ISSN 1392-3196
Zemdirbyste-Agriculture, vol. 95, No. 3 (2008), p. 58–64
UDK 633.521:632.1/.4

THE PECULIARITIES OF THE OCCURRENCE OF PASMO DISEASE (*SEPTORIA LINICOLA*) IN CENTRAL LITHUANIA

Elvyra GRUZDEVIENĖ

Upyte Research Station of the Lithuanian Institute of Agriculture
Linininkų g. 3, Upytė, Panevėžys distr., Lithuania
E-mail: upyte@upyte.lzi.lt

Abstract

The present paper analyses the peculiarities of the occurrence of the pasmo disease (*Septoria linicola* (Speg.) Garassini) during the flax growing season. Experiments were carried out over the period 2001–2003 in Central Lithuania, Panevėžys district. The tests involved an industrial flax variety 'Kastyčiai'.

Pasmo disease occurred on flax stems and leaves in 2001 and in the 2003, it was affected by a lot of rainfall, when flax crops were lodged, stems and capsules were damaged by hail. The disease causal agent was identified with a microscope when typical conidia were found on the damaged plant parts. Visual symptoms of pasmo disease on flax were not detected in the year 2002, when the weather conditions were not favourable for the occurrence of the disease.

Our experimental evidence suggests that the infestation of *S. linicola* on stems and leaves was significantly influenced by the weather conditions.

Key words: flax, pasmo, *Septoria linicola,* disease severity, weather conditions.

Introduction

Pasmo disease is common in all flax growing countries – it is widespread on flax in the United Kingdom /Mercer et al., 1994; Perryman, Fitt, 2000/, Germany, France, and England /Paul et al., 1991/, Belarus /Портянкин, 2007/, Canada /Ferguson et al., 1987/, and the USA /Oplinger et al., 1997; Bradley et al., 2004/. The first symptoms of pasmo disease were identified on flax plants in several experimental stations in Poland during 1955–1957 /Andruszewska, Korbas, 1989/. In Russia the disease spreads on fiber flax in specific areas /Курчакова, 2000/. It reduces the yield and quality of harvested seed, thus negatively affecting the health of food and feeding stock /Perryman, Fitt, 2000; Bradley et al., 2004/. Pasmo also reduces the yield and quality of the fiber in the infected stems, resulting in reduced interest of the industry and a lower market value of the straw from infested fields /Ferguson et al., 1987; Pristchepa et al., 2006/.

The causal agent of pasmo disease is fungus *Septoria linicola* (Speg.) Garassini. Spores of this fungus are dispersed by rain, wind, dew, insects etc. /Skuta, 2000/. Fungus *S. linicola is* favoured by wet and hot weather and it affects plants during the growing season /Brentzel, 1926; Musket, Colhoun, 1947; Лучина, Будревич, 1978; Lamey, 2000/.

The fungus *Septoria linicola* was reported as a new species of *Coelomycetes* in Lithuania in the year 1999. This species was found on *Linum usitatissimum* in two districts of Lithuania and in both cases *S. linicola* injured cultivars of flax that have been newly introduced in Lithuania /Jovaišienė, Taluntytė, 2000/. This fungus caused flax disease known as pasmo disease. It shows on stems and leaves of flax. The teleomorph of the fungus (*Mycosphaerella linicola* Naumov) has still not been found in Lithuania /Markevičius, Treigienė, 2003/.

Most literature sources suggest that depending on the earliness and severity of the infection, pasmo reduces the yield as well as the quality of seed and fibre /Цветков, 1984; Perryman, Fitt, 2000/. The purpose of this study was to describe the peculiarities of the occurrence of the pasmo disease agent *S. linicola* on the industrial flax crops in Central Lithuania.

Materials and Methods

Investigations of pasmo occurrence on fiber flax var. 'Kastyčiai' were conducted in Central Lithuania, Panevėžys district, in the industrial flax fields during 2001–2003.

Soil tillage, weed and pest control were performed following the flax cultivation recommendations applied in Central Lithuania /Pluoštiniai linai, 1999/. The preceding crop of flax was winter cereal. The sowing rate was 22 million of viable seeds ha^{-1}. Flax was sown at 6 cm inter-row spacings with a sowing machine SPU-6.

Assessment of pasmo incidence was performed in the stand of flax in the marked record plots in four replications. Pasmo disease on flax plant was assessed in 0.25 m^2 plots, every three days till flax pulling by observing 100 plants per replication and by estimating the disease severity and incidence. Pasmo incidence was estimated by visual symptoms.

Per cent of affected plants was estimated and disease severity was recorded following a five-point scale: 0 – healthy plants; 1 – weakly affected; 2 – moderately affected; 3 – heavily affected; 4 – very heavily affected or dead plants and disease severity index was calculated /Методические указания... 1969; 2001/.

Meteorological conditions. The weather conditions varied throughout the study and affected the development and spread of the pathogens. We calculated hydrothermal coefficient (HTC) to establish the weather conditions during the experimental period. The Selyaninov hydrothermal coefficient – $HTC = P/0,1\Sigma t$, where P = total precipitation in the given period, expressed in mm, and t = mean daily air temperature in ^{o} C. The optimum humidity is when HTC is 1.0–1.5; excess humidity when HTC is 1.6 and higher; moderate humidity when HTC ranges between 0.7–0.6 /Бюлетень почвенного..., 1988/.

In the first ten-day period of May it was very dry (0.6 mm of precipitation, while long-term average was 16 mm) and cool (mean temperature – 10.6^{o} C), therefore, conditions for flax emergence were not favourable. But at the end of the second ten-day period of May 19 mm of rainfall fell and the air temperature increased by 4 degrees and flax emerged completely. This suggests that the weather conditions were conducive to the development and spread of the pathogens, especially in June and July in the year 2001. In June HTC was 2.0, and there were 10 days with rainfall higher than 1 mm. The mean air temperature in the 2nd and 3rd ten-day periods of July was by 2^{o} C higher than the long-term average. HTC of the 2nd ten-day period of July was 2.79 and that of the 3rd ten-day period it was 0.29.

The year 2002 was characterised by a shortage of moisture during the growing season. The weather conditions for flax emergence were favourable. There was enough moisture for seed germination and seedling establishment, HTC was 2.18. In the first ten-day period of May the mean air temperature was by 3.5^{o} C higher than long-term average, the amount of precipitation was very low – only 0.9 mm (when long-term average was 16 mm) and the HTC was only 0.06 – a very severe drought. Excess of precipitation was noticed in the 2nd and 3rd ten-day periods of June and first ten-day period of July HTC was 2.09; 2.28 and 2.23, respectively. It was warm and dry in the first ten-day period of June and in the 2nd and 3rd ten-day periods of July.

It was warm and dry in the first ten-day period of June in 2003 and very dry in the 2nd ten-day period of June (the amount of rainfall (13.5 mm) was only half of the long-term period). HTC was 0.37; 0.16; 0.95, respectively. Because of the lack of precipitation in the first half of the growing season, flax did not perform well. But in July the weather was warm and normally wet, conditions for flax development were favourable. Heavy rainfall at the end of July partially lodged flax crops. The weather during the first ten-day period of August was dry and warm.

Results and Discussion

Our experimental evidence showed that pasmo disease did not occur on seedlings at "fir-tree" stages during the whole experimental period but affected flax at green ripening or at early yellow ripening stage. First symptoms of pasmo disease were identified on flax leaves and stems at the green ripening stage in the year 2001 and on stems in the year 2003. Symptoms of pasmo damage on leaves show as greyish brown or dark brown lesions. In older, dark brown lesions we can see pycnidia. On stems lesions were from light brown to dark brown in colour, present along the stem. At early stage the lesions are small, and do not encircle the stem. Affected sections alternate with green bands of healthy tissue on the same stem. Eventually the entire stem turns brown or brownish grey and the areas of damaged stems define like brown blurs in the flax field. Many literature sources note that flax is most susceptible to pasmo at ripening stage /Brentzel, 1926; Musket, Colhoun, 1947; Лучина, 1981/.

The weather conditions were favourable for the spread of pasmo causal agent especially in June and July in the year 2001. Flax crop was slightly lodged by wind and heavy rain at flowering stage. Hailstorm and wind on the 17th of July lodged flax stand, the hail damaged flax stems and green capsules. The incidence of pasmo was higher also because of mechanically injured cuticle on flax stems. Flax stayed lodged until harvesting, which favoured the spread of pasmo disease. Flax was severely affected – the disease was present on 96% of flax stems and the disease severity index was 55.0% (Figure 1).

In 2002, wet weather in the spring favoured the development of pathogenic fungi, which continued during June, when it was warm and very humid. In July and August, hot, dry weather eventually impaired the spread of fungal diseases. Pasmo did not occur on flax crop in the year 2002.

In 2003, the weather conditions in spring and early summer were conducive to the development of the fungi, and warm, humid weather in June and July meant that fungal diseases could spread with ease. Excess rainfall (26.1 mm per day) on the 26th of

July partially lodged the flax crop. Warm and wet weather at the end of July and in first ten-day period of August promoted the spread of pasmo on flax stems. The disease was identified on 74% of flax stems and the disease severity index was 40.0% (Figure 2).

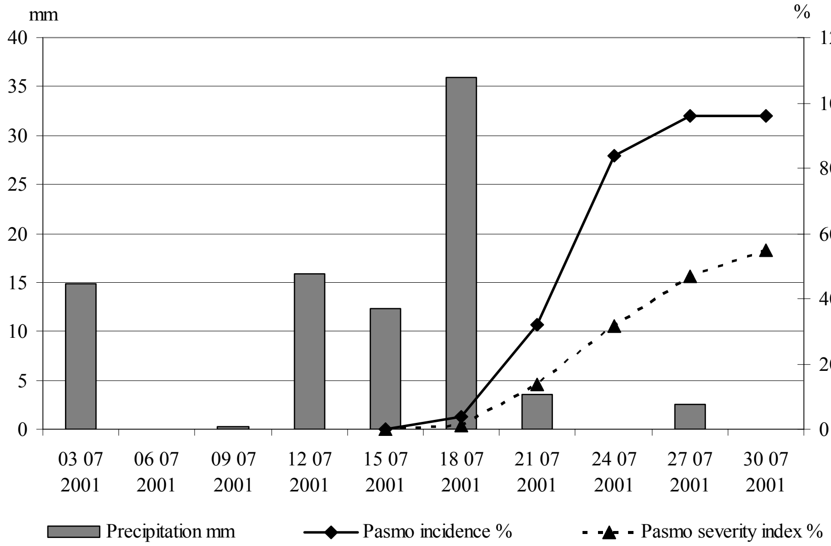

Figure 1. The influence of precipitation on the incidence and severity of pasmo disease in 2001

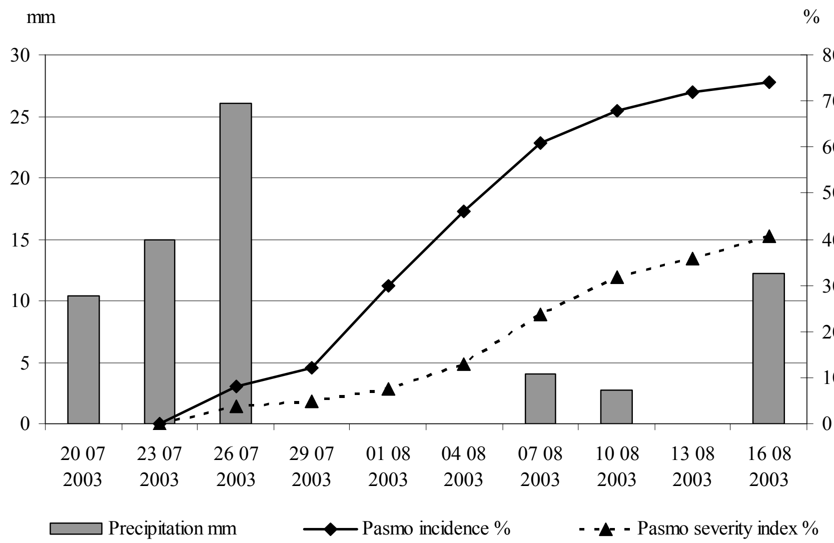

Figure 2. The influence of precipitation on the incidence and severity of pasmo disease in 2003

Our experimental evidence showed that the amount of precipitation during the growing season is one of the main factors promoting pasmo spreading. Korneeva and others /Корнеева, Лошакова, 1976; Andruszewska, Korbas, 1989; Gruzdevienė, Dabkevičius, 2005/ observed that the spread of pasmo disease in flax crop is promoted by rainfall and air temperature during June–August. Investigations of pasmo spreading in the USA and Poland showed that epidemics can occur early in the season when moist conditions, favourable to fungus spreading, prevail /Ferguson et al., 1987; Андрюшенко, Кульбида, 1988/.

Significant positive correlations were detected between pasmo incidence and severity and total rainfall accumulated from June to August in the USA /Bradley et al., 2004/. We recorded the days with temperatures above 20^{o} C, precipitation, and number of rainy days covering the period from June 1 to September 1 (results are provided in Table).

Table. Factors that influenced the spread of pasmo disease during the flax growing period in 2001, 2002 and 2003

Factors	Experimental year		
	2001	2002	2003
Date of the flax early- yellow ripening stage	July 30	July 18	August 5
Date of the appearance of the first spot of pasmo disease	July 16	–	July 30
Maximum incidence of pasmo on flax stems %	96	–	74
Number of rainy days from date of appearance of first spot to maximum incidence of pasmo on flax stems	5	–	5
Days with temperatures above 20^{o} C (from June 1 to September 1)	21	22	21
Rainfall, mm (from June 1 to September 1)	233.4	181.3	188.8
Number of rainy days (1 mm and more from June 1 to September 1)	29	16	28
Number of rainy days (1 mm and more from June 10 to June 31)	8	2	6
Rainfall, mm from date of appearance of first spot to maximum incidence of pasmo	42.0	–	6.7

It is apparent from the data, that the spread of *Septoria linicola* was promoted by abundant rainfall in the second half of flax growing season. In 2001 until July the temperature was lower than the long-term mean and since July the temperature was higher than the long-term mean. The air temperature in 2002 and 2003 was higher than the long-term mean. Pasmo disease spread just in 2001 and in 2003, therefore we can propose that the amount of rainfall had a greater effect on the spread of pasmo in Central Lithuania compared with air temperature.

Conclusions

Pasmo disease in the crops of the variety 'Kastyčiai' severely affected plants in the year 2001 (96%) and in 2003 (74%) at the end of flax growing period. The spread of *Septoria linicola* was favoured by high air temperature and abundant rainfall in the second half of the flax growing season. The amount of rainfall had a greater effect than air temperature. In drier year 2002 pasmo disease did not spread as in the rainy years of 2001 and 2003.

Received 2008-07-08
Accepted 2008-08-22

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