

Stem Rust Diseases of *Pinus kesiya* in Vietnam

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Surveys of two stem rust diseases of *Pinus kesiya* were implemented in Da Lat, Lam Dong province, in the Central Highlands of Vietnam. Symptoms of the first disease, a gall rust, are very similar to those of *Cronartium quercuum* in North America. Our surveys found many *Quercus cambodiensis* trees severely infected by the uredinial and telial states of a *Cronartium* species, later identified by microscopic characteristics as *Cronartium orientale*, which is native to eastern Asia. The aecial state of *C. orientale* occurs on various two-needle pines. We tentatively identified the gall rust on *P. kesiya* as *C. orientale*. We conducted inoculation experiments to demonstrate host alternation by *C. orientale*.

The gall rust of *P. kesiya* is very common in both forest plantations and natural stands in Lam Dong province. Disease incidence and severity vary among survey areas. In cases of high disease severity, almost all branches of a pine tree have galls, and exhibit poor form due to the death of many branches and stems. Disease incidence and severity are lowest in young plantations, reach the greatest levels in 5- to 10-year-old plantations, and are lower again in 15-year-old plantations. Main stems that have galls are very brittle.

The second rust found during surveys was a blister rust, with symptoms much like those produced by *C. flaccidum* and *Endocronartium* species, although these

species have not previously been recorded in Vietnam. The blister rust attacks stems and branches of the pine. The period of aeciospore production is longer than 3 months. The germination type of aeciospores differed from that of *Endocronartium*, which has a pine-to-pine life cycle. The microscopic characteristics of the aecial states are also identical to those of *C. flaccidum*. By comparisons with *C. flaccidum* from Japan and Russia based on nucleotide sequences of the D1/D2 region of 28S rDNA, the blister rust on *P. kesiya* was identified as *C. flaccidum*. This species is a host-alternating species, but no suspected alternate hosts have been found in Da Lat. A pine-to-pine biological form of this species is known in Europe. To clarify the life cycle in Da Lat, an artificial inoculation experiment with aeciospores onto seedlings of *P. kesiya* was conducted in Hanoi. However, the seedlings remained uninfected for 2 years after the inoculation. Further studies on the life cycle are needed.

The damage by the two rusts to young pine plantations is very severe. Infected trees were very susceptible to attack by bark beetles (*Dendroctonus* spp.) and the longhorned beetle *Monochamus alternatus*, a vector of the nematode *Bursaphelenchus* species, which causes pine wilt disease. Measures for minimizing disease impacts based on integrated pest management methods are discussed.

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