Genetic diversity of red clover varieties listed in Germany concerning the resistance to Southern Anthracnose

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Abstract

Recently, there has been evidence both from testing sites and agriculturally used fields concerning the appearance of *Colletotrichum trifolii* Bain *et* Essary, causing Southern Anthracnose in red clover and red clover pasture stands. This disease is able to cause large losses in yield. The aim of this investigation was to evaluate all red clover cultivars listed in Germany (in 2009) with regard to their resistance against the pathogen. One foreign genotype 'Starfire', bred in the USA and known to be highly resistant to Southern Anthracnose, was also incorporated into this research. A ranking of the cultivars could be generated based on a test for resistance performed in the greenhouse. The resistance of the cultivars was expressed as a percentage of plant survival seven weeks after inoculation. Results showed a wide range in quantitative resistance characteristics towards *Colletotrichum trifolii* from 29 to 87% survival. Hence the evaluated genotypes can be classified into resistant to susceptible forms. Another important finding was that among the screened varieties diploid cultivars overall seemed to be more resistant than tetraploid genotypes.

Keywords: *Colletotrichum trifolii*, red clover, Southern Anthracnose, *Trifolium pratense*, variety

Introduction

Red clover (*Trifolium pratense* L.) is an essential element in crop rotations, especially for organic farming. In recent years, it became more obvious that there were failures of red clover plants in the field because of 'Southern Anthracnose', a disease caused by the fungus *Colletotrichum trifolii* Bain *et* Essary.
This seed-borne pathogen is known to cause aggressive damage in red clover fields. Typical symptoms are stem lesions resulting in a bending of the stem in the upper zone of the plant. The fungus spreads out via conidia preferentially under warm and moist weather conditions.
At the beginning of 2009, twenty-eight cultivars of *Trifolium pratense* were listed in Germany. This research was intended to find out if there are differences in resistance to *C. trifolii* among the red clover cultivars listed in Germany and to identify sources of resistance for further breeding.

Materials and methods

To classify these listed genotypes according to their level of susceptibility against *C. trifolii*, a test for resistance as stated by Schubiger *et al.* (2003) was performed in the greenhouse under controlled conditions in 2008 and 2009. For that purpose, germinated grains were planted into Quickpots™. The spatial arrangement was totally randomized. The plants were cut five weeks after planting. Two weeks later, they were inoculated with a conidia suspension (spore density

3 x 10^6 spores ml^{-1}; inoculum provided by ART Zürich). Subsequently, the plants were covered with a PVC-tent for incubation for six days. Plants were cut two and six weeks after inoculation and after one week of regrowth (seven weeks after inoculation) the number of dead plants was determined. After having converted the data with the arcsin square root transformation, analysis of variance was performed with the SAS program. The Student-Newman-Keuls Test was used to identify significant differences among genotypes.

Results and discussion

The tested genotypes showed a clear differentiation in terms of susceptibility against the pathogen. The number of survived plants varied over a wide range (Table 1).

Table 1. Ranking of the tested cultivars concerning their resistance against *Colletotrichum trifolii* based on a biennial test in the greenhouse. Same letters mark non-significant differences, $P = 0.05$ (Student-Newman-Keuls Test).

Genotype	Level of ploidy	Plant survival [%]
Starfire	2n	87 a
Pavo	2n	79 b
Merula	2n	69 c
Elanus	4n	66 cd
Global	2n	65 cde
Lemmon	2n	64 cde
Harmonie	2n	60 cdef
Odenwaelder Rotklee	2n	59 cdef
Larus	4n	57 cdefg
Regent	2n	54 defgh
Astur	4n	54 defgh
Milvus	2n	53 defgh
Nemaro	2n	53 defgh
Pirat	2n	50 defgh
Montana	2n	50 efghi
Rotra	4n	48 fghij
Temara	4n	47 fghijk
Diplomat	2n	47 fghijk
Heges Hohenheimer	2n	47 fghijk
Tempus	4n	41 ghijkl
Wiro	2n	39 hijkl
Lucrum	2n	38 hijkl
Taifun	4n	35 ijkl
Maro	4n	35 ijkl
Atlantis	4n	35 ijkl
Titus	4n	35 jkl
Amos	4n	34 jkl
Mars	4n	31 kl
Kvarta	4n	29 l

As expected, the American cultivar 'Starfire' showed the highest level of resistance (87% plant survival). Among the varieties listed in Germany, 'Pavo' showed the best level of resistance, the percentage of surviving plants was 79% on average. The most susceptible cultivar tested was 'Kvarta' with a plant survival rate of 29% only.
The two varieties with the highest level of resistance among the cultivars listed in Germany, 'Pavo' and 'Merula', were bred in areas where *C. trifolii* was present (Boller *et al.,* 1998; Schubiger *et al.,* 2003).

A correlation between plant survival and year of listing can be excluded. Among the screened cultivars in this investigation, diploid genotypes appeared to have a higher rate of plant survival than tetraploid ones. The improvement of resistance occurs earlier in the diploid varieties because of the breeding process performed in praxis, as preselected diploid genotypes are in most cases base material in breeding tetraploid red clover (Boller *et al*., 2010). In surveys by Schubiger *et al.* (2003) the best ranked varieties were also diploid.

Conclusion

The results demonstrated that there were differences in resistance to the fungus *C. trifolii* among red clover cultivars listed in Germany. Although the greenhouse data have to be verified in field tests, it seems to be already possible to identify sources of resistance for further breeding.

References

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