A COMPARISON OF FUNGICIDES AGAINST *PLASMOPARA HALSTEDII* AND A PROPOSAL FOR THEIR PRACTICAL USE

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INTRODUCTION

Downy mildew of sunflower (SDM), incited by *Plasmopara halstedii* (Farlow) Berlese et de Toni, is a widespread and destructive disease (Sackston, 1981). As genetic resistance of sunflower to SDM is known to be incomplete (Vear, 1978; Virányi, 1978) and may be overcomed by new pathogenic races (Carson, 1981), a permanent and effective chemical control of SDM, primarily as seed dressing is required.

THE EIGENVALUES OF THE R-MATRIX

No.	Eigenvalues	Cumulated %
1	3.8635	35.12
2	2.8319	60.87
3	1.6398	75.77
4	.9833	84.71
5	.7955	91.95
6	.6598	97.94
7	.1588	99.39

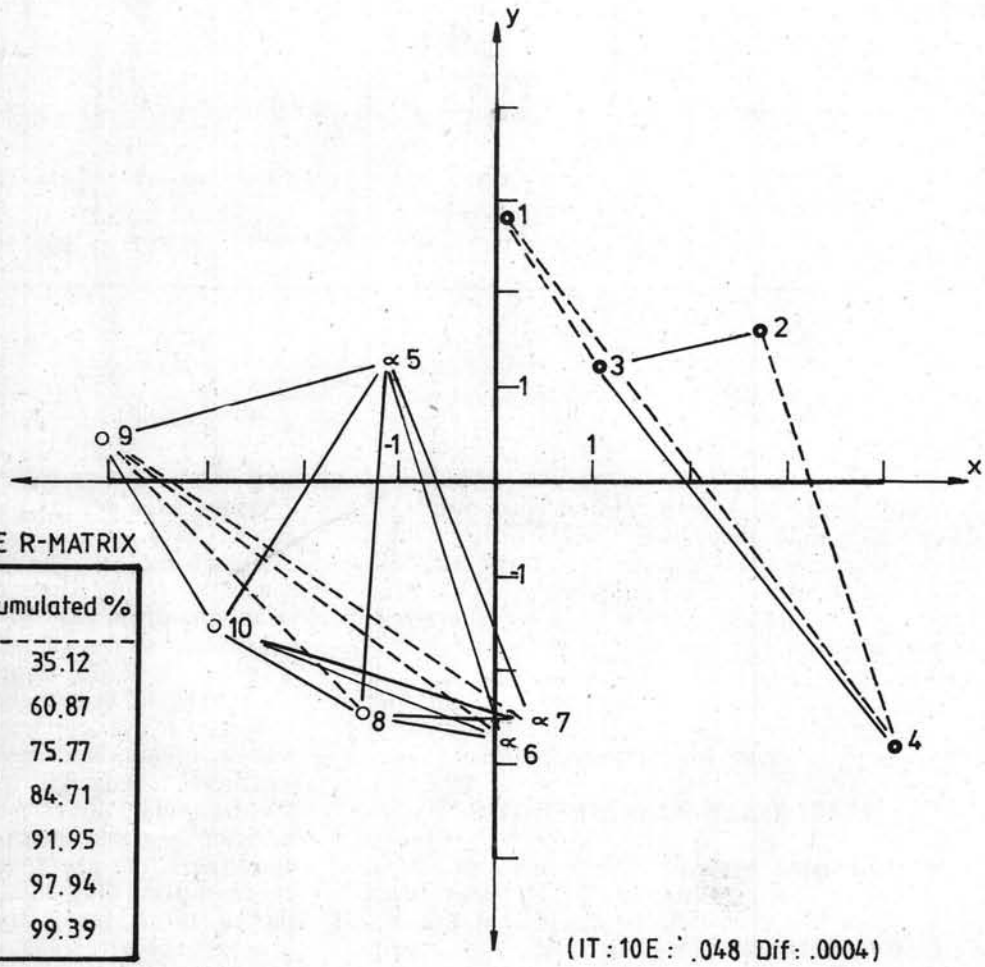

Fig. 1. — Classification of developmental stage responses of *Plasmopara halstedii* to anti-oomycete fungicides as Spectral Component Variables by Non-linear Mapping. Numbers on the map indicate developmental stage responses corresponding to Table 1

Table 1

Efficacy of various fungicides against developmental stage in the life cycle of *Plasmopara halstedii*

Fungicides (commercial product)	Host-dependent stages				Host-independent stages					
	hyphal growth	sporulation on cotyledon (*in vivo*)	sporulation on detached hypocotyl	eradicant effect	zoospore release	zoospore motion	zoospore membrane function	encystment	cystospore germination	cystospore germ tube elongation
	1*.	2	3	4	5	6	7	8	9	10
I. Benalaxyl (Galben)	0.41	0.12	317	90	252	15—31	31—62	62—125	4—8	31—62
II. Cyprofuram (Vinicur)	0.15	0.07	62	435	89	>1 000	500—1 000	250—500	4—8	15—31
III. Furalaxyl (Fongarid)	0.06	0.08	48	17	176	62—125	250—500	125—250	125—250	125—250
IV. LAB 149202F**	0.18	0.14	262	9	375	500—1 000	250—500	250—500	15—31	62—125
V. Metalaxyl (Apron)	0.08	0.08	103	11	192	>1 000	500—1 000	500—1 000	2—4	125—250
VI. Ofurace (Milfuram)	0.14	0.09	59	330	72	250—500	62—125	125—250	62—125	31—62
VII. Oxadixyl (Sandofan)	0.29	0.28	313	106	470	>1 000	>1 000	500—1 000	250—500	250—500
VIII. RE 26745	0.04	0.03	212	20	116	>1 000	>1 000	500—1 000	62—125	250—500
IX. Cymoxanil (Curzate)	0.82	0.09	29	26	242	>1 000	>1 000	>1 000	4—8	15—31
X. Fosetyl Al (Aliette)	192.97	98.86	7007	4000	2	1—2	1—2	2—4	0.1—0.5	0.5—1
XI. Etridiazole (Terrazole)	0.05	0.10	1	291	21	62—125	62—125	125—250	15—31	2—4
XII. Propamocarb (Previcur N)	0.27	0.12	336	431	140	>1 000	62—125	250—500	250—500	250—500

* ED_{50} (1 to 5), MIC (6 and 8), MEC (7,9 and 10) values are given in mg/L, respectively.
** Experimental fungicides

Although metalaxyl, and related compounds of the phenylamide group were found to have high efficacy against SDM, tolerance to this chemicals may soon occur in the fungal population (Oros and Virányi, 1984). There is a need, therefore, to find alternative ways for protection. For this reason, both contact and systemic efficacy of 12 compounds, recommended for use against peronosporaceous fungi, were compared in a highly standardized model experiment.

MATERIALS AND METHODS

Host-parasite system. The sunflower cultivar GK-70, susceptible to SDM, was used throughout this study. A metalaxyl sensitive isolate of *P. halstedii,* designated H1, was maintained in the greenhouse as described earlier (Virányi, 1977).

Chemicals. The fungicidal compounds tested are shown in *Table 1.* Their characteristics were decribed in a recent paper (Oros and Virányi, 1987).

Fungicide test. The way of treatments and assessments other than detailed here were made by means of an easy-to-handle and reproductible evaluation system devised recently (Oros and Virányi, 1987). Sporulation of the fungus was also assessed in detached hypocotyl segments as follows : hypocotyl segments, 10 mm in length, were cut from eight-day-old systemically infected sunflower seedlings, immersed in a solution of the fungicide concerned and incubated for 18 h. After a further incubation of 48 h under humid conditions, the presence of viable mycelium was checked according to Virányi (1977). The effect of fungicides on the „host-independent" stages (zoospore release, encystment and germination of cystospores) in the life cycle of *P. halstedii* was determined in a watery suspension microscopically as described earlier (Oros and Virányi, 1986).

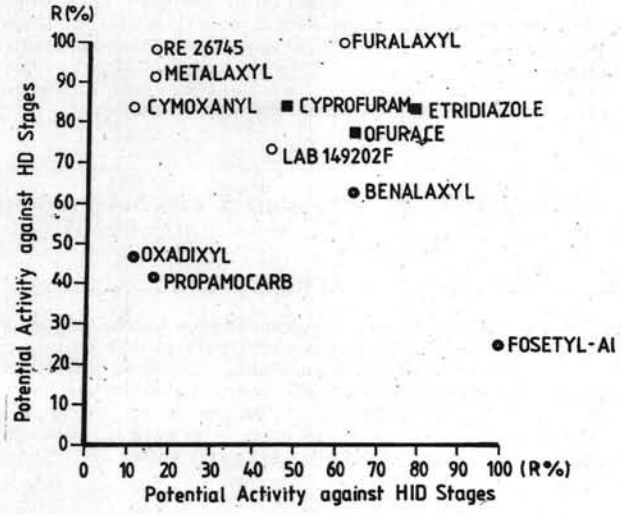

Fig. 2. — Groupement and possible use of fungicides as eradicant (●), protectant (■) and not recommended to use alone (▶) against *Plasmopara halstedii*

Data analysis. Fungal responses to the compounds were characterized by the appropriate toxicological parameters (MIC, ED_{50} and MEC values in mg/L), obtained from a reliable assessment. The interrelationships between responses and fungicidal efficacies were analysed by employing the Potency and Spectral Mapping technique described by L e w i (1976).

RESULTS AND DISCUSSION

The developmental stage response to fungicides of *P. halstedii* is shown in Table 1. A well remarkable difference in sensitivity occurred between „host-dependent" and „host-independent" stages of the fungus. Thus, hyphal growth and sporangium production on intact plants were found to be more sensitive to the chemicals tested, with an exception of fosetyl Al showing high efficacy against asexual spores, than zoosporogenesis. The sensitivity of young and well established mycelia differed significantly ($r_{3,4} = 0,2 < r_{p=0,1} = 0,5$).

Based on their sensitivity to fungicides, the developmental stages could be divided into two, significantly separating groups *(Fig.1)*, and these well corresponded to their dependence on the host. Similarly, the compounds tested were grouped on the basis of their potential activity (Pa) (i.e. summarized efficacy by Potency Mapping) against the above developmental stage groups *(Fig. 2)*. As fungicides with ED_{50} values more than 50 mg/L for eradicant action were found uneffective to prevent both seedborne infection and the introduction of *P. halstedii* to new areas by latent infected seeds (O r o s and V i r á n y i, 1987), the compounds with PA less than 55% against „host-dependent" stages are considered useless as eradicants. However, fungicides with PA more than 50% against „host-independent" stage may be useful for protecting airborne infections.

From practical point of view, for eradication of *P. halstedii* (seed dressing) the use of cymoxanil and some of phenylamides (furalaxyl, LAB 149202 F, metalaxyl and RE 26745) are proposed, whereas for protective action acetamides (cyprofuram, ofurace) and ethridiazole, alone or in appropriate combination, can be used. The other compounds, as fosetyl Al, benalaxyl, propamocarb and oxadixyl, belonging to the third group, are likely to be of no practical value in controlling SDM.

Our results with developmental stage response specificity are in good agreement with those reported by W i c k s and L e e (1982), B r u c k et al. (1980), C o f f e y and J o s e p h (1985), and F a r i h et al. (1981) on *Plasmopara viticola, Phytophthora infestans, P. cinnamomi, P. citricola, P. citrophthora* and *P. parasitica,* respectively. The effectivity of both eradicant and protective fungicides should be justified in field experiments.

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COMPARAISON ENTRE LES FONGICIDES UTILISÉS DANS LA LUTTE CONTRE LE *PLASMOPARA HALSTEDII* ET LEUR APPLICATION PRATIQUE

Résumé

Douze substances chimiques recommandées dans la lutte contre les Peronosporaceae ont été comparées selon l'efficacité des applications de contact ou systémiques. On a utilisé un système expérimental standardisé du cycle vital du champignon *Plasmopara halstedii.* D'après la réaction des plantes en différentes phases de végétation aux produits chimiques testés, les auteurs font des recommandations pour l'application pratique curative ou préventive des produits.

COMPARACION DE FUNGICIDAS CONTRA *PLASMOPARA HALSTEDII* Y SU APLICACION PRACTICA

Resúmen

Doce productos quimicos recomendados contra hongos peronosporaceous fueron comparados para probar su eficacia de su uso por contacto y sistémico, utilizando un sistema experimental estandarizado del ciclo del *Plasmopara halstedii.* En base a la respuesta del estado de desarrollo a los productos utilizados, se hacen propuestas para su utilización práctica bien como eradicadores o protectores.