromone kits consist of sex pheromones, pheromones and dry glue. They are produced by different components. Pheromones are used against agricultural pests in many ways:

1. To determine butterfly and their flight dynamics;
2. To study the activity of butterflies;
3. To detect quarantine pests and to determine the boundaries of their spread;
4. To determine the appropriateness of chemical measures (According to critical number);
5. To study the frequency of pest settlement in vineyards.

In addition to the above, pheromones are involved in integrated pest control systems. Pheromones will be involved in:

1. By the method which disorients males.
2. Male vacuum;
3. By sterile and insecticidal sex catcher methods.

Their use reduces the frequency of chemical drugs by 2-3 times, is economically profitable and environmentally friendly. To determine the flight butterfly alarm and flight dynamics in the vineyard, catchers are hung one piece every five hectares. Insects are observed daily before the massive flight, and then once a week. Even one butterfly caught indicates the beginning of the flight (in early spring), while the weekly accounting analysis determines the daily and seasonal dynamics of the butterfly flight.

In order to study the activity of butterflies, one sex catcher is placed on five hectares. Butterflies should be collected once an hour. This will accurately determine the beginning and end of butterfly flight in all generations, which is of practical importance. The activity of butterflies, the period of laying eggs, hatching of worms and invasion of fruits can also be determined there.

In order to take rational measures against pests – Grape berry moth, Grape mealy bug, etc. - the plots will be examined with pheromone catchers, thus determining the critical number at which it is necessary to take measures against them. For example, in case 20 butterflies are recorded per day, it is necessary to use the chemical method on the Grape berry moth. The emergence of the first generation takes place 17-20 days after the capture of the first butterflies, and the second generation - 13-16 days after. This period, obviously, depends on meteorological factors, a properly conducted measure in the first and second generation regulates the number of pests.

A promising method of using pheromones is to disorient males. The essence of this method is as follows: the odorous substance evaporated from the pheromone dispensers interferes with the flow of air, gets into the receptors of the insect bite and disrupts its olfactory communications. The male can't find the female to fertilize and the female remains infertile, resulting in a reduction in their reproductive potential.

The method of vacuuming males is also promising, the essence of which is as follows: males fly on sexually transmitted insects, stick to the glue and die, creating a so-called male vacuum - destroying males, which leads to female sterility and infertility. Consequently, the number of pests decreases and the damage caused by it decreases.

In the fight against males by the vacuum method, different numbers of sex catchers are used against different species, for example, against Grape berry moth - 10-15 Per heqtare, against Grape mealy bug - 25 heqtare, etc.

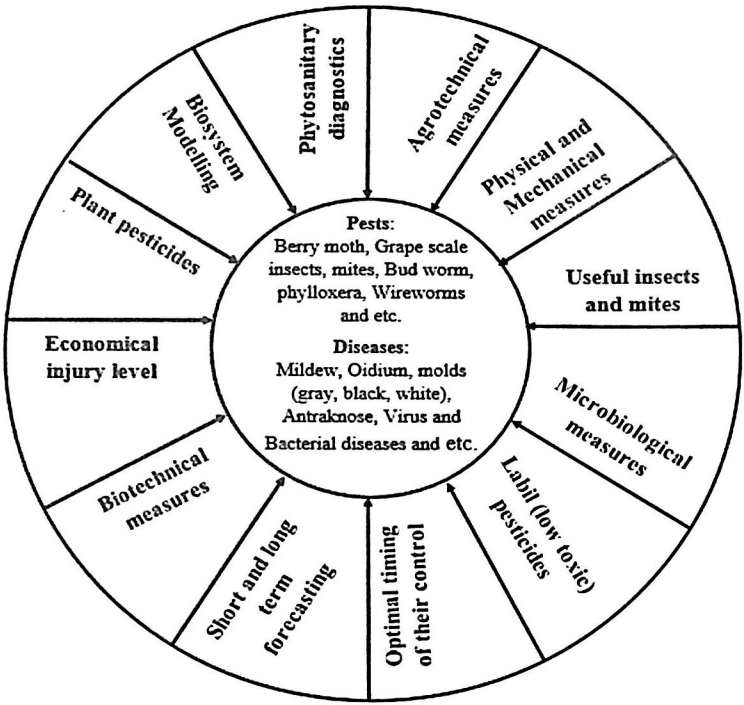
Pheromones and sterilizers are used actively. In such catchers, the inner surface is covered with an aqueous solution of 4-5% Thiotep, instead of glue. 9-10 minute contact of butterflies attracted by sex pheromones to the surface of the treated cut leads to their complete genetic fertility.

Thus, pheromone lures can easily determine: the exact date of pests release on the plot, the density of the settlement, seasonal dynamics of their flight, quarantine pests and their distributed area, the critical number of pests use and, accordingly, the target number.

Pheromone Lures

IV.2. Integrated Pest Control for Georgia (Georgian Experience)

Main Principals of Grape Integrated Pest Management in Georgia



Phytosanitary characterization (see pp.98-105):

- Investigation of different agroclimatic zones of Georgia (Kakheti, Kartli, Imereti);
- Distribution of pests and diseases of grape in those regions.

Agrotechnical measures (see pp. 84):

- Profilactic measures; Crop rotation; Soil cultivation; Proper irrigation; Proper use of fertilizers; Destroy the weeds; Proper pruning.

Selection methods (see pp. 85):

- Increase the immune system of grape with classical selection methods (hybridization);
- Increase grape immune system with different chemical compounds (microstimulators);
- Increasing the grape immune system with genetically modified organisms (GMO in Viticulture), mostly against diseases (potentially in the future).

Physical - Mechanical method in Viticulture (see pp. 85):

- Collecting and burning falling leaves and damage twigs in early Spring;
- Cleaning the steams with old bark (against wintering pests);
- Use of water floodings against soil insects.

Use of beneficial insects and mites (see pp. 75-83):

- Predators and Parasitoides
- Optimal timing to use pesticides (phenological methods)
- Use of *Chryptolaemus* against mealybugs;
- Use of Predator thrips (6-spotted) against spider mite;
- Use of Predator mite - *Metaseiulus* – against spider mite;
- Use local parasitoides against grape berry moth and another destructive insects;
- Use of attractive plants for parasitoides (Faselia, Mustard, etc.).

Use of microbiological pesticides (see pp. 86):

- Use of bacterial pesticides (based on *Bacillus thuringiensis*) Dendrobacilin, Bitoxibacilin, Lepidocid and etc.
- Use of virus pesticides (Virin tipe)
- Use of biofungicides - Timorex against diseases.

Use of labile (low toxic) pesticides (see pp. 89-91):

- Use only those pesticides which are characterized with low toxicity for beneficial insects and mites
- Use of Medium and low toxicity pesticides in Viticulture (list of recomended pesticides);
- Plant pesticides for small farmers.

Forecasting of pest and diseases (see pp. 109-114):

- Long term forcasting (one year);
- Short term forecasting (one month);
- Signalization (10 days, appearance of insects on grape).

Use of pheromons (see pp. 92-95):

- For forcasting of appearance of insects on grape;
- For male elimination;
- For male dezorientation;
- For predicting economic injure level

Use of Economically injury levels for pests (see pp. 88);
Use of plant pesticides (see pp. 145-147).

Chepter V - Phytosanitary Characterization and Control Systems According to Viticulture Zones

V.1. Phytosanitary Characterization

In various natural conditions of Georgia, vine pests and diseases are not the same everywhere and are not characterized by the same pests.

The individual areas of viticulture differ from each other in the varietal composition of vines, phenophases, peculiarities of agro-technical measures, different complexes of pests and diseases and the intensity of their spread and development. Naturally, this circumstance requires the division into pests according to the spread-development of diseases, which is necessary for a better management of the fight against them.

In order to develop a differentiated control measures against vine pests and diseases, viticulture districts are divided into 3 main zones: Kakheti, Kartli and Imereti.

V.1.1. Kakheti

Kakheti is located in the south-eastern part of Georgia and is divided into inner and outer Kakheti by Tsiv Gombori Mountain. Inner Kakheti includes vineyards of Akhmeta, Telavi, Kvareli, Gurjaani, Sighnaghi, Dedoplistskaro districts. Main leading varieties are: Rkatsiteli, Saperavi and Mtsvane. Outer Kakheti includes Gurjaani district - Kachreti zone and part of Sighnaghi (back) and Dedoplistskaro districts. Indoor and outdoor Kakheti climate differ from each other, in that indoor Kakheti climate is relatively dry and continental. The average annual air temperature is 13-12^{0}C, and in July and August - 24.5-23.5^{0}C. The average annual rainfall is 800-1000 mm. Most precipitation falls in May and June.

The course of the main phases of vine development in this zone on the variety Rkatsiteli is as follows: the third leaf falls off on May 2-5; Vine blooms from June 5 to June 15; Grapes begin to ripen on August 10-25 and reach full maturity by September 15-25; Leaves begin to fall from November 15-20.

In this zone are spread mainly Powdery mildew, Downy mildew, Rots, Bacterial cancer, Anthracnose and others. The average annual prevalence of Grape powdery mildew is 54%, development - 24%. The same can be said for the gray maturity of the grapes. Its prevalence does not exceed 18% and its development is 4.5%. As for Powdery mildew, the prevalence is 61% and the development is 21%. In this zone we can also find Grape white rot, Grape black rot, etc., which have no practical significance if the measures against powdery mildew and ash are carried out on time and with quality.

V.1.2. Kartli

Kartli differs from other zones by the peculiarities of natural conditions. It is characterized by relatively harsh climatic conditions. Kartli is divided into two sub-zones according to the course of vine vegetation and the intensity of its mycoflora development: 1. Shua and Kvemo; 2. Zemo Kartli.

Shua and Kvemo Kartli, compared to **Zemo Kartli**, are characterized by warm, dry weather and moderate, cold winters. The average annual air temperature is 12-13^{0}C, its absolute minimum temperature in January is 20-22^{0}C, maximum 35-40^{0}C. Precipitation in July-August is 400-600 mm. The vineyards are mainly cultivated in Mtskheta, Kaspi, Gori, Gardabani, Marneuli, Bolnisi and partly Tetri Tskaro districts. Rkatsiteli, Chinuri and different varieties of table grapes are more common in this zone. The speed of vegetation phases on Rkatsiteli is as follows: the third leaf of the vine starts to open about May 5-10, flowers on June 10-20, the grapes ripen on August 15-30, reach full maturity on September 25-30, and the leaf fall begins on November 15-20. Powdery mildew in this sub-zone is characterized by relatively less damage than in the other zone. Its prevalence is 35.4% ± 4.1, its development is 15.8% ± 2.3, its distribution of grape maturity is 28% ± 1.2, its development is 1.9% ± 0.3, which should be explained by the lack of precipitation and the lack of relative humidity of the air. Powdery mildew finds very favorable conditions here. That is why the prevalence reaches 80.2% ± 15.1 and the development - 28.5% ± 6.7.

The climatic condition of Zemo Kartli is very unusual for other viticulture zones of Georgia. The average annual temperature is 10.5 - 8.5, the absolute minimum temperature is 31-27°C. The maximum temperature in July averages 28-25, the annual rainfall reaches 550-600 mm. Precipitation is in spring and early summer. The lowest rainfall is observed in July-August. We should mention the natural climatic indicators of Meskheti micro-district, where the absolute minimum temperature is 24-32., So here in winter, it is necessary to bury the vines in the ground. The hottest month for this crop is August, when the average temperature is 28-29, sometimes up to 39. Precipitation is 450-500 mm. The main production varieties are: Chinese, Goruli Mtsvane and Aligote. The vegetative course of the vine on the Chinuri variety is as follows: the third leaf falls off on May 15-20, flowers on June 15-25, the grapes reach maturity from September 10-15, at full maturity - October 10-15, the fall of leaf begins on October 30.

Natural-climatic conditions prevent the epiphytotic development of diseases. Compared to other viticulture zones of Georgia, the lowest Powdery mildew is in this zone. Its prevalence does not exceed 32.6% ± 3.1, development - 12.5% ± 2.4. The same can be said for the Gray mold of the grapes. According to the average multi-year data, its prevalence is 12.5% ± 1.2, and its development is 3.2% ± 0.4. Mealdew distribution reaches 76.3%. 1.2, development - 28.2% ± 5.1.

V.1.3. Imereti

Imereti is the main viticulture zone after Kakheti. It is located on the humid subtropical side, but is significantly affected by the continental climate. This zone is bordered by Racha-Lechkhumi Mountain from the north, Meskheti from the south. The climate of Imereti is changeable - mainly in terms of temperature and precipitation. These factors influence the development of vine pests and diseases. The micro-districts of this zone are: Zestaponi, Terjola, Baghdati, Vani, Samtredia, Kutaisi, Tskaltubo, Sachkhere, Chiatura and others. The main production varieties are: Tsolikouri, Tsitska, Alexandrouli, Rachuli Tetri, Chkhaveri, Aladasturi.

The course of phenological phases in Tsolikouri variety in this zone is as follows: by April 30-May 6, the third leaf has already opened, flowering begins on May 25-30, ends on June 10-16, enters maturity on September 14-20, reaches full maturity on October 10-25. Leaf fall begins on November 15-20.

Frequent east winds affect the climatic characteristics of this zone. Precipitation is quite high, 1200-1,500 mm per year and is unevenly distributed over the months. During the period of active vegetation of the vine, during the period of flowering, flowering and ripening, rains are frequent, when the decadent amount of precipitation reaches 100 mm and contributes to the spread and development of diseases. The average annual temperature is 14-15. Epithelial spread-development of Powdery mildew, Downy mildew, Grey rot is a frequent event for this zone. For example, according to the average multi-year data, the prevalence of Powdery mildew is 80-82%, the development - 30-32%. The harm of ash is relatively less. The prevalence is 35.4-40.1%, the development is 11.4-13.0%. Gray rot of grapes develops quite strongly. Its average prevalence is 38.4-40.3%. Anthrachosis and various diseases develop in some years, but the development of special measures against them has no practical significance.

Dynamics of development of diseases was studied in Kakheti, Kartli and Imereti. These diseases have the longest epiphytic development in western Georgia. Grey rot spreads in Kakheti with less intensity. It is weaker in the Kartli zone, so that the fight against it should not be considered expedient. Strong epiphytic development of powdery mildew is observed in Kartli, then in Kakheti, it is presented more weakly in western Georgia.

V.2. Control Systems According to Viticulture Zones

Kakheti. During the dormant period, after the fall of the leaves in late autumn, the soil should be removed to a depth of 20-22 cm, which significantly reduces the supply of fungal infections caused by powdery mildew, ash and rot, kills soil pests, etc. During the same period in foci of bacterial cancer spread, if tumors spread to the graft site or rootstock, such vines will be uprooted and burned. In case of tumor development

above the graft site, the vine will be cut on the stem, at a distance of 10-15 cm from the tumour. If the shoots are damaged, they should be removed from the plant. In early spring the vine stem should be cleaned of the exposed bark, pruned, and the shoot removed and burned.

Measures to be taken during the vegetation period: from bud germination to the appearance of 3-4 leaves, used against mites: 0.2% B-58 top, 0.2% Neuron, etc. The treatment is carried out only in this case, when the number of pests per leaf is more than 3 mites.

During the same period, pheromone catchers (1-2 c / ha) are used to signal the appearance of a Grape berry moth and the fight measure.

During the period of separation of buds on the flower - the measure is intended for Powdery mildew, Anthracnose, Mites, Grape berry moth`s I generation, where 0.2% Polymer, 0.2% B-58 top and combined solution will be sprayed.

Treatment of first-generation Grape berry moth should be carried out if 5-7 butterflies and 10 worms per 100 flowers appear on the adhesive catch within 5 days after the start of the butterfly flight.

In the pre-flowering period, treatment is provided against Grape powdery mildew, Downy mildew, Grape rot and pests. A combined mixture of 0.2% Acrobat (or 0.25% Ridomyl gold) with insecticides.

At the end of flowering, 0.2% Acrobat, or 0.04% Topaz and 0.04% Karate zeon or a combined mixture of their substitutes will be used against Grape downy mildew, Powdery mildew, Mites and Coccidia. Predator Metaceillus is used against harmful mites.

Coccidia treatment will be carried out when the pest settlement rate per plant reaches 5-6 individuals. At the beginning of the pea - sized berries period, spray a 0.2% Cabrio top, 0.03% fastak or a combination of their substitutes with a powder mixture of Powdery mildew, Downy mildew, Black rot, Grape berry worm II generation. During the period of full maturity, spray with a combined mixture of any copper-containing fungicide, 0.5% Thiovit jet or anothers used against grape powdery mildew, etc.

At the beginning of grape ripening, only bacterial preparations are used against the third generation of Grape berry moths and Mites: Bitoxibacillin (0.6%), or Lepidocide (0.3%) and pheromones (15-25 pieces / ha), and Cryptolaemus against Mealy bug (1000 c/ha).

At the period of ripening of berries, against Grey rot, we spray the clusters with 2% Bordeaux mixture.

Kartli. From bud germination to the appearance of 3-4 leaves, 0.2% B-58 top and 0.2% Neuron should be used against pests and mites (Spider, Philocoptes, Epitrimerus). Spraying against mites is carried out only, when the number of pests is more than 3 mites per leaf.

During the same period, pheromone catchers (1-2 c/ha) are used to signal the appearance of Grape berry moth and control measures during the period of separation of buds, 0.5% Thiovit jet and 0.03% Fastac or 0.04% Karate or with a combined mixture of their substitutes. It is directed against the first generation of Grape berry moth, Powdery mildew, Mites and grape another worms.

Treatment against first-generation Grape berry moth should begin when 5-7 first-generation butterflies or 10 worms per 100 flowers appear on the sticky trap within 5 days of the butterfly's flight. Before flowering, it is necessary to apply a 0.2% Cabrio top treatment against Powdery mildew, etc. At the end of flowering or as soon as the berries are sprouted, it is necessary to use combination with 0.2% Acrobat (or 0.25% Ridomyl gold), or 0.04% Topaz and 0.03 % mixture of Fastac against Powdery mildew, Downy mildew, Grape berry moth, different species of mites and coccides.

Measures against Grape berry moth, Coccides and Mites are based on an economically injury level of pests on the grape.

It will be needed during the pea -sized berries period against Powdery mildew and Downy mildew, combination pesticide with 0.2% Acrobat and 0.25% Ridomyl gold and 0.04% Topaz.

Prior to maturation, the pesticide is directed against the Powder and Downy midews with the same combined mixture as indicated in the previous combination. Against the third generation of Grape berry worms, we treat the places of its spread with 0.3% Lepidocide or 0.6% Bitoxybacillin, or we use pheromone catchers to control it (15-20 c / ha).

Note: In the absence of the named fungicides, we will use 1% Bordeaux mixture against Downy mildew. It can't be combined with the insecticides and acaricides named above. In this case, the necessary measures should be taken separately for each pest.

Imereti. From the germination of buds until the emergence of 3-4 leaves, we should use 0.2% B-58 top, 0.2% Actelik or 0.04% Karate or their combinated emulsion against grape pests.

When the shoots reach a length of 15-20 cm, a combination of 0.2% Polyram, 0.5% Delan or 0.3% Kaurite and 0.2% Actellic emulsion will be required for spraying. This combination is directed against Powdery mildew, Anthracnose, chewing and sucking pests and mites.

When separating flowers, we should use a combined of 0.2% Cabrio top or their substitutes against powdery mildew and mites.

A measure against Mites will be taken if the number of pests per leaf is more than 3.

A combination of 0.25% Ridomyl gold (or 0.2% Acrobat) and 0.04% Collis and 0.04% Karate is required before or at the end of flowering. This combination is directed against Powdery mildew, Downy mildew, Grey rot, Mites, Leaf worm I generation worms, Berry moth, Coccides. The measures against mites and coccides depend on the critical number of pests.

In the period of pea -sized berries , a combined of 0.25% Ridomil gold and 0.02% Strobe and 0.03% Fastak will be used against Powdery mildew, Downy mildew, Leaf worms, II generation of Grape berry moth, as well as Coccides. During the period of full maturity, combination of 0.5% Delan and 0.02% Strobe and 0.5% Thiovit Jet or their substitutes should be used.

Before the onset of grape ripening, the same fungicides are prescribed against Powdery mildew as in the previous application, and 0.3% Lepidocide, 0.6% Bitoxybacillin should be used against Grape berry moth and Leafhoppers.

During the ripening period, the treatment of epiphytic spread of Grey rot is carried out with only 2% Bordeaux mixture. If necessary, the application is repeated after 10-12 days.

Chapter VI. Grape Protection From Birds

Studies show that poultry in Georgia, especially during the ripening of grapes, suffer great losses. They are distinguished by negative qualities: sparrows, starlings and catbirds. Because these species of birds can also be of great benefit in the destruction of plant pests at other times of the year, it is not advisable to carry out chemical control measures against them. The problem can be solved by using warning devices. These devices operate in automatic mode and emit beam and sound signals, thus significantly reducing the losses of the grape harvest and the bunch of grapes damaged by them.

To solve this problem in the world, "Purivox" warning devices are successfully used, which protect thousands of hectares of agricultural crops. These devices run on propane and are very economical. These are:

Carousel: It is an independently converted sound alarm. The device serves an area of 3-4 hectares. The shots are constantly changing direction. The device is used in vineyards, cereal crops, orchards, as well as potato and beet plantations;

Double shot carousel: It is used away from the settlement. The device is automatically controlled. It is possible to adjust the interval between individual shots;

Duplex: It is a stationary warner that protects vineyards, orchards, cereals (1-2 hectares) from wild birds;

Clock Mechanism: It is ruled by hand. It can be turned on and off at any time, day or night. Using the apparatus the alarm can operate independently for 10 days, without human intervention;

Ratso: It is a combination of sound and beam alarms. Its height is 7.5 meters. An explosion of propane catapults the antenna. It can be used in vineyards, vegetable crops, gardens, near populated areas, where no sound shots can be made. This device protects the area from pigeons, shrews and herons.

When using these warnings, it is advisable to use the devices alternately, because in case of prolonged use, the bird may become accustomed to the beam or sound signals and therefore the efficiency of the device may decrease.

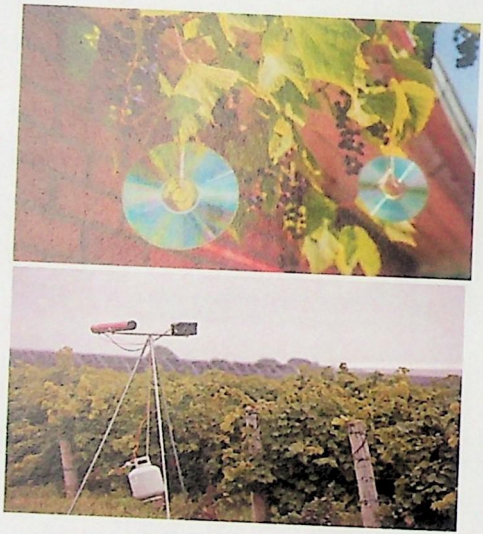
In Israel, wire mesh is used as a means of protecting the grape crop from sparrows. There, in 1981, a loss of 10 hectares of vineyards from sparrows cost $ 45,000, so in June 1982, 57 m of barbed wire was used. 2754 sparrows were caught within 10 days, of which 57% were females, 15% were males, and 32% were young individuals. 27% of these were caught in one day and in the days after 2-6 decades. Most of the birds were caught in the morning and evening hours. In the autumn of 1982, the grape harvest in the area was not damaged by birds. Jewish experts suggest using wire rods to repel sparrows and other pests on their small plots along the migration route.

A bird-alert acoustic device has been developed in the United States to emit the sounds of alarming birds. Audio signals are transmitted at 600-6000 Hertz. At the same time the machine gun can scare 2 species of birds. The device is equipped with a photocell that turns on the device at sunrise and turns off at dusk.

The machine was created in England to protect birds in gardens. It is equipped with a 12-volt electric motor. 2 sirens are turned on at the same time. The electro-automatic device turns on the device at dawn and turns off at dusk. The batteries will power the appliance for 14 days.

Grape cluster damaged by common starling

Male and female Sparrow and their damage



Grape protection from birds

Chapter VII. Forecasting Main Pests and Diseases

Forecasting and alarming the spread and multiplication of vine pests and diseases is the basis for planning and organizing protection measures. Forecasts are developed taking into account the zonal characteristics of the development and distribution dynamics of the individual species. Forecasting and alarming are developed based on defined models that characterize the variability of the spread of each pest. In relation to the state of environmental factors, these models are based on the study of individual species's ecology, physiology, behaviors and pests to determine their influence on crop formation in geographical aspects.

The modern level of processing of pest-disease propagation, multiplication, pest, number dynamics models allows us to consistently move to a unified system of information collection, processing and decision-making.

The following types of long-term forecast are being developed in Georgia:

1. At the end of August, a preliminary forecast is made for the main harmful objects. The forecast will be submitted to the Ministry of Environmental Protection and Agriculture. It is used to plan plant protection measures for prophylactic work next year and in the fall.
2. The full forecast will be developed in December. It contains additional information on the condition of the wintering population of the pest, the protection work carried out and the volume of agro-technical measures, based on this forecast, preliminary plans are specified.
3. The clarifying forecast is developed in spring taking into account overwintering and hydro-meteorological situation for some particularly important species (in terms of distribution).
4. The short-term forecast is completed for some harmful objects, as needed, over a period of one month, taking into account generations.
5. All types of forecasting can be processed in a timely manner if the center that carries out this work receives the necessary information that characterizes certain elements of the ecological situation of the past. Four types of information are used to make long-term (annual and seasonal) forecasts. On the whole, they are characterized by the

state of the ecological environment, the population structure of the pest species and the morpho-physiological features, thus determining their possible distribution.

Phenology characterizes the development of the main agricultural crops of the region taking into account the periods.

Carrying out agro-technical measures is the most important feature, the knowledge of which is necessary for forecasting.

Population status refers to populations of pest species, information is collected by technical means and includes for each pest species: plant types in specific seasons; % of populated area (from each surveyed plot); winter phase of the pest,% of deaths (compared to the number of winters in autumn); the main phenological moments, the dates of settlement and damage of plants, the phases of their development during this period, the development of harmful objects and their dates compared to perennial data; the scope and timing of defensive work, their effectiveness (for individual crops). The degree of damage to the plants, the quality of the quantity of the crop is reduced. In accordance with the methodological instructions processed in full, the relevant departments of the Ministry of Environmental Protection and Agriculture should forward this information to the research organizations that develop the forecasts.

When planning the collection, processing and transmission of information, the circumstance that the preliminary forecast characterizes the situation for August 15-20 should be taken into account, the full forecast should characterize the situation for the spring forecast forecast for November 15-20, transmitted separately, for each object separately.

Grape berry moth. The following information is required for preliminary forecasting:

1. Pest prevalence limits should be set for individual farms by showing the populated area examined. In order to record the percentage of damage, 20 model trees will be selected for every 10 ha, on which damaged and undamaged clusters are registered.
2. The percentage of pest infestation by entomophagous (parasites, predators).

The following information is required for a complete forecast:

1. Last generation flight intensity (using sex catcher);
2. The average number of wintering pupae per 1 plant;
3. Third-generation mortality rate of pupae;
4. % Of damage is recorded by generations (1. in the second decade of June; 2. in the third decade of July; 3. before harvest);
5. Phenophases of vines: budding, 3-5 leaf phase, flower formation, flowering, fruiting, ripening period, leaf fall.

Indirect climatic data are used as an indirect indicator of the general condition of the population before the transition to wintering.

The following information is necessary for a clarifying forecast:

1. The general condition of overwintering chicks where a large percentage of their natural worm mortality (50-100 individuals) was reported in the fall.
2. Butterfly flight dates (units, mass) are determined by means of sex catcher.
3. Laying eggs and start hatching.
4. Vine phenophases: onset of vegetation, budding, 3-5 leaf appearance, flower separation, flowering. The average daily air temperature, the transition period on 10^0C, as well as the average air temperature during the mass flight of butterflies, the absolute minimum and the amount of precipitation are used to determine the condition of the overwintering generation of Grape berry moth.

Spider mites. The following information is required for preliminary forecasting:

1. Pest distribution, naming frequency (on buds, leaves, branches) (5-10 plants per hectare, 40-40 leaves per plant);
2. Pest wintering period;
3. Volume of chemical measures carried out, terms of use, efficiency (average).

The following information is required for a complete forecast:

1. Pest spread and damage intensity (strong, weak, medium) area display, taking into account recent generations;
2. Efficacy of entomophages in reducing the number of pests (predatory mites, other predators);
3. Transfer of pest to winter (beginning, mass) by recording temperature conditions;

4. Volume, timing, effectiveness of chemical and biological measures (average);
5. Vine phenophases.

Indirect indicators are defined as:

Average air temperature, absolute maximum temperature (intensity), relative humidity of the air, precipitation during the summer.

The following information is necessary for a clarifying forecast:

1. Natural mortality of wintering mites, recorded at the wintering place;
2. Getting the pest out of winter (onset, mass) by recording air temperature and relative humidity. As an indirect indicator, the average air temperature, absolute minimum (intensity), hydrothermal coefficient during the period of hatching and laying eggs are used to characterize the winter and spring periods.

Grape downy mildew. The following information is required for preliminary forecasting:

1. Percentage of disease spread and development on leaves and clusters.

For every 1 ha - 20 model plants are recorded on the diagonal. Registration of diseased leaves begins one week after the onset of the disease. Subsequent registrations are conducted once a month, assessing the degree of disease on a 9-point scale. 0- is not a disease; I - diseased up to 2.5% of the leaf surface (unit on leaves, slightly noticeable spots); II- from 2.5 to 5% of the leaf surface is diseased (spots are noticeable); III – from 5 to 10% is diseased; IV - from 10 to 15%; V - from 15 to 25%; VI - from 25 to 35%; VII - from 35 to 67.5%; VIII - above 67.5%.

The evaluation of cluster disease is done from 100 clusters in each plot. The degree of Downy mildew of berries and clusters is produced by a 5-point system: 0 - the disease is not observed; I - 10% of grains and clusters are diseased; II - from 10 to 25%; III - from 25 to 50%; IV - above 50%;

2. The date of appearance of Downy mildew on leaves and clusters. Primary Downy mildew in leaves is detected by microscopic analysis of spore. Favorable conditions for primary disease with Powdery mildew are the presence of spores and precipitation for 2–3 days, the minimum air temperature (not less than 12-15^{0}C).

3. Chemical treatment timing and volume, indicating plant phenophases and efficacy.
4. Scope, timing and effectiveness of agro-technical, hygienic measures.

The following information is required for a complete forecast:

1. The percentage of disease spread and development on leaves and clusters, during berry formation period and before harvest.

Quantitative and qualitative characterization takes place during the harvest. Quantitative accounting and analysis of the crop is carried out on average per 1 ha.

2. The percentage of vine damage at the end of vegetation (average) showing the total area and crop loss from diseases.
3. Vine pheno-phases especially in leaf fall, with month and decade indications (October, November).

The meteorological data of the autumn period are used as indirect indicators, which characterizes the fungus population before wintering, meteorological data of the autumn period are used. For this purpose, with the help of a microscope on the autumn leaves, mosaic spots are examined on different varieties of vines in order to detect their oosphoras.

The following information is necessary for a clarifying forecast of spring:

1. Infection stock in diseased vine leaves at the end of vegetation (average).

The moisture content of overwintering leaves in spring, its duration (winter-spring period). During this period, air temperature (maximum, minimum, optimal), relative humidity, precipitation, number of rainy days and wind speed are recorded.

Grape powdery mildew. The following information is required for preliminary forecasting:

1. Record the spread of the disease in June and September of the previous year. Evaluation of cluster disease is done by recording 20 plants on each plot (diagonally). Grains damaged by mealdew are recorded according to the following scale: 0- the disease is not observed; I - diseased from 1 to 10% of clusters and berries; II-

diseased from 0% to 25% of clusters and berries; III - 25% to 50% of clusters and berries are diseased;
2. Average decadent temperatures in June and July of the previous year, air humidity, precipitation and wind speed.
3. The first signs of the appearance of Powdery mildew on the clusters.
4. The volume of chemical measures carried out, fungicides on display, processing times, their effectiveness.
5. Agro-technical and hygienic measures taken, processing times, their volume, efficiency (average limits).

The following information is required for a complete forecast:

1. The percentage of damaged grape (average, limits) showing total area and crop loss at the end of vegetation.
2. Vine phenology.

The timing of the fall season is used as an indirect indicator of the condition of the population before fungal damage.

The following information is necessary for a clarifying forecast of spring:

1. Infection stock at the end of vegetation on the damaged plant (average, minimum, maximum).

Chapter VIII. Hygienic Requirements for Pesticides

The acute and chronic poisoning of humans and haematothermals is expected when the rules for the use of pesticides are not followed.

The acute poisoning can be predominantly caused by strong and highly toxic, as well as resorbably toxic and easily volatile drugs (hygienic classification I and II), while chronic poisoning can be caused by persistent, high cumulative pesticides.

The pesticides should not be used by anyone who has had an infectious disease, undergone surgery or has a central or peripheral nervous system disorder or mental illness, tuberculosis, diabetes, cardiovascular disease, disease of the digestive organs, disease of the liver, kidneys and some other organs, vision impairment etc.; they are also not allowed for older women, pregnant and women with infants.

Food, water, forage and household items may not be stored in permanent or temporary pesticide warehouses, as well as in areas where pesticides are used. It is also not allowed to leave pesticides in the field, but if they are left, it is also temporarily, under special protection, in designated areas, 200 meters or more away from water reservoirs and animal grazing areas.

The use of pesticides on sunny days is allowed in the morning and evening and in cloudy weather - throughout the day. When spraying and spraying with surface equipment, as well as when applying granular preparations to the soil, the wind speed should not exceed 4 meters per second.

To prevent food contamination with pesticides, precise accounting of all work carried out with pesticides and microbiological preparations on crops and crops has been introduced. Special journals provide data on individual plots for food, technical and forage crops, in what form, concentration and norm the pesticide is applied, as well as when it was processed and how long it was harvested.

For all pesticides, the thresholds that are allowed in the human food product are set. This value is known as the, allowable amount of pesticide residue'' and is defined in milligrams per kilogram of product, or mg / kg. If the product contains more than the permissible residues of very toxic and highly toxic preparations (hygienic classification of I and II group); it can't be used as a food. In the case of other groups of preparations, the use of such products is permissible after such culinary and technological processing, which ensures the decomposition of the pesticide into non-toxic components.

Pesticide workers usually need to have personal protective equipment, especially when using spray, powdered and seed-dried preparations, as well as sprays with non-toxicity, whose volatility is negligible (Hygiene Class II according to volatility indicators), dust catchers are enough to protect the respiratory system.When using highly toxic and volatile preparations (hygienic classification I and II groups according to toxicity and volatility), respirators, with the addition of special air-gas masses for quicksilver-containing preparations - "C" brand, for various organic preparations - "A" brand and special clothing are made of powder-type pellicle preparations to work with liquid preparations - and from specially impregnated tissues.

Rubber Gloves made of cotton cloth covered with pellicle, with chlorinated powder are used in order to protect hands when using liquid preparations. Special clothes for working with powdered preparations are made of tarpaulin, for liquid - rubber and for working in warehouses, special leather.

These products should be used not only to assist with pesticides and microbiological preparations, but also to defrost the vehicles, equipment, containers, buildings and special clothing that are being transported and used.

The special clothes of rubber and clothes covered with pellicle are treated with 3-5% of calcined soda (30-40 g per 10 liters of water) and in case of contaminated clothes with other types of phosphorous and dinitrophenolic preparations - with a solution of laundry soap and soda, as 1% of synthetic organic preparations, solution containing quicksilver etc.

The treatment of soil contaminated with pesticides, dust collected during building cleaning, transport, equipment, containers and overalls is treated with chlorinated waste (500 g per 10 liters of water).

The pesticides that are unsuitable due to expiration or improper storage should be handed over to special services for disposal.

In case of pesticide poisoning, medical care can be provided by both self-employed (self-help and mutual assistance) and medical staff. First of all, it is necessary to get rid of dirty clothes and remove the respirator (if there is no danger of pesticides entering the body through the skin or respiratory tract) and then measures that are common to all pesticides, namely: a) Transfer of people from the danger zone to fresh air; b) When the pesticide gets on the skin - carefully clean it with a cloth and wash it with cold water or a weak alkaline solution; c) In case of contact with eyes, rinse immediately with a jet of water, then with baking soda or a 2% solution of boric acid; d) When the pesticide enters the body through the digestive tract - give a few glasses of warm water, or slightly pink (dilution 1: 50000-1: 100000) potassium permanganate solution and induce vomiting (by irritating the back wall of the throat). After vomiting the patient will be given 2-3 teaspoons of activated charcoal diluted in half a glass of water, after a while again 20 g of English salt dissolved in half a glass of water. However, we must keep in mind that artificial insemination of vomit for unconscious and

convulsive poisoning, as well as the use of laxatives (castor oil) for this purpose can not be used.

The poisoned one is transferred to a warming room, warm clothes are made in the unconscious state, but in the latter case caution is required. Namely: In case of poisoning with dinitrortocresol, nitrafen, pentachlorophenol and sodium pentachlorophenolate, heat is not allowed, only cold bath, wet towel, cold compresses and ice packs are needed. When breathing is weakened, ammonium hydroxide alcohol is inhaled and when stopping, artificial respiration is performed, before the oral cavity is cleansed of saliva and the back tongue is corrected.

When the heart stops, an external massage of the chest is done, and in case of a convulsion, any irritation should be washed away and the poisoned person should have complete calm.

The irritating substances, such as formalin, should be given to starch porridge, while milk, fats, and alcohol should not be used. When blood is flowing from the skin, hydrogen peroxide-soaked tampons should be applied, and from the nose - a cold compress on the head, and again a hydrogen peroxide-soaked tampon in the nose. Organophosphorus poisoning is different from poisoning by other pesticides, accompanied by salivation, tearing, narrowing of the gums, difficulty breathing, slowing of the pulse, and shivering. At this time will be given preparations of belladonna, 3-4 tablets of Besalos (bicarbonate) or 2-3 tablets of Bellagin. With pesticides, all types of poisoning, including mild poisoning, it is necessary to call a doctor.

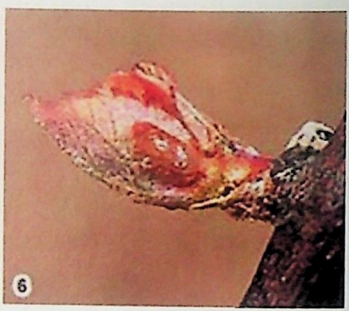
Annex

I. Grape Phenophases[2]

Winter dormancy

Wool (doeskin stage)

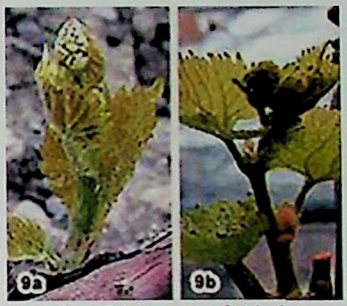
Bud burst



Green shoot

[2] Sourse: https://www.agr.gc.ca/

First leaf unfolded

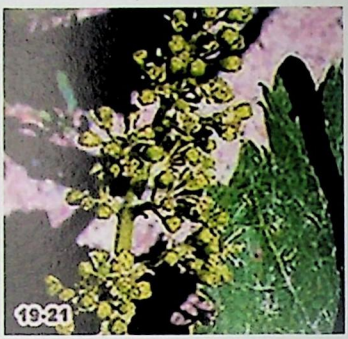


2 to 3 leaves unfolded

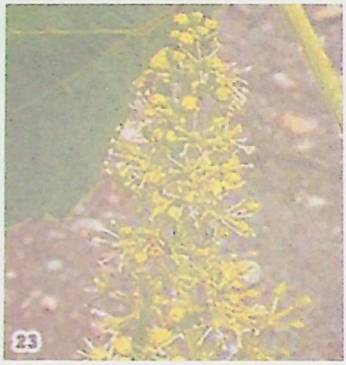
4 to 6 leaves unfolded, inflorescence clearly visible

Inflorescence elongating; flowers closely pressed together

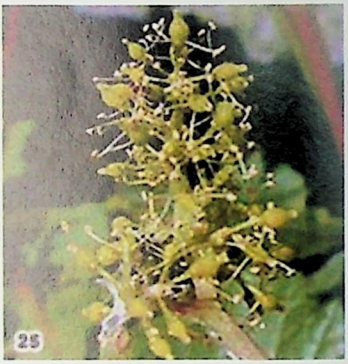
Inflorescence fully developed;
flowers separating



Beginning of flowering;
first caps falling (21)
Early flowering;
25% of caps fallen



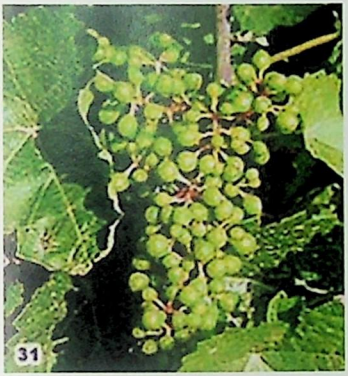
Full flowering;
50% of caps fallen



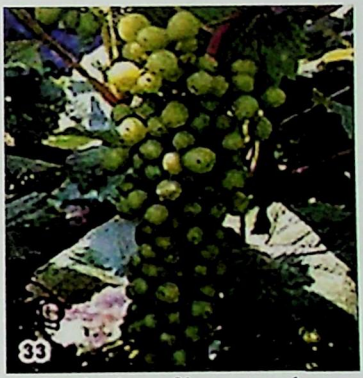
Late flowering;
80% of caps fallen

Fruit set; young fruits beginning to swell

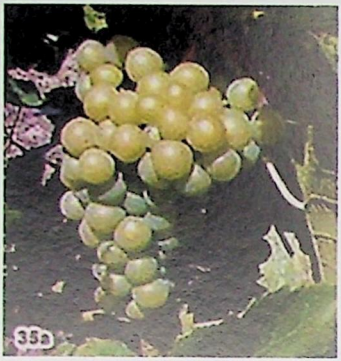
Berries small; bunches begin to hang (4-6 mm)



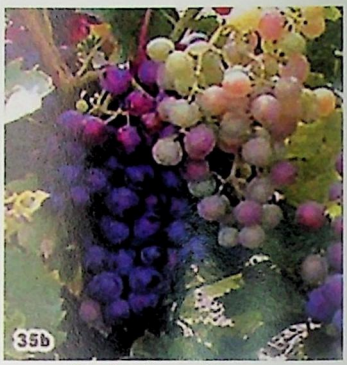
Berries pea-sized; bunches hang (7-10 mm)



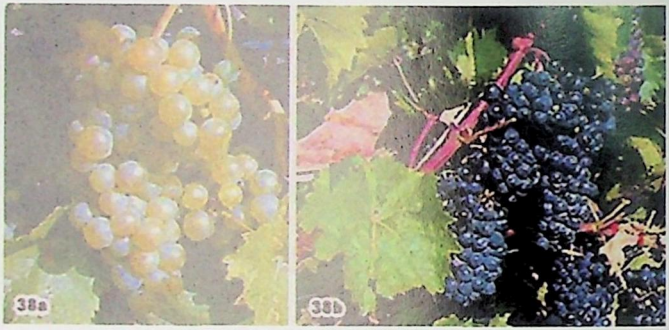
Beginning of berry touch



Beginning of berry ripening (veraison)



Beginning of berry ripening (veraison)



Berries ready for harvest

II. List of Pesticides Recommended for Use in Vineyards of Georgia[3]

Approved by the Plant Protection Service of the Ministry of Environmental Protection and Agriculture of Georgia

#	Trade Name	Used Amount (L/ha, kg/ha, L/t, kg/t)	Targets (Pests, Diseases)	Specification during application	Waiting time before harvesting
			Insecticides		
1	Altak	0.3-0.35	Grape berry moth, Leafrollers	Application during the vegetation	15
2	Admit	0.5-0.6	Leafrollers	Application during the vegetation	30
3	Avant	0.25	Grape berry moth, Leafrollers	Application during the vegetation	10
4	Alarm	0.4-0.5	Leafrollers	Application during the vegetation	25
5	Aldex	0.25-0.35	Leafrollers	Application during the vegetation	30
6	Alpak	0.25-0.36	Leafrollers	Application during the vegetation	15
7	Alpgor	2.0-2.5	Coccidae,	Application	20

[3] Source - 2021, State Catalog of Pesticides Permitted for Use in Georgia

			Mites, Leafrollers	during the vegetation	
8	Alfamilin	0.2-0.3	Leafrollers	Application during the vegetation	30
9	Ampligo	0.3-0.4	Grape berry moth	Application during the vegetation	25
10	Antikolor ad	0.3-0.35	Leafrollers, Tortiacidae, Mites, Cikades	Application during the vegetation	10
11	Antikhrus hch	1.0	Grape berry moth, Leafrollers, Phylloxera, Fleas, Mites, Brown marmorated stink bug	Application during the vegetation when pests appearanced	30
12	Applaud	1.0-1.5	Grape mealybug, Leafhoppers	Application during the vegetation	25
13	Apollo	0.24-0.36	Mites	Application during the vegetation in early Spring	60
14	Actara	0.1-0.3	Tortiacidae, Cicades	Application during the vegetation	60
15	Aztec	0.5-1.0	Spider mites, Gall mites	Application during the vegetation twiced	14
16	Belt	0.3-0.4	Grape berry moth, another moth	Application during the vegetation	25
17	Belt expert	0.3-0.4	Grape berry moth,	Application during the	21

			Leafrollers	vegetation during oviposition	
18	Bi-58 top	1.0-2.0	Mites, Leafrollers, Coccidae	Application during the vegetation	20
19	Boikot	1.5	Scale insects	Application during the vegetation	40
20	Borey Neo	0.2-0.25	Grape berry moth	Application during the vegetation	20
21	Brand D	1.0-1.5	Grape berry moth, Phylloxera	Application during the vegetation	30
22	Bronx	0.9-1.2	Scale insects, Mites, Aphids, Fals scale, Fleas	Application in Winter and early Spring	20
23	Buffalo	1.0-1.25 1.5	Grape berry moth, Mites	Application during the vegetation	30
24	Grand - 5	0.3-0.4	Mites, Leafrollers	Application during the vegetation	20
25	Decis flux	0.2	Leafrollers, Geometridae	Application during the vegetation	30
26	Dingo 40	1.1-2.8	Mites, Leafrollers, Coccidae	Application during the vegetation	20
27	Dursban	1.5-2.0	Scales, Mites	Application during the vegetation	40
28	Eco oil	10.0-15.0	Scales, Mites, Aphids, Fleas	Application in early Spring with 12 days interval	20

29	Eforia	0.1-0.5	Mites, Leafrollers	Application during the vegetation	30
30	Exirel	0.5-1.0	Leafrollers	Application during the vegetation	10
31	Exitox	0.5-0.8	Mites	Application during the vegetation	30
32	Valsamba	0.6-0.8	Leafrollers, Mites	Application during the vegetation	30
33	Valsaciper	0.26-0.32	Leafrollers	Application during the vegetation	25
34	Thiovit jet	3.0-4.0	Mites	Application during the vegetation	1
35	Imidor	0.15-0.35	Grape berry moth	Application during the vegetation	30
36	Indox	0.2	Leafrollers	Application during the vegetation	14
37	InsectOil	10.5-16.0	Scale insects, Mites	Application during the Winter	20
38	Kaizer	0.3-0.4	Grape berry moth, Leafrollers	Application during the vegetation	10
39	Kaiso	0.3-0.4	Leafrollers, Mites	Application during the vegetation	30
40	Calypso	0.2	Grape berry moth	Application during the vegetation	30
41	Karate	0.3-0.4	Leafrollers, Mites	Application during the vegetation	30
42	Karate	0.3-0.4	Leafrollers,	Application	30

	Zeon		Mites	during the vegetation	
43	Confidor	0.15-0.2	Grape berry moths, Cicades	Application during the vegetation	25
44	Confidor max	0.1	Grape berry moth	Application during the vegetation	25
45	Coragen	0.15-0.2	Grape berry moth	Application during the vegetation with 10-14 days interval	14
46	Lamdex	0.35-0.4	Grape berry moth	Application during the vegetation	30
47	Lannate	1.0-1.2	Leafrollers	Application during the vegetation with 10-12 days interval	20
48	Mavrik	0.25-0.4	Mites	Application during the vegetation	30
49	Mite killer	0.5-0.75	Mites	Application during the vegetation	30
50	Merton	3.0-5.0	Gall mite	Application during the vegetation	1
51	Movento	0.75-1.5	Grape mealy bug, phylloxera, Trips	Application during the vegetation	14
52	Nomolt	0.5	Leafrollers	Application during the vegetation	30
53	Nuprid	0.15-0.2	Grape berry moth, Cicadea	Application during the vegetation	25

54	Nurelle - D	1.5	Scales, fals scales	Application during the vegetation	40
55	Oleo look	0.5	Scale insects, fals scales, Mites, Aphids	Application during the Winter with 10 days interval	-
56	Ordus	0.6-0.9	Grape mites	Application during the vegetation	30
57	Orion	0.3-0.45	Grape berry moth, Leafrollers	Application during the vegetation	15
58	Ortus 5	0.6-0.9	Grape mites	Application during the vegetation	30
59	Perfecto	0.25-0.3	Grape berry moth, Leafrollers, Mites, Cicadea	Application during the vegetation	10
60	Pyranica	0.25-0.375 0.375-0.5	Grape mites, Grape gall mite	Application during the vegetation by twice	14
61	Pyrate	0.5-1.0	Mites, Grape gall mite	Twice application during the vegetation	14
62	Pyrinex	1.2-1.8	Leafrollers, Fals scales, Mites	Application during the vegetation	60
63	Pyrinex Super	0.6-1.25	Grape berry moth, Mites	Application during the vegetation with 15-20 days interval	30
64	Piriphos	1.5-2.0	Scale and	Application	40

	48		fals scale, Mites	during the vegetation	
65	Ritmus	0.4-0.6	Leafrollers, Aphids, Moths	Application during the vegetation	30
66	Summit	0.5-0.75	Mites	Application during the vegetation	30
67	Sivanto Prime 200	0.15-0.5	Cicades, scale, Trips, Aphids	Application during the vegetation	30
68	Sipcamol	10.0-15.0	Scales, fals scales, Mites, Aphids	Application in Winter time with 10 days interval	20
69	Sniper	0.4-0.7	Spider mite	Application during bud opening and at the end of flowering	14
70	Talstar 10	0.2	Grape berry moth	Application during the vegetation against I and II generation of caterpillars	30
71	Trebon	0.3	Grape berry moth, cicades, Aphids, Trips	Application during the vegetation	21
72	Fastac 100	0.25-0.35	Leafrollers	Application during the vegetation	30
73	Fend	0.5-0.6 0.25-0.35	Grape berry moth, Leafrollers, Mites	Application during the vegetation against I and II generation of caterpillars	30

74	Fiur	0.2-0.36	Grape berry moth	Application during the vegetation	30
75	Fos-Bi	1.5-2.5	Coccidae, Leafrollers, Mites	Application during the vegetation	20
76	Kemol	20.0-25.0 5.0-7.0	Mites and their eggs, Mealy bug	Application during the Winter, Application during the Summer	20
77	Cezar	0.2	Leafrollers, Mites	Application during the vegetation	30
78	Cipersin	0.26-0.32	Leafrollers	Application during the vegetation	25
79	Ciprin	0.25-0.4	Leafrollers, Fals scale	Application during the vegetation	25
80	Hectolineum	10.0-15.0	Mites, Aphids - wintery phase, Fals scale	Application during the Spring before opening of buds	-
81	Astral	0.15-0.2	Mites, Grape berry moth	Application during the vegetation	7
82	Beltirul	0.25-0.5	Grape berry moth	Application during the vegetation after the beginning of butterflies` flying	5
83	Bermectine	0.6-1.2	Grape mites	Application in case of economical injery level	10

			Grape berry moth	Application during the appearance of pests against I and II generation of caterpillars	
84	Bitoxibacilin	6.0-8.0 kg/ha 60.0-80.0 g/10L	Grape berry moth	Application after 10 days of moths flying, against each generation, interval of 5-7 days	5
85	Brandon	0.15-0.3	Grape berry moth	Application during the vegetation against each generation	8
86	Dicaprioni	0.5-1.2	Mites, Grape berry moth	Application during the vegetation after appearance of pest	14
87	Elan	0.3-0.4	Grape berry moth	Application during the vegetation against each generation	7
88	Vertamectin Forte	0.16	Mites, Cicades, Bud worm, Grape berry moth	Application during the vegetation after appearance of pests	3
89	Vertimec	0.16-1.2	Mites,	Application during the vegetation after appearance of pests	2
			Grape berry	Application	2

			moth	during the vegetation against I and II generation	
90	Kraft	0.75-1.2	Grape mites	Application during their appearance after according to economy injury level	2
91	Lepidin	2.0-4.0	Grape berry moth	Application after 8-10 days of their flying	2
92	Lepidocid	2.0-3.0	Grape berry moth	Application during the vegetation after the beginning of butterflies` flying with the 8-10 days interval	5
93	Nimbecidine	5.0	Grape berry moth, cicades	Application during the vegetation, before flowering and green berry stage	-
94	Surrender	0.25	Grape berry moth	Application during the vegetation against of each generation	14
		0.5	Trips		
95	Spintor	0.15-0.3	Grape berry moth, Leafrollers, Spider mites	Application against of each generation	16
96	Spodhel	0.25-0.4	Grape berry moth	Application during the vegetation	10

				against each generation	
97	Terra Neem Oil	5.0	Bud worm, Mites, Fals scale, Grape berry moth, May and June Beetle, Leafrollers, Bugs	Application during the vegetation, before flowering and berry green stage and 10 days before harvesting	-
98	Tina	0.6-1.2	Spider mite, Gall mites	Application during the vegetation after appearance of pest and according their economic injury level	7
99	Thuringen	6.0-8.0 kg/ha	Grape berry moth	Application after 8-10 days of moths flying and after 5-7 days against each generation	5
		60.0-80.0 g/10 L water	Grape mealy bug		
100	Gipnoz	2.5	Grape berry moth	Application during the vegetation against each generation	10
Fungicides					
101	Aboga-Pik	4.8-6.2	Downy mildew, Anthracnose	Application during the vegetation	30
102	Avalon	4.0	Powdery mildew	Application during the vegetation	35
103	Azobin	0.25-1.0	Grey mold, Powdery mildew,	It is used only in protection when fungicider	35

			Downy mildew, Gray mold	are rotated	
104	IRON	2.0-4.0	Downy mildew, Anthracnos, Black rot	Prophylactic application during the vegetation with 7-8 days interval	25
105	Acrobat	2.0	Downy mildew	Application during the vegetation	-
106	Antracol	2.0-2.5	Downy mildew	Application during the vegetation after first symptoms appearing, repeating in 10-14 days	30
107	Baron	2.0	Downy mildew, Anthracnose	Application during the vegetation	21
108	Benelux	0.8-1.6	Grey mold, Downy mildew, Powdery mildew	Application during the vegetation with the interval of 7-10 days	30
109	Blue fox	1.0-1.5	Downy mildew	Application during the vegetation	7
110	Bordeaux Caffaro Blue	7.0-10.0	Downy mildew, Anthracnose	Application during the vegetation	25
111	Bordeaux mixture	8.0-10.0	Downy mildew	Application during the vegetation	15
112	Bordeaux Flow New	10.0-12.0	Downy mildew	Application in early Spring	-
113	Boxer	1.5-3.0	Downy mildew,	Application during the	7

			Black spots, Grey mold	vegetation during the buds opening	
114	Bravo	2.0-3.0	Downy mildew, Grey mold, Anthracnose	Application during the vegetation	30
115	Ganzo	0.2-0.3	Black rot	Application during the vegetation before the end of flowering, interval in 14 days	20
116	Geophyte	3-5 L/ha 1000 L water	Powdery mildew, Downy mildew, Phytophthora, Phytium, Fusarium, Root rot, Bacterial rot	Application during the vegetation, interval of 14-21 days	-
117	Gold copper	1.5-2.0	Downy mildew, Black rot, Black spots	Application during the vegetation during the first sign appier	14
118	Gorila	2.0-2.5	Downy mildew, Powdery mildew, Phomofosi, Black rot, Rednish	Application during the vegetation before flowering green berries before ripening	30
119	Grand	2.0	Downy mildew	Application during the vegetation	40
120	Danon	1.0	Downy mildew,	Application during the	30

			Anthracnos, Molds	vegetation	
121	Delan	0.5-0.7	Downy mildew, Anthracnos, Molds	Application during the vegetation	30
122	Dithane M-45	2.0-3.0	Downy mildew	Application during the vegetation	30
123	Dinal	0.7-0.9	Powdery mildew, Phomofsis, Rednish, Black rot	Application during the vegetation in the phase of buds formation before the berries formation in interval of 10-15 days	30
124	Domark	0.25	Powdery mildew	Application during the vegetation before flowering with 10-14 days interval	20
125	Duet forte	2.0	Downy mildew, Black spots, Rednish	Application during the vegetation with 10-14 days interval	30
126	Valsazeb	2.0-3.0	Downy mildew	Application during the vegetation	30
127	Valsalaxil	2.5-3.0	Downy mildew	Application during the vegetation before flowering with 10-14 days	20

				interval	
128	Vivando	0.2-0.25	Powdery mildew	Application during the vegetation	50
129	Vinextra	1.5-1.75	Downy mildew, Powdery mildew, Grey mold, Black spots, Rednish	Application during the vegetation before flowering and berries formation with 7-14 days interval	35
130	Zato star	0.5	Downy mildew, Powdery mildew, Grey mold	Application during the vegetation	30
131	Zakhisnik	2.0	Powdery mildew, Grey mold	Application during the vegetation	30
132	Thiovit jet	3.0-4.0	Powdery mildew	Application during the vegetation	1
133	Imperium	2.0	Downy mildew, Black rot, Phomophsis, Rednish	Application during the vegetation	30
134	Cabrio top	2.0	Downy mildew, Powdery mildew, Black spots, Grey mold, Rednish	Application during the vegetation, before flowering and formation of cluster	40
135	Cantus	1.0-1.2	Grey mold	Application during the vegetation with 7-14 days	30

				interval and before clusters formation	
136	Capsula	1.3-1.7	Downy mildew, Powdery mildew, Alternaria, Grey mold	Application during the vegetation	30
137	Collis	0.4	Grey mold, Powdery mildew	Application during the vegetation	50
138	Copper-Count-N	4.5-5.0	Downy mildew, Powdery mildew, Anthracnos, Black rot	Application during the vegetation during the bud opening and 7-10 days interval before 4-6 leaves formation	25
139	Chorus	0.5-0.7	Grey mold, Downy mildew, Powdery mildew	Application during the vegetation	28
140	Kocide	2.5-3.0	Grey mold, Downy mildew	Application during the vegetation. Application before buds separating continue after 8-10 days interval	21
141	Kumulus DF	3.0-5.0	Powdery mildew	Application during the vegetation	3
142	Cuperval blue	7.0-10.0	Downy mildew	Application during the	25

				vegetation	
143	Cupertin super	4.0	Downy mildew, Anthracnos, Black rot	Application during the vegetation	30
144	Cuprablau	1.7-1.9	Downy mildew, Anthracnos, Black rot	Application during the vegetation	7-10
145	Cuproxat	4.0-5.0	Downy mildew	Application during the vegetation	20
146	Curzate	2.0-3.0	Downy mildew	Application during the vegetation	30
147	Lennox	1.2-1.5	Downy mildew, Powdery mildew	Application during the vegetation with 7-14 days interval	28
148	Luna sensation	0.2-0.55	Downy mildew, Powdery mildew, Grey mold, Phomophsis	Application during the vegetation with 12-14 days interval	20
149	Melody duo	2.0-3.0	Downy mildew	Application during the vegetation after flowering with 10-12 days interval	30
150	Mikal flash	4.0	Downy mildew	Application during the vegetation with 14 days interval	42
151	Mystic	0.4	Powdery mildew	Application during the vegetation	35
152	Nando	0.5-0.75	Downy	Application	21

		1.0-1.5	mildew Grey mold	during the vegetation with 7-8 days interval Application during the vegetation after the flowering end, before the formation of cluster	21
153	Nixon	2.5	Molds	Application during the vegetation	28
154	Ondar/Captan	3.0-4.0	Downy mildew, Grey mold, Powdery mildew	Application during the vegetation with 7-10 days interval	30
155	Pandora	7.0-10.0	Downy mildew, Anthracnos, Escorious, Black rot	Application during the vegetation in Summer with 7-10 days interval	25
156	Pasodoble	2.0	Downy mildew, Black rot	Application during the vegetation: prophylactic in the phase of leaf development, with 10-12 days interval	
157	Pergado	4.0-5.0	Downy mildew	Application during the vegetation: prophylactic with 10-14 days	14

				interval	
158	Prius	1.2-2.5	Downy mildew, Grey mold	Application during the vegetation: prophylactic and treated	21
159	Polyram	1.5-1.75	Downy mildew, Anthracnos, Black spots, Black rot, Rednish	Application during the vegetation, during the formation of flowers, second – during the flowering, third – during the berries formation	30
160	Ridomil gold	2.5	Downy mildew	Application during the vegetation	21
161	Rock N Roll	0.5-1.0	Downy mildew, Powdery mildew, phomophsis	Used only the grape predator systems, with rotation of another fungicides	25
162	Switch	0.6-1.2	Grey mold, Penicilium, Molds	Application during the vegetation with 14-21 days interval	35
163	Sphinx extra	1.3-2.0	Downy mildew, Grey mold, Powdery mildew	Application during the vegetation with 2-3 weeks interval	28
164	Strobe 50 WG	0.15-0.2	Downy mildew, Powdery mildew	Fungicide used only in systems with rotation of another ones	10

165	Sulphur	2.0-4.0	Powdery mildew	Application during the vegetation	1
166	Super cuper	6.0	Downy mildew, Anthracnose	Application during the vegetation	30
167	Talendo	0.25	Powdery mildew	Application during the vegetation with 14-15 days interval	28
168	Tanos	0.4	Downy mildew	Application during the vegetation with 10-12 days interval	30
169	Triumph	0.16-0.18	Downy mildew, Grey mold, Powdery mildew, Black rot	Application during the vegetation	14
170	Topaz	0.15-0.25	Powdery mildew	Application during the vegetation	20
171	Falcon	0.3	Powdery mildew	Application in the period of buds separation	30
172	Folpan	1.5-2.0	Downy mildew, Grey mold, Powdery mildew, Black rot	Application during the vegetation during the first symptoms appearing	40
173	Quadris	0.6-0.8	Downy mildew, Powdery mildew	Fungicide used only in systems with rotation of another ones	25
174	Quadris max	2.0-2.5	Downy mildew,	Application during the	30

			Powdery mildew, Rednish, Phomophsis, Black rot	vegetation with 8-14 days interval before the ripening	
175	Shavit	2.0-2.5	Downy mildew, Grey mold, Powdery mildew, Black rot, White rot	Application during the vegetation during the first symptoms appearing	40
176	Champion	2.0-3.0	Downy mildew, Rednish	Application during the vegetation during the buds separation with 8-10 days interval	25
177	Chorus	0.5-0.7	Downy mildew, Grey mold, Powdery mildew	Application during the vegetation	20
178	Heliocuivre	1.4-2.6	Downy mildew, Anthracnos, Bacteriozis	Application during the vegetation during the first symptoms appearing and 7-10 days interval	21
179	Herkules	0.4-0.8	Grey mold, Powdery mildew	Application during the vegetation with 7-14 days interval	35
180	Hydromicron	2.0-4.0	Downy mildew, Bacterial rot	Application during the separating of	25

				buds ripening after 10 days interval	
181	Agrocaten a	3 L/ha	Powdery mildew	Application during the vegetation, prophylactic, with 7-14 days interval	1
182	Bactophyt e	3 L/ha	Powdery mildew	Application during the vegetation, prophylactic, with 8-10 days interval. It is possible to combine with another fungicide	1
183	Biokatena	8-10 L/ha	Verticilozes, Molds	Application during the vegetation, on leafs	3
184	Progranic	3-5 L/ha	Downy mildew	Application on leaves with 7 days interval	-
185	Serenade	6.0-8.0	Grey mold	Application during the vegetation: before flowering, during flowering and before the harvest 7-10 days interval	-

III.Plant Pesticides[4]

This group of plant pesticides is characterized by many positive properties: they are quite easy to prepare, low toxicity to humans and animals, and cheap. Here are some ways to make pesticides from different plants, which is quite simple. Every farmer can make and use it.

Tincture of potato stems - 1.2 kg of green stems or 0.6-0.8 kg of dried stems are soaked in 10 liters of warm water for 3-4 hours and drained. Use freshly prepared tincture, add 40 g of soap for every 10 liters.

Tincture of Great oregano - 1/3 of finely chopped leaves are put in 10 liters of water for 3 days, then squeezed and used accordingly.

Tincture of Headed Onion - The first method of preparation - 200 g of peel is poured into 10 liters of water for 4-5 days, drained.

The second method - pour 10 liters of hot water in a half-full bucket of onion peel, drain the solution after one day, mix it with water twice.

Tincture of Medicinal dandelion - Put 300 g of crushed roots or 400 g of live leaves in 1-2 liters of warm water (not more than 400 C) and strain. The roots should be stored in the cellar.

Tincture of Absinthe - well-defined above-ground parts of the plant collected during flowering is boiled in for 10-15 minutes in a small amount of water, then the tincture is cooled, strained, water (up to 10 liters) and 40 g of soap are added.

Tincture of Chamomile - put 1 kg of leaves and flowers in 10 liters of hot (up to 60-700C) water for 12 hours. The filtered solution is mixed with water three times before spraying the plants and 40 g of soap is added to 10 liters of water.

Tincture of Tobacco, Rustic tobacoo and decoction - used for leaf crumbs, dust to prepare the tincture, 400 g of dried raw material is crushed and put in 10 liters of water for 2 days - overnight, squeezed, mixed with water twice. Before spraying, add 40 g of soap per 10 liters of tincture.

---

[4] Source: K. Buachidze. 1997. Herbal Pesticides. Tbilisi.

In order to get the decoction, 400 g of dried raw material is put in 10 liters of water for 1 day, then boiled, after cooling for 2 hours, mixed with water - twice. Before use, add soap 40 g per 10 liters of water.

Tincture of Tomato - 4 kg of green, undamaged aboveground parts or roots of the plant are poured into 10 liters of water and boiled on low heat for 30 minutes, then drained. Before spraying, mix 3 times with water and add soap - 40 g per 10 liters of tincture.

Tincture of Bot yarrow and decoction - 800 g of dried raw material (collected at the beginning of green mass flowering) is crushed and boiled, then boiled in 10 liters of water, put for 36-48 hours or boiled for 30 minutes, add 40 g of soap on 10 liters of tincture. The prepared solution is stored in a covered container.

Tincture of Imeruli Saffron - pour half a bucket of saffron plant in 10 liters of warm water, drain after 2 days and nights and add 40 g of soap.

Tincture of Sowing Garlic - 100-150 g of crushed, dried leaves or peels are put in 10 liters of water for 24 hours and used for processing plants.

Tincture of Bot wild sorrel - 300 g of crushed roots are put in 10 liters of water for 2-3 hours, squeezed and immediately used to spray the plants.

Mustard - 10 grams of mustard powder is poured into 1 liter of water and left for 48 hours. Then add 4 liters of water and use against aphids, mites and others.

Hebdane - 1 kg of finely chopped dried plant or 0.5 kg of roots pour 10 liters of water and leave for 12 hours. Drain, add 30-40 grams of soap.

Red pepper - 1 kg of freshly crushed fruit (or 500 grams of dry pepper) is boiled for 1 hour in 10 liters of water in a closed enamel container, the solution is left for 48 hours, squeezed, poured into tightly closed bottles, stored in the ground. To spray the trees, 0.5 liters of concentrate and 40 grams of soap per 10 liters of water are taken before the buds' gemmation. 10-15 days after the buds' gemmation, the trees are sprayed with the solution (100-120 grams of concentrate is dissolved in 10 liters of water).

Hellebore - 1 kilogram of raw crushed two 250 grams of dry plants, or 100 grams of roots are soaked in 10 liters of cold water for 3 hours. Then boil for 30 minutes, strain and pour.

Green soap (200-400 g) and antitline are also effective against aphids, sawflies, larvaes.

It should take into account that preparations derived from insecticidal plants, with few exceptions, are to some degree dangerous to humans and animals, therefore, when storing, crushing, preparing and using powders and decoctions, it is necessary to follow the same safety rules as when using pesticides. Plants should be treated with tinctures and decoctions no later than 15 days before harvest (raspberry burial can be sprayed only before flowering and after harvest).

The preparations made from plants are usually contact-based during actions (destroying pests when they come in contact with them directly). They quickly lose their toxicity to light and are not characterized by residual action. Plants should be collected in dry weather, during certain periods of vegetation. Diseased, blackened leaves and stems should not be used, the soil from the roots should be carefully cleaned. In the shade of plants, in covered areas, in a dryer or in a well-ventilated building, dry a thin layer stacked or hung. The faster plants dry, the more it will retain toxins harmful to organisms. Dried plants are stored in dry storage, in bags with the name of the plant. In order to obtain powdered preparations, spray the dried plants as finely as possible. It is better to do this shortly before use. During the evaporation of the tincture, water must be added to the initial level. The technology of collection, drying and storage of insecticidal plants should not be disrupted, as this will inevitably lead to a sharp reduction in the toxicity of the preparations.

If the use of Plant Pesticides did not have the expected effect and the number of pests remained high, it is necessary to use factory-made chemicals.

IV.IPM in India[5]
(Indian Experience)

In this book, we included the IPM systems, which used in India, because the pests and diseases are common for Georgia. So, for specialists working on this problem will be useful to know what IPM methods are used in India.

Sowing stage

Root-knot nematode. Cultural control:

- Intercropping of marigold reduces nematode population
- Nursery should be raised in nematode free sites or fumigated or solarized beds
- Repellant plants: Marigold
- Follow common cultural practices.
- Application of decomposed poultry manure 200g / sq. m

Leaf blight Anthracnose. Cultural control:

- Irrigation by rose can.
- Use of resistant varieties such as– Bangalore Blue, Beauty Seedless, Bharat Early, Golden queen, Large white.

Chemical control: For anthracnose

- Aureofungin or benomyl or Carbendazim or chlorothalonil or iprodione or kitazin or mancozeb.

Vegetative stage

Common cultural practices:

- Provide irrigation at critical stages of the crop. Avoid water stress and water stagnation conditions.
- Enhance parasitic activity by avoiding chemical spray, when larval parasitoids are observed

---

[5] **Source:** *NIPHM* and *Directorate of Plant Protection, Quarantine & Storage* https://vikaspedia.in/agriculture/crop-production/integrated-pest-managment/ipm-for-fruit-crops/ipm-strategies-for-grapes/grapes-crop-stage-wise-ipm

Common mechanical practices:
• Collection and destruction of eggs, and larvae
• Removal and destruction of dead vines along with root system from the garden is essential as this reduces the build up of inoculum (fungal population).
• Collect and destroy diseased and insect infected plant parts
• Use blue sticky traps for thrips 4-20 traps/acre.
• Install pheromone traps 4-5 traps/acre
• Use light trap 1/acre and operate between 6 pm and 10 pm
• Erecting of bird perches 20/acre for encouraging predatory birds such as King crow, common mynah etc.
• Set up bonfire during evening hours at 7-8 pm
Common biological practices:
• Conserve natural enemies through ecological engineering
• Augmentative release of natural enemies.
Leaf eating caterpillar. Cultural control:
• Growing of castor as trap crop all around the vineyard for oviposition.
• Follow common cultural and mechanical practices.
Biological control: • Spraying NSKE 5 % against eggs and first instar larva
• Follow common biological practices
Stem borer/cane borer. Cultural control:
• Piercing the infested plants with a sharp needle or knife to kill the caterpillar in the stem.
• Remove loose bark at the time of pruning to prevent egg laying
• Follow common cultural practices.
Biological control:
• Follow common biological practices.
Hoppers. Cultural Control:
• Plant tall border crops like maize, sorghum or pearl millet to reduce hopper infestations.
• Keep the nursery area clean, free of weeds and grasses to keep away the grass hoppers.
• Removal of weeds and alternate hosts plants like hibiscus, okra, custard apple, guava etc. in vineyards.
Biological control:
• Follow common biological practices.

Chemical control:

• Spray oxydemeton–methyl 25%

Mealybugs. Cultural control:

• Removal of weeds and alternate host plants like hibiscus, okra, custard apple, guava etc in and nearby vineyards throughout the year.

• Deep ploughing in summer or raking of soil in vineyards helps to destroy its nymphal stages and minimizing the incidence.

Mechanical control:

• Remove and destroy the loose bark.

Biological control:

• Release exotic predator, *Cryptolaemus montrouzieri* 10 beetles/vine

• Neem based, emulsifiable water soluble formulations can be sprayed. Doses depend on azadirachtin concentrations in formulations viz., 50000 ppm formulation is sprayed at 1ml / l, while that with 10000 ppm and 3000 ppm can be sprayed at 2.5 ml and 5 ml per l, respectively.

Chemical control:

• Buprofezin 25% or methomyl 40%

Flea beetle. Cultural control:

• Remove the loose bark at the time of pruning to prevent egg laying.

• Shake vines to dislodge adult beetles, collect into trays containing kerosenated water (1 kerosene: 9 water) and destroy them.

• Put bundles of dry shreds of banana on the pruned end of the vines in the evening. Beetles, which take shelter on these at night, can be shaken and collected in the morning and kill them.

• Use high quality, large, vigorous seed- the quicker a seedling can establish itself the more damage it can withstand from flea beetles.

• Seed early - a plant that establishes quickly can ward off flea beetles more effectively. Caution advised if high populations are seen early in fields when planting. Crops must be monitored daily upon emergence for damage.

• Crop rotation - flea beetles over-winter along field edges and migrate so following a crop rotation does not make your crop immune to flea beetles, but if problems with flea beetles persisted the year before,planting canola again will contribute to high populations once again.

• Direct seeding - provides a microclimate that warms slower than a conventionally seeded crop. Cooler temperatures slow flea beetle

activity, reducing damage.
• Increase seeding rates - increased plant populations means less damage to each specific plant.
• Wider row spacing - reduces the attractiveness to the flea beetles

Mechanical control:
• Follow common practices.
• Setting up of light trap 1/acre (6-10 pm).

Botanical control:
• Neem based, emulsifiable water soluble formulations can be sprayed. Doses depend on azadirachtin concentrations in formulations viz., 50000 ppm formulation is sprayed at 1ml / l, while that with 10000 ppm and 3000 ppm can be sprayed at 2.5 ml and 5 ml per liter dose, respectively.

Chemical control:
• Imidacloprid 17.8% or lambda-Cyhalothrin 4.9% or malathion 50%

Chafer beetle. Cultural control:
• Eliminate hibernating site
• Follow common practices.

Chemical control:
• Malathion

Girdle beetle/Grape cane girdler. Cultural control:
• Cutting of infested shoot bellow the lower girdle before adult emerge in the summer and destroy them may help to reduce the population of insects.
• If low levels of grape cane borer are present in your vineyard, populations can be reduced by cultural practices such as removal and destruction of affected canes and excess dead wood from the canopy during pruning.

Chemical control:
• Malathion

Thrips. Cultural control:
• Install 4-20blue sticky coloured traps per acre to monitor thrips population.
• Deep ploughing in summer or raking of soil in vineyards helps to destroy its nymphal stages and minimizing the incidence.
• Removal of weeds and alternate host plants like hibiscus, okra, custard apple, guava etc. in and nearby vineyards in and around the vineyards

throughout the year.
• Collect and destroy damaged leaves, fruits and flowers.

Chemical control:

• Emamectin benzoate or fipronil or lambda-cyhalothrin

Mite. Cultural control:

• Proper irrigation scheduling reduces the water stress and also increases the humidity thereby reducing the mite population

Biological control:

• Several predatory insects and spiders feed on mites but the most efficient natural predators of mite pests are predatory mites.

Leaf folder/Leaf roller. Cultural control:

• Simple method to control the pest population is to collect and burn the infested leaves.

Biological control:

• Follow common practices.

Diseases

Powdery mildew. Cultural control:

• Cultural practices that reduce humidity within the vineyard, enable good air circulation through the canopy, and provide good light exposure to all leaves and clusters aid in managing powdery mildew.
• Use an under vine irrigation system and manage it carefully, excess can favour the disease

Chemical control:

• Benomyl or carbendazim or dinocap or flusilazole or hexaconazole or hexaconazole or kresoxim-methyl or lime sulphur.

Downy mildew. Cultural control:

• Pruning of the vines after the second week of October helps to minimize the damage by this disease. All affected portions of the vine should be removed at the time of pruning and destroyed immediately.
• Downy mildew infected leaves should be selectively collected and disposed in compost pit.

Chemical control:

• Aureofungin or captan or chlorothalonil or copper oxychloride or copper oxy chloride or copper sulphate or cymoxanil or dimethomorph or fosetyl-AL or kresoxim-methyl or mancozeb or propineb or zineb or

ziram or cymoxani 18%+ Mancozeb or famoxadone16.6%+ Cymoxanil or fenamidone or fenamidone or metalaxyl M or metalaxy or metiram + pyraclostrobin

Anthracnose, Blight. Cultural control:

• Prophylactic measures should be followed for effective control.

• All affected twigs or canes showing cankers should be removed while pruning.

• The pruned twigs and leaves should be burnt or buried deep in the soil.

Chemical control:

• Same as sowing stage.

Bitter rot and bacterial leaf spot, Rust. Cultural control:

• Collecting and burning the infected plant parts minimizes the spread of the disease.

• Increase air circulation in the vineyard

• Remove disease cane from the vineyard during normal pruning operations in the dormant season.

• Follow up hand pruning

Flowering and Fruiting stage. Leaf eating caterpillars, Stem borer/Cane borer, Hoppers, Mealybugs, Flea beetle, Girdle beetle/Grape cane girdler, Thrips, Leaf roller/Folder - Same as vegetative stage.

Powdery mildew, Downy mildew. Cultural control:

• Remove abnormal un-harvested bunches from vines and burn them.

• Remove all shoots emerging from the crown near ground.

• Shoots hanging from trellises towards ground should be tied on trellises or can be removed if they are extra.

Chemical control:

• Same as vegetative stage

Blight, Anthracnose, Bitter rot and Bacterial leaf spot. Cultural control:

• Promote good air circulation and light penetration by controlling weeds and suckers, proper pruning, and positioning or removing shoots for uniform leaf development.

• Where possible, rows should be planted in the direction of the prevailing wind. Good air circulation and light penetration will promote faster drying of plant parts and reduce disease incidence.

• Prevent wounding of berries by controlling insects, birds and other grape diseases.

Botrytis rot. Cultural control:

• Careful handling in the field, pre-cooling and refrigeration helps in controlling the disease.

• Pruning and thinning of the vineyard reduces • Humidity around the clusters.

Blue rot. Cultural control:

• Avoiding injuries to the ripe berries helps to reduce soft rot.

• Clean planting stock; (i) Disease wood removal and immediate burning; (ii) fungicide application at shoot extension and later if temperatures are cool.

Birds. Bats. Cultural:

• Remove nesting and roosting areas

• **Bird patrols:** takes time and energy but still effective, wear bright colors

• **Pyrotechnics** – bombs and whistlers

• **Whistles:** Thunderer is the Cadillac of whistles

• **Site selection:** no trees, open fields

• **Noise makers:** propane canons, electronic scare devices

• **Nets:** still the best option for full protection

• **Traps**

• Tape, balloons, kites, etc.

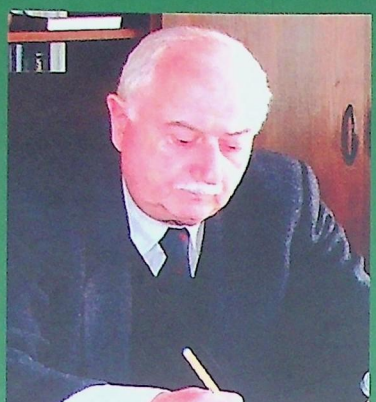
• Trap crops

SELECTED REFERENCES:

1. Aleksidze G., Beruashvili M., Goginashvili N.. 2022. Plant Pests in Agriculture and Forestry. Fourlingual Nomenclature Dictionary. Tbilisi, 219 p. ISBN 978-9941-33-213-5;
2. Aleksidze G., Japaridze G., Kavtaradze G., Barjadze Sh.. 2021. Invasive Alien Species: Observation and Issues from Around the World. V. 3. Issues and Invasions in Europe. Invasive Alien Species of Georgia. Publisher John Wiley & Sons LTD. pp. 88-123. ISBN 9781119607045 DOI: 10.1002/9781119607045;
3. Aleksidze G., Japaridze G., Giorgadze A., Kacharava T. 2018. Biodiversity of Georgia. Global Biodiversity, Selected Countries in Europe. Volume 2. Apple Academic Press. pp. 33-70. ISBN 978-77188-717-5, ISBN 978-0-42948-775-0;
4. Aleksidze G.. 2016. Plant Protection. Second edition. European Union, MercyCrops, CENN. Tbilisi, 311 p.;
5. Aleksidze G. et al. 2015. Agrobiodiversity of Georgia (Catalog). Publisher: Georgian Academy of Agricultural Sciences. Tbilisi, 235 p. ISBN 978-9941-0-8245-0;
6. Aleksidze G. 2013. Man and Insects. Publisher "Iverioni", Tbilisi, 152 p. ISBN 978-9941-9336-2-2;
7. Aleksidze G. et al. 2009. Grape Protection from Harmful Organisms. Publishing house "Lega", Tbilisi, 115 p. ISBN 978-9941-9074-3-2;
8. Aleksidze G., Kuparashvili O. 1992. The Vinear Agronomomy's Guide in Plant Protection. Publishing House "Georgia". Tbilisi;
9. Aleksidze G., Kuparashvili O. 2001. Plant Pests and Diseases. Publishing House "Saqartvelo", Georgian Academy of Agricultural Sciences, Tbilisi;
10. Aleksidze N., Aleksidze G. 1976. Grape Pests. Publisher "Sabchota Saqartvelo", Tbilisi, 94 p.
11. Aleksidze N. 1962. Entomology, II part (grape pests). Publishing house "Georgian Agriculture Institute", Tbilisi;
12. Buachidze K. 1997. Herbal Pesticides. Pub. "Ganatleba", Tbilisi.
13. Chkhartishvili N., Aleksidze G. and et al. 2016. Viticulture – Technology. Publi. "Sachino", Tbilisi;

14. Chubinishvili Ts. 1979, Tetrapodil mites of grapes and continental fruit trees and modern measures against them. Publishing House "Ganatleba", Tbilisi;
15. Chubinishvili Ts. 1978. Study of the Grape bud worms eunology and some questions of ecology. Scientific works of the Institute of Horticulture, Viticulture and winemaking of Georgia. Vol. XXV, Tbilisi;
16. Dekanoidze G. 1982. Harmful mites of agricultural crops and modern measues against them. Publishing House "Agricultural Institute". Tbilisi;
17. Dolidze G. 1998. Recommendations against grape pests and diseases. Tbilisi;
18. Gegenava Gr. 1991. Biotechnology in Plant Protection. Tbilisi;
19. Gegenava Gr. 1993. Integtrated Plant Protection. Publ. Agricultural University, Tbilisi;
20. Kipiani A., Machavariani E. 1988. Pheromones and Environment Protection. Publishing House "Ganatleba", Tbilisi;
21. Kuparashvili O. 1976. Measures against grape diseases. Tbilisi.
22. Kanchaveli L. 1987. Agricultural Phytopathology. Pub. "Ganatleba", Tbilisi;
23. Ketskhoveli N. Vegetation of Georgia, Publishing House of the Georgian Academy of Sciences, Tbilisi, 1959;
24. Natsarashvili A. 1972. Grape diseases and measures against them. Publishing house "Sabchota Sakartvelo", Tbilisi;
25. Lanek J., Shimko K., G. Vanek. 1972. Nature. Pub. Bratislava;
26. Metcalf C.L. Frint W.P. 1962. Destructive and useful insects. New York. MeGRaw-Hill Book Company;
27. Crape pest management, 1992. University of California, USA;
28. Sabashvili M. 1965. Georgian Soils. Publishing House "Metsniereba", Tbilisi;
29. Schruft G., Kassemeyer H.H. 2008. Plant Protection in Viticulture. BASF. The Chemical Company. www.agro.basf.ru;
30. Schruft G., Kassemeyer H.H. Plant Protection;
31. Tofoleti S. L., Magradze D. et al. 2018. Unique resistant traits against downy mildew from center of origin of grapevine (vitis vinifera). Scientific reports, Milan, Italy;

32. Quaglino F., Magradze D. et al. 2016. Identification and Characterization of New "Candidates Phytoplasma Soleni" Strains Classical with Bois Noir Disease in Vitis vinifera L. Cultivars showing a range of symptom Severity in Georgia, the Caucasus Region". Pub. The American Phytopatological Society, vol 100 N5 Washington. USA;
33. Urushadze T., Aleksidze G., Tkhelidze A., Baqradze E. 2021. Vineyard and Environment. Free and Agricultural Universities Press. Tbilisi, 191 p. ISBN 978-9941-8-1870-7;
34. Vasiliev V. 1973. Pests of crops and forest plantations. Publishing house "Urozhai", Kyiv;
35. Encyclopedia of Viticulture. 1986. Moscow.



Guram Aleksidze

Was born in 1939, in Telavi (Georgia) i family of a well-known scientist, one o founders of grapevine protection, Prof Niko Aleksidze.

In 1957, G. Aleksidze finished Tbilisi p school, and continued higher educatio Georgian Agricultural Institute, Facult Agronomy. In 1962 he successfully gradu and in the same year, enrolled in postgra studies in the field of plant protection Research Institute of Horticulture, Viticu and Winemaking.

In 1966, he defended his dissertation earned a scientific degree "Candidat Agricultural Sciences"; later, in 1976, he defended a Doctoral Dissertation and awarded a scientific degree - Doctor of Biology.

In 1989, Higher Attestation Commission of the USSR, Dr. Guram Aleksidze awar title of a Professor; In 1992, he was elected a Member of Georgian Acaden Agricultural Sciences and in 2018, Academician of Georgian National Academy.

Guram Aleksidze was working at Scientific Research Institute of Horticu Viticulture and Winemaking for thirteen years until he moved to the Scientific Res Institute of Plant Protection to direct a research laboratory, soon after, in 1974, h appointed a Deputy Director in the field of Science at the same Institute. From 19 2004, G. Aleksidze was a Chief Academician- Secretary of Georgian Acaden Agricultural Sciences; since 2004, he occupies a position of Vice President and since he is the President of Georgian Academy of Agricultural Scinces.

In 1983-1987, G. Aleksidze was working in the United States of America, Washin D.C. at the Embassy of the USSR as a representative of Ministry of Agricultur received an Official Thanks Letter from the Ambassador a few times for his succe work.

Prof. Aleksidze, a very resourceful scholar, he has almost 280 scientific publica out of which 80 are published in international Scientific journals. More than 20 doct dissertations have been defended under his supervision.

Academician G.Aleksidze, a public figure, is involved in a wide range of socia international activities. Since 2015, he is the Head of the *Scientific Association of Ce Asia and Caucasus Countries,* and the President of "*Union of European Academi Science Applied to Agriculture, Food and Nature*" (2020-2022). He was awarde