Interspecific Hybrids - A Source for Disease Resistance in Sunflower ?

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Summary

During recent years, sunflower cultivation has been greatly expanded worldwide and particularly in Europe. This expansion of cultivation area causes an increasing confrontation with fungal diseases, such as *Sclerotinia sclerotiorum* and *Botrytis cinerea.* Commercial hybrids of *Helianthus annuus* do not show pronounced resistance against these pathogens, but in different Wild *Helianthus* species distinct resistances against pathogens have been described. Therefore, an interspecific hybridization program, aided by "embryo rescue", was performed between sunflower and different ecotypes of *H. mollis, H. rigidus, H. strumosus* and *H. maximiliani.* Hybrid plants were propagated *in vitro* by meristem culture and backcrossed or selfed in the greenhouse. In 1990 and 1991 resistance tests of $F_2(S_1)$, $F_3(S_2)$, BC_1 and BC_2 progeny were carried out under different environments with highly contaminated fields and also under semicontrolled conditions in the greenhouse. The interspecific hybrid progeny tested showed significant differences in their susceptibility against *Sclerotinia, Botrytis* and *Verticillium.* These differences must be due to the specific genetic constitution of the respective lines.

Introduction

Recently, sunflower production has been expanded in favourable regions of Germany (1988: 20.000 ha, 1992: 77.000 ha) and other European countries (ZMP, 1992). However, the susceptibility of sunflower against various fungal pathogens such as *Sclerotinia sclerotiorum, Botrytis cinerea* and *Verticillium dahliae* causes severe problems, since these pathogens can also attack other important crops. Only a few resistance genes have been found against fungal pathogens so far. Therefore, breeding for resistance is of great importance.

In contrast to cultivated sunflower, several primitive or wild species of *Helianthus* show partial resistances against these fungi. For example resistance against *Sclerotinia* was described in *H. resinosus, H. rigidus* and *H. tuberosus,* whereas *H. decapetalus, H. petiolaris* and *H. tuberosus* were reported to be resistant against *Verticillium* (HOES *et al.*, 1973; PUSTOVOIT *et al.*, 1976; GEORGIEVA-TODOROVA *et al.*, 1979 ; SEILER *et al.*, 1988).

Materials and Methods

In 1991 a selection of 45 progeny lines of interspecific hybrids, which were produced by 'embryo-rescue' (KRÄUTER *et al.*, 1991), were tested together with 3 check hybrids at 3 locations under different climatic conditions. A total of 78 plants of each line were observed in the field after natural infection and in a greenhouse under high temperature and humidity. The interspecific hybrids were subdivided into three groups according to their flowering date; group I needed 49 to 52 days, group II 53 - 58 days and group III 59 to 65 days from emergence to the beginning of flowering.

Results

The disease symptoms caused by *Sclerotinia*, *Botrytis* and *Verticillium* observed in 1991 were relatively weak, because the summer weather was very dry (Fig. 1). Until the end of flowering only a small, linear increase of disease symptoms was visible. At beginning of maturity, i.e. stages 83 - 85 (BIOLOGISCHE BUNDESANSTALT, 1988) the first differences in disease reaction could be observed. While the disease reaction against *Verticillium* decreased, because of plant maturation, the attack by *Botrytis* grew in a very strong way when in late summer the climatic conditions for the fungus, i.e. lower temperature and higher humidity, were more favourable. *Sclerotinia* reaction increased too, but not in the same way as *Botrytis*. Since sunflower heads could be infected by ascospores during maturity, the progress of disease has been relatively linear for *Sclerotinia*.

The interspecific hybrid progeny tested showed significant differences in their susceptibility against *Sclerotinia*, *Botrytis* and *Verticillium* (Tab. 1). In spite of their common pedigree some progenies deviated in their reactions against *Sclerotinia* and *Verticillium*. For example, in progeny of *H. annuus* 'Baso(cms)' x *H. mollis* (MOL-RH, S_2) the mean scores for *Sclerotinia* varied between 1.00 and 2.03 and in the progeny of *H. annuus* 'HA89(cms)' x MOL-1873 (S_3) *Verticillium* scores ranged between 1.20 and 1.33.

In some hybrids, for example 'Baso(cms)' x MOL-RH (S_3), 'HA89(cms)' x *H. giganteus* GIG-1897, S_3) and 'HA89(cms)' x *H. rigidus* (RIG-1848, S_3), progenies could be selected which were less susceptible against *S. sclerotiorum*, and progenies of 'HA89(cms)' x MOL-1873 (S_3) and 'HA89(cms)' x RIG-1848 (S_3) had less susceptibility against *V. dahliae* than the check cv. 'Alphasol'. However, only one cross progeny could be identified so far, i.e. 'HA89(cms)' x MOL-1873 (S_3), which showed a better reaction to *Botrytis* than the check variety.

Early and late flowering interspecific hybrid progeny were less susceptible against *Sclerotinia* than those with an average flowering date. The early group (49 to 52 days from emergence to flowering) showed the highest susceptibility to *Verticillium* (Fig. 2).

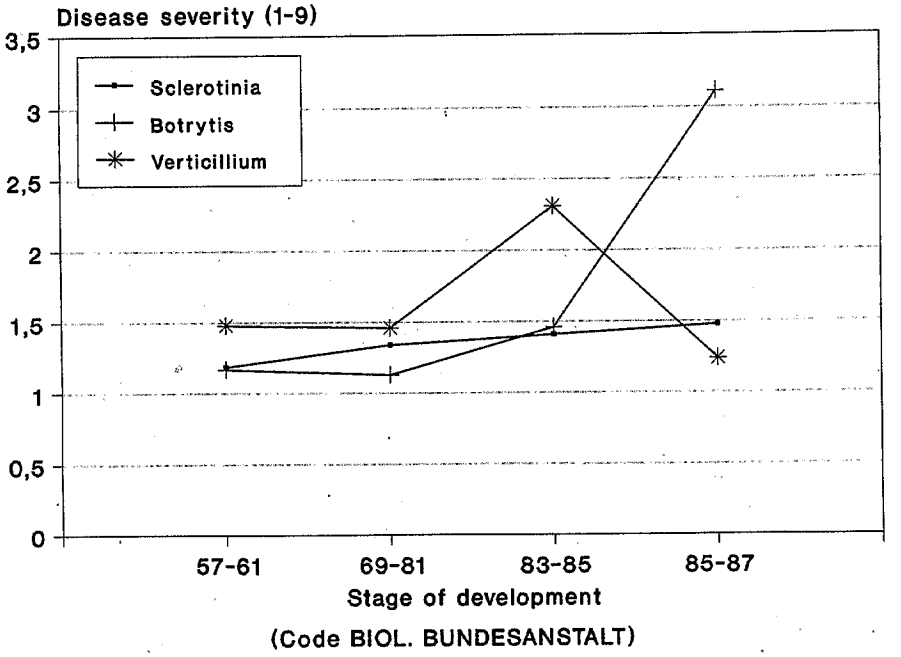

Figure 1. Infestation curves of different sunflower diseases in 1991 .

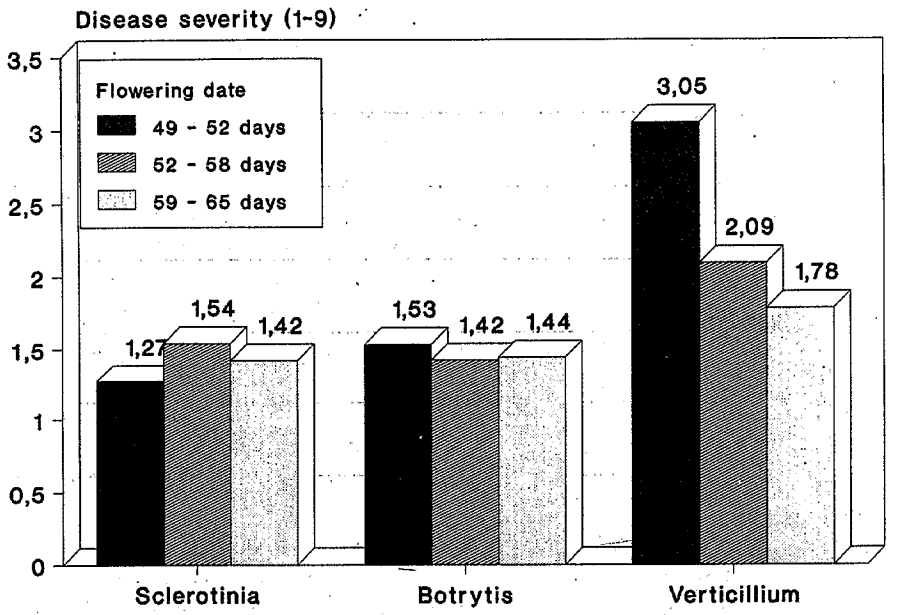

Figure 2. Disease severity in relation to flowering date

Tab.1 Disease reactions of selected progeny of interspecific hybrids in the genus *Helianthus* as compared to sunflower check cultivars

Interspecific Hybrid	Generation [a)]	Mean score [b)] Sclerotinia	Botrytis	Verticillium
group I (49 to 52 days from emergence to beginning of flowering)				
Baso(cms) x MOL-RH	S_2	1.00	3.08	2.90
Baso(cms) x MOL-RH	S_2	2.03	3.96	3.02
Baso(cms) x MOL-RH	S_2	1.36	3.21	2.52
Baso(cms) x MOL-RH	S_2	1.35	3.78	2.68
Baso(cms) x MOL-RH	BC_1S_1	1.00	2.56	2.80
'Sunking-256' (check variety)		1.96	3.67	3.39
group II (53 to 58 days from emergence to beginning of flowering)				
Baso(cms) x MOL-RH	S_2	1.04	3.47	3.53
HA89(cms) x DEC-Dijon [c)]	BC_2S_1	1.47	3.51	2.82
HA89(cms) x STR-1974 [c)]	BC_2S_1	1.09	4.04	1.64
HA89(cms) x MAX-40 [c)]	S_3	1.36	2.42	1.81
HA89(cms) x MOL-1873	S_3	1.35	1.97	1.20
'Alphasol' (check variety)		2.61	2.77	2.28
group III (59 to 65 days from emergence to beginning of flowering)				
HA89(cms) x GIG-1897	S_3	1.00	3.04	2.56
HA89(cms) x GIG-1897	S_3	1.18	3.38	1.20
HA89(cms) x MOL-1873	S_3	1.44	3.15	1.33
HA89(cms) x RIG-1848	S_3	1.00	3.25	1.81
HA89(cms) x RIG-1848	S_3	1.58	3.18	1.56
'Frankasol' (check variety)		1.53	1.80	1.93
Average (48 entries)		1.48	3.11	2.31
LSD 5%		0.87	0.80	0.60.60

[a)] S = Selfed generation; BC = Backcross generation; [b)] 3 locations, 3 replications, 1991; score: 1-9 (1 = no infection; 9 = dead); [c)] DEC-Dijon = *H. decapetalus*, STR-1974 = *H. strumosus*, MAX-40 = *H. maximiliani*

Discussion and Conclusion

Clear differences in the degree of susceptibility to all pathogens were recorded between interspecific hybrids and between progenies of the same cross. These differences must be due to the specific genetic constitution of the respective lines (S_2- and S_3-generation).

However, the results presented above are based on annual observations only. Therefore,

the trial will be repeated in subsequent years, because the reaction of sunflower to pathogens like *Botrytis*, *Sclerotinia* and *Verticillium* depends on both, genetic and environmental factors. Their specific contributions will be further clarified in respective experiments. For example, factorial crosses are to be carried out in order to estimate genetic variances.

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