RESULTS OF A TWO-YEAR INVESTIGATION ON THE MOST IMPORTANT PATHOGENS IN ITALY

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The cultivation of sunflower in Italy has notably increased in recent years. The crop has been extended into new areas and two new types of agrotechniques introduced : early spring planting with irrigation and summer planting following wheat or barley. Furthermore, many new hybrids have been introduced into Italy and new chemical biological methods of disease control have been experimented. In consequence, there have been substantial modifications in the field of phytopathology with respect to the past.

The purpose of this research was to provide information on the pathological situation of sunflower in Italy, particularly the severity of the diseases present in the most important areas of sunflower cultivation.

Plasmopara helianthi Novot : the pathogen which was the most destructive disease in the 1970's (Monotti and Zazzerini, 1974), when it caused notable damages to production primarily in Central Italy (Zazzerini *et al.*, 1978), is no longer a problem, due to introduction of hybrids resistant to the R 1 and R 2 races of the parasite, as well as to seed treatment with Metalaxyl (mandatory for seeds produced in Italy and for all imported seeds which is generally carried out by the distributor).

The discovery of a new physiological race R 3 (Carson, 1981 ; Fick and Auwarter, 1981) and the possibility of the appearance of new races have provided the impetus to continue research on this parasite. In particular, new chemicals (Oxadixyl, Cyprofuram) have been experimented for crop protection (Tosi and Zazzerini, 1986). Studies have been carried out on the long-term effects of Apron 35 SD (Metalaxyl 35%) on seed germination (Zazzerini et al., 1984).

Sclerotium bataticola Taub. : this pathogen causing charcoal stem rot has invaded all sunflower areas within the last ten years and the severity of the attacks has been very high. The lack of control methods, especially in certain zones where it is most frequent, does not allow the level of production which should be possible with the soil conditions and the agronomic techniques used.

Recent experiments carried out in Central Italy (Zazzerini *et al.*, 1985 a) have shown that damage can be contained by reducing plant density and even limited irrigation. In fact, there is a positive correlation between plant density and percentage of infected plants. On the contrary, there is a negative correlation between the amount of water added and the incidence of infection, indicating that plant stress favours the pathogen attack. It has been observed that the onest of an attack occurs at flowering time (Zazzerini *et al.*, 1985 b).

Irrigated sunflower summer crops planted after wheat or barley gave very different results from those planted at the same sowing dates in 1985. No significant pathogen attack was registered in 1984, when rains were frequent and temperatures lower than in the summer mean. In contrast, very heavy attacks were observed in 1985, an extremely dry and hot year until harvesting (Table 1). In this year an abnormal symptom of the disease was observed and the infected plants were difficult to identify because they appeared almost normal without the classical silver-grey discoloration of the stem. Longitudinal stem sections showed the fungus present in the main roots or a little above the collar of the stem. This phenomenon may perhaps be attributed to the high temperatures recorded throughout the summer, that probably may have inhibited parasite development.

In 1984 and 1985 the percentage of infected plants was documented at the two localities in Central Italy, where trials for comparison of sunflower cultivars were carried out (Table 2).

All cultivars available in Italy, during the two years, were tested at S. Apollinare. These cultivars and those listed in the Italian Register at the end of 1985 and 1986, as well as cultivars listed in the French Register were tested at Schiavo.

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Table 1

Percentage of plants infected by *S. bataticola* observed in sunflower cultivars seeded at two different dates in the 1985 summer cropping

Seeding dates	Cultivars										Mean percentage of infected plants
	Cerflor	Florom 305	Romsun HS 52	Gloriasol	Vulcano	Isa	Romsun HS 90	Primasol	Topflor	Stromboli	
June 17	79	77	77	70	81	66	81	78	81	83	77
July 4	61	48	43	48	48	59	69	55	51	52	52
Cultivar means	70	63	60	59	64	63	70	67	66	67	—

Seeding dates, cultivars and interaction seeding date × cultivar were all significant at $P \leq 0.05$

As shown in Table 2, the percentage of attack was very high in all trials. The heaviest attacks occurred in 1985 when the exceptional drought and high temperatures resulted particularly favourable to pathogen development. All cultivars were susceptible to the fungus. In only a few cases was the percentage of plants attacked less than 30%, whereas the attacks exceeded 90% in many cultivars, especially in the 1985 trials. A "rank correlation" was calculated to test the differences in the susceptibility level between cultivars. The correlation was computed using data (percentage of infected plants) from the cultivars present in both locations in each year, and from those grown both years at each location. All comparisons gave significant r values (Table 3). The elevated incidence of infection in almost all cultivated sunflower cultivars and the frequency of climatic conditions favourable to fungal development clearly indicate the importance and urgency of breeding programmes for the selection of cultivars resistant or tolerant to *S. bataticola*.

Table 2

Percentage of plants infected by *S. bataticola* recorded in cultivar trials carried out at two different localities in 1984 and 1985

	1984		1985	
	Schiavo	S. Apollinare	Schiavo	S. Apollinare
Adalaid 18	67	—	52	—
Adonis 82	69	48	94	96
Airelle	67	48	—	—
Ala	76	49	85	72
Aniflor	44	—	80	—
Arancio	68	36	—	—
Argentario	62	51	79	70
Bolero	61	—	76	88
Cargisol	58	—	79	—
Cerflor	91	66	82	95
Cernianka	71	41	83	90
Cucciolo	—	—	44	—
Drysol	54	45	79	96
Elisa	76	—	54	75
Eolo	—	—	52	—
Felix	66	—	81	—

Table 2 (continuation)

	1984		1985	
	Schiavo	S. Apollinare	Schiavo	S. Apollinare
Fiora	78	—	76	97
Flamme	—	—	89	76
Florasol	77	—	91	—
Florica	85	—	91	—
Florom 305	67	58	83	82
Forsol	58	36	47	58
Fundulea 85	72	—	91	—
Frankasol	—	—	94	—
Fructisol	65	—	—	—
Galatea	—	—	62	—
Gela	81	—	83	—
Gianni	36	38	64	84
Giove	—	—	95	98
Gloriasol	36	54	73	72
Ida	68	—	96	93
Ina	75	—	89	90
Isa	88	—	77	81
Isabel	45	—	89	88
Isardo	85	—	84	74
Isea PM 22	44	52	—	—
Ismus	87	—	84	88
Isola	86	—	80	91
Iva	39	—	74	78
Jumbo	56	57	80	84
Kaliflor	—	—	88	—
Kiwi	76	—	69	67
Lora	71	—	93	—
Lemon	39	40	79	72
Licia	52	—	78	—
Life	—	—	87	—
Linda	66	—	81	—
Lisa	45	—	58	—
Lumisol	18	—	59	—
Mango	92	—	91	—
Maremma	54	52	77	62
Maryflor	84	—	96	—
Mega	80	—	87	—
Miosol	22	—	44	—
Mirage	97	71	88	89
Mirasol	79	—	85	—
Novisol	73	54	65	81
Oliflor	—	—	90	92
Ombrone	53	—	85	80
Oregon	76	70	90	83

Table 2 (continuation)

	1984		1985	
	Schiavo	S. Apollinare	Schiavo	S. Apollinare
Orion	80	—	87	—
Pharaon	76	—	96	88
Pisa	70	—	89	91
Pordoi	78	—	97	—
Prestiflor	—	—	94	—
Primasol	74	62	90	92
Regisol	72	—	80	—
Riosol	14	—	79	—
Rodeo	87	—	82	92
Rolle	83	—	59	—
Romsun HS 52	50	54	65	78
Romsun HS 53	60	65	91	81
Romsun HS 90	80	80	99	94
Romsun HS 301	93	77	95	99
Rustiflor	59	53	72	73
Select	71	—	82	—
Sirio	71	—	94	—
Solaris	66	56	95	96
Soldux	67	—	73	—
Solix	7	—	52	—
Solmax	21	—	51	—
Solre	27	—	14	—
Soltop	80	—	96	—
Sorem 80	87	79	—	—
Stromboli	36	53	81	78
Timo	51	—	91	—
Topflor	43	47	90	70
Torretta	61	—	78	62
Trident	40	—	84	81
Tula	72	—	86	—
Tuscania	83	66	77	90
Upsol-Veraflor	—	—	82	—
Viki	—	—	92	—
Vitaflor	—	—	96	—
Vulcano	53	—	79	67
Yuma	—	—	64	83
L.S.D. = 0.05	6	3	6	6
L.S.D. = 0.01	11	6	10	11
Field mean	64	55	79	82
Mean of 26 CVS used in all 4 trials	64	56	81	82

Table 3

Correlation coefficients (r) between percentage of infected plants (*S. bataticola*) of different cultivars in different trials

Comparisons	No. of varieties	r *	Significance
2 trials in 1984	30	0.595	$P \leqslant 0.01$
2 trials in 1985	50	0.478	$P \leqslant 0.01$
2 years at Schiavo	77	0.467	$P \leqslant 0.01$
2 years at S. Apollinare	26	0.456	$P \leqslant 0.05$

* The coefficients were calculated with data from cultivars grown in both locations each year and from cultivars grown both years at each location.

Other observations on *S. bataticola* attacks were carried out during 1984 and 1985 on a small number of cultivars grown at a mountain site in Central Italy, at 900 m a.s.l. (S. Maria di Lignano). In the 1984 trial no attack was found on field which had never been planted with sunflower. The 1985 trial was conducted on a field previously planted with sunflower in 1983. The percentage of infected plants is given in Table 4. The incidence of infection was much less than that at Schiavo and S. Apollinare (Table 2). Sufficient data are not available to ascertain whether the absence or lower incidence of attack at S. Maria di Lignano is imputable to less favourable environmental conditions for fungal development (lower temperatures, higher rainfall) or to insufficient presence of inoculum in the field.

Table 4

Percentage of plants infected by (*S. bataticola*) in 1985 at S. Maria di Lignano

Cultivars	Infected plants *
Argentario	38 ab
Cerflor	51 a
Florom 305	13 d
Gloriasol	45 ab
Isa	48 ab
Maremma	19 cd
Primasol	36 ab
Romsun HS 52	18 cd
Romsun HS 90	42 ab
Stromboli	17 cd
Topflor	32 bc
Vulcano	19 cd

* Values followed by the same letter are not significantly different at $P \leqslant 0.05$.

Sclerotinia sclerotiorum (Lib.) de Bary : all investigations conducted so far in the major Italian sunflower zones have shown that attacks of *S. sclerotiorum* are not sufficiently important to significantly harm sunflower yield. Generally, the infection on early spring seeded sunflower was primarily found in the stem and occasionally on the head. In contrast, head rot was more common on sunflower planted as a summer crop, probably lower temperatures and higher humidity near harvest time favoured ascosporic infection on the head. As shown in Table 5, the incidence of attack was related to the summer sowing date. Regardless of seeding time, all cultivars were susceptible to the pathogen, even though infection was consistently higher in the earlier planting.

Botrytis cinerea Pers. : sporadic attacks of *B. cinerea* were found on early spring seeded sunflower and almost always on those irriga-

Table 5

Ascosporic attacks of *S. sclerotiorum* on heads of sunflower cultivars seeded at two different dates in 1984

Cultivars	% of infected heads	
	sowing date	
	June 22	July 6
Cerflor	13	7
Florom 305	6	3
Gloriasol	10	2
Luciole	13	6
Primasol	14	1
Romsun HS 90	7	3
Solaris	8	1
Stromboli	3	2

ted and/or planted later. Infections of modest intensity (about 20%) were noted in Umbria in 1976. A completely different situation was observed on sunflower planted under the new summer cropping system, which is only used to a limited extent. In 1984, following abundant and continuous rain during the latter part of the summer, heavy head attacks occurred. The heads were almost entirely covered by mycelium and conidia of the fungus, whereas stem attacks were less frequent. Occasionally attacks by both *B. cinerea* and *S. sclerotiorum* were observed on the heads. In 1985, a summer characterized by dry hot conditions, no disease development was noted. Therefore, *B. cinerea* is somewhat dangerous for summer planted sunflower, especially the late cultivars.

Puccinia helianthi Schw. : sunflower rust was only recorded in 1978 on some open-pollinated varieties : Argentario, Uniflor 70 and Cernianka. Thereafter, rust attacks were not seen. Laboratory research using the inbred lines CM 90 RR and 953—88 showed that race 4 occurred in Central Italy ; the inbred line HA 61 was found to be resistant to race 4 (Zazzerini and Cappelli, data unpublished).

A harmful level of attack by *Erwinia carotovora* var. *carotovora* (Jones) Dye, *Alternaria alternata* (Fr.) Keiss. and *Erysiphe cichoracearum* D.C. have never caused concern, although they have occasionally been observed.

Beginning with 1983, two new parasites, *Rhizopus oryzae* Went & Prinsen Geerligs and *Orobanche ramosa* L. (Zazzerini and Tosi, 1984) were noted in two regions of Central Italy : Umbria and The Marche. *R. oryzae* does not cause great concern, whereas *O. ramosa*, found in land previously planted with tobacco, may become a problem should sunflower be planted in these fields in the future.

Finally, in 1984, an alteration of the stems was recorded on a consistent number of plants of different cultivars. Longitudinal sections of the stems displayed pale red piths. Isolation done on these tissues showed the presence of a fungus identified as *Fusarium tabacinum* (Beyma) W. Gams. Trials are now in process to verify its pathogenicity (Zazzerini and Tosi, data unpublished).

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RÉSULTATS D'UNE INVESTIGATION BIENNALE SUR LES PLUS IMPORTANTS AGENTS PATHOGÈNES EN ITALIE

Résumé

Le but des recherches a été de fournir des informations récentes (1984—1985) sur la situation phytopathologique du tournesol en Italie et en particulier sur l'importance des maladies rencontrées dans les grandes zones de culture du tournesol. On examine quelques aspects de la biologie et de l'épidémiologie des agents pathogènes impliqués. En outre, on discute les méthodes de combat, en particulier l'utilisation des cultivars résistents disponibles.

RESULTADOS DE LAS INVESTIGACIONES BIENALES SOBRE LOS MAS IMPORTANTES PATOGENES EN ITALIA

Resúmen

El objectivo de las investigaciones fue proporcionar informaciones recientes sobre la situación fitopatológica del girasol en Italia y especialmente sobre la importancia de las enfermedades encontradas en las zonas grandes cultivadores de girasol. Se examinan algunos aspectos de la biología y epidemiología de los patogenes implicados. Además se analizan los métodos de combate, sobre todo el empleo de los cultivares resistentes disponibles.