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Determining invasiveness and risk of dothistroma needle blight

Justyna A. Nowakowska[1] ✉, *Anna Tereba*[1], *Tomasz Oszako*[2,3]

[1] Forest Research Institute, Laboratory of Molecular Biology, Sękocin Stary, Braci Leśnej 3, 05-090 Raszyn, Poland, phone: +4822 7150467, fax: +4822 7150313, e-mail: J.Nowakowska@ibles.waw.pl

[2] Forest Research Institute, Department of Forest Protection, Sękocin Stary, Braci Leśnej 3, 05-090 Raszyn, Poland

[3] European Food Safety Authority (EFSA), Via Carlo Magno 1, 43100 Parma, Italy

Dothistroma septosporum (Gremmen & Morelet) is an economically important fungal disease that affects needles of conifers, in particular pines. Nowadays, over 60 tree species have been reported to be susceptible to infection, among them *Pinus nigra* (Arn.), *P. brutia* (Ten.), *P. pinaster* (Ait.), *P. pinea* (L.), *P. mugo* (Tur.) and *P. sylvestris* (L.) are the most susceptible in Europe. The discovery of dothistroma needle blight (DNB) dates from 1933 in Spain, 1971 in Slovenia, 1980 in Greece, 1985 in Scotland, 1986 in Serbia, 1995 in Poland, 1996 in Slovakia, 1999 in Czech Republic, 2002 in Lithuania, 2006 in Estonia, 2007 in Finland and Sweden, 2008 in Latvia and Russia, 2009 in Norway. Recently, some data of newly infected *Larix* spp., *Abies* spp. and *Picea* spp. by *Dothistroma* sp. have been reported from Lithuania, Latvia, Serbia and Macedonia.

The exact origin of the disease is unknown, although it is suggested that it might be originated from the pine forests in Nepal, India and Pakistan, or also from the high altitude rain forests in South America. It is believed that the disease has been prevalent in the southern hemisphere before reaching high levels of infection in the northern hemisphere, with unprecedented records of the disease in Asia, Europe and the UK. In general, the spores of *Dothistroma* spread initially in moist conditions (through mist and rain), or by direct contact with other infected needles. Once the needles have been exposed to spores, the fungus germinates in wet conditions, followed by needle penetration through stomata. The optimal germination temperature is 12–18°C, with high level of humidity. The needles soon turn to reddish discoloration and on their the pathogen produces eventually the pycnidia, which are the pathogen's fruiting body. The pycnidia are formed in the spring and early summer, and usually coincide with high level of precipitations.

Photo. Symptoms of dothistroma needle blight (former red band needle blight, or RBNB) on *Pinus nigra*

Source: Robert L. James, USDA Forest Service, http://utahpests.usu.edu/uppdl/htm/plant-diseases-2010/diseases-diagnosed-in-october-2010).

The first visible signs of infection are yellow and brown spots that develop on the living needles, which soon become red (Photo). These symptoms can be clear-

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ly seen between June and July, which occur on plant tissue every year. The succeeding spread of DNB weakens the trees and cause large percentage of crown damage leading to lower yields of timber, or even the mortality. The disease causes defoliation which progresses every year, predisposing trees to other diseases, like *Cenangium ferruginosum* (Fr.) or *Gremmeniella abietina* (Lagerb.) M. Morelet.

Dothistroma septosporum (previously *Dothistroma septospora* or *D. pini*) is asexual (anamorphic) stage of sexual form (teleomorph – *Mycosphaerella pini* [(A. Funk & A.K. Parker) Arx], which occurs very seldom in nature. The sexual reproduction of the disease pose a higher risk because the division of cells *via* meiosis allows a far greater genetic variation of the disease, and increases its ability to adapt to local climates and resistance to various forms. Between *D. septosporum* and *D. pini* there are some differences in DNA structure based on ITS fragments, β-tubulin-1 and -2 genes, and elongation factor *ef-1α* gene. According to the morphological structure, three varieties of *D. septosporum* were described, i.e. var. *linearis* (occurring mainly in France, Canada, USA), var. *keniensis* (Kenya, South Africa), and var. *pini* (England, USA and Australia). Genomic studies revealed that two different mating types of *D. septosporum* coexist Europe: MAT1 and MAT2. Moreover, two main haplotypes (A and B) were determined by studies of 12 microsatellite *loci*, suggesting the direction of *D. septosporum* spread from Europe to the USA. Consequently, more genetic variation is usually found in location of pathogen origin, and less variation in new habitats. Still, the most relevant pine protection options consist in preventing the genotype or haplotype mixing between different *Dothistroma* spp. isolates, which could result in new (more virulent) genetic hybrids.

Because of the increasing numbers of DNB reported in Northern America, Southern Africa and Europe, a three-day workshop from 28th of April to 2nd of May 2014 entitled "Determining invasiveness and risk of dothistroma" was held in Antalya (Turkey), involving 40 forest plant pathologists, invasion biologists, and molecular biology specialists. Among different topics, the defining of current disease situation and risk of DNB on different hosts were conferred. The workshop also dealt with the host resistance and susceptibility, as well as the best practice guidance for forest management. Up to now, many relevant questions still remain unanswered, especially those reflecting the host susceptibility, the pathogen virulence and the environmental conditions. We still do not know what is the relationship between *Dothistroma* sp. and the genetic structure of the plant, e.g. what plant genes (encoding chitinases or heat shock proteins?) control the resistance mechanism. Are different genotypes found in *P. sylvestris* and *P. abies* (L.) Karst. populations in Poland predispose trees to particular pattern of resistance against pathogen? Concerning the pathogen itself, it is not obvious if *D. septosoporum* and *D. pini* hydridise between them, and what is the exact origin of the DNB in Europe. Environmental issues involve unclear conditions needed for pathogen sexual stage development and the influence of landscape on the level of DNB.

Several measures of pine stand protection against DNB can be undertaken. As a fungal disease, any intervention that increases airflow and reduces humidity will be beneficial. It has been observed that some thinning or eradication of the DNB from nurseries can efficiently reduce the spread of the *Dothistroma*. European Food Safety Authority (EFSA) has recently prepared an analysis of the risk assessment (PRA – Plant Risk Assessment), which shows the need to strengthen precautions and regulations on EU level without which inhibition of the spread of DNB will be impossible. The environmental and economic factors behind copper based fungicide treatment on large scale commercial crops makes control still difficult and inadvisable. Recent research data suggests that biological alternatives e.g. microbial solutions from compost may help to maintain seedlings in forest nurseries in better health condition, preventing DNB.

In view of the growing threat posed by alien pathogenic organisms to forest ecosystems, the advanced research on biological plant protection combined with the understanding of pathways of transmission and interaction with other pathogens is needed. The knowledge based on the relationship between the genetic structure of forest trees and the degree of infection by pathogens, will allow the development of effective methods against the DNB prevention in forest stands.

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Source and additional information

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