V1.0 – 10/01/2022

Apple scab

Biofix

The apple scab fungus overwinters in fallen leaves. Late winter development of the fungus is insufficiently understood to allow the date of first mature ascospores to be calculated. Therefore RIMpro uses the first observed ejectable ascospores as BIOFIX to start the simulations. Ways to establish the BIOFIX in order of preference:

1.First ejection under lab conditions from freshly collected leafs.

2.First spores observed in spore traps under field conditions. (tendency: too late)

3.First (=10%) morphologically mature spores under microscope. (tendency: too early)

4.First (=10%) green tip on main apple variety. Based on co-evolution of apple scab and apple tree.

Set the BIOFIX to the date of first ascospores discharge, or Green Tip, WHATEVER COMES FIRST.

You have to provide a BIOFIX date for each of your stations individually in the 'Local parameters' menu. The biofix dates you set are saved, and used when you simulate a previous year.

On the date you enter as BIOFIX the model assumes that 0.1% of the spore population is mature and ready for ejection.

Maturation of ascospores

The progress of the maturation of the ascospores in the leaf litter depends on the temperature and the water content of the leaf litter. At the same time, the leaf litter decreases due to the work of earthworms and micro-organisms. The remaining ascospore potential decreases with the decreasing amount of leaf litter.

Starting at BIOFIX date, the maturation of the spore population is simulated using a non-linear temperature function, with a maximum rate at 20 °C. The maturation rate is reduced when the leaf litter dries.

By default, a dehydration model is used to simulate the effect of leaflitter drying on the maturation rate.

Discharge of ascospores

Apple Scab ascospore ejection is diurnal: most spores are ejected between start of twilight in the morning, and end of twilight in the evening. The fraction of spores that can be ejected during the night slightly increases towards the end of the ascospore season.

For accurate calculation of the light conditions, the setup information for your station in RIMpro should be correct. (geographical location, time zone, use of daylight savings). The time indication in the weather data files should be the local time.

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Any measurable amount of rain can trigger ascospore ejection. Most spores are ejected during rain hours, but ejection can continue for some time after rain has ended.

At lower temperatures ascospore ejection is delayed.

Observations show that fairly no ascospores are ejected during hours where the relative humidity is below 50%. By default, in the model spore ejection is stopped when relative humidity falls below 50%.

Germination of ascospore and conidia

The germination speed of ascospores and conidia is depending on temperature. In RIMpro the germination rate is calculated using the “Rivised Mills infection curve” (Mac Hardy 1988), further improved for the lower temperature range by Stensvand (1997).

These ‘infection curves’ are only dealing with infection by the very first spores in the population. The severity of the infection is determined by the number of spores that get the chance to infect the plant after this moment.

Survival of germinating spores during dry intervals

When the leaves dry, the infection process of the spores on the leaves is interrupted. Some spores can survive more than 24 hours, but the longer the dry period lasts, and the more solar radiation the spore population receives, the less spores survive. When the leaves are rewetted, only the still surviving spores can continue their development.

During the dry interval, the ontogenetic resistance of the leaves on which the spores germinate increases what further contributes to the reduction of the infection severity resulting from an interrupted infection event.

Spore mortality is simulated based on duration of the dehydration, and incoming solar energy during the dry period, estimated from date, time and geographical position.

Stroma formation

In the first 200 to 300 Degree Hours after infection the primary stroma is formed. During this stage the mycelium is still vulnerable and the infection can be stopped by weak systemic chemistry like limesulfur and potassium bicarbonate. This stage is shown in the RIMpro graphs for primary scab infections.

Appearance of spots

The model of shoot growth and leaf development in apple is based on detailed observations of the development of flower clusters and rosette leaves and vegetative shoots of the Jonagold variety in the Netherlands in 1991, 1994 and 1995.

The development of the leaves depends on the type of leaf and its position. Development correlates well with the degree days accumulated above 4°C.

Seven to fourteen days after an infection event, the first scab spots become visible. But it may take another 10-14 days before all the lesions caused by a single infection are visible. The incubation time of infections on older leaves and fruits is longer than on young leaves. The duration of this latent phase depends on the temperature. The average incubation time and the default standard deviation

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for the incubation process in RIMpro are derived from the field work of Soenen (1956), and were confirmed by the observations of the members of the European Apple Scab Working Group.

Secondary infections on leaves and fruits

The increase of the disease by secondary infections is depending on disease level caused by earlier (primary) infections, the susceptibility of the apple variety, and the level and duration of the vegetative growth in the orchard.

These very local conditions do not allow to quantify the severity of the secondary infections. For secondary infections RIMpro can only show the favorability of the weather conditions for infection. When conditions are favorable for infection, spore potential, growth level and susceptibility of the variety determine the actual severity of the infection event.

Conidiospores are splash-distributed from sporulating scab spots to leaves and fruits.

The infection progress of conidiospores on young leafs is temperature dependent and is calculated using a relation that is fitted to the 'Mills/c infection curve' as revised by MacHardy (1988) and improved for the lower temperature range by Stensvand (1997).

Young apple and pear fruits are very susceptible to infections by the scab fungus, but their susceptibility declines as fruits mature. From bloom till harvest at equal temperature a steadily increasing wetness time is necessary to create an infection event.

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