

Pasmo Disease on Flax

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Flax (*Linum usitatissimum* L.), which is believed to have originated in Europe and Asia, has been cultivated for over 5000 years (Mckay and Loughnane, 1947). Flax grows from 20 to 120 cm tall, can have a shallow or deep root system, and has alternate and lanceolate shaped leaves (Kolte and Fitt, 1997). The flowers are self pollinated with five petals forming around a globular capsule that can contain up to 10 yellow or dark brown colored seeds. The typical flax grown in this region has a blue flower but the color can be white or pale pink. Flaxseed oil is used as both an edible oil and an industrial oil, but flax is also grown for its fiber. For three of the last five years the flax acreage in North Dakota has approached 750,000 acres with a production market value of \$120 million in 2005 (USDA, National Agricultural Statistic Service, 2007).

Pasmo disease has been geographically identified in Argentina (1911), Peru and Uruguay in South America, North Dakota (1916), Minnesota and Canada in North America, the former Yugoslavia (1936) in Europe, Kenya (1941) and Morocco (1947) in Africa, and Australia (1940), New Zealand in Oceania (CMI Map, 1986; Kolte and Fitt, 1997). The disease caused 20% losses in Minnesota in 1928 (Rodenhiser, 1930). Severe losses were reported in Argentina in 1930 and 1931 (Bolley, 1931). More recently, pasmo disease has caused yield losses in South Dakota (Ferguson et al., 1987) and England on winter linseed (Perryman and Fitt, 1999). Stem incidence and severities exceeded 15% in 2002 and 20% in 2003 respectively in North Dakota (Halley et al., 2004). Pasma can also affect oil concentration of the seed (Sackston and Carson, 1951).

The disease can be visually identified by circular to oblong shaped lesions that change from green to yellow and eventually dark brown in the center (Rashid, 2003). The leaves eventually dry and wither. Lesions also develop on the sepals and flower buds and stems. Seed infected by the organism may exhibit a bluish black tinge. White eruption of fungal growth on seed has also been reported.

Pasmo disease is caused by the pathogen *Septoria linicola* (Speg.) Garassini, teleomorph: *Mycosphaerella linorum* Wollenw. Garcia-Rada (syn. *M. linicola* Narum). Pycnidia develop in the lesions. Pycnidiospores are exuded in a slime and are transported by rain splash, animals, and insects. Because of their large size, pycnidiospores are usually not transported by the wind (Christensen et al., 1953). The fungus grows well from 5 to 31°C with an optimal temperature of 20-21 °C (Brentzel, 1926). The spores are 3 or 7-septate and have dimensions of 1.5-3 x 12-28 µm (Sivanesan and Holliday, 1981). Sporulation can occur in 8 days after infection. In the teleomorph, perithecia develop on diseased flax stems and resemble black spherical dots. The asci are oblong, straight or hyaline. Ascospores are fusiform; two celled and are 2.5 x 4.0 x 11-17 µm in size (Sivanesan and Holliday, 1981). Although ascospore transmission and disease transmission through the seed are considered of minor importance, the organism can persist in the seed for over a year and in crop residue for up to four years. Two races, designated A and B, have been identified by differences in virulence (Rodenhiser, 1930) and geographic distribution. Race A, a less aggressive race that grows well on artificial media, is widespread in Germany, Hungary, the former Yugoslavia and the Americas. . Race B is widespread in Argentina and Czechoslovakia, grows with difficulty on artificial media and forms no perithecia on agar but is characterized by a very short incubation period. The races can be distinguished easily in culture by their color, surface consistency and topography.

S. linicola can be controlled on the seed with the fungicide Thiram and a hot water treatment of 38 °C for ten minutes. Foliar fungicides, benomyl, mancozeb, thiophanate methyl

and pyraclostrobin, have been used to reduce the intensity of the disease. Varietal resistance has been reported (Covey, 1962; Rashid, 1994) but is not often utilized in breeding programs due to its polygenic inheritance. A four year rotation, field sanitation, early sowing and using disease free seed are recommended to reduce losses.

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