ACTA
FORESTALIA
FENNICA

Vol. 101, 1969

Antagonism of Healthy and Diseased Ericaceous Plants to Snow Blight on Scots Pine

Terveen ja kuolleen Ericaceae-varvuston ja männyn lumikaristeen välisestä antagonismista

Timo Kurkela

SUOMEN METSÄTIETEELLINEN SEURA

Suomen Metsätieteellisen Seuran julkaisusarjat

Acta Forestalia Fennica. Sisältää etupäässä Suomen metsätaloutta ja sen perusteita käsitteleviä tieteellisiä tutkimuksia. Ilmestyy epäsäännöllisin väliajoin niteinä, joista kukin käsittää yhden tutkimuksen.

Silva Fennica. Sisältää etupäässä Suomen metsätaloutta ja sen perusteita käsitteleviä kirjoitelmia ja lyhyehköjä tutkimuksia. Ilmestyy neljästi vuodessa.

Tilaukset ja julkaisuja koskevat tiedustelut osoitetaan Seuran kirjastolle, Unioninkatu 40 B, Helsinki 17.

Publications of the Society of Forestry in Finland

Acta Forestalia Fennica. Contains scientific treatises mainly dealing with Finnish forestry and its foundations. The volumes, which appear at irregular intervals, contain one treatise each.

Silva Fennica. Contains essays and short investigations mainly on Finnish forestry and its foundations. Published four times annually.

Orders for back issues of the publications of the Society, subscriptions, and exchange inquiries can be addressed to the Library: Unioninkatu 40 B, Helsinki 17, Finland.

ANTAGONISM OF HEALTHY AND DISEASED ERICACEOUS PLANTS TO SNOW BLIGHT ON SCOTS PINE

TERVEEN JA KUOLLEEN ERICACEAE-VARVUSTON JA MÄNNYN LUMIKARISTEEN VÄLISESTÄ ANTAGONISMISTA

TIMO KURKELA

HELSINKI 1969

Suomalaisen Kirjallisuuden Kirjapaino Oy Helsinki 1969

A possible biological means was discovered to control spread of the snow blight caused by *Phacidium infestans*. Healthy foliage of various ericaceous plants inhibited spread of snow blight on excised branches of Scots pine under snow. Spread also was inhibited by dead foliage of *Vaccinium vitis-idaea* and *Calluna vulgaris* infected with unidentified snow molds.

INTRODUCTION

Snow blight caused by *Phacidium infestans* Karst. is one of the most important diseases of seedlings of Scots pine (*Pinus silvestris* L.). It is especially severe in northern Finland (KANGAS 1937). There are no satisfactory methods to control the disease in the field, although in nurseries it is effectively controlled with pentachloronitrobenzene (JAMALAINEN 1961).

The mycelium of *P. infestans* grows in snow between branches and needles of its host. The severity of snow blight depends upon the depth and duration of snow cover (BJÖRKMAN 1948). It is most severe on poor sites (LINDBERG 1914, KOSSINSKAJA 1962). In fertilization experiments on poor peat land, in Finland, the abundance of snow blight was influenced by the amount of potassium and phosphorus added to the soil (KURKELA 1965). Snow blight was most abundant on plots deficient in potassium and where there was only scanty vegetation on the forest floor. According to KOSSINSKAJA (1962), dense vegetation on the ground can decrease the severity of snow blight. Preliminary observations indicated that the development of snow blight depends not only on the susceptibility of pine seedlings but also on the nature and extent of surrounding vegetation.

The objective of this study was to test the hypothesis that healthy and diseased ericaceous vegetation can influence the spread of snow blight in excised branches of Scots pine.

MATERIALS AND METHODS

Three experiments were conducted in Punkaharju and Leivonmäki during the winter of 1966—67. The spread of the snow blight was investigated in rows of excised branches from a ten-year-old stand of Scots pine. The branches were taken at a height of 0.5 m. Branches from different trees were mixed together and inserted vertically into the soil in rows 2 m long, on sites selected to include the various types of soil cover and vegetation listed in Table 1. The distance between branches was 10 cm and between tips of needles of different branches 0.5—2 cm. It was assumed that *P. infestans* could spread from branch to branch without difficulty because BJÖRKMAN (1948) had shown earlier that the fungus could grow up to 46 cm in one winter, at least 20—30 cm in rows of seedlings and 12 cm even on bare ground.

The rows of branches were inoculated with *P. infestans* at the both ends and in the middle, so that the distance between the points of inoculation was 1 m. Two needles of Scots pine, naturally infected by *P. infestans*, were used for each inoculation.

The experiments were established in November before the ground was covered by snow. The border between healthy and infected parts of needles and branches in Scots pines is very sharp (LAGERBERG 1912). In the present investigation the determination and measurement of the spread of snow blight in rows of branches was based on the discolortion in the needles and on the remnants of mycelia, which are visible just after the melting of snow. Thus, the spread of snow blight was measured visually in rows with an accuracy of 1 cm after snow melted in April.

In an experiment in Ikaalinen parish during the winter of 1967—68, ericaceous plants (*Calluna vulgaris* (L.) Hull and *Vaccinium vitis-idaea* L.) infected with snow molds were used to determine their influence on the spread of snow blight. The method used in this experiment was much the same as in the previous experiments. The differences were as follows:

The branches of Scots pine were layed horizontally in rows 2 m long on forest humus exposed by removing all other vegetation. The rows were inoculated with *P. infestans* at two points, each 0.5 m from both ends of the rows. The dead ericaceous plants were placed across the rows 2—5 cm on one side of the point of inoculation. No vegetation was placed on the other side of the point of inoculation. The presence of snow molds in the foliage of dead ericaceous plants was detected by culturing dead leaves on agar plates at +5° C. The determination of the limit of spread of snow blight was based on the discoloration in needles only. Three types of controls were used: (i) rows without inoculation and without vegetation; (ii) rows without inoculation but with vegetation; and (iii) rows with inoculation but without vegetation.

In Punkaharju the rows were replicated twice, in Leivonmäki three times, and in Ikaalinen four times. Four measurements on the spread of snow blight were made on each row of branches. The significance of differences in the results were tested statistically by orthogonal comparisons and LSD-tests.

RESULTS

Influence of healthy foliage

Large differences in spread of snow blight were associated with the various types of vegetative ground-cover tested in these experiments. In all cases spread of snow blight was inhibited significantly when growing among healthy foliage of ericaceous evergreens in comparison with the spread observed in the rows of branches on the ground where the vegetation was removed, or on lichens, mosses, and in naturally defoliated vegetation of *Betula nana* L. (Table 1).

In the experiment in Punkaharju the spread of snow blight was inhibited most completely by the foliage of *Calluna vulgaris* and *Vaccinium vitis-idaea*, both of which are evergreens. Mineral soil (control), forest humus, and moss (*Pleurozium schreberi* (Brid.) Mitt.) apparently did not affect the spread. The effect of *Vaccinium myrtillus* L. was intermediate. *V. myrtillus* overwinters without leaves, but its twigs usually form comparatively dense vegetation.

Similar results were obtained in the two experiments in Leivonmäki (Table 1). The ericaceous evergreens inhibited spread of snow blight very effectively. In vegetation of *Empetrum nigrum* L. (mixed with either live foliage of *Andromeda polifolia* L. or dead foliage of *Eriophorum vaginatum* (L.)) and in vegetation of *Ledum palustre* L. the average spread of snow blight was only 7.4 cm. On moss (*Polytrichum commune* L.), by comparison, the spread was 13.1 cm and on *Sphagnum*-peat, lichen (*Cladonia* sp.), and in shrubby vegetation of *Betula nana* the average spread of snow blight was 22.7—25.4 cm.

Table 1. Spread of snow blight in rows of Scots pine branches placed on different types of ground cover and on different types of vegetation.

Taulukko 1. Lumikaristeen leviäminen männynoksariveissä erilaisella maaperällä ja erilaisessa kasvillisuudessa.

Type of ground cover or vegetation	Average spread, cm		
	Punkaharju	*Leivonmäki*	
	Expt. I	Expt. II	Expt. III
Mineral soil (control)	13.3	— [c]	—
Ground cover:			
Sphagnum-peat (control)	—	22.7	25.2
Forest humus (control)	14.1	—	—
Lichens:			
Cladonia sp.	—	—	25.4
Mosses:			
Polytrichum commune L.	—	13.1	—
Pleurozium schreberi (Brid.) Mitt.	12.4	—	—
Defoliated plants:			
Betula nana L.	—	—	23.8
Vaccinium myrtillus L.	9.4	—	—
Evergreen plants:			
Empetrum nigrum L. [a]	—	—	7.8
Empetrum nigrum L. [b]	—	6.5	—
Ledum palustre L.	—	—	6.9
Vaccinium vitis-idaea L.	6.8	—	—
Calluna vulgaris (L.) Hull	5.9	—	—

[a] Mixed with *Andromeda polifolia* L.
[b] Mixed with dead leaves of *Eriophorum vaginatum* L.
[c] No experiment

Influence of diseased foliage

The dead twigs and leaves of *Calluna vulgaris* and *Vaccinium vitis-idaea* significantly inhibited the spread of snow blight in rows of excised branches of Scots pine in comparison with the spread in rows where no treatment with ericaceous plants was made (Fig. 1). An even greater difference in the spread was observed on the sides of the inoculum

with and the other without ericaceous plants. The spread of snow blight on the side without ericaceous evergreens did not differ significantly from that in control rows (Fig. 1). No significant differences were detected between the spread, when rows of branches were treated with *V. vitis-idaea* or with *C. vulgaris*. In the control rows, which were not inoculated with *P. infestans*, there was no evidence of snow blight.

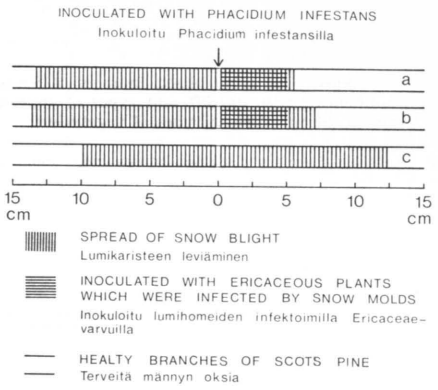

Fig. 1. Spread of snow blight in rows of excised branches of Scots pine. The spread in the both directions was measured from the point of inoculation with *Phacidium infestans*. a) Rows treated with dead foliage of *Vaccinium vitis-idaea*, b) Rows treated with dead foliage of *Calluna vulgaris*, c) Rows not treated with vegetation.

Kuva 1. Lumikaristeen leviäminen maahan riviin asetetuissa männyn oksissa. Leviäminen mitattiin inokulointikohdasta lähtien. a) Kokeissa käytettiin kuolleita puolukan varpuja, b) kokeissa käytettiin kuolleita kanervan varpuja, c) kokeet ilman Ericaceae-varpuja.

DISCUSSION

The results of this investigation show that significant inhibition of snow blight in Scots pine can be achieved with foliage of ericaceous evergreens. The mechanism of this inhibition is an object of conjecture. In healthy ericaceous vegetation it might be caused by saprophytic fungi living on surfaces of plants or by some constituent of the foliage itself. In the case of dead ericaceous foliage the cause of inhibition seems to be the antagonism of other snow molds. The antagonism of certain saprophytic organism is well known. In some cases this antagonism has been used to control pathogens of plants (Weindling and Fawcett 1936, Rishbeth 1952, 1959).

Generally, the vegetation on the forest floor is considered as impediment for reforestation (crf. Hertz 1935, Yli-Vakkuri 1961). The observed inhibition suggests that ericaceous vegetation may be helpful for reforestation by offering a natural control of snow blight, when seedlings of Scots pine do not stand above the surrounding vegetation. According to Darpoux (1960), positive results in control of plant pathogens with antagonistic microorganisms are still uncommon in natural unsterilized soils. The conditions in snow are obviously more like those in sterilized soil. If the first organism colonizing snow is antagonistic, it might be able to inhibit the growth of subsequent colonizers.

The author gratefully acknowledges financial support by the Society of Forestry in Finland and assistance in preparing the manuscript for publication by Dr. Ellis B. Cowling of North Carolina State University at Raleigh (USA).

LITERATURE CITED

Björkman, E. 1948. Studier över snöskyttesvampens (*Phacidium infestans* Karst.) biologi samt metoder för snöskyttets bekämpande. (English summary). Medd. Stat. Skogsforskningsinst. 37,2.

Darpoux, H. 1960, Biological interference with epidemics. Pp. 521–565. *In* J. G. Horsfall and A. E. Dimond (ed.) Plant Pathology: an advanced treatise. Vol. 3. Academic Press, New York.

Hertz, M. 1935. Tutkimuksia kasvualustan merkityksestä männyn uudistumiselle. Comm. Inst. Forest. Fenn. 20,2.

Jamalainen, E. A. 1961. Havupuiden talvituhosienivauriot ja niiden kemiallinen torjunta. (English summary). Silva Fennica 108,4.

Kangas, E. 1937. Tutkimuksia mäntytaimistotuhoista ja niiden merkityksestä. (German summary). Comm. Inst. Forest. Fenn. 24,1.

Kossinskaja, I. S. 1962. Phacidiosis of forest plantations in Karelian A.S.S.R. (In Russian). Lesn. Zh. 1962: 42–44.

Kurkela, T. 1965. Männyn lumikaristetaudin ja lannoituksen suhteesta Kivisuon metsänlannoitusalueella. (English summary). Folia Forestalia 14.

Lagerberg, T. 1912. Studier öfver den norrländska tallens sjukdomar med hänsyn till dess föryngring. (German summary). Medd. Stat. Skogsförsöksanst. 9: 135–170 and XXI–XXIV.

Lindberg, F. 1914. *Telephora laciniata*, flikig barksvamp, och *Phacidium infestans*, snöskytte, två stora skadegörare i de norrländska plantskolorna. Sv. Skogsvårdsför. Tidskr. 1914: 569–574.

Rishbeth, J. 1952. Control of *Fomes annosus* Fr. Forestry 25: 41–50.

—»— 1959. Stump protection against *Fomes annosus*. II. Treatment with substances other than creosote. Ann. Appl. Biol. 47: 529–541.

Weindling, R. and H. S. Fawcett. 1936. Experiments in the control of *Rhizoctonia*-damping-off of citrus seedlings. Hilgardia 10: 1–16.

Yli-Vakkuri, P. 1961. Emergence and initial development of tree seedlings on burnt-over forest land. Acta For. Fenn. 74,1.

SELOSTE:

TERVEEN JA KUOLLEEN ERICACEAE-VARVUSTON JA MÄNNYN LUMIKARISTEEN VÄLISESTÄ ANTAGONISMISTA

E r i c a c e a e-varvuston vaikutusta lumikaristeen leviämiseen tutkittiin syksyllä maahan asetetuissa männynoksariveissä. Tutkimus jakautui kahteen osaan. Toisessa selviteltiin elävän varvuston, ja toisessa edellisenä talvena kuolleen, todennäköisesti lumihomeiden tappaman varvuston vaikutusta.

Elävään varvustoon asetettiin 15 cm pituisia männyn oksien kärkiä 2 m riveihin 10 cm välein, jolloin eri oksien neulasten väliin jäi 0,5–2 cm pituinen tila. Kuolleen varvuston vaikutuksen selvittelyssä käytettiin yhtenäisiä 2 m oksarivejä, jotka olivat paljaalla humuksella. Molemmissa tapauksissa oksarivit inokuloitiin lumikaristeisilla männyn neulasilla. Kuolleitten varpujen vaikutusta tutkittiin panemalla oksarivien päälle inokulointikohdan viereen n. 5 cm pituiselle osalle kuolleita puolukan tai kanervan varpuja.

Lumikaristeen leviäminen mitattiin oksariveissä keväällä lumen sulamisen jälkeen inokulointikohdasta alkaen niin pitkälle kuin värinmuutosta neulasistossa oli havaittavissa. Tulokset osoittivat sekä terveen että kuolleen varvuston vähentäneen lumikaristeen leviämistä verrattuna lumikaristeen määrään oksariveissä, jotka olivat mineraalimaalla, turpeella, humuksella, jäkälällä, sammalella tai vaivaiskoivun varvustossa. Elävään Ericaceae-varvustoon asetetuissa oksariveissä lumikariste levisi yleensä 4–10 cm. Erilaisissa kontrollikokeissa lumikaristeen leviäminen talven aikana vaihteli 10 ja 30 cm:n välillä (taulukko 1). Kuva 1. osoittaa kuolleen varvuston vaikutuksen. Oksariveissä, joissa oli kuolleita varpuja, lumikaristeen keskimääräinen leviäminen oli 10–14 cm. Tämä oli n. 50 % vähemmin kuin kontrolliriveissä ilman varpuja.

ACTA FORESTALIA FENNICA

EDELLISIÄ NITEITÄ — PREVIOUS VOLUMES

Vol. 90, 1968. Yrjö Kangas.
Beschreibung des Wachstums der Bäume als Funktion ihres Alters.

Vol. 91, 1968, Pekka Kilkki.
Income-Oriented Cutting Budget. Seloste: Tulotavoitteeseen perustuva hakkuulaskelma.

Vol. 92, 1969. Matti Leikola.
The Influence of Environmental Factors on the Diameter Growth of Forest Trees. Auxanometric Study.

Vol. 93, 1969, Kustaa Seppälä.
Kuusen ja männyn kasvun kehitys ojitetuilla turvemailla. Summary: Post-Drainage Growth Rate of Norway Spruce and Scots Pine on Peat.

Vol. 94, 1969. Erkki Lähde.
Biological Activity in Some Natural and Drained Peat soils with Special Reference to Oxidation-Reduction Conditions.

Vol. 95, 1969. Olli Makkonen.
Ancient Forestry. An Historical Study, Part II. The Procurement and Trade of Forest Products.

Vol. 96, 1969. Yrjö Ilvessalo.
Luonnonnormaalien metsiköiden kehityksestä Pohjanmaan kivennäismailla. Summary: On the Development of Natural Normal Forest Stands on Mineral Soils in Ostrobothnia.

Vol. 97, 1969. Eino Oinonen.
The Time Table of Vegetative Spreading of the Lily-of-the-Valley (*Convallaria majalis* L.) and the wood Small-Reed (*Calamagrostis epigeios* (L.) Roth) in Southern Finland.

Vol. 98, 1969. Peitsa Mikola.
Comparative Observations on the Nursery Technique in Different Parts of the World.

Vol. 99, 1969. P. M. A. Tigerstedt.
Progeny Tests in a Pinus silvestris (L) Seed Orchard in Finland.

Vol. 100, 1969. Matti Kärkkäinen.
Metsän vaurioituminen kesäaikaisessa puunkorjussa. Summary: The Amount of Injuries Caused by Timber Transportation in the summer.

KANNATUSJÄSENET — UNDERSTÖDANDE MEDLEMMAR

CENTRALSKOGSNÄMNDEN SKOGSKULTUR
SUOMEN PUUNJALOSTUSTEOLLISUUDEN KESKUSLIITTO
OSUUSKUNTA METSÄLIITTO
KESKUSOSUUSLIIKE HANKKIJA
SUNILA OSAKEYHTIÖ
OY WILH. SCHAUMAN AB
OY KAUKAS AB
RIKKIHAPPO OY
G. A. SERLACHIUS OY
TYPPI OY
KYMIN OSAKEYHTIÖ