Study of resistance to *Sclerotinia* head disease in sunflower genotypes

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ABSTRACT

In Hungary, the most dangerous head diseases of sunflower are white and grey rots, caused by *Sclerotinia sclerotiorum* (Libert de Bary) and *Botrytis cinerea* (Persoon) respectively. In recent years, the role of fungal species well-disposed to higher temperatures (above 30°C) has also become more important. The intensity of attack by pathogens is not the same from year to year. Nevertheless, in certain years, they cause heavy yield losses and reduced quality. In 2005, the heaviest damage in seed and commercial grain production was caused by *Sclerotinia* head rot. Protection of the sunflower head has some difficulties and, in many cases, treatments do not produce any results. One of the most important aspects of our breeding work is the development of hybrids tolerant to head diseases. Heavy epidemic in 2005 made it possible to confirm the success of selection aimed at tolerance to *Sclerotinia* head rot. Genetic differences in susceptibility to *Sclerotinia* head rot were assessed in performance trials at 4 locations with 17 experimental hybrids and 3 check varieties of MGSZH (Central Agricultural Office, Directorate of Plant Production and Horticulture). Impact of sowing date on degree of infection was studied in two experiments with an earlier (15th April) and a later (2nd May) sowing time. Differences in the level of infection were scored in the plots of nearly isogenic lines and with their hybrids flowering at different dates. Efficiency of chemical treatment was evaluated on the basis of data obtained in treated and untreated plots. Temperature, humidity and rainfall were systematically recorded. Results of trials reflected differences in tolerance between hybrids. Planting date had an indirect influence because the level of damage was highly dependent on the average temperature and quantity of rainfall during bloom. Differences in percentage of infection in nearly isogenic lines and their hybrids flowering at different dates, as well as those in performance trials of hybrids sown on two dates, showed a close significant correlation r=0.84*** with the quantity of precipitation from the beginning to the end of the flowering period. Combining ability of 5 CMS female lines and 5 male restorer lines was studied by coupling model of Comstock and Robinson and analysis of variances was used for the evaluation of the experiment.

Key words: head rot – flowering – *Sclerotinia sclerotiorum* – sunflower – susceptibility – weather.

INTRODUCTION

Sclerotinia sclerotiorum (Lib.) de Bary is one of the most important pathogens in sunflower widely spread all over the world. Korf and Dumont (1972) assigned the species to *Whetzelinia,* a new genus, but objections to this disposition were raised by Dennis (1974). Not only *S. sclerotiorum*, but also *Sclerotinia minor* and *Sclerotinia trifoliorum* Fuckel, are pathogenic to sunflower (Cormack, 1946). After ontogenetic studies of *Sclerotinia* (Willets and Wong, 1971) and electrophoretic investigations (Wong and Willetts, 1973), it was concluded that *S. scelorotiorum, S. trifoliorum* and *S. minor* are three different species.

Originally identified on sunflower in 1861, the fungus has been reported from all sunflower-growing regions of the world (Gulya et al., 1997). Depending on the environmental conditions, it attacks the seedling, root, petiole, stem, and inflorescence. Since there is no 100% efficient chemical protection, hybrids should have good field resistance against this pathogen as well. As chemical control of *S. sclerotiorum* is difficult and uneconomical (Mestries et al., 1998), genetic control appears to be of great value. In the literature, there are no articles showing total resistance to *Sclerotinia sclerotiorum* in cultivated sunflower. However, reports on the identification of sunflower genotypes with low susceptibility or partial resistance are common worldwide. Some wild species include important *Sclerotinia* resistance genes (Seiler and Rieseberg, 1997; Köhler and Friedt, 1999; Degener et al., 1999). Resistance is a polygenic trait (Castaño et al., 1993.) There are two types of resistance in sunflower: (i) resistance to penetration, and (ii) resistance to mycelial extension in the tissues.

Breeders have a better opportunity to assess genetic resistance. A first approach is to make use of the natural infection, but the intensity of pathogen attacks is not the same from year to year. A second approach is to produce artifical infection (Tourvieille and Vear, 1984; Rodríguez et al., 2004). These authors used the following procedure: Ascospores were suspended in sterile distilled water with Tween 80 (0.05%) to a concentration of 5×10^3 spores/ml (10 ml per inflorescence). Plants were checked regularly for flowering. Sunflower heads were sprayed with inoculum when the anthesis of the two outer rows was completed, and so inoculation was produced at anthesis. Control plants were sprayed with water and drops of detergent.

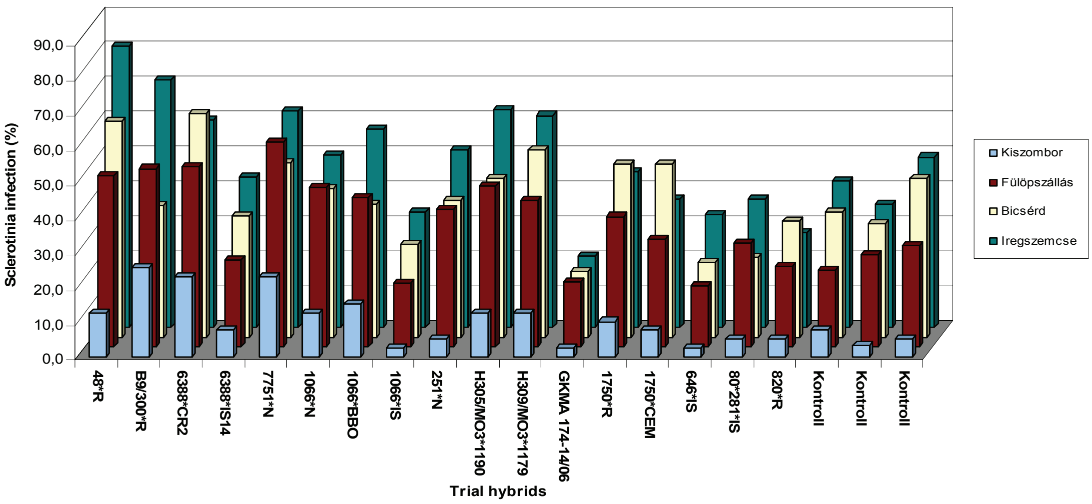
The aim of this study was to analyse genetic differences in susceptibility to *Sclerotinia* head rot at different locations.

MATERIALS AND METHODS

Genetic differences in susceptibility to *Sclerotinia* head rot were assessed in performance trials at 4 locations with 17 experimental hybrids and 3 check varieties of MGSZH (Central Agricultural Office, Directorate of Plant Production and Horticulture). Impact of sowing date on degree of infection was studied in two experiments with an earlier (15th April) and a later (2nd May) sowing time. Differences in the level of infection were scored in the plots of nearly isogenic lines and their hybrids flowering at different dates. Efficiency of chemical treatment was evaluated on the basis of data obtained in treated (6 pair of leaves, initial reproductive stage, and full flowering) and untreated plots. Temperature, humidity and rainfall were systematically. Combining ability of 5 CMS female lines and 5 male restorer lines was studied by coupling model of Comstock and Robinson (1948) and analysis of variances was used for the evaluation of the experiment.

RESULTS AND DISCUSSION

The four locations showed different levels of head infection. The highest and lowest average of attack were 47.7% and 10.2%, respectively. Degree of infection in the most susceptible genotype at the location with the heaviest infection pressure attained 80%, whereas that of the most tolerant hybrid was only 15.1% (Fig. 1.)



LSD 5%=9.3

Fig. 1. *Sclerotinia* infection of trial-hybrids at four locations, 2005

The *Sclerotinia* head rot resistance of hybrids was studied as a function of sowing time and chemical treatment. In the experiment, the mean infection was 14.3%, the highest was 30% and the lowest was 1.5% (Fig. 2). There was no significant difference between chemically treated and untreated plots.

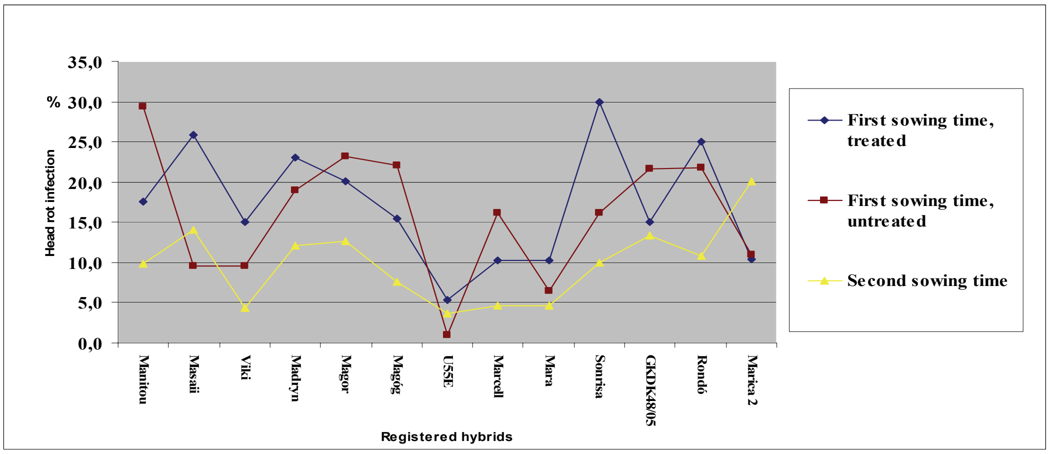


Fig. 2. The *Sclerotinia* head rot resistance of registered hybrids as a function of sowing time and chemical treatment.

Differences for disease incidence between the two sowing dates was analysed with the data of temperature and rainfall at the beginning of flowering, 50% flowering, and full flowering Significant difference was found between the percentages of infection at the two sowing times, the lower infection being on the second sowing date (Fig. 2).

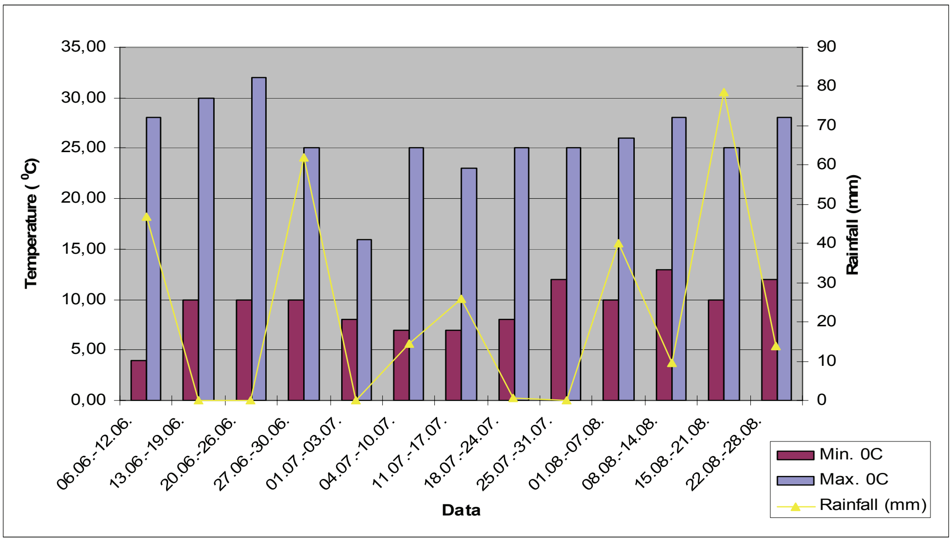


Fig. 3. The ecological conditions during flowering time.

The results of the experiments of the registered hybrids were assessed compared to the results of nearly isogenic lines and their hybrids. The hybrids sown on 28th April were flowering between 10-20 July and their average infection was 17.2%. The hybrids sown on 14th May were flowering between 18-27 July and the average infection was 9%. The ecological conditions during flowering time were examined on the basis of the data (Fig. 3).

The weather during the flowering time of the genotypes sown on 1st April was hot (30 °C), there was no rain, and the humidity was under 40%. After flowering, there was 62 mm rainfall but it did not affect the extent of infection.

The head rot infection was significantly higher in the case of the genotypes sown on 30th April, the temperature during the flowering time of these genotypes was lower, the relative humidity was more then 60% all day and the rainfall was 40 mm, compared to the plots flowering before and afterwards. In the experimental area the rainfall was 0.5 mm and there were no hot days. The degree of head rot infection of the genotypes flowering this time was less than that of the genotypes flowering till mid July.

The observations have shown that the weather during flowering time had a huge influence on the head rot infection. Besides genotype sensitivity, the degree of infection was determined by favourable weather conditions for the germination of the ascospores. The failure of the artifical infection can be attributed to the high temperature during the period after infection. Many researchers claim that the optimal temperature for spores germination and infection is 16-25°C. In the experiments at more locations, the considerable differences in the genotype susceptibility were determined by the ecological conditions duing the flowering of a given genotype. Differences in infection percentage in nearly isogenic lines and their hybrids flowering at different dates, as well as those in performance trials of hybrids sown at two dates, showed a close significant correlation (r=0.84***) with the quantity of precipitation recorded from the beginning to the end of the flowering period.

In relation to combining ability, there was a significant difference with respect to general combining ability (GCA) in the mother lines and specific combining ability (SCA) between parental lines. There was one restorer line which had a good GCA to the head rot infection, and this line transmitted the resistance to its hybrids.

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