**Downy Mildew of Grape:**

 This is one of the best known of the many diseases of plants of economic impor­tance. It has an interesting historical background associated with the accidental discovery of Bordeaux mixture as a fungicide by the French plant pathologist, Millardet who perfected the Bordeaux mixture as a spray for this disease.

The best information available indicates that the downy mildew of grape is endemic in North America, where it was for the first time reported by Schweinitz in 1837. This disease was introduced in France in 1874 and subsequently in other parts of Europe by 1917, where it became a serious disease because of frequent epiphytotics. It is also well established in North and South Africa, Australia and New Zealand.

The disease is confined largely to species and varieties of grapes (Vitis) although it has been reported also on the five-leaved ivy (Parthertocissus quinquefolia Planch.), and on English ivy (P. tricuspidata Planch).

####  Symptoms of Downy Mildew of Grape:

The disease attacks all green parts of the plant leaf blades, petioles, tendrils, green shoots, and fruits at different stages of development.

Early symptoms of the disease on the leaves consist of round light-green spots of an oily appearance on the upper surface, which enlarge even 1 /2 cm or more in diameter. On the corresponding under side white downy mildew consisting of the tufts of sporangiophores soon appear, bearing sporangia in great numbers (Fig. 361B).

Early symptoms of the disease on the leaves consist of round light-green spots of an oily appearance on the upper surface, which enlarge even 1 /2 cm or more in diameter. On the corresponding under side white downy mildew consisting of the tufts of sporangiophores soon appear, bearing sporangia in great numbers (Fig. 361B).



In moist weather it persists; in extremely dry weather it may disappear. Later the spots become yellow, or variegated with tints of yellow and yellowish-brown forming patches of irregular shape, especially between the larger veins of the leaf (Fig. 361 A). Old spots turn brown owing to the killing of the leaf tissue.

The leaf spots may be few in number or so numerous as to, coalesce and involve nearly the entire leaf area. At this time the leaves are in a morbid condition, and the fungus within enters upon the sexual phase, producing oogonia, anteridia, and finally oospores which survive the winter in the fallen leaves.

On the stems, the lesions are brown and sunken, and along with the death of the affected parts, portions of the wine become brittle and break off easily. In extreme cases of infection the whole shoot may be dwarfed, the leaves remaining very small and densely covered with the mildew.

Flowers may be completely blighted by early attacks of the disease. Fruits may be attacked when young or when approaching maturity. The young fruits show brow­nish spots and later become covered with downy mildew, their growth is checked. The young fruits then darken and finally dry up.

They may also assume a reddish- brown colour and failing to ripen, develop a soft root. On full-grown fruits, brownish patches appear and the fruits harden ultimately becoming mummified.

The disease may often strip plants of their leaves and tendrils, flowers may fail to set, fruit may be destroyed in the early stages of growth, causing severe loss.

**Causal Organism of Downy Mildew of Grape:**

In moist weather it persists; in extremely dry weather it may disappear. Later the spots become yellow, or variegated with tints of yellow and yellowish-brown forming patches of irregular shape, especially between the larger veins of the leaf (Fig. 361 A). Old spots turn brown owing to the killing of the leaf tissue.

The leaf spots may be few in number or so numerous as to, coalesce and involve nearly the entire leaf area. At this time the leaves are in a morbid condition, and the fungus within enters upon the sexual phase, producing oogonia, antheridia, and finally oospores which survive the winter in the fallen leaves.

On the stems, the lesions are brown and sunken, and along with the death of the affected parts, portions of the wine become brittle and break off easily. In extreme cases of infection the whole shoot may be dwarfed, the leaves remaining very small and densely covered with the mildew.

Flowers may be completely blighted by early attacks of the disease. Fruits may be attacked when young or when approaching maturity. The young fruits show brow­nish spots and later become covered with downy mildew, their growth is checked. The young fruits then darken and finally dry up.

They may also assume a reddish- brown colour and failing to ripen, develop a soft root. On full-grown fruits, brownish patches appear and the fruits harden ultimately becoming mummified.

The disease may often strip plants of their leaves and tendrils, flowers may fail to set, fruit may be destroyed in the early stages of growth, causing severe loss.

Plasmopara viticola (Berk, and Curt.) Berl. The charac­teristic aseptate, intercellular mycelium produces knob-like haustoria to absorb food from the host cells. Fasciculate- sporangiophores arise from the hyphae in the inter­cellular spaces just beneath the lower epidermis and emerge through the stomata.

They are branched monopodially along the main trunk and dichotomously at the extremities. The branches in turn give off other branches more or less at right angles so that the system of branches shows many small branches with arms projecting out in cross-like fashion.

The tips of the branches are provided with short finger-like pro­jections on which the sporangia are borne. The sporangia are hyaline, ovate, and attached to the sporangiophore branches at the small end, in which the wall is thin­nest. The profuse growth of sporangiophores and sporangia on the surface of the host accounts for the downy appearance which characterizes the downy mildew.

The sporangia germinate by secondary zoospores which after an active period shed their flagella and each one produces a. germ tube from which aseptate mycelium is deve­loped.

The oospores are produced from the mycelium embedded within the leaf tissue. The oospore consists of a thick endospore wall surrounded by a thinner rough expo­sure wall. On germination, an oospore sends up a short un-branched stalk, at the apex of which a single sporangium is produced. The sporangium so formed germinates by zoospores exactly in the same manner as the sporangia borne on the sporangiophores.

**Disease Cycle of Downy Mildew of Grape:**

In general, the sporangia are not adopted for long survival but serve to spread the disease in localities where the leaves may remain on the vines all the year round. In such cases infection by sporangia may be continuous from season to season. On the other hand, the oospores are capable of survival in the soil for at least a year.

Oospores which remain in the fallen leaves, vine debris, or shri­velled fruits on the ground are probably responsible for the primary infections which break out in the spring. Moreover the fungus may, in some localities, survive in the form of mycelium perennating in the winter buds.

The oospores germinate at a temperature range of 13°C to 33 °C. Primary in­fections are believed to occur when the zoospores formed during oospore germina­tion, are conveyed by splashing raindrops from the soils on to the lowermost leaves of the vines.

It may so happen that the sporangia produced during oospore germina­tion may themselves be carried on the leaves near the ground and then zoospores are produced there. In any case, the earliest symptoms usually appear on the leaves near the ground.

Host petetration of the pathogen takes place through the stomata. The myce­lium invades the intercellular spaces, ramifies in the host tissue deriving its nutrients in a large measure through haustoria which penetrate the cell lumen. In almost all cases, infection of the leaves takes place through the lower surface.

The optimum temperature for the development of the disease is 18°C to 24°C. Prolonged warm wet weather is conducive to an epidemic of the disease.

Dry weather, however, checks the growth of the fungus. After the mycelium has established itself in the host tissue, sporangiophores are sent to the host surface through the stomata (Fig. 361B). Sporan­gia produced on the sporangiophores serve for rapid dissemination of the disease.

They also serve as the source of secondary inocula of the disease. Through the secon­dary inocula, secondary infections are induced resulting in secondary cycles .The sporangia are transported from host to host and to different parts of the host by both wind and rain.

Disease cycle of Downy mildew of grape is very similar to that of Downy mil­dew of pea, except that the sporangia germinate by secondary zoospores.

**Control of Downy Mildew of Grape:**

**The chief methods of control of the disease are as follows:**

**(i) Sanitation:** Destruction of old leaves is recommended to eradicate the source of inoculum since the causal organism of the disease usually hibernates as oospores in the fallen leaves.

**(ii) Spraying of Bordeaux Mixture:** Bordeaux mixture, 5-5-50 strength is usually recommended as a protective spray to the susceptible parts; but even up to 8-8-50 is often recommended for epiphytotic conditions. Sporangia or zoospores absorb copper until a toxic limit is reached, the more epiphytotic the disease, the stronger must be the spray to be effective.

But emphasis is laid on the value of timely and early spraying, and of the thinning of the foliage during the growing season in order to gain better access for sprays, and the removal of the shoot tips in order to increase resistance in the remaining parts.

The first application of spray should be made soon after the buds open, a second before the flowers open, a third after the fall of the petals, and a final application should be given 14 days later. The time of application, however, varies with prevailing environment and the relative suscep­tibility of the host concerned.

**(iii) Spraying of Other Fungicides:** The spread of the disease can be effec­tively controlled by spraying the vines with 0.3 per cent. Blitox-50, Dithane Z-78, Ferbam or Captan first when the shoots are 6 to 8 inches high, again when they are about to flower, and finally when the fruits are just about to change their colour.

Depending on the local weather conditions and the nature of virulence of the disease number of spray applications may be increased to 6 to 8 times.

**(iv) Improved Cultivation Practices:** Certain improved methods of culti­vation are helpful to control the disease incidence. Vineyards should be sufficiently open to allow the foliage to dry quickly after rains. This method not only ensures free access of air but facilitates spraying as well. The risk of infection from resting oospores is reduced.

All green shoots or suckers that develop at the base of the stocks should be removed, as they are very susceptible to primary infections.

**(v) Use of Resistant Varieties:** The use of resistant varieties is of course a very useful practice. But even with resistant vines, spraying with Bordeaux mixture is advisable.