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Emergence of apple scab in orchards of Himachal Pradesh

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Due to the onslaught of monsoon, there is an excess of moisture in the air due to which an outbreak of diseases in plants is witnessed. The problem of scab in apple, which was considered to be almost diminished, was also seen in some areas of Himachal Pradesh last year. This year, incidents of scab disease have been reported from some districts of Kullu, Mandi and Shimla. An advisory to farmers has been issued for the effective management of apple scab.

What is Apple Scab

Apple scab is caused by the fungus, *Venturia inaequalis*. The fungus overwinters mainly in the infected fallen leaves on the orchard floor through the formation of pseudothecia, which produce ascospores in the spring. After deposition on leaf or fruit surface, the ascospores germinate in a film of moisture. The minimum wet period needed for infection is 9 hrs at 17 ^{0}C. Once the infection has occurred, the fungus produces conidiophores and conidia. Sporulating lesions become visible approximately 9-17 days after infection depending upon the temperature, leaf wetness and relative humidity. The minimum relative humidity needed for sporulation to occur is between 60-70%. Upon sporulation, conidia are dispersed to leaf and fruit tissue by wind and splashing rain.

Symptoms

Scab symptoms are observed on leaves, petioles, fruits and twigs. The symptoms appear in the spring as small dull olive-green patches on the young emerging leaves and sometimes only on the underside. As the disease progresses, darker spots develop on both surfaces of the leaves. Young lesions are velvety, brown to olive green or mousy black

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having feathery and indistinct margins.Later, these lesions coalesce and the tissues surrounding them thicken and the leaf surface is deformed, curled and distorted. Sometimes, the entire leaf surface gets covered with scab lesions. Such infected leaves turn yellow and may fall prematurely. Small superficial lesions or large patches develop on the fruit surface usually at the calyx end. The severe early infection results in the formation of misshapen fruits and serious cracking while shriveling often occurs. The lesions on the twig are small, 3–5 mm long, slightly raised and reddish-brown spots which later develop as blisters and cause bursting of bark.

Disease Cycle

The apple scab fungus has two distinct stages in its life cycle: the saprophytic pseudothecial or over- wintering stage in dead fallen leaves, and the conidial, summer tage which is parasitic on leaves, flower buds, fruits and shoots on the tree during spring and summer. The saprophytic stage is considered the major source of survival of the pathogen during dormancy of the host in winter and provides the inoculums in the form of ascospores for primary infection of new leaves and flower buds in spring. This initiates the active parasitic stage by formation of lesions on leaves in which millions of conidia are produced.

The scab fungus overwinters in fallen leaves on the orchard floor. The fungus is also capable of overwintering in dormant apple buds (Becker et al., 1992) and, in maritime climates, as mycelium in twig lesions; the importance of these methods of overwintering and their contribution to epidemic development has not been well researched. The fungus is heterothallic, meaning that opposite mating types are required for the formation of ascospores. The formation of pseudothecial initials occur within four weeks after leaf fall. Sufficient moisture is required for the maturation of pseudothecia. The optimum temperature for the development of ascogonium is 8-12^{0}C. The optimum temperature for the ascospore maturation is 16-18^{0}C. Ascospores are released by forcible discharge from the pseudothecia in response to wetting events. The ascospores are disseminated to susceptible host tissue by wind. The first release of ascospores often occurs around budbreak and typically continues over a 5-9 week period. The peak period of ascospore discharge usually occurs between the

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pink and the full bloom stage. Free moisture is required for the initiation of ascospore germination and it is usually present because wetting is also needed to trigger ascospore release. Once initiated, germination will continue as long as the relative humidity is above 95%. Once infection has occurred the fungus produces conidiophores and conidia. The minimum relative humidity needed for sporulation is between 60-70%. Upon sporulation, conidia are dispersed to susceptible leaf and fruit tissue by wind and splashing rain. Several infection cycles can occur throughout the course of the season depending upon host susceptibility and weather conditions.

Disease Management

Apple scab is managed primarily via the timely application of fungicides

Managing Primary Inoculum

Primary inoculum refers to the spores that cause the first infections in spring.For apple scab, this almost exclusively refers to the ascospores. Ascospore discharge begins around the green tip (bud break) phonological stage. One strategy for managing primary inoculums is through the destruction of leaf litter in the fall or spring via shredding, litter degrading compounds or biological control agents). The idea is to hasten the decomposition of leaf litter and, hence, the decomposition of overwintering inoculums in an effort to reduce the potential ascospore dose or PAD. Other approaches for reducing spore production in leaf litter include application of urea to fallen leaves in late fall or early spring, or application of lime to leaves in late autumn. Ultimately, this will result in fewer diseased fruit or a reduction in the number of fungicide applications needed to manage scab. Fungicides are almost always needed to manage scab in a commercial setting. The first two applications are usually a contact fungicide. Strobilurin and SI fungicides can be used in a single season. Because the peak period of apple scab activity occurs around pink, a fungicide with both protectant and post infection activity is used at this time to prevent disease from establishing.

Managing Secondary Inoculum

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Secondary inoculum refers to the spores that initiate secondary cycles of disease. For apple scab, these are the conidia which develop from infections initiated by ascospores. Secondary infections result in exponential increase in disease and are responsible for terminal leaf and, more importantly, fruit infections. In seasons when weather conditions are particularly conducive for disease development, numerous secondary cycles can occur and lead and lead to substantial terminal leaf infection and extensive defoliation.

Resistant Varieties

There are a number of apple varieties that have high levels of resistance to apple scab. Currently, there are six major genes that are known to confer resistance to apple scab: Vf (Malus floribunda), Vr (Russian apple seedling), Vbj (M. baccata Jackii), Vb (Hansen's baccata), Va (Antonovka), Vm (M. micromalus susceptible to race 5). Each of these genes, except for Vm, confer resistance to all known races of the pathogen. Nearly all resistant commercial varieties contain the Vf gene. Resistant varieties include 'Prima', 'Priscilla', 'Macfree', 'Florina', 'Liberty', 'Jonafree' and 'Pioneer' to name a few.

Chemical Management

For mid-hills

The sprays of propineb @ 0.3% (600gm / 200L water) or dodine @ 0.075% (150gm / 200L water) or metiram 55% + pyraclostrobin 5% WG @ 0.150% (300gm / 200L water) or tebuconazole 8% + captan 32% SC @ 0.25% (500ml / 200L water) are recommended for the management of apple scab.

For low hills

The sprays of propineb @ 0.3% (600gm / 200L water) is recommended for the management of apple scab, while tebuconazole 50% + trifloxystrobin 25% WG @ 0.04% (80gm / 200 L water) is recommended for the management of premature leaf fall. 20-25 days before harvest, the sprays of metiram 55% + pyraclostrobin 5% WG @ 0.1% (200gm / 200 L water) is recommended for the management of apple scrab.