T1988CROP33

CORRELATION BETWEEN ENVIRONMENTAL CONDITIONS AND THE DEVELOPMENT OF THE TELEOMORPHOSIS IN DIAPORTHE HELIANTHI

M. Muntañola-Cvetković*, J. Vukojević*, M. Mihaljčević**, M. Petrov**
* Institute for Biological Research "Siniša Stanković", Belgrade
** Institute of Field and Vegetable Crops, Novi Sad; Yugoslavia.

SUMMARY

The teleomorph Diaporthe helianthi develops as a saprobe on dead sunflower stems which during the plant vegetative period were attacked by Phomopsis helianthi. The fungus nuclear phase change, from anamorphosis to teleomorphosis, occurs in autumn, when ascogonia begin to form in dead host tissues. Protoperithecial development is adapted to winter conditions. The low temperatures of the winter months prevent the ascoma initials from developing too fast. Ascoma must achieve maturation at the onset of the host vegetation to fit the nutritive requirements of the fungus parasitic phase. The development of the teleomorphosis in the field will be as harmonious to the parasitic nature of the fungus anamorphosis as the ecological circumstances will permit. During field or laboratory warm spells, perithecia may precociously mature if a high moisture level in the substrate is available. This precocity could be of 2-4 months in the field.

RESUMEN

En su fase teleomórfica, Diaporthe helianthi se desarrolla como sáprobo en restos de tallos de girasol que en el período vegetativo de las plantas fueron atacados por Phomopsis helianthi. El cambio de fase nuclear del hongo, de la anamorfosis a la teleomorfosis, ocurre en otoño, cuando en los tejidos muertos o moribundos del hospedante empiezan a formarse ascogonios. El desarrollo de éstos está sujeto a las condiciones invernales. Las bajas temperaturas de los meses de invierno impiden a los primordios de los ascocarpos desarrollarse con rapidez. La maduración de los peritecios debe coincidir con el arranque de la vegetación del hospedante para que los requerimientos nutritivos de la fase parasitaria del hongo puedan ser satisfechos. El desarrollo de la teleomorfosis en el campo estará tan en armonía con la naturaleza parasitaria de la fase anamórfica como las circunstancias ecológicas lo permitan. Durante periodos más templados en el campo, o en condiciones de laboratorio, los peritecios pueden madurar precozmente en presencia de un alto nivel de humedad. Esta precocidad puede ser de 2-4 meses.

INTRODUCTION

In a histological study on the development of Diaporthe helianthi Munt.-Cvet. et al. in natural conditions it was shown (Muntañola-Cvetković et al., 1988) that in Yugoslavia the parasitic phase of this holomorph, i.e. the anamorph Phomopsis, develops on living sunflower plants during their vegetative period; the teleomorph, the Diaporthe state, develops as a saprobe on sunflower debris beginning from autumn, when ascogonia form in the moribund or dead host tissues. Further events lead to protoperithecial development, which normally begins to be evident in November-December. During the next months internal differentiation and dimensions of these structures gradually increase. Perithecial maturation may occur from April-May, but it becomes a large scale phenomenon in June-July. Ascospore release during these months have been reported by Petrov et al.(1981) in Yugoslavia, and by Fayret & Assémat (1987), Bertrand & Tourvieille (1987) and others in France.

However, Muntañola-Cvetković et al. (1988) have also reported that, in certain years, many ascomata naturally formed in sunflower stem fragments left in the field mature before the onset of the host vegetation.

Investigations have been carried out here to determine what kind of correlation exists between environmental conditions and ascospore maturation.

Additional studies have been conducted using diseased sunflower stem fragments that underwent experimental conditions in which water supply and temperatures were varied.

MATERIAL AND METHODS

Material collections and histological techniques were the same as those employed by Muntañola-Cvetković et al. (1988) in their investigations on the development of D.helianthi in sunflower stems under natural conditions.

Meteorological data were obtained from the official meteorological stations in Vojvodina (1980-1988). Mean, max. and min. temperatures were recorded at 5 cm above the soil since these have the greatest effect upon debris left in the field from Sept. until May. Data from Rimski Šančevi were used to illustrate the results obtained, since the bulk of the studied material originates from that locality.

RESULTS

Graphs 1 and 2 and Table 1 present the results obtained.

During the years comprised in this study, D.helianthi ascogonia were observed in dead sunflower stem fragments beginning from early autumn and continued to be found in subsequent months. Dry and/or cold periods retarded the appearance of these structures, which indicate that the anamorphosis had passed to the teleomorphosis.

Protoperithecia were detected sometimes as early as mid-November (1980, 1985), but environmental factors obviously influenced the ontogenesis of these structures. Mild temperatures and high humidity in the soil favoured their fast development, so that precocious perithecial maturation might occur during the winter months, as in February and March 1982, or in January 1986. Unsuitable levels of these two factors, or of one of them, prevented the development of the protoperithecia. In January 1987 the moisture was high in the soil, but the low temperatures were the factor which restrained protoperithecial further differentiation. In January 1988 the holding factor was the lack of atmospheric precipitation.

Experiments carried out in vitro sustain these findings. Sunflower stem fragments were periodically collected during 1980/81 and 1987/88 winter months. No perithecia were macroscopically visible on these samples, but histological sections revealed the presence of protoperithecia up to 135 µm in diam. The fragments were placed in wet chambers under laboratory light conditions at 22°-23°C. Perithecial necks showed through the host epidermis in 5-10 dy and ascospore maturation was attained in 10-20 dy (Table 1). These phenomena were not observed in those samples that were not placed in wet chambers. The results obtained here in this context confirm those recently reported by Fayret & Assémat (1987) in France.

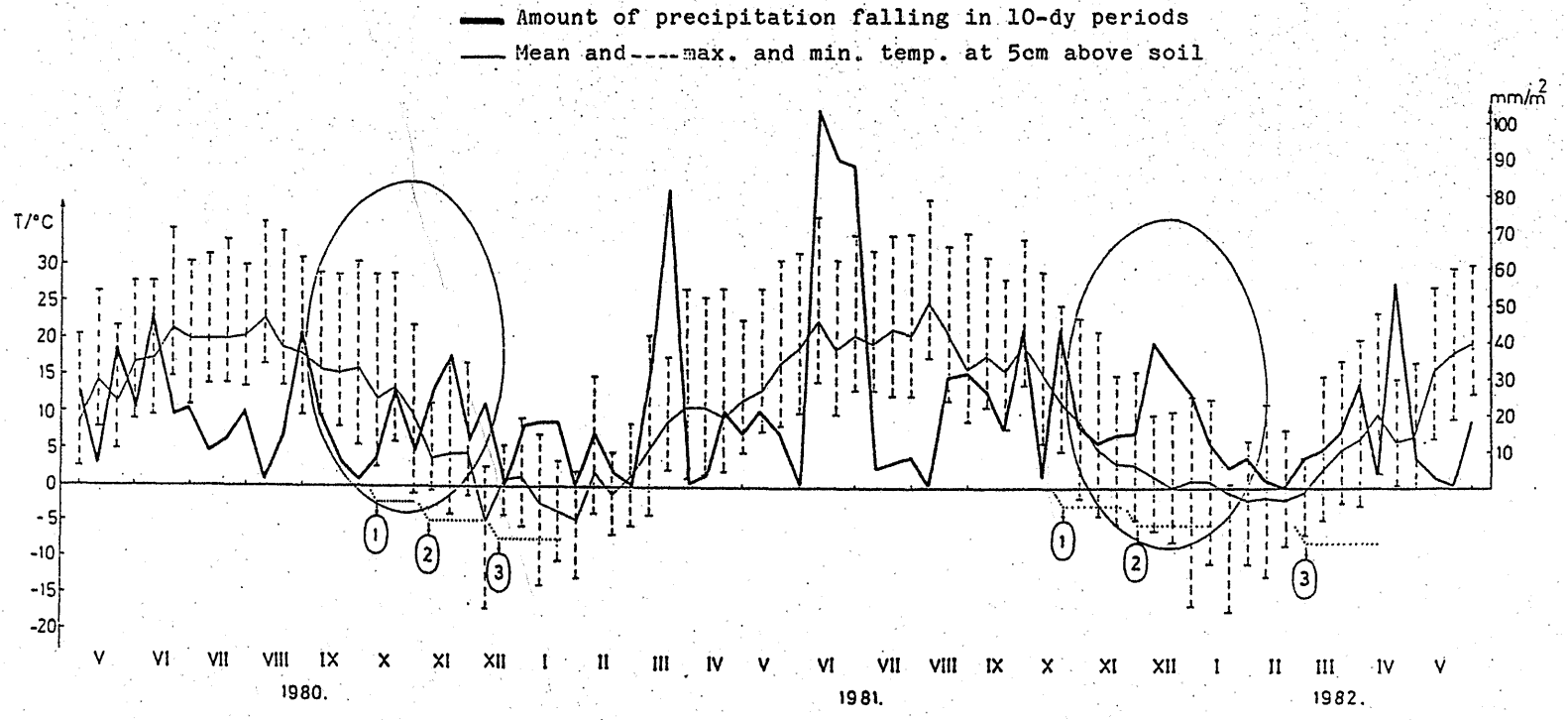
DISCUSSION

In temperate climates winter is often a decissive factor in fungal fruting patterns. Many parasitic Ascomycotina are adapted to winter conditions, so that the development cycles of these fungi fits the development cycles of their hosts: ascospores will be ready to carry out infections in spring, at the onset of the host vegetative growth.

Two hypothesis can be stated in this context:

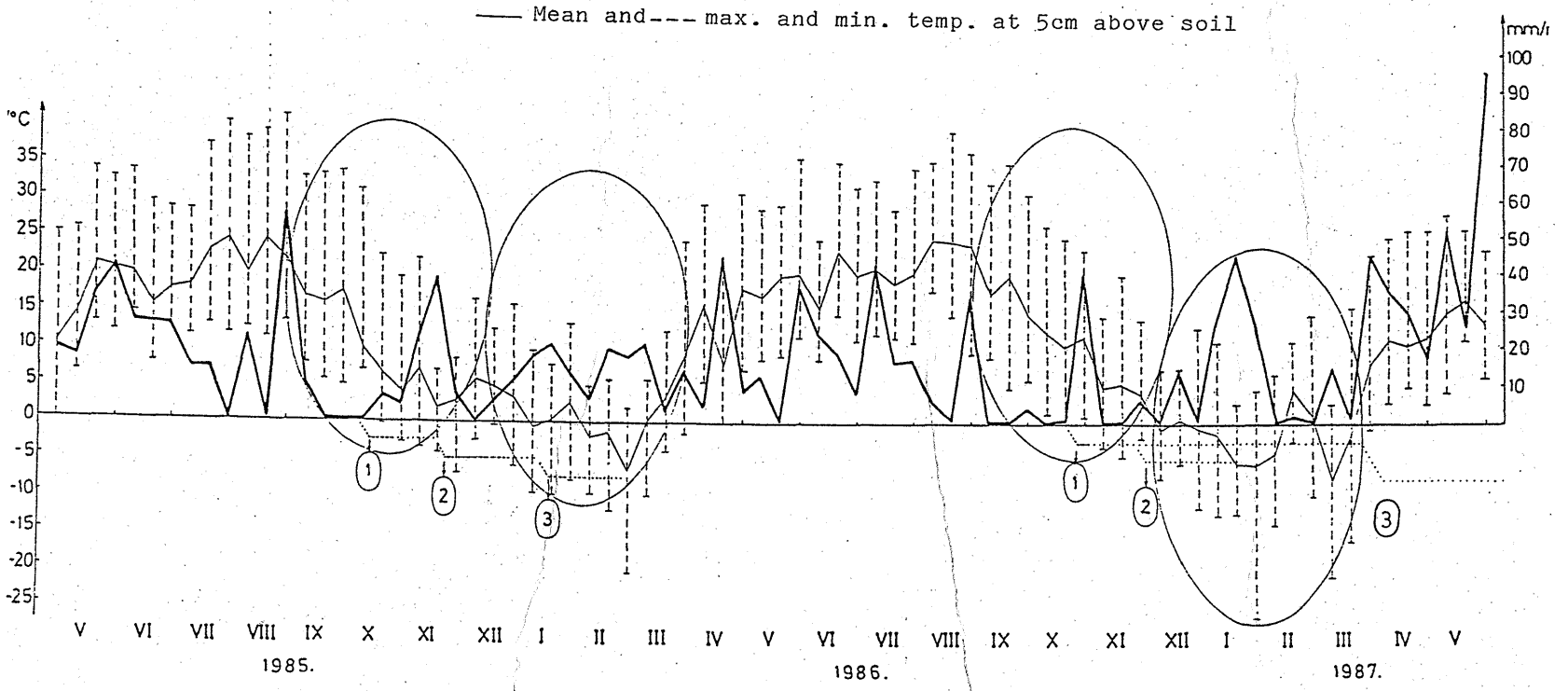
1) Some mechanisms prevent the teleomorphs of these fungi from a precocious maturation; or
2) the winter environmental conditions prevent these teleomorphs to develop in the way they would do under favourable conditions.

Graph 1. Weather diagram compiled from observations taken in Rimski Šančevi in a 2-yr period, between V.1980 and V.1982



Legends: ① ascogonia; ② protoperithecia; ③ mature perithecia

Graph 2. Weather diagram compiled from observations taken in Rimski Šančevi in a 2-yr period, between V.1985 and V.1987



Legends: (1) ascogonia; (2) protoperithecia; (3) mature perithecia

TABLE 1.

THE EFFECTS OF WARM SPELLS ON THE TELEOMORPHOSIS DEVELOPMENT IN DIAPORTHE HELIANTHI

FIELD MATERIAL COLLECTED ON	TELEOMORPHOSIS EXPRESION	WET CHAMBER AT 22° - 23°C UNTIL	
26.XII 1980	- Perithecia not visible on the host epidermis	15.I 1981:	Mature perithecia
15.I 1981	- "	30.I 1981:	Mature perithecia
25.XII 1987	- "	5.I 1988:	Perith. necks show through the host epidermis
	- protoperith. up to 115 µm in diam	10.I 1988:	Perith. necks 340-650 µm long above the host epidermis
		12.I 1988:	Ascospore maturation.
21.I 1988	- protoperith. up to 135 µm in diam	25.I 1988:	Perith. necks show through the host epidermis
		30.I 1988:	Perith. necks 300-675 µm long above the host epidermis.
		2.II 1988:	Ascospore maturation.
8.II 1988	- protoperith. up to 100 µm in diam	18.II 1988:	Perith.necks show through the host epidermis.
		22.II 1988:	Perith. necks 100-310 µm long above the host epidermis.
		23.II 1988:	Ascospore maturation
15.II 1988	- protoperith. not measured	19.II 1988:	Incipient perith. necks.
18.II 1988	- protoperith. up to 135 µm in diam	22.II 1988:	Incipient perith. necks.

The obtained results sustain the second hypothesis for D.helianthi.

1. In natural condition, periods of very cold temperatures from December to March are holding periods in which only slow or no fungal development occurs; after these periods have passed, normal growth is possible. In that case perithecial maturation coincides with the sunflower vegetative onset.

However, during winter months with relatively mild temperatures and high humidity in the soil perithecia may precociously achieve maturation, as it was observed in a number of samples collected in February and March 1982, or in January-February 1986.

2. In experimental conditions, the results presented in Table 1 show that perithecial ontogenesis iniciated in the field can be accelerated under suitable laboratory temperatures and water supply. Under a laboratory warm spell, perithecia achieve maturation in a much shorter period than in natural field conditions, if a high moisture level is available in the substrate.

CONCLUSIONS

* The anamorphosis nuclear phase change to the teleomorphosis of Diaporthe helianthi occurs in autumn. Further development of the teleomorph in the field is adapted to winter conditions. The low temperatures of the winter months prevent the ascoma initials from developing too fast. Ascomata must achieve their maturation at the onset of the host vegetation to meet the parasitic requirements of the fungus.

* The development of the teleomorph in the field will be as harmonious to the parasitic nature of the anamorphic phase of the fungus as the ecological circumstances will permit.

* During field or laboratory warm spells, perithecia may precociously mature if a high moisture level in the substrate is available.

REFERENCES

Bertrand F., Tourvieille D., 1987. Phomopsis tournesol: Tests de selection. Inform. Techn. CETIOM nº 98, 12-18.

Fayret J., Assémat P., 1987. Evolution du Diaporthe helianthi Munt-Cvet et al. et différentiation des organes reproducteurs sur les plantes de tournesol après la période de végétation. Inform. Techn. nº 98, 2-11.

Muntañola-Cvetković M., Vukojević J., Mihaljčević M., 1988. Pathohistology of sunflower stems attacked by Diaporthe helianthi (submitted).

Petrov M., Muntañola-Cvetković M., Mihaljčević M., 1981. New findings on the disease of sunflower plants caused by Phomopsis helianthi Munt.-Cvet. et al. (Diaporthe helianthi Munt.-Cvet. et al.). Archives des Sciences Biologiques (Beograd) 33, 13-19.