Agriculture and Agri-Food Canada
Research Branch
Agriculture et Agroalimentaire Canada
Direction générale de la recherche

Horticultural R & D Centre
Saint-Jean-sur-Richelieu
Horticulture

STRAWBERRY LEAF SPOT
Control strategies

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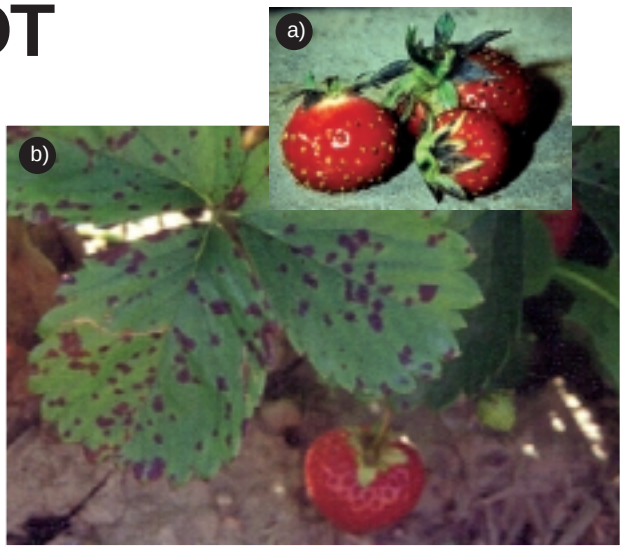

Figure 1: *Mycosphaerella fragariae*, pathogen of strawberry leaf spot a) on sepals, b) on leaves

You don't have to look at too many strawberry fields to realize that there have been renewed outbreaks of leaf spot in recent years. The problem is that producers have gradually dropped resistant cultivars in favour of those offering other agronomic advantages, such as yield, colour and taste.

Fields infested by leaf spot are unattractive and put off many pickers. It is important to bear in mind, however, that this disease is purely cosmetic. It is a secondary disease, attacking the fruit only during particularly severe epidemics. Gray mold rot, on the other hand, attacks primarily the fruit, which can result in substantial losses. Leaf spot is probably over-treated.

Nursery growers, ever concerned about providing plants that are completely free of blemishes, have zero tolerance for leaf spot and may apply up to a dozen or so fungicide treatments per season. Some producers may also overtreat against leaf spot. In both cases, however, if we understand how this disease works, it is possible to substantially reduce the number of fungicide applications. This results in reduced economic and environmental costs, without compromising the quality of production.

THE DISEASE

Strawberry leaf spot is caused by an ascomycete fungus, *Mycosphaerella fragariae* (Tul.) Lindau (asexual state *Ramularia tulasnei* Sacc.). The disease is now found in several strawberry cultivars. The first symptoms of the disease are small lesions on the surface of young leaflets. The lesions enlarge, forming more or less circular spots, measuring 3 to 6 mm in diameter. As the spots enlarge, the centers turn gray to white and are surrounded by reddish borders, hence the name *bird's eye spot* (see fig. 1). The lighter centre distinguishes leaf spot from leaf scorch, which is caused by *Diplocarpon earliana*, and which appears as small dark-purple spots. When weather conditions are favourable, the spots multiply and coalesce, causing the entire leaf to dry up and die. All aerial parts of the plant, particularly sepals, can eventually be attacked and black spots can appear on the achenes of the fruit when the disease reaches epidemic levels (Dale and Fulton, 1957).

Mycosphaerella fragariae overwinters in lesions in old leaves and produces its first spores in about mid-May. The spores fall on other leaves and germinate when it rains. After an incubation period ranging from 15 to 30 days, new spots appear and produce new spores that infect other young leaflets. This cycle can be repeated several times during a single growing season (see fig. 2).

Recent studies conducted at Agriculture and Agri-Food Canada's Horticultural Research and Development Centre (HRDC) in Saint-Jean-sur-Richelieu in collaboration with Laval University, in Sainte-Foy, have shown that sporulation begins as soon as the average temperature reaches 5°C, but that infections actually begin at 10°C. The fungus reaches optimum growth between 20 and 25°C and is barely viable at 30°C.

Strawberry leaf spot is spread by water. During rainfall events or spray irrigation, the water droplets that make contact with the leaves tear spores away from the lesions and project them onto new leaves. Unlike several other species of fungi, the spores are not transported by the wind, limiting their propagation. Heavy, frequent downpours can, however, result in epidemic outbreaks of the disease.

The spores germinate, then enter the leaf tissue through stomata located almost exclusively on the lower leaf surface.

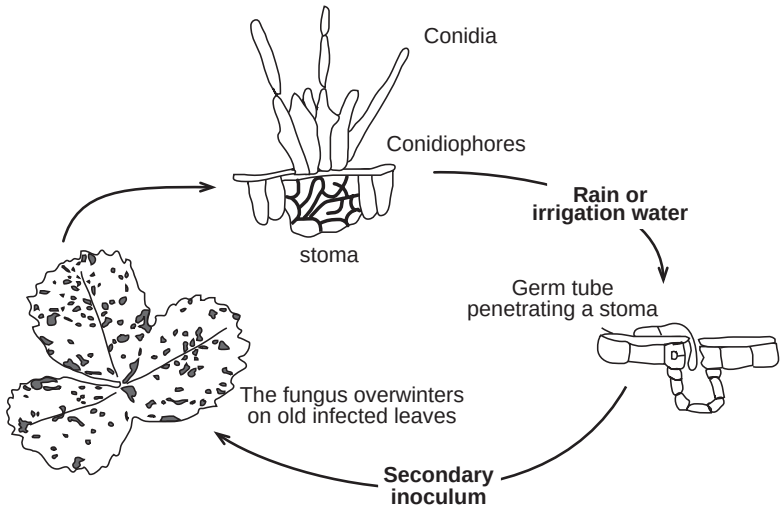

Figure 2: Life cycle of *M. fragariae*. Its survival in structures resistant to cold, such as sclerotia and perithecia, is hypothetical in Quebec, to say the least.

Young open leaves and those in the process of opening are particularly susceptible to attack by *M. fragariae* because, among other reasons, they form small recipients that retain water, thereby allowing the spore to germinate and penetrate the leaf surfaces. Sensitivity to the disease is not, however, a function of the age of the plant. It is important to bear this in mind during renovation.

PROBLEMS CAUSED BY LEAF SPOT

Leaf spot attacks the fruit only during very severe epidemics, in warm, wet weather, which promotes the development of the disease. As a result, producers have considerable leeway with respect to the control of the disease (high economic threshold), unlike in the case of gray mold rot, red stele or several insect pests.

Marketing and appearance
The problems caused by leaf spot are largely cosmetic. Some "pick-your-own" enthusiasts are not particularly interested in picking fruit from an infected field, and some consumers turn up their noses at fruit whose appearance is marred by spotted, dried-out sepals.

Reductions in photosynthesis and yield
Leaf spot likely has an adverse effect on photosynthesis owing to the presence of foliar lesions. However, such an effect has never been reported or quantified in scientific studies. It is known (Kerkhoff *et al.*, 1988) that reduced photosynthetic leaf area of strawberry plants in the fall can affect the following spring's yield. Thus, in theory, the loss of photosynthetic leaf area caused by leaf spot could cause a decrease in yield the following year. Recent studies conducted by the HRDC suggest that yield losses the following year are minimal, even non-existent. With respect to first year strawberries, no significant decline in yield is observed, even in fields with an artificially high infestation level.

SOLUTIONS

Prevention
There are a number of justifications for more rational use of fungicides, including their high price, the resistance of fungal pathogens to fungicides and the environmental concerns of consumers. In order to reduce fungicide applications while still ensuring that strawberry fields remain free of disease, it would certainly be advisable to reverse the trend of recent years and to return to tolerant or resistant cultivars. New varieties adapted to Quebec have recently been developed and, in addition, offer other very interesting characteristics, such as Chambly, Oka and Joliette, which have quite respectable yields.

According to the experts, it is advisable to purchase certified plants and to ask the nursery grower about the presence of the disease in his fields. As is the case for most diseases, reducing the initial inoculum by using plants that are free of disease can sometimes substantially delay the development of infestations.

Moreover, considering the way leaf spot is spread, there is every reason to believe that drip irrigation may limit the spread of the disease (Corbaz, 1990).

For producers who are open to innovative approaches, effective alternative control techniques have already been proposed. The treatment of strawberry plants with a 1% bleach solution could destroy the fungus. Good results have also been obtained by dipping the plants in water at 52°C for 3 minutes (Paulus, 1990). Finally, destroying weeds and removing old infected foliage from strawberry fields during renovation reduces the amount of inoculum in the fields and may be an effective control measure.

Management
Scouting for the disease
Despite all precautions, it is impossible never to have problems with leaf spot. The provisional scouting method for leaf spot approved by the Réseau d'avertissements phytosanitaires (RAP) consists in observing 100 leaflets at random (one leaflet per plant) twice—once at the end of September of the planting year and again during flowering in the first growing season. In the spring, treatment is not recommended if less than 25% of the old leaves have symptoms the previous fall, and, during the growing season, if less than 10% of the new leaflets are infected at flowering.

Umbrella effect
If the scouting results indicate that control measures are required, preventive measures should be taken. The threshold limit value for leaf spot is higher than that for gray mold rot, which attacks the fruit directly. However, recent Quebec studies reveal that owing to the method of infection of *M. fragariae*, the best strategy is to obtain the "umbrella effect" (see fig. 3).

The "umbrella" strategy is based on the fact that only young strawberry leaflets are susceptible to the disease. It is important, therefore, to protect the young foliage through fungicide applications during the rapid growth period of strawberries. The foliage must then be protected until the plant has formed a few leaves and these leaves have passed the stage at which they are susceptible to the disease. The leaves at the very top of the plant, which are free of disease, protect the new leaves, hence the name "umbrella". This prevents spores from infected leaves from contaminating the smaller leaves located below by dripping rainwater. When the crop is mowed, the same approach must be taken, i.e., to treat until the umbrella effect is obtained (see fig. 4).

Figure 3: The "umbrella" effect consists in protecting the young leaflets using a fungicide until they are no longer susceptible to the disease, i.e., approximately 15 days. These leaves will, in turn, protect susceptible new leaflets.

Preventive treatment
M. fragariae requires water to produce infection. When treatment is necessary, it is highly recommended that preventive treatment be carried out when weather forecasts call for rain within 24 hours.

Informing customers
If producers opt for fewer fungicide applications and are prepared to tolerate more leaf spot, good contacts with the «pick-your-own» operations will make it possible to inform them of the low fungicide applications. This can be advantageous particularly during summers when the weather is unfavourable to the development of other strawberry diseases.

Overview of fungicide treatments
When the economic treatment threshold is reached and the weather forecast calls for rain, special attention should be focused on which fungicides to use and the method of application.

Use the right product
As always, don't hesitate to vary the fungicides used to prevent or promote the development of resistance. Bear in mind that too many applications of any pesticide can lead to the development of resistance.

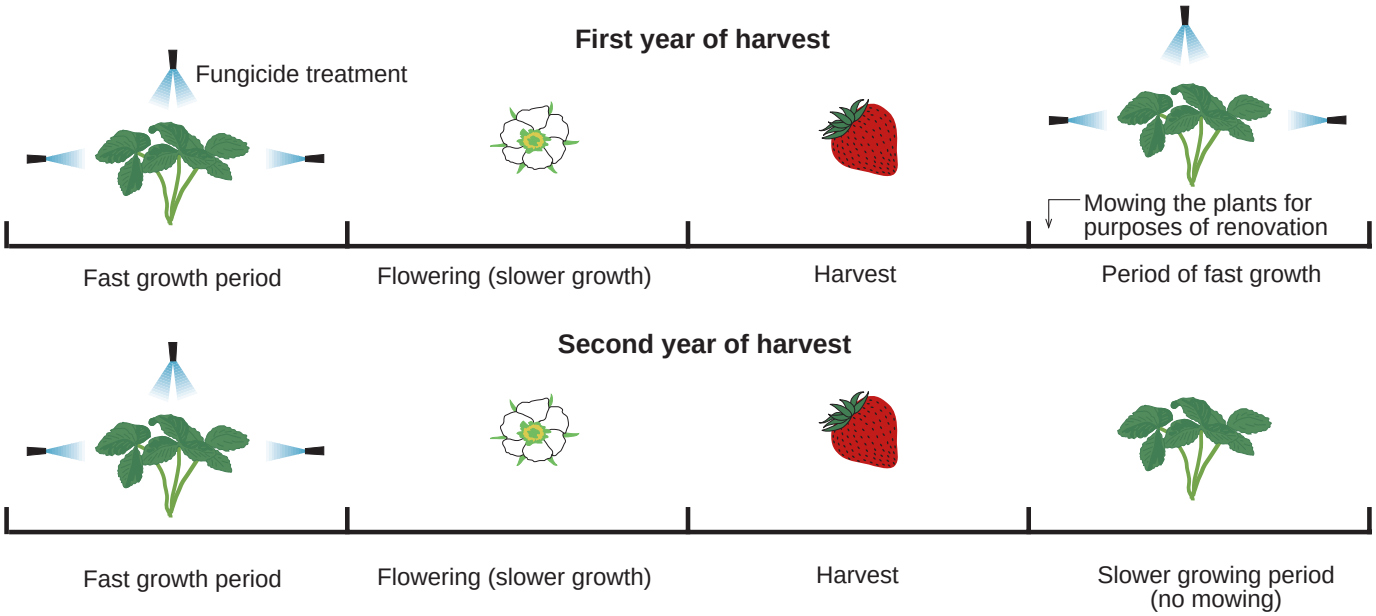

Figure 4: Recommended control strategy against strawberry leaf spot. The *Conseil des productions végétales du Québec* (CPVQ) recommends a spring treatment if over 25% of the leaves the previous fall had spots. During the growing season, a treatment is recommended if 10% of the new leaves were affected during flowering.

Captan, folpet, dodine and copper are a few of the fungicides recommended by RAP. It is recommended that copper be applied (in the form of tribasic copper sulfate) during the year of harvest. It is important not to abuse this metal since it accumulates in the soil and could reach toxic concentrations.

Apply the product in the right spot
Because the spores of *M. fragariae* penetrate the leaf surface primarily through the lower leaf surface and because fungicides and insecticides are traditionally applied on the upper leaf surface, it is common to incur losses in effectiveness of 50%. Conformation of strawberry plants requires spraying from both above and below to obtain good coverage on both the upper and lower leaf surfaces. Good results can be obtained using directed application or pneumatic spraying.

SUMMARY

To effectively control strawberry leaf spot with minimal use of fungicides, it is important to:

- select less susceptible cultivars, as was the practice several years ago; there are several new interesting varieties worth watching, including Chambly, Oka and Joliette;
- use certified plants from fields that are free of disease and determine whether they should be treated before planting;
- scout fields and wait until the economic threshold is reached before spraying;
- when you have decided to treat, apply preventive treatment, i.e., 24 hours before rain;
- protect the young leaves during rapid growth of the strawberries, i.e. at the start of growth and at regeneration;
- try to obtain the umbrella effect, i.e. keep the foliage protected until the plant has formed a few leaves and until these leaves reach the stage at which they are no longer susceptible to the disease (over 15 days);
- choose the right product;
- spray properly, i.e., both the upper and lower leaf surfaces.

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ACKNOWLEDGEMENTS
We thank Pierre Thibodeau, agronomist and phytopathologist, Quebec Department of Agriculture, Fisheries and Food, Sainte-Foy, and Patrice Thibault, agronomist, Réseau de lutte intégrée Orléans inc.

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