# EVALUATION OF SUNFLOWER GERMPLASM FOR RESISTANCE TO PHOMOPSIS STEM CANKER

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**Summary**

Evaluation of resistance to *Phomopsis* stem canker of Yugoslav commercial and experimental hybrids, some USDA released inbreds, and Plant Introduction sunflower germplasm continued during 1997-1999. The Yugoslav hybrids proved to be the best, with no symptoms or less than 10% of diseased plants attacked by *Phomopsis* in Yugoslavia and the U.S.A. Some French and Yugoslav/French joint hybrids showed good resistance to *Phomopsis* too. The hybrids, particularly those from Yugoslavia and France, continued to display the highest level of *Phomopsis* resistance in comparison with hybrids from the rest of the world. Most European hybrids still do not have the necessary level of resistance to *Phomopsis*.

Hybrids in the FAO trial showed a wide variation in number of infected plants (from less than 10% to as much as 87 %).

USDA inbreds are quite susceptible to *Phomopsis*. After three years of testing, it can be seen that 3 lines might be used in future breeding programs. These lines are interesting because they can be supplied free of charge to breeders all over the word.

The best 50 entries from the plant introduction station in Ames, Iowa were re-tested in Novi Sad and also in Minnesota, USA. Only 12 of the 50 entries had a *Phomopsis* infection level of less than 20%. In Novi Sad, the same entries had an 8.3 to 60% infection rate.

In 1997 we had the most severe attack by *Phomopsis* and it was one of the most favorable year for this pathogen. Any material that showed resistance in that year is undoubtedly resistant.

Key words: *Phomopsis* stem canker, evaluation, resistance,

## Introduction

Ever since *Phomopsis* (*Diaporthe*) was found and identified in Yugoslavia (Maric and Masirevic 1980, Mihaljcevic *et al*., 1980), it has been considered the most serious disease in Europe in the last fifteen years.

In the U.S.A., *Phomopsis* stem canker has steadily increased in prevalence until it was found in 88% of fields and affected 17% of plants in 1995 (Gulya, 1996)

This pathogen has caused yield losses of up to 40% (1t|ha) in sunflower crops in France since its appearance in 1984 (Carre 1993). In France, genetic and chemical control methods developed in the last 15 years have been quite efficient in limiting the attacks. Cetiom in France classified some hybrids as having low susceptibility or very low susceptibility to *Phomopsis* and suggested their growing in the most infected regions. This may be complemented by chemical control during the periods most favorable for infections (Penaud and Jouffret 1996. and Lespinas 1998).
In Hungary, according to Waltz and Csikasz (1998), particular attention must be paid to the pathogen diversity in screening for resistance and in breeding programs.

Yugoslav hybrids that are widely used in commercial production do not need to be treated with chemicals against *Phomopsis*.

The highest level of *Phomopsis* attack, a *Phomopsis* epidemic, was recorded in 1997 in the valley of the Danube River. The high level of attack observed in Yugoslavia that year even in tolerant hybrids suggests that more aggressive isolates may have developed (Masirevic et al., 1998). In breeding programs, where the level of resistance or tolerance of a genotype is determined either in field trials under natural infections or by artificial infections with ascospores, it is necessary to know whether any interactions occur between the responses of sunflower genotypes and either climatic conditions or fungal isolates (Bertrand and Tourvieille 1987;Vranceanu *et al*., 1983) Field screening of germplasm was established in 1989 and is a continuing job (Masirevic and Gulya 1996). Foliar infections are generally observed in early July (4 -7 July) at flowering. The most susceptible lines are killed before the physiological maturity and are very often lodged. (Masirevic and Gulya 1992.) The objectives of these studies were to continue the testing of germplasm for *Phomopsis* resistance under natural infection and to gather information on the *Phomopsis* reaction of different hybrid and lines.

In breeding for resistance, it is very important to take care of host interactions both with pathogen isolates and the environment over several years. An objective of these studies was also to confirm this, which is why our investigations were undertaken during a three-year period and why the same genotype was tested in different locations in the U.S.A. and Yugoslavia. With such an experiment, we might have differential genotypes. That way we can very easily identify different *Phomopsis* populations.

## Materials and methods

Evaluation of the sunflower germplasm was done in field trials in Novi Sad, Yugoslavia. The nearest known sunflower field from the previous year was about 400 m away, so the amount of airborne inoculum was unknown.

Each entry was planted in 4-row, 6-m long plots, with 25 plants per row, a row-to-row spacing of 70 cm, and four replications. No supplemental inoculum was used in the trial.

The plot was planted with several different trials: the first trial included 123 commercial Yugoslav and joint hybrids. In Minnesota, U.S.A., 131 different hybrids have been sown with the same design as in Yugoslavia. The second trial involved foreign hybrids from the FAO trials and 22 released USDA inbreds, some plant introductions (a group of 37 plant introductions) that had shown a high level of resistance in previous tests in Yugoslavia and the U.S.A.

The disease symptoms - stem lesions, plants killed by *Phomopsis* and lodging - were assessed after flowering and again at physiological maturity. In order to simplify the disease rating, counts were made of plants showing the type of *Phomopsis* symptoms on the stem (lesions).

## Results and discussion

*Commercial and experimental hybrids*

A total of 123 oilseed hybrids from Yugoslavia and joint hybrids developed with different companies were included for comparisons and tested in 1997. In these very late-sown crops only 12 hybrids had less than 30% of plants attacked by *Phomopsis*. In this extremely favorable year for *Phomopsis*, the most resistant hybrids were NS-H-452, NS-H-474, NS-H- 500 and Alamo.

*FAO hybrids*

The most resistant hybrids were NS-H-476, NS-H-482 and NS-H-470. A local susceptible check had 73.1% of infected plants. A local resistant hybrid had 11.9% of diseased plants.

In the U.S.A, the hybrids NS-H-470 and NS-H-476 had 1% of diseased plants and were the most resistant hybrids among the 131 genotypes tested.

Hybrids, particularly Yugoslav and some French-Yugoslav joint ones, continued to display the highest levels of *Phomopsis* resistance. Most of the European hybrids do not have the necessary resistance to *Phomopsis* to be suggested for growing in infected areas. A similar situation exists with Australian and most US hybrids.

*USDA released inbreds-*

During the three-year period (1997-1999), 26 inbreds were evaluated. Table 1 shows that 1997 was the most favorable year for *Phomopsis*. In that year, only four entries had less than 20% of

**Table. 1. REACTION OF SOME USDA INBREDS TO *PHOMOPSIS* IN 1997-1999 YEAR**

| No | LINES | *Phomopsis % - Year* | | | Average |
|---|---|---|---|---|---|
| | | ***1997.*** | ***1998.*** | ***1999.*** | |
| 1 | HA 61 | 30,77 | 5,10 | 8,30 | 14,72 |
| 2 | HA 300 | 45,45 | 25,00 | 8,30 | 26,25 |
| 3 | HA 302 | 75,00 | 10,00 | 8,30 | 31,10 |
| 4 | DEM-2 | 42,10 | 10,00 | 16,70 | 22,93 |
| 5 | DEM-3 | 39,10 | 57,50 | 8,30 | 34,97 |
| 6 | HAR-4 | 11,76 | 5,12 | 4,20 | 7,03 |
| 7 | HA-335 | 35,00 | 85,32 | 4,20 | 41,50 |
| 8 | HA-337 | 15,00 | 20,10 | 12,50 | 15,87 |
| 9 | RHA-265 | 22,22 | 5,10 | 12,50 | 13,27 |
| 10 | RHA-274 | 14,28 | 10,15 | 4,20 | 9,54 |
| 11 | RHA-801 | 10,00 | 13,12 | 4,20 | 9,11 |
| 12 | RHA-293 | 50,00 | 30,72 | 12,50 | 31,07 |
| 13 | HA-207 | 57,89 | 15,22 | 20,80 | 31,30 |
| 14 | HA-850 | 35,00 | 30,08 | 4,20 | 23,10 |
| 15 | ND-01 | 81,81 | 25,14 | 4,20 | 37,05 |
| 16 | CM-29 | 40,00 | 17,15 | 4,20 | 20,45 |
| 17 | RHA-801 | 30,43 | 30,12 | 4,20 | 21,58 |
| 18 | RHA-325 | 38,89 | 8,12 | 8,30 | 18,44 |
| 19 | NS-H-T(DM-4) | 85,71 | 0,0 | 12,50 | 32,74 |
| 20 | HIR-34 | 41,18 | 45,10 | 4,20 | 30,16 |
| 21 | 803-1 | 94,74 | 0,0 | 8,30 | 34,35 |
| 22 | RHA-295 | 42,86 | 22,19 | 8,30 | 24,45 |
| | **AVERAGE** | 42,70 | 21,38 | 8,33 | 24.14 |

infected plants. These lines are HAR-4, HA 337,RHA 274 and RHA 801. Over the three-year period (1997 - 1999), only three lines had less than 10% of infected plants - HAR-4, RHA 274 and RHA 801. Furthermore, only 6 entries had less than 20% of infected plants during the three-year period on average.

*Re-testing of some plant introductions*

The 37 entries have been also planted for re-testing in the U.S.A. and Yugoslavia for the purpose of comparison. In the Minnesota test, only 12 of 50 entries had a less-than-20% infection level. The best entry in that trial was PI 431567 (2%), followed by 490282 (8%). In the Novi Sad trials, during the three-year period, four entries had less than 5% of diseased plants. Fourteen entries, or 37,8% of tested Plant Introductions, had up to 10% of diseased plants. Furthermore, it can be seen that 27 entries had less than 20% of infected plants.

The most resistant varieties were 490282 (also in the U.S.A.), 490281 and An 18294. For future breeding programs, lines 433862,494862, A-10101, 494857, A 5892 and A 18924 may be used as promising materials in breeding for resistance or tolerance to *Phomopsis* stem canker.

The results from the three-year period are slighty different compared with comparing with the results from U.S.A. It might be thought that different responses suggested a different fungal

**Table. 2. REACTION OF PLANT INTRODUCTIONS SUNFLOWER GERMPLASM TO *Phomopsis* IN 1997-1999 IN USA AND YUGOSLAVIA**

| No | ENTRIES | *Phomopsis %* | | | | Average |
|---|---|---|---|---|---|---|
| | | *YEAR* | | | | |
| | | *1997.* | | *1998.* | *1999.* | |
| | | *USA* | *YU* | | | |
| 1 | A-3082 | 59,4 | 50,00 | 11,00 | 8,30 | 23,10 |
| 2 | 433862 | 31,0 | 14,28 | 1,00 | 0,00 | 5,10 |
| 3 | 494862 | 46,8 | 16,67 | 1,00 | 0,00 | 5,89 |
| 4 | 21671 | 36,9 | 33,33 | 0,00 | 0,00 | 11,11 |
| 5 | 433377 | 48,2 | 28,57 | 0,00 | 16,70 | 15,10 |
| 6 | A-15656 | 27,7 | 44,44 | 0,00 | 8,30 | 17,58 |
| 7 | A-14176 | 37,2 | 60,00 | 1,00 | 0,00 | 20,33 |
| 8 | A-10101 | 21,0 | 9,09 | 0,00 | 8,30 | 5,80 |
| 9 | 253771 | 30,2 | 15,38 | 0,00 | 8,30 | 7,90 |
| 10 | 250085 | 10,5 | 33,33 | 1,00 | 0,00 | 11,44 |
| 11 | A-10102 | 14,0 | 42,86 | 0,00 | 16,70 | 19,85 |
| 12 | A-10103 | 18,9 | 20,00 | 1,00 | 16,70 | 12,57 |
| 13 | 494864 | 20,5 | 57,14 | 0,00 | 0,00 | 19,05 |
| 14 | P.I. 243078 | 37,7 | 28,57 | 0,00 | 0,00 | 9,52 |
| 15 | 431567 | 2,4 | 60,00 | 1,00 | 33,33 | 31,44 |
| 16 | 480473 | 30,5 | 44,44 | 0,00 | 0,00 | 14,81 |
| 17 | 490282 | 7,9 | 8,33 | 0,00 | 0,00 | 2,80 |
| 18 | 490281 | 17,4 | 0,0 | 0,00 | 8,30 | 2,80 |
| 19 | 494857 | 34,8 | 0,0 | 9,40 | - | 4,70 |
| 20 | 497249 | 71,2 | 33,33 | 0,00 | 8,30 | 13,88 |
| 21 | A-5892 | 50,1 | 0,0 | 1,00 | 16,70 | 5,90 |
| 22 | 377530 | 40,3 | 33,33 | 0,00 | 16,70 | 16,70 |
| 23 | 431562 | 23,0 | 14,28 | 67,00 | 33,33 | 38,20 |
| 24 | 431563 | 11,3 | 33,33 | 22,22 | 25,00 | 26,85 |
| 25 | A-3416 | 14,7 | 33,33 | 63,10 | 8,30 | 34,91 |
| 26 | 219649 | 38,50 | 16,67 | 8,70 | 0,00 | 8,46 |
| 27 | A-3414 | 27,00 | 0,00 | 16,60 | 8,30 | 8,30 |
| 28 | 243074 | 47,10 | 0,00 | 27,80 | 0,00 | 9,27 |
| 29 | A-3085 | 41,60 | 20,00 | 0,00 | 0,00 | 6,67 |
| 30 | A-3301 | 30,30 | 14,28 | 44,44 | 16,70 | 25,14 |
| 31 | A-3426 | 10,20 | 6,00 | 55,60 | 0,00 | 20,53 |
| 32 | 500693 | 48,70 | 50,00 | 11,10 | 16,70 | 25,93 |
| 33 | A-3307 | 22,00 | 25,00 | 10,50 | 8,30 | 14,60 |
| 34 | A-3231 | 22,10 | 25,00 | 21,10 | 0,00 | 15,37 |
| 35 | 500695 | 22,80 | 25,00 | 5,60 | 0,00 | 10,20 |
| 36 | A-18924 | 7,80 | 0,00 | 0,00 | 8,70 | 2,90 |
| 37 | A-3372 | 27,10 | 25,00 | 61,10 | 8,70 | 31,60 |
| | ***AVERAGE*** | 29,43 | 24,90 | 11,95 | 8,35 | - |

biotype, but examination of the data from the three years and different locations in the same year revealed enviroment by genotype interactions.

A similar variation was identified with some of the inbred lines. In breeding for good and stable resistance to *Phomopsis*, it is neccesary to take into consideration interactions of the pathogen and the enviroment over several years.

In a study we conducted in France (Viguié *et al*., 1999) to determine the aggressiveness of *Phomopsis* isolates sampled in Yugoslavia compared with those of French origin, the isolates of the Institute of Field and Vegetable Crops showed the same variability of aggressiveness as the French isolates. Earlier, we found that Yugoslav and French isolates of *Phomopsis* are very similar. So, the results we obtained in Yugoslavia can be used in France. The aggressiveness observed among the Yugoslav isolates has not been particularly great. Thus, the high attack levels observed in Yugoslavia in 1997 may have been due to climatic conditions and other environmental factors that depend on the location rather than to new, highly aggressive isolates (Viguié *et al*., 1999). It is very clear that the resistance to *Phomopsis* depends not only on the virulence of the pathogen but also on the environment.

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