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DIFFERENCES BETWEEN STRAINS OF THE CABBAGE BLACK RING VIRUS FROM HORSE-RADISH AND GARLIC MUSTARD

J. BRČÁK, Z. PROCHÁZKOVÁ

BRČÁK J., PROCHÁZKOVÁ Z. (Institute of Experimental Botany, Czechoslovak Academy of Sciences, Praha). *Differences between Strains of the Cabbage Black Ring Virus from Horse-Radish and Garlic Mustard.* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 243-253, 1976.

Two strains of cabbage black ring virus (CBRV) isolated from horse-radish and one from garlic mustard were compared. Out of 46 treated plant species or cultivars 15 behaved as unsusceptible to the three CBRV strains and 22 showed symptom differences between CBRV strains, esp. in susceptibility, sensitivity, incubation period, symptoms in rubbed leaves, systemic infection, arising or failure of systemic infection etc. Unimportant or no strain differences were established in inclusion bodies, electron microscopic investigation of virus particles, and in stability *in vitro*. CBRV could be transmitted from horse-radish roots to hypersensitive hosts with difficulties, sometimes not at all. CBRV in horse-radish can often be masked under field conditions in summer.

cabbage black ring virus; horse-radish; garlic mustard; susceptibility of hosts; virus strain properties; virus transmission from roots

Following virus diseases were reported from horse-radish [*Armoracia rusticana* (Lam.) G. M.&S. (syn. *A. lapathifolia* Gilib.)]: cabbage black ring, cauliflower mosaic, tobacco necrosis, arabis mosaic, tomato black ring (Shukla and Schmelzer, 1972), and tobacco ringspot (Thomas and Procter, 1973). In Czechoslovakia Blattný et al. (1950) described „the virus blotch of horse-radish", a disease also mentioned by Novák and Vlk (1950) and being as far as its symptoms were concerned identical with the horse-radish mosaic described by Dana and McWhorter (1932), which was recorded also from Germany by Böning (1938). Pound (1948) and Larson et al. (1950) stated the cabbage black ring virus (CBRV) (= turnip mosaic virus – TuMV) to be the causal agent of the horse-radish mosaic.

From horse-radish plants collected at random in various districts of Bohemia we succeeded in isolating only CBRV. All horse-radish plants showing symptoms (yellow mosaic, spots, necrosis etc.) mentioned by Pound (1948) were infected with CBRV. For further investigation some CBRV strains isolated from single lesions on tobacco leaves were used and compared with a strain isolated from garlic mustard [*Alliaria petiolata* (Beib.) Cavara et Grande (syn. *A. officinalis* Andr.)] in Prague on the same site where it was originally described (Brčák and Polák, 1963). Some CBRV strains caused different symptoms in horse-radish in field conditions as well as in a greenhouse suggesting strain differences that might be important for CBRV diagnosis.

MATERIAL AND METHODS

All leaves were cut off from horse-radish plants before being transferred into a greenhouse. Newly grown leaves showed the following symptoms: interveinal chlorotic spots 1—5 mm in diam. in young leaves and diffuse blotches in older leaves. Some plants collected in Malín showed convex deformations; one isolate from Praha-Smíchov caused large blotches enlarging along veins (Fig. 1). Infected plants originating from Praha-Hodkovičky showed large interveinal yellow spots (approx. 5 mm in diam.) with a dark centre spot etc. In field horse-radish plants the symptoms either disappeared during the summer season or became very mild. Only the isolate from Praha-Hodkovičky showed severe leaf symptoms during the whole vegetation period.

CBRV isolates obtained from horse-radish plants collected in Malín and Mladá Boleslav caused the same reactions in tobaccos cv. Java and Samsun, *Chenopodium quinoa, C. giganteum* and *Tetragonia expansa* as the isolate from Praha-Hodkovičky. Some differences were observed in the incubation period in *Gomphrena globosa* (a shorter one of the Malín isolate) and in *Petunia hybrida* (a longer one of the Ml. Boleslav isolate). *Nicotiana glutinosa* infected with the Malín isolate showed simultaneously symptoms of local and systemic infection in 7 days; later on the mosaic changed into systemic necrosis.

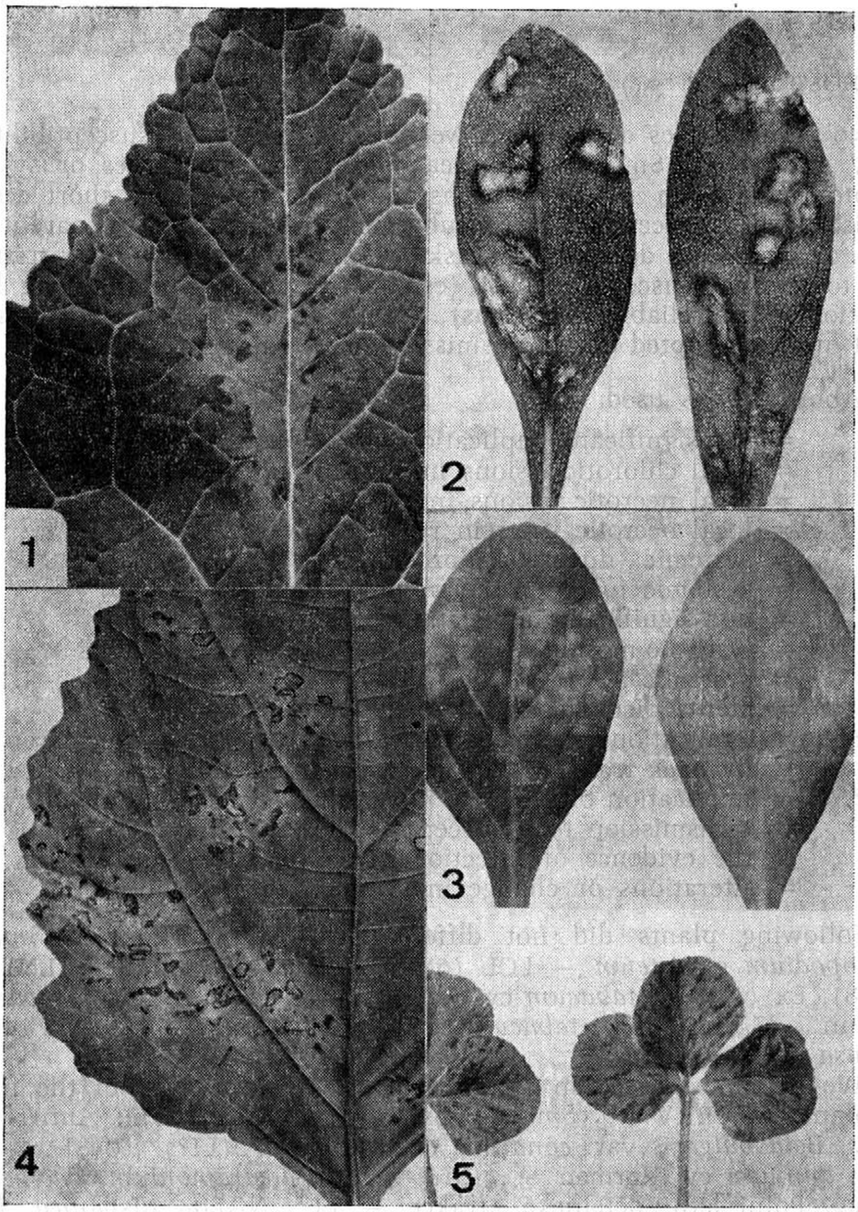
Three CBRV isolates originating from Prague territory were then chosen for comparing: *Ho* — obtained from a horse-radish plant in Praha-Hodkovičky, *Sm* — from horse-radish in Praha-Smíchov and *Ao* from a garlic mustard plant in Praha-Dejvice.

Inocula obtained from single necrotic lesions in tobacco cv. Samsun leaves were used for infection of *Nicotiana glutinosa*, which served as the infection source for further experiments. (Chenulu and Thornberry /1964/ stated that CBRV reached the highest titre in *N. glutinosa*.) Manual inoculations were performed according to Yarwood (1969), using K_2SO_3, K_2HPO_4 and charcoal.

Infectivity of aged sap (longevity *in vitro* — LIV) and the dilution factor (dilution end point — DEP) were evaluated according to mean number of necrotic lesions per leaf of tobacco cv. Java; 15 to 17 leaves dusted with 600 mesh carborundum were inoculated with a glass spatula and rinsed immediately. For these experiments low-speed centrifuged crude sap from systemically infected leaves of *N. glutinosa* was employed. Thermal stability *in vitro* (thermal inactivation end point — TIP) was investigated with the same sap to which an equal volume of 0.01 M phosphate buffer pH 7.0 was added. Sealed ampoules, each containing 1 ml of buffered sap, were treated for 10 min. within an ultrathermostatic bath and cooled immediately.

Methods by Berkeley and Weintraub (1952) and Rubio-Huertos (1959) were combined for investigation of intracytoplasmic inclusion bodies: Epidermal strips taken from veins of the lower leaf side of *N. glutinosa* infected 19 days ago were fixed for 25 min. in Carnoy solution, rinsed in absolute alcohol, transferred into water and stained for 10 min. in 0.5% trypan blue or 30 min. in 0.5% phloxin and rinsed with water. Control specimens were taken from healthy *N. glutinosa* leaves of the same age and grown simultaneously.

Specimens for electron microscopy of virus particles were prepared from *N. glutinosa* using the following four procedures: (1) Epidermal strips from lower leaf side were homogenized with 0.2% formaldehyde in 0.005 M borate buffer pH 9.0 and kept for 24 h. at 4 °C. This suspension was mixed with the equal volume of 4% potassium phosphotungstate, pH 6.8. (2) A small piece of a leaf was homogenized in 2% sodium phosphotungstate. (3) Approximately 0.5 cm^2 of the leaf blade was homogenized in 5 ml of water; a drop of the suspension was placed on a grid and sucked out immediately. When the grid dried, a drop of 2% or 4% sodium (or potassium) phosphotungstate (pH 6.8 or 7.0) was put on it and sucked out after 30 sec. Carbon coated grids were used in the above methods. (4) Drops of a diluted leaf homogenate were applied on formvar coated grids and sucked out; the grids were then shadow casted with platinum. In all trials tobacco mosaic virus was treated in the same way to be used as a standard for determining the particle dimensions. Electron micrographs were taken on electron microscopes Tesla BS 500 and JEM 100 B.



1. Systemic symptoms of CBRV *Sm* in horse-radish

2. Local necrotic lesions in *Gomphrena globosa* 13 days after inoculation with CBRV *Sm*

3. Reactions in rubbed leaves of *Petunia hybrida nana* cv. Simona on the 22nd day after inoculation: LCL by CBRV *Ho* (left) and total chlorosis by CBRV *Ao* (right)

4. Chlorotic and necrotic systemic symptoms of CBRV *Ao* in *Nicandra physaloides*, 28 days after infection

5. Systemic infection in *Trifolium incarnatum* with CBRV *Ao*, 28 days after infection

RESULTS

THE HOST RANGE

46 plant species or cultivars were tested for their susceptibility to CBRV strains Ho, Sm, and Ao. Reactions in rubbed leaves or systemic symptoms are given in abbreviations and (exceptionally) a short description is added. If necessary, the incubation period is given in parenthesis, e. g. (6) means six days. An asterisk (*) means a positive back transmission to another susceptible host (esp. performed for establishing latent infections or unreliable symptoms). On the contrary + means a negative result of an attempted back transmission.

Abbreviations used:

LI?	=	non-significant implication of infection in rubbed leaves
LCL	=	local chlorotic lesions in rubbed leaves
LNL	=	local necrotic lesions in rubbed leaves
LNR	=	local necrotic rings in rubbed leaves
SC	=	systemic (diffuse) chlorosis
SI	=	systemic infection (symptoms briefly described)
SI?	=	non-significant implication of systemic infection
SM	=	systemic mosaic
SN	=	systemic necrosis
Ex	=	plants died due to infection
o(LI?)$^+$	=	implication of infection in rubbed leaves was not ascertained by back transmission to a susceptible host
o(SI?)$^+$	=	implication of systemic infection was not ascertained by back transmission to a susceptible host plants
*	=	the evidence of infection given by back transmission trials
→	=	alterations or change in symptom expression.

Following plants did not differentiate CBRV strains *Ho, Sm, Ao: Chenopodium giganteum* – LCL (6), *Nicotiana clevelandii* – LNL (6), SN (8), Ex (13), *N. tabacum* cv. Java – LNL (4 or 6), *N. tabacum* cv. Samsun – LNL (5), *N. tabacum* cv. Xanthi – nc. – LNL, *Tetragonia expansa* – LCL (6).

We did not succeed in ascertaining the susceptibility of the following plants to CBRV *Ho, Sm, Ao* by manual inoculation: *Antirrhinum majus, Beta vulgaris* var. *conditiva* cv. Rubín – o(LI?)$^+$, o(SI?)$^+$, *Capsicum annuum* cv. Karmen – o(SI?)$^+$, *Datura stramonium, Lactuca sativa* cv. Polní letní dětenická atrakce – LI?, *Nigella hispanica, Phlox drummondii* var.*cuspidata, Physalis floridana* – o(SI?)$^+$, *Plantago major* – o(SI?)$^+$, *Salvia splendens* cv. Libochovický jánský oheň, *Trifolium alexandrinum* 'Carmel multicut' – o(SI?)$^+$, *T. hybridum* cv. Oderský – o(SI?)$^+$, *T. pratense* 'Horal' – o(SI?)$^+$, *T. resupinatum* cv. Maral – o(SI?)$^+$, *Viola wittrockiana*.

Some other plants did not sprout well in greenhouse experiments, esp. cabbage cv. Bílé rané ditmarské and cauliflower cv. Expres and Praga.

The highest susceptibility and sensitivity for all CBRV strains was observed with *Nicotiana clevelandii, N. glutinosa, N. megalosiphon, N. tabacum* cv. Java and White Burley, *Physalis peruviana* and *Sinapis alba*.

Differences between CBRV strains Ho, Sm, Ao were ascertained in many hosts (Table I).

I. CBRV hosts showing different reactions to CBRV strains *Ho, Sm, Ao*

Host plants	CBRV strain		
	Ho	*Sm*	*Ao*
Alyssum benthamii var. *procumbens minimum*	LNL (10), gray SI*, dwarf, flowering inhibition	LNL (10); gray O (SI ?)+	LNL (10), gray SN*
Amaranthus caudatus	LNL (10), low susceptibility	O	LNL (10), low susceptibility
Campanula medium	O (SI ?)+	O (SI ?)+	SC*; implication of rings
Chenopodium murale	LNL, LCL → LNL	O (LI ?)+	LNL, LCL → LNL
Chenopodium quinoa	LCL (7); O (SI); or LCL → LNL, SI (yellow spots, deformat.)	LCL (7), O (SI); or LCL → LNL, O (SI)	LCL (7), O (SI); or LCL → LNL, SI (yellow spots and deformations)
Datura innoxia	LCL	O (LI ?)+	LCL, SM (13)*
Gomphrena globosa (Fig. 2)	LNL (7)	LNL (6)	LNL (9–14)
Nicandra physaloides (Fig. 4)	O	O	LNL, SC, SN*
Nicotiana debneyi	LCL, LNL, O (SI ?)+; or LCL (8) → LNL (29)	LCL, LNL, O (SI ?)+; or LCL (8) → LNL (13–20)	LCL, LNL, O (SI ?)+; or LNL (8), LCL (8)
Nicotiana glutinosa	LCL (7), SM; or LNL (4), SM (10) → SN	LCL (6), SM, SN; or LNL (4), SM (10) → SN	LCL (5), SM; or LNL (4), SM (7) → SN, severe deformation
Nicotiana megalosiphon	LNR (4), LCL → LNR (10), SN (10)	LNR (4), LCL → LNR (10), SN (10)	LCL (4) → LNR (10), SN (10)
Nicotiana sanderae sanquinea	LCL, SC	LNL, SC, SN, deformations	LCL, SC, deformations
Nicotiana sylvestris	LNL ⌀ 1 mm, a longer incub. period than in Sm and Ao	LNL ⌀ 3 mm	LNL ⌀ 3 mm
Nicotiana tabacum 'White Burley'	LNL	LNL	LCL, LNL
Petunia hybrida 'Láska'	SM (11)	SM (7)	SM (7)
Petunia hybrida nana 'Simona' (Fig. 3)	LCL, SM (severe)	SM (mild)	LC, SM (severe)
Phaseolus vulgaris 'Prince'	LCL (12)*	O	O
Physalis peruviana	LCL, SM* (yellow), SN	LCL, SM* (yellow), SN	LCL, SM (green), SN
Pisum sativum 'Libochovický I'	SC (18)*, spots and yellow rings ⌀ 1 mm, mild deform.	O (SI ?)+	SC (18)*, spots and mild deformations
Silene pendula	LCL (10)* (brown-red), SC*	O (LI ?)+	LCL (10)* (red-bordered), O (SI ?)+
Sinapis alba	LNL, SM, SN, deformations	LCL, SM, deformations	SM (mild)
Trifolium incarnatum (Fig. 5)	O (SI ?)+	O (SI ?)+	SM*, deformations

We had no references at disposal dealing with the susceptibility of some plants tested, esp. with *Nicandra physaloides, Nicotiana debneyi, N. sanderae, Physalis peruviana, Silene pendula,* and *Trifolium incarnatum.* Chenulu and Thornberry (1964) failed to infect *Pisum sativum* with CBRV; however, Fischer and Lockhart (1976) stated systemic infection of *P. sativum* by a Moroccan isolate of CBRV.

Attempts to infect *Phlox drumondii, Datura stramonium* and *Beta vulgaris* with the three CBRV strains failed despite the fact that these plants were said to be susceptible to CBRV.

Systemic infection of *Petunia hybrida* was mostly characterized also by color deviations in corolla. The strains *Ho* and *Ao* caused systemic infection in *Chenopodium quinoa* in spring only. Necrotic symptoms in *Nicotiana glutinosa* and in some other species seemed to depend on the year season and temperature. In repeated transmission trials, performed simultaneously with the three strains, only some strains could be transmitted to some hosts. E. g. *Trifolium incarnatum* was susceptible only to *Ao* and this virus strain reached a very high titre in this plant. Out of 46 plant species and cultivars tested, 22 were able to differentiate the strains. Some of them were susceptible only for one or two strains or did not produce systemic infection with all strains. The strain *Sm* seemed to be the weakest one in this sense.

STABILITY *IN VITRO*

The thermal stability *in vitro* of the strain *Ho* (TIP > 58 < 60 °C) differed a bit from that of the strains *Sm* and *Ao* (TIP > 56 < 58 °C). Table II demonstrates the results. Literature references on the TIP

II. TIP of CBRV strains. Numbers indicate mean numbers of LNL per leaf of tobacco cv. Java

CBRV strains	°C/10 min.				
	50	55	56	58	60
Ho	34.1	7.1	8.0	2.0	0
Sm	6.4	0.2	0.2	0	0
Ao	1.4	0.1	0.4	0	0

of CBRV usually indicate the value of 56 – 65 °C/10 min. Our results are very similar to those given by German authors, e. g. Uschdraweit and Valentin (1957) and Herold (1958).

Fig. 10 demonstrates the DEP being almost the same with the three strains. Sap diluted 1 : 10,000 proved to be still infective, which was in agreement with the results by Pound (1948) and by Uschdraweit and Valentin (1957).

The LIV differed very little (Fig. 11). The strain Ho retained its infectivity longer than 48 h., but not 72 h. The strains Sm and Ao showed the LIV > 45 < 48 h. Our results are conformable to the reports by Pound (1948) and by Berkeley and Weintraub (1952), but not by Uschdraweit and Valentin (1957) or by Chenulu and Thornberry (1965) indicating LIV of CBRV up to 12 – 20 or 10 days, respectively.

INCLUSION BODIES

Identical granular amorphous inclusion bodies were found in all strains. The inclusion bodies were usually larger than the nucleus and mostly adhered to nuclei (Figs. 6, 7). However, inclusion bodies were often observed in cytoplasma, distant from nuclei. Vesicular formations were observed at seldom. Healthy *N. glutinosa* plants grown simultaneously in the same greenhouse conditions did not contain any similar bodies. Trypan blue proved to be a better stain than phloxin. Granular inclusion bodies and vesicular formations corresponded to those originally described with CBRV by Rubio-Huertos (1950, 1956).

ELECTRON MICROSCOPY

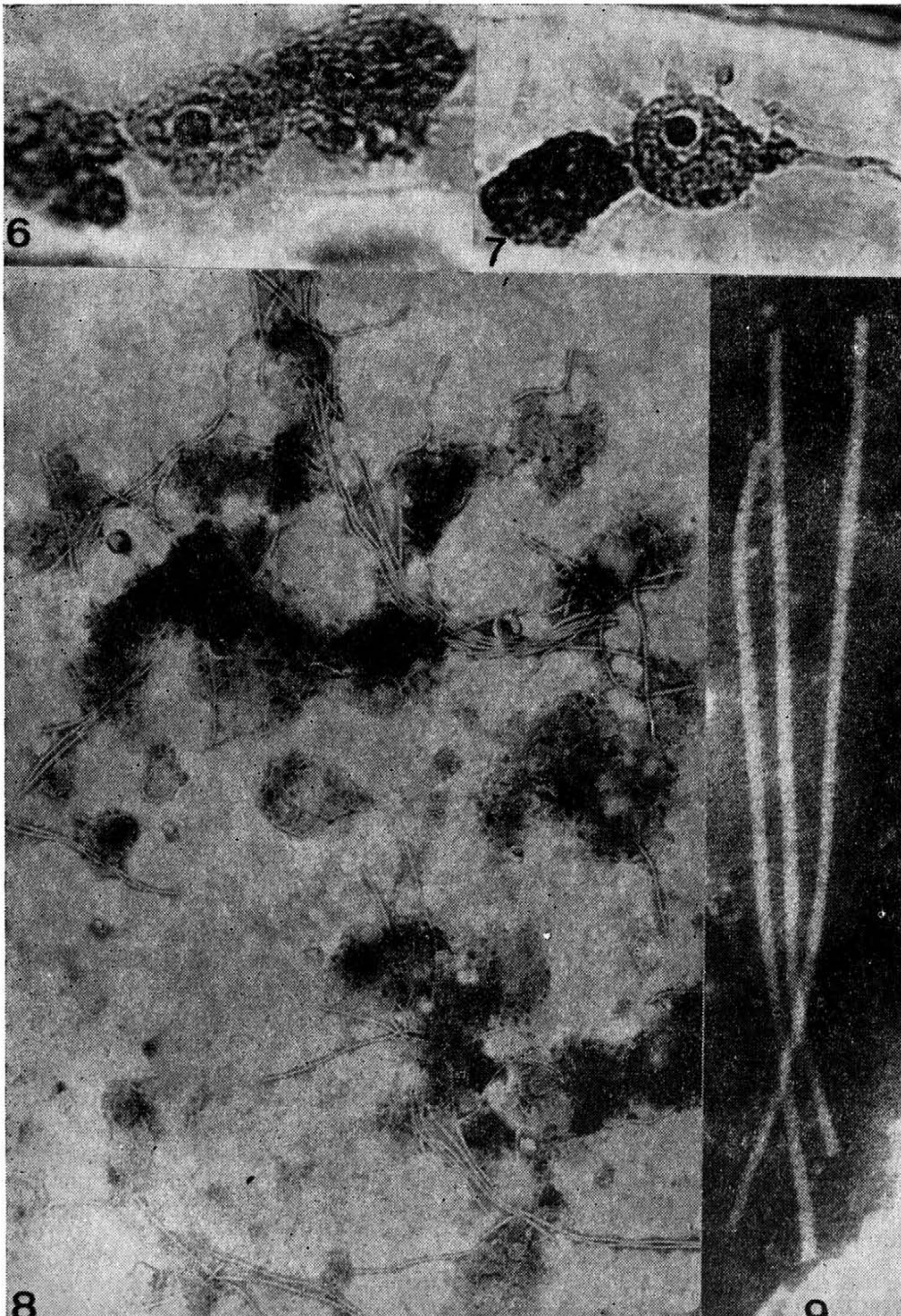
The best results were achieved using methods (3) and (4). With all three strains identical elongated flexuous virus particles approximately 760 nm long were found (Figs. 8, 9). This agreed with older references, e. g. by Uschdraweit and Valentin (1957) – 756 nm, Bode and Brandes (1958) – 754 nm, Brčák and Polák (1963) – 759 nm.

ISOLATION OF CBRV FROM HORSE-RADISH ROOTS

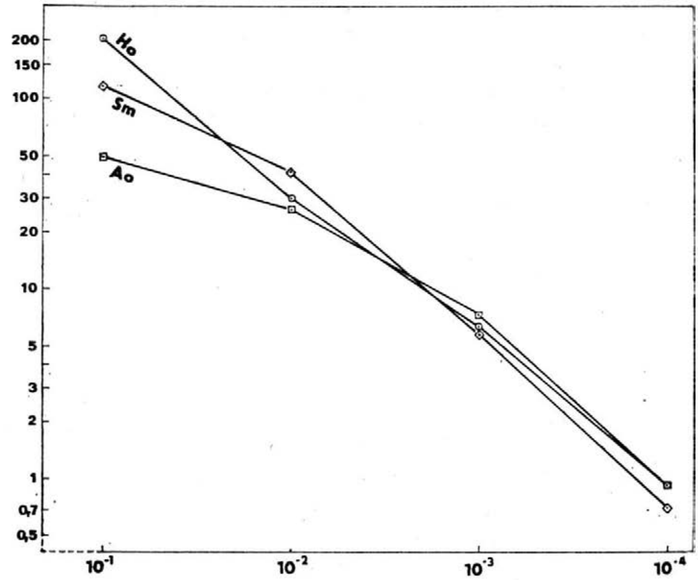
Pound (1949) found a higher concentration of CBRV in horse-radish at 16 °C than at 28 °C; at a higher temperature symptoms became milder or masked. We can confirm the masking of symptoms under field conditions during summer – with few exceptions, e. g. with the strain Ho. Therefore, one cannot simply select horse-radish plants without symptoms for further reproduction. Furthermore, we were not able to find any reliable CBRV symptoms in roots of diseased plants. Mechanical transmission of CBRV to tobacco plants cv. Samsun or Java from foliage of horse-radish was much easier than from roots. We did not succeed in isolating CBRV from horse-radish roots in March as well as at the beginning of August. (Homogenized pieces of the central cylinder, superficial root tissues or upper root parts served as inocula.) CBRV Ho could be isolated from the root central cylinder in October, the infectivity was, however, very poor: mean number of LNL on tobacco cv. Java leaves reached merely 0.3, while that from foliage resulted in 15.4 LNL per leaf. Therefore, such an indexing of horse-radish roots could hardly be used for practical purposes.

DISCUSSION

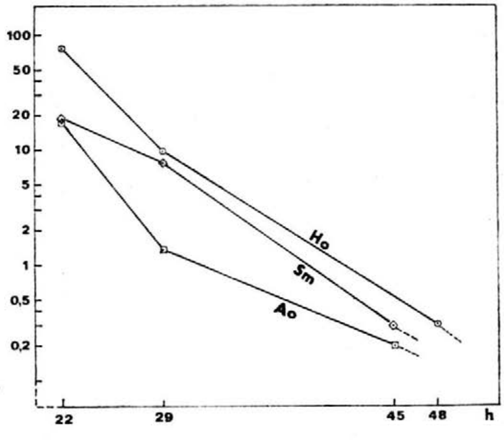
Strains of CBRV infecting horse-radish and garlic mustard are easily detectable in greenhouse experiments by means of some host plants (esp. *Nicotiana tabacum, N. glutinosa, N. clevelandii, Petunia hybrida, Chenopodium quinoa, Gomphrena globosa, Sinapis alba* etc.) – see also e. g.



6. Two large granular inclusion bodies adhering to the nucleus (CBRV *Ho*, trypan blue)
7. One large and some small inclusions round the nucleus (CBRV *Ho*, trypan blue)
8. Negative staining of CBRV *Ho* particles; dried suspension stained additionally with 4% PTA, pH 6.8; 32,000 times
9. The same as in Fig. 8, magnified 160,000 times



10. DEP of CBRV strains in the logarithmical scale: relation of the mean number of lesions per leaf of tobacco cv. Java to the dilution factor



11. LIV of CBRV strains in the semilogarithmical scale: infectivity of aged sap (mean number of lesions per leaf of tobacco cv. Java) in relation to the time of aging (in hours)

Shukla and Schmelzer (1973). All strains showed identical amorphous inclusion bodies in epidermal cells of *N. glutinosa,* were easily detectable by means of an electron microscope and possessed similar stability *in vitro.*

Individual CBRV strains showed the greatest differences in transmission trials to *Campanula medium, Chenopodium quinoa, Datura innoxia, Nicandra physaloidies, Nicotiana debneyi, N. glutinosa, N. sanderae, N. sylvestris, Phaseolus vulgaris, Pisum sativum, Silene pendula, Sinapis alba,* and *Trifolium incarnatum.* Some CBRV strain differences found in TIP and also implicated in DEP and LIV might be due to their unequal titre in *N. glutinosa.*

CBRV could hardly be detected in horse-radish roots by manual inoculation of susceptible plant; however, no investigations were performed in order to establish the relative CBRV concentration in roots or the influence of a possible inhibitor. We suggest that this fact might itself be felt in a practical control of horse-radish plants selected for further reproduction etc. and in checking healthy plants obtained after thermotherapeutical treatments. Pound (1949) failed to get virus-free horse-radish plants by thermotherapy, nevertheless, Shukla and Schmelzer (1972) succeeded in eliminating CBRV from horse-radish by thermotherapy (37 – 40 °C for up to 100 days) after which 50 % of plants survived.

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BRČÁK J., PROCHÁZKOVÁ Z. (Ústav experimentální botaniky ČSAV, Praha). *Rozdíly kmenů viru černé kroužkovitosti zelí z křenu a z česnáčku.* Sbor. ÚVTIZ - - Ochr. rostl. 12 (4) : 243-253, 1976.

Z izolátů viru černé kroužkovitosti zelí (CBRV) z křenu selského byly vybrány dva, které byly srovnávány s izolátem CBRV získaným z česnáčku lékařského. Ze 46 zkoušených rostlinných druhů nebo kultivarů se 15 nepodařilo nakazit žádným z kmenů CBRV, u 22 se projevily rozdíly podle jednotlivých kmenů CBRV ve vnímavosti, citlivosti, inkubační době, v příznacích infekce očkovaných listů, v příznacích systémové infekce, ve vzniku systémové infekce apod. Nebyly zjištěny významné rozdíly při studiu inklúzí v pokožkových buňkách, při elektronové mikroskopii, ani ve vlastnostech kmenů CBRV *in vitro*. Mechanickým přenosem na hypersensitivní hostitele je obtížné identifikovat CBRV v kořenech křenu. Na poli je v létě infekce křenu CBRV často maskována.

černá kroužkovitost zelí; křen; česnáček; vlastnosti kmenů viru; vnímavost hostitelských rostlin; přenos viru z kořenů

БРЧАК Я., ПРОХАЗКОВА З. (Институт экспериментальной ботаники ЧСАН, Прага). **Различия штаммов вируса черной кольцевой пятнистости капусты, изолированных из хрена и чесночика аптечного.** Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 243-253, 1976.

В статье сравниваются два штамма вируса черной кольцевой пятнистости капусты (ЧКПК), изолированные из хрена из один штамм ЧКПК, полученный из чесночика аптечного. Из 46 видов или сортов подопытных растений 15 оказалось нечувствительными к ЧКПК, 22 проявляли симптоматические различия по отдельным штаммам ЧКПК. Различия касались чувствительности, инкубационного периода, реакций инокулированных листьев (местная реакция), общего заболевания, возможности возникновения общего заболевания итд. Незначительные или нулевые различия проявились при изучении включений, электронной микроскопии вирусных частиц и устойчивости вирусов в соке. Доказать присутствие вируса ЧКПК в корнях хрена посредством инокуляции чувствительных растений-хозяев весьма трудно. Растения хрена, заражённые ЧКПК летом в полевых условиях, часто не имеют никаких признаков.

черная кольцевая пятнистость капусты; хрен; чесночик аптечный; свойства штаммов вируса; чувствительность растений-хозяев; перенос вируса из корня

The Authors' Address:

RNDr. Jaroslav Brčák, DrSc., RNDr. Zdeňka Procházková, Ústav experimentální botaniky ČSAV, Na Karlovce 1, 160 00 Praha 6

REVIEW

GRAPEVINE PROTECTION

Vanek, G. — Vaneková, Z.: Ochrana viniča. 1977. Published by Priroda, Bratislava, Czechoslovakia (in Slovak).

By this book, which is dedicated to academician Ctibor Blattný, the oldest well-known Czechoslovak plant pathologist, the publishing house „Priroda" try to overcome the lapse of twenty years, since the first book on a similar subject was issued in Czechoslovakia.

The book in spite of its narrow and specialized subject is unusually comprehensive. An attempt has been made by the authors' married couple to place before readers and students the most complete account of the more important pests and diseases and their control in vineyards.

The book conception and structure is unusual. For the wide range of readers the basis of this publication is an illustrated, coloured and comparative key for grapevine diseases and disorders comprising 24 pages. This key contains almost all pathogenic symptoms which the grapevine grower comes across.

The coloured plates show leaf, grape and shoot symptoms as well as symptoms of old wood and roots. In contradistinction to the older illustrated publication of similar character, various symptoms of certain diseases are not given on one page, but on several pages and are compared with resembling symptoms produced by the other harmful agents on the same plant part.

The text part of this book, nevertheless, has not a traditional arrangement. A great emphasis is given to the physiological disorders, diagnosis of which (visual and also chemical leaf analysis) is an inevitable part of the modern plant protection measures in the intensive vineyards.

The chapter dealing with virus, mycoplasma and rikettsia like diseases is long and detailed. Almost complete is a part related to bacterial and fungi diseases. In Czechoslovakia less known or yet undescribed grapevine diseases are quoted as well.

Animal pests are dealt with according to their economic importance. Weeds in vineyards are listed in clear tables with complete instructions to control them and inclusive susceptibility of individual weed plants to various types of herbicides.

The machinery used for vineyard protection against harmful agents is presented in brief to inform the readers about the most used machines for plant protection in Czechoslovakia.

Properties of pesticides applied in vineyards are given with directions for use. A special attention is paid to the possibility of mixing various pesticides used in vineyard pests, diseases and weeds control.

It is not possible to discuss each chapter in detail within the space of this review but is necessary to mention very instructive coloured tables and drawings which are the most interesting features of this book.

The book will be sought for by those who need a good and instructive survey of grapevine pathological disorders of various origin. It may serve as an outstanding source of valuable information in the field of grapevine pathology. Although the aim of the book is to provide information for grapevine growers, it may be recommended to university students and young research workers and others as well, and it will certainly fulfil the aim for which it was written.

B. A. Kvičala

DISTRIBUTION OF BEET MILD YELLOWING VIRUS IN CZECHOSLOVAKIA

J. POLÁK, J. CHOD

POLÁK J., CHOD J. (Institute of Plant Protection, Praha - Ruzyně). *Distribution of Beet Mild Yellowing Virus in Czechoslovakia.* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 255-257, 1976.

Beet mild yellowing virus (BMYV) is distributed in all sugar-beet growing regions in Czechoslovakia from North-East Bohemia to East Slovakia. This virus even prevails (at least in some years) over the beet yellows virus (BYV). Both viruses often occur in a complex. The survey carried out proved that in Czechoslovakia the main vector of beet yellows caused by viruses is the aphid *Myzus persicae* (Sulz.), not *Aphis fabae* Scop.

beet yellows viruses; BMYV; distribution in Czechoslovakia

In 1974 we proved the occurrence of beet mild yellowing virus – BMYV in several localities of Bohemia (Polák, Chod, 1975). It is known that beet yellows virus – BYV, identified in Czechoslovakia for the first time by academician Blattný in 1946 (Černý, Drachovská, 1947), is spread in all sugar-beet growing regions in both Czech and Slovak Socialistic Republics. In 1975 we investigated the occurrence of BMYV in these regions. At the same time we also studied the occurrence of BYV and the proportion of both viruses in sugar-beet fields.

MATERIAL AND METHODS

Samples of sugar-beet leaves showing symptoms of yellows were sent to us by workers of sugar-factories in the second decade of September. Samples of yellows were taken at random, the workes did not know the differences in symptoms of both viruses in sugar-beet. This was a guarantee that the sampling was representative providing a sufficient number of sampling localities. In several districts of Bohemia we ourselves identified the occurrence and relative proportion of both viruses in sugar-beet fields. Samples we received from more than 350 sugar-beet fields of Czechoslovakia were classified first according to symptoms. Then the presence of BMYV was detected by transmission of aphids *Myzus persicae* (Sulz.) from the tested leaf to indicator plants — *Capsella bursa-pastoris* (L.) Med., *Sinapis alba* L. and *Lepidium campestre* (L.) R. Br. One plant of each species was used for one sample. Acquisition feeding was 48, inoculation feeding 72 hours; 10 aphids were applied per one plant. Symptoms on indicator plants were evaluated after 25 and 40 days from inoculation. Samples in which one indicator plant showed symptoms of the virus at least were designated as infected with BMYV. Beet yellows virus was tested serologically using microprecipitin drop method and biologically using mechanical inoculation of crude extract with buffer on the indicator plant Chenopodium quinoa Willd (Polák et al., 1975). We worked with an antiserum prepared beforehand (Polák, 1974). Opel and Fuchs (1975) used successfully a combined serological and biological method in the greenhouse tests for the demonstration of BYV. We always inoculated six upper leaves of two decapitated indicator plants in the stage of ten fully developed true leaves. The plant reaction (number of local lesions) was examined twice, after 20 and 35 days from inoculation.

RESULTS AND DISCUSSION

Classification of 136 samples from Bohemia, 125 samples from Moravia and 78 samples from Slovakia was included in the results, the total being 339 samples from the whole of Czechoslovakia. In Bohemia 125 samples contained BMYV, 51 samples BYV, out of these 43 samples contained both viruses, 3 samples were physiological yellows. The relative proportion of BMYV and BYV was 71.0 : 29.0. Results from our own survey in Central and East Bohemia, where the percentage of BMYV distribution was examined in 16 fields at the beginning of September 1975, can be added to the results of analyses of beet yellows samples. Diagnosis was carried out according to symptoms, in disputable cases by objective methods in the laboratory. Beet mild yellowing virus prevailed in eleven fields, in two fields the proportion of both viruses was well balanced, in three fields BYV prevailed. On the average the proportion between BMYV and BYV was 65.8 : 34.2. The complex disease caused by both viruses was revealed in only 13.6 % of the cases. On the basis of the laboratory analyses of disputable cases and results of analyses of samples sent to us we assume that our subjective survey slightly favoured BYV. In Moravia 112 samples contained BMYV, 82 samples BYV, out of these 71 samples contained both viruses. Two samples were physiological yellows. The relative proportion of BMYV and BYV was 57.7 : 42.3. In Slovakia 62 samples contained BMYV, 63 samples BYV, out of these 49 samples contained both viruses. Two samples were physiological yellows. The relative proportion of BMYV and BYV was 49.6 : 50.4. In Czechoslovakia BMYV was proved in 299 samples altogether whereas BYV only in 196 samples in the year 1975. Out of these both viruses in 163 samples, i. e. almost in half the samples examined. The relative proportion of BMYV and BYV was 60.4 : 39.6. The results of the survey show that beet mild yellowing virus has considerable distribution in the whole of Czechoslovakia. Its occurrence can prevail over the occurrence of beet yellows virus in single years like in 1975 when the distribution of both viruses was approximately equal only in Slovakia. The results indicate that with the increasing proportion of BYV, the proportion of the complex disease caused by both viruses increases as well. Whereas the proportion of the complex disease caused by both viruses in the total occurrence rate of beet yellows was 32.2 % in Bohemia, in Moravia already as much as 57.7 % and in Slovakia even 64.5 %. In view of the ascertained facts the opinion that the aphid *Aphis fabae* Scop. is the main vector of beet yellows caused by viruses has to be revised. This species of aphis is not a vector of BMYV under the field conditions. This is also in agreement with the fact that in 1975 the occurrence of *A. fabae* was minimum in Bohemia, whereas in Moravia and Slovakia localities with heavier occurrence of this species in sugar-beet were recorded. Therefore we can affirm that also in Czechoslovakia the potential vector of beet yellows viruses from primary sources of infection is the aphid *M. persicae* whereas the aphid *A. fabae* is probably more important only in the secondary spread of beet yellows virus.

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POLÁK J., CHOD J. (Ústav ochrany rostlin, Praha - Ruzyně). *Rozšíření viru mírné žloutenky řepy v Československu.* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 255-257, 1976.

Virus mírné žloutenky řepy (BMYV) je rozšířen ve všech oblastech pěstování cukrovky v Československu, od severozápadních Čech po východní Slovensko. Tento virus dokonce převládá (alespoň v některých letech) nad virem žloutenky řepy (BYV). Oba viry se často vyskytují v komplexu. Na základě provedeného průzkumu je hlavním přenašečem žloutenkových virů řepy v Československu mšice *Myzus persicae* (Sulz.), nikoli *Aphis Fabae* Scop.

viry žloutenky řepy; BMYV; rozšíření v ČSSR

ПОЛАК Я., ХОД Й. (Институт защиты растений, Прага - Рузыне). **Распространение вируса умеренной желтухи свеклы в Чехословакии.** Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 255-257, 1976.

Вирус умеренной желтухи свеклы (BMYV) распространен во всех областях выращивания сахарной свеклы в Чехословакии, от северозападной Чехии до восточной Словакии. Этот вирус даже преобладает (в некоторые годы) над вирусом желтухи свеклы (BYV). Оба вируса часто появляются в комплексе. На основе проведенного исследования было установлено, что переносчиком вируса умеренной желтухи в Чехословакии является тля *Myzus persicae* (Sulz.), а не *Aphis fabae* Scop.

вирусы желтухи свеклы BMYV; распространение в ЧССР

The Authors' Address:

Ing. Jaroslav Polák, CSc., ing. Jiří Chod, CSc., Ústav ochrany rostlin, 161 06 Praha 6 - Ruzyně

3RD INTERNATIONAL CONGRESS OF PLANT PATHOLOGY

The 3rd International Congress of Plant Pathology will be held in München, 16–23 August, 1978. The Congress is being organized by the „Deutsche Phytomedizinische Gesellschaft" on behalf of and in collaboration with the „International Society for Plant Pathology".

The sessions will be held in the following twelve sections:

1. Virology – coordinator: F. Nienhaus, Bonn
2. Bacteriology – coordinator: H. P. Maas Geesteranus, Wageningen
3. Mycology – coordinator: G. M. Hoffmann, Freising-Weihenstephan
4. Nematology – coordinator: B. Weischer, Münster
5. Soil-borne Pathogens – coordinator: B. Schippers, Baarn
6. Physiological Plant Pathology – coordinator: R. Heitefuss, Göttingen
7. Post-harvest Pathology – coordinator: E. Laville, Montpellier
8. Genetics of Resistance and Pathogenicity – coordinator: A. Brönnimann, Zürich
9. Epidemiology – coordinator: J. Kranz, Giessen
10. Pollution Effects – coordinator: R. Guderian, Essen
11. Disease Control – coordinators: J. Dekker, Wageningen a F. J. Schwinn, Basel
12. Professional Aspects of Plant Pathology (Phytomedicine) – coordinator: H. C. Weltzien, Bonn

Further information can be obtained from:

Congress Plant Pathology Biologische Bundesanstalt
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D-3300 Braunschweig
Federal Republic of Germany

THE OCCURRENCE OF THE FUNGI OF THE GENUS FUSARIUM ON SUGAR-BEET SEEDS, IN THE RHIZOSPHERE AND TISSUES OF PLANTS ATTACKED BY BLACK LEG

D. VESELÝ

VESELÝ D. (Institute of Plant Protection, Praha - Ruzyně). *The Occurrence of the Fungi of the Genus Fusarium on Sugar-Beet Seeds, in the Rhizosphere and Tissues of Plants Attacked by Black Leg.* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 259-266, 1976.

Microbiological analyses revealed a considerable proportion of *F. sambucinum* and *F.* sp. on sugar-beet seeds. The species *F. javanicum* and *F. oxysporum* were represented only slightly on the seeds. The greatest number of colonies and the richest specific representation were found in rhizosphere soil where fusaria were present in the following order: *F. moniliforme, F. solani, F. sambucinum, F. culmorum, F, javanicum, F. prope roseum, F. lateritium* var. *stilboides,* and *F. oxysporum.* Free soil showed a much smaller population of fusaria than rhizosphere soil. The following four species were present here on the whole: *F. moniliforme, F.* sp., *F. culmorum,* and *F. lateritium.* The following ten species were isolated from plants diseased with black leg: *F. prope roseum, F. javanicum, F.* sp., *F. sambucinum, F. oxysporum, F. moniliforme, F. solani, F. nivale, F. culmorum,* and individually *F. javanicum* var. *radicicola* and *F. solani* var. *redolens.* Certain population relations to seeds or soil were found in *F. gibbosum, F. graminearum,* and *F. lateritium* var. *stilboides;* however, these relations were not clearly demonstrated. Fresh isolates of the strains of *F. nivale* showed greater pathogenicity to beet. Otherwise all *Fusarium* species were only slightly pathogenic. Emerging beet plants attacked by fusaria suffered from excessive root branching.

sugar-beet; fusaria; fusaria population of seeds and soil; black leg; pathogenicity

Literature often presents data concerning the isolation of the fungi of the genus *Fusarium* LINK ex Fr. from beet plants attacked by black leg (Harmos & Kiss, 1966; Saad & Nienhaus, 1969; Polevoj et al., 1972, Požarova, 1975; Munford, 1968; Čatská, 1972).

Nevertheless, fusaria are mostly mentioned in connection with store diseases of sugar-beet. The following fusaria have been found on rotting sugar-beet roots in the Soviet Union: *Fusarium gibbosum, F. sambucinum, F. moniliforme, F. javanicum,* and *F. solani.* Kocková-Kratochvílová et al. (1958) isolated 15 species of fusaria of seven systematic groups from beet cores in relation with the occurrence of sugar-beet heart rot in Slovakia. *F. culmorum, F. sambucinum, F. solani,* and *F. coeruleum* occurred most frequently. According to Bilajová (1955), *Fusarium oxysporum* f. *betae* is pathogenic to beet seedlings. Nalepina (1971) found that the intensive production of fusaric acid in this fungus was not always connected with high pathogenicity of an isolate. No close specialization to some hosts has been found in this species, but certain prevailing bond of isolates to the host plants and related species was the case. Valášková (1972) showed the relative ease with which not only different physiological forms but also various species of fusaria colonize non-host plants and evoke the same typical symptoms as the forms and species specialized on the given host. Menzinger (1969) asserts that free amino acids stimulate the germination of *F. oxysporum chlamydospores* in soil even in such cases when suitable hosts are absent. In Bartels' trials (1971) the development of plants was not retarded when secondary roots of sugar-beet were exposed to attack by *Fusarium* spp. alone.

It is a well-known fact that pathogenic fungi responsible for black leg in sugar-beet colonize the root surface as the first object of invasion and that the mycoflora of the surface of these roots develops as a result of the combination of the mycoflora of beet seeds and soil. This applies also to the representatives of the genus *Fusarium* populating seeds as well as soil. However, according to Schäufele & Winner (1972) no greater importance is attached, as a rule, to the occurrence of *Fusarium* fungi on seeds, although the representatives of this genus are known as being able to damage young beets. The authors state that due to difficult determination, little work has been done in the species differentiation of fusaria on beet.

The fungi of the *Fusarium* genus are very frequently isolated from the tissues of plants diseased with black leg and the data on the role of fusaria in the origin and course of the disease are quite contradictory; therefore we concentrated our efforts on the examination of these problems in greater detail.

This study deals, in particular, with the specific representation of the fungi of the genus *Fusarium* populating the seeds, rhizosphere, root surface of sugar--beet; these fungi were isolated from the plants diseased with black leg in 1971—1975. Pathogenicity tests were performed with these species on emerging beets.

MATERIAL AND METHOD

Determinations were performed in all representatives of the genus *Fusarium* isolated within the period of 1970 to 1975. Fusaria populating beet seeds, beet rhizosphere, and soil were studied separately. In addition, the author attempted to identify the isolates obtained from plants attacked by black leg. Microbiological analyses were performed in the Smith-Dawson medium with the Bengal red. The suspension used for fungus determination was diluted at a 10^{-3} ratio.

The species and strains determined preliminarily at the Beet-Growing Research Institute at Semčice were determined in greater detail by the Department of Botany of Charles University, Prague. The exact identification and systematic classification were performed after Bilajová (1955).

Trying to find the pathogenicity of the isolated Fusarium species to emerging sugar-beet, the author subjected them to a series of infection tests. Carrot disks, 7 mm in diameter overgrown with fungus mycelium were used as an inoculum. The tests were performed in Drigalski's dishes having a diameter of 185 mm. The dishes contained a mixture of 20 % soil and 80 % siliceous sand. Before the experiments were started, this substrate had been sterilized twice for three hours with a 24-hour interval. Each infection test was replicated 10 times. The seeds of the genetically monogerm cv. Monohybrid 1 were sterilized in a sublimate solution (conc. 1 : 1000) for 20 minutes. Fifteen agar disks, overgrown with the tested fungus, were placed in the middle of seeds sown to the depth of 2 cm in a circular arrangement. The disks were placed in the same depth as the seeds. The seeds and the inoculum were covered with a layer of sterilized soil. The tests were performed in a vegetation chamber, 135 × 75 × 75 cm in size, under artificial light and in glasshouse conditions with natural light. In the vegetation chamber, the source of light (10 hours of light in the 24-hour period) was represented by a set of parallelly arranged four low-pressure fluorescent lamps. The most intensive light flow of these lamps is within the area of visible light, wavelength from 550 to 600 nm. The mentioned light source provided lighting at the intensity of 8000—9000 Lux. The infection trials were performed at the temperature of 20—25 °C and the relative humidity of 60—65 %. These pathogenicity tests were carried out, at the same time, under glasshouse conditions; in the glasshouse trials the methods were the same but the light was natural. The controls were included in each series of infection trials. The number of germinated and ungerminated seeds, plants killed before dying), as well as re-isolation of the fungi from the dead plants were determined. emerging (pre-emergent dying), and plants dying after emerging (post-emergent The pathogenicity tests continued until the plants reached the stage of the first pair of true leaves.

RESULTS

First of all, our attention was concentrated on the specific determination of the isolated Fusarium strains. These determinations were made in fusaria found on natural seeds, untreated with disinfectants, in the rhizosphere of emerging sugar beets, in open soil, and in the inter-row space, and finally in the tissues of plants with black leg.

A total of 12 ***Fusarium*** species were determined out of several hundred isolates. One strain was classified as *Fusarium* of the roseum section within the range of ***F. semitectum.*** Other fusaria which were not determined so precisely are referred to as ***Fusarium*** sp. Besides the species composition the species frequency was studied as well (Table I).

We dealt with the determination of fusaria found on sugar-beet seeds. Our analyses, performed in seed suspension, revealed a rich representation of *Fusarium sambucinum* Fuck. and *Fusarium sp.* There were also some findings of *Fusarium javanicum* Koord. and *Fusarium oxysporum* Schlecht.

However, the greatest number of colonies and the richest specific representation of fusaria were found in the rhizosphere. On the whole, 10 species were identified from the rhizosphere (see Table I).

For a comparison with the population of the rhizosphere, free soil was also subjected to microbiological analyses; the samples for analysing were taken from the inter-row spaces in sugar-beet stands. Here, in com-

I. Populations of fungi of the genus *Fusarium* on sugar-beet seeds, rhizosphere, in free soil and in plants attacked by black leg

Fusarium species	Colonies form sugar-beet seeds		Colonies from rhizosphere soil		Colonies from free soil		Isolates from diseased plants	
	no.	%	no.	%	no.	%	no.	%
F. sp.	322	39	718	12.9	369	24.8	30	13
F. prope roseum	0	0	93	11.9	0	0	42	21
F. gibbosum	45	5	0	0	0	0	0	1
F. graminearum	0	0	1	0	0	0	0	1
F. sambucinum	451	54	1348	24.3	0	0	25	12.5
F. culmorum	0	0	301	5.4	98	6.6	3	1.5
F. lateritium var. *stilb.*	0	0	66	1.19	15	1	0	1
F. nivale	0	0	0	0	0	0	5	2.5
F. oxysporum	2	0.8	46	0.8	0	0	19	9.5
F. moniliforme	0	0	1431	25.8	1000	67.6	16	8
F. javanicum	10	1.2	144	2.59	0	0	38	19
F. javanicum var. *radicicola*	0	0	0	0	0	0	1	0
F. solani	0	0	1394	25.1	0	0	20	10
F. solani var. *redolens*	0	0	0	0	0	0	2	1
Total	830	100	5342	100	1490	100	200	100

parison with the soil of rhizosphere, the population by the fungi of the genus Fusarium was much lower (see Table I).

Ten species of fusaria were obtained from the diseased plants, the number and species were the same as in rhizosphere soil. The individual species were isolated from the plants attacked by black leg in the order given in Table I.

Besides the specific determination we also attempted to find out which fusaria came from seeds and which from soil. Twelve species of the genus *Fusarium,* in which we tried to identify their origin, were determined out of many strains. When some species populated the seeds, it was found in the rhizosphere and in diseased plants, but it did not occur in free soil, then it was inferred that the species came from seeds. This relation played a particularly important role in the *F. sambucinum* species which was very frequently represented in seeds, in the rhizosphere, and in plants diseased with black leg, without occurring in free soil. Though *F. oxysporum* occurred at a much smaller amount, populating very slightly the seeds and the rhizosphere and was absent in free soil, it was frequently found in diseased plants. *F. javanicum* occurred at a low rate on seeds and in the rhizosphere and no representatives of this species were isolated from free soil; however, *F. javanicum* showed a high occurrence rate in diseased plants. *F. javanicum* var. *radicicola* was isolated from diseased plants in individual cases.

Fusaria absent from seeds but present in the rhizosphere and diseased plants and occurring, at the same time, in free soil, were treated as species originating from soil. These species included, in particular, *F. moniliforme,* which did not populate the seeds, occurred at a high rate in the rhizosphere and in free soils, as well as in diseased plants. *F. culmorum,* occurring at a lower rate, was not found in seeds; however, this species was present in the rhizosphere, in free soil, and in diseased plants, *F. solani* was also absent from seeds, yet its occurrence in the rhizosphere was high. Although this fungus is quite wide-spread in soil in our experiments we did not succeed in isolating it from free soil. However, it was frequently found in diseased plants. *F. solani* var. *redolens* was isolated individually from diseased plants.

Nevertheless, some fusaria even showed neither of the two mentioned relations. Although *Fusarium gibbosum* App. et Wr. emend. Bilai occurred on all seeds, it was not revealed either in rhizospheric soil or free soil, or in diseased plants. *Fusarium graminearum* Schwabe was individually revealed in rhizosphere soil. *F. lateritium* var. stilboides was not found on seeds and in diseased plants but occurred sporadically in rhizosphere soil and in free soil. *F. nivale,* a soil saprophyte, and a well-known pathogen on cereals, was isolated from diseased plants in individual cases. In this connection it is interesting to note that *F. nivale* was isolated from diseased sugar-beet plants grown after rye.

Another part of our study included tests of Fusarium pathogenicity to emerging sugar-beet. The results of these infection trials show that all the species tested were only slightly pathogenic (Table II). Plant losses (related to the number of actually germinated seeds) reached only a low percentage, the majority of dying plants being represented by emerged plants at the stage of cotyledons or at the stage of the first pair of true leaves. Greater losses ($< 13\ \%$) were suffered only in the cases of in-

II. Pathogenicity tests of fusaria on emerging sugar-beet

Fusarium species	Number of seeds		Number of plants killed		Number of reisolates	Percentage of killed plants from germinated seeds	Final no. of emerged plants	No. of plants with excessively branched roots
	sown	germinated	before emergence	after emergence				
F. prope roseum	100	75	0	4	2	4.8	71	41
F. gibbosum	100	89	0	2	0	2.2	87	73
F. graminearum	100	62	0	3	1	4.8	59	57
F. sambucinum	100	82	0	2	1	2.4	80	66
F. culmorum	100	73	0	3	2	4.1	70	65
F. lateritium var. *silb.*	100	79	0	10	8	12.7	69	58
F. nivale	100	80	0	4	2	5.0	76	46
F. oxysporum	100	79	0	6	5	7.6	73	48
F. moniliforme	100	74	0	3	2	4.0	71	71
F. javanicum var. *radicicola*	100	76	0	4	3	5.3	72	68
F. solani	100	79	2	2	3	2.5	75	62
F. solani var. *redolens*	100	82	0	1	0	1.2	81	68
Control	100	65	0	20	0	30.6	45	31

fection with *F. lateritium* var. *stilboides*. Fusaria with which the pathogenicity tests were performed came from the collection of microorganisms of the Beet-Growing Research Institute at Semčice. The trials were carried out both with fusaria isolated from the plant material and with those deposited as cultures in the collection for several years. Nevertheless, no different results, ascribable to the age of the cultures, were obtained. However, the differences in the pathogenicity of fresh and old isolates of *F. nivale* deserve mentioning. During pathogenicity tests performed in a vegetation chamber in 1972–1973, fresh *F. nivale* strains were responsible for considerable mortality of beet plants, even before emergence. The level of plant losses, as well as the course of the attack of this species on the plants, were the same as the results obtained in the infection trials with *Pythium debaryanum*. In the mentioned period, these trials were replicated several times and the same result was obtained each time. The compared species of other fusaria showed weak pathogenicity even in these trials. After two years of storage in the collection, the same strain of *F. nivale* lost its virulence and the glasshouse tests with it in 1975 provoked only five-per-cent plant losses.

The higher plant losses in the control variant deserve special mentioning. This phenomenon occurs quite frequently in the cases of artificial infections with weaker pathogens such as, for instance, fusaria. Soil sterilization does not always totally kill all germs of pathogenic fungi in soil. When an inoculum of a weaker pathogen (for instance *Fusarium* sp.)

is placed in this sterilized soil during artificial infection, this pathogen dominates the substrate. It grows richer and its presence prevents even the germs of stronger pathogenic fungi which have survived sterilization from growing and then from attacking the plant with which the infection trials are performed. Although in the control variant sterilization also kills a majority of soil fungi, a smaller part of the pathogenic fungi germs which have survived grows very quickly in the sterilized substrate without any artificial population of another fungus, and can result even in the extensive killing of beet plants. In such cases, *Phoma betae, Alternaria* sp., *Rhizoctonia solani, Fusarium spp.*, and other species are usually isolated from plants killed in the control.

In our experiments, the damage of emerging beet plants by excessive root branching was found a common trait of all the tested fusaria. As a result of soil inoculation with fusaria, excessive root branching affected 60 % of the plants on an average; in the control only 31 % of the plants were affected. No such root branching was observed in infections with other fungi. It can be supposed that such root deformations, though allowing the plant to grow, are not unimportant for further plant development. Beet plants affected in this way show a lower technological value of roots and the yields are lower.

DISCUSSION

The results indicate the species of fusaria populating sugar beet seeds and beet rhizosphere in our trials and the species isolated from plants infected with black leg. *F. sambucinum* frequently revealed on seeds, in the rhizosphere and in diseased plants belongs to fungi spread on many host plants (Domsch & Gams, 1970). It is interesting in this connection that this species was not isolated from free soil at all. *F. javanicum* was isolated at a much lower frequency, although it is well-known that this species is an arbitrary plant pathogen. *F. oxysporum,* otherwise wide-spread on plants (Domsch & Gams, 1970), was also found only in individual cases.

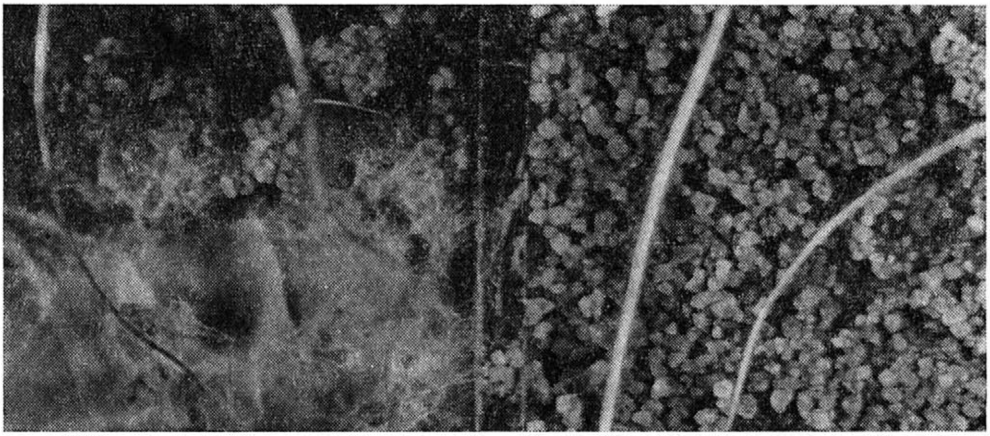
The considerable proportion of the representatives of *F. moniliforme,* isolated mainly from soil, also deserves mentioning. This species is usually wide-spread on many plants, especially in tropical and subtropical countries; in Europe it is ascertained less frequently (Domsch & Gams, 1970). The cosmopolitan species *F. culmorum*, generally considered a soil fungus with high competitive ability, was isolated from soil (though to a smaller extent). The occurrence of *F. gibbosum* only on sugar-beet seeds is an interesting phenomenon: this species, having a cosmopolitan character, is found mostly in topsoil.

It is also interesting that *F. nivale* is isolated from diseased sugar-beet plants grown after rye. These findings were obtained in the marginal regions of sugar-beet growing where rye is frequently grown as the fore-crop. There is a hypothetical possibility that relations may be sought between black leg and rye winter killing, also caused by *F. nivale*. However, this species was isolated from diseased beets only individually – hence the possible pathogenicity of some strains to beet need not be of great economic importance. *F. nivale* strains were found to be highly pathogenic to sugar-beet only in infections immediately following isolations from diseased plants collected in the field. After two years of deposition in the collection these strains lost their pathogenicity.

Valášková (1972) recommends the use of fresh Fusarium isolates for infection.

The branching of sugar-beet roots affected with fusaria (Fig. 1), as revealed by our trials, can entail serious technological consequences which can influence both root and sugar yield.

Hence it occurs that the infection of emerging beets with fusaria, however slight their pathogenicity may seem, should not be disregarded.



1. Left: sugar-beet root branching in the stage of the first pair of true leaves after the attack by the fungus Fusarium nivale. Right: healthy roots of uninfected plants

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VESELÝ D. (Ústav ochrany rostlin, Praha - Ruzyně). *Výskyt hub rodu Fusarium na semenech cukrovky, v rhizosféře a v pletivech rostlin ochořelých spálou.* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 259-266, 1976.

Mikrobiologickými rozbory bylo na semenech cukrovky zjištěno silné zastoupení *F. sambucinum* a *F.* sp. Slabě byla semena osazena druhy *F. javanicum* a *F. oxysporum*. Nejvíce kolonií a rovněž i nejhojnější druhové zastoupení bylo v půdě rhizosféry, kde byla fusaria zastoupena v pořadí: *F. moniliforme, F. solani, F. sambucinum, F. culmorum, F. javanicum, F. prope roseum, F. lateritium* var. *stilboides* a *F. oxysporum*. Ve volné půdě bylo osídlení fusarii ve srovnání s půdou rhizosféry mnohem menší. Celkově zde byly přítomny čtyři druhy: *F. moniliforme, F.* sp., *F. culmorum* a *F. lateritium*. Z rostlin nemocných spálou bylo izolováno jedenáct druhů: *F. prope roseum, F. javanicum, F.* sp., *F. sambucinum, F. oxysporum, F. moniliforme,, F. solani, F. nivale, F. culmorum,* ojediněle *F. javanicum* var. *radicicola* a *F. solani* var. *redolens*. Nevyhraněné vztahy vzhledem k osidlování semen nebo půdy byly u *F. gibbosum, F. graminearum* a *F. lateritium* var. *stilboides*. Čerstvě izolované kmeny *F. nivale* byly vůči řepě silněji patogenní. Jinak všechny druhy fusarií byly jen velmi slabě patogenní. Vzcházející řepné rostliny, které byly fusarii napadeny, trpěly silným rozvětvováním kořene.

cukrovka; fusaria; populace fusarií na semenech a v půdě; řepná spála; patogenita

ВЕСЕЛЫ Д. (Институт защиты растений, Прага - Рузыне). **Появление грибков рода фузариоз на семенах сахарной свеклы в ризосфере и в тканях растений заболевших корнеедом.** Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 259-266, 1976.

Микробиологические анализы показали, что семена сахарной свеклы сильно заражены *F. sambucinum* и *F.* sp. Слабее были заражены семена видами *F. javanicum* и *F. oxysporum*. Больше всего колоний, а также больше всего видов было в почве рисозсферы, причем фузария находилась в следующем порядке: *F. moniliforme, F. solani, F. sambucinum, F. culmorum, F. javanicum, F. prope roseum, F. lateritium* var. *stilboides* и *F. oxysporum*. В свободной почве наличие фузариоза по сравнению с почвой ризосферы было намного меньше. В общем здесь присуствовали четыре вида: *F. moniliforme, F.* sp., *F. culmorum* и *F. lateritium*. Из растений больных корнеедом было изолировано десять видов: *F. prope roseum, F. javanicum, F.* sp., *F. sambucinum, F. oxysporum, F. moniliforme, F. solani, F. nivale, F. culmorum,* изредка *F. javanicum* var. *radicicola* и *F. solani* var. *redolens*. Не отчетливые отношения, ввиду распространения на семенах или в почве, были у *F. gibbosum, F. graminearum* и *F. lateritium* var. *stilboides*. Свежеизолированные штаммы *F. nivale* были по отношению к сахарной свекле более патогенными. Остальные виды рода *Fusarium* были весьма слабо патогенными. Прорастающие растения сахарной свеклы, зараженные фузариозом, страдали сильным разветвлением корней.

сахарная свекла; физариоз; заселение семян и почвы; корнеед сахарной свеклы; патогенность

The Author's Address:

Ing. Dáša Veselý, CSc., Ústav ochrany rostlin, 161 06 Praha - Ruzyně

REACTION OF VARIETIES TO A RACE OF POWDERY MILDEW (ERYSIPHE GRAMINIS DC. F. SP. HORDEI MARCHAL) VILURENT TO THE RESISTANCE DONOR MONTE CRISTO C. I. 1017

F. BRÜCKNER

BRÜCKNER F. (Cereal Research Institute, Kroměříž). *Reaction of Varieties to a Race of Powdery Mildew (Erysiphe graminis DC. f. sp. hordei Marchal) Virulent to the Resistance Donor Monte Cristo C. I. 1017*. Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 267-271, 1976.

In Czechoslovakia a new race of powdery mildew of barley (*Erysiphe graminis* DC. f. sp. *hordei* Marchal) was found which is virulent to the variety Monte Cristo C. I. 1017. After its appearance in Sweden it is the second finding of this race in Europe. The race was designated „AmC42". It is virulent to a considerable number of resistance genes, such as Mlg, Mla4, Mla6, Mla7, Mla9, and further genes not designated up to now, especially from numerous Ethiopian barleys with moderate resistance. This enables it to attack also the variety Trumpf from the German Democratic Republic with the resistance genes Mla4, Mla7 and resistance gene from S 3170 (Ab. 12).

powdery mildew; resistance of barley varieties

In consequence of great physiological adaptability of powdery mildew, the breeding of barley for the resistance to this parasite is very difficult. New physiologic races have been continually occurring, so that the number of effective genetic sources of resistance is constantly reduced. Highly virulent races which are capable to overcome the effect of several resistance genes simultaneously are especially dangerous. Such an example can be seen in the occurrence of new races in Sweden (Wiberg, 1974a) which are capable to attack varieties bred from different resistance sources, such as e. g. the variety Wing with resistance of Lyallpur 3645 and the variety Mona with resistance of the donor Monte Cristo C. I. 1017.

MATERIAL AND METHOD

In December 1974 numerous pustules of powdery mildew occurred in the F_1 cross with the variety Monte Cristo in the glasshouse of the Research Institute of Cereal Crops at Kroměříž in Czechoslovakia. After its isolation it was ascertained that there was discovered a new race different from the races virulent to Monte Cristo which had been found in Sweden.

With this new race a collection of varieties with the most different genes of resistance to powdery mildew was inoculated. The basis of this collection of varieties was formed by the assortment of 1975 E. B. D. N. (European Barley Disease Nursery) and E. E. B. D. N. (Expanded European Barley Disease Nursery) supplemented by some additional varieties. The inoculation was made in the glasshouse all at once and after 9 days in the temperature ranging from 12 ° to 22 °C the evaluation was conducted. According to the reaction the varieties were divided into four groups. The first group with resistant varieties (type 0, 0n, 0-1n, 0/4), the second one with moderately resistant varieties (type 1-2n, 2n), the third group with moderately susceptible varieties (type 2n-3, 3), and the fourth one with susceptible varieties (type 3-4, 4).

RESULTS AND DISCUSSION

The reactions of the expanded differentials according to Nover (1972) to the new race were as follows:

Weihenstephan CP 127422	4	Balkan HOR 1036	0–1
Weihenstephan 37/136	4	Algerian C. I. 1079	0
Weihenstephan 41/145	4	Anatolien HOR 1104	1
Voldagsen 8141/44	4	Anatolien HOR 1402	2
Gatersleben Mut. 511	1	Balkan HOR 723	0
Gatersleben Mut. 501	4	Emir	0
Anatolien HOR 1063	4	Amsel	4
Indien HOR 1657	4	Elgina	4

With regard to the races described up to now by Wiberg (1974a), Kavacs et al. (1974) and to the findings in the German Democratic Republic (NOVER's communication by letter), this new race was designated as the race AmC_{42}. In contrast to the races from Sweden virulent to Monte Cristo, this race is virulent to the differentials Voldagsen 8141/44 (gene Mla_6) and Gatersleben Mut. 501.

Classification of varieties according to their reactions to race AmC_{42}:

I. Resistant varieties

Engledow India C. I. 7555 (1), Vagabond C. I. 3933 (2), Rupee C. I. 4355 (3), Rupal (4), Oliveros 1 (5), Oliveros 2 (6), Sv. 57/510–44 (7), C. I. 8503 (8), I 25 HOR 805 (9), F 784/70 (10), I 265/70 (11), P 1647/70 (12), Marret Puntes (13), Nepal 81 (14), C. I. 10241 (15), Ricardo C. I. 6306 (16), HOR 1036 (17), T 2146/70 (18), Algerian C. I. 1179 (19), Arabische 2 zl. (20), Sultan (21), Emir (22), Aramir (23), Hassan (24), Australische No 22 (25), M. C. 20 (26), No 5678 (27), No 6018 (28), No 7372 (29), Mit. RF 7 (30), Mut. H 3502 (31), Mut. 7085 (32), L 96 v. nudimelanocrithon (33), E. P. 79 (34), E. P. 80 (35), Ab. 1102 (36), Ab. 1105 (37), Ab. 1139 (38), Ab. 6 (39), G 1028/70 (40).

II. Varieties with moderate resistance

C. I. 7672 (41), C. I. 8251 (42), HOR 728 (43), I 5 HOR 802 (44), HOR 1035 (45), HOR 1402 (46), Vierzeilige BBA 810 (47), BBA 822 (48), Nigrate C. I. 719 (49), Gun Eki (50), Belfor (51), Kwan C. I. 1016 (52), Psaknon C. I. 6305 (53), Russian 12 (54), E. P. 71 (55), KM 1192 (56).

III. Varieties with moderate susceptibility

C. I. 4219 (57), C. I. 4974 (58), C. I. 13988 (59), Jerusalem II (60), Fréja×Jerusalem 7-14 (61), Minerva (62), Pauline (63), Ariana C. I. 2524 (64), Batna C. I. 3391 (65), Menelik (66), Marco (67), Palmella Blue C. I. 3609 (68), A 222 (69), Ab. 3 (70), E. P. 74 (71), L 97 (72), Ab. 1128 (73), Nigrisubnudum (74).

IV. Susceptible varieties

Monte Cristo C. I. 1017 (75), Sv. 64505 (76), Sv. 65505 (77), Åkka (78), E 1388/70 (79), Lyallpur BS (80), Fida×(T. A. L.×Aurore) 2 (81), Weider C. I. 1021 (82), HOR 1063 (83), Gujarat C. I. 3397 (84), Amsel (85), Linie 4831 (86), Rogers winter barley (87), Multan C. I. 3101 (88), Long Glumes C. I. 6168 (89), Lyallpur 3645 (90), Lyallpur 3647 (91), H. E. 162 (92), Spiti (93), Mian-wali C. I. 3400 (94), Heine 4808 (95), Mazurka (96), Elgina (97), Voldagsen 8141/44, (98), Ametyst (99), Maris Canon (100), B 294 (101), Chiro Chinko (102), HOR 1630 (103), Lyallpur P (104), C. I. 9588 (105), Maryland (106), Russian 81 (107), C. I. 1237 (108), C. I. 1243 (109), L 100 (110), Ab. 12 (111), Ab. 14 (112), Ab. 15 (113), Ab. 16 (114), Ab. 23 (115), Ab. 1116/47 (116), Ab. 6208/48 (117), E. P. 72 (118), E. P. 73 (119), E. P. 75 (120), E. P. 76 (121), E. P. 77 (122), Medicum 026 (123), Decorticatum (124), Nigrinudum (125), Trumpf (126).

According to the results by Nover (1972), Nover and Lehmann (1972), Wiberg (1974a), and our own results, in the group of resistant varieties only some of them resist all races known in Europe up to now. First of all varieties 1–14 belong to them. Ten to twelve varieties from these are the strains which have arisen from the crossing with barley I 25 (9). They are two-rowed, var. nutans and differ in distinct resistance genes to leaf rust of barley (Brückner, 1973).

Further, there are varieties with the reaction 0/4, typical for the gene ml-o, which is either induced in various mutants (26–32), or spontaneous in some Ethiopian barleys (33–39). The strain G 1028/70 (40) has inherited its resistance from the barley Ab. 6 (39).

The other varieties resistant to the race AmC_{42} have been attacked by some of the other known races. So varieties 16–18 contain the gene Mla_3, the variety Algerian C. I. 1179 the genes Mla and Mlat, varieties 20–24 contain the resistance gene after the first of them Arabische 2 zl.

From the varieties of the group with the moderate resistance, C. I. 7672 (41) is worth the attention because it is resistant to all powdery mildew races known in Europe, but it is invaded by the races 63.4 and 63.5 virulent to Monte Cristo from Japan (Moseman, 1968). The further one is highly effective strain KM 1192 (56) which derives its resistance from the mutant with the resistance gained by the action of Co^{60} (Lekeš, 1971).

In the group of varieties with moderate susceptibility, the varieties with the resistance derived from *Hordeum laevigatum* (62 and 63), the varieties with the genes Mlat (64 and 65) and Mla_{11} (69) are included. From Ethiopian barleys Ab. 1128 (73) deserves mentioning as it is characterized by a high resistance in field conditions, although in glasshouse tests it reacts to individual races with moderate resistance or susceptibility.

In the fourth group of susceptible varieties, the varieties with the known genetical background of resistance to a certain spectrum of powdery mildew races are included, or the varieties which are characterized by a certain degree of resistance in field conditions. This group contains first of all varieties with the proved or supposed gene Mla_9 (75–81).

For the variety Monte Christo C. I. 1017 (75) two closely linked resistance genes were ascertained (Favret, 1949; Hiura, 1960; Starling et al., 1963; Brückner, 1965; Wiberg, 1974b). One of these genes conditions the immune reaction and was designated Mla_9 by Moseman and Jørgensen (1971).

As the race AmC_{42} as well as the races virulent to Monte Cristo from Sweden are simultaneously virulent also to the varieties Weider and HOR 1063, in which N o v e r (1972) supposes the gene Mla_4 designated by M o s e m a n and J ø r g e n s e n (1971) for No. 22 C. I. 13654, it would seem that in Monte Cristo just the gene Mla_4 will be this second gene. However, this contradicts the results of M o s e m a n (1968) with the Japanese races 63.4 and 63.5 to which the variety Monte Cristo was highly susceptible, whereas the varieties Hor. 1063 and No. 22 were moderately resistant.

Another difference is in the reaction of the variety Lyallpur BS (80), which was susceptible to the European races virulent to Monte Cristo, whereas it was moderately resistant to the Japanese races (type 2).

Other varieties behaved quite in concordance with the stated or supposed genetical background: varieties 85 – 89 with the gene Mla_7, varieties 90 – 97 with the genes Mla_4 and Mla_7, varieties 98 – 100 with the gene Mla_6.

Among susceptible varieties there is also a greater number of Ethiopian barleys (108 – 125) with moderate resistance to most powdery mildew races and with relatively good field resistance. Moderate resistance or moderate susceptibility also to the race C_{17} virulent to Lyallpur 3645 was proved in some of them by S l o o t m a k e r (1970).

The last of the barleys is a highly effective variety from the German Democratic Republic – Trumph (126) possessing the genes Mla_4 and Mla_7 after the variety Ciro. Further, it is resistant to leaf rust of barley (*Puccinia hordei* Otth.) and stripe rust (*Puccinia striiformis* West.) after the Ethiopian barley S 3170, which is identical with Ab. 12 (106). The resistance after this barley also to powdery mildew can be ascertained only by means of inoculation with the races virulent to the genes Mla_4 and Mla_7, as e. g. the race AmC_{12}. However, this resistance gene proves to be ineffective just only at the inoculation with the race AmC_{42}.

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BRÜCKNER F. (Výzkumný ústav obilnářský, Kroměříž). *Reakce odrůd ječmene k rase padlí (Erysiphe graminis DC. f. sp. hordei Marchal) virulentní pro nositele rezistence kultivar Monte Cristo C. I. 1017*. Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 267-271, 1976.

V Československu byla nalezena nová rasa padlí na ječmeni (*Erysiphe graminis* DC. f. sp. *hordei* Marchal), virulentní pro odrůdu Monte Cristo C. I. 1017. Je to po Švédsku druhý nález rasy tohoto druhu v Evropě. Rasa byla označena „AmC42". Je virulentní pro značný počet genů rezistence, jako jsou Mlg, Mla4, Mla6, Mla7, Mla9 a další doposud neoznačené geny, zvláště z četných etiopských ječmenů se střední rezistencí. To ji umožňuje napadat i kultivar Trumpf z NDR s geny rezistence Mla4, Mla7 a z S 3170 (Ab. 12).

padlí travní; odolnost odrůd ječmene

БРЮКНЕР Ф. (Научно-исследовательский институт зерновых культур, Кромержиж). **Реакция сортов ячменя к расе мучнистой росы** (*Erysiphe graminis DC. f. sp. hordei* Marchal) **вирулентной для носителя сопротивляемости культивар Монте Христов С. I. 1017.** Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 267-271, 1976.

В Чехословакии была открыта новая раса мучнистой росы на ячмене (*Erysiphe graminis* DC. f. sp. *hordei* Marchal), вирулентной для сорта Монте Христо С. I. 1017. Это после Швеции второе открытие расы данного вида в Европе. Раса была обозначена «AmC42». Она вирулентна из-за большого количества генов устойчивости, как например Mlg, Mla4, Mla6, Mla7, Mla9 и др. до сих пор необозначенных генов, главным образом из многочисленных эфиопских ячменей со средней устойчивостью. Это ей позволяет заражать и сорт Трумпф из ГДР с генами устойчивости.

роса мучнистая злаков; устойчивость сортов ячменя

The Author's Address:

Ing. František Brückner, CSc., Výzkumný ústav obilnářský, Havlíčkova 2787, 767 41 Kroměříž

REVIEW

TOPICAL GENETIC PROBLEMS IN PLANT BREEDING

K o v á č i k, A. et al.: Aktuální otázky genetiky ve šlechtění rostlin. 1977. Published by State Agricultural Publishing House (SZN), Praha, Czechoslovakia. (In Czech).

The book deals with topical genetic problems closely related to plant breeding and concerning breeding methods and breeding aims. Selection of the problems is based on research tasks solved at the Department of Genetics, Institute of Genetics and Plant Breeding in Prague - Ruzyně. That's why the book utilizes the latest experimental evidence and its theoretical parts are comparable with the present level of world literature in this field.

The first chapter deals with crossing and heredity of properties and characters as well as with biochemical methods. Its aim is to introduce the reader to the theory and new knowledge in heterotic breeding, obtaining lines and selection of suitable line pairs, crossing of selected lines and manifestation of hybrid vigour, as well as to simultaneously briefly explain the basic genetic terms and laws governing heredity of qualitative and quantitative characters. It is also concerned with statistical methods used in genetics and plant breeding. Examples from experimental work, especially from the study of sunflower, are presented. The authors of the first chapter are doc. ing. A. K o v á č i k, DrSc. and ing. V. Š k a l o u d.

The second chapter deals with male sterility and its utilization in hybrid breeding. It is concerned with classification, incidence, phenotypical manifestation and heredity of male sterility and summarizes the evidence on male sterility induction by means of chemical substances. The largest part of this chapter is devoted to utilization of genetic male sterility, especially cytoplasmatic male sterility oriented to CMS in wheat, for breeding purposes.

Attention is also focused on practical problems connected with the use of hybrid wheat, seed production, and agronomical properties of hybrids. In the conclusion of this chapter its authoress, ing. M. A p l t a u e r o v á, CSc., assesses the perspectives of hybrid wheat breeding.

The third chapter summarizes the knowledge of genetic resistance to diseases in agricultural plants. It follows the development of resistance breeding in connection with the development of general genetic evidence and presents a survey of resistance breeding methods. It deals in detail with the variability of pathogens, genetic mechanisms conditioning it and genetic relations between the host plant and the pathogen. The chapter also summarizes theoretical knowledge of the hereditary basis of resistance, resistant gene localization, factors influencing resistance manifestations and genetic resistance sources. Practical examples given in this chapter, the author of which is ing. P. B a r t o š, CSc., refer in the first place to cereals.

The fourth chapter introduces the reader to the theory of mutations and their significance for plant breeding. It deals with the distinct nature of mutations, genome mutations, chromosomal aberrations and their induction by means of chemomutagens. It evaluates the significance of chemomutagens and mutagenic effects of ionizing radiation for plant breeding practices. It gives examples of utilizing mutations in plant breeding. The authoress of this chapter, Dr. D. T o m á š k o v á, CSc., illustrates it in her own successful experimental material.

The objective of the book Topical Genetic Problems in Plant Breeding, written by A. K o v á č i k et al., is to serve all those working in the plant breeding field. Yet the general character of the book and chapters on disease resistance and on mutations and mutation breeding may also be interesting for workers in the field of plant protection.

P. B a r t o š

DIFFERENTIAL SENSITIVITY OF FUSARIUM SPP. TO BENZIMIDAZOLES AND THE DEVELOPMENT OF CROSS-RESISTANCE

E. VALÁŠKOVÁ

VALÁŠKOVÁ E. (Institute of Ornamental Gardening, Průhonice). *Differential Sensitivity of Fusarium spp. to Benzimidazoles and the Development of Cross-Resistance.* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 273-282, 1976.

Five benzimidazole fungicides were tested by the toxic plate method against eight *Fusarium* spp. The results have shown specific differences both in the sensitivity of the fungi and in the general effectiveness of the fungicides (the lowest MID were found in Bavistin, the highest in TBZ). Repeated transfers on increasing Benlate concentrations lead to resistance development (e. g. in *F. oxysporum* f. *tulipae* the tolerance increased from the initial MTD 0.00045 % to 0.92 %). The tolerant strains retain their resistance even after 8 transfers on fungicide-free media or after a passage on a sublethal dosis of mercury fungicide. The resistance to Benlate confers resistance to other benzimidazole compounds though the degree of cross-resistance depends on the specific sensitivity of the *Fusarium* sp. to the given fungicide (e. g. a strain resistant to 0.23 % of Benlate tolerates only 0.0072 % of TBZ). Some sequences of benzimidazole derivatives accelerate the resistance development (e. g. Benlate —> Fundazol), other retard it (e. g. Benlate —> TBZ).

systemic fungicides; tolerance; resistance

Since the introduction of systemic benzimidazole fungicides in agricultural practice many cases of acquired pathogen resistance have been reported. The first tolerance symptoms were noted in obligate parasites of the *Erysiphaceae* family. *Sphaerotheca fuliginea* developed profusely on powdery mildew resistant cucurbit selections (Schroeder and Provvidenti, 1969), benomyl treated greenhouse vegetables showed an increased attack by *Erysiphe cichoriacearum* (Netzer et al., 1970). Within a short time resistant strains appeared in further fungal species: *Cladosporium cucumerinum* (Dekker, 1972), *Cercospora beticola* (Georgopoulos and Dovas, 1973), *Ustilago hordei* (Ben-Yephet et al., 1975), *Verticillium fungicola* (Bollen and van Zaayen, 1975). Tolerance was found also in the group of common facultative parasites such as *Botrytis cinerea* (Bollen and Scholten, 1971; Grossmann, 1974) or *Penicillium compactum* and *P. corymbiferum* (Bollen, 1971). Although the acquired resistance may cause difficulties in practical fungus control, in all above mentioned diseases there are, besides the use of benzimidazoles, still other possibilities to reduce the severity of fungal infection.

Unfortunately tolerant strains developed very soon also in fungi causing the tracheomycosis syndrome, especially in *Fusarium* spp., where the systemic benzimidazoles can be presently replaced by no other fungicide. Thanassoulopoulos et al. (1971) found benomyl resistant strains of *Fusarium oxysporum* f. *lycopersici*, Bartels-Schooley and MacNeill (1971) obtained natural as well as UV-induced mutants of *F. oxysporum* f. *melonis* tolerant to benomyl, thiabendazole or furidazole. Our own Benlate experiments, carried out since **1969,** have shown differences in the sensitivity of various *Fusarium* spp. and a relatively easy „training“ of the most tolerant *F. oxysporum* f. *tulipae* to increasing Benlate concentrations (V a l á š k o v á, 1973).

In order to gain more information about the resistance phenomenon further studies were undertaken with a threefold purpose : to test the reaction of different *Fusarium* spp. to a larger assortment of benzimidazole formulations; to ascertain the development of cross-resistance; to define the stability of Benlate tolerance.

MATERIAL AND METHODS

The problem of sensitivity and resistance was studied in eight *Fusarium* spp. (Table I) by the toxic plate method using five benzimidazole formulations (Table II). The fungicides were tested in geometrically increasing concentrations calculated from the usual 50 % commercial W.P. formulations. The doses of Thiabendazole (TBZ) which occurred in the form of a water suspension with 42.7 % of active ingredient were appropriately modified in order to allow the comparison of results. The applied benzimidazole doses, the corresponding actual fungicide concentrations,

I. List of *Fusarium* spp. in the trials

Strain No	Species
91	*Fusarium bulbigenum* Cooke et Mass.
13	*F. culmorum* (W. G. Smith) Sacc.
93	*F. dianthi* Prill. et Del.
15	*F. lateritium* Nees
41	*F. orthoceras* App. et Wr.
88	*F. oxysporum* Schlecht.
110	*F. oxysporum* Schl. f. *gladioli* (Mass.) Snyd. et Hans.
109	*F. oxysporum* Schl. f. *tulipae* Apt.

II. The tested benzimidazole preparations

		a. s. indicated by the manufacturer
Bavistin	BASF — Germany	2-methoxy-carbamoyl-benzimidazole — 50 %
Benlate	DuPont — USA	benomyl — 50 %
Fundazol	Chinoin — Hungary	benomyl — 50 %
San 7117	Sandoz — Switzerland	2-(4 thiazolyl)-benzimidazole — 50 %
Thiabendazole	Merck — USA	2-(4 thiazolyl)-benzimidazole — 42.7 %

and the symbols indicating successive Fusarium transfers are summarized in Table III.

III. Geometrically increasing benzimidazole doses with corresponding transfer figures and concentrations in %

Ordinal transfer numbers	Doses multiples	Concentrations in % of commercial preparations	Ordinal transfer numbers	Doses multiples	Concentrations in % of commercial preparations
			6	64 n	0.0144
	lowest (initial) dose = n	0.00022	7	128 n	0.0288
1	2 n	0.00045	8	256 n	0.0576
2	4 n	0.00090	9	512 n	0.115
3	8 n	0.0018	10	1,024 n	0.23
4	16 n	0.0036	11	2,048 n	0.46
5	32 n	0.0072	12	4,096 n	0.92

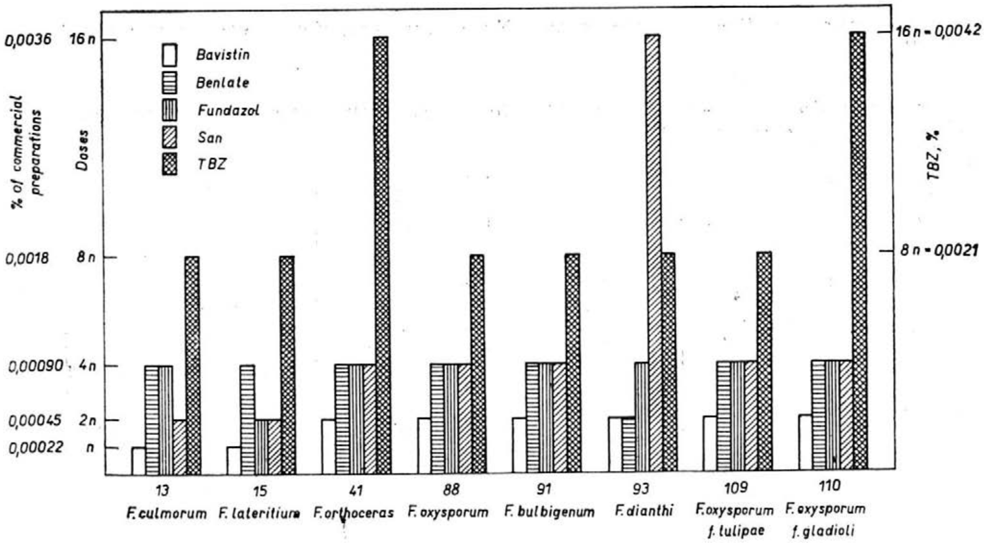
a = 1st; d = 4th
b = 2nd; e = 5th
c = 3rd; f = 6th etc.
transfer on the same benzimidazole concentration

RESULTS

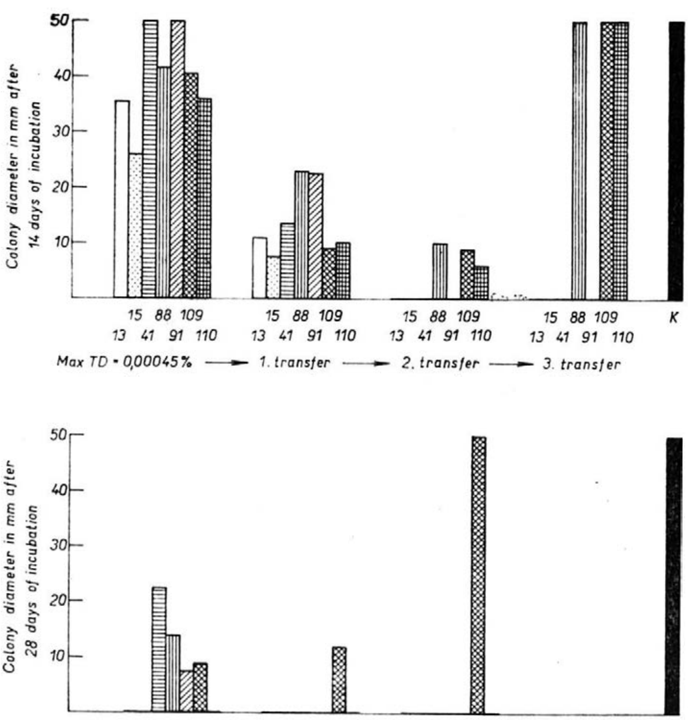
INHIBITION EFFECT OF VARIOUS BENZIMIDAZOLES

The most effective against all tested Fusaria was Bavistin which inhibited fungal growth in the lowest minimum inhibitory doses (MID), i. e. 0.00022 or 0.00045 % (Fig. 1), corresponding to the experimental concentrations n and 2 n (Table III). Its enhanced fungistatic effect is probably due to the fact that the active ingredient is benzimidazole methylcarbamate. The poorest effect was found in TBZ whose MID were 8- to 16-times higher, undoubtedly because the formulation stability was in the form of a water suspension markedly reduced. Benlate (used in all experiments as a standard), Fundazol, and the other TBZ formulation San, have shown an intermediate degree of efficacy.

Striking differences were found also in the individual reaction of each particular *Fusarium* sp. (Fig. 1) : e. g. *F. culmorum* and *F. lateritium* are specifically sensitive to Bavistin, *F. dianthi* to Benlate. On the contrary, enhanced resistance was noted in *F. dianthi* to San and in *F. orthoceras* and *F. oxysporum* f. *gladioli* to TBZ.



1. Sensitivity of ***Fusarium*** spp. to various benzimidazoles: minimum inhibitory doses (in % of commercial prepartion) which ensure, during 14 days, total growth inhibition of inoculated fungus colonies



2. Development of Benlate resistance as influenced by the species of *Fusarium*, the number of transfers and the length of incubation on the fungicide medium

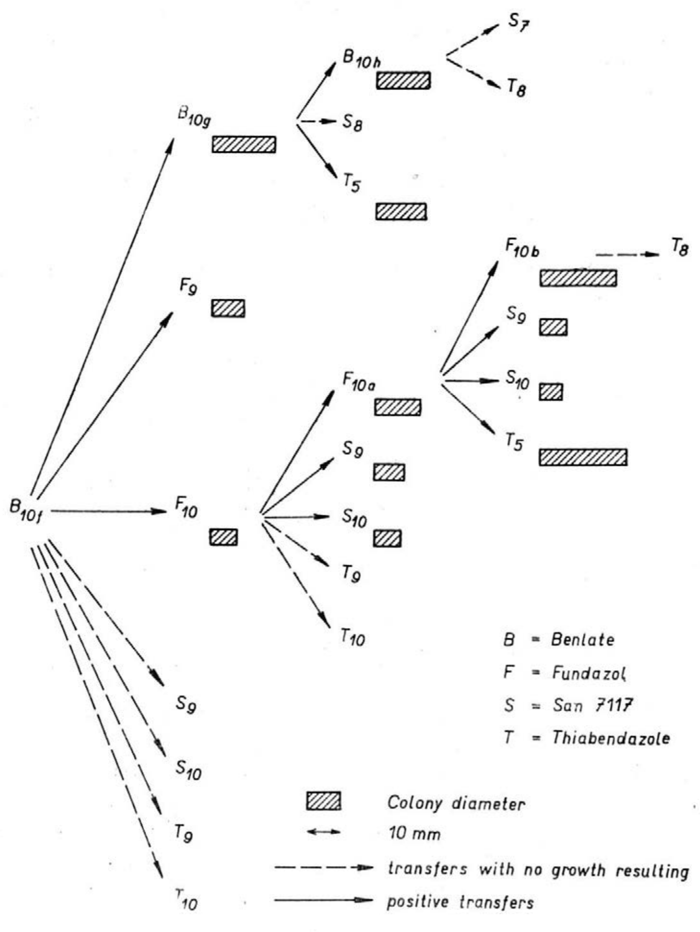
The degree of individual sensitivity to the given benzimidazole is an important factor in the development of *Fusarium* resistance (Fig. 2).

Repeated transfers on the maximal tolerated dose (MTD) of Benlate, i. e. 0.00045 %, lead after temporary growth depression to the adaptation of the more resistant species to increasing fungicide concentrations (2-times MTD etc.). *F. oxysporum* f. *tulipae*, the most resistant species in Benlate trials, was in that way adapted from the inital MTD = 0.00045 % to 0.92 %, that is to a concentration more than 2.000-times higher. On the contrary, in highly Benlate-sensitive Fusaria, e. g. *F. dianthi*, the development of resistance by the „training" of the fungus on gradually increasing fungicide concentrations is very slow. After 15 transfers the adaptation degree obtained was not higher than that corresponding to 4n (Table III).

CROSS-RESISTANCE

In further experiments the highly Benlate-tolerant strain of *F. oxysporum* f. *tulipae* was inoculated on malt agar plates with different contents of other benzimidazoles – in order to disclose possible cross-resistance. The executed transfers and their results are schematically summarized in Fig. 3. The transfer symbols are explained in Table III.

The results have proved that the Benlate resistance confers simulta-



3. Growth of the resistant strain of ***Fusarium oxysporum*** f. *tulipae* after cross-transfers to various benzimidazoles: transfer scheme and colony diameter (after 28 days of cultivation)

neously resistance to the other benzimidazole compounds – though the degree of cross-tolerance depends on the specific sensitivity of the tested *Fusarium* sp. to the given fungicide. A strain of *F. oxysporum* f. *tulipae* in the adaptation degree B_{10f} – i. e. growing after the 6th transfer on 0.23 % Benlate – is simultaneously tolerant (Fig. 3) to an equally high dose of Fundazol (F_{10}), but not to the same or even reduced concentration of TBZ ($S_{9,10}$ $T_{9,10}$). It appears that in general the resistance to benomyl formulations develops more readily than that to the TBZ formulations (San, TBZ). This is striking especially in the case of Thiabendazole. Even highly adapted strains, resistant to 0.23 % Benlate or Fundazol (B_{10}, F_{10}) are unable to grow on TBZ doses higher than 0.0072 % – which means that they tolerate an about 33-times lesser amount of TBZ than of benomyl.

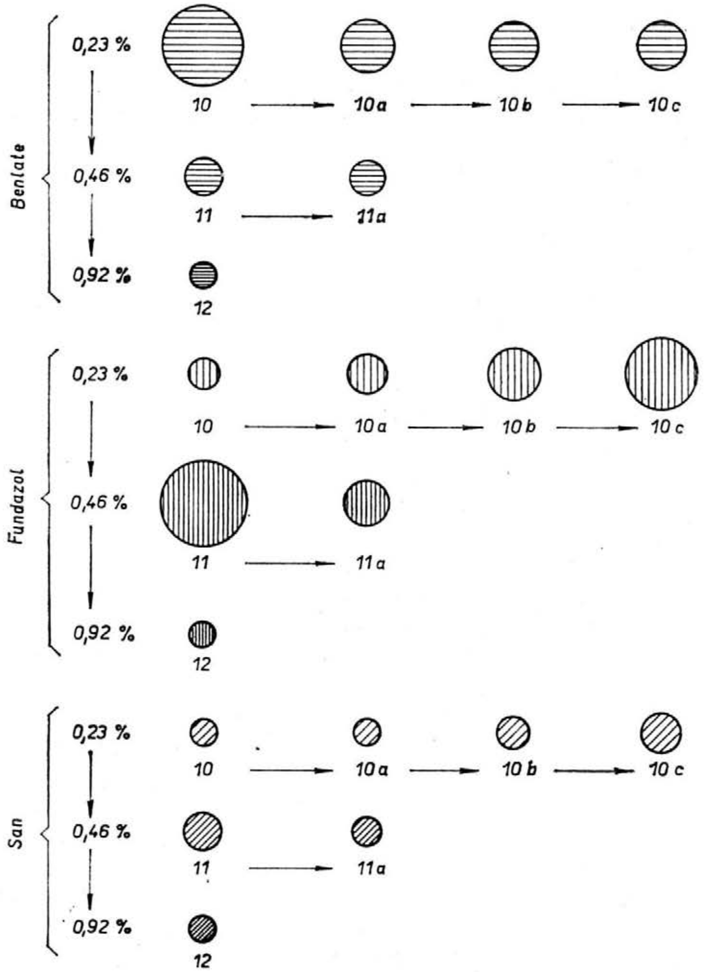
Some sequences of benzimidazoles accelerate the resistance development, other retard it. The transfer from B_{10g} to F_{10}, i. e. from Benlate to Fundazol, induces already after the first passage the tolerance of an equally high concentration of San (= 0.23 %) – whereas repeated transfers on Benlate alone ($B_{10f \rightarrow 10g \rightarrow 10h}$) are unable to assure the *Fusarium* growth even on San doses about 10-times lower, i. e. 0.0288 %.

The resistance to Fundazol not only develops with unusual speed, but it also stimulates the development of resistance to the other benzimidazoles. The Fusarium strain transferred to the variant T_5 (= 0.0072 % of TBZ) from the adaptation degree F_{10a} (Fig. 3) grows with almost 2-fold rapidity in comparison with the strain transferred to T_5 from the adaptation degree B_{10g} – i. e. from an even higher degree of adaptation to Benlate (a = 1st transfer, g = 7th transfer).

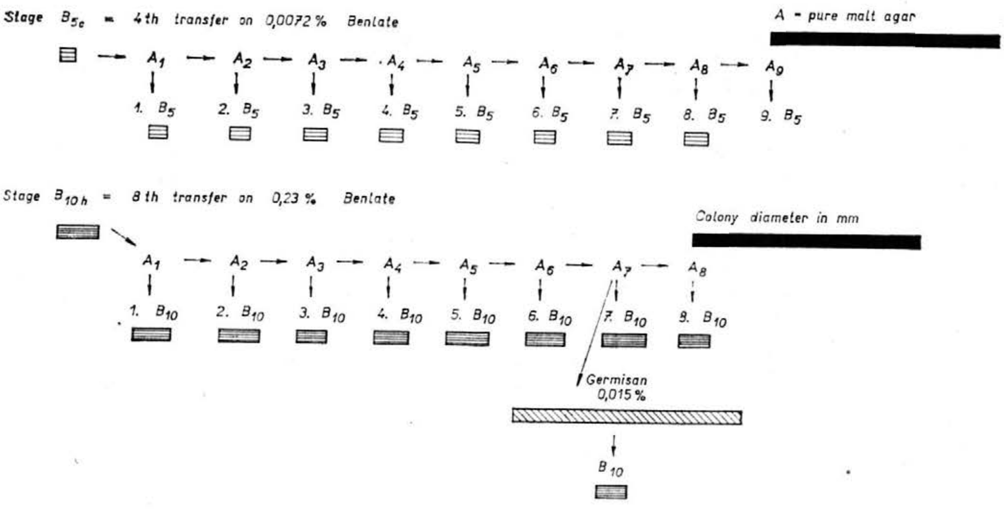
The response of *F. oxysporum* f. *tulipae* to various benzimidazoles shows a well defined correlation between the rate of radial colony growth during successive transfers and the rapidity of resistance development (Fig. 4). Fundazol and Benlate, though both benomyl formulations, differ greatly in their effect on the radial colony growth in high fungicide concentrations (0.23 to 0.92 %). In the Benlate variants repeated transfers on equal or geometrically increasing doses lead always to temporary growth inhibition, whereas in the presence of Fundazol the radial mycelium extension is further enhanced after each passage. The TBZ formulation San has shown, during all transfers, similar slow and uniform growth of the inoculated *Fusarium* strain, which corresponds to a relatively slow adaptation to the fungicide.

STABILITY OF THE BENLATE RESISTANCE

The resistant strain of *Fusarium oxysporum* f. *tulipae* was in the stages B_{5c} and B_{10h} – i. e. in the resp. phases of adaptation to 0.0072 % and 0.23 % of Benlate – transferred alternately to pure malt agar (Fig. 5: variants A_1, A_2 etc.) and back to the original fungicide concentration. The resistance of the adaptation stage B_{5c} was lost only after 9 alternate passages on pure malt agar. The adaptation stage B_{10h} retains still its unaltered growth ability after 8 passages on pure malt agar, and even after a tentative passage on a sublethal (= 0.015 %) concentration of the mercury fungicide Germisan. The diameter of the resistant colonies remained during all trials almost unchanged (Fig. 5).



4. Radial colony growth of the Benlate resistant *F. oxysporum* f. *tulipae* during passages on high benzimidazole concentrations: colony diameter in mm after 4 weeks incubation



5. Colony diameter of two Benlate-adapted stages of *Fusarium oxysporum* f. *tulipae* during alternate passages on Benlate medium and pure malt agar, with a tentative transfer to a sublethal concentration of Germisan

DISCUSSION

The trial results have proved the differential sensitivity of single Fusarium species to various benzimidazole derivatives. Specific differences were found even when the formulations were based on the same active ingredient, e. g. Benlate and Fundazol, or San and Thiabendazole. These differences appear not only in the manifestation of resistance, but also in the specific relationship of cross-resistance. They show clearly the great sensitivity of biological material to the way of fabrication of the chemicals, to the method of finalization of the product, and to the presence of various ballast matters.

A close relationship was found between the sensitivity of a given *Fusarium* sp. to a particular benzimidazole derivative and the speed of resistance development. The greater the sensitivity of the fungal species (i. e. the lower the necessary MID) – the slower and more difficult the resistance development (e. g. in *F. dianthi* to Benlate). On the basis of that correlation a forecast would be possible as to how long a particular benzimidazole derivative will remain effective on a particular crop.

Furthermore, the specific sensitivity of a given *Fusarium* sp. to a particular benzimidazole formulation could be used in practice for delaying the onset of resistance. Because of its efficacy in very low MID, the practically used concentration of that particular benzimidazole would be relatively high – those preventing the drop of its content in the plant to a sublethal level, which would stimulate by its selection pressure the tolerant mutants among the fungus population. The costs of the treatment would at the same time remain within economical limits.

Some features of the cross-resistance development may also be of practical interest. Although the tolerance to Benlate confers also the tolerance to all other benzimidazole derivatives, the degree of cross-resistance depends again on the specific relationship between the *Fusarium* sp. and the particular formulation. In our trials with the Benlate-resistant strain of *F. oxysporum* f. *tulipae* all passages through Fundazol accelerated the cross-resistance development to other derivatives, whereas Thiabendazole retarded it.

The specificity of the mutual relationship between the benzimidazole derivative and the fungus species concerned, as well as the decisive influence of the used benzimidazole sequence were proved also in cross-resistance trials with other fungi.

Bollen and Scholten (1971), working with a benomyl-resistant strain of *Botrytis cinerea* stated its cross-resistance to thiabendazole, fuberidazole and thiophanate methyl. The same author (Bollen and van Zaayen, 1975) found in a benomyl-resistant strain of *Verticillium fungicola* an equally high cross-resistance level to carbendazim (Derosal, Bavistin), thiabendazole, thiophanate methyl, and cypendazole.

With other fungus species and other benzimidazole sequences the results may be different. Specific individual reactions were demonstrated even in species of the same family (Harding, 1972). Isolates of *Penicillium digitatum* resistant to TBZ were cross-resistant to benomyl, whereas analogically resistant strains of *P. italicum* were benomyl sensitive. Some explication of the cross-resistance phenomenon was suggested by Bartels-Schooley and MacNeill (1971). In their trials benomyl or TBZ tolerant strains of *F. oxysporum* f. *melonis* were cross-resistant to both compounds as well as to furidazole; but the furidazole-resistant strain was both benomyl- and TBZ-sensitive, just as the wild type. From the evidence that all benzimidazole fungicides act as antimetabolites the authors suggest that benomyl and thiabendazole may have an additional mechanism of action which is lacking in furidazole.

It is obvious that the development of resistance and cross-resistance to benzimidazole fungicides is a very complicated and until now unexplained process. In order to retard its course it would be possible to alternate some appropriately chosen benzimidazole derivatives – yet that would imply testing in each particular case the reactions of the fungus species concerned. Although the immediate practical benefit of such proceeding is rather dubious, from the theoretical point of view further studies of these fungus-benzimidazoles interactions may finally throw light on the most important questions of modern fungicide application.

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VALÁŠKOVÁ E. (Výzkumný ústav okrasného zahradnictví, Průhonice). *Rozdílná citlivost hub rodu Fusarium k benzimidazolům a vývoj křížové rezistence* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 273-282, 1976.

Pět benzimidazolových fungicidů bylo testováno metodou otrávených ploten proti osmi druhům fusarií. Výsledky ukázaly specifické rozdíly jak v citlivosti hub, tak v účinnosti fungicidů. Nejnižší MID byly zjištěny u Bavistinu, nejvyšší u TBZ.

Opakované přenosy na stoupající koncentrace Benlatu vedou k vývoji rezistence (např. *F. oxysporum* f. *tulipae* bylo tímto způsobem adaptováno z původní MTD 0,00045 % na 0,92 %). Tolerantní kmeny neztrácejí odolnost ani po osmi přenosech na médium bez fungicidu, ani po přechodu na subletální dávce rtuťnatého přípravku Germisanu. Rezistence vůči Benlatu propůjčuje odolnost i vůči ostatním benzimidazolům — avšak stupeň křížové rezistence závisí na specifické citlivosti testovaného druhu fusaria k danému fungicidu (např. kmen rezistentní k 0,23 % Benlatu toleruje pouze 0,0072 % TBZ). Některé sekvence benzimidazolů vývoj rezistence urychlují (např. Benlate —> Fundazol), jiné jej zpomalují (např. Benlate —> TBZ).

systémové fungicidy; tolerance; rezistence

ВАЛАШКОВА Е. (Научно-исследовательский институт декоративного садоводства, Пругонице). **Разная чувствительность грибков рода *Fusarium* к бензимидазолам и развитие перекрестной устойчивости.** Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 273-282, 1976.

Пять бензимидазоловых функицидов тестировалось по методу отравленых досок против всьми видам рода *Fusarium*. Результаты показали специфические различия как в чувствительности грибков, так в эффективности фунгицидов. Самые низкие МИД были установлены у Бавистина, самые высокие у ТБЗ. Повторение переноса на увеличивающуюся концентрацию Бенлата ведут к развитию устойчивости (например, *F. oxysporum* f. *tulipae* было этим путем адаптировано из первичного МИД 0,00045 % на 0,92 %). Толерантные штамы не теряли устойчивость даже после 8 переносов на медиум без фунгицидов, ни после перехода на сублетальную дозу ртутного препарата Гермиса. Устойчивость против Бенлата предоставляет устойчивост и против остальным бензимидазолам — однако, степень перекрестной устойчивости зависит от специфической чувствительности тестированного вида рода *Fusarium* к данному фунгициду (например, штам устойчив к 0,23 % Бенлата толерует лишь 0,0072 % ТБЗ). Некоторые секвенции бензимидазолов ускоряют развитие устойчивости (например, Бенлате ——> Фундазол), другие ее замедляют (например Бенлате ——> ТБЗ).

системные фунгициды; толерантность; устойчивость

The Author's Address:

RNDr. PhMr. Eva Valášková, CSc., Výzkumný ústav okrasného zahradnictví, 252 43 Průhonice

VARIETAL RESISTANCE TO FRIT FLY CARYOPSIS ATTACK IN OAT

R. PERUTÍK

PERUTÍK R. (Cereal Research Institute, Kroměříž). *Varietal Resistance to Frit Fly Caryopsis Attack in Oat.* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 282-291, 1976.

Resistance and susceptibility to the frit fly larvae attack of oat caryopsis (summer larval population) were evaluated in 146 oat varieties, constituting new items in the World oat assortment. Degrees of varietal resistance are illustrated in Figures 1—4. Higher resistance in comparison with the standard variety Diadém was shown by the varieties Kota and Holden in all experiments and years. Resistance of a lesser degree was shown by the variety Thor. There were signs of higher resistance in the varieties Endres, Eta, Flamo, Nodoway, Chilocco and Compact. In other varieties the resistance was altogether the same as in the variety Diadém or lower. High susceptibility was shown by the varieties Pendrum, Lane, Forager, C. W. 490 × ROO cross and others. The variety Palestine Dwarf was very heavily attacked in 1974. It seems that the varieties Kota and Holden are convenient for resistance breeding; their commercial and other characteristics are given in Table II.

oat assortment; genetic sources

The growing of varieties more resistant to caryopsis attack by the summer larval population of frit fly seems at present one of the biological methods for population density limiting this dangerous oat pest. It means the lowering of its high harmfulness, evaluated in this country as high as 45,000 t yearly (P e r u t í k, 1969). The contemporary highest-yielding oat varieties Diadém and Tiger cultivated in this country, are characterized by their high resistance to this pest. In order that new higher-yielding and more resistant varieties can be introduced or bred, it is necessary to seek for or create new genetical sources. A possibility of replacing these sources is given e. g. by items in the World oat assortment (P e r j u 1966); among them varieties having high or higher resistance were found in 1969 – 71 (P e r u t í k, 1973a). In this paper there are results of a varietal resistance evaluation in new varietal items of the World oat assortment in the period of 1972 to 1974.

MATERIAL AND METHODS

Resistance evaluation in new varietal items of the World oat assortment was performed in experiments laid out by the Laboratory of genetical sources, immunology and seed growing (individual sowings, in 1972 three replications, Kroměříž, in 1973 one replication, Kroměříž and Havlíčkův Brod, in 1974 one replication in Bystřice n. Peršt.). Twenty average panicles were sampled from the central part of a replication (five-rowed plot) from which spikelets were removed, thrashed with aid of a thrashing machine for spikes and the glumes were exhausted. From the grain sample of 600—700 caryopses a radiogram was made (P e r u t í k, 1966); this radiogram was evaluated in order to ascertain percentage of damaged caryopses (= characterization of resistance) from the formula A/B × 100, where A — total number of caryopses in the radiogram, B — number of damaged caryopses by the larvae of frit fly.

Resistance and susceptibility degrees in varieties evaluated in relation to the variety Diadém were ascertained in 1972 by an interval estimation of the arithmetic mean (Perutík, 1973b); in 1973 and 1974 this was done by simple comparison with the resistance level of the standard. Other data of agricultural and biological varietal characteristics originated from results of the World oat assortment evaluation done by the Laboratory of genetic sources, immunology and seed growing.

RESULTS

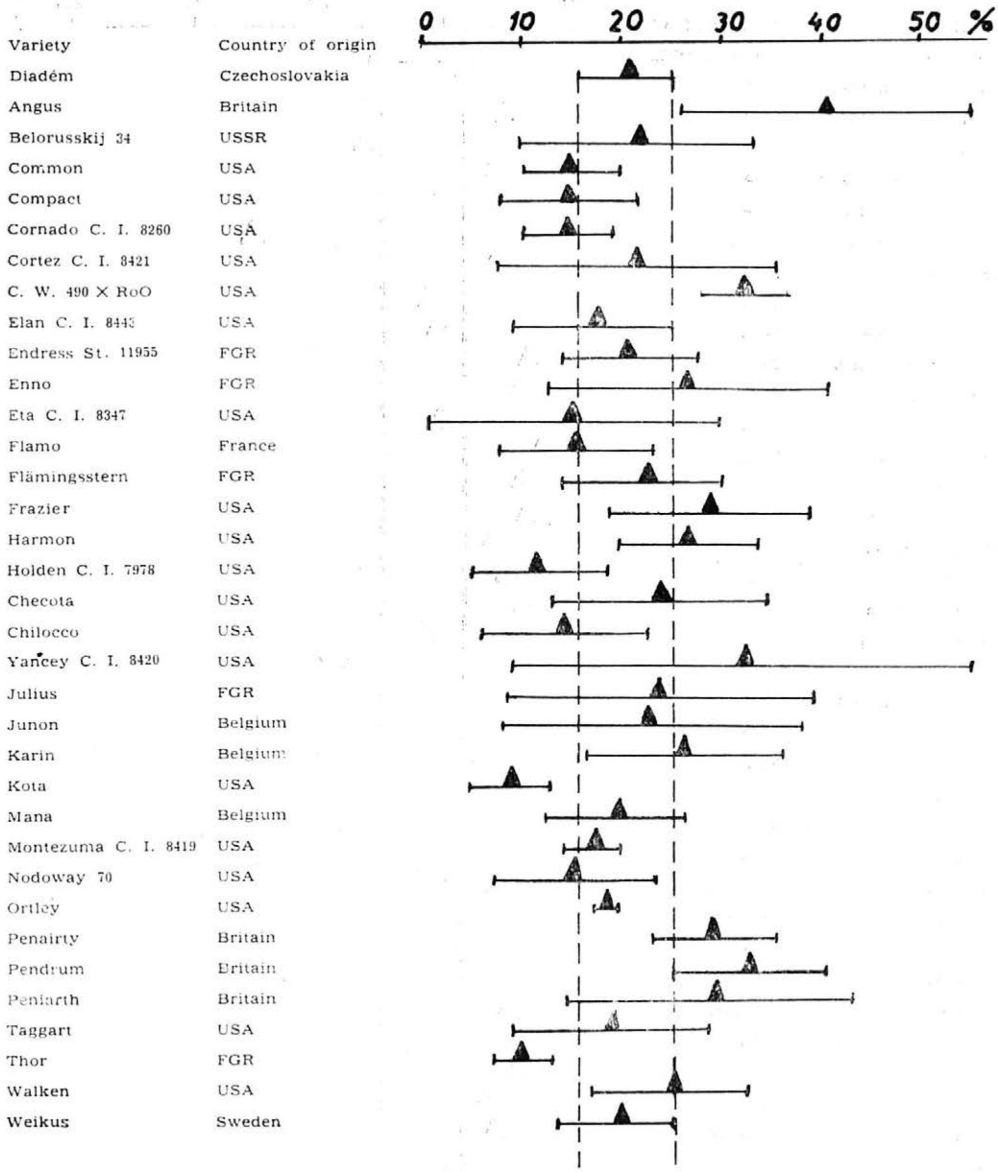
In 1972–1974 the resistance of 146 varieties was evaluated; in 1972, 1973 and 1974 there were evaluations of 34, 42 and 70 varieties, respectively. The resistance degree of individual varieties is given in Figures 1–4. In all years there were varieties having a higher degree of resistance in comparison with the standard variety Diadém, and varieties more susceptible than the standard; but the greatest number of varieties showed resistance comparable to that of the standard. But the number of varieties more resistant than the standard was relatively small. The most resistant (significantly better than the standard) were the varieties Kota and Holden in all experiments and years. The variety Thor was characterized by higher resistance too, but this superiority was not so pronounced. There were some signs of higher resistance in the varieties Endres, Eta, Flamo, Nodoway, Chilocco and Compact. However, it is necessary to verify the resistance of the latter varieties in the following years (Table I). On the

I. Resistance characterization in some oat varieties in experiments during 1972—1974

Variety	Locality			
	Kroměříž 1972	Kroměříž, H. Brod 1973		Bystřice n. Peršt. 1974
Kota	PO	—	PO-NO	PO-NO
Holden	NO	PO-NO	PO-NO	—
Thor	PO	NO	—	ÚD
Endres	ÚD	PO-NO	—	NO-ÚD
Eta	NO	PO-NO	—	—
Flamo	NO	NO	—	—
Nodoway	NO	NO	—	—
Chilocco	—	—	ÚD	PO-NO
Compact	—	—	NO	PO-NO

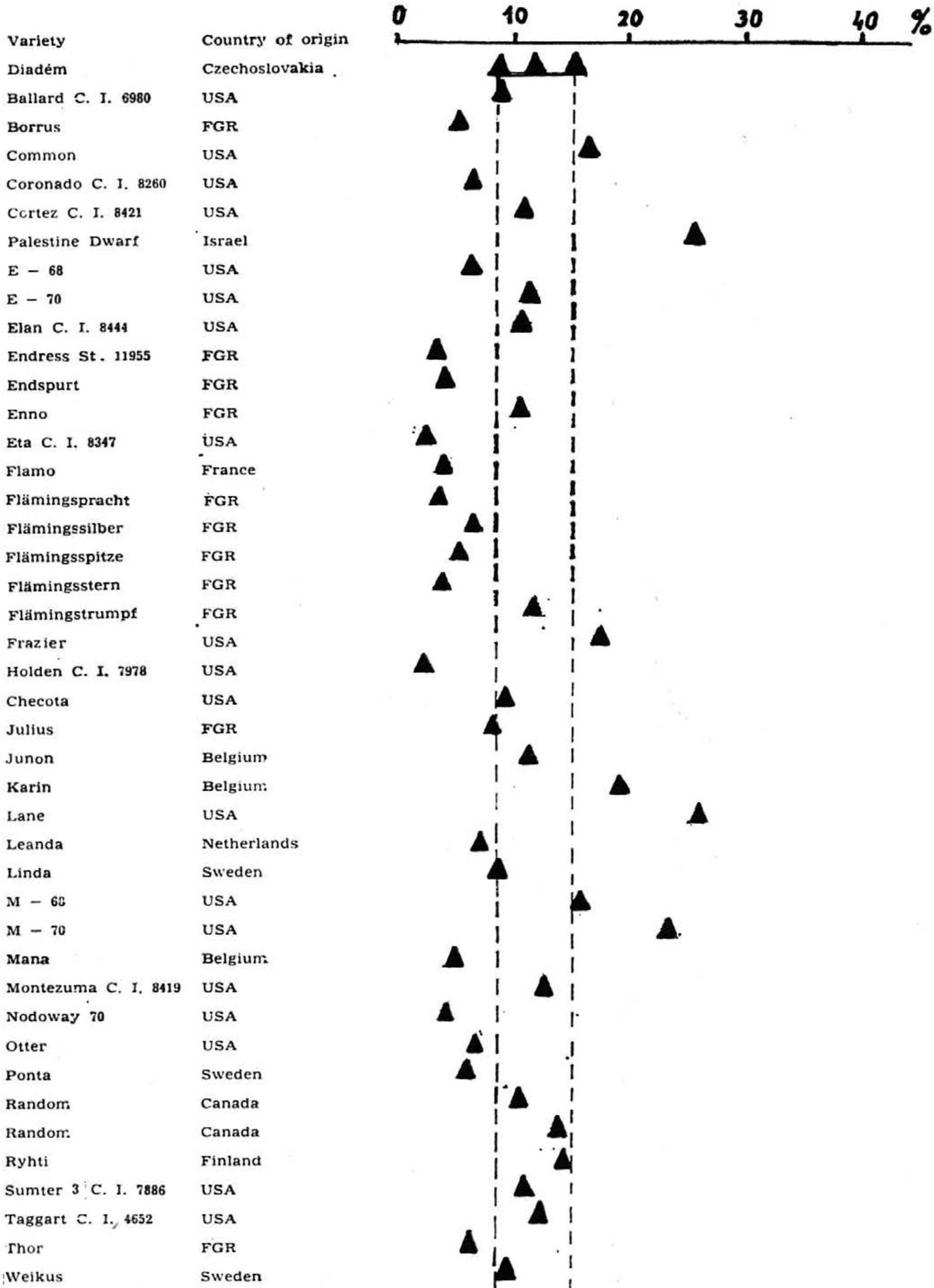
PO — more resistant — significantly
NO — more resistant — not significantly
ÚD — at the level of the variety Diadém (standard)

contary some varieties showed high susceptibility to the frit fly attack, e. g. the varieties Pendrum, Lane, Forager, C. W. 490×ROO cross and others; similarly the variety Palestine Dwarf (1st test year), characterized by a short and stiff stem bearing a panicle of great density. As to



1. Varietal resistance in the World oat assortment to caryopsis attacking by the larvae of Oscinis frit — locality Kroměříž 1972

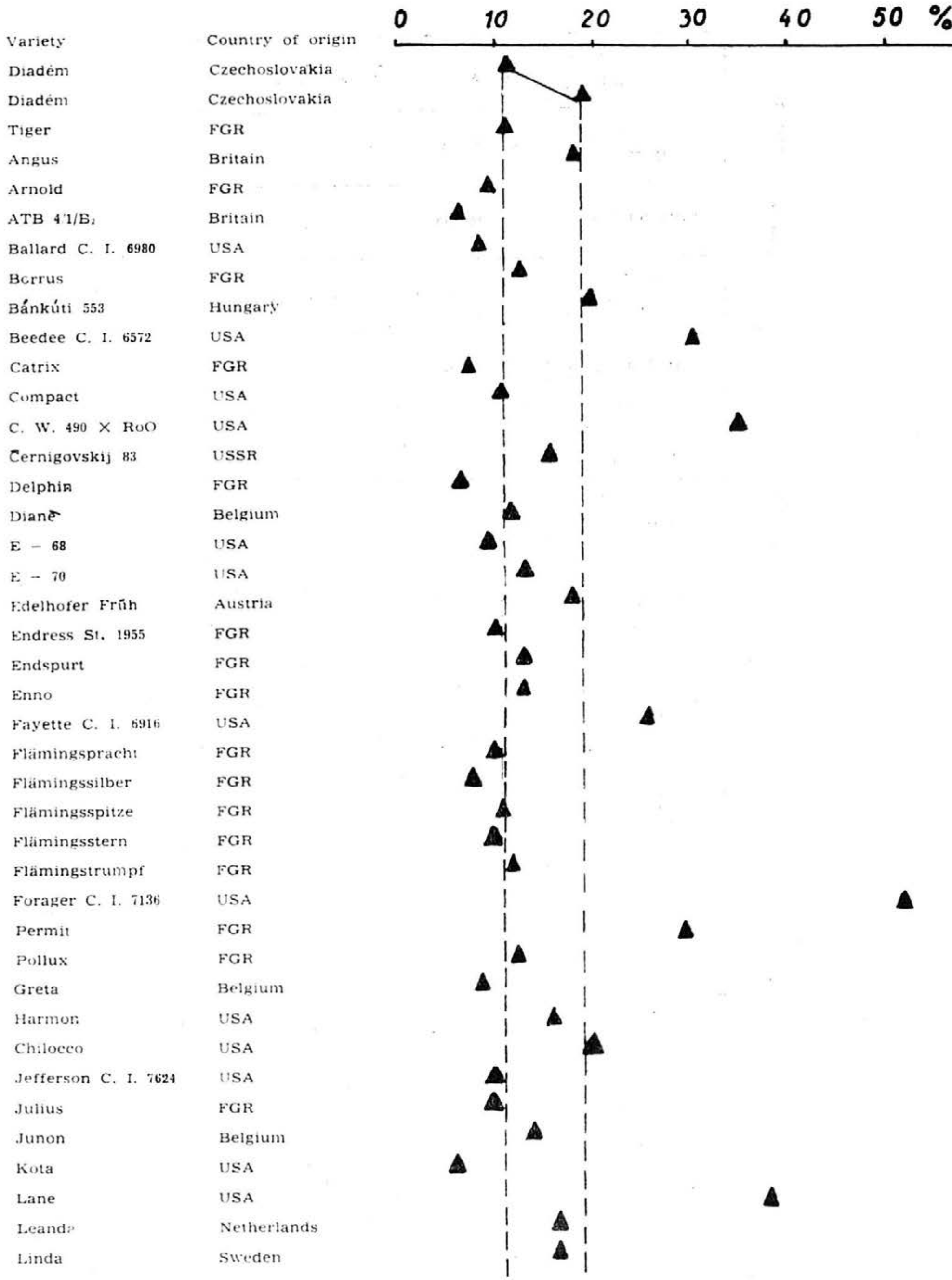
agricultural peculiarities of varieties showing higher resistance to frit fly (evaluated by the point system — F o r a l et al., 1971), they were not better than the standard (Table II). For a crossing programme in order to obtain hybrids resistant to the summer population of frit fly the varieties Kota and Holden seem convenient only, the variety Thor is less suitable.



2. Varietal resistance in the World oat assortment to caryopsis attacking by the larvae of Oscinis frit — locality Kroměříž 1973

II. Point evaluation of some characters in oat varieties having higher resistance to Oscinis frit (based on results from the laboratory of gen. sources, immunology and seed growing, Cereal Research Institute, Kroměříž, 1973—1974)

Cultivar	Country of origin	Botanical variety	Resistance to Oscinis frit	Grain yield per 1 plant	No. of fertile stems	Kernel no. per 1 panicle	1000 kernel weight	Lodging resistance	Stem height	Husk proportion	Protein content	Vegetation period	Sum of points
Chilocco	USA	mutica	5+	1	6	2	5	5	5	3	7	4	43
Compact C. I. 8280	FGR	grisea	5+	3	4	4	4	5	4	4	8	4	45
Endres St. 11955	FGR	aurea	5+	5	5	6	5	5	6	5	6	6	54
Eta C. I. 5347	USA	mutica	6	4	5	5	5	5	6	5	7	7	55
Flamo	France	brunnea	6	3	4	6	4	5	5	5	4	5	47
Holden C. I. 7978	USA	aurea	6+	5	5	5	6	6	5	5	7	7	57
Kota	USA	aurea	7	5	4	6	6	5	6	5	6	4	54
Nodoway 70	USA	mutica	6	3	4	4	7	5	6	4	7	7	53
Thor	FGR	aurea	6+	4	4	6	4	5	6	5	5	5	50
Diadém	Czechoslovakia	aurea	5	6	4	7	7	5	7	5	5	5	56



3. Varietal resistance in the World oat assortment to caryopsis attacking by larvae of Oscinis frit — locality Bystřice nad Pernštejnem 1974

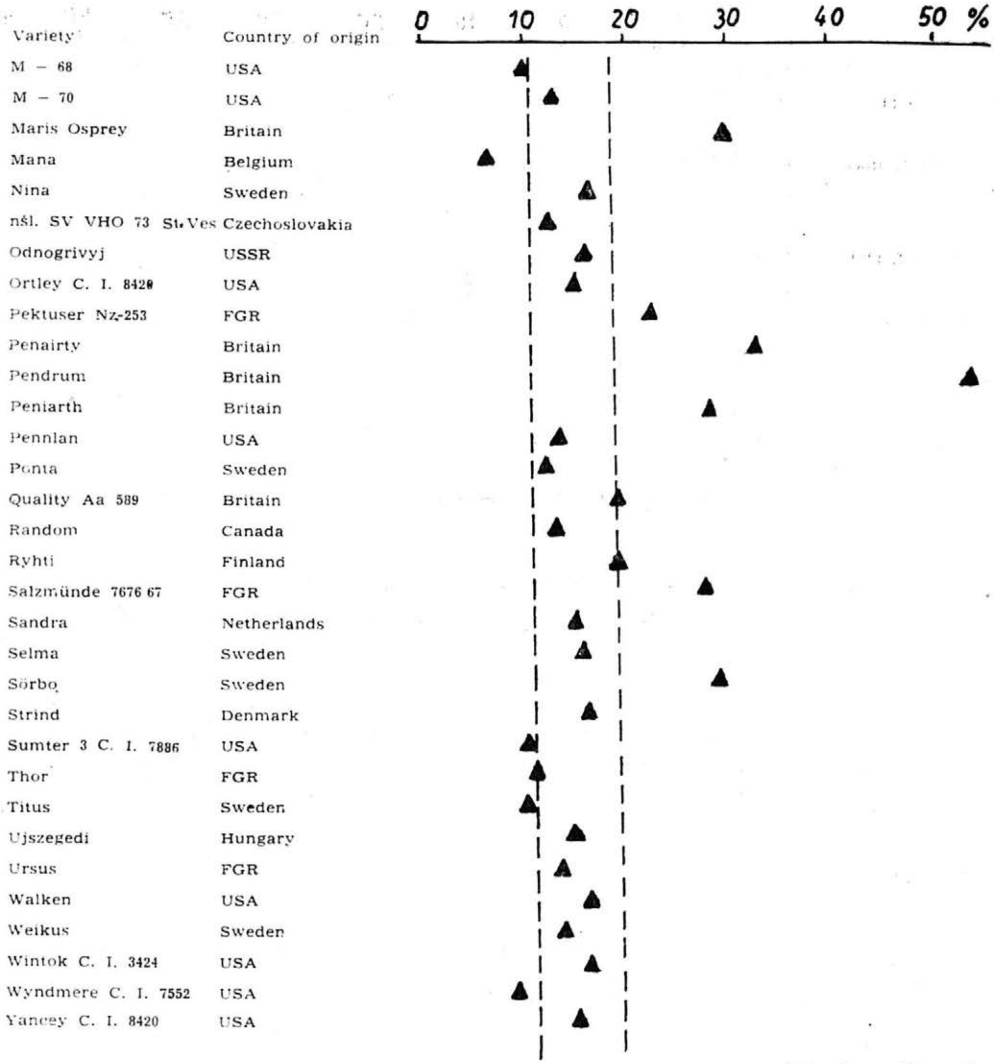
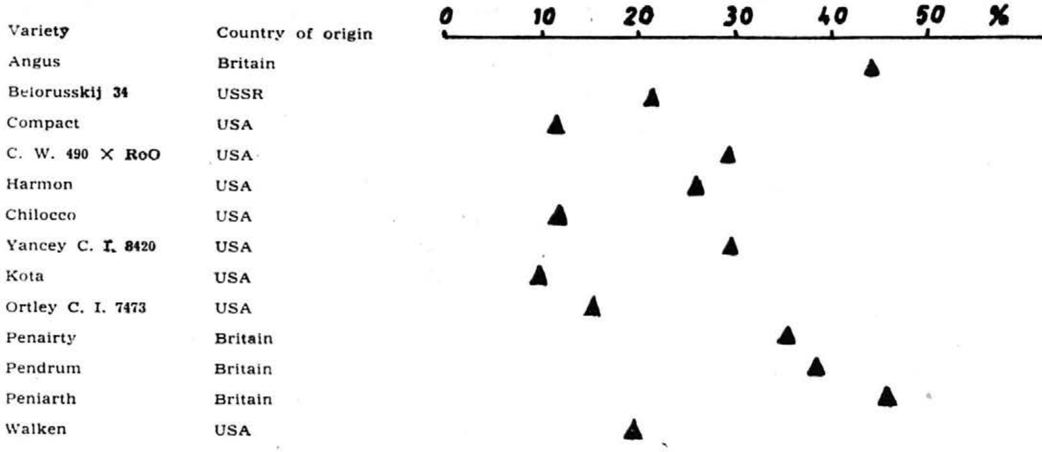


Fig. 3 continued

DISCUSSION

Due to the fact that the standard variety Diadém is characterized not only by the high resistance to the summer larval population of frit fly, but also by other agricultural characteristics, there were, in new items of the World oat assortment, only very few samples having higher resistance levels, none of them being simultaneously better in the set of other agricultural characteristics. It seems that in the World production (breeding) of new varieties it will be more difficult (P e r u t í k, 1973a) to find new genetical oat sources, characterized by higher resistance to caryopsis attacking by the larval population of frit fly and by other, from an agricultural point of view, significant features overcoming in the complex the variety Diadém.

In the author's view it would be better to solve the problem by



4. Varietal resistance in the World oat assortment to caryopsis attacking by larvae of Oscinis frit — locality Havlíčkův Brod 1973

forming genetical sources by means of resistance crossings aiming at the creation of lines with significantly higher resistance in comparison with the variety Diadém.

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PERUTÍK R. (Výzkumný ústav obilnářský, Kroměříž). *Odolnost kultivarů ovsa k napadení obilek bzunkou ječnou.* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 283-291, 1976.

Byla hodnocena odolnost a náchylnost 146 odrůd — přírůstků světového sortimentu ovsa — k napadení obilek letní populací larev bzunek. Stupeň odolnosti odrůd je znázorněn graficky. Vyšší odolností nežli je odolnost standardního kultivaru Diadém se vyznačovaly kultivary Kota a Holden, a to ve všech pokusech i ročnících. Poněkud méně výraznou vyšší odolností se vyznačoval kultivar Thor. Náznaky vyšší odolnosti se projevily u kultivarů Endres, Eta, Flamo, Nodoway, Chilocco a Compact. Odolnost ostatních kultivarů byla vesměs na stupni odolnosti kultivaru Diadém, případně nižší. Vysokou náchylností se vyznačovaly kultivary Pendrum, Lane, Forager, C. W. 490 X ROO aj. Velmi silně byl v r. 1974 napaden kultivar Palestine Dwarf. Kultivary Kota a Holden se jeví vhodnými pro účelné šlechtění na odolnost; jejich další hospodářské a jiné vlastnosti jsou uvedeny v tab. II.

sortiment ovsa; genetické zdroje; bzunka ječná; rezistence

ПЕРУТИК Р. (Научно-исследовательский институт зерновых культур, Кромержиж). **Устойчивость культиваров овса к заражению зерновки мухой шведской.** Sbor. ÚVTIZ - .Ochr. rostl. 12 (4) : 283-291, 1976.

Проводилась оценка устойчивости и предрасположенности 146 сортов — прирост мирового сортимента овса — к заражению зерновок летней популяции ларвами мухи шведской. Степень устойчивости приводится графически. Большей устойчивостью, чем устойчивость стандартного культивара. Диадем, отличались культивары Кота и Голден, причем во всех испытаниях и каждый год. Несколько менее выразительной высшей устойчивостью отличался культивар Тор. Предпосылки высшей устойчивости проявились у культиваров Эндрес, Эта, Фламо, Нодовай, Хилоцо и Компакт. Устойчивость остальных культиваров в общем была такой же как у культиваров Диадем или даже выше. Высокой предрасположенностью отличались культивары Пендрум, Лане, Форажер, С. В. 490 X POO и др. в 1974 году очень сильно был заражен культивар Палестине Дварф. Культивары Кота и Голден оказались весьма подходящими для целевой селекции на устойчивость; их дальнейшие экономические и другие свойства приводятся в табл. II.

сортимент овса; генетические ресурсы; муха шведская, устойчивость

The Author's Address:

RNDr. Radomír Perutík, CSc., Výzkumný ústav obilnářský, Havlíčkova 2787, 767 41 Kroměříž

THE EFFECT OF THE HERBICIDE SIMAZINE ON THE RESPIRATION RATE OF SCENTLESS MAYWEED, SILKY APERA, WHITE MUSTARD, WHEAT, AND MAIZE

D. CHODOVÁ, J. ZEMÁNEK

CHODOVÁ D., ZEMÁNEK J. (Institute of Plant Protection, Praha - Ruzyně). *The Effect of the Herbicide Simazine on the Respiration Rate of Scentless Mayweed, Silky Apera, White Mustard, Wheat and Maize.* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 293-298, 1976.

In laboratory experiments the effect of the herbicide Gesatop (50 per cent Simazine) on respiration rate of the aboveground parts of plants differently sensitive to the herbicide was followed. Reduced respiration rate was recorded in wheat, mustard, silky apera and scentless mayweed. Differences due to different concentrations (with the exception of scentless mayweed) and differences due to individual days of respiration rate determination were highly statistically significant. In maize the differences were insignificant. Mustard, silky apera, and scentless mayweed were damaged with all concentrations, on the other hand, wheat and maize were not damaged by Simazine in the course of 10 days' experiment.

sensitivity and respiration; Simazine; respiration rate

Herbicides affect physiological processes in plants. There are differences in the intensities of the influence of certain herbicides on plant organisms. Respiration is one of the most important processes in the plant, closely related to other life manifestations. For this reason, our attention is focused on the study of the effect of Simazine as an important herbicide, or component of herbicides in current use, on plant respiration rate. Five plant species were chosen for the experiments. Scentless mayweed and silky apera were included as species subjected to complex research (Zemánek et al., 1972; Zemánek, 1973). White mustard was studied as a dicotyledonous plant sensitive to Simazine, wheat as a medium-sensitive plant, and maize as a resistant species.

MATERIAL AND METHODS

Test plants: white mustard — *Sinapis alba* L. (cv. Přerovská), maize — *Zea mays* L. (cv. KAZ); winter wheat *Triticum aestivum* L. (cv. Mironovskaya); scentless mayweed — *Tripleurospermum maritimum* (L.) Sch. Bip. ssp. *inodorum* (L.); silky apera — *Apera spica-venti* (L.) P. Beauv.

Plant growing: Mustard seeds were disinfected with a 0.1 % solution of mercury dichloride for 10 minutes, scentless mayweed was treated with Agronal at the rate of 0.04 g disinfectant per 1 g seed. The seeds were sown in a plastic pot (volume 240 ml) filled with fine siliceous sand and 50 ml Knop's nutrient solution. The pots were covered with watch glass. When the plants emerged, the glass was removed and the plants were irrigated with distilled water. The temperature in the cultivation room was 22—26 °C, the average air humidity ranged from 65 to 80 %, light was provided by fluorescent lamps at the intensity from 4,500 to 5,000 lux, the photo-period being 12 hours.

Herbicide applications: The herbicide Gesatop = 50 % Simazine (i. e.

2-chlor-4,6-bis [ethylamino]-1,3,5-triazine) was applied to plants after a fortnight's cultivation, in wheat and maize after a week's cultivation. In this period, mustard and scentless mayweed had the first pair of true leaves, silky apera two leaves, wheat two or three leaves, maize three leaves. The water suspension of Gesatop was applied to the surface of sand in the cultivating pot; the herbicide quantity in the suspension, applied with a pipette, corresponded to the concentrations of 1 mg, 0.3 mg, and 0.1 mg l^{-1} active substance. Respiration rate was determined by the method according to Kleinzeller et al. (1954) one, four, seven, and ten days after treatment. The Warburg respirometer was used for this determination. The whole above-ground parts of plants were placed in flasks. Oxygen consumption was measured in 10-minute intervals at the temperature of 25 °C, with 60 oscillations per minute. Dry matter was adapted in the experiment to constant weight at 78 °C.

The results were evaluated by the method of variance analysis (Hrubý and Konvička, 1954) and included in tables, showing the mean values for four trials.

RESULTS AND DISCUSSION

The results suggested (Table I–VI) that in resistant maize Simazine applied in three concentrations (1, 0.3, and 0.1 mg l^{-1}) considerably increased respiration rates on the first post-treatment day. The evaluation of the results by variance analysis proved that the differences in respiration rates were neither significant for determinations on individual days, nor for individual concentrations. Similar results were obtained by Eastin et al. (1964). When a sensitive maize line was treated with Simazine, the uptake of oxygen decreased until the plants died; the leaves of the resistant maize line had the same oxygen consumption as the controls.

I. The respiration rates of the above-ground parts of wheat after Simazine treatment

Average respiration rate in μl O_2 (60′) 1 g dry matter on individual days after treatment					
Herbicide concentration mg l^{-1}	1	4	7	10	Average respiration rate at concentrations (irrespective of days)
0 (control)	1.80	1.79	1.79	2.11	1.87
1	1.47	1.22	0.92	1.00	1.15
0.3	1.62	1.54	1.05	1.19	1.35
0.1	2.07	1.75	1.36	1.45	1.66
Aver. resp. rate (irrespect. of concentr.)	1.47	1.57	1.28	1.44	Average respiration rate for whole trial 1.50

Explanatory notes:
The lowest significant differences (d)
a) for comparing means for individual concentrations — $P = 0.05$ (d) = 0.159; $P = 0.01$ (d) = 0.213
b) for comparing means for individual days — $P = 0.05$ (d) = 0.159; $P = 0.01$ (d) = 0.213
c) for comparing means obtained on a certain day for different concentrations or for comparing different days at the same concentration — $P = 0.05$ (d) = 0.318; $P = 0.01$ (d) = 0.426

II. The respiration rates of the above-ground parts of silky apera after Simazine treatment

Average respiration rate in μl O_2 (60′) 1 g dry matter on individual days after treatment				
Herbicide concentration mg l^{-1}	1	4	7	Average respiration rate at concentrations (irrespective of days)
0 (control)	1.71	1.24	1.43	1.46
1	1.58	1.07	0.61	1.08
0.3	1.78	1.33	0.63	1.24
0.1	2.15	1.25	1.22	1.54
Aver. resp. rate (irrespective of concentration)	1.80	1.22	0.97	Average respiration rate for whole trial 1.33

Explanatory notes:
The least significant differences (d)
a) $P = (d) = 0.222$ b) $P = 0.05$ (d) $= 0.192$ c) $P = 0.05$ (d) $= 0.385$
$P = 0.01$ (d) $= 0.298$ $P = 0.01$ (d) $= 0.252$ $P = 0.01$ (d) $= 0.505$

III. The respiration rates of the above-ground parts of maize after Simazine treatment

Average respiration rate in μl O_2 (60′) 1 g dry matter on individual days after treatment					
Herbicide concentration mg l^{-1}	1	4	7	10	Average respiration rate at concentrations (irrespective of days)
0 (control)	2.48	2.63	2.63	2.34	2.52
1	3.36	2.62	2.52	2.36	2.71
0.3	3.73	2.48	2.63	2.33	2.79
0.1	4.01	2.80	3.06	2.86	3.18
Aver. resp. rate (irre-spect. of concentr.)	3.39	2.63	2.71	2.47	Average respiration rate for whole trial 2.80

Explanatory notes:
(see Tab. I)
a), b) $P = 0.05$ (d) $= 0.598$ c) $P = 0.05$ (d) $= 1.196$
$P = 0.01$ (d) $= 0.799$ $P = 0.01$ (d) $= 1.598$

Simazine treatment reduced the respiration rates of wheat, white mustard, silky apera, and scentless mayweed, especially 4, 7, and 10 days after treatment. On the first day following the application of the herbicide the respiration rates of these species were usually higher than in the controls. The statistical processing of the results proved that the differences in the values of respiration rate were highly significant for de-

IV. The respiration rates of the above-ground parts of white mustard after Simazine treatment

Average respiration rate in $\mu l\ O_2$ (60′) 1 g dry matter on individual days after treatment				
Herbicide concentration mg l^{-1}	1	4	7	Average respiration rate at concentrations (irrespective of days)
0 (control)	1.77	2.33	2.55	2.21
1	2.09	0.96	0.47	1.17
0.3	2.43	1.76	1.40	1.86
0.1	2.26	1.94	1.69	1.97
Aver. resp. rate (irrespective of concentration)	2.14	1.74	1.52	Average respirations rate for whole trial 1.80

Explanatory notes:
(see Tab. I)
a) $P = 0.05$ (d) = 0.231 b) $P = 0.05$ (d) = 0.202 c) $P = 0.05$ (d) = 0.404
$P = 0.01$ (d) = 0.310 $P = 0.01$ (d) = 0.273 $P = 0.01$ (d) = 0.538

V. The respiration rates of the above-ground parts of scentless mayweed after Simazine treatment

Average respiration rate in $\mu l\ O_2$ (60′) 1 g dry matter on individual days after treatment				
Herbicide concentration mg l^{-1}	1	4	7	Average respiration rate at concentrations (irrespective of days)
0 (control)	2.43	2.25	2.30	2.32
1	1.55	1.00	0.73	1.09
0.3	2.23	0.97	0.88	1.36
0.1	2.48	2.24	1.49	2.07
Aver. resp. rate (irrespective of concentration)	2.17	1.61	1.35	Average respiration rate for whole trial 1.71

Explanatory notes:
(see Tab. I.)
a) $P = 0.05$ (d) = 0.203 b) $P = 0.05$ (d) = 0.176 c) $P = 0.05$ (d) = 0.352
$P = 0.01$ (d) = 0.272 $P = 0.01$ (d) = 0.237 $P = 0.01$ (d) = 0.474

terminations on individual days and at different concentrations. In the case of scentless mayweed the differences due to concentrations were not significant. Hence all the plants sensitive to Simazine were severely affected by the herbicide, as to their respiration; the factors underlying this effect were the time of exposure and the use of different concentrations. Similarly, Maštakov and Paromčik (1966) mentioned that respiration rate was affected in sensitive plants. The fact is explained in the light of a primary impairment of photosynthesis by triazine herbicides.

VI. The respiration rates of wheat, silky apera, maize, white mustard, and scentless mayweed after Simazine treatment, expressed as percentage of control

The plant treated	Herbicide concentration (ppm) mg l^{-1}	Days after treatment with Simazine			
		1	4	7	10
Wheat	1	81	69	51	47
	0.3	90	86	58	56
	0.1	115	98	76	69
Silky apera	1	92	86	42	—
	0.3	104	107	44	—
	0.1	126	101	85	—
Maize	1	135	99	96	101
	0.3	150	94	100	100
	0.1	162	107	117	122
White mustard	1	118	41	18	—
	0.3	137	75	55	—
	0.1	129	83	66	—
Scentless mayweed	1	63	45	32	—
	0.3	92	43	38	—
	0.1	102	99	65	—

The table shows average values for four trials

All test plants were studied for the responses to Simazine. Maize showed no manifestation of impairment; on the contrary, 10 days after treatment the plants were dark green, as distinct from the controls. It is an interesting fact that respiration rate of wheat was affected from the very first day, although even on the tenth day the plants showed no signs of impairment. Wheat began to yellow only after a 14-day exposure to the herbicide. In silky apera the signs of impairment (wilting) occurred at the concentration of 1 mg l^{-1} already the fourth day from treatment and on the tenth day the plants were almost entirely wilted. At lower concentrations only leaf tips were dry. Mustard had dry cotyledons on the fourth day and the plants were almost completely wilted on the tenth day. Similar symptoms were observed in scentless mayweed. When lower concentrations were used, the impairment was not so severe.

The results prove the finding mentioned already in previous papers by the same authors (Chodová, Zemánek, 1971a,b): The study of the effect of herbicides on some physiological processes (especially on respiration) may serve as a certain criterion of plant resistance to herbicides.

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CHODOVÁ D., ZEMÁNEK J. (Ústav ochrany rostlin, Praha - Ruzyně). *Vliv herbicidu simazinu na intenzitu dýchání heřmánkovce přímořského, chundelky metlice, hořčice bílé, pšenice a kukuřice.* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 293-298, 1976.

V laboratorních pokusech byl sledován vliv herbicidu Gesatopu (50% simazin) na intenzitu dýchání nadzemních částí různě citlivých rostlin k tomuto herbicidu. Bylo zjištěno snížení intenzity dýchání u pšenice, hořčice, chundelky metlice a heřmánkovce přímořského. Rozdíly způsobené různými koncentracemi (vyjma heřmánkovce) a rozdíly způsobené jednotlivými dny při stanovení intenzity dýchání byly vysoce průkazné. U kukuřice byly tyto rozdíly neprůkazné. Hořčice, chundelka a heřmánkovec byly poškozeny při užití všech koncentrací, pšenice a kukuřice během 10denního pokusu poškozeny simazinem nebyly.

citlivost a odolnost; simazin; intenzita dýchání

ХОДОВА Д., ЗЕМАНЕК Й. (Научно-исследовательский институт защиты растений, Прага - - Рузыне). **Влияние гербицида симазина на интенсивность дыхания ромашки непахучей, метлицы обыкновенной, горчицы белой, пшеницы и кукурузы.** Sbor. ÚVTIZ - .Ochr. rostl. 12 (4) : 293-298, 1976.

В лабораторных опытах изучали влияние гербицида Гезатопа (50% симазин) на интенсивность дыхания надземных частей растений с разной чувствительностью к этому гербициду. Установлено понижение интенсивности дыхания у пшеницы, горчицы, метлицы обыкновенной и ромашки непахучей. Различия, вызванные разными концентрациями (за исключением ромашки), и различия, вызванные отдельными днями при определении интенсивности дыхания, были высоко достоверны. У кукурузы эти различия были недостоверными. Горчица, метлица и ромашка были повреждены при применении любой концентрации, пшеница и кукуруза в ходе 10-дневного опыта не были симазином повреждены вовсе.

чувствительность и восприимчивость; симазин; интенсивность дыхания

The Authors' Address:

Daniela Chodová, grad. biologist, doc. ing. Jiří Zemánek, DrSc., Ústav ochrany rostlin, 160 06 Praha - Ruzyně

THE EFFECT OF SUBLETHAL DOSES OF THIOMETON ON INSECTICIDE RESISTANCE IN PYRRHOCORIS APTERUS L. (HETEROPTERA, PYRRHOCORIDAE)

A. HONĚK, I. NOVÁK

HONĚK A., NOVÁK I. (Institute of Plant Protection, Praha - Ruzyně). *The Effect of Sublethal Doses of Thiometon on Insecticide Resistance in Pyrrhocoris apterus L. (Heteroptera, Pyrrhocoridae).* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 299--305, 1976.

The treatment of larvae and/or young imagines of *P. apterus* with sublethal doses of thiometon changed subsequent susceptibility to the same insecticide and increased the variation in the length of survival of insects. The changes in resistance, especially its increasing, are small and apparently of little commercial importance. The increase in variation, however, may facilitate the selection of resistant strains.

insecticides; resistance

The resistance of insects to pesticides, in most cases, is due to the selection of strains with greater capacity to resist the intoxication. This capacity is mostly determined by the greater quantity of detoxifying enzymes produced by resistant strains, although other factors (physiological or behavioural) may be involved. This genetically determined level of resistance, however, can be altered by a previous experience with insecticide itself. The early experiments led to the conclusion that such a treatment only increases the probability of death under subsequent exposure to lethal doses (Crow, 1957). Recently a number of authors have reported the increase in the activity of various detoxifying enzymes after exposure to the insecticide. The effect depends on the strain used (on its original level of enzyme activity), on the physiological status of insect (e. g. age) as well as on the kind of inducer (toxical or nontoxical) (Terriere and Yu, 1974). These great physiological changes are accompanied by a relatively modest increase in resistance (Walker and Terriere, 1970; Yu and Terriere, 1973). Thus the two--step model was proposed of an insecticide resistance origin (Perry and Agostin, 1974). It involves: (1) the selection of a resistant strain and (2) the induction of detoxifying enzymes to greater activity.

We investigated whether some changes in insecticide resistance might arise even in natural population, provided that exposure to sublethal doses was really long (several weeks or so), as it occurs in the nature.

MATERIAL AND METHODS

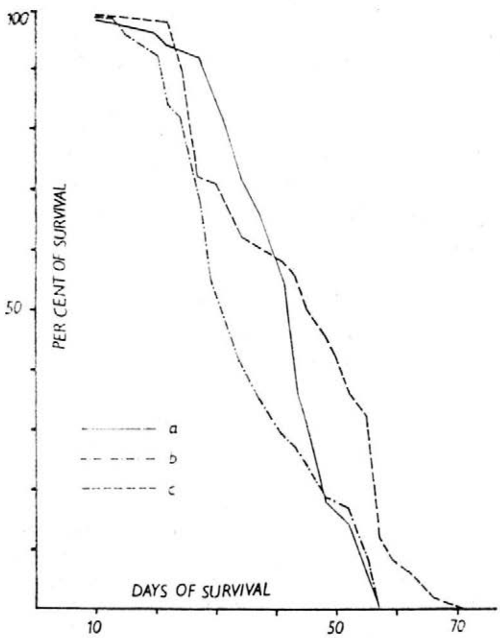
We used the species *Pyrrhocoris apterus* L. (*Heteroptera, Pyrrhocoridae*) in our experiments. The larval development in this species lasts for about four weeks and diapausing imagines can survive several months (at the temperature of about 20—25 °C). In order to reveal even small changes in resistance, we observed the differences in survival under the conditions of chronical poisoning with low lethal concentrations of insecticide rather than the effect of one exposure to a high dose.

The material originated from the site of Hostivice in western surroundings of Prague. The experimental animals (first generation) were bred from eggs in laboratory conditions, short day (12 h light, 12 h dark) and 25 °C (larvae) or 21 °C (imagines), fed by linden seeds. The larvae were supplied with drinking water or 25 ppm or 100 ppm water emulsions of thiometon, prepared from the Czechoslovak product Intration 50. Soon after the imaginal moult the adults from each of these three replicates were sexed and divided into groups of 50 animals. Within each replicate the groups of males and females were supplied with water or 200, 400, 600 and 800 ppm emulsion of thiometon. The concentrations of 600 and 800 ppm appeared to be lethal within 100 days. In water or 200 and 400 ppm water emulsions of thiometon there was 2—5 % mortality during the first 100 days. After 100 days the individuals from these breedings were transferred to the lethal dose (900 ppm) and the length of survival was measured. The counts of dead animals were made every two days, the criterion of death being the complete immobility. The total mortality in controls after the termination of experiments did not exceed 5 %. Therefore no corrections of the death rate in our experiments were made. In this paper we reserve the term „sublethal" for the doses eliciting no mortality at a given time (LD_0).

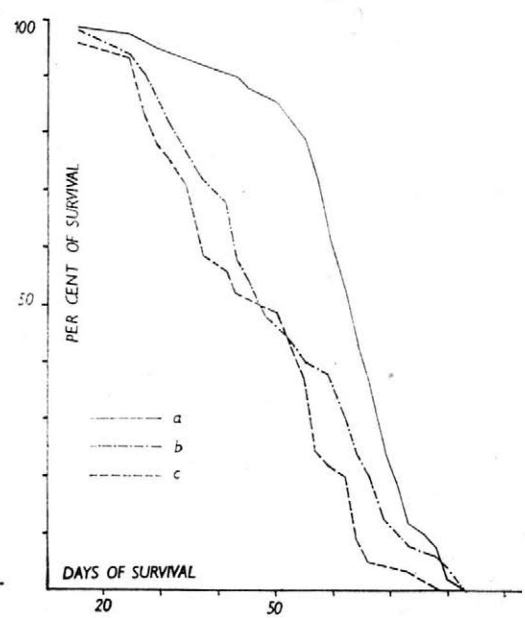
RESULTS

THE EFFECTS ON SENSITIVITY

The young imagines reared on 0, 25 and 100 ppm thiometon emulsions as larvae were tested for the length of survival when 600 and 800 ppm water emulsions of thiometon were offered as the only source of drinking. The Pyrrhocoris tolerate these doses for a rather long time. The mean length of survival in replicates on 600 ppm was about 55–80 days; on 800 ppm it was substantially shorter, about 30–60 days. The males were killed sooner than females. The length of survival was affected by the concentration of thiometon offered to the tested insects during their larval development (Fig. 1–4). This pretreatment of larvae

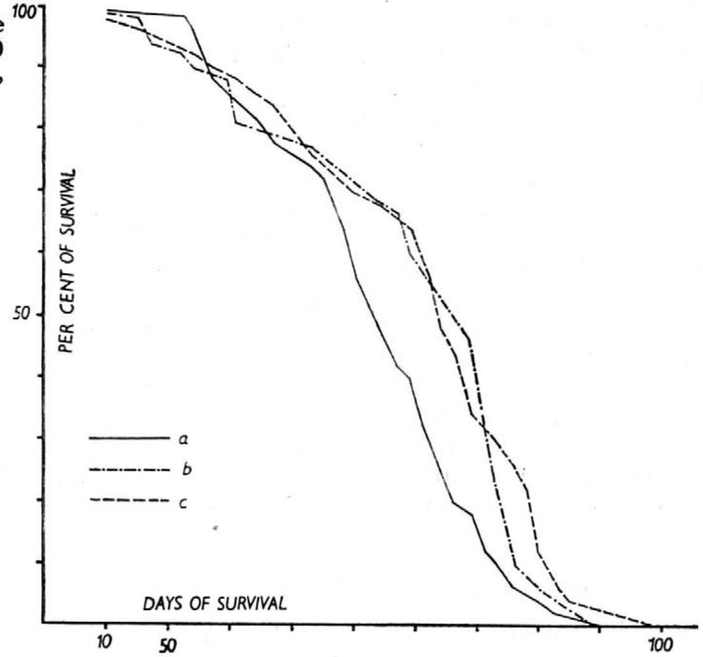


1. The length of the survival of males



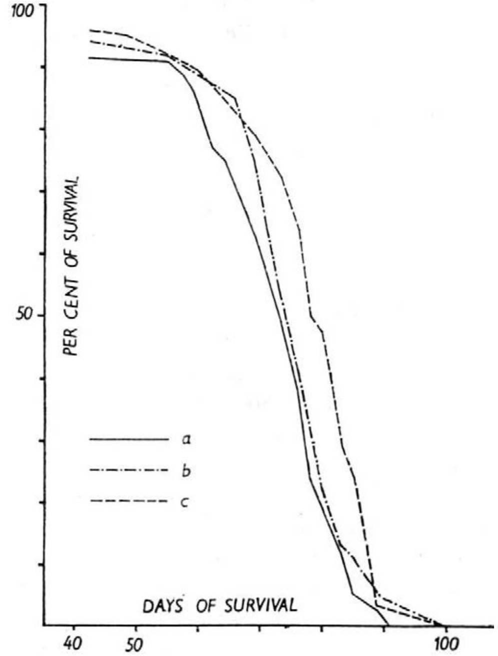
2. The length of the survival of females

800 ppm thiometon emulsion (in water) was offered as the only source of drinking to the tested imagines. The males and females were supplied with water (a), 25 ppm (b) and 100 ppm (c) water emulsions of thiometon as larvae



3. The length of the survival of males. 600 ppm thiometon solution, otherwise as in Fig. 1

showed some positive survival effect in imagines provided that the latter were supplied with 600 ppm emulsion of thiometon. The difference in the males was greater compared with that in the females. In the males the difference of survival between pretreated samples and nontreated control was on the same day as high as 30 %, or, in other words, it took another 10–15 days of feeding the insecticide emulsion till the pretreated sample overtook this 30 % difference of mortality. When a 800 ppm emulsion was used for the testing of resistance, there was practically no difference in survival between the males reared in the larval stage on water and those pretreated as larvae with a 25 or 100 ppm emulsion of thiometon. In females the larval treatment with insecticides had unequivocally a negative effect.



4. The length of the survival of females treated as the males in Fig. 3

In the second experiment, the imagines (reared out on 0, 25 and 100 ppm thiometon emulsions as larvae) were kept on water or 200 or 400 ppm emulsions of thiometon for another 100 days. This treatment proved to be sublethal for diapausing imagines during this time. After subsequent exposure to 900 ppm the length of survival (Table I) differed according to the concentration which the insects experienced as larvae (0, 25, 100 ppm) as well as imagines (0, 200, 400 ppm). The 100-day treatment of imagines with a high sublethal dose (400 ppm) of insecticide significantly decreased the length of survival, while 200 ppm had practically no effect in comparison with the control. The results differed also substantially according to the larval pretreatment. The samples which were treated with the insecticides during the larval development were less resistant than the nontreated ones.

It appears from these results that the uptake of sublethal doses of insecticides can influence the subsequent sensitivity of a population to insecticides. The changes are sufficient to cause rather large differences in survival after exposure to lethal doses. The precise mechanism determining the amount and direction of changes remains unresolved. It only appears that the larvae are more sensitive than imagines to the action of very low doses, and only the low doses can, sometimes, affect the resistance positively.

THE EFFECTS ON VARIATION

Besides the changes in an over-all level of resistance of a population, the arrangement of our experiments enabled to estimate the individual variability in the length of survival (Tab. I). The change in variability in the length of survival is best apparent when the variability is expresed relatively as a „coefficient of variation“ (i. e. the standard deviation is expressed in per cent of the arithmetical mean). When compared in this way, the relative variability increased in most cases with a sublethal dose which the animals met with. In some cases also the absolute maximum survival length was greater in treated than in nontreated animals. Moreover, sometimes it was so, even when the mean length of survival in both samples did not differ or was slightly shorter in the treated sample. This indicates the positive effect of experience with sublethal doses on an increase in variability. A small portion of population may gain a relatively greater advantage in treated than in nontreated population.

DISCUSSION

In our experiments we ascertained the influence of pretreatment with sublethal doses both on the changes in the level of susceptibility to insecticides in population and on the variability of individual responses within the sample.

As far as the changes in susceptibility are concerned, we ascertained only relatively unimportant ones. The small differences in the results obtained may be due to the fact that the differences in sensitivity do not often perfectly reflect the amount of biochemical changes in the insect body. Thus, whereas a 25-fold increase of heptachlor oxidase activity was induced by phenobarbital in a susceptible strain of houseflies, only approximately a twofold increase in resistance was observed, when the flies were tested against low doses of propoxur (Y u and T e r r i e r e, 1973). However, just the changes of resistance in vivo are important in the field conditions.

I. The effect of pretreatment with sublethal doses of thiometon on sensitivity to the same insecticide

Pretreatment		Length of survival (days) on 900 ppm water emulsion of thiometon							
Larvae (all the life) ppm	Imagines (100 days) ppm	Males				Females			
		N	Range	X ± SD	V (%)*)	N	Range	X ± SD	V (%)*)
0	0	28	5–35	25.0 ± 5.7	22.7	29	19–51	39.4 ± 7.6	19.3
0	200	27	9–35	23.1 ± 5.6	24.3	32	16–51	29.2 ± 9.8	29.2
0	400	16	5–26	10.4 ± 5.6	53.8	29	9–35	21.0 ± 7.0	33.3
25	0	30	5–26	12.1 ± 4.9	40.5	30	26–44	35.8 ± 4.6	12.8
25	200	30	9–21	15.2 ± 3.3	21.7	30	19–44	33.1 ± 7.5	22.7
25	400	20	5–30	9.5 ± 5.8	61.0	30	5–47	20.8 ± 9.9	47.6
100	0	30	12–26	19.2 ± 3.4	17.7	27	19–44	30.6 ± 5.8	19.0
100	200	21	12–26	19.4 ± 4.0	20.6	—	—	—	—
100	400	31	5–19	11.1 ± 3.4	29.3	25	9–42	21.8 ± 9.0	41.3

*) Coefficient of variation (V = SD × 100 × x^{-1})

The insecticide pretreatment influenced the resistance in some cases negatively, in other cases positively.

We see the main contribution of our work in increasing the knowledge, how different inductive procedures may affect the results. The question of the inductive dose is of prime importance. Terriere and Yu (1974), summarizing available information, conclude that the effective dose was always rather high. In resistant strains it exceeds the lethal doses for sensitive populations. For the resistant strains themselves, however, in which in induces resistance, it is sublethal (at least in modes of application used in experiments). On the other hand, the authors who ascertained a negative effect of insecticide pretreatment on subsequent resistance, worked with fairly high doses, causing considerable mortality after the pretreatment: 17–37 % (Hoffman et al., 1951), 10–82 % (Chang and Crowell, 1953), 30–70 % (Beard, 1952). Such doses decreased subsequent resistance either by irreversible damage of the organism (Chang and Crowel, 1953) or by leaving remnats of unmetabolised toxicants which interfered with toxicants of subsequent exposure (Hoffman et al., 1951). In our experiments only really sublethal doses had (sometimes) positive effects. When the doses approached the threshold of lethality, they had clearly harmful effects. The second is the question of appropriate time when the doses should be applied. According to our experience, the treatment of larvae seems to be more effective than the treatment of (diapausing) imagines.

In our experiments we ascertained also the relative increase in the variability in tolerance to insecticides among the individuals of treated samples in comparison with those of nontreated ones. It signifies that certain individuals are apparently induced to greater relative resistance. As the individuals, carrying the preadaptive genes for insecticide resistance are also most capable of resistance induction (Terriere et al., 1971), it appears that the survivors of subsequent insecticide impact will be with greater probability the insects carrying those genes. In this way, in our opinion, the increase in variability as a response to treatment with sublethal doses may create better conditions for the operation of selection and thus hasten the formation of resistant strains.

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HONĚK A., NOVÁK I. (Ústav ochrany rostlin, Praha - Ruzyně). *Vliv subletálních dávek thiometonu na odolnost ruměnice pospolné, Pyrrhocoris apterus L. (Heteroptera, Pyrrhocoridae) vůči insekticidům.* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 29-305, 1976.

Po ošetření larev nebo mladých imag ruměnice pospolné subletálními dávkami thiometonu byla pozorována změněná citlivost imag k použitému přípravku a zvýšená variabilita v délce přežívání. Změny odolnosti, zejména její zvýšení byly malého rozsahu a nelze tedy předpokládat jejich ekonomický význam. Naproti tomu vzrůst variability může vytvářet předpoklady pro selekci rezistentních kmenů.

insekticidy; odolnost

ГОНЕК А., НОВАК И. (Институт защиты растений, Прага - Рузыне). **Влияние сублетальных доз тиометона на устойчивость красного клопа** *Pyrrhocoris apterus* L. (*Heteroptera, Pyrrhocoridae*) **к инсектицидам.** Sbor. UVTIZ - Ochr. rostl. 12 (4) : 299-305, 1976.

После обработки личинок или молодых имаго красного клопа сублетальными дозами тиометона, наблюдалось изменение чувствительности имаго к использованному средству и увеличение изменчивости в процессе переживания. Изменения устойчивости, главным образом ее повышение, были небольшими и потому нельзя ожидать, что они имеют экономическое значение. Наоборот повышение изменчивости может создавать предпосылки для селекции устойчивых клонов.

инсектициды; устойчивость

The Authors' Address:

RNDr. Alois Honěk, RNDr. Ivo Novák, CSc., Ústav ochrany rostlin, 161 06 Praha - Ruzyně

REVIEW

FOREST PLANT PATHOLOGY

Č e r n ý, A.: Lesnická fytopatologie. 1976. Published by State Agricultural Publishing House (SZN), Praha, Czechoslovakia. 320 p., 200 figs., (in Czech).

In this book an attempt has been made to place before practical foresters and university students of forestry a complete account of the more important diseases of forest tree and timber as well and possible means for their control.

The book is divided in two main parts. Contents of the general part: Introduction. Section 1. Importance of forest plant pathology. History of forest plant pathology. What forest tree disease means. Conditions of forest tree diseases occurrence. Relationships between host and pathogen. Occurrence of infection and disease of forest tree. Spread of forest tree diseases.

Section 2. Protection of forest trees against diseases and their control. Fundamental presumptions for protection and control of forest tree diseases. Knowledge of conditions important for disease occurrence. Phytopathological checking. Phytopathological prognosis. Epiphytology. Symptomatology and diagnosis. Quarantine precautions.

Section 3. Etiology of forest tree diseases. Nonparasitic diseases. Parasitic diseases.

Section 4. Control methods for forest tree diseases. Seed dressing and seed disinfection. Soil disinfection. Control of diseases by fungicidal spraying, dusting and other applications. Fungicides used for controlling forest tree diseases. Acts and regulations for fungicides application. Machinery used for application of fungicides. Agrotechnical means of forest tree protection against diseases. Resistance breeding against forest tree diseases. Eradication of disease sources. Therapy of diseased trees. Biological control of forest tree diseases.

The second special part has the following chapters: Section 1. Dumping off forest tree seedlings. Section 2. Diseases of conifers, fir, spruce, whitepine, blackpine, limba, pseudotsuga, kneepine, larch, Weymouth pine. Fungi causing conifer wood coloration. Saprophytic wood decaying fungi of conifers.

Section 3. Diseases of leafy tree. Beech, oak, ash, elm, maple, common hornbeam, birch, quaking aspen, poplar, willow, alder, lindentree, locust tree (accacia), gleditsia, mountain ash, horse chestnut, chestnut, oriental plane tree, occidental plane tree, wild cherry, walnut.

Section 4. Technical precautions for timbre protection in forest storage stands.

Section 5. Important wood decaying fungi in buildings and mines. Literature references. Index of Latin names. Index of Czech names. Index of Slovak names.

In general this book may be recommended as a good source of information on forest tree diseases and forest plant protection not only for those readers referred to above but also for the other workers including research workers who will find in this book some valuable and basic information from many branches of forest plant pathology.

B. A. K v í č a l a

DETERMINATION OF ATRAZINE RESIDUES BY A BIOASSAY METHOD

J. BENADA, M. VÁŇOVÁ

BENADA J., VÁŇOVÁ M. (Cereal Research Institute, Kroměříž). *Determination of Atrazine Residues by a Bioassay Method.* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 308-314, 1976.

First leaf segments of barley seedlings were floated in a full nutrient medium containing atrazine, which inhibits the photosynthesis. A wetting agent was added to the solution and dishes with the segments were transferred to an illuminated room with the temperature of 23—25 °C. After 16 hours in regular time intervals the numbers of cuttings which had sunk in each dish were recorded. The rate of sunk segments was dependent on the concentration of herbicide and to some extent on the age of leaves and on temperatures, too. The oat leaf segments gave similar results as barley segments. The residues in soil were assessed in the water extracts. By this method 0.005 mg of atrazine in one litre solution can be detected.

herbicide; barley; oat

In recent years, the results of numerous investigations have been published in which the presence of triazine herbicides at intervals after application has been assessed by the use of an indicator in situ (Switzer and Rauser, 1960), by chemical estimation (Burschel, 1961; Roadhouse and Birk, 1961), or by the use of various bioassay techniques (van der Zweep, 1958; Aelbers and Homburg, 1959; Burnside et al., 1961). Zemánek et al. (1976) presented a bioassay method for the determination of atrazine residues in water.

Bioassay techniques to measure soil persistence have an advantage over chemical methods of estimation because they measure directly the residues which are capable of affecting plant growth. Extraction techniques used in chemical methods can remove residues which are too firmly adsorbed in soil to affect plants and such methods do not always differentiate the herbicide from possible biologically inactive products of degradation. On the other hand chemical techniques can often determine smaller amounts with greater precision.

Oat (*Avena sativa* L.) has been the plant species most frequently used in biological assays of soil for these triazine herbicides. Behrens (1970) gives a comprehensive review of literature dealing with biological assays for the triazine herbicides in soils. Most methods are based on the growth of seedlings and on comparison of either length or weight of shoots or roots with controls.

In our experiments we have modified a technique of Truelove et al. (1974) based on the inhibition of photosynthesis in leaves.

MATERIAL AND METHODS

In the original method of Truelove et al. (1974) the tissue excised from cotyledons of 10-day old pumpkin (*Cucurbita pepo* L.) seedlings was floated in a phosphate-based medium containing a photosynthesis inhibitor, transferred to an oscillating platform and illuminated at the intensity of 30 klux at approximately 28 °C. At regular time intervals, shaking was halted and the numbers of discs or half-discs which had sunk in each treatment were recorded. The discs sank in a few hours if photosynthesis had been inhibited. Otherwise they continued to flow. In darkness no photosynthesis occurs and discs sank both in the presence and absence of a herbicide.

For our experimental conditions we had to modify the original method of Truelove et al. (1974). The cotyledons of pumpkin were replaced by the cotyledons of the cucumber cv. Produkta. It was found that the time required for their sinking was too long and not suitable for the time schedule in the laboratory. We tried to use the leaf blades of barley seedlings of the cv. Ametyst grown in the glasshouse with good results. The leaf blades of the oat cv. Diadém were used too. The segments of the length of 7 mm from these leaves (the tops and bottoms were omitted) were transferred to the herbicide solution or to the water extract from soil. To all solutions or extracts two drops of the wetting agent Citowett and traces of chloramphenicol per one litre were added. The model solutions contained either phosphate buffer (pH 6.7) or 0.1 % nutrient salt Herbapon (manufactured by Synthesia, Kolín) and decreasing amounts of Zeazin, containing 50 % a. i. of atrazine (product of the Chemical Works of J. Dimitrov, Bratislava). For extracts 100 g dry soil and 300 ml of half-strength nutrient solution with following filtration were used.

The controls contained all ingredients with the exception of atrazine. The details of individual experiments are given in texts to tables.

The glass dishes with 50 segments of cereal leaves in the 200 ml solution were transferred to a room with the temperature of 23—25 °C under continuous illumination of 4,000 lux. After 16 hrs in regular time intervals the number of cuttings which had sunk in each dish were recorded. At that time the content of dishes was stirred with a glass rod. The time in tables is given from the beginning of exposition. The concentration of herbicide is expressed in mg of atrazine in one litre. The results are expressed in percentage of sunk segments.

RESULTS

1. The effect of the substrate with phosphate buffer or with nutrient solution (Herbapon) on the buoyancy of barley leaf segments

It was found that the segments in the full nutrient solution began to sink earlier. Nevertheless, at the end of the experiment after 22 hrs the differences obtained with both phosphate buffer and full nutrient solution were very close with the exception of the lowest concentration of atrazine. Using this method 0.005 mg of atrazine in one litre solution can be detected. In these preliminary experiments we obtained some variation in the time necessary for buoyancy and therefore we investigated the effect of some factors.

2. The effect of temperature

At a lower temperature the sinking is delayed. At a higher temperature the sinking is very early, even in controls. The best results were obtained at the temperature of 25 °C.

3. The effect of the concentration of a wetting agent

Two drops of the wetting agent Citowett in one litre solution did not cause sinking even after 24 hrs. With the increasing concentration the sinking increased. Nevertheless, even with the addition of 15 or 30 drops only very few segments sank after 21 hrs. When adding only two drops of the wetting agent per one litre in most experiments its toxicity was negligible.

4. The comparison of barley and oat seedlings

The oat segments began to sink earlier, but at the end of the experiment (after 24 hrs) the difference between barley and oat was very small.

5. The estimation of the variability of biological material

The experiments were performed on five different days using four concentrations of atrazine (Table I) and at four repetitions. The variation is expressed as a standard error ($s_{\bar{x}}$). The first leaves were taken from plants grown in the glasshouse. In experiments carried out on March 30 and 31 the leaves from the same set of plants were used. In these two days it could be seen how the buoyancy increased with the age of leaves. The most suitable leaves for these experiments are the first leaves of seedlings when the second leaf overgrows the first one. Nevertheless, there is variability of segments in sensitivity to atrazine and it could be probably diminished by mixing all segments and thereafter dividing them to individual dishes. The variability is supposed to be the cause of an irregular reaction of segments to decreasing concentration of atrazine in some experiments (e. g. on March 29).

6. The comparison of the sensitivity of different leaves of barley plants grown in the field to atrazine

The leaves were counted from the bottom and were taken from the main tiller. On the date of experiments (May 5) four leaves were completely grown, the fifth leaf was only partly developed. In this experiment the leaves from the field were compared with the first leaves of seedlings from the glasshouse. In Table II the means of two repetitions are presented. Only one concentration (0.5 mg l^{-1}) of atrazine was used. From this experiment it can be concluded that the leaves with the supposed highest assimilation activity (3rd leaf from the bottom) had the lowest buoyancy. These leaves are not suitable for the estimation of atrazine because the inhibition by low concentrations of atrazine is surpassed by high assimilation. On the contrary this test can be suitable for estimating the relative assimilation activity of leaves in physiologic studies. The first leaves from the glasshouse, as well as from the field, showed very similar sensitivity to atrazine in this experiment.

7. The estimation of atrazine adsorption to soil components.

The given amounts (Table III) of atrazine were added to 100 g of dry sandy loam soil and mixed thoroughly with 300 ml of water several times during one hour. The suspension was then filtrated in the course of another 6 hours. The filtrate was taken in four repetitions for measurements on buoyancy of seedling segments and compared with the atrazine solution (0.5 mg l^{-1}). This experiment was repeated several times and the variability was expressed as the mean error. The results are shown in Table III. When comparing the addition of the same amount of atrazine to soil and to a nutrient solution one can see that buoyancy in the nutrient solution was approximately the same or higher than in the filtrate. The adsorption of this type of soil was low. However the addition of atrazine to soil resulted in disturbed reactions of segments in comparison with experiments in nutrient solutions shown in Table I.

I. The estimation of variability in buoyancy of segments from barley leaves of the cv. Ametyst. n = 4

Date	Concentration of atrazine mg l^{-1}/hrs	Percentage of sunk segments															
		16		17		18		19		20		21		22		23	
		$\bar{x}$	$s\bar{x}$	$\bar{x}$	$s\bar{x}$	$\bar{x}$	$s\bar{x}$	$\bar{x}$	$s\bar{x}$	$\bar{x}$	$s\bar{x}$	$\bar{x}$	$s\bar{x}$	$\bar{x}$	$s\bar{x}$	$\bar{x}$	$s\bar{x}$
March 29	2.5	3.50	1.30	6.50	2.50	10.00	6.76	18.00	8.28	28.50	12.90	48.50	13.28	62.00	11.60	74.00	8.36
	0.5	0.00	0.00	1.00	0.00	2.50	1.92	6.00	5.24	9.00	8.50	24.50	12.82	42.00	12.26	62.50	10.40
	0.25	0.00	0.00	1.50	0.56	4.50	1.74	12.50	5.30	20.50	7.60	40.00	15.02	49.00	17.70	57.50	19.68
	0.05	0.00	0.00	0.00	0.00	0.50	0.00	2.00	2.00	4.50	2.06	11.50	5.18	25.00	8.72	50.00	15.02
	0 (Control)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.56	1.50	1.00	1.50	1.00
March 30	2.5	29.50	10.96	45.50	13.58	67.00	12.64	79.50	7.08	84.00	6.54	92.00	4.08	95.00	1.74	—	—
	0.5	14.00	7.52	23.50	7.84	38.50	8.62	55.00	8.70	74.00	1.82	85.00	1.74	87.00	3.00	—	—
	0.25	10.50	5.00	20.50	8.18	38.50	7.46	40.00	4.32	72.00	3.72	77.00	4.20	84.00	2.94	—	—
	0.05	2.50	1.92	4.00	2.70	10.00	3.36	20.20	3.36	34.50	5.38	45.50	5.50	56.00	4.08	—	—
	0 (Control)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	—
March 31	2.5	59.50	4.48	71.00	3.92	—	—	86.50	1.92	92.50	2.50	—	—	97.50	19.2	99.50	0.56
	0.5	12.50	2.24	28.00	8.56	—	—	49.00	9.72	58.50	8.98	—	—	68.50	9.42	80.50	8.34
	0.25	1.00	1.00	2.00	1.40	—	—	13.00	2.38	24.00	2.82	—	—	40.00	4.90	60.00	4.36
	0.05	0.00	0.00	0.00	0.00	—	—	1.50	0.56	2.00	0.00	—	—	7.00	2.06	29.00	3.86
	0 (Control)	0.00	0.00	0.00	0.00	—	—	0.00	0.00	0.00	0.00	—	—	0.00	0.00	00.00	0.00
April 1	2.5	88.50	1.00	93.00	0.60	97.00	0.56	—	—	99.50	0.00	—	—	99.50	0.00	—	—
	0.5	85.00	5.16	89.50	4.28	91.50	3.50	—	—	95.50	2.22	—	—	99.50	0.56	—	—
	0.25	80.00	7.54	83.50	8.28	90.00	5.94	—	—	93.50	5.16	—	—	97.00	0.56	—	—
	0.05	50.50	11.16	66.00	8.72	79.50	7.54	—	—	82.50	7.04	—	—	91.50	3.96	—	—
	0 (Control)	0.00	0.00	2.00	0.44	4.00	1.30	—	—	6.00	1.52	—	—	14.00	3.10	—	—
April 7	2.5	66.00	5.88	72.50	3.70	—	—	78.50	3.42	84.00	0.44	—	—	90.50	4.10	—	—
	0.5	32.50	4.66	38.50	4.28	—	—	58.00	3.90	66.00	4.24	—	—	81.00	2.36	—	—
	0.25	18.50	8.06	25.00	7.76	—	—	48.50	4.50	61.50	5.68	—	—	78.00	2.94	—	—
	0.05	6.00	1.82	10.00	2.58	—	—	20.00	4.16	24.50	5.60	—	—	42.50	4.20	—	—
	0 (Control)	0.00	0.00	0.00	0.00	—	—	0.00	0.00	0.00	0.00	—	—	1.50	1.00	—	—

II. The sensitivity of different leaves of barley plants grown in the field (cv. KM 1192) to atrazine (0.5 mg l^{-1}). Means of two repetitions. Without atrazine no buoyance was observed

Origin of leaves/hrs	Percentage of sunk segments				
	16	17	18	19	20
Glasshouse seedlings	36	57	63	72	82
Field:					
1st leaf	34	57	60	83	87
2nd leaf	18	31	46	55	61
3rd leaf	4	6	8	19	36
4th leaf	6	17	34	38	41

8. In foregoing experiments dry matter of segments was estimated in the control dishes after exposition. The dry matter of segments floated in atrazine solutions was decreased (e. g. on May 17 by 5.25 mg and on May 18 by 8.71 mg).

9. The estimation of atrazine concentration to which the extraction should be compared

Barley was grown in hydroponic culture in the glasshouse during May with addition of increasing amount of atrazine. When the second leaf was developed, then rapid wilting of leaf tips or blades appeared. The plants in vessels containing 0.50 mg of atrazine in one litre were little damaged and the wilting increased with increasing concentrations (Table IV). The concentration of 0.50 mg of atrazine in one litre can serve as a standard in buoyancy tests. When the percentage of sunk segments is close to this control, then cereals cannot be sown without danger. When the percentage is substantially lower or close to the control without atrazine, the cereals can be sown in this soil. Here the great leap is striking in the reaction between the concentration of 0.25 and 0.05 mg l^{-1} which can be seen from results shown in Table I, too. This test was verified by taking soil samples from the field in which atrazine was applied and by cultivation of barley in these samples in the glasshouse as well as by sowing barley to these places in the field. It is necessary to be aware that the content of atrazine changes and decreases during the time. For example in a field in which damage on winter wheat appeared at the beginning of April, no residues could be proved a month later and barley grew well on this place in the field as well as in this soil in the glasshouse.

10. The use of this test for estimation of the water pollution with atrazine

The samples of water can be compared with standard concentrations of atrazine in a nutrient solution.

11. In all tests two to four repetitions should be used to exclude the variability of biological material. For practical purposes the count-

III. The absorption of atrazine in sandy loam soil. Seedling first leaves from the glasshouse

Date	Concentration of atrazine mg l^{-1}/hrs	Percentage of sunk segments											
		16		17		18		19		20		21	
		$\bar{x}$	$s\bar{x}$	$\bar{x}$	$s\bar{x}$	$\bar{x}$	$s\bar{x}$	$\bar{x}$	$s\bar{x}$	$\bar{x}$	$s\bar{x}$	$\bar{x}$	$s\bar{x}$
May 17	2.5	56.50	10.00	64.50	5.74	80.50	6.90	87.50	5.86	91.50	5.20	96.00	3.20
	0.5	27.50	4.04	37.00	4.20	43.50	3.60	49.50	4.12	56.50	2.22	64.50	1.92
	0.25	9.50	1.92	16.50	2.82	23.50	5.32	33,50	7.60	37.50	8.36	40.00	7.60
	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Control												
	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.5	11.50	1.72	18.50	2.16	31.50	1.30	43.50	2.80	57.00	2.16	63.00	1.74
May 18	2,5	62.00	7.40	68.50	1.54	78.50	5.34	83.50	3.58	86.50	3.56	87.00	3.52
	0.5	63.00	8.02	73.00	22.16	83.00	6.52	89.50	7.60	93.50	3.56	96.50	2.40
	0.25	20.50	3.86	30.50	7.54	35.00	11.14	42.50	9.80	55.50	9.94	67.50	8.22
	0.05	3.00	1.92	4.00	2.44	8.00	2.04	11.50	3.10	19.50	5,25	21.50	5.90
	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Control												
	0	0.00	0.00	0.00	0.00	0.50	0.00	1.50	1.00	2.00	1.40	2.50	1.28
	0.5	76.00	2.94	84.50	1.00	92.50	2.06	96.50	1.52	97.00	1.30	99.50	0.56
May 20+	2.5	53.00	6.52	87.00	3.50	92.00	2.58	95.50	2.22	97.00	1.30	98.50	1.00
	0.5	24.00	3.74	61.50	6.70	66.00	7.50	69.50	5.56	77.00	4.78	83.00	4.12
	0.25	19.50	2.22	49.00	5.26	34.50	5.38	57.50	5.44	61.00	5.18	67.00	6.60
	0.05	3.00	5.60	10.00	1.42	12.50	2.08	17.50	3.16	20.50	1.30	22.00	1.40
	0	2.50	2.52	17.50	4.92	21.00	5.20	25.00	5.80	32.50	7.18	33.50	8.26
	Control												
	0	0.00	0.00	10.00	3.64	12.50	4.44	15.50	3.96	23.00	5.00	25.00	3.88
	0.5	13.00	1.74	78.00	3.74	87.00	2.08	90.00	2.16	93.50	2.64	98.50	1.00
May 24++	2.5	40.00	14.34	55.50	14.48	60.50	14.58	63.00	8.68	74.50	9.92	79.50	7.10
	0.5	27.00	13.02	37.50	13.58	44.50	12.86	55.50	12.80	63.00	10.96	69.00	9.82
	0.25	12.50	4.68	26.50	10.18	32.50	10.96	42.00	13.42	52.50	12.96	57.50	12.00
	0.05	0.00	0.00	0.00	0.00	0.50	0.00	0.50	0.00	1.50	1.00	2.00	1.40
	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Control												
	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.5	2.00	0.82	34.50	5.50	51.50	7.70	64.44	7.40	87.50	3.00	92.00	3.90

+ too young leaves, very early buoyance

++ segments of the third leaf from the field vere used

IV. The effect of decreasing concentration of atrazine on phytotoxicity of barley seedlings in hydroponic culture in the glasshouse grown during the month of May. Two hydroponic vessels were used for each concentration. Means of 40 plants are presented

Concentration of atrazine mg l^{-1}	Length (mm)		Dry weight (mg)	
	shoots	roots	shoots	roots
2.5	140	117	17	7
0.5	155	133	19	8
0.25	170	137	20	9
0.05	280	200	44	20
0 (Control)	269	212	55	30

ing of the percentage of sunk segments may be done only after 20 hours when the segments were transferred to dishes, but the segments should be stirred with the rod every hour. The necessary time depends on the age of leaves and therefore on the time when the segments in the control solutions without atrazine begin to sink. For testing the first leaf of plants grown in the glasshouse should be taken at the time when the second leaf overgrows the first leaf. The temperature should be 25 °C. Evaluating the results it is necessary to take into consideration the time and the percentage of sunk segments. The extraction of soil should be made for 24 – 48 hrs.

DISCUSSION

Biological assay methods are of particular importance in studies of an influence of edaphic and climatic factors on the phytotoxicity of triazines. Accurate, expensive equipments are not necessary in conducting bioassays. Furthermore, they are relatively simple to conduct. These are additional significant advantages over present chemical assay techniques.

The methods using the inhibiton of plant growth (Zemánek et al., 1976) and other methods as cited by Behrens (1970) are more time-consuming. The methods evaluating the inhibiting effect of photosynthesis are more rapid and specific for a distinct group of herbicides. For example it is possible to measure the oxygen rate produced by photosynthesis using bioluminescence of some bacteria (Tchan et al., 1975). Using this method results can be obtained within one hour. For our conditions this method was not accessible. On the contrary very good results were obtained using the method of Truelove et al. (1974). This method with our adaptation is very simple and rapid so that it is suitable for the practical use on a large scale. Truelove et al. (1974) showed different sensitivity of different species in this test. Moreover we have shown that the sensitivity depends on the age of organs, too.

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BENADA J., VÁŇOVÁ M. (Výzkumný ústav obilnářský, Kroměříž). *Zjišťování reziduí atrazinu biologickou metodou.* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 307-314, 1976.

Úkrojky prvních listů ječmene byly nastříhány do misek obsahujících plný živný roztok, smáčedlo a atrazin, pak přeneseny do místnosti s umělým osvětlením a teplotou 23—25 °C. Po 16 hod. v pravidelných časových intervalech byly počítány úkrojky, které klesly ke dnu. Procento potopených úkrojků záviselo na koncentraci herbicidu, ale do určité míry i na stáří listů a na teplotě. Obdobné výsledky byly získány i s listy ovsa. Rezidua v půdě byla zjišťována ve vodném eluátu. Touto metodou bylo možné zjistit až 0,005 mg atrazinu v jednom litru roztoku.

herbicid; ječmen; oves

БЕНАДА Я., ВАНЬОВА М. (Научно-исследовательский институт зерновых культур, Кромержиж). **Определение остатков атразина биологическим методом.** Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 307-314, 1976.

Отрезки первых листьев ячменя были нарезаны в миски, содержащие полный питательный раствор, смачивающее вещество и атразин, потом они были перенесены в комнату с искусственным освещением и температурой 23—25 °C. После 16 час. в правильных интервалах считались отрезки, упавшие на дно. Процент потонувших отрезков зависел от концентрации гербицида, а до некотрой степени и от возраста листьев и от температуры. Аналогичные результаты были получены и с листьями овса. Остатки в почве определялись в водном элюате. Путем данного метода можно было определить 0,005 мг атразина в одном литре раствора.

гербицид; ячмень; овес

The Authors' Address:

Ing. dr. Jaroslav Benada, CSc., ing. Marie Váňová, CSc., Výzkumný ústav obilnářský, 767 41 Kroměříž, Havlíčkova 2787

Short Communication

THE OCCURRENCE OF TYPHULA ISHIKARIENSIS LASCH EX FR. ON WINTER WHEAT IN CZECHOSLOVAKIA

BENADA J. (Cereal Research Institute, Kroměříž). *The Occurrence of Typhula ishikariensis Lasch ex Fr. on Winter Wheat in Czechoslovakia.* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 315-317, 1976.

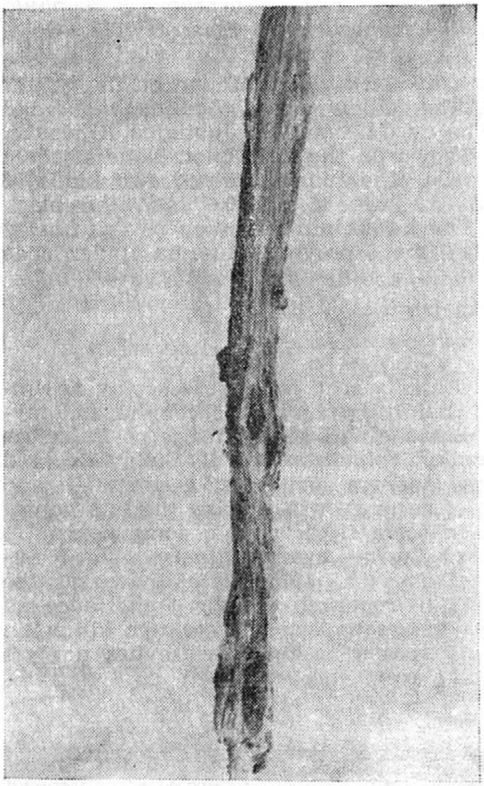
In April 1976 sclerotia of the fungus *Typhula ishikariensis* were found on the winter wheat cv. Sáva grown after barley forecrop. The fungus caused seedling blight and is one of the pathogens of winter killing. The cv. Mironovská, Jubilejná, Iljičovka, Kavkaz, Grana, Jubilar, Zora and Lena were sown on the same plot. None of these cultivars was, however, attacked by the fungus. The fungus formed two kinds of sclerotia: the redish sclerotia measured 0.7—0.8 mm × 0.4—0.6 mm, the black sclerotia measured 0.35—0.5 mm × 0.2 mm. The herbarium specimen of this fungus is preserved in the Botanical Department of the Moravian Museum under code BRNM 254.729.

barley; sclerotia of the fungus *Typhula ishikariensis*

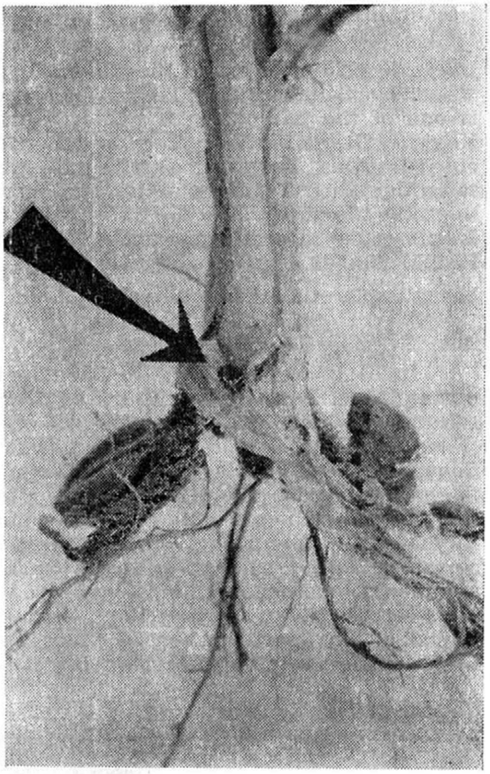
In early phases of the development of winter wheat two diseases play an important role. It is the seedling blight caused mainly by fungi, the conidia and mycelium of which are transported on or in the kernels as some species of *Fusarium* [*F. nivale* (Fr.) Ces., *F. avenaceum* (Fr.) Sacc., *F. culmorum* (W. G. Sm.) Sacc. and *Septoria nodorum* (Berk.) Berk.]. This disease appears soon after germination and is characterized by deformation or inhibition of germ growth. During the late winter months the winter killing is quite common in some fields and in some years. Up to that time *Cercosporella herpotrichoides* (Fr.) Ces. — eyespot disease — and *Fusarium nivale* (Fr.) Ces. — snow mold — (Benada, 1975) were known as the commonest pathogens. Michalíková (1972) reported on the importance of *Helminthosporium sativum* Pam., King et Bakke, as the cause of winter killing in Slovakia. The participation of other *Fusarium species* in this disease has not yet been verified in Czechoslovakia but it is known from abroad.

1. The group of killed plants of the winter wheat cv. Sáva infected by *Typhula ishikariensis*

In the spring of 1976 sclerotia of *Typhula* were found quite commonly on the winter wheat cv. Sáva of Yugoslav origin. With this cv. top yields were obtained in southern parts of Moravia and Slovakia as well as on rich sugar beet soils in the central part of Moravia. This cv. was known to be susceptible to winter killing and it was recommended to be cultivated after good forecrops only. The occurrence of *Typhula* was ascertained in a field trial with several winter wheat cultivars (Mironovská, Jubilejná, Iljičovka, Kavkaz, Grana, Jubilar, Zora, Lena) sown after barley. Only in the cv. Sáva in the middle of April dispersed groups of killed plants were found. Light or dark brown sphaerical sclerotia were seen under the sheaths of leaves, on the crowns and roots. Sclerotia could be found on some neighbouring still green plants too, the roots of which were damaged. On older leaves killed already in the autumn, black smaller sclerotia were formed.



2. Sclerotia under the sheaths of a killed plant



3. Sclerotia of *Typhula* on a partly damaged plant

The redish sclerotia measured 0.7—0.8 mm in longer diameter, 0.4—0.6 mm in shorter diameter. The black sclerotia measured 0.35—0.5 mm in longer diameter and about 0.2 mm in shorter diameter. The sclerotia were covered by thin-walled cells, which is a characteristic feature for *Typhula ishikariensis* Lasch ex Fr. (syn. *T. idahoensis Remsberg)* (R e m s b e r g, 1940). This determination is supported by smaller diameters of sclerotia in comparison with *T. incarnata* Lasch ex Fr. (syn. *T. itoana* Imai).

Typhula incarnata was reported in this country only as the cause of winter killing of winter barley (B e n a d a, 1959; B e n a d a et al., 1967). The occurrence of this species in wheat is rare in the German Democratic Republic (L e h m a n n, 1965). Both species are reported on wheat in Finland (J a m a l a i n e n, 1957) and in the U. S. A.

The yellowing of leaf tips which is characteristic for winter barley in the case of the incidence of *T. incarnata* was not observed in the cv. Sáva.

The herbarium specimen of *T. ishikariensis* is preserved in the Botanical Department of Moravian Museum in Brno under the code BRNM 254.729.

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MICHALÍKOVÁ, A.: Príspevok k výskytu *Ophiobolus graminis* Sacc. a *Helminthosporium sativum* (PKB) Ito et Kurib. na pšenici. (Incidence of *Ophiobolus graminis* Sacc. and *Helminthosporium sativum* (PKB) Ito et Kurib. in wheat.) Poľnohospodárstvo, *18*, 1972 : 1062-1969.

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BENADA J. (Výzkumný ústav obilnářský, Kroměříž). *Nález houby Typhula ishikariensis Lasch ex Fr. na ozimé pšenici v ČSSR.* Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 315-317, 1976.

Na ozimé pšenici cv. Sáva pěstované po předplodině ječmeni byla nalezena v dubnu 1976 sklerotia houby *Typhula ishikariensis.* Houba způsobovala hynutí rostlin a je jednou z příčin vyzimování pšenice. Na stejném pozemku byly vysety také kultivary Mironovská, Jubilejná, Iljičovka, Kavkaz, Grana, Jubilar, Zora a Lena. Na žádné z těchto odrůd však houba nalezena nebyla. Houba tvořila dva druhy sklerotií: červená sklerotia měřila 0,7—0,8 mm × 0,4—0,6 mm, černá sklerotia měřila 0,35 až 0,5 mm × 0,2 mm. Herbářský materiál je uložen v botanickém oddělení Moravského muzea pod číslem BRNM 254.729.

ječmen; sklerotia houby *Typhula ishikariensis*

БЕНАДА Я. (Научно-исследовательский институт зерновых культур, Кромержиж). **Появление грибка *Typhula ishikariensis* Lasch ex Fr. на озимой пшенице в ЧССР.** Sbor. ÚVTIZ - Ochr. rostl. 12 (4) : 315-317, 1976.

На озимой пшенице цв. Сава выращиваемой после предшественника ячменя была установлена в апреле склеротиния грибка *Typhula ishikariensis.* Действие грибка причиняло гибель растений и это было одной из причин выпревания пшеницы. На одной площади были засеяны также культивары Мироновская, Юбилейная, Ильичовка, Кавказ, Грана, Юбиляр, Зора и Лена. Ни на одной из этих сортов, однако, не был найден грибок. Грибок состоял из двух видов склеротинии: размер красых склеротий составлял 0,7—0,8 мм × × 0,4—0,6 мм, величина черных склеротий была 0,35—0,5 мм × 0,2 мм. Гербарийный материал находится в Моравском музее в ботаническом отделе под номером БРНМ 254.729.

ячмень; склеротия грибка *Typhula ishikariensis*

Ing. dr. Jaroslav Benada, CSc., Výzkumný ústav obilnářský, 767 41 Kroměříž

SECOND CONFERENCE ON VIRUS DISEASES OF GRAMINEAE IN EUROPE

At the 1st conference at Belgrade it was decided that 2nd Conference on Virus Diseases of Gramineae in Europe would take place at Montpellier, France, in 1977.

This conference will be held from Tuesday May 10th to Friday May 13, 1977.

The time will be devoted to paper reading sessions, short excursions to experimental plots and cereal growing areas and also to sea border.

The official languages of the conference will be French and English without simultaneous translations.

The conference is organized by the Laboratoire de Biologie et Pathologie Végétales, Ecole National Superieure Agronomique et Institut National de la Recherche Agronomique, address 34060, Montpellier-Cedex, France and the convener is prof. P. A. Signoret, president of the European Working Group on Virus Diseases of Gramineae, to whom the mail should be sent.

B. A. Kvíčala

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KURZE MITTEILUNGEN

Rozšiřuje Poštovní novinová služba. Objednávky a předplatné přijímá PNS — ústřední expedice tisku, administrace odborného tisku, Jindřišská ulice 14, 110 00 Praha 1. Lze též objednat u každé pošty i poštovního doručovatele. Objednávky do zahraničí vyřizuje PNS - ústřední expedice tisku, oddělení vývozu tisku, Jindřišská ulice 14, 110 00 Praha 1. Vytiskl MÍR, novinářské závody, n. p., závod 6, Legerova ulice 22, 120 00 Praha 2.