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Breeding for Disease Resistance

Breeding for disease resistance in various crops has an increasing importance. Significant rise of yields in field crops, especially in cereals, has been achieved both by highly productive cultivars and high doses of fertilizers. Breeding aiming primarily at high yields led to a limited genetic diversity in most cultivars. This offers favourable conditions for the pathogen to spread on large areas. Higher doses of fertilizers, particularly of nitrogen, are usually favourable for the disease development as well.

Breeding for disease resistance has been remarkably successful but sometimes it also suffered failures in the past. It failed when the variability of the pathogen was not taken into consideration. Various methods of resistance breeding were elaborated that can diminish losses caused by a sudden breakdown of resistance. Great attention is paid to the quantitative aspects of resistance, described as horizontal, general or field resistance. There is no doubt that the easy success of breeding for vertical resistance (although temporary) often led to the underestimation of horizontal resistance in developing resistant cultivars. On the other hand the effectiveness of horizontal resistance under the conditions of intensive farming and heavy disease pressure should not be overestimated. Heterogeneity of points of view regarding this problem — aspects of epidemiology, genetics, mechanism of resistance etc. — contributes to a comprehensive discussion but sometimes may lead to confusions.

Whatever theoretical conclusions will be obtained in future, breeding for disease resistance will remain one of the important directions in plant breeding. Application of pesticides can be limited by resistance breeding. This is desirable particularly in crops used for direct human consumption. The increasing trend to limit pollution of the biosphere and noxious residues of chemicals in the food also supports the importance of resistance breeding.

In Czechoslovakia plant disease resistance is investigated in several research institutes of the Ministries of Agriculture, and breeding for disease resistance is carried out in various plant breeding stations. Mechanism of resistance to plant diseases, biochemistry and physiology of healthy and diseased plants are studied in the laboratories of the Czechoslovak and Slovak Academy of Sciences.

The objective of this separate issue of the journal Sborník ÚVTIZ - Genetika a šlechtění is to present some recent results achieved in genetic studies of resistance. In Czechoslovakia, increasing cropping area of wheat and barley is an additional factor to the factors mentioned earlier supporting importance of resistant cultivars. The paper by Mráz deals with the sources of resistance to powdery mildew in wheat, a disease having an increasing trend at presence. Wheat stem rust occurs periodically but can decrease the yield by half in susceptible cultivars. Genes for stem rust resistance in wheat are discussed in the report by Bartoš. Resistance to powdery mildew in barley often breaks down soon after the release of resistant cultivars. The paper by Brückner informs about a dominant gene for medium resistance to powdery mildew in barley conditioning resistance of the horizontal type. New high-yielding lines of spring barley possessing resistance to powdery mildew, net blotch of *barley and Rhynchosporium scald are described in the contribution by* Zeniščeva *and* Lekeš. *Report on the genetics of crown rust resistance in two cultivars of oats is given by* Šebesta. *The paper by* Piovarči *and* Masler *deals with the genetics of resistance to corn smut. Breeding for tolerance to virus diseases is illustrated in the contributions by* Petrák *and* Řimsa *in sugar-beet and by* Hervert *and* Kazda *in cucumber. Resistance breeding in potatoes has an old tradition. It is represented in this issue by the paper by* Zadina *dealing with virus Y.* Kůdela *with co-authors discusses in his study the genetic background of resistance to Verticillium and bacterial wilt. The contribution by* Vanek *and* Pospíšilová *presents information on the resistance of grape-vine to powdery mildew.*

One issue of Sborník ÚVTIZ - Genetika a šlechtění cannot comprise all recent results of the genetic research for plant disease resistance. Papers on this topic are being published in Czech issues of this journal and in Sborník ÚVTIZ - Ochrana rostlin with English, Russian and German summaries.

Ing. Pavel Bartoš, CSc.

POSTULATED GENES FOR STEM RUST RESISTANCE IN SOME WHEAT CULTIVARS

P. BARTOŠ

BARTOŠ, P. (Institute of Genetics and Plant Breeding, Praha - Ruzyně): *Postulated Genes for Stem Rust Resistance in Some Wheat Cultivars.* Sbor. ÚVTIZ - - Genet a šlecht., *13*, 1977 (1) : 3-7.

Wheat cultivars were classified into 12 groups according to their stem rust reactions to 6 (4) races. The largest group resembled the reactions of Marquis-*Sr 5*. Several cultivars displayed additional resistance compared with Marquis-*Sr 5*. Some cultivars showed a reaction pattern similar to Marquis-*Sr 10*. Several cultivars resembled Marquis-*Sr 6* by their reactions. One group included cultivars with similar reactions to Etoile de Choisy. Another group comprised cultivars displaying similar reactions like Mironovskaya 808. Two groups included cultivars possessing the „rye" resistance derived from Salzmünder Bartweizen, Neuzucht or similar sources. One of these two groups manifested the presence of an additional gene, probably *Sr 5*. Some cultivars had a reaction pattern unlike any of the lines with single genes for resistance or unlike cultivars with known resistance genes included in the trial.

wheat; stem rust; genes for resistance

Classical genetic analysis based on segregation in F_2 and F_3 progenies and in back-crosses is rather time-consuming. Therefore, an estimation based on the reaction pattern of the investigated cultivars to a collection of physiologic races was often applied to obtain some information on the genetic background of resistance useful in the breeding for resistance as well as in additional genetic analysis of resistance (Browder, 1973; Loegering et al., 1974).

MATERIAL AND METHOD

Cultivars from the World Wheat Assortment in the Institute of Genetics and Plant Breeding, Praha - Ruzyně, were classified into groups according to their stem rust reactions to races 14, 21, 34 and 214 in the year 1973 and races 14, 21, 34, 214, 1 and 56 in the year 1974. The plants were inoculated with rust at the first leaf stage and kept in the greenhouse at 15—25 °C. Rust reactions were classified according to the infection types described by Stakman et al. (1962).

RESULTS

The cultivars were placed into 12 groups according to their reaction pattern (Table I). Cultivars tested with only 4 races are designated with+.

1. The largest group of cultivars displayed reactions similar to those of the line Marquis-*Sr 5*. The following cultivars were included in this group: Bizel, Dacia, Dobrudza, Donetzkaya 61, Festival, Geber, Gelpa, Kharkovskaya 63, Chebros, Ylyitchovka, Yubileynaya 50, Justin, Krasnodarskaya 33, Krasnodarskaya 46, Lutescens 39, Mojor, Panis, Provence 45-A-10/169/, Rembrandt, Zagadka, Aronde+, Atys+, Crystal+, Odesskaya 51+.

I. Infection types produced on 12 groups of wheat cultivars and on 4 wheat lines with single substituted genes for resistance

Cultivar or line	Race					
	21	214	56	14	1	34
1. Yubileynaya 50	0	4	4	0	0;	3–4
2. Bartl	0	1–2+	4	0	0	4
3. Bezostaya 1	0	3–4	3–4	0	0	1+
4. Janus	3	3	;1	;1	3–4	3+
5. Mironovskaya 808	2+	4	2–3	1–2	2–3	2
6. Etoile de Choisy	1	3–	–	1	–	;1
7. Sáva	0,1+	4	4	4	3	;1,3
8. Bocquian	0	2	;1+	;1+	0	2
9. Luron	;1	;1	;1–2+	;1	;1–2+	2–3
10. Siete Cerros	0	;	;	0;	;	;
11. Benno	;1	;	;1	;	;1	;1
12. Kavkaz	0	;	;1	0	0	;
Marquis-*Sr* 5	0	4	3–4	0	0;	3
Marquis-*Sr* 6	;1	;1+	2	2+	;1–2+	2–3
Marquis-*Sr* 10	3–4	3–4	;1–2+	;1	4	3
Marquis-*Sr* 11	;	;	2	;1	;1	;

2. Compared with the line Marquis-*Sr 5*, additional resistance to race 214 was possessed by the cultivars Bartl, Victor 1, Samos and Robert+.

3. Compared with the line Marquis-*Sr 5*, additional resistance to race 34 was found in the cultivars Bezostaya 1, Bezostaya rannaya, Bezostaya 1-chemomutant, Olt (Caracal 277), Fournit, Francest+, Levent, Lutescens 32, Nadezhnaya 45, Dneprovskaya 521, Mironovskaya ulutchshennaya, Regulus.

4. Several cultivars – Hatri, Janus, Melchier, Breustedts Arin+, Cappelle Desprez+, Carola+, Cresus+, Sirius+, Tom pouce blanc+ – were comparable in their reactions with the line Marquis-*Sr 10.*

5. The reactions of Mironovskaya 808 were not comparable with any isogenic line tested. Similar reactions were displayed by Kharkovskaya 159 and Belotzerkovskaya 33.

6. Another group incomparable with any isogenic line tested included the cultivars Etoile de Choisy+ and Luna+.

7. The cultivar Sava, originating from the cross Fortunato^2 × Redcoat, was resistant to races 21 and 34 but susceptible to race 14 unlike any of the lines in the experiment.

8. The French cultivars Bocquian and Quest Desprez are immune to races 21 and 1 and resistant to other races applied in the test.

9. The cultivars Luron, Goya, Heima and Monjovie differ from the preceding French cultivars only by resistant instead of immune reactions to races 21 and 1.

10. A number of cultivars prevalently of Mexican origin displayed only resistant reactions: Siete Cerros, Penjamo 62, Choti Lerma, Inia 66, Kalyan Sona, Tobari 66.

11. Reaction type; 1 to all races included in the test was characteristic for a large group of cultivars: Benno, Cebeco 97, Clement, Mamut, Mildress, Mironovskaya 10, Saladin, Salzmünde 14/44, Weique, Winnetou, Riebesel 1360/71, Lovrin 13+.

12. The cultivars Aurora, Kavkaz, Lovrin 10, Lovrin 12, Orlando, Predgornaya 2, Skorospelka 35 differed from the preceding group by immune reactions to races avirulent to *Sr 5* (21, 14, 1). Several cultivars – Bezostaya 2, Burgaz 2, Lovrin 13, Feldkrone, Poleskaya 71 – showed on some plants reaction type 0 and on others ;1.

DISCUSSION

The largest group of cultivars was that displaying reactions typical of gene *Sr 5*. A number of European wheat cultivars derive their resistance from the cultivar Bezostaya 1. For instance the cultivar Krasnodarskaya 46 originates from the cross (Bezostaya 1 × Odesskaya 16) × Bezostaya 1, the cultivars Zagadka 44, Nadezhnaya 45 and Kharkovskaya 68 originate from the cross Bezostaya 1 × Mironovskaya 808, the cultivar Dneprovskaya 521 was developed from the cross (Ukrainka × Elymus) × Bezostaya 1. The cultivars Yubileynaya 50 and Ylyitchovka possess Bezostaya 4 as one of the parents. From Bezostaya 4 the cultivar Bezostaya 1 was selected. Bezostaya 1 possesses at least two genes effective at the seedling stage and other gene (*s*) effective at the adult stage (B a r t o š, 1975). Consequently cultivars derived from Bezostaya 1 can possess a varying number of genes for stem rust resistance.

It is of interest that the cultivar Mironovskaya ulutchshennaya described as a selection from Mironovskaya 808 resembles the cultivar Bezostaya 1 by the stem rust reactions. Only the reaction to race 56 is similar to Mironovskaya 808. In Mironovskaya 808 one gene for stem rust resistance was identified (B a r t o š et al., 1970; S m i r n o v a et al., 1974). However, our results do not confirm the conclusion by S m i r n o v a et al. (1974) that this gene is *Sr 5*.

Another source of gene *Sr 5* and other genes was the cultivar Thatcher that was widely used in the European wheat breeding. Of the varieties listed in this paper it is given in the parentage of Atys. Several other cultivars possessing *Sr 5* of this origin were described earlier (B a r t o š et al., 1970).

The cultivars of group 4, prevalently West European spring wheats, may possess the resistance of Marquis and *Sr 10*.

In the cultivar Etoile de Choisy two genes for stem rust resistance were revealed, genes Sr 23 and SrEC. The cultivar Luna from Poland, which displayed similar reactions, is derived from Etoile de Choisy. Also the French cultivar Moisson is of similar origin and has similar reactions (B a r t o š et al., 1970).

Cultivars in group 11 and 12 include many important East and West European wheats. Their resistance is derived from rye (located on chromosome 1B). Stem rust resistance is linked with leaf and yellow rust and mildew resistance. However, races virulent to these genes were already found in rusts as well as in mildew. Considerable losses were caused by the breakdown of leaf rust resistance in the USSR (cultivars Aurora and Kavkaz), yellow rust resistance in the Netherlands (cultivar Clement) and mildew resistance in Czechoslovakia (cultivars Kavkaz and Aurora).

Grouping the cultivars according to their pattern of reactions to several races can offer valuable data. However, it cannot replace a genetic analysis. The cultivars in separate groups probably possess genes in common, but tests with other races, especially races from other rust populations, would be expected to separate them into a larger number of groups. Particularly the groups including cultivars resistant to all races used in the trial may comprise various genotypes of effective genes unless other data support the relationship of cultivars in the groups.

References

BARTOŠ, P. — GREEN, G. J. — DYCK, P. L.: Reactions to stem rust and genetics of stem rust resistance in European wheat cultivars. Can. J. Botany, *48*, 1970 : 1439-1443.

BARTOŠ, P.: On stem rust resistance of wheat cultivars from USSR grown in Czechoslovakia. Annual Wheat Newsletter, *21*, 1975a : 71-72.

BARTOŠ, P.: On the presence of the gene *Sr 5* in some European cultivars. Cereal Rusts Bulletin, *3*, 1975b : 27-28.

BROWDER, L. E.: Probable genotype of some *Triticum aestivum* "Agent" derivates for reaction to *Puccinia recondita* f. sp. *tritici*. Crop Sci., *13*, 1973 : 203-206.

LOEGERING, W. Q. — BURTON, C. H.: Computer-generated hypothetical genotypes for reaction and pathogenicity of wheat cultivars and cultures of *Puccinia graminis tritici*. Phytopathology, *64*, 1974 : 1380-1384.

McINTOSH, R. A. — DYCK, P. L. — GREEN, G. J.: Inheritance of reaction to stem rust and leaf rust in the wheat cultivar Etoile de Choisy. Can. J. Genet. Cytol., *16*, 1974 : 541-577.

SMIRNOVA, L. A. — KUZNECOVA, E. V.: Nasledovanie u sortov pšenicy ustojčivosti k steblevoj ržavčine. Genetika, *10*, 1974 : 11-20.

STAKMAN, E. C. — STEWART, D. M. — LOEGERING, W. Q.: Identification of physiologic races of *Puccinia graminis* var. *tritici*. US. Dep. Agr. ARS Bull. E 617, 1962.

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BARTOŠ, P. (Ústav genetiky a šlechtění VÚRV, Praha - Ruzyně): *Geny podmiňující rezistenci ke rzi travní u některých kultivarů pšenice.* Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 3-7.

Odrůdy pšenice byly rozděleny do 12 skupin podle jejich reakce k 6 (4) rasám rzi travní. Nejvíce odrůd mělo reakce shodné s linií Marquis-*Sr 5*. Některé odrůdy měly ve srovnání s linií Marquis-*Sr 5* další rezistenci. Jiné odrůdy měly reakce podobné linii Marquis-*Sr 6*. Jedna skupina odrůd připomínala reakce linie Marquis-*Sr 10*, jiná odrůdu 'Etoile de Choisy' a opět jiná skupina odrůdu 'Mironovská 808'. Do dvou skupin byly zařazeny odrůdy mající „žitnou" rezistenci odvozenou od odrůdy 'Salzmünder Bartweizen', 'Neuzucht' nebo podobných zdrojů. Jedna z těchto dvou skupin měla další gen rezistence, pravděpodobně *Sr 5*. Některé odrůdy se lišily reakcemi od všech testovaných linií s různými geny rezistence i odrůd se známými geny rezistence.

pšenice; rez travní; geny rezistence

БАРТОШ, П. (Институт генетики и селекции НИИР, Прага - Рузыне): **Гены, обусловливающие устойчивость некоторых культиваров пшеницы к стеблевой ржавчине.** Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 3-7.

Пшеничные сорта разделили на 12 групп на основе их реакции к 6 (4) расам стеблевой ржавчины. Большинство сортов реагировали подобно линии Marquis-*Sr 5*, но некоторые из них обладали еще другой устойчивостью. Другие сорта реагировали подобно линии Marquis-*Sr 6*. Одна группа сортов напоминала реакции линии Marquis-*Sr 10*, другая — обладающие «ржаной» услойчивостью, выведенной из сорта 'Salzmünder Bartweizen', сорта 'Нейцухт' или подобных источников. Одна из этих 2 групп обладала еще одним геном устойчивости, правдоподобно *Sr 5*. Некоторые сорта отличались по своим реакциям от всех тестированных линий с разными генами устойчивости и от сортов с известными генами устойчивости.

пшеница; стеблевая ржавчина; гены устойчивости

BARTOŠ, P. (Institut für Genetik und Pflanzenzüchtung, Praha - Ruzyně): ***Schwarzrostresistenz bedingende Gene bei einigen Weizenkultivaren.*** Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 3-7.

Die Weizensorten wurden nach der Reaktion auf 6 (4) Rassen von Schwarzrost in 12 Gruppen aufgeteilt. Die meisten Sorten erwiesen mit der Linie Marquis-*Sr 5* übereinstimmende Reaktionen. Einige Sorten zeigten eine weitere Resistenz im Vergleich zur Linie Marquis-*Sr 5*. Andere Sorten wiesen mit der Linie Marquis-*Sr 6* ähnliche Reaktionen auf. Eine Sortengruppe erinnerte an die Reaktionen der Linie Marquis-*Sr 10*, eine andere an die Sorte 'Etoile de Choisy' und noch eine andere an die Sorte 'Mironovskaja 808'. In zwei Gruppen wurden die Sorten eingereiht, deren „Roggen"-Resistenz von der Sorte 'Salzmünder Bartweizen', 'Neuzucht' oder ähnlichen Quellen abgeleitet wurde. Bei einer von diesen Gruppen wurde ein weiteres Gen der Resistenz, wahrscheinlich *Sr 5*, festgestellt. Einige Sorten unterschieden sich in den Reaktionen von allen getesteten Linien mit verschiedenen Resistenzgenen, sowie auch von den Sorten mit bekannten Genen der Resistenz.

Weizen; Schwarzrost; Gene der Resistenz

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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. Therefore 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 pathogen, 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

THE INHERITANCE OF RESISTANCE TO POWDERY MILDEW (*ERYSIPHE GRAMINIS* DC. F. SP. *HORDEI* MARCHAL) IN THE ETHIOPIAN BARLEY AB. 1128

F. BRÜCKNER

BRÜCKNER, F. (Institute of Cereal Crops, Kroměříž): *The Inheritance of Resistance to Powdery Mildew (Erysiphe graminis DC. f. sp. hordei Marchal) in the Ethiopian Barley Ab. 1128.* Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 9-12.

The medium resistance of Ethiopian barley Ab. 1128 to powdery mildew is conditioned by a dominant gene which is inherited independently of the *Mla* locus. The moderate resistance to slight susceptibility to all known powdery mildew races in glasshouse tests, good field resistance and long latent period prove this resistance horizontal. The proposed designation of this gene is *Mlab.* The possibility to use this gene in connection with individual genes of the *Mla* locus is discussed.

powdery mildew of barley; horizontal resistance

Ethiopian barleys have been important sources of resistance to various diseases. According to several infection types formed in these barleys when inoculated with powdery mildew, as well as according to genetic analyses made up to now, more genes of resistance to this disease appear in them.

The medium resistance of barley designated as *Hordeum laevigatum,* which has often been used in breeding practice in Europe, is based on a dominant gene (Brückner, 1968; Wiberg, 1974b). In other Ethiopian barleys Unbegrannte Nackte (Lau, 1962) and Ab. 6 (Brückner, 1968) a monofactorially recessive form of inheritance was ascertained. Jørgensen (1971) found the identity of these genes with the genes that arose by an induced mutation.

MATERIAL AND METHOD

Ethiopian barley Ab. 1128 has a six-rowed, compact spike (var. *parallelum* Körn.), is medium high and has a firm stem. Under field conditions it is infected with powdery mildew only slightly in the form of necrotic blotches in a small number, sometimes with a thin cover of mycelium. However, it is highly susceptible to leaf rust of barley (*Puccinia hordei* Otth.).

First Hoffmann and Nover (1959) drew attention to this barley as a suitable initial material for breeding the mildew resistant barleys. That was recommended by them due to the results of tests for resistance to 11 powdery mildew races. From these reactions the barley was evaluated as resistant to 7 races, as moderately resistant to 4 races.

Brückner (1964) evaluated Ab. 1128 under the conditions of artificial illumination on the basis of reactions to 10 powdery mildew races as moderately susceptible (type 3). Slootmaker (1970) reported the resistance of this barley to a highly virulent race of Lyallpur 3645-C17.

When testing 11 powdery mildew races, both Nover and Lehmann (1972) evaluated Ab. 1128 as moderately resistant. At the same time they reported the resistance to stripe rust (*Puccinia striiformis* West.). Wiberg (1974b) found a broad scale of infection types when he inoculated this barley with 52 races. The reactions to 9 races were assessed as resistant (R), 28 reactions were moderately resistant (r), 3 moderately susceptible (s) and 9 susceptible (S).

In our experiments as partners for crossing with Ab. 1128, the French Clermont variety (var. *hybernum* Vib.) susceptible to powdery mildew and strain X 246/72 (var. *hybernum* Vib.) with mildew resistance conditioned by the Mla_6 gene were used.

To ascertain the F_2 segregation ratios, the C_5 race virulent to the Mla_6 gene and the C_{16} race avirulent to this gene were used. The tests were performed on the seedlings in the glasshouse at temperatures ranging considerably from 12 °C to 25 °C. The evaluation was made after the distinct symptoms of infection had appeared on the control of Ab. 1128.

RESULTS AND DISCUSSION

While in the first crosses the expected segregation ratio was a little above the significance limit, in the other crosses there was an absolute coincidence between the expected and actual number of resistant and susceptible seedlings (Table I).

I. The inheritance of resistance of the Ab. 1128 barley to powdery mildew (*Erysiphe graminis* DC. f. sp. *hordei* Marchal)

Cross $P_1 \times P_2$	Race	Infection type on		Number of F_2 seedlings with infection type				Ratio	P
		P_1	P_2	0	2–3	4	Total		
Ab. 1128 × × Clermont	C_5	2–3	4		640	189	829	3 : 1	0.3–0.1
X 246/72 × × Ab. 1128	C_5	4	2–3		831	277	1108	3 : 1	1
X 246/72 × × Ab. 1128	C_{16}	0	2–3	824	198	58	1080	12 : 3 : 1	0.5–0.3
Ab. 1128 × × X 246/72	C_{16}	2–3	0	596	129	45	770	12 : 3 : 1	0.5–0.3

The last reciprocal crosses have proved that the resistance in Ab. 1128 is conditioned by a dominant gene which is inherited independently of the Mla_6 gene. The proposed designation of this gene is *Mlab*.

According to various infection types ascertained by different authors especially by Wiberg (1974a) after the inoculation with distinct powdery mildew races, it may be supposed that the resistance in Ab. 1128 is conditioned by several complementary genes. Nevertheless, our results do not verify this assumption.

In our tests we observed that in Ab. 1128 the symptoms of infection with powdery mildew occurred 3 to 4 days later than in susceptible varieties. Due to a longer latent period in Ab. 1128 in contrast to susceptible varieties, in some cases the evaluation may have been made prematurely and thus the differences could have arisen.

According to our experience the manifestation of resistance in Ab. 1128 was also influenced by light conditions during the tests. With decreasing light intensity, the intensity of infection increased, especially on the basal parts of leaves.

According to the reasons given above it does not seem probable that Ab. 1128 would be susceptible to some powdery mildew races. It is true that Wiberg (1974b) reports the susceptibility of Ab. 1128 to some races, but he includes type 3 to this reaction too.

The assessments of the field resistance in E. B. D. N. (European Barley Disease Nursery) made for several years in different European countries also testify to the fact that up to now no race virulent to Ab. 1128 has occurred.

With regard to the type of resistance and the long latent period, the resistance in Ab. 1128 to powdery mildew may be considered a horizontal resistance according to Van der Plank's (1968) conception, being exposed to a slight selection pressure towards the compatible races.

The value of this resistance consists in a simple genetic background and in the possibility of its combination with a vertical resistance of any allele in the *Mla* locus.

According to the experience obtained in the Cereal Research Institute at Kroměříž the tests were performed in such a way that F_3 families from the crossing of Ab. 1128 with a variety possessing a gene in the *Mla* locus were inoculated first with a race which was avirulent to this gene. The families which remained highly resistant also after the symptoms on Ab. 1128 had appeared, were inoculated for the second time with a virulent race. The families which reacted by an infection type typical of Ab. 1128 after the second inoculation, possessed the resistance genes from both parents.

References

BRÜCKNER, F.: Padlí travní (*Erysiphe graminis* DC.) na ječmeni. V. Odolnost odrůd ječmene k fyziologickým rasám padlí a možnosti využití této odolnosti při šlechtění na rezistence. [*Erysiphe graminis* DC. on barley. V. The resistance of barley varieties to physiological races of *Erysiphe graminis* DC. detected in Czechoslovakia and the possibility to use it in breeding for resistance.] Rostl. výroba, *10*, 1964 : 395-408.

BRÜCKNER, F.: Dědičnost rezistence některých odrůd ječmene vůči padlí travnímu (*Erysiphe graminis* DC.). [Inheritance of resistance to powdery mildew (*Erysiphe graminis* DC.) in some barley varieties.] Sbor. ÚVTI - Genet. a šlecht., *4*, 1968 : 99-104.

HOFFMANN, W. — NOVER, I.: Ausgangsmaterial für die Züchtung mehltauresistenter Gersten. Z. Pflanzenzüchtg., *42*, 1959 : 68-78.

JØRGENSEN, J. H.: Comparison of induced mutant genes with spontaneous genes in barley conditioning resistance to powdery mildew. In: Mutation breeding for disease resistance. Atomic energy agency, Vienna, 1971 : 117-124.

LAU, D.: Ein Beitrag zur Züchtung mehltauresistenter Gersten. Z. Pflanzenzüchtg., *48*, 1962 : 80-90.

NOVER, I. — LEHMANN, Chr.: Resistenzeigenschaften im Gersten- und Weizensortiment Gatersleben. 14. Prüfung von Sommergersten auf ihr Verhalten gegen Mehltau (*Erysiphe graminis* DC. f. sp. *hordei* Marchal). Kulturpflanze, *19*, 1972 : 283-298.

SLOOTMAKER, L. A. J.: The isolation of a further new race of *Erysiphe graminis* DC. f. sp. *hordei* Marchal and the genetical basis of the resistance of Lyallpur 3645. Neth. J. Pl. Path., *76*, 1970 : 64-69.

Van der PLANK, J. E.: Disease resistance in plants. Academic Press New York and London, 1968.
WIBERG, A.: Sources of resistance in barley. Hereditas, 78, 1974a : 1-40.
WIBERG, A.: Genetical studies of spontaneous sources of resistance to powdery mildew in barley. Hereditas, 77, 1974b : 89-148.

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BRÜCKNER, F. (Výzkumný ústav obilnářský, Kroměříž): *Dědičnost odolnosti ethiopského ječmene Ab. 1128 proti padlí travnímu (Erysiphe graminis DC. f. sp. hordei Marchal).* Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 9-12.

Střední rezistence ethiopského ječmene Ab. 1128 proti padlí je podmíněna jedním dominantním genem, který se dědí nezávisle na genech *Mla* lokusu. Střední rezistence až střední náchylnost proti všem známým rasám padlí při skleníkových testech, dobrá polní odolnost a dlouhá latentní doba opravňují považovat tuto rezistenci za rezistenci horizontální. Navrhuje se označení tohoto genu *Mlab.* Je diskutována možnost využití tohoto genu ve spojitosti s jednotlivými geny *Mla* lokusu při šlechtění rezistentních ječmenů.

padlí na ječmeni; horizontální rezistence

БРУКНЕР, Ф. (Научно-исследовательский институт зернового хозяйства, Кромержиж): **Наследуемость устойчивости эфиопского ячменя Аb. 1128 к мучнистой росе злаков** (*Erysiphe graminis* DC. f. sp. *hordei* Marchal). Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : : 000-000.

Средняя устойчивость эфиопского ячменя Ab. 1128 к мучнистой росе злаков обусловлена 1 доминантным геном, который наследуется независимо от генов *Mla* локуса. Средняя устойчивость — средняя восприимчивость ко всем известным расам рос в тепличных тестах, хорошая полевая устойчивость и длительный латентный период позволяют обозначить эту устойчивость как горизонтальную. Предлагается назвать данный ген *Mla*б. Обсуждается возможность использования этого гена в связи с отдельными генами *Mla* локуса при селекционировании устойчивых ячменей.

роса на ячмене; горизонтальная устойчивость

BRÜCKNER, F. (Forschungsinstitut für Getreidebau, Kroměříž): *Erblichkeit der Resistenz äthiopischer Gerste Ab. 1128 gegen Getreidemehltau (Erysiphe graminis DC. f. sp. hordei Marchal).* Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 9-12.

Mittlere Resistenz äthiopischer Gerste Ab. 1128 gegen Getreidemehltau ist durch ein dominantes Gen bedingt, das unabhängig von den Genen des *Mla* Lokus geerbt wird. Mittlere Resistenz bis mittlere Anfälligkeit gegen alle bekannten Rassen des Getreidemehltaus bei Gewächshaustesten, gute Feldwiderstandsfähigkeit und lange Latenzperiode berechtigen die Authoren diese Resistenz für eine horizontale Resistenz zu halten. Es wird vorgeschlagen dieses Gen als *Mlab* zu bezeichnen. Die Möglichkeit, dieses Gen in Verbindung mit einzelnen Genen des *Mla* Lokus bei der Züchtung resistenter Gersten auszunutzen wird diskutiert.

Getreidemehltau auf Gerste; horizontale Resistenz

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NEW INTENSIVE SPRING BARLEY GENOTYPES WITH COMPLEX RESISTANCE TO *ERYSIPHE GRAMINIS* D. C.

L. ZENIŠČEVA, J. LEKEŠ

ZENIŠČEVA, L. — LEKEŠ, J. (Cereal Research Institute, Kroměříž): *New Intensive Spring Barley Genotypes with Complex Resistance to Erysiphe graminis D. C.* Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 13-21.

Spring barley lines of intensive type (KM 1192, KM 932, KM 1402), bred in the Cereal Research Institute, Kroměříž, are characterized by their high yielding capacity, specific resistance to *Erysiphe graminis* and horizontal resistance to *Helminthosporium teres* and *Rhynchosporium secalis*. They are highly significantly different from varieties of standard type and from sources of resistance to *Erysiphe graminis* used as yet (Algerian, *H. spontaneum nigrum, H. transcaspicum*, Lyallpur H53 3645, etc.) in being short strawed and from the cultivars derived from the Diamant variety in having greater stem firmness, namely in the internode just below the ear. Stability of high yields in KM 1192 in individual years and in different soil ecological conditions is due to high resistance to lodging and complex resistance to all aggressive races of *Erysiphe graminis*, occurring in this country and in Europe. Its high yielding stability is increased in conditions as follows: high level of farming, higher doses of commercial fertilizers (namely nitrogenous) and application of appropriate cultivation methods.

spring barley; *Erysiphe graminis* D. C.; resistance

Genetically based yielding capacity of contemporary spring barley varieties amounts to 8—9 t ha^{-1}. Its materialization (actual yield) is in a direct dependence on soil-climatic conditions, general level of agriculture, application of complex varietal cultivation methods, etc. According to FAO results (1973) yielding capacity of all crops is utilized on an average up to 15—20 % throughout the World, in the most advanced countries up to 30—40 %. In the Czechoslovak Socialist Republic (ČSSR) yield fluctuations of the recent spring barley varieties are mainly due to the mass occurrence of fungal diseases, mainly powdery mildew, and to premature lodging. Honecker (1936), James (1969) and Benada (1973) estimate the yield reducing effect of *Erysiphe graminis* of spring barley to be 25 %, 18 % and 15—25 %, respectively.

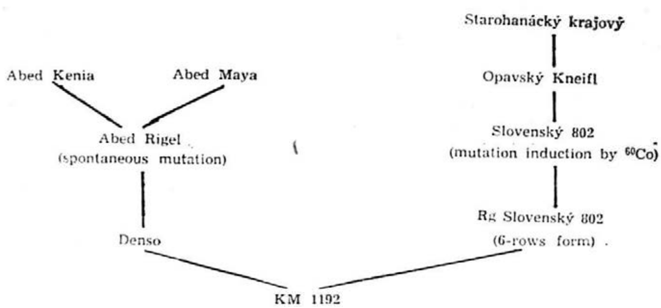
Nilsson-Ehle (1911) and Biffen (1907) were the first to point out the necessity of acceptable breeding for disease resistance. Vavilov (1936, 1964) was the first to determine the laws of geographical localization of genes, conditioning immunity to the most spread fungal diseases. From both centres of the greatest gene variability of barley, defined by Vavilov, primitive, from breader's point of view not selected genetical sources of resistance to powdery mildew were determined. The most significant resistance sources are as follows: Monte Cristo C. I. 1017, Endeldow C. I. 755, Multan C. I. 3401 (India) and Chinese Black (China), Algerian C. I. 1179, Modia C. I. 2483 (an ecological group from North Africa), forms from Pakistan, namely those of Lyallpur 3645, Lyallpur 3647 and also one form of wild barley, *H. spontaneum* (nigrum) var. *transcaspicum*, from which some have been widely used in practical breeding as donors of mildew resistance. But overcoming the negative influences, native to the mentioned sources, on yield and grain quality of hybrids requires the long-term and complex breeding methods and, therefore, the immediate using of the mentioned material is very difficult. From that point of view the cited genetical sources of resistance are of great importance: e. g. the X-ray mutation gained in 1957 as a result of the irradiation of the dry seed of the Slovensky 802-variety by Co^{60}, 12 Kr (L e k e š, 1971). The Rg Slovensky 802-mutation (many-rowed form) is showing specific race resistance to powdery mildew, having not been overcome as yet, and simultaneously very good yielding capacity, earliness and good malting quality of grain (Table I).

MATERIAL AND METHOD

B r e e d i n g m e t h o d s: The method of periodic and reciprocal crossing was used in breeding new short-strawed high-yielding spring barley varieties based on the old-Hanna genotype resistant to lodging and wide-spread fungal diseases. This method differs from the standard scheme in comprising complete or partial diallel crossing in the first step in order to gain forms having high combining ability. Hybridization of the parental forms the selection of which was based on their general and specific combining was performed by the method of single or double crossing with parents having important biological and commercial characteristics differing highly significantly from one another.

In the determination of races the testing collection by N o v e r et al. (1968) was used.

Sources of short-strawedness were used as follows: Denso (a spontaneous mutation from the Abed Rigal variety) and Rg Valtický (a semi-dwarfed X-ray mutation from the Valtický variety, gained by the irradiation of dry seeds by Co^{60}, 12 Kr). The genealogical origin of the gained forms, designated as KM 1192, KM 932 and KM 947 is shown in Figures 1–3. Biological peculiarities, yielding capacity and its stability in the



1. Genealogy of KM 1192

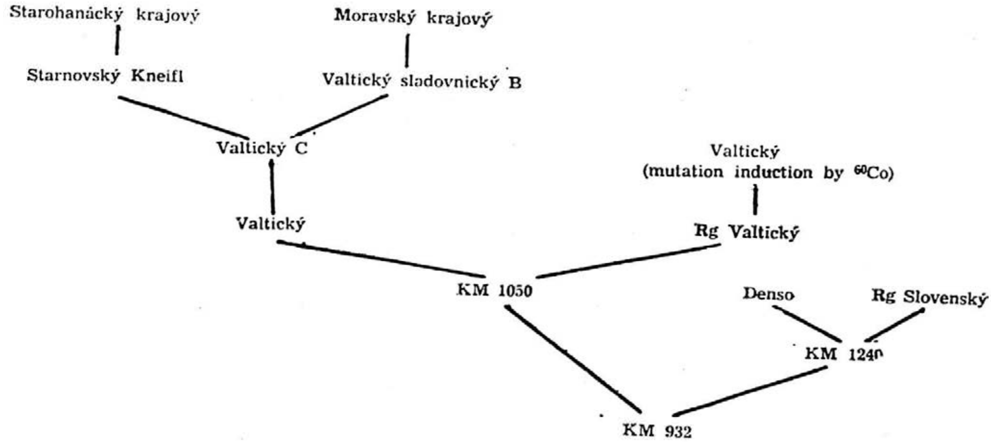
new breeding strains in different years and different soil-ecological conditions in the CSSR assessed by means of convenient statistical methods.

By means of convenient crossing it was possible to obtain hybrid lines of KM 1192, KM 932 and KM 1402 (spontaneous mutations from semidwarfed lines of KM 947), having positive recombination of high yielding components (high number of productive tillers and great caryopsis weight) and features ensuring yield stability, high resistance to lodging and stem breaking in overmatured plants and complex resistance to

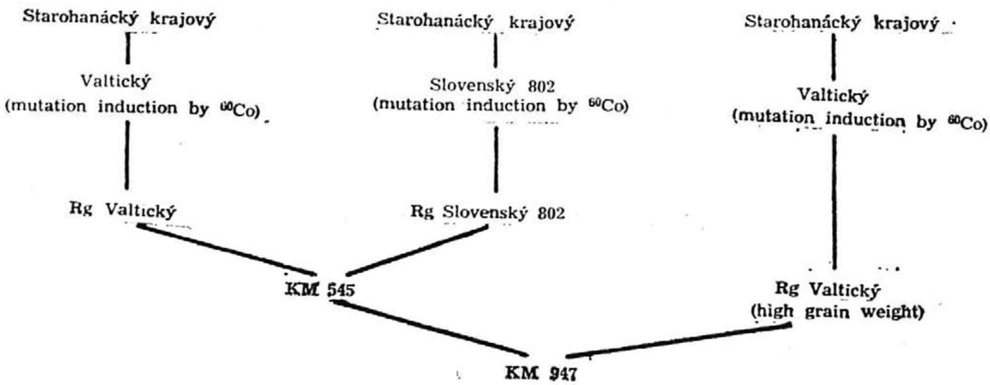
I. World sources of genetical resistance to *Erysiphe graminis* D. C.

Sources	Country of origin	Races									
		A_{26}	D_{10}	A_mC_2	E_mC_2	C_5	C_{10}	A_mC_{12}	C_{14}	C_{16}	A_mC_{42}
Hordeum spontaneum	Afghanistan	R	S	R	R	S	S	R	R	R	S
Lyallpur 3645	India	R	R	R	R	R	R	MR	R	R	S
Monte Cristo	India	R	R	R	R	R	R	R	R	R	S
Arabian	Arabia	R	R	R	S	R	R	R	R	R	R
Hord. Laevigatum	Kenya	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
Algerian C. I. 1179	North Africa	MR	R	R	R	R	R	R	R	S	R
Abyssinian 1102	Abyssinia	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
Jerusalem	Israel	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
Emir	Netherlands	R	R	R	S	R	R	R	R	R	R
Amsel	German Federal Republic	R	R	S	R	R	R	MR	R	R	S
Rg Slovenský	Czechoslovakia	R	R	R	R	R	R	R	R	R	R

R = resistant, MR = medium resistant, S = susceptible



2. Genealogy of KM 932



3. Genealogy of KM 947

Erysiphe graminis. Based on the evaluation of resistance degree in the recent European varieties and new breeding strains to the most spread races of powdery mildew it can be stated that all contemporary varieties grown on greater acreage are being attacked by aggressive powdery mildew races. From the Czechoslovak assortment of registered varieties and new breeding strains being at present tested in state varietal tests only above lines are showing complex resistance to all powdery mildew races of A, D and C groups (Table II). From the characterization of individual lodging resistance indices (Table III) it is seen that the lines of KM 1192, KM 932 and namely KM 1402 are highly significantly different from standard varieties and from original sources of powdery mildew resistance in having short stems and in comparison with the cultivars derived from the Diamant variety they have a higher degree of stem firmness, namely in the internode just below the ear (Zeniščeva, 1975; Voňka, 1975).

The mentioned lines have great yielding capacity. In field experiments carried out during three years in the Cereal Research Institute, Kroměříž, the KM 1192 line in comparison with original sources of powdery mildew resistance, long-strawed Dvoran variety and intensive

II. Reaction of some recent European varieties and of Czechoslovak new breeding strains to the infection with 10 selected European races of powdery mildew

Variety	Country	Races									
		A_{26}	D_{10}	A_mC_2	E_mC_2	C_5	C_{10}	A_mC_{12}	C_{14}	C_{16}	A_mC_{42}
Elgina	German Democratic Republic	R	R	MR	R	R	R	S	R	R	S
Galina	German Democratic Republic	R	R	MR	R	R	R	S	R	R	S
Trumph	German Democratic Republic	R^+	R^+	R^+	R^+	R^+	R^+	R^+	R^+	R^+	S
Oriol	German Federal Republic	R	R	S	S	S	S	S	S	S	S
Carstens Contra	German Federal Republic	R	R	S	S	S	S	S	S	S	S
Hages Hornisse	German Federal Republic	R	R	S	R	R	R	S	S	R	S
Ortola	German Federal Republic	R	R	MR	R	R	R	S	S	R	S
Carina	German Federal Republic	R	R	R	R	S	S	R	R	R	S
Multum	German Federal Republic	R	R	MR	MR	MR	MR	MR	MR	MR	MR
Aramir	Netherlands	R	R	R	S	R	R	R	R	R	R
Hassan	Netherlands	R	R	R	S	R	R	R	R	R	R
Mazurka	Netherlands	R	R	MR	R	R	R	S	R	R	S
Belfor	Netherlands	R	R	MR	R	R	R	MR	R	R	S
Ofir	Netherlands	R	R	R	S	R	R	R	R	R	S
Paloma	Netherlands	R	R	MR	MR	MR	MR	MR	MR	MR	MR
Pauline	Netherlands	R	R	MR	MR	MR	MR	MR	MR	MR	MR
Maris Mink	England	R	R	R	S	R	R	R	R	R	R
Maris Canon	England	R	R	R	R	S	S	R	R	R	S
Sultan	England	R	R	R	S	R	R	R	R	R	R
Dauphine	Belgium	R	S	R	R	S	S	R	R	R	S
Quantum Plus	Austria	R	R	S	S	S	S	S	S	S	S
Hellas	Sweden	S	S	S	S	S	S	S	S	S	S
Kristina	Sweden	S	S	S	S	S	S	S	S	S	S
Wing	Sweden	R	R	S	R	R	R	S	S	R	S
Åkka	Sweden	R	R	R	R	R	R	R	R	R	S
Mona	Sweden	R	R	R	R	R	R	R	R	R	S
Rupal	Sweden	R	R	R	R	R	R	R	R	R	R
Abed Bomi	Denmark	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
Abed Lofa	Denmark	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
Abed Mala	Denmark	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
Siri	Denmark	S	S	S	S	S	S	S	S	S	S
Diamant	Czechoslovakia	S	S	S	S	S	S	S	S	S	S
Ametyst	Czechoslovakia	R	S	R	R	S	S	R	R	R	S

Pokračování tabulky II.

Favorit	Czecho-slovakia	R	R	S	S	S	S	S	S	S	S
HE 593	Czecho-slovakia	R	R	R	R	S	S	R	R	R	S
HE 607	Czecho-slovakia	R	R	R	R	R	R	R	R	R	S
KM 1192	Czecho-slovakia	R	R	R	R	R	R	R	R	R	R
KM 1402/74	Czecho-slovakia	R	R	R	R	R	R	R	R	R	R
KM 932	Czecho-slovakia	R	R	R	R	R	R	R	R	R	R

R = resistant, MR = medium resistant, S = susceptible, R^+ = segregates a negligible quantity of susceptible plants

III. Characterization of lodging resistance (Cereal Research Institute, Kroměříž, 1972—1974)

Variety	Plant height (cm)	2nd basic node length (cm)	Stem firmness (g)	Root firmness (kg)	Lodging (1–9)
Ametyst	75.0	7.80	290.0	5.00	8
Dvoran	84.00^{++}	10.20^{++}	350.0^{+}	5.20	6
Lyallpur	86.0^{++}	10.17^{++}	315.2	3.53^{+}	4
Algerian	116.9^{++}	12.93^{++}	611.0^{++}	6.12	5
H. spontaneum nigrum	103.3^{++}	12.18^{++}	346.0	4.71	3
KM 1192	79.2^{+}	8.50	375.0^{+}	5.20	9
KM 932	76.1	7.90	295.0	6.70^{+}	7
KM 1402	68.0^{++}	7.00	388.0^{+}	4.50	9

$^{+}$, $^{++}$ = significant at the 0.05 and 0.01 levels, respectively

short-strawed Ametyst variety yielded more grain by 3 t ha^{-1}, 1.17 t ha^{-1} and 0.73 t ha^{-1}, respectively. The high grain yield in KM 1192, KM 932 and KM 1402 is due to the high number of ears per m^2, to the higher caryopsis weight in KM 1192 and KM 1402 in comparison with the varieties studied.

From the physiological aspects the gained lines respond in the best way to modern cereal breeding. They are able to produce maximum dry matter weight from unit area, having a narrower grain : straw ratio (Table IV); they have more active dynamics of dry matter accumulation in aboveground parts, namely after earing (Table V) and are outstanding in intake and accumulation of mineral nutrients, namely those of N and P (Table VI).

IV. Characterization of yield components (Cereal Research Institute, Kroměříž, 1972—1974)

Variety	Ears/m²	Grains/ear	Thousand kernel weight	Yield q ha^{-1}	Ratio kernel/straw
Ametyst	858	19.0	42.6	69.5	1 : 1.0
Dvoran	758^{++}	20.0	43.0	65.1^{+}	1 : 1.8^{+}
Lyallpur	801	13.5^{++}	40.7	44.0^{++}	1 : 2.1^{++}
Algerian	505^{++}	28.1^{++}	36.0^{++}	51.2^{++}	1 : 2.1^{++}
H. spontaneum nigrum	720^{++}	15.2^{+}	40.0	43.8^{++}	1 : 2.8^{++}
KM 1192	881	19.0	45.9^{+}	76.8^{++}	1 : 1.1
KM 932	1050^{++}	16.8^{+}	42.6	75.1^{++}	1 : 1.4
KM 1402	930^{+}	18.2	44.5	75.4^{++}	1 : 1.1

$^{+}$, $^{++}$ = significant at the 0.05 and 0.01 levels, respectively

V. Rate of daily dry matter increase in mg/plant (Pot experiment)

Varieties	N-fertilization variants	Aboveground phytomass in g		Roots in g
		3rd—4th leaf stage	earing to harvest	3rd—4th leaf stage
Ametyst	N_1	32.6	44.9	18.9
	N_2	41.6	31.1	20.8
	N_3	43.5	67.9	18.2
KM 1192	N_1	30.2	23.1	15.1
	N_2	51.1	63.0	20.9
	N_3	45.8	72.3	12.6
Dvoran	N_1	40.9	56.2	20.2
	N_2	28.2	51.3	12.3
	N_3	19.6	43.8	7.5

N_1 = low, N_2 = medium, N_3 = high; N_1 = 0.14 g/pot in $(NH_4)_2SO_4$ form

VI. Genotype differences of N and P uptake in mg/plant. Shooting (6th phase according to Feekes) — Pot experiment, 1973—74

Genotype	N				P			
	Aboveground plant parts		Roots		Aboveground plant parts		Roots	
	x	d	x	d	x	d	x	d
Ametyst	41.1	—	9.4	—	5.9	—	1.7	—
KM 1192	61.4	+20.3^{++}	11.6	+2.2	9.0	+3.1^{+}	2.3	+0.6
KM 932	63.4	+22.3^{++}	13.1	+3.7^{++}	10.3	+4.4^{++}	2.6	+0.9^{+}
Dvoran	42.2	+1.1	8.1	+1.3	5.3	−0.6	1.4	−0.3

$^{+}$, $^{++}$ = Significant at the 0.05 and 0.01 levels, respectively

References

BENADA, J.: Ochrana ječmene proti padlí travnímu. (Barley protection against powdery mildew, *Erysiphe graminis.*) In: Zb. referátov z I. konferencie o chorobách obilnin, 1973 : 55-63.

BIFFEN, R. H.: Studies in the inheritance of disease resistance. J. Agric. Sci., *2,* 1907 : 109.

HONECKER, L.: Über den derzeitigen Stand und die Aussichten der Bekämpfung des Mehltaubefalles der Gerste durch Züchtung. Prakt. Bl. Pflanzenbau, *13,* 1936 : 309-320.

JAMES, W. C.: A survey of foliar diseases of spring barley in England and Wales in 1967. Ann. Appl. Biol., *63,* 1969 : 253-263.

LEKEŠ, J.: Hospodářské vlastnosti mutanta sladovnického jarního ječmene odolného k padlí travnímu, získaného z odrůdy 'Slovenský 802'. (Economic characteristics in a malting barley mutation from Slovenský 802 cv., resistant to powdery mildew.) Rostl. Výroba, *17,* 1971 : 343-350.

NOVER, I.: Eine neue für die Resistenzzüchtung bedeutungsvolle Rasse von *Erysiphe graminis* DC. f. sp. *hordei* Marchal. Z. Phytopath., *62,* 1968 : 199-201.

NILSSON-EHLE: Kreuzungsuntersuchungen am Hafer und Weizen. II. Lund. 1911.

VAVILOV, N. I.: Zakonomernosti o raspredelenii immuniteta rastenij k infekcionnym zabolevanijam. Problemy immuniteta kulturnych rastenij. Trudy AN SSR, Moskva-Leningrad, 1936 : 5-16.

VAVILOV, N. L.: Vyvedenije ustojčivych sortov pri pomošči skreščivanija. Izbr. trudy, Nauka-Moskva, *5,* 1964 : 518.

VOŇKA, Z.: Zjištění vlivu sklizně a posklizňového ošetřování na technologickou hodnotu zrna. (Influence of harvest and post-harvest treating on technological grain quality.) [Závěrečná zpráva.] Výzk. úst. obilnářský, Kroměříž 1975.

ZENIŠČEVA, L.: Vytváření krátkostébelných vysoce produktivních forem jarního ječmene s vysokou váhou zrna a efektivním využitím N-hnojení. (Breeding of short-stemmed highly productive spring barley forms having high grain weight and utilizing effectively N-fertilization.) [Závěrečná zpráva.] Výzk. úst. obilnářský, Kroměříž 1975.

FAO: Ausblick auf die Versorgung der Welt mit Nahrung im Jahr 2000. Chemische Technik, *25,* 1973 : 386-390.

Received for publication February 18, 1976

ZENIŠČEVA, L. — LEKEŠ, J. (Výzkumný ústav obilnářský, Kroměříž): *Nové intenzívní genotypy jarního ječmene s komplexní rezistencí k Erysiphe graminis D. C.* Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 13-21.

Linie jarního ječmene intenzívního typu (KM 1192, KM 932, KM 1402), vytvořené ve Výzkumném ústavu obilnářském v Kroměříži, jsou charakterizovány vysokým výnosovým potenciálem, specifickou rasovou rezistencí k *Erysiphe graminis* a horizontální rezistencí k *Helminthosporium teres* a *Rhynchosporium secalis.* Od odrůd klasického typu a dosud použitých zdrojů rezistence k *Erysiphe* (Algerian, *H. spontaneum nigrum,* Lyallpur HES 3645 apod.) se vysoce průkazně liší krátkostébelností a od odrůd diamantové řady zvýšenou pevností stébla, zejména v internodiu pod klasem. Stabilita vysokého výnosu KM 1192 v jednotlivých letech a různých půdně-ekologických podmínkách je podmíněna vysokou odolností k poléhání a komplexní rezistencí ke všem dosud se vyskytujícím v ČSSR a Evropě agresivním rasám *Erysiphe graminis.* Výnosová stabilita se u něj zvyšuje v podmínkách s vysokou úrovní hospodaření, při vyšších dávkách průmyslových hnojiv, zejména dusíkatých a při dodržení pěstební technologie.

jarní ječmen; *Erysiphe graminis* D. C.; rezistence

ЗЕНИЩЕВА, Л. — ЛЕКЕШ, Я. (Научно-исследовательский институт зерновых культур, Кромержиж): **Новые интенсивные генотипы ярового ячменя с комплексной устойчивостью к *Erysiphe graminis* D. C.** Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977, (1) : 13-21.

Линии ярового ячменя интенсивного типа (KM 1192, KM 932, KM 1402), созданные в НИИ зерновых культур в Кромержиже, характеризуются высоким потенциалом урожайности, специфической расовой устойчивостью к *Erysiphe graminis* и горизонтальной устойчивостью к *Helminthosporium teres* и *Rhynchosporium secalis.* Они высокодостоверно

отличаются от сортов классического типа испалозованных источников в *Erysiphe* (Algerian, *H. spontaneum nigrum*, Lyallpur HES 3645 и пр.) а короткостебельностью, а от сортов типа Диамант — повышенной прочностью стебля, особенно в колосовом междоузлии. Стабильность высокой урожайности КМ 1192 в отдельные годы и в разных почвенно-экологических условиях обусловлена высокой устойчивостью к полеганию и комплексной устойчивостью ко свем встречающимя в ЧССР и Европе агрессивным расам *Erysiphe graminis*. Стабильность урожая у нее возрастает в условиях интенсивного земледения, при повышенных дозировках минеральных удобрений, особенно азотных, и соблюдении правильной технологии выращивания.

яровой ячмень; *Erysiphe graminis* D. C.; устойчивость

ZENIŠČEVA, L. — LEKEŠ, J. (Forschungsinstitut für Getreidebau, Kroměříž): *Neue intensive Genotypen der Sommergerste mit Komplexresistenz gegen Erysiphe graminis D. C.* Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 13-21.

Die im Forschungsinstitut für Getreidebau in Kroměříž entwickelten Linien der Sommergerste intensiven Typs (KM 1192, KM 932, KM 1402) zeichnen sich durch hohes Ertragsvermögen, spezifische Rassenresistenz gegen *Erysiphe graminis* und horizontale Resistenz gegen *Helminthosporium teres* und *Rhynchosporium secalis* aus. Von den Sorten klassischen Typs und von den bisher benutzten Quellen der Resistenz gegen *Erysiphe* (Algerian, *H. spontaneum nigrum*, Lyallpur HES 3645 u. ä.) unterscheiden sie sich signifikant durch Kurzhalmigkeit und von den Sorten der Diamant-Reihe durch erhöhte Halmfestigkeit, hauptsächlich im Internodium unter der Ähre. Die Stabilität der hohen Erträge bei KM 1192 in einzelnen Jahren und unter unterschiedlichen boden-ökologischen Bedingungen scheint durch hohe Lagerfestigkeit und Komplexresistenz gegen alle bisher in der ČSSR und in Europa vorkommenden aggressiven Rassen von *Erysiphe graminis* bedingt zu sein. Ihre Ertragsstabilität wird gesteigert unter Bedingungen mit hohem Wirtschaftsführungsniveau, bei Einhaltung der Anbautechnologie und bei höheren Gaben der Kunstdünger, vor allem der Stickstoffdüngung.

Sommergerste; *Erysiphe graminis* D. C.; Resistenz

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SYMPTOMS AND INTENSITY OF GRAPEVINE POWDERY MILDEW DISEASE (*OIDIUM TUCKERI* BERK.) IN RELATION TO GRAPEVINE (*VITIS VINIFERA* L.) VARIETIES

G. VANEK, D. POSPÍŠILOVÁ

VANEK, G. — POSPÍŠILOVÁ, D. (Research Institute for Viticulture and Enology, Bratislava): *Symptoms and Intensity of Grapevine Powdery Mildew Disease (Oidium Tuckeri BERK.) in Relation to Grapevine (Vitis vinifera L.) Varieties.* Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 23-30.

The effect of spontaneous powdery mildew infection in the world assortment of grapevine cultivars was studied in 1975. Symptomatological differences of the given varieties in disease symptoms were determined and classified into four main groups. The differences in symptom expression and intensity of infestation of foliage and grapevine bunches are given in the tables and figures. The degree of resistance of *Vitis vinifera* species varies not only within the given varieties but among their clones as well. It can be said that interspecies hybrids are, in general, more resistant, but not wholly resistant. This paper contributes to the present knowledge of breeding work in creation of new varieties. Moreover it gives a classification of grapevine varietal resistance to powdery mildew in ecological conditions of the Small Carpathian vinegrowing area of Czechoslovakia.

grapevine; varietal resistance; powdery mildew

Powdery mildew of grapevine is one of the most serious fungal diseases in vineyards of Czechoslovakia. In favourable conditions and when neglected, powdery mildew heavily attacks leaves and young shoots and may cause the total loss of crops.

Infected small berries do not ripe, become cracked and hard. The infected fruits are less valuable for wine production because wine made from them has a mouldy taste. The fungus is able to survive during winter by means of persistent mycelium which hibernates within buds or on young twigs. Moreover it can hibernate in spore cases (perithecia) formed on various parts of the plants only under very favourable climatic conditions. The first infection symptoms appear early in spring and the mycelium grows from buds to young shoots and leaves. From the weft of fungus hyphae errected branches (conidiophores) produce chains of spores in great numbers which are the source of primary infection. Sometimes the primary infection may come from ascospores inside of asci in perithecia. The fungus forms white powdery patches being most conspicuous on leaves but infection also appears on young shoots, flowers, and young fruit. From a small spot in a vineyard the epidemic can arise and attack the whole vineyard area because the conidia are spread by air currents. During summer the mycelium grows from the surface inside to the buds for hibernation.

MATERIAL AND METHOD

The conditions for infection and epidemic outbreak of this fungus in 1975 were extremely favourable. The winter 1974/1975 with mild temperatures (no frosts below −12 °C) conditioned the early spring occurrence of this fungus. The long lasting warm period without rains gave suitable developmental conditions for the fungus. On the sites without a proper control of this disease, mostly in vineyards in bad conditions, overfertilized with nitrogen, the parasite appeared and developed in masses and serious damages occurred. Under such conditions we studied the varieties of the world assortment of grapevine in our Institute. The susceptibility to the fungus *Oidium tuckeri* BERK. was determined approximately in 1000 cultivars. In this paper, however, we analyze only those cultivars which are of commercial importance for Czechoslovakia and some foreign varieties inclusive interspecies hybrids. In two cultivars Ruland and Rizling of Rhine we also determined the clonal susceptibility to powdery mildew.

With regard to the climatic conditions, and for the development of this fungus the application of fungicides was to allow the infection in a limited way, up to the stage of fruit formation. Since that stage no control measures had been carried out and the infection became very severe. The parasite spread throughout the whole experimental field and no fruit at all was gathered owing to the mildew. Conditions for varietal susceptibility verification were ideal because the powdery mildew infection pressure in the whole vineyard was equal.

Susceptibility of cultivars was determined in the period of fruit ripening. The degree of the sensitivity of grape bunches and leaves was evaluated according to a nine-point scale in which number 1 signified no infection and number 9 the maximum infection. The objectivity of the evaluation was assured by the fact that in each variety 10 plants were observed. Nevertheless some varieties in repeated trials in various parts of this vineyard proved the same intensity of infection.

RESULTS

VARIETAL DIFFERENCES IN DISEASE SYMPTOMS

In the evaluation of varieties of the world assortment of grapevine two things were apparent. The response of individual varieties to the external parasite *Oidium tuckeri* BERK. varied in the symptomatic manifestation and in the intensity of extension and degree of damage on the generative organs.

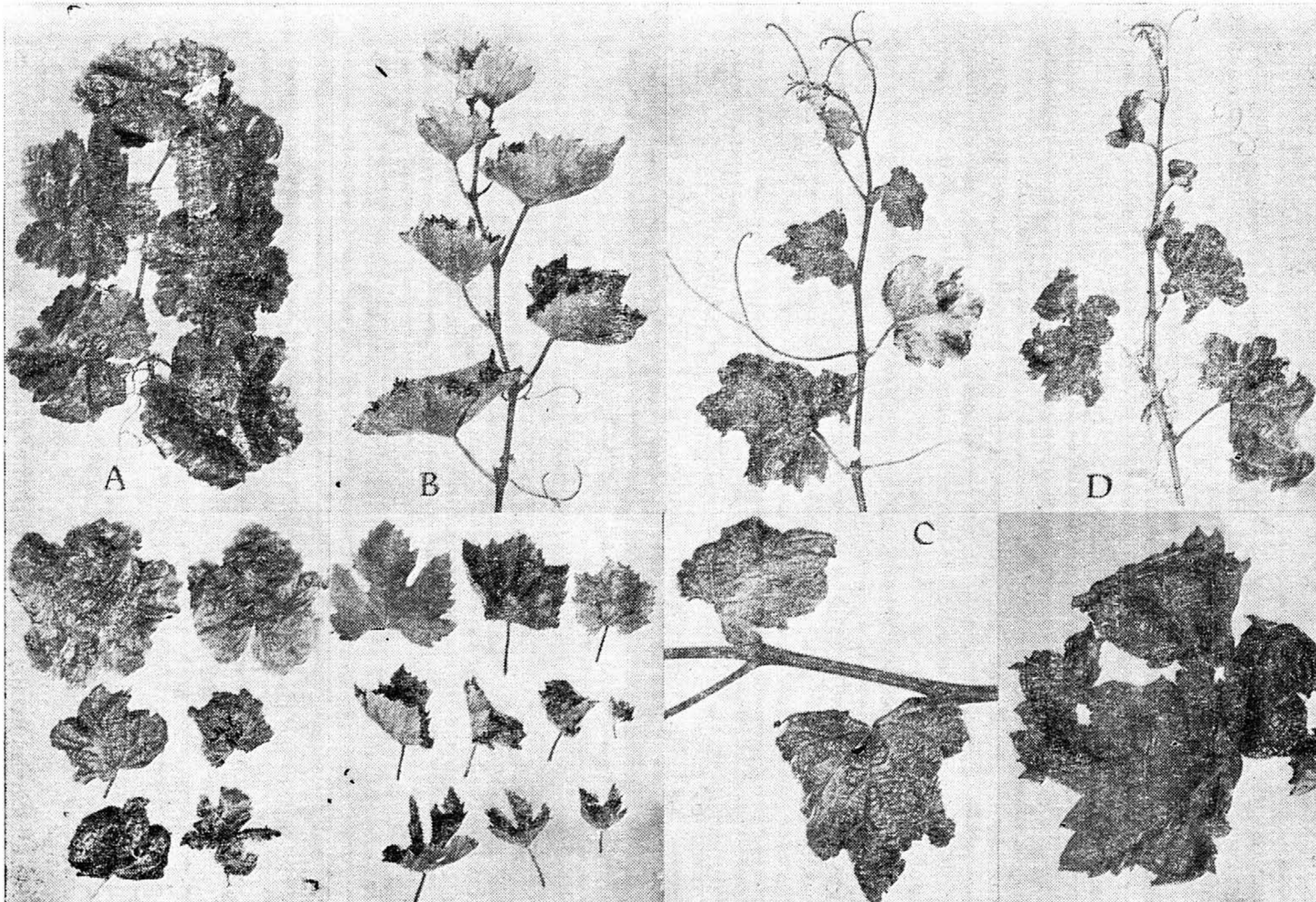
The symptomatic manifestation (qualitative) differs within various groups of cultivars. Mostly on the upper and lower surface of the leaves little conspicuous, pale, greenyellow spots of 0.5 – 1.0 cm in diameter appear, with a characteristic greasy shine. The whitish patches of mycelium with erected conidiophores giving a rise of conidia occur later. The changes of the leaf shape are different according to the variety. We observed four fundamental types of symptoms:

a) In the first type (cv. Negru moale) the infected leaves are intensively curled namely in the vicinity of primary and secondary veins. The younger leaves may be deformed, split and rolled in manifold directions (Fig. 1-A).

b) The second symptomatic type of *Oidium tuckeri* infestation consists of severe leaf rolling with margins towards the upper leaf part. The rolled leaves are often closed and of pale colour in the visible leaf part, mostly at varieties with felty lower leaf surface (Fig. 1-B).

c) The further type of symptoms is striking mainly on young leaves, with margins rolling downwards. The leaves are conspicuously rough and wrinkled along the primary and secondary veins (Fig. 1-C). These symptoms resemble a physiological disorder of grapevine caused by boron deficiency. However, the presence of mycelium with conidiophores and conidia shows exactly the etiology of this disease.

d) In some varieties (e. g. Baccator, Steinschiller), the powdery mildew fungus is evident on leaves primarily as orange lesions, later on



1. Differences in symptomatic expression of powdery mildew on grapevine foliage
A – Negru moale; B – Foča; C – Gamza varnenská; D – Baccator

as necrotic spots in the accumulated mycelium. The decayed necrotic tissues dry and fall off, but the mycelium grows further into the living leaf tissues. As the effect of partial decay of the leaf blade striking leaf deformation and curling appear. Habit of the leaves resembles the mite infestation (Fig. 1-D).

Symptoms of powdery mildew on berries and grapevine bunches of different cultivars are distinguished only by their intensity, or by a greater or smaller disposition of various cultivars to form protrusions on berries. On cultivars or clones with a high degree of resistance, only sporadic and local patches of mycelium were formed on berries, without any practical effect on growth and ripening (Fig. 2-A). The other lower degree of resistance observed on some cultivars, e. g. Keracuda (Fig. 2-B), was manifested by an intensive growth of the mycelium covering almost the whole berry surface. Nevertheless these berries grew further more without any protrusions and the development was regular up to the phenophase of ripening.

In cultivars with a substantially lower degree of resistance the abundant mycelium growth suspended the epidermal tissue growth of berry skin and the affected berries formed protrusions. Yet a part of berries was not infested inspite of the high degree of devastation (e. g. cv. Gordan, Fig. 2-C).

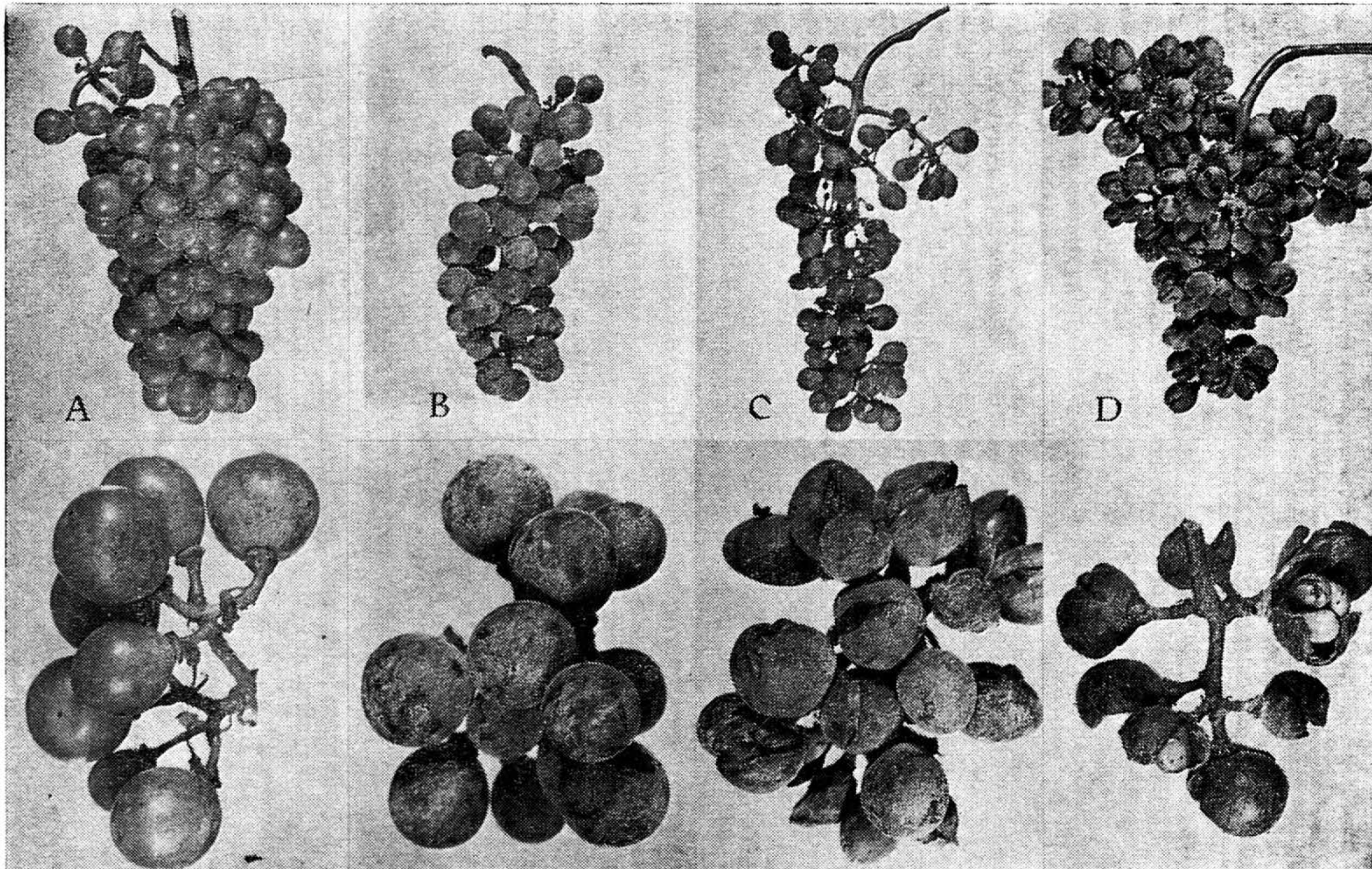
The great part of cultivars showed insignificant, that is to say minimum resistance to *Oidium tuckeri* characterized by high sensibility. The growth of the mycelium was very rapid. The attacked berries became cracked, dried off as a result of high turgor and ceased the epidermal tissue growth (e. g. cv. Karmašat, Fig. 2-D). The berries were practically totaly destroyed and worthless.

THE VARIETAL RESPONSE TO POWDERY MILDEW INFECTION

The intensity of the cultivar susceptibility (qualitative) to the powdery mildew infection shows remarkable differences even in the species of *Vitis vinifera*. The degree of infection on fruit and foliage is not always in accordance at the same variety. There are varieties, e. g. Muskat, Susanna and Veritas, having very sensitive grapevine clusters and the foliage is less affected, and vice versa, varieties with slightly infected clusters and more infested foliage (Dunavski misket). However, the majority of cultivars manifest an almost equal degree of susceptibility of grape clusters and foliage.

Considering the intensity of damage evaluated with degree 1 to 3 as low, we may classify as the most resistant to powdery mildew the following cultivars of grapevine: Furmint, Neuburg, Semillon (for white wine); Blue Burgund, and Early Blue Burgund (for red wines), and Qeen of Vineyards (as table grapevine). The majority of European grapevines possesses only very slight resistance to powdery mildew.

Within the cultivars Ruland and Rizling of Rhine we could demonstrate great differences in resistance among individual clones selected from these cultivars. Varieties of grapevine propagated from their origin in a vegetative way form populations among which several positive and negative biotypes occur. According to the quality and yield only plus-types



2. Differences in the intensity of symptoms of powdery mildew on grapevine bunches
A – Ruland; B – Keracuda; C – Gordan; D – Karmašat

are selected. Therefore it happens that among clones with a high quality, in our case in Rizling of Rhine, clones less resistant to powdery mildew are clones 237 Gm and 198 Gm. These two clones are far behind the population of this variety, because the resistance was neglected during the selection procedure. On the contrary, in the variety Ruland all studied clones show a higher degree of resistance to powdery mildew as the normal population of this variety.

Varieties obtained from the interspecies crossings, having a genotype of resistance, demonstrate usually a higher degree of resistance to the powdery mildew. However, in this case the varietal differences exist as well as a result of the use of numerous parental varieties of these interspecies hybrids transferring the resistance to a various degree.

DISCUSSION

The varietal resistance of grapevine to powdery mildew is in the literature mentioned only sporadically. From 17 cultivars which we studied simultaneously with Zirojevič (1974) our results differ only in the cultivars Blue Burgund and Čauš Belyj. Zirojevič (1974) considers these two varieties little resistant, but our results classify them as resistant or medium resistant.

Vojtovič et al. (1965) declare cultivars Kachet, Tagobi, Kišmiš Rozovyj, and Kišmiš Vatkana as very resistant according to the greenhouse artificial infection. Our observations are similar only in the variety Kišmiš Vatkana, whereas we consider the other three resistant only.

In the last few years the problem of resistance has been concentrated mainly on the active resistance more than on the mechanical resistance based on structural barriers of various plant organs. In plants chemical substances of fungicidal character, the so called phytoalexins, were discovered; they are responsible for the plant resistance or immunity (Ingham, 1972). In this sense Hadijev and Zotov (1972) determine in grapevine varieties resistant to the fungus *Plasmopara viticola* nine specific substances. Furthermore these authors claim that sensitive or resistant varieties differ by a different content and proportion of phenolic substances, tannin fractions, and by the intensity of antibiotic substances production.

Breeding tendency and programme in the last few years have lead to the so called complex resistance to a large scale of grapevine pathogens, e. g. downy mildew, powdery mildew, grey mould, phylloxera, but even to the frost resistance (Fuchs and Ulrich, 1972; Verderevskij et al., 1972; 1972 and others). Only a medium degree of resistance is required which prevents an occurrence of disastrous damages. That is why these authors developed methodical systems of gradated breeding in which the use of genetic sources of immunity and intraspecies selection of resistant varities are included (Vojtovičová, 1973; Rosenberg, 1973; Verderevskij and Vojtovičová, 1973). More resistant interspecies hybrids and resistant species of the genus *Vitis* are used as well. In view of genotypes as extraordinary suitable for fungal diseases resistance the following species are considered: *Vitis rotundifolia, V. Romaneti, V. Wilsonae, V. aestivalis, V. Champinii, V. Rupestris, V. Longii, V. Riparia* (Vojtovič, 1969). Among the resistant types for *Plasmopara viticola* of inter- or intraspecies crossings 24.2 % of seedlings manifest resistance to powdery mildew and grey mould (*Botrytis cinerea*). By further gradated crossings with resistant varieties the required aim is achieved.

This positive balance of grapevine resistance breeding aimed mainly at fungal disease resistance is partly thrown into the shade by scientific results of Breider (1972), Breider and Wolf (1967), who point out two fundamental and negative consequences of interspecies crossings:

– a negative correlation between the quality of grapevine (the quality of wine as well) and the resistance.

– harmful effects of substances responsible for resistance (the so called biostatics) on animal organism. The experiments with chicken and guinea pigs proved that these substances in the pre- and post-natal stage display themselves as plasma toxins causing the death of experimental animals and having negative hereditary consequences.

The higher or lower varietal resistance of grapevine to fungal diseases, namely powdery mildew, has in the climatic conditions of Czechoslovakia decisive commercial importance. In our opinion the breeding work in this direction is necessary. Nevertheless, the basic requirements for resistant varieties, the high quality and harmlessness on human organism, have to be respected. Moreover during the resistance breeding based on interspecies crossings the research in biochemistry and effects of biostatics has to be developed.

As one of the possible solutions of the serious problem we consider a selection of more resistant varieties in the species *Vitis vinifera* or clones of the same variety as donors of resistance in crossings. Our classification of grapevine varietal susceptibility to powdery mildew may be a contribution for proper selection of parental varieties for crossings.

We assume that the evaluation of a resistance grade to powdery mildew of selected biotypes of a given cultivar added to the selection method helps to create clonal populations commercially advantageous.

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References

BREIDER, H.: Über resistente Reben-Arthybriden und ihre Qualitätsleistungen. Mitteilungen, Rebe und Wein, *22*, 1972 : 232-244.

BREIDER, H. – WOLF, E.: Qualität und Resistenz. Über das Vorkommen von Biostatica in der Gattung Vitis und ihren Bastarden. Der Züchter, *36*, 1967 : 366-379.

FUCHS, W. H. – ULLRICH, J.: Züchtung resistenter Kulturpflanzen. Ber. Landwirtsch., *50*, 1972 : 441-453.

HADIJEV, R. Š. – ZOTOV, V. R.: Miľdjustijkisť vinogradu. Vynohradstvo i vynorobstvo, vyp. *13*, 1972, Kyjiv Urožaj : 14-28.

INGHAM, J. L.: Phytoalexins and other natural products as factors in plant disease resistance. Bot. Rev., *38*, 1972 : 342-424.

ROZENBERG, P. S.: Genetičeskije osnovy immuniteta i selekcija rastenij na ustojčivosť k gribnym boleznjam. Izv. Akad. Nauk. Lotyš. SSR, *7*, 1973 : 64-69.

VERDEREVSKIJ, D. D. — VOJTOVIČOVA, K.: Das Genreservoir plasmopararesistenter Rebenarten- und Varietäten und die Methode der stufenweisen Züchtung auf komplexe Immunität gegen die wichtigsten Pilzkrankheiten und Reblaus. Intern. Symposium über Rebenzüchtung, Geilweilerhor, Siebeldingen, 1973.

VERDEREVSKIJ, D. D. — VOJTOVIČ, K. A. — NAJDENOVA, I. N.: Genofond ustojčivych i immunnych vidov raznovidnostej i biotipov vinograda. Seľskochozjajstvennaja biologija, 7, 1972 : 895-903.

VOJTOVIČ, K. A.: Ob ischodnych formach v selekciji na milďjustojčivosť. Sadov. vinograd. vinodelije Moldavii, *24*, 1969 : 41-44.

VOJTOVIČ, K. A. — NAJDENOVA, I. N. — KROPIS, E.: Immunitet plodovych rastenij i vinograda. Zaštita rastenij ot vredit. i bolezn., *10*, 1965 : 21-23.

VOJTOVIČOVÁ, K.: Metódy vypestovania novych odrod viniča odolných proti peronospóre, oídiu, botrytíde i fyloxére. Vinohrad, *11*, 1973 : 224-244.

ZIROJEVIČ, D.: Poznavanje sorta vinove loze I. Beohrad, Nolit, 1974.

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VANEK, G. — POSPÍŠILOVÁ, D. (Výskumný ústav vinohradnícky a vinársky, Bratislava): *Symptomatologický prejav a intenzita výskytu huby Uncinula necator (Schwein) Burr. vo vzťahu k odrôdám Vitis vinifera.* Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 23-30.

V r. 1975 sa na svetovom sortimente viniča sledoval účinok spontánnej infekcie múčnatky. Stanovili sa symptomatologické rozdiely na listoch odrôd, ktoré sa zaradili do štyroch základných skupín. Rozdiely v prejave príznakov a v intenzite poškodenia listov i strapcov sa dokumentujú fotograficky a tabuľkove. Stupeň odolnosti druhu *Vitis vinifera* je veľmi variabilný nielen v rámci odrôd, ale aj ich klonov. Všeobecne sa dá konštatovať, že medzidruhové hybridy sú viac odolné, ale nie rezistentné. Práca je príspevkom pre využitie poznatkov v šľachtiteľskej práci pri tvorbe nových odrôd, lebo podáva klasifikáciu odolnosti odrôd viniča proti múčnatke v ekologických podmienkach malokarpatskej vinohradníckej oblasti v ČSSR.

vinič; odolnost proti múčnatke; symptomatologické rozdiely

ВАНЕК, Г. — ПОСПИШИЛОВА, Д. (Научно-исследовательский институт виноградарства и виноделия, Братислава): **Симптоматологическое проявление и интенсивность распространения гриба** *Uncinula necator* (Schrein) Burr. **по отношению к сортам** *Vitis vinifera.* Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 23-30.

В 1975 г. на мировом сортименте винограда определяи действие спонтанного заражения оидиумом, симптоматологические различия на листьях сортов, включенных в 4 основные группы. Ралзичия проявлений признаков и интенсивности поражения листьев и кистей документируются в фотографиях и таблицах. Степень устойчивости вида *Vitis vinifera* весьма изменчива не только в рамках сортов, но и их клонов. В общем итоге можно сказать, что межвидовые гибриды устойчивее, но не резистентны. Работа является вкладом в использование данных в селекционной работе при образовании новых видов, в ней приводится и классификация устойчивости виноградных сортов к мучнистой росе в экологических условиях малокарпатской виноградарской области ЧССР.

виноград; устойчивость к оидиуме; симптоматологические различия

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RESISTANCE OF A CUCUMBER MOSAIC VIRUS-TOLERANT CUCUMBER LINE TO VIRUS WILT

V. HERVERT, V. KAZDA

HERVERT, V. – KAZDA, V. (Institute of Experimental Botany of the Czechoslovak Academy of Sciences, Praha): *Resistance of a Cucumber Mosaic Virus-Tolerant Cucumber Line to Virus Wilt.* Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 31-36.

The influence of cucumber mosaic virus (CMV) in a tolerant line and susceptible cucumber cultivar on the course of infection during the incubation period and at temperatures lower than 20 °C was studied. Wilting occurred only in 1.6 % of infected plants of the tolerant Line 140 while it amounted to 33.3 % of plants of the susceptible cultivar Nejlepší ze všech. Results showed that the tolerance of the Line 140 to CMV manifested itself by the resistance to virus wilt even under the conditions of increased intensity of wilting in the susceptible cultivar which often resulted in the dying-out of the whole plant.

cucumber mosaic virus; virus wilt; cucumber; resistance

Wilting frequently occurs in cucumbers cultivated both in glasshouse and under field conditions and is often followed by dying out of the crop. The cause can be of a non-parasitic or pathogenic origin. Virus wilt in cucumbers infected by cucumber mosaic virus (CMV) is often demonstrated as one of the symptoms which are neither usual nor frequent in virus infections of plants. Tjallingii (1952) proved that cucumbers inoculated by CMV wilted and died out when the temperature during the incubation period fell below 20 °C.

Schmelzer and Naumann (1966) assert that virus wilt in field cucumbers is often disregarded. In 1962 and 1965 disastrous dying out of the plants occurred in the GDR after virus infection and coincidental fall of the temperature. Hervert and Kazda (1975) show that the course of virus wilting which results in the dying out of plants is more complicated. They assume co-action of other factors, namely those of soil. Interaction between CMV and soil pathogens was proved by other authors (Nitzany, 1966; Nitzany et al., 1973).

Resistance of cucumber cultivars to CMV has also a considerable influence on the course and intensity of virus wilting (Havránek et al., 1970/71). The results described here follow those observations. The authors investigated the course of virus infection at temperatures below 20 °C in a susceptible cultivar and CMV--tolerant line. The cultivation of plants in different media was to prove that the resistance to virus wilt did not change under such conditions when the plants of susceptible cultivars died out after wilting.

MATERIAL AND METHOD

Our experiments were carried out with cucumber (*Cucumis sativus* L.), cultivar Nejlepší ze všech and Line 140 VÚZ.

According to our experience, cv. Nejlepší ze všech is one of the cultivars susceptible to CMV infection. The disease is manifested by leaf spots, mosaic symptoms and stunted growth. The seed was supplied by Sempra, Praha. The Nejlepší ze všech cultivar belongs to glasshouse cucumbers that have been grown in this country for many years. Mikeš (1942) mentions it as Weigelt's cv. Nejlepší ze všech, which came from the crossing of the English cultivars Tottenham Prolific and Telegraph Improved. Its initial growth is rather slow and it has relatively large leaves; it does not belong to the earliest varieties.

Line 140 VÚZ is CMV tolerant. The seeds were obtained for our experimental purposes from ing. Havránek, CSc., from Vegetable Research Institute, Olomouc. The data concerning the origin of this line are given with his permission as follows: Line 140 VÚZ ("L 140") has been selected from the slicing-cucumber cultivar Jet of American origin (seeds from Asgrow Seed Co., USA). The description of this cultivar indicates that it is resistant to virus mosaic (without mentioning the type of the virus). „L 140" was derived from the tested plants which reacted with the weakest symptoms (down to none) of infection by A-strain of CMV.

Cucumber mosaic virus (CMV): for the purpose of inoculation the Ke-strain isolated from cucumbers by dr. Brčák, D. Sc., was used. The properties of the isolate are described in our previous paper (Kazda et al., 1975). According to Havránek (1971) it belongs to the D-group of CMV strains.

The plants were grown in plastic pots 6 cm in diameter, in non-sterilized compost soil, in compost soil that was steam-sterilized, and hydroponically in perlite. Each variant comprised at least 20 plants. For perlite hydroponics a nutrient solution was prepared from Herbapon (1 % water solution) and changed once a week. The decrease of the solution was filled up with water.

The seedlings were inoculated mechanically on the 7th to 10th day following planting after having been dusted with carborundum powder. Distilled water instead of virus inoculum was applied to control plants.

The experiments were carried out in a glasshouse during spring months; temperature was controlled by additional electric heating. However, we were unable to prevent overheating above 20 °C due to intensive sunshine. Average daily temperatures were calculated from thermographic data (in two-hour intervals); similarly the minimum and maximum temperatures.

RESULTS

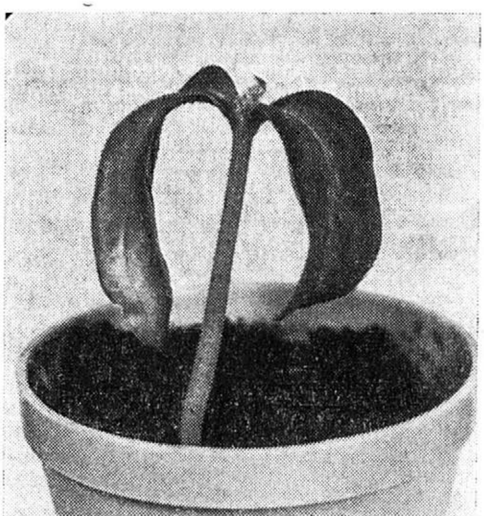
The proportion of wilting plants in L 140 was very low. Only 1.6 % out of 120 inoculated seedlings, cultivated in the above mentioned media and inoculated on one or both cotyledons, showed wilting. However, in the case of the susceptible Nejlepší ze všech cultivar the wilting occurred in 33.3 % of individuals.

The experiments were repeated three times without considerable differences. Results of one experiment are given in Table I; the data represent the symptom expression 14 days after inoculation; no further changes took place. The average temperature for the whole period was 17.7 ° and the averages of the maximum and of the minimum daily temperatures were 24.8 °C and 14.7 °C, respectively.

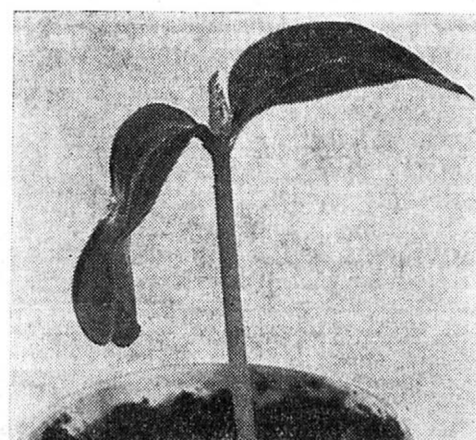
The first symptoms of wilting were observed on the 9th day after inoculation; they became evident by the loss of cotyledon turgor (slackening) of several plants of the cv. Nejlepší ze všech (Fig. 1). The described symptoms appeared in other plants during the next three days. Wilting resulted in necrotization of cotyledons, partial in some cases (Fig. 2), total in others (Fig. 3, the plant on the right). Inoculated cotyledons of other seedlings reacted by coiling, as shown in Fig. 4. In the tolerant L 140 inhibition of growth took place in several inoculated cotyledons (Fig. 5). Their wilting was quite exceptional (see the table).

I. The influence of CMV Ke-strain infection on cucumber seedlings cultivated at temperatures below 20 °C. Evaluation of observations two weeks after inoculation

Medium	Cultivar	Inoculation on 1 cotyledon			Inoculation on both cotyledons		
		wilting		wilted and died out - total (%)	wilting		wilted and died out - total (%)
		necrotiza-tion (%)	died out (%)		necrotiza-tion (%)	died out (%)	
Non-steriliz-ed soil	Nejlepší ze všech	25	20	45	25	15	40
	L 140	0	0	0	0	0	0
Sterilized soil	Nejlepší ze všech	30	0	30	40	0	40
	L 140	0	0	0	0	0	0
Hydroponics -perlite	Nejlepší ze všech	20	0	20	25	0	25
	L 140	10	0	10	0	0	0

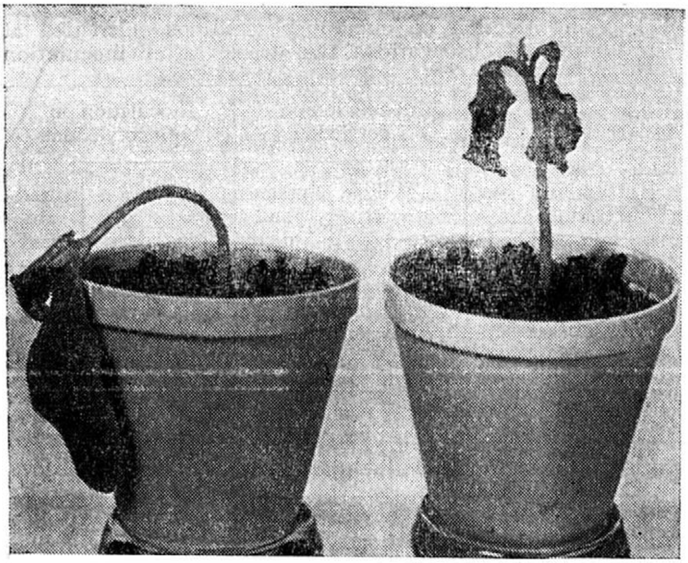


1. Wilting as a result of the loss of turgor of inoculated cotyledons (cv. Nejlepší ze všech)



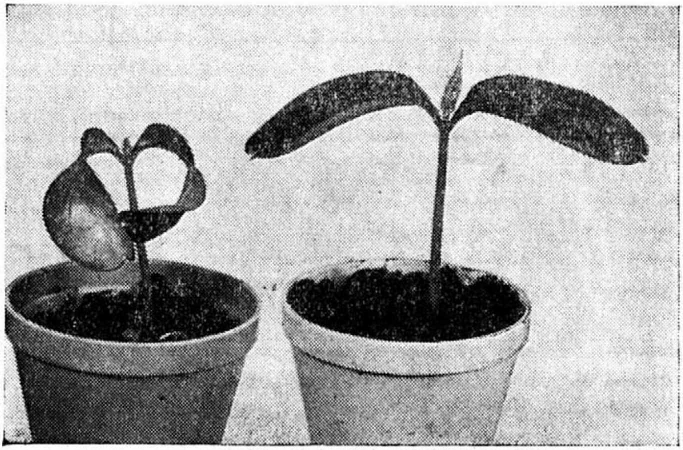
2. Mild necrotization of an inoculated cotyledon as a result of progressing wilt (cv. Nejlepší ze všech)

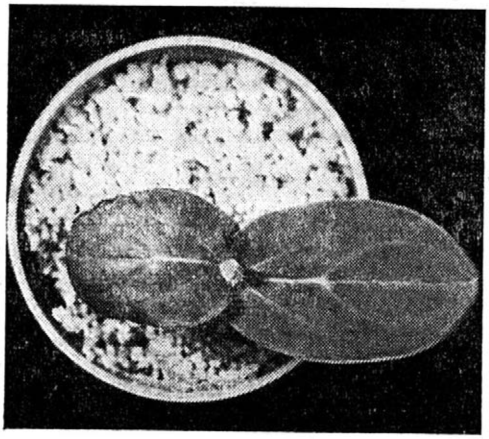
Infection of cv. Nejlepší ze všech seedlings was determined from the coiling of the cotyledons, from mosaic symptoms on the first true leaves and from growth retardation. The inhibition of growth is evident from a comparison of the length of the midrib of the first true leaf; in infected plants (cultivated in soil) the average length was 16 mm while in healthy plants it was 42 mm.



3. Total necrotization of cotyledons after CMV inoculation (the plant on the right). Interaction with an unidentified soil pathogen in the other plant (left). Both plants of the cv. Nejlepší ze všech were cultivated in non-sterilized soil

4. Coiling cotyledons after inoculation by CMV — left; the healthy **plant — right**





5. Inhibition of growth of one CMV-infected cotyledon (L 140)

Plants of L 140 showed no visual symptoms of virus infection; the seedlings were of the same growth as those in the control group. The presence of the virus was confirmed by back transmission to healthy cucumber seedlings. Relative infectivity of the sap from the plants of L 140 and the Nejlepší ze všech cultivar was compared also on leaves of the tobacco *Nicotiana tabacum* cultivar Java by the half-leaf assay method. The inocula were prepared from groups of 5 plants of each compared variant. On the average (of all 20 tests) the number of lesions caused by the infectious sap from plants of the tolerant line was half as compared with the susceptible cultivar.

DISCUSSION

Considerable differences in cultivar resistance were pointed out by Havránek et al. (1970/71). Different tendency to virus wilting of intolerant cultivars is called „mortality percentage". The data given in this paper were obtained in an experiment during a relatively cold period in June at glasshouse temperatures between 15 and 21 °C.

Our aim was to investigate the virus wilt resistance of the recently developed L 140. We studied the course of infection in inoculated plants grown also in non-sterilized soil in which – as it becomes evident even from our experiments – strong necrotization and dying out of plants takes place in the susceptible cultivar.

Co-action of soil factor was shown either by strong wilting and necrotization of cotyledons or by interaction with unidentified soil pathogens (Fig. 3, the plant on the left); fungous infection was found on the base of the hypocotyl or on the roots of plants whose growth was strongly inhibited.

Results of our experiments show that L 140, which is CMV-tolerant and resistant to virus wilt, retains this property even under the described conditions. This fact is very important for practical application. The soil for the cultivating of cucumbers is hardly ever sterilized even for glasshouse production. It is possible to assume that intentional breeding of cucumber for resistance is one of the correct ways how to prevent effectively and to avoid considerable economic losses.

We are grateful to Ing. Havránek, CSc., for the supply of the seed material and for the description of the Line 140.

References

HAVRÁNEK, P. – MORAVEC, J. – KVASNIČKA, S. – TRONÍČKOVÁ, E.: Průzkum odolnosti vybraných odrůd okurek vůči viru mozaiky okurky. Bull. Výzk. ústavu zelin., Olomouc, 14/15, 1970/71 : 130-137.

HAVRÁNEK, P.: Differentiation and properties of five strains of cucumber mosaic virus isolated from somples of cucumber fruits. Biol. Plantarum (Praha), *13,* 1971 : 22-32.

HERVERT, V. – KAZDA, V.: Příspěvek k otázce vadnutí okurky (*Cucumis sativus* L.) indikované virem mozaiky okurky. Sborník věd. prací z V. celost. konference o ochraně rostlin, Brno, 1974. Vyd. SZN Praha, 1975 : 255-259.

KAZDA, V. – HERVERT, V. – POLÁK, Z.: Biologická charakterizace Ke kmenu viru mozaiky okurky a jeho potenciální škodlivost. Sborník věd. prací z V. celost. konference o ochraně rostlin, Brno, 1974. Vyd. SZN Praha, 1975 : 247-253.

MIKEŠ, J.: Rychlení a pěstování raných zelenin. Praha, 1942.
NITZANY, F. E.: Synergism between *Pythium ultimum* and cucumber mosaic virus. Phytopathology, *56*, 1966 : 1386-1389.
NITZANY, F. E. — JOFFE, A. F. — PALTI, V.: Synergism between *Fusarium* ssp. and cucumber mosaic virus. Phytopath. Z., *26*, 1973 : 314-318.
SCHMELZER, K. — NAUMANN, K.: Das Gurkenmosaik-Virus als Ursache schwerster Schädigungen des Gurkenbaus in kühlen Sommern. Der deutsche Gartenbau, *13*, 1966 : 181-186.
TJALLINGII, F.: Onderzoekingen over de mozaikziekte van de augurk (*Cucumis sativus* L.). Investigations on the mosaic disease of gherkin. Veenman and Zonen, Wageningen, 1952.

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HERVERT, V. — KAZDA, V. (Ústav experimentální botaniky ČSAV, Praha) : *Linie okurky tolerantní k viru mozaiky okurky a rezistentní k virovému vadnutí.* Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 31-36.

Byl sledován vliv viru mozaiky okurky (CMV) u tolerantní linie a vnímavého kultivaru okurky na průběh infekce během inkubační doby při teplotách pod 20 °C. U tolerantní Linie 140 došlo k vadnutí pouze u 1,6 % infikovaných rostlin, u vnímavého kultivaru Nejlepší ze všech u 33,3 % infikovaných rostlin. Výsledky pokusů ukázaly, že tolerantní Linie 140 k CMV se projevuje odolností k virovému vadnutí i za podmínek, kdy intenzita symptomů u vnímavého kultivaru stoupá a končí často odumřením rostliny.

virus mozaiky okurky; virové vadnutí; okurky; rezistence

ГЕРБЕРТ, В. — КАЗДА, В. (Институт экспериментальной ботаники ЧСАН, Прага). **Линия огурца толерантная к вирусу мозаики огурца и устойчивая к вирусному увяданию.** Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 31-36.

Исследовалось влияние вируса мозаики огурца (CMV) у толерантной линии и предрасположенного культивара огурца на ход инфекции в инкубационный период при температуре ниже 20 °С. У толерантного культивара Линии 140 наблюдалось увядание лишь у 1,6 % зараженных растений, у чувствительного культивара Наилучший из всех у 33,3 % зараженных растений. Результаты испытаний показали, что толерантный культивар Линии 140 CMV проявляет устойчивость к вирусному увяданию и при условии, что интенсивность симптомов у предрасположенного культивара повышается и часто заканчивается гибелью растения.

вирус мозаики огурца; вирусное увядание; огурец; устойчивость

HERVERT, V. — KAZDA, V. (Institut für experimentelle Botanik der Tschechoslowakischen Akademie der Wissenschaften, Praha): *Eine zum Virus der Gurkenmosaik tolerante und gegen Viruswelke resistente Gurkenlinie.* Sbor. ÚVTIZ-Genet. a Šlecht., *13*, 1977 (1) : 31-36.

Bei einer toleranten Linie und einem empfindlichen Gurkenkultivar wurde der Einfluß des Grukenmosaikvirus (GMV) auf den Verlauf der Infektion während der Inkubationszeit bei Temperaturen unter 20 °C untersucht. Bei dem tolerant cv. Linie 140 erfolgte Welke nur bei 1,6 % der infizierten Pflanzen, bei dem empfindlichen Kultivar Nejlepší ze všech bei 33,3 % der infizierten Pflanzen. Die Versuchsergebnisse zeigten, daß der zu CMV tolerante cv. Linie 140 eine Resistenz gegen Viruswelke aufweist und zwar auch unter solchen Bedingungen, wenn bei dem empfindlichen Kultivar die Intensität der Symptome ansteigt und oft mit dem Absterben der Pflanze endet.

Gurkenmosaikvirus; Viruswelke; Gurke; Resistenz

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EXPRESSION OF HIGHER RESISTANCE IN LUCERNE TO *VERTICILLIUM ALBO-ATRUM* IN DEPENDENCE ON THE RESISTANCE TO *CORYNEBACTERIUM INSIDIOSUM*

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KŮDELA, V. – ROD, J. – NEDBÁLKOVÁ, B. – MALÍK, O. (Institute of Plant Protection, Praha - Ruzyně; Research Station of Fodder-Crop Growing, Troubsko u Brna; Plant Breeding Station, Želešice u Brna): *Expression of Higher Resistance in Lucerne to Verticillium albo-atrum in Dependence on the Resistance to Corynebacterium insidiosum*. Sbor. ÚVTIZ - Genet. a šlecht., *13*, 1977 (1) : 37-44.

Generative progenies of clones with a known degree of resistance were tested for resistance to the two pathogens of vascular wilt. A free combinability of resistance to both pathogens has been proved with the exception of a certain dependence of resistance to *Verticillium albo-atrum* on resistance to *Corynebacterium insidiosum*. It is possible to select progenies resistant to *Verticillium* wilt and susceptible to bacterial wilt, but resistance to *Verticillium albo-atrum* rises with concurrent resistance to *Corynebacterium insidiosum*.

lucerne; resistance; combinability of resistance; *Verticillium albo-atrum; Corynebacterium insidiosum*

Breeding for resistance to bacterial and *Verticillium* wilt in lucerne is becoming one of the main tasks in breeding schemes. Its success will obviously depend on its ability to combine resistance to both pathogens, and on their specific or nonspecific character.

A free combinability and consequently also a different genetical basis of resistance to both pathogens has been proved (Kůdela, Malík, 1974). This may be, to a great extent, modified by the specificity of their realization, with definite consequences for the choice of suitable breeding strategy. The results of this study present a contribution to the question formulated in this way.

MATERIAL AND METHOD

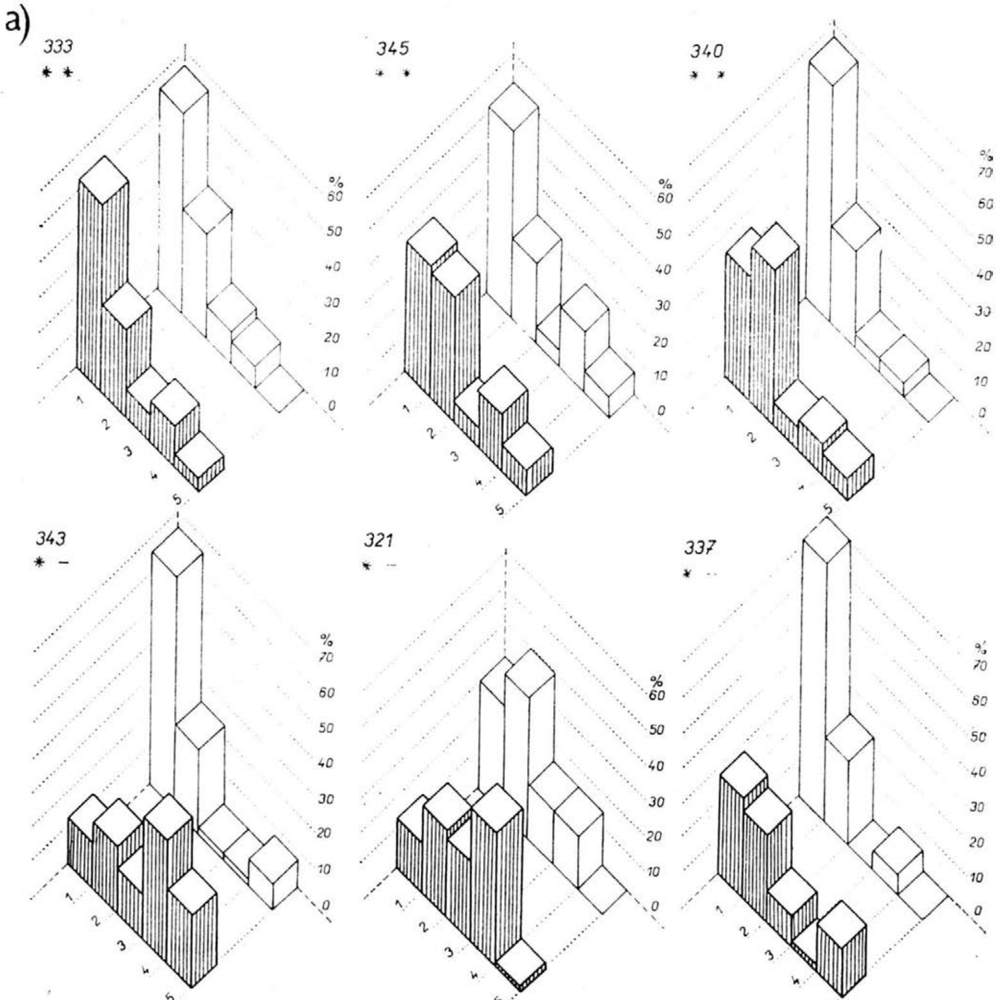
To solve the given task we used 12 mother plants with a known degree of resistance to both pathogens. They were three mother plants resistant to both pathogens (No. 333, 345, 340), three resistant to bacterial and susceptible to *Verticillium* wilt (No. 343, 321, 337), three susceptible to bacterial and resistant to *Verticillium* wilt (No. 468, 429, 367) and finally three susceptible to both pathogens (No. 373, 443, 445). Their specification to the given groups is based on the results of testing plants which were obtained from stem cuttings of individual mother plants (Kůdela, Malík, 1974). Under the conditions of free pollination in the nursery, including 160 clones, we got generative progenies and tested them for resistance to both pathogens.

We inoculated the plants, which were raised in wooden boxes with soil, at the age of 10 weeks by dipping the shortened roots in a suspension of either *Corynebacterium insidiosum* (McCulloch) Jensen cells or *Verticillium albo-atrum* Reinke et Berthold conidia. The detailed technique of inoculation is described in a previous paper of Kůdela and Řezáč (1972).

We planted the inoculated and control plants in field plots. Four months after inoculation we dug up all plants and evaluated the degree of resistance. The number of individuals in the two groups fluctuated from 48 to 60, so that the resultant data are comparable. We evaluated the resistance by means of a 7 point scale (0, . . . , 6) by K ů d e l a (1970). With regard to the low frequencies of extreme values we summarized them in a 5 point scale and after conversion into relative numbers we expressed graphically the distribution of individuals in the progenies of individual clones and groups of infection (Fig. 1). Then we expressed the resistance of progenies by means of a coefficient of resistance (k), respecting the representation of individuals in individual categories. This coefficient was defined by the equation

$$k = (1 \, . \, f_1 + 2 \, . \, f_2 + \ldots + 5 \, . \, f_5) \, / \, f_i,$$

where: 1, . . . , 5 are the point values (weights) of individual degrees of resistance,



f_i the corresponding frequencies of individuals in progenies. With a decrease in resistance the value of the coefficient increases from 1 to 5.

We used the attack of *Corynebacterium insidiosum* (C) and *Verticillium albo-atrum* (V) on progenies for the following comparisons:

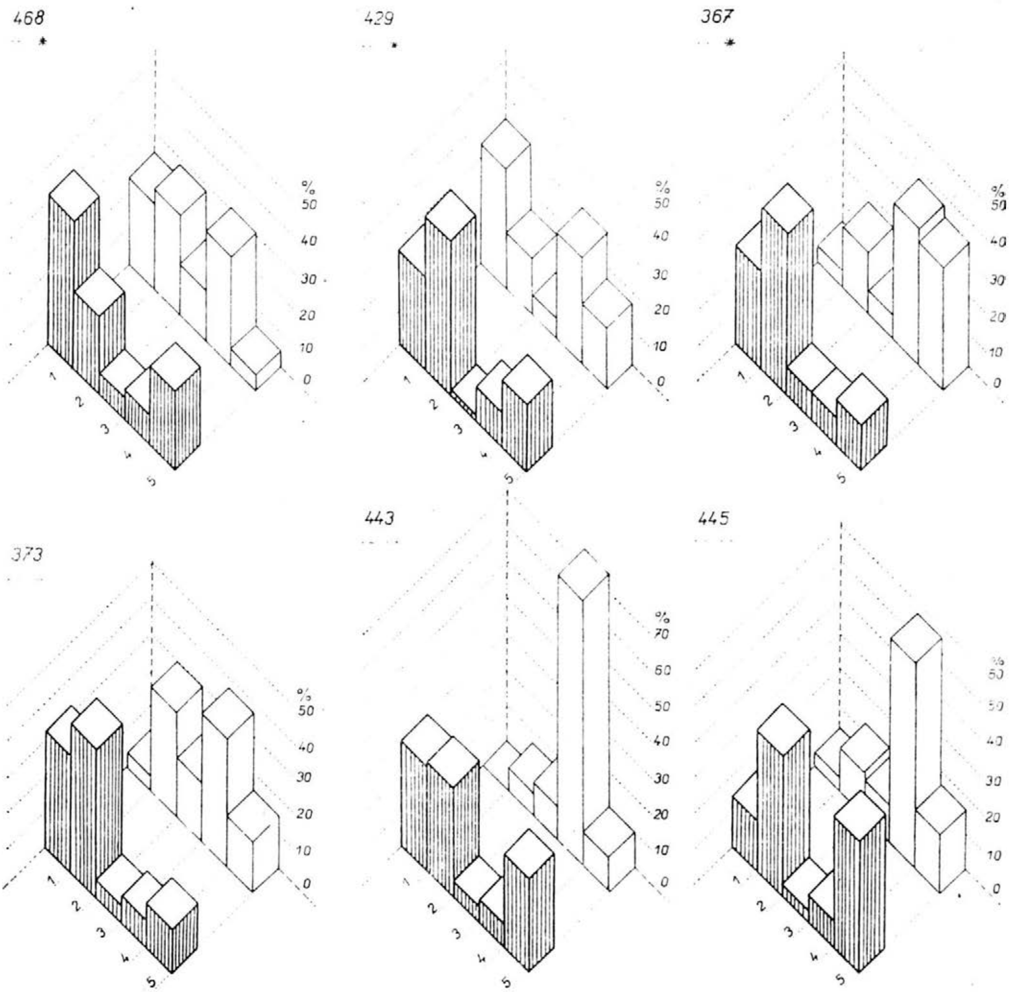
A) We compared the attack on progenies of the same clone by C and V (Tab. I).

B) We compared the attack on individual progenies of all clones by C, similarly by V (Tab. II).

C) We compared the attack by C and V on all possible pairs of clones (Tab. III).

In all cases given above we started from the distribution of individuals into classes according to resistance, in the framework of individual progenies, and we tested the coincidence of their distribution by the x^2-test.

b)



1.a-b Distribution of individuals in the progenies of individual clones: resistant to *Corynebacterium* and *Verticillium* (✳✳), resistant to *Corynebacterium* and susceptible to *Verticillium* (✳—), susceptible to *Corynebacterium* and resistant to *Verticillium* (—✳), and susceptible to both pathogens
Progeny after infection by *Corynebacterium*
Progeny after infection by *Verticillium*

I. Comparison of the degrees of attack by *Corynebacterium* and *Verticillium* between seed progenies of the same clone

Clone	Resistant		Coefficient		Test of the distribution agreement of progenies		
	C	V	C	V	X_2	Degrees of freedom	P
333	+	+	1.645	1.886	2.077	2	$0.500 < P < 0.250$
345	+	+	2.018	2.236	3.142	2	$0.250 < P < 0.100$
340	+	+	1.428	2.083	13.859	2	$P < 0.005$
343	+	−	1.615	3.328	45.887	2	$P < 0.005$
321	+	−	2.150	2.915	14.015	3	$P < 0.005$
337	+	−	1.383	2.700	31.462	2	$P < 0.005$
468	−	+	2.620	2.460	3.979	2	$0.250 < P < 0.100$
429	−	+	2.816	2.500	15.749	3	$P < 0.005$
367	−	+	3.818	2.333	40.683	4	$P < 0.005$
373	−	−	3.290	2.254	22.477	2	$P < 0.005$
443	−	−	3.875	2.683	69.280	3	$P < 0.005$
445	−	−	3.693	3.229	30.531	2	$P < 0.005$

II. Comparison of the degrees of attack by *Corynebacterium* and *Verticillium* among seed progenies of all clones

Progenies after infection by	Test of distribution agreement		
	X_2	Degrees of freedom	P
Corynebacterium	274.277	11	$P < 0.005$
Verticillium	92.860	11	$P < 0.005$

RESULTS

When comparing the reaction of progenies to the infection by both pathogens (Fig. 1), it is evident that in the progenies of resistant clones resistant individuals predominated (clones No. 333, 345, 340 for C and V, clones No. 343, 321, 337 for C, clones No. 468, 429, 367 for V). The values of the resistance coefficient in Tab. I confirm this as well. It must be stressed that the distribution of resistance degrees in the progenies as well as the finally formed expression are conclusively higher in C than in V. This is evident in the progenies resistant to both pathogens, above all in the progenies of clones resistant to either of them.

The differences between the attacks on progenies regardless of origin, after infection with both pathogens, are proved by the results in Tab. II. They are due to the character of the mother plant and also to the heritability of resistance to the corresponding pathogen. That is why we compared the progenies of each clone with each other for both pathogens (Tab.III).

III. Pair comparison of the progenies of all clones. A survey on the number of progenies with significantly and nonsignificantly different distribution of individuals after the infection by *Corynebacterium* (C) and *Verticillium* (V)

Row	Definition of compared pairs of clones				Number of progenies with significantly and nonsignificantly different distribution			
	Resistance				*Corynebacterium*		*Verticillium*	
	C	V	C	V	Nonsignif.	Signif.	Nonsignif.	Signif.
1	+	+	+	+	2	1	3	—
2	+	+	+	—	5	4	1	8
3	+	+	—	+	—	9	6	3
4	+	+	—	—	—	9	3	6
5	+	—	+	—	1	2	3	—
6	+	—	—	+	1	8	1	8
7	+	—	—	—	—	9	1	8
8	—	+	—	+	1	2	3	—
9	—	+	—	—	2	7	7	2
10	—	—	—	—	2	1	2	1

On the basis of the results summarized in this way it is possible to state that the mother plants resistant to C gave progenies highly resistant to bacterial wilt. The distribution is explicitly one-sided (clones 333, 345, 340, 343, 337, with a minor deviation in clone 321). The degree of resistance of the mother plants to *Verticillium* wilt and of their progenies had obviously no influence on resistance to C. If we consider the situation from the point of view of resistance to V, we find a slightly different picture. The entirely one-sided character of distribution in the direction of resistance to V is found only in the progeny of clone 333, and sometimes in 345 and 340. A shift toward susceptibility is above all striking with clones 468, 429 and 367, defined as resistant to V, but susceptible to C. The resistance of progenies to V manifested itself to a much lesser extent than in the progenies of mother plants resistant to both pathogens.

We find similar results when comparing pairs of all progenies (Tab. III). A hypothesis of conforming distribution was, in many cases, rejected on different levels of statistical significance. Summarizing these results we can see that in the case of the resistance of mother plants to both pathogens we find predominantly similar distribution among their progenies (row 1). If one of the mother plants is susceptible to V, there are usually significant differences among progenies regarding V, but also with half of them regarding C (row 2). In the opposite case, if one of the mother plants is susceptible to C, all progenies show significantly different distribution regarding C and a third also regarding V (row 3). In the case of quite different characters of the two mother plants the progenies are differently distributed in all cases only regarding C, while only in two thirds regarding V (row 4). The progenies of clones resistant to one of the pathogens and susceptible to the other (rows 5 and 8) show significantly different distribution only regarding C. Supposing the character of both mother plants (row 6) is opposite, significantly different distribution of progenies also predominates. We find a similar situation in the case of a difference in C – resistance between mother plants (row 7). If they differ in resistance to V (row 9), both being at the same time susceptible to C, we find significant differences in the distribution of progenies, above all again in C. When comparing the progenies of clones susceptible to both pathogens, we find insignificant differences as to the distribution of their progenies (row 10).

According to the results referred to, a free combining ability of resistance to both pathogens is evident with the exception of certain dependance of resistance to V on resistance to C. Though it is possible to find progenies resistant to V and susceptible to C, resistance to V rises in the presence of resistance to C. At the same time there are differences in the realization of resistance in progenies showing phenotypically same considerable degree of resistance, especially to *Corynebacterium.* This statement follows on the one hand from Fig. 1, on the other from the comparison of individual distribution in the progenies of clones defined in the same way (Tab. III row 1, 5, 8, 10). We find significantly different distributions mostly with regard to C. Certain dependance of resistance to upon resistance to C is confirmed.

DISCUSSION

A diverse genetical basis of lucerne resistance to bacterial and *Verticillium* wilt on the one side (Kůdela, Malík, 1974) and a certain dependance of higher resistance to *Verticillium albo-atrum* on the resistance to *Corynebacterium insidiosum* on the other side can be explained from the existance of specific (oligogenic) and general (polygenic) resistance of lucerne to the pathogens of vascular wilt. On the basis of the results obtained we can suppose that the resistance to bacterial wilt is, in the material studied, mainly due to specific resistance, while that to *Verticillium* wilt especially to general resistance. Increased resistance to *Verticillium* wilt associated with simultaneous resistance to bacterial wilt can be explained as follows: oligogenic resitance to *Corynebacterium insidiosum* raised the effect of polygenic resistance to *Verticillium albo-atrum.*

We can deduce the decisive meaning of specific resistance to bacterial wilt according to:

1. less expressed manifestation of resistance and susceptibility, progenies,

2. higher resistance of progenies also in such cases when the mother plant was susceptible to *Verticillium* wilt.

We arrived at the conclusion that the resistance to *Verticillium* wilt is secured especially by general nonspecific resistance as result of:

1. less expressed manifestation of resistance and susceptibility,

2. a lower degŕee of resistance heritability than in bacterial wilt,

3. dependence of a higher resistance degree on the resistance of the mother plant not only to *Verticillium*, but also to bacterial wilt,

4. dependence of resistance variability on external conditions (K ů d e l a, Ř e z á č, 1972; K ů d e l a, 1975).

The idea that lucerne shows specific and general resistance as far as the pathogens of vascular wilt are concerned would be confirmed by studies of individual genes of resistance. The resistance of lucerne to *Corynebacterium indiosum* is, according to W i l s o n (1947), conditioned by four genes with different actions. B a r n e s et al. (1971) quote that in one source the resistance was controlled by some major genes, meanwhile in the second source by a set of minor genes. A paper by P a n t o n (1967) shows that the resistance to *Verticillium* wilt is influenced by polygenes with a multiplicative rather than additive action.

One of the mechanisms conditioning general resistance of lucerne to both pathogens of vascular wilt could be the anatomic structure of tissues. A lower number of vascular bundles, shorter vessel elements and thicker cortex of the root, which is characteristic for plants resistant to bacterial wilt (C h o et al., 1973), could be important in the retarded spreading of both bacterial and *Verticillium* wilt in the plant.

Formation of pectinogels in the vessels, which inhibit the spread of pathogens in the plant, is obviously conditioned in both pathogens by the same mechanism. It has to be proved whether the mechanism of increased resistance to *Verticillium albo-atrum* in plants which are at the same time also resistant to *Corynebacterium insidiosum* does not lie in the fact that specific resistance to bacterial wilt gives to the plants the capability of mobilizing much sooner and more effectively after the pathogenic penetration of these common defence mechanisms than in the plants which are resistant only to *Verticillium* wilt (predominantly nonspecific).

One of the factors of specific resistance could be physiological and biochemical properties of tissues and especially changes in biochemical processes which arise after the contact of the plant with pathogen. That is why papers about the antibiotic effect of an extract from plants resistant to *Corynebacterium insidiosum* are of interest (H a w n, L e B e a u, 1962; C h o et al., 1973). It is probable that specific resistance to *Verticillium* wilt is conditioned by the formation of phytoalexins as been proved for instance, in *Verticillium* of cotton (B e l l, P r e s l e y, 1969).

The finding concerning higher resistance to *Verticillium* wilt in plants resistant to bacterial wilt is important for practical breeding for resistance. It is possible to suppose that the plant material distinguished by high resistance to both pathogens is accumulated both specific and general resistance. The testing of breeding material for resistance to *Corynebacterium* and *Verticillium albo-atrum* could be of importance also in regions free from bacterial wilt because this would speed up the selection of plants with higher resistance to *Verticillium* wilt.

References

BARNES, D. K. – HANSON, C. H. – FROSHEISER, F. I. – ELLING, L. J.: Recurrent selection for bacterial wilt resistance in alfalfa. Crop Sci., *11*, 1971 : 545-546.

BELL, A. A. – PRESLEY, J. T.: Temperature effects upon resistance and phytoalexin synthesis in cotton inoculated with *Verticillium albo-atrum*. Phytopathology, *59*, 1969 : 1141-1146.

HAWN, E. J. — Le BEAU, J. B.: Antibiotics in bacterial wilt of alfalfa. Phytopathology, *52*, 1962 : 266-268.
CHO, Y. S. — WILCOXON, R. D. — FROSHEISER, F. I.: Differences in anatomy, plant extracts, and movement of bacteria in plants of bacterial resistant and susceptible varieties of alfalfa. Phytopathology, *63*, 1973 : 760-765.
KŮDELA, V.: Způsob hodnocení odolnosti odrůd vojtěšky vůči cévnímu vadnutí. (A Way to Evaluate the Resistance of Lucerne Varieties to Vascular Wilt.) Rostl. Výroba, *16*, 1970 : 1041-1050.
KŮDELA, V.: Reaction of lucerne to *Verticillium albo-atrum* at different photoperiod lengths. Sbor. ÚVTI - Ochr. rostl., *11*, 1975 : 275-282.
KŮDELA, V. — MALÍK, O.: Vzájemný vztah mezi odolností vojtěšky k bakteriálnímu a verticiliovému vadnutí. (The Relations between Bacterial and *Verticillium* Wilt Resistance in Lucerne.) Sbor. ÚVTI - Ochr. rostl., *10*, 1974 : 11-18.
KŮDELA, V. — ŘEZÁČ, A.: Testování evropských odrůd vojtěšky na odolnost proti bakteriálnímu a verticiliovému vadnutí. (Testing the European Lucerne Varieties for Resistance to Bacterial and *Verticillium* Wilt.) Sbor. ÚVTI - Ochr. rostl., *8*, 1972 : 271-279.
PANTON, CH. A.: The breeding of lucerne, *Medicago sativa* L., for resistance to *Verticillium albo-atrum* Rke et Berth. II. The quantitative nature of genetic mechanism controlling resistance in inbred and hybrid generations. Acta Agric. Scand., *17*, 1967 : 43-57.
WILSON, M. C.: Inheritance of resistance in alfalfa to bacterial wilt. J. Amer. Soc. Agron., *39*, 1947 : 570-583.

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Generativní potomstva klonů o známém stupni odolnosti byla testována na rezistenci k dvěma patogenům cévního vadnutí. Byla potvrzena volná kombinovatelnost odolnosti k oběma patogenům s výjimkou jisté závislosti odolnosti k *Verticillium albo-atrum* na odolnosti ke *Corynebacterium insidiosum*. Je možné vytypovat potomstva odolná k verticiliovému vadnutí a náchylná k bakteriálnímu vadnutí, ale odolnost k *Verticillium albo-atrum* se zvyšuje při současné odolnosti ke *Corynebacterium insidiosum.*

vojtěška; rezistence; kombinovatelnost rezistence; *Verticillium albo-atrum; Corynebacterium insidiosum*

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Наследственные потомства клонов с известным процентом устойчивости тестировались на устойчивость к двум патогенам сосудистого увядания. Подтвердилась способность к свободной комбинацинной устойчивости к обоим патогенам, исключая некоторую зависимость устойчивости к *Verticillium albo-atrum* на устойчивость к *Corynebacterium insidiosum.* Можно отобрать потомства, которые устойчивы к вертициллезному вилту и предрасположенных к бактериальному вилту, но их устойчивость к *Verticillium albo-atrum* возрастает при одновременной устойчивости к *Corynebacterium insidiosum.*

люцерна; устойчивость; способность к комбинационной устойчивости; *Vericillium albo-atrum; Corynebacterium insidiosum*

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IMMUNITY TO THE POTATO Y VIRUS AND ITS UTILIZATION FOR BREEDING PURPOSES

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ZADINA, J. (Research Institute of Potato Growing, Havlíčkův Brod): *Immunity to the Potato Y Virus and its Utilization for Breeding Purposes.* Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 45-52.

In this paper the author presents the results obtained in an investigation of the immunity of potatoes to the Y virus in the sector of the genetics of immunity, and the possibilities of its utilization in the breeding of potatoes for resistance to this virus. For this purpose the Bison and Fanal varieties that are immune to the Y virus and which were crossed with a number of varieties of *S. tuberosum*, and material originating from *S. stoloniferum* were used. Immunity to the Y virus was tested in the seed generation and in the vegetative generations. The immunity is estimated on the basis of the results obtained in provocation tests of resistance, based on infection by means of carborundum (mechanical infection) and on the grafting of plants, and on a diagnosis of the state of health of the infected material by means of biological tests (indicator plant TE1). It was found that in the Bison and Fanal varieties immunity to the Y virus is caused by the gene R_y, which occurs in them in a simplex composition. In the progeny from a combination of the crossing of these varieties with varieties that are susceptible to the Y virus, hybrids that are immune to the Y virus and susceptible to the Y virus occur in the ratio of 1 : 1 ($x^2 < 3.841$). In the material deriving its origin from *S. stoloniferum* the segregation ratios mostly did not correspond to the ratio 1 : 1. The reason is a considerable waste of the tested material because of a strong occurrence of the Y virus in the field. The Y virus eliminated hybrids that were susceptible to the Y virus and thus relatively increased the proportion of hybrids that were immune to the Y virus and disturbed the expected segregation ratio. However, the results obtained do not refute the finding regarding the dependence of the immunity on the dominant gene R_y. From the point of view of immunity as such breeding of potatoes for immunity to the Y virus does not cause any serious problems and it can be performed in the widest possible extent.

potatoes; resistance to viruses; potato Y virus

Under the conditions of the CSSR the Y virus is one of the most serious viruses of potatoes. It is spread especially in warmer regions, in regions at a lower altitude, in the so-called degeneration areas. However, in the "mosaic years" it occurs to a considerable extent also at higher altitudes and its occurrence predominates over that of leaf roll, in the "leaf roll years" the opposite is the case. This phenomenon is connected with the occurrence of some species of aphids. The "mosaic years" result from the spreading of the aphid *Aphis nasturii* Kalt, and the "leaf roll years" follow the spreading of the aphid *Myzus persicae* Sulz. (R a s o c h a, 1966).

The most suitable method of control of the Y virus is breeding for resistance; breeding of potatoes for immunity to the Y virus is of greatest importance.

The purpose of the submitted report is a description of the results obtained in the search for immunity of potatoes to the Y virus; both in the sector of the genetics of resistance and in the field of the possibility of its utilization in potato breeding.

The investigation of the problems mentioned was based on the present knowledge regarding the genetics of the immunity of potatoes to the Y virus. This immunity is determined, as stated by Ross (1958, 1961, 1970), by the dominant gene R_y, inherited tetrasomically and effective already in a simplex composition. Its source is *S. stoloniferum*. The gene R_y secures immunity both to the current strain Y^o and also to the later strain Y^N.

MATERIAL AND METHOD

In the investigation of the problems of the genetics of the immunity to the Y virus and its utilization in breeding the following material was used:

the Bison and Fanal varieties, which are immune to the Y virus and which had been crossed with a number of varieties of *S. tuberosum*, and

material (seeds) originating from *S. stoloniferum*, obtained from the Max-Planck-Institute für Züchtungsforschung in Köln-Vogelsang in the GFR from prof. Ross.

With the material of the first group immunity to the Y virus was investigated, on the one hand in the seed generation, and on the other hand in the vegetative generation, with the material of the second group only in the vegetative generations.

For the inoculation of the material tested with the Y virus we applied mechanical infection by means of carborundum powder (twice repeated), and by grafting the plants (the method of ablactation, Zadina, 1975). In the latter case a tomato previously infected with the Y virus was grafted on to the tested material.

For the inoculation both strain Y^o and strain Y^N were used. The strain Y^o had been propagated on tobacco *Nicotiana tabacum* var. Samsun, and the strain Y^N on *Nicotiana silvestris.*

Diagnosis of the Y virus was carried out by means of a biological test on TE_1 (Zadina, 1974).

Crossing for the determination of the transferring of the immunity to the progeny was performed on cut stems (Zadina, 1968).

On the basis of the experience gained the Fanal and Bison varieties were used in the crossing as maternal parents. In the case of their use as paternal parents it was not possible to obtain berries because of their sterile pollen (Zadina, 1976).

RESULTS

THE BISON AND FANAL VARIETIES, THE GENETIC BASIS OF THEIR IMMUNITY TO THE Y VIRUS AND THE POSSIBILITIES OF ITS UTILIZATION

Data on the material deriving its origin from the Bison and Fanal varieties and tested for immunity to the Y virus are shown in Table I. Testing of immunity to the Y virus, as can be seen from this table, began in the offspring of two combinations of crossing in the seed generation and in the offspring of five combinations of crossing only in the vegetative generations. Immunity tests were performed in the years 1971–1975. In all the offspring tested there is a proportion of hybrids immune and of hybrids susceptible to the Y virus, with the exception of the combination 72.40 (Bison × Pana), close to the ratio 1 : 1. The calculated results of the χ^2-test confirm the fact that assumed segregation ratio corresponds to the theoretical ratio. This means that the results obtained

- confirm the genetic basis of the immunity of potatoes to the Y virus by the dominant gene Ry (Ross, 1961, 1970; et al.) mentioned in the literature, and the fact that
- the gene Ry causing immunity to the Y virus occurs in the Bison and Fanal varieties in a simplex composition (Ryryryry).

I. Segregation ratios in the material tested for immunity to the Y virus

Combination of crossing		Hybrids tested	Ascertained hybrids		Assumed ratio	Theoretical number of hybrids		X^2
marking	parental varieties		resistant	susceptible		resistant	susceptible	
a) material tested in the seed generation								
72.44a	Bison × Schwalbe	382	201	181	1 : 1	191.0	191.0	1.046
72.45a	Fanal × Schwalbe	371	178	193	1 : 1	185.5	185.5	0.606
b) material tested in the vegetative generations								
71.47	Bison × Pana	46	23	23	1 : 1	23.0	23.0	0.000
72.40	Bison × Pana	149	89	60	1 : 1	74.5	74.5	5.644
72.44b	Bison × Schwalbe	197	103	91	1 : 1	97.0	97.0	0.742
72.45b	Fanal × Schwalbe	177	98	79	1 : 1	88.5	88.5	2.038
72.46	Bison × S 70.135/304	65	38	27	1 : 1	32.5	32.5	1.860

Critical value X^2 — test for P 0.05 = 3.84

From a comparison of the proportion of offspring immune and susceptible to the *Y* virus in the material tested for resistance in the vegetative generations it can be seen that, practically in all combinations, there occurs a predominance of immune hybrids. The cause is the appearance of the potato *Y* virus in hybrids susceptible to *Y* virus and their removal at roguing in the field. (Equal incidence of the leaf roll virus both in hybrids susceptible to *Y* virus and resistant ones is assumed.) This is also the reason why, in the combination 72.40 – Bison × Pana, the calculated χ^2-test does not confirm any agreement between the ascertained and the theoretical segregation ratio.

MATERIAL DERIVING ITS ORIGIN FROM *S. STOLONIFERUM* AND ITS IMMUNITY TO THE Y VIRUS

The detailed origin of the material deriving its origin from *S. stoloniferum* is contained in Table II.

Data on the number of hybrids immune to the *Y* virus and susceptible to the *Y* virus are presented in Table III. They are the results obtained in provocation tests of their resistance to the *Y* virus carried out in the years 1972–1975. Among hybrids, both immune and susceptible, only hybrids tested for resistance for at least 2 years, but no hybrids that had been tested for only one year are included (regardless of whether they showed a positive or negative reaction). No more hybrids could be tested because, in the course of the years in which the provocation tests of resistance were performed, they had been eliminated by roguing due to having been attacked by viruses (by the *Y* virus or by the leaf roll virus) in the field. The considerable elimination of hybrids in the various combinations of crossing is shown by the data contained in Table IV. In the year 1971,

II. Origin of the material obtained from *S. stoloniferum*

Marking of sowing	Origin of material
71.56	57.1775/110 (= *S. acaule, S. stoloniferum, S. demissum, S. tuberosum*) × × Rheinhort
71.57	57.1775/110 (= *S. acaule, S. stoloniferum, S. demissum, S. tuberosum*) × × Antje
71.58	59.703/135 (= *S. acaule, S. stoloniferum, S. demissum, S. tuberousm*) × × Clivia
71.59	55.957/35 (= *S. acaule, S. stoloniferum, S. demissum, S. tuberosum*) × × Avenir

Note: The hybrids 57.1775/110, 59.703/135 and 55.957/35 are immune to the viruses *Y*, X, and *A*

III. The segregation ratios in the material deriving its origin from *S. stoloniferum* tested for immunity to the Y virus

Combination of crossing		Hybrids tested	Ascertained hybrids		Assumed segregation ratio	Theoretical number of hybrids		X^2
marking	parental varieties		resistant	susceptible		resistant	susceptible	
71.56	57.1775/110 × Rheinhort	156	96	60	1 : 1	78.0	78.0	8.306
71.57	57.1775/110 × Antje	39	28	11	1 : 1	19.5	19.5	7.410
71.58	59.703/135 × Clivia	12	10	2	1 : 1	6.0	6.0	5.332
71.59	55.957/35 × Avenir	59	33	26	1 : 1	29.5	29.5	0.830

Note: Critical value of X^2 — test for P 0.05 = 3.841

IV. Survey of the extent of the material deriving its origin from *S. stoloniferum* grown in the years 1971—75

Combination of crossing		Number of hybrids grown in				
marking	parental varieties	1971	1972	1973	1974	1975
71.56	57.1775/110 × Rheinhort	328	300	195	158	149
71.57	57.1775/110 × Antje	221	168	58	38	33
71.58	59.703/135 × Clivia	106	94	25	16	16
71.59	55.957/35 × Avenir	624	563	136	67	44
Total		1279	1125	414	279	242

1279 seedlings were obtained, of which 1125 hybrids were planted in the first vegetative generation in the field. In the course of the years 1972–1974, 883 hybrids were eliminated that had been attacked by virus diseases (by the mosaic virus and by the virus of leaf roll), i. e. 78.5 p. c. of the hybrids planted in the first vegetative generation. Out of these 151 hybrids were eliminated (50.3 p. c.) in the combination 71.56, in the combination 71.57 135 hybrids (80.3 p. c.), in the combination 71.85 78 hybrids (82.9 p. c.), and in the combination 71.59 519 hybrids (92.2 p. c.). The reaction to infection with the Y virus could be evaluated only in 266 hybrids, i. e. in 23.6 p. c. of the hybrids planted in the first tuber generation. The situation mentioned doubtlessly influenced the occurrence of hybrids immune to the Y virus and of hybrids suceptible to the Y virus and the segregation ratios ascertained in the different crossing combinations. Assuming an equal attack by the virus of leaf roll, hybrids susceptible to the Y virus were eliminated for being attacked by the Y virus. In this case more hybrids immune to the Y virus than susceptible to the Y virus were obtained, and from this point of view it is necessary to evaluate the results obtained, and even though the data obtained experimentally do not correspond to the expected data ($\chi^2 > 3.841$), it is not possible, for the above-mentioned reason, to refute the segregation ratio of 1 : 1 and the finding regarding the dependencea of the immunity to the Y virus on the gene Ry.

DISCUSSION

The results obtained in the investigation of the immunity of potatoes to the Y virus confirm the findings given by Ross (1961, 1970) regarding the controlling of the immunity of potatoes against the Y virus by the dominant gene Ry transferred tetrasomically and effective even in its simplex composition. The gaining of the Bison and Fanal varieties has to a considerable extent facilitated the work of potato breeders engaged in the breeding of potatoes for immunity to the Y virus, because as initial breeding stock they can use both varieties which already show comparatively good commercial properties. This avoids the complicated and protracted work connected with the direct utilization of *S. stoloniferum*, the source of immunity to the Y virus and the carrier of the gene Ry, which transfers a number of undesirable properties to the progeny and frequently also difficulties at crossing. Both mentioned varieties contain the gene Ry in a simplex composition (Ryryryry), i. e. the progeny resulting from the crossing of these varieties with susceptible varieties consists of 50 p. c. of hybrids with immunity to the Y virus. However, for the obtaining of sufficient number of seeds it is necessary to use these varieties as maternal parents. In the opposite case it is not possible to obtain seeds, as their pollen is sterile (Zadina, 1976). The actual procedures employed at the determination of the immunity of the breeding material to the Y virus are comparatively simple. At the first selection method used in the provocation tests of their resistance it is possible to apply mechanical infection with the use of carborundum powder. This method has proved very effective and its inclusion in the system of tests in the determination of the immunity to the Y virus is very important as it decreases the need for further selection methods (grafting of tubers and plants), which are more exigent as regards work, and above all because it limits the numerical quantity of susceptible material (Zadina, 1975). A very suitable indicator plant for the diagnosis of the Y virus in provocation tests is TE_1. It ensures high reliability of the serial tests performed on the material used in the provocation tests of resistance, it is not very exigent as regards work or the conditions of the environment in which the tests are performed nor as regards the experience of the workers performing the tests. Its reaction to the *Y* virus is specific. It shows a positive necrotic reaction to infection with *Y* virus, and it reacts with no symptoms to the viruses *X*, *S*, *M*, and *A*. For the diagnosis leaves of various age, with the exception of very old leaves (yellowing), can be used. The leaves do not rot. It is not very sensitive to temperatures after the establishment of the tests either; the temperature can range from 18 to 25 °C. For a precise diagnosis leaves of the tested material must be used. Tests carried out with sprouts are less accurate (Zadina, 1974). From the point of view of breeding the finding that gene Ry, the source of which is *S. stoloniferum*, controls immunity both to the strain Y^O and to the strain Y^N is of great importance.

References

RASOCHA, V.: Mšice a šíření virových chorob brambor v sadbových oblastech. (Aphids and the Spreading of Virus Diseases of Potatoes in the Seed Production Regions.) In: Vědecké práce Výzk. úst. bramborářského, Havlíčkův Brod, 1966 : 101-116.

ROSS, H.: Resistenzzüchtung gegen die Mosaik- und andere Viren der Kartoffel. In: Rudorf W.: Kartoffel. Handbuch der Pflanzenzüchtung. Berlin und Hamburg 1958.

ROSS, H.: Über die Vererbung von Eigenschaften für Resistenz gegen das Y- und A-virus in *Solanum stoloniferum* und die mögliche Bedeutung für eine allgemeine Genetik der Virusresistenz in *Solanum Sect. Tuberarium.* In.: Proc. 4th Conf. Potato Virus Dis., Braunschweig, 1960, 1961.

ROSS, H.: Kartoffeln (*Solanum tuberosum* L.). In: Hoffman, Mudra, Plarre: Lehrbuch der Züchtung landwirtschaftlicher Kulturpflanzen, B. 2, Berlin and Hamburg 1970.

ZADINA, J.: Křížení brambor na odříznutých stoncích bramborových rostlin. (Crossing of potatoes on cut off stems of potato plants.) Sbor. ÚVTI - Genet. a šlecht., *4,* 1968 : 105-108.

ZADINA, J.: Roubování rostlin ablaktací jako metoda zjišťování rezistence proti vi-indicator plant for the diagnosis of the Y virus of potatoes.) Sbor. ÚVTI - Ochr. rostl., *10,* 1974 : 257-263.

ZADINA, J.: Roubování rostlin ablaktací jako metóda zjišťování rezistence proti virům. (Grafting of plants by means of ablactation as a method for the determination of the resistance to viruses.) Sbor. ÚVTI - Ochr. rostl., *11,* 1975 : 21-26.

ZADINA, J.: Metodika pro šlechtění brambor na rezistenci proti viru Y na bázi imunity. (A method for the breeding of potatoes for resistance to the Y virus on the basis of immunity.) Výzk. ústav bramborářský, Havlíčkův Brod, 1975.

ZADINA, J.: Imunita proti viru *A* a možnosti jejího šlechtitelského využití. (Immunity to the *A* virus and the possibilities of its utilization in breeding.) Sbor. ÚVTIZ - Genet. a Šlecht., *12,* 1976 : 251-257.

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ZADINA, J. (Výzkumný ústav bramborářský, Havlíčkův Brod): *Imunita proti Y viru brambor a její šlechtitelské využití.* Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 45-52.

V práci jsou uvedeny výsledky, které byly dosaženy při řešení imunity brambor k viru Y, a to jednak na úseku genetiky, a jednak na úseku možnosti jejího využití ve šlechtění brambor na rezistenci proti tomuto viru. K tomuto účelu byly využity jednak odrůdy 'Bison' a 'Fanal' imunní proti viru Y, které byly nakříženy s řadou odrůd *S. tuberosum,* jednak materiál odvozující svůj původ od *S. stoloniferum* a jiných druhů brambor. Imunita k viru Y byla zjišťována jednak v semenné generaci, jednak ve vegetativních generacích. Na imunitu je usuzováno z výsledků provokačních zkoušek rezistence, spočívajících v infekci pomocí karborunda (mechanická in-

fekce) a roubováním rostlin a v diagnóze zdravotního stavu infikovaného materiálu pomocí biologických testů (indikátorová rostlina TE1). Bylo zjištěno, že imunita k viru Y u odrůdy 'Bison' a 'Fanal' je podmíněna genem R_y, který se u nich vyskytuje v simplexní sestavě. V potomstvech z kombinací křížení těchto odrůd s odrůdami k viru Y náchylnými se kříženci imunní k viru Y a náchylní k viru Y vyskytují v poměru 1 : 1 ($x^2 < 3{,}841$). V materiálu odvozujícím svůj původ od *S. stoloniferum* a dalších druhů brambor neodpovídaly většinou štěpné poměry zcela poměru 1:1. Příčinou je značný odpad vedeného materiálu pro silný výskyt viru v poli. Virus Y vyřadil křížence k viru Y náchylné, a tím se relativně zvýšilo zastoupení kříženců k viru Y imunních a narušil se očekávaný štěpný poměr. Dosažené výsledky však nevyvracejí zjištění o podmíněnosti imunity dominantním genem R_y. Šlechtění brambor imunních k viru Y nepředstavuje žádné problémy a lze ho uskutečnit v co nejširším měřítku.

brambory; rezistence vůči viru; virus Y brambor

ЗАДИНА, Я. (Научно-исследовательский институт картофелеводства, Гавличкув Брод): **Иммунитет картофеля к вирусу Y и его селекционное использование.** Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 45-52.

В работе отмечены результаты, достигнутые при исследовании иммунитета картофея к вирусу Y, а именно в области генетики и в области его использования при селекции картофеля на устойчивость к этому вирусу. Для этой цели использовались сорта 'Бизон' и 'Фанал', иммунные к вирусу Y, которые скрещивались с рядом сортов *S. tuberosum* и с материалом, ведущим свое начало от *S. stoloniferum* и других видов картофеля. Иммунитет к вирусу Y определялся как в семенной генерации, так в вегетативных генерациях. Иммунитет устанавливался на результатах провокационных испытаний устойчивости, заключающихся в инфекции при помощи карборунда (механическая инфекция) и прививке растений и в диагнозе состояния здоровья инфицированного материала при помощи биологических тестов (индикаторное растение TE1). Было установлено, что иммунитет к вирусу Y у сорта 'Бизон' и 'Фанал' обуславливается геном R_y, который находится в их симплексной комбинации. В потомствах из комбинаций скрещивания этих сортов со сортами, предрасположенными к вирусу Y, помеси иммунные и предрасположенные к вирусу Y, находятся в отношении 1 : 1 ($x^2 < 3{,}841$). В материале с началом от *S. stoloniferum* и других видов картофеля чаще отношения расщепления не соответвовали отношению 1 : 1. Причина заключается в больших отходах используемого материала из-за большого наличия вируса в поле. Вирус Y устранил помеси, предрасположенные к вирусу Y, причем относительно повысилось наличие помесей, иммунных к вирусу Y, что нарушило ожидаемое отношение расщепления. Полученные результаты, однако, не опровергают определение обусловленности иммунитета доминантным геном R_y. Селекция иммунного картофеля к вирусу Y не представляет никаких проблем и ее можно осуществить в самом широком масштабе.

картофель; устойчивость к вирусу; вирус картофеля

ZADINA, J. (Forschungsinstitut für Kartoffelanbau, Havlíčkův Brod): *Immunität gegen Virus* Y *der Kartoffeln und ihre züchterische Nutzung.* Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 45-52.

In der Arbeit sind Ergebnisse angeführt, die bei der Lösung der Kartoffelimmunität gegen Virus Y, einmal auf dem Gebiet der Genetik, einmal auf dem Gebiet der Möglichkeit ihrer Nutzung in der Resistenzzüchtung von Kartoffeln gegen dieses Virus erzielt wurden. Zu diesem Zweck wurden einmal die gegen Virus Y immune Sorten 'Bison' und 'Fanal', die mit einer Reihe von Sorten *S. tuberosum* gekreuzt wurden, einmal das, von den *S. stoloniferum* und anderen Kartoffelsorten abstammende Material verwendet. Immunität gegen Virus Y wurde einmal in der Samengeneration, einmal in vegetativen Generationen festgestellt. Auf Immunität wird von Ergebnissen der, aus Infektion mittels Karborundum (mechanische Infektion) und durch Propfen der Pflanzen und aus Diagnose des Gesundheitszustands des infizierten Materials mit Hilfe biologischer Teste (Indikatorpflanze TE1) bestehenden Provokations--Resistenzprüfungen geschlossen. Es wurde festgestellt, daß bei den Sorten 'Bison' und 'Fanal' die Immunität gegen Virus Y durch das Gen R_y, das bei ihnen in einer Simplexzusammensetzung vorkommt, bedingt ist. In Nachkommenschaften aus Kombinationen von Kreuzungen dieser Sorten mit den zu Virus Y anfälligen Sorten kommen immune und zu Virus Y anfällige Kreuzlinge im Verhältnis von 1 : 1 ($\chi^2 < 3,841$) vor. In dem, seine Abstammung von *S. stoloniferum* und anderen Kartoffelsorten ableitenden Material waren die Spaltverhältnisse zumeist nicht ganz dem Verhältnis 1 : 1 entsprechend. Die Ursache ist der wesentliche Abfall des geführten Materials infolge des starken Vorkommens des Virus im Feld. Virus Y schloß die zu Virus Y anfälligen Kreuzlinge aus, dadurch wurde relativ die Vertretung der gegen Virus Y immunen Kreuzlinge erhöht und das zu erwartende Spaltverhältnis gestört. Die erreichten Ergebnisse entkräften jedoch nicht die Feststellung über die Bedingtheit der Immunität durch das dominante Gen R_y. Die Züchtung von gegen Virus Y immunen Kartoffeln bereitet keine Probleme und kann im möglichst breitem Maße durchgeführt werden.

Kartoffeln; Resistenz gegen Virus; Virus Y der Kartoffeln

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INCREASING THE RESISTANCE OF BREEDING MATERIAL TO BEET YELLOWS VIRUS AND ITS UTILIZATION IN THE BREEDING PROCESS

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PETRÁK, Z. — ŘÍMSA, V. (Research Institute of Sugar Beet Growing, Semčice): *Increasing the Resistance of Breeding Material to Beet Yellows Virus and its Utilization in the Breeding Process.* Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 : (1) : 53-60.

Productive polygerm sugar beet breeding material obtained in the years 1965—1975 reached high values in major commercial properties when artificially infected in the period of 1974—1975. Tolerant progenies of this material maintain their constant technological value. Breeding material tolerant to beet yellows virus was obtained by means of the crossing of domestic material with a foreign variety, tolerant to BYV and by performance tests of progenies in the F_1 and F_3 generation. Polygerm tolerant material is in further breeding utilized as a component (pollinator) to pollen sterile monogerm lines.

sugar beet; beet yellows virus; breeding to tolerance

The increasing of biological efficiency by means of decreasing losses, root and sugar yield drop with a heavy infection rate of beet stands is at present considered to be one of the possibilities of efficient protection from virosis. According to McFarlane (1963, 1969) breeding can bring about a decrease in yield losses of more than 50 %. The decreasing of yield depends on the time of infection, growth phase of the plant, virulence of the strain (Bennet, McFarlane, 1967; Hull, 1968; Steudel, 1973; Polák, 1970 and others) and on the influencing of growth by means of decreasing photosynthesis (Hull, 1972).

According to Koch (1972) tolerant breeding material can be obtained by crossing lines of wild beet (Filutowitz, Pawelska-Kozinska, 1973) or through mass selection of tolerant plants from extensive breeding material. Gleij (1970) applied selection and inbreeding using the tolerant material in combination crossing with pollen sterile lines. Combination crossing with selection according to root yield, sugar yield and technological values is carried out in Czechoslovakia (Petrák, Smrž, 1971, 1974). When breeding for tolerance we must take into account all breeding criteria (Chod, 1968; Chod et al., 1972, 1973; Polák, Chod, 1974).

Tolerant sugar beet varieties grown under conditions of heavy BYV infection are superior to susceptible varieties, but under non-infectious conditions they do not reach their performance (Koch, 1972). In accordance with experience obtained breeding methods are aimed at getting tolerant material, because immunity to BYV is difficult to obtain while maintaining commercial properties. According to McFarlane et al. (1969) in the U. S. A. monogerm hybrid sugar beet varieties were bred by means of crossing monogerm pollen sterile lines with polygerm pollinator that had been bred for resistance to beet yellows virus.

MATERIAL AND METHOD

Selected beet varieties were used as initial material. The breeding material which showed under natural infectious conditions in the field relatively slight infection with yellows in the period 1965—1968 was at the same time characterized by good growth. Tests with progeny of the selected beet varieties were performed in the following years in station trials under conditions of artificial infection with BYV.

The best progenies characterized by important morphological and technological properties were used in further breeding. The foreign variety Maris Vanguard, which is tolerant to virus beet yellows, and achieved good results in our trials, was included for the tests under infectious conditions which were carried out in 1968–69.

The arrangement of station trials under infectious conditions was carried out in accordance with standard current methods of sugar beet breeding. The standard variety for comparison with the root and sugar yield and technological value of all variants included in experimental blocks was Dobrovická A from the Czech assortment, which was highest-yielding in all years.

Infection with beet yellows virus (BYV) was performed at the stage of the fully developed first to second pair of true leaves with black bean aphids (*Aphis fabae* Scop.) by means of the transfer of cca 10 aphids on a piece of leaf from the infection source. Mother beets usually served as an infection source. 24 hours after infection with aphids the infected sugar beet stand was treated with a systemic insecticide.

The intensity of the infection symptoms was assessed twice during the growth period. The first assessment was always carried out 3 weeks after infection (determination of infection efficiency) and the second towards the end of August at the time of the culmination of external disease symptoms. At the same time the over-all health conditions and morphological traits of progeny were evaluated. At harvest time root yield, technological value and sugar yield of tested progenies and standard varieties were determined. After evaluating the performance of all progenies in comparison with the standard variety from the most efficient ones a new selection for further material reproduction was performed. Progenies which had the highest productivity in the tests in 1966–1968 were in the years 1969 and 1970 employed in crossing with a selection of the foreign variety Maris Vanguard. Progenies from this crossing were in the following years tested in performance tests. The best tolerant polygerm materials were used in 1974 as pollinators in crossing with two monogerm pollen sterile lines. The performance of these hybrids was verified in station tests by means of the same methods in the year 1975.

RESULTS

About 400 progeny were tested in the period 1970–1975 in field provocative tests for tolerance to beet yellows virus. Progeny from crossing in the year 1969, i. e. generation F_1-F_3, were tested in 1970, 1972 and 1974 and progeny of generation F_1-F_3 (from crossing in 1970) in the years 1971, 1973 and 1975. The results of tests and productivity of all progeny of individual years in relation to the standard variety are mentioned in Table I.

In 1970, progeny of the F_1 generation reached a root yield of 98.8 %, sugar content of 99.7 % and sugar yield of 98.8 % in comparison to the Dobrovická A variety. Selection of new material, i. e. progeny of the F_2 generation reached in the year 1972 a root yield of 98.4 %, sugar content of 99.5 % and sugar yield of 97.8 %. Progeny of the F_3 generation, tested in the year 1974, reached considerably better results in all major properties.

The breeding material reached, on an average, as related to the D. A standard variety, a root yield of 101.8 %, sugar content of 105.3 % and sugar yield of 105.7 %.

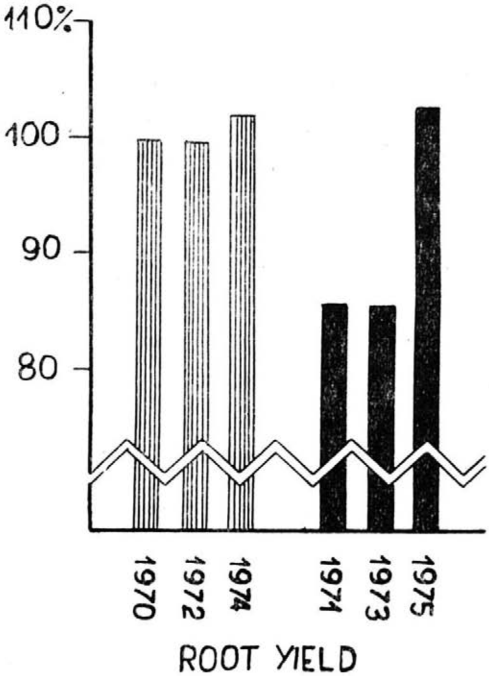
The F_1 generation from 1970 crossing and tested in 1971 produced a root yield of 85.3 %, sugar content was 101.6 % and sugar yield 87.4 %. The selection of new material from this progeny, i. e. progeny of the F_2 generation, gave approximately the same performance in the tests in 1973: root yield 86.4 %, increased sugar content (105.5 %) and

I. Summary of breeding material performance tested under conditions of artificial infection with beet virus yellows

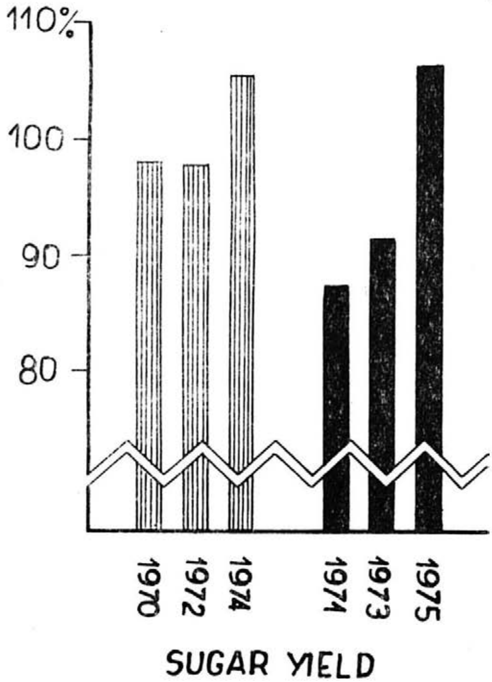
Year	Productivity of progenies compared to the standard (relative)														
	root yield					sugar content					sugar yield				
	$\bar{x}$	s	$s\bar{x}$	sd	HD 5 %	$\bar{x}$	s	$s\bar{x}$	sd	HD 5 %	$\bar{x}$	s	$s\bar{x}$	sd	HD 5 %
1970	98.8	29.9	6.0	8.5	17.4	99.7	4.3	0.9	1.2	2.5	98.8	41.6	8.3	11.8	24.2
1971	85.3	18.9	3.7	5.2	10.8	101.6	4.2	0.8	1.2	2.4	87.4	19.6	3.9	5.5	11.2
1972	98.4	16.7	2.8	4.0	8.1	99.5	4.1	0.7	1.0	2.0	97.8	17.6	3.0	4.2	8.6
1973	86.4	15.3	1.8	2.6	5.1	105.5	3.2	0.4	0.5	1.0	91.2	16.7	2.0	2.8	5.5
1974	101.8	16.6	2.1	2.9	5.8	105.3	3.9	0.4	0.6	1.2	105.7	17.5	2.0	2.8	5.5
1975	102.7	20.6	2.7	3.8	7.6	103.3	4.1	0.5	0.7	1.5	106.3	20.9	2.7	3.8	7.6

there was a slight improvement in productivity of the material to 91.2 % due to a good sugar content. New repeated selection from the most productive progeny brought about, in harmony with the preceding finding from 1974, a remarkable improvement of the productivity of the whole material. Progeny of the F_3 generation, tested in 1975, reached a root yield of 102.7 %, sugar content of 103.3 % and sugar yield of 106.3 % in relation to the Dobrovická A variety.

Significantly improved productivity of the polygerm tolerant material of the F_3 generation was proved equal in the last two test years when the breeding material, on an average, surpassed the standard Dobrovická A variety in all main commercial properties (Figs. 1 and 2).



1. Root yield of the F_1–F_3 generation progeny of the breeding material, tolerant to beet virus yellows



2. Sugar yield of the F_1–F_3 generation progeny of the breeding material, tolerant to beet virus yellows

Monogerm diploid fertile material tested in the period 1972–1974 under infectious conditions, and with the same methods did not reach the performance of polygerm tolerant material and in all commercial properties lagged behind considerably in productivity. During vegetation strong symptoms and heavy susceptibility to yellows were found, as compared with the diploid polygerm material. These progenies had an average root yield of 80.1 %, sugar content of this material was on a low level and amounted to 95.4 % and sugar content was considerably lower than in the standard variety – 79.6 %.

For experimental crossing of polygerm diploid tolerant material with CMS material 2 pollen sterile monogerm lines were used.

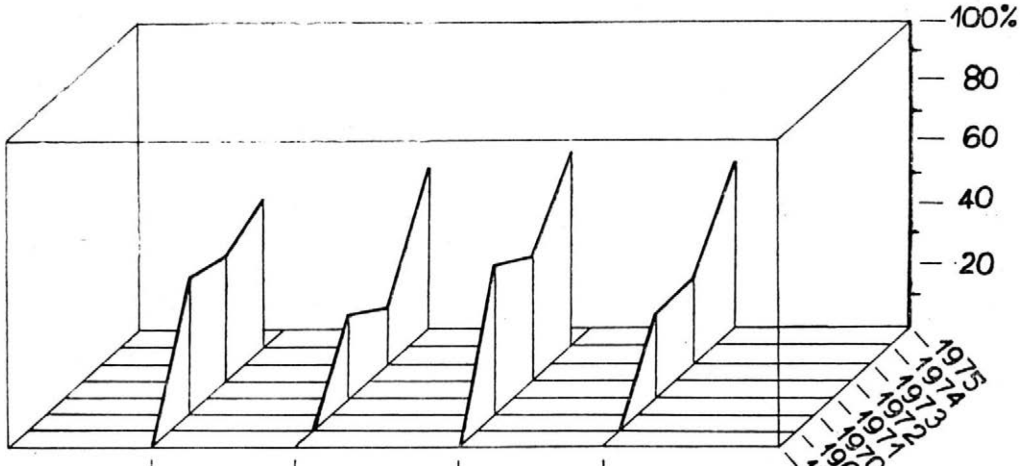
C o m b i n a t i o n s :

MS lines (2 × mm) × N (2 × MM)
Root yield 101.7 %, sugar content 99.3 %,
sugar yield 100.1 %
MS lines 2. (2 × mm) × N (2 × MM)
Root yield 93.3 %, sugar content 100.0 %
sugar yield 93.3 %

DISCUSSION

The advancing development of the productivity of tolerant breeding material is evident not only from the higher average root yield obtained, sugar content and sugar yield in all progeny of the F_3 generation in 1974–1975, but also from a maximally favourable shift towards productive progeny. During the assessment of material productivity in individual selection years according to the determined average values of root and sugar yield and technological value, at the same time with the incidence of progeny harmony with the two basic performance classes (with performance to 100 % and more) we can state that the breeding material has, since the beginning, enforced its good technological quality. The mentioned finding is in harmony with our recent statements (P e t r á k, S m r ž, 1971 and S m r ž, P e t r á k, 1974). The tolerant material has a higher sugar content and even under the conditions of heavy artificial infection contains a high percentage of polarizing sugar. This property has recently been of great importance, because the sugar content generally decreases (K e c et al., 1968).

Progenies of the F_3 generation tested in the years 1974 and 1975 (see Fig. 3) are in this period equal in average root yield or they surpass the standard variety. In the year 1974 47.5 % and in the year 1975



3. Frequence of the F_1–F_3 generation progeny of the breeding material, tolerant to beet virus yellows, in root and sugar yield

51.7 % of progenies were superior to the yield of Dobrovická A. In the sugar content 3/4 of all progenies, i. e. 78.7 % in 1974 and 73.3 % of progenies in the year 1975 are superior to the Dobrovická A variety. Due to the improved root yield and better technological value 62.5 % of progenies in the year 1974 and 53.3 % of progenies in 1975 were more productive than the standard Dobrovická A variety.

At a constant good technological value of this material the root yield is most important because the sugar yield is a decisive factor influencing the productivity of the material. From summarised results from Tab. II

II. Effect of selection upon the incidence of breeding material in the productivity increasing under the conditions of artificial infection with beet virus yellows

Year	Incidence of progenies (standard = 100 %)					
	in root yield		in sugar content		in sugar yield	
	to 100 %	more than 100 %	to 100 %	more than 100 %	to 100 %	more than 100 %
1970	56.0	44.0	56.0	44.0	52.0	48.0
1971	80.8	19.2	34.6	65.4	73.1	26.9
1972	60.0	40.0	57.1	42.9	60.0	40.0
1973	81.9	18.1	5.6	94.4	73.6	26.4
1974	52.5	47.5	21.3	78.7	37.5	62.5
1975	48.3	51.7	26.7	73.3	46.7	53.3

and Fig. 3 it is evident that the selection of tolerant breeding material brought about a certain improvement in breeding for a higher root yield. Most of the progenies of the F_3 generation were superior, in the sugar yield in the tests in 1974–1975, to the standard Dobrovická A variety, newly because of the improved root yield. Following high quantitave and qualitative values of tolerant material showed a demonstrable improvement in material productivity. This is in correspondence with the views of Rietberg (1956), Hull (1960), Russel (1960, 1965, 1972) and others, because varieties bred for resistance must be characterized by these good properties.

A part of breeding activities was successfully finished by obtaining productive breeding material tolerant to virus beet yellows, whose properties will be continually improved in further years. The polygerm tolerant material will, in further work, be used as a component (2 × pollinator) to monogerm (2×) pollen sterile lines in the production of the monogerm hybrid, because the productivity of fertile monogerm material is under infectious conditions considerably lower than that of monogerm hybrids on the basis of CMS.

References

BENNET, C. W. – Mc FARLANE, J. S.: Damage produced by beet yellows and beet western yellows under greenhouse and field conditions. J. Amer. Soc. Sugar Beet Technol., *14*, 1967 : 619-636.

GLEIJ, G.: Breeding for tolerance to virus yellows in sugar beet. I. I. R. B., *4,* 1970 : 225-236.

FILUTOWICZ, A. — PAWELSKA-KOZIŇSKA, K.: Mieszance buraka cukrowego z gatunkami *Beta maritima* L. i *Beta trigyna* Wald. et Kit. i mozliwosci ich wykorzystania w hodowli na tolerancje przeciwko zoltasze wirusowej buraka Beta Virus 4 Smith. Hod. Roslin Aklim., Nas., *17,* 1973 : 177-189.

HULL, R.: The selection of sugar beet varieties for tolerance to virus yellows. Publ. I. I. R. B., 24th Winter Meeting., 1960 : 407.

HULL, R.: The effect of infection with beet yellows virus on the growth of sugar beet. J. Amer. Soc. Sugar Beet Technol., *15,* 1968 : 192-199.

HULL, A. E.: Photosynthesis and respiration by healthy and beet yellows virus infected sugar beet *(Beta vulgaris* L.). Crop. Sci., *12,* 1972 : 566-572.

CHOD, J.: Současný stav poznatků o viru žloutenky řepy se zřetelem na možnost vyšlechtění odrůd tolerantních k tomuto viru. (The present state of knowledge about the yellows virus of sugar beet considering a possibility of breeding varieties tolerant to this virus.) Stud. inform. ÚVTI, ř. Ochr. rostl. 1968, No. 8.

CHOD, J. — POLÁK, J. — SMRŽ, J. — PETRÁK, Z.: Ověřování a spolehlivost sérologické metody zjišťování viru žloutenky řepy v kořenech cukrovky. (Proof and reliability of a serologic method of determination of beet yellows virus in sugar beet roots.) Listy cukrovarnické, *88,* 1972 : 29-31.

CHOD, J. — POLÁK, J. — SMRŽ, J. — PETRÁK, Z.: Srovnání titrů virů žloutenky řepy sérologickou metodou v kořenech a listech cukrové řepy. (The Use of the Serological Method for the Comparison of the Beet Yellows Virus Titres in the Roots and Leaves of Sugar Beet.) Sbor. ÚVTI - Ochr. rostl., *9,* 1973 : 23-26.

KEC, V. — ŠMATLÁK, V. — SCHMIDT, L.: Příčiny klesající cukernatosti řepy v ČSSR. (Causes of decreasing sugar content in Czechoslovak sugar beet.) Listy cukrovarnické, *84,* 1968 : 241-245.

KOCH, F.: Zielsetzungen und Ergebnisse der Züchtung von Zuckerrüben auf Resistenz gegen *Cercospora beticola* und Toleranz gegen Vergilbungsviren. Z. PflKrankh., *5,* 1972 : 291-307.

Mc FARLANE, J. S. — BENNETT, C. W.: Occurrence of yellows resistance in the sugar beet with an appraisal of the opportunities for developing resistant varieties. J. Amer. Soc. Sugar Beet Technol., *12,* 1963 : 503-514.

Mc FARLANE, J. S. — SKOYEN, I. O. — LEWELLEN, R. T.: Development of sugarbeet breeding lines and varieties resistant to yellows. J. Amer. Soc. Sugar Beet Technol., *15,* 1969 : 347-360.

PETRÁK, Z. — SMRŽ, J.: Produktivnost šlechtitelského materiálu cukrovky v souvislosti s odolností proti virové žloutence. (Productivity of selected sugarbeet in relation to resistance to virus beet yellows.) Listy cukrovarnické, *87,* 1971 : 219-222.

PETRÁK, Z. — SMRŽ, J.: Účinnost selekce na zvyšování tolerance cukrovky proti žloutence řepy. (Efficiency of selection for increasing the tolerance of sugarbeet to sugarbeet yellows.) Listy cukrovarnické, *90,* 1974 : 123-126.

POLÁK, J.: K poznání kmenů virů žloutenky řepy v Československu. (On the Identification of the Strains of the Beet-Yellows Virus in Czechoslovakia.) Sbor. ÚVTI - Ochr. rostl., *6,* 1970 : 167-174.

POLÁK, J .— CHOD, J.: Metody šlechtění cukrovky na odolnost k viru žloutenky řepy. (The Methods of Breeding Sugarbeet for Resistance to the Beet Yellows Virus.) Sbor ÚVTI - Genet. a šlecht., *10,* 1974 : 321-326.

RIETBERG, H.: Breeding for tolerance to virus yellows. Rep. 22nd Winter Congr., I. I. R. B., 1956 : 88-89.

RUSSELL, G. E.: Breeding for resistance to sugar beet yellows. Brit. Sugar Beet Rev., *28,* 1968 : 163-170.

RUSSELL, G. E.: Breeding for resistance to sugar beet diseases. Brit. Sugar. Beet Rev., *24,* 1965 : 19-22.

RUSSELL, G. E.: Inherited resistance to virus yellows in sugar beet. Proc. R. Soc. Lond. B., *181,* 1972 : 267-279.

STEUDEL, W.: Neuere Erfahrungen zur Frage der Ertragsverluste durch die viröse Vergilbung bei Zuckerrüben. I. I. R. B., *6,* 1973 : 60-66.

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PETRÁK, Z. — ŘÍMSA, V. (Výzkumný ústav řepařský, Semčice): *Zvyšování odolnosti šlechtitelského materiálu k viru žloutenky řepy a jeho využití ve šlechtitelském procesu.* Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 53-60.

V letech 1965—1975 byl získán produktivní víceklíčkový šlechtitelský materiál cukrovky, který v podmínkách umělé infekce virem žloutenky řepy (BYV) dosáhl v letech 1974 a 1975 vysoké produktivnosti v hlavních užitkových vlastnostech. Tolerantní potomstva tohoto materiálu si udržují stále svoji vysokou technologickou hodnotu. Získání šlechtitelského materiálu tolerantního proti viru žloutenky řepy bylo dosaženo křížením domácích materiálů se zahraniční odrůdou, tolerantní proti BYV a výkonnostními zkouškami potomstev F_1 až F_3 generace. Víceklíčkový tolerantní materiál je v další selekční práci využíván jako komponent (opylovač) k pylově sterilním jednoklíčkovým liniím.

cukrovka; virus žloutenky řepy (BYV); šlechtění na toleranci

ПЕТРАК, З. — РЖИМСА, В. (Научно-исследовательский институт свекловодства, Семчице): **Повышение устойчивости селекционного материала к вирусу желтухи свеклы и его использование в процессе селекции.** Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 53-60.

В 1965—75 гг. был получен продуктивный многоростковый материал для селекции сах. свеклы, который в условиях искуссвтенного заражения вирусом желтухи свеклы (BYV) достиг в 1974 и 1975 гг. высокой продуктивности по главным полезным свойствам. Толерантные потомства этого материала все еще сохраняют свою высокую технологическую ценность. Получение толерантного к BYV селекционного материала было достигнуто путем скрещивания отечественного материала с зарубежным сортом, толерантным к BYV, прошедшим испытания продуктивности потомств F_1—F_3 поколений. Многоростковый толерантный материал используется в дальнейшей селекционной работе как компонент (опылитель) к стерильным однoростковым линиям.

сахарная свекла; вирус желтухи свеклы (BYV); селекция на толерантность

PETRÁK, Z. — ŘÍMSA, V. (Forschungsinstitut für Zuckerrübenanbau, Semčice): *Erhöhung der Resistenz des Züchtungsmaterials gegen das Virus der Vergilbungskrankheit der Rübe und ihre Ausnützung im Züchtungsprozeß.* Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 53-60.

In den Jahren 1965—1975 wurde produktives mehrkeimiges Züchtungsmaterial gewonnen, das unter den Bedingungen künstlicher Infektion mit dem Virus der Vergilbungskrankheit der Rübe (BYV) in den Jahren 1974 und 1975 eine hohe Produktivität betreffs Hauptnutzeigenschaften erreichte. Tolerante Nachkommenschaften dieses Materials behalten stets ihren hohen technologischen Wert. Züchtungsmaterial mit der Toleranz gegen das Virus der Vergilbunskrankheit der Rübe wurde durch Kreuzung des inländischen Materials mit ausländischer gegen BYV toleranter Sorte, und durch Leistungsprüfungen der Nachkommenschaften der F_1 bis F_3-Generation gewonnen. Mehrkeimiges tolerantes Material wird in weiterer Selektionsarbeit als Komponente (Pollenspender) zu pollensterilen einkeimigen Linien benutzt.

Zuckerrübe; Virus der Vergilbungskrankheit der Rübe (BYV); Züchtung auf Toleranz

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COMBINING ABILITY AND GENETIC ANALYSIS OF THE *USTILAGO MAYDIS* (DC.) CDA RATE OF DAMAGE OF *ZEA MAYS* L. INBRED LINES

A. PIOVARČI, V. MASLER

PIOVARČI, A. (Maize Research Institute, Trnava): *Combining Ability and Genetic Analysis of the Ustilago maydis (Dc.) Cda Rate of Damage of Zea mays L. Inbred Lines.* Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 61-66.

Inbred lines of different degrees of *Ustilago maydis* (Dc.) Cda resistance Co 114, Co 108, Co 140, Co 167 and Early 1 were crossed in complete diallel crossing. All single crosses and parent inbreds were tested by artificial inoculation to state mean rate of damage. The data obtained were processed by means of the analysis of general and specific combining ability, by means of genetic analysis, and reciprocal effects were determined. Both general and specific combining ability were highly significant but the GCA F ratio was more than 6 times higher. Reciprocal effects were also highly statistically significant. Genetic analysis showed that additive gene action complicated with non-allelic interactions and partial dominance is contributing in the control of the character. The distribution of array points showed an excess of dominant alleles except the inbred Early 1. Synthesis of genetic analysis and analysis of combining ability gives complete information about inbred lines and offers to a breeder a chance of intentional construction of resistant hybrids.

Ustilago maydis (Dc.) Cda rate of damage; genetic analysis; GCA — general combining ability; SCA — specific combining ability; reciprocal effects

Resistance of corn hybrids to any disease, *Ustilago maydis* (Dc.) Cda included, is proportionate to the degree of resistance in inbreds that are combined to make hybrids. Dominance of resistance or susceptibility to the disease, interaction of genetic factors and environmental effects complicate general relations. Therefore general information on the genetical basis of corn resistance to the disease and specific information on any inbred line included to a breeding program are very important to release resistant corn hybrids.

Inheritance of corn resistance to *Ustilago maydis* (Dc.) Cda is determined by a relatively large number of genes and has a quantitative character (Ullstrup, 1955). According to Saboe and Hayes (1941) genes for resistance to the disease are located in the short arm of chromosome 6 and in the long arms of chromosome 7 and 8. Reciprocal effects were reported very often (Jugenheimer, 1958; Miščerjakova, 1963). However, additive gene action is supposed generally as the main, non-allelic interactions are also reported (Cabulea et al., 1971; Munteanu et al., 1969).

This work was initiated to obtain information on the importance of different gene action conditioning corn resistance to *Ustilago maydis* (Dc.) Cda and reciprocal effects.

MATERIAL AND METHOD

Inbred lines of different degrees of *Ustilago maydis* (Dc.) Cda resistance Co 114, Co 108, Co 140, Co 167, Early 1 were crossed in complete diallel crossing (all p^2 combination). Single crosses and parent inbreds were planted in a randomized complete block experiment, having three replications and 20 experimental plants in each replication in the 1967 and 1968 growing season at Trnava. All plants were artificially inoculated by injecting sporidia into young plants at their 3—4 leaf stage. Evaluation of the rate of damage was done by screening the grade of damage (size and number of galls and their localization on the plant) of all attacked plants and stating the mean rate of damage using the system suggested by Voždová (1965).

For the data of the mean rate of damage general and specific combining ability analysis was carried out according to Griffing (1956) using Method 1, Model I. Reciprocal effects were also estimated according to Griffing's Method 1, Model I. The genetic analysis was carried out by graphic analysis Wr Vr (Jinks, Hayman, 1953; Hayman, 1954).

RESULTS AND DISCUSSION

Analysis of variance for the values of the *Ustilago maydis* (Dc.) Cda rate of damage (Table I) yielded highly significant mean squares for

I. Analysis of variance for the *Ustilago maydis* (Dc.) Cda rate of damage

Source	df	Mean squares	*F*
Varieties (A)	24	81.049	17.98++
Blocks (B)	2	21.24	0.47
Years (C)	1	860.16	19.08++
A × C	24	97.36	2.16+
Error	48	45.09	

++ $P = 0.01$
+ $P = 0.05$

varieties and years. The differences among the values of the rate of damage in F_1 crosses were also found to be significant and it might be assumed that genotype differences in resistance existed among the crosses tested.

Highly significant mean squares for years and significant for interaction varieties × years showed a fluctuation of the rate of damage of the crosses caused by ecological weather conditions.

The rate of damage mean values for F_1, and reciprocal F_1, and parent inbred line (Table II) shows that variability of the rate of damage is

II. F_1 and reciprocal F_1 mean values for the *Ustilago maydis* (Dc.) Cda rate of damage

Inbred	Co 114	Co 108	Co 140	Co 167	Early 1
Co 114	18.9	17.6	4.9	21.2	10.1
Co 108	17.8	7.8	23.7	35.6	5.0
Co 140	6.5	6.6	1.2	12.9	12.3
Co 167	25.0	37.1	13.5	32.8	31.5
Early 1	4.6	9.5	4.3	36.3	1.1

adequate to illustrate the relative importance of various types of gene action which condition resistance of the crosses tested.

General and specific combining ability analysis of variance of the *Ustilago maydis* (Dc.) Cda rate of damage (Table III) shows that both GCA and SCA F ratios are highly significant, but the GCA F ratio is more than 6 times higher. It indicated that GCA played the main role in conditioning resistance to *Ustilago maydis* (Dc.) Cda and that mainly additive gene effects were contributing in the control of this character. Furthermore GCA effects of inbred lines (Table IV) are very important for combining hybrids with a high degree of resistance to the disease. The table data show that inbred lines Co 140 and Early 1 (GCA effects – 7.19 and – – 4.31) are best for combination of hybrids resistant or tolerant to the disease.

III. Analysis of variance of general and specific combining ability for the *Ustilago maydis* (Dc.) Cda rate of damage (G r i f f i n g, 1956; Method 1, Model I)

Source	df	Mean squares	*F*
GCA	4	539.41	71.82++
SCA	10	85.94	11.44++
Reciprocal effects	10	22.49	2.99++
Error	48	7.51	

++ $P = 0.01$

IV. General combining ability effects for the *Ustilago maydis* (Dc) Cda rate of damage (G r i f f i n g, 1956; Method 1, Model I)

Inbred line	GCA effect
Co 114	−1.36
Co 108	0.92
Co 140	−7.19
Co 167	11.94
Early 1	−4.31
$s(\hat{g}_i - \hat{g}_j)$	1.23

Specific combining ability effects (Table V), in some cases, approached GCA effects in terms of their relative importance in conditioning resistance to the damage by *Ustilago maydis* (Dc.) Cda and show that non-allelic interactions are important in those combinations.

Highly statistically significant reciprocal effects (Table III) indicate differences between reciprocal F_1, and their values are shown in Table V.

Genetic analysis using graphic analysis Wr Vr is presented in Fig. 1, and its parameters in Table VI. Regression coefficient in the Wr Vr graph for the *Ustilago maydis* (Dc.) Cda rate of damage indicated that additive gene action complicated with non-allelic interactions is contributing in the control of the expression of the character. Regression line intercrossed the Wr axis close above the origin, which showed that partial dominance was found to be an important type of gene action.

In the Wr Vr graph the distribution of the array points of inbreds

V. Specific combining ability and reciprocal effects for the *Ustilago maydis* (Dc.) Cda rate of damage (G r i f f i n g, 1956; Method 1, Model I)

Inbred	Co 108	Co 140	Co 167	Early 1
Co 114	2.22 −0.11	−1.65 −0.81	−3.43 −1.91	−2.88 2.77
Co 108		5.53 8.53	7.55 −0.72	−5.28 −2.29
Co 140			−7.45 −0.31	3.40 4.00
Co 167				10.31 −2.42
$s(\hat{s}_{ij} - \hat{s}_{ik})$		2.45		
$s(\hat{s}_{ij} - \hat{s}_{kl})$		2.12		
$s(\hat{r}_{ij} - \hat{r}_{kl})$		2.74		

1 line — SCA effects
2 line — reciprocal effects

VI. Vr, Wr, Vp, b and s_b values of graphic analysis

Inbred	Vr	Wr
Co 114	46.34	90.08
Co 108	153.83	121.28
Co 140	23.22	29.29
Co 167	84.34	40.03
Early 1	205.52	166.03
Vp = 182.05		
b = 0.66		
s_b = 0.127		

(families) above or below the line designating 50 % dominant alleles determined the ratio of dominant and recessive alleles of the parents for the trait. Array points close to origin represented parents with an excess of dominant alleles.

In our case the array points were located below the 50 % – line (except inbred Early 1) and in the whole diallel crossing dominant alleles were in excess. Only in inbred line Early 1 recessive alleles were in excess.

Synthesis of genetic analysis and analysis of combining ability of the *Ustilago maydis* (Dc.) Cda rate of damage gives complete information on the breeding value of inbred lines and offers to a breeder a chance for intentional and purposeful construction of resistant hybrids.

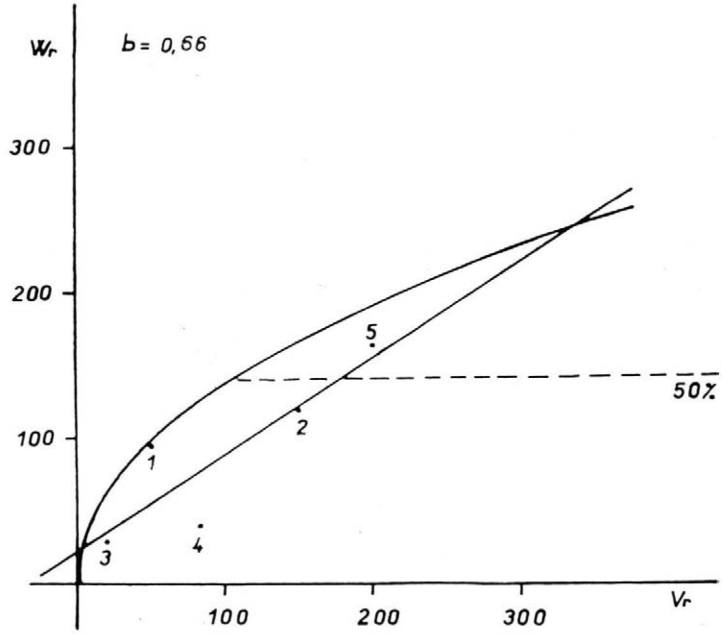
References

CABULEA, I. –MUNTEANU, I. – POMPILIA, ARDALEAN: Certains aspects concernant le controle génétique de la réaction du maïs à *Ustilago maydis* (Dc.) Corda. Z. Pflanzenzücht., *66*, 1971 : 1-8.

GRIFFING, B.: Concept of general and specific combining ability in relation to diallel cross systems. Aust. Jour. Biol. Sci., *9*, 1956 : 463-493.

HAYMAN, B. J.: The theory and analysis of diallel crosses. Genetics, 1954 : 789-809.

1. The Wr Vr graph for the *Ustilago maydis* (Dc.) Cda rate of damage. (Inbred lines: 1 — Co 114, 2 — Co 108, 3 — Co 140, 4 — Co 167, 5 — Early 1)



JINKS, J. L. — HAYMAN, B. J.: The analysis of diallel crosses. Maize genetics coop. News Letter, 1953 : 58-64.

JUGENHEIMER, R. W.: Hybrid maize breeding and seed production. FAO, Rome 1958.

MIŠČERJAKOVA, P.: Differences in resistance to smut in reciprocal crosses of maize. In: Pl. Breed. Abstr., *38*, 1968 : 2429.

MUNTEANU, I. — CABULEA, T. — RADULESCU, E.: Studies in immunity and inheritance of corn response to *Ustilago maydis* (DC) Corda. Savremena poljoprivreda, Novi Sad, 1969 : 407-416.

SABOE, L. C. — HAYES, H. K.: Genetic studies of reaction to smut and of firing in maize by means of chromosomal translocations. Jour. Am. Soc. Agron., 1941 : 463-470.

ULLSTRUP, A. J.: Diseases of corn. In: SPRAGUE et al.: Corn and Corn Improvement. Acad. Press Inc., Publ. New York, 1955.

VOŽDOVÁ, G.: Metodické otázky hodnocení kukuřice na odolnost ke sněti kukuřičné [*Ustilago zeae* (Beckm) Ung.] (Methodical problems in the evaluation of maize resistance to corn smut [*Ustilago zeae* (Beckm) Ung.] In: Vědecké práce Výzk. úst. kukurice, Trnava, 1965 : 55-71.

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PIOVARČI, A. — MASLER, V. (Výskumný ústav kukurice, Trnava): *Kombinačná schopnosť a genetická analýza stupňa napadnutia samoopeľovaných línií kukurice sneťou kukuričnou [Ustilago maydis (Dc) Cda].* Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 61-66.

Samoopeľované línie rôzneho stupňa odolnosti proti sneti kukuričnej Co 114, Co 108, Co 140, Co 167 a Early 1 boli krížené metódou úplného dialelického kríženia. Všetky krížence a rodičovské samoopeľované línie boli testované cestou umelej inokulácie a bol stanovený priemerný stupeň napadnutia. Tieto výsledky boli spracované analýzou kombinačnej schopnosti, genetickou analýzou a boli stanovené recipročné efekty. Všeobecná a špeciálna kombinačná schopnosť sa ukázali štatisticky vysoko významné, avšak pomer F pre všeobecnú kombinačnú schopnosť bol šesťkrát vyšší. Recipročné efekty boli tiež štatisticky vysoko preukazné. Genetická analýza ukázala, že aditívne pôsobenie genetického systému komplikované nealelickými interakciemi a čiastočnou dominanciou zodpovedajú za regulovanie študovaného znaku. Distribúcia priesečníkov *Wr* a *Vr* rodín rodičovských samoopeľovaných línií ukazuje prevahu dominantných génov nad recesívnymi s výnimkou samoopeľovanej línie Early 1. Syntéza genetickej analýzy a analýzy kombinačnej schopnosti dáva úplnú informáciu o samoopeľovaných líniach a poskytuje šľachtiteľovi možnosť zámernej konštrukcie odolných hybridov.

snet kukuričná; odolnosť; kombinačná schopnosť; genetická analýza

ПИОВАРЧИК, А. — МАСЛЭР, В. (Научно-исследовательский институт кукурузы, Трнава): **Комбинационная способность и генетический анализ степени поражения самоопыляющихся линий кукурузы пузырчатой головней кукурузы** [*Ustilago maydis* (Dc) Cda]. Sbor. Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 61-66.

Скрещивали самоопыляющиеся линии кукурузы разной степени устойчивости к пузырчатой головне Co 114, Co 108, Co 140, Co 167 и Early 1 по методу полного диаллельного скрещивания. Все гибриды и родительские самоопыляющиеся линии тестировали путем искусственного инокулирования, определяя среднюю степень поражения. Результаты обрабатывали с помощью анализа комбинационной способности, генетического анализа и определяли реципрокные эффекты. Общая и специальная комбинационная способность оказались статистически высокозначимы, но отношение F для общей комбинационной способности в 6 раз больше. Высокодостоверными были также реципрокные эффекты. Как показал генетический анализ, аддитивное действие генетической системы, усложненное неаллельными взаимодействиями и частичной доминантностью, обусловливает регулировку данного признака. Распределение точек пересечения W_r и V_r семейств родительских самоопыляющихся линий показывает преобладание доминантных генов над рецессивными за исключением самоопыляющейся линии Early 1. Синтез генетического анализа и анализа комбинационной способности дает полное представление о самоопыляющихся линиях, позволяя таким образом селекционеру целенаправленно составлять устойчивые гибриды.

пузырчатая головня кукурузы; устойчивость; комбинационная способность; генетический анализ

PIOVARČI, A. — MASLER, V. (Forschungsinstitut für Maisanbau, Trnava): *Kombinationsvermögen und genetische Analyse des Grades des Maisbeulenbrandbefalls [Ustilago maydis (Dc) Cda] bei selbstbefruchtenden Maislinien.* Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 61-66.

Selbstbefruchtende Maislinien von verschiedenen Stufen der Widerstandsfähigkeit gegen Maisbeulenbrand Co 114, Co 108, Co 140, Co 167 und Early 1 wurden mittels der Methode der vollständigen Diallelkreuzung gekreuzt. Alle Hybriden und selbstbefruchtende Elternlinien wurden durch künstliche Inokulation getestete und durchschnittlicher Befallsgrad ermittelt. Die Ergebnisse wurden der Analyse des Kombinationsvermögens unterzogen und reziproke Effekte mit Hilfe der genetischen Analyse bestimmt. Beide Kombinationsfähigkeiten, allgemeine und spezielle, erwiesen sich als statistisch hoch signifikant, doch war das Verhältnis F für allgemeine Kombinationsfähigkeit sechsmal höher. Reziproke Effekte waren auch statistisch hoch signifikant. Genetische Analyse zeigte, daß die additive, durch nichtallele Interaktion und partielle Dominanz komplizierte Wirkung des genetischen Systems für die Regulation des beobachteten Merkmals verantwortlich ist. Die Distribution der Schnittpunkte *Wr* und *Vr* der Familien der selbstbefruchtenden Elternlinien zeigt, daß die dominanten Gene den rezessiven überlegen sind, mit der Ausnahme von der selbstbefruchtenden Linie Early 1. Die Synthese der genetischen Analyse und der Analyse des Kombinationsvermögens bietet vollkommene Information über selbstbefruchtende Linien und ermöglicht es, eine zielbestrebte Konstruktion resistenter Hybriden vorzunehmen.

Maisbeulenbrand; Resistenz; Kombinationsvermögen; genetische Analyse

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THE SOURCES OF RESISTANCE TO POWDERY MILDEW (*ERYSIPHE GRAMINIS* DC. F. SP. *TRITICI* MARCHAL) IN WINTER AND SPRING WHEAT

F. MRÁZ

MRÁZ, F. (Cereal Research Institute, Kroměříž): *The Sources of Resistance to Powdery Mildew (Erysiphe graminis DC. f. sp. tritici Marchal) in Winter and Spring Wheat.* Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 67-70.

The paper gives a list of winter and spring wheat varieties resistant to powdery mildew race 57 discovered in Czechoslovakia. From the winter wheat collection only 3.3 %, from the spring wheat collection 13.3 % of varieties were resistant to this race.

powdery mildew; race 57; sources of resistance

In 1969 a new physiologic powdery mildew race was ascertained for the first time, namely on the territory of Czechoslovakia; it was designated as race 57.

This race was identified from the powdery mildew sample found on the differential variety Salzmünde St. 14/44. This new race overcomes the resistance genes 1B/1R, Pm 1, and Pm 3b in the varieties Salzmünde St. 14/44, Ulka (Red Fern) and Chul from the test assortment arranged by Dr. Nover. Its occurrence was rare in the number of powdery mildew samples designed for the identification of races in that year. It was determined on the same host variety also in 1970. In 1971 it was ascertained on the variety Kavkaz, in 1972 on Carsten V and Kavkaz, in 1973 on Aurora, Bezostá 1, Carsten V, Chul, Kavkaz, Orlando, and VDH 2/69 (the Netherlands), and in the last year before its publication on Carsten V, Chul, and Salzmünde St. 14/44 (Mráz, Šolc, 1976).

The identification of a new race and description of its virulence to differentials are sufficient just for the race evidence and knowledge of physiologic specialization of a parasite in the given country. However, it is insufficient for its utilization by a breeder. Then it is necessary to learn more about it, to know the sources of resistant material which every plant pathologist – breeder is interested in, when he wants to produce new mildew race resistant genotypes. The object of this study was to ascertain them.

MATERIAL AND METHOD

The collections of varieties and strains from the assortment of winter and spring wheat were tested with race 57 gained mostly from the Department of Genetics and Plant Breeding of the Cereal Research Institute at Kroměříž. The seeds of samples of both collections were sown gradually into pots and after emerging the plants were placed under glass covers (to prevent the infection from the environment) in the glasshouse till the two-leaf-stage. In this phase the leaves of varieties were inoculated uniformly by dusting the conidia of race 57 and the infected plants were transferred into an air-conditioned chamber with a standard temperature of +17 °C (± 2 °C) at artificial illumination (fluorescent lamps + normal bulbs) with a 16-hour-photoperiod.

Seven to nine days were sufficient for the development of large pustules of the parasite on leaf blades of susceptible varieties. At that time the varieties were evaluated. Those appearing as resistant (0, 1 and 2 in the current 5-grade-scale; 3 and 4 = susceptible) were verified, when repeatedly sown and infected. The resistant varieties from the tested ones (degrees 0—2) are given in the following section of this paper.

RESULTS

Simultaneously with the identification of the new race, resistant varieties were ascertained which also the differentials from our test assortment belong to. They are spring wheats of variety Axminster, Halle St. 13471, Weihenstephan St. M_1, and Hope with resistance genes Pm 2, Pm 1 + „Pm-d", PM 4, and PM 5. It may be supposed that varieties given in the following list may possess some of the resistance genes, too.

WINTER AND SPRING WHEAT VARIETIES WITH RESISTANCE TO POWDERY MILDEW RACE 57

a) winter wheat

As II/8 × Chancellor (C. I. 14116); Aximinster/8 × Chancellor; Biserka; C 919/69; Centurk; C. I. 13836/8 × Chancellor; Drina; Elia × Mara; Eros × Ibis; Fredrick; Hohenthurm 4891/67; Hohenthurm 15080/66; Hume; Khapli/8 × Chancellor; Kranich; L 707; Libellula; Luron; McNair 1813; (Mex. 9 × 35.2.1) 14.8; Norka/8 × Chancellor; NS 447; Purdue II; Rothwell Tetrix; Sava; US (60) 41; Yuma/8 × Chancellor; 35/68 (Poland); 203 × 65 (Bulgaria)

b) spring wheat

Africa Mayo; As II; Aubers; B 9242 (line Mexico); *Bicop;* BT 20; BT 2095; *C. I. 15099; C. I. 15117;* C. I. 15686; Cinnamon; Crvenka (VIR 40023); Currawa; Delhi 2; Era; Fange 16; *GE 363; GER 472*; Hadmerslebener 31041/67; Hadmerslebener 33146/68; Hadmerslebener 41679/69; Hope; Chile (2-1656); IRN — 145 (C. I. 13836); Jufy I; Khapli; Kleinwanzlebener 3681/67; M 23/66 (Argentine); M 374 — Sr; Md /Mc M/E $(Af\text{-}My)^2$ 14159-7t-36-2f; Mexico 43; Mexipak 68; Mexique 40; Min — 8156 × Jar (On) Az 67; Minn. II-61-13; [(Nor. 10 × Brevor) 14 × Centana] B 59.3; [(Nor. 10 × Brevor) 14 × $Centana^2$] B 61.122; *Norka*; *Normandie*: PN 217 TN 15 — Nai 60 PK 2659-13Mv-Od; Pompe; Praga; P. V. 18; Qt 254 — Ravi 66 × Mxp 65; Regue 66; Ridley 48; Sicco; Siete Cerros T 66; Solo; Son 64 × C 271; *Streng*; Tr. carthlicum; UV-SK × San Pastore × Mara /Kalyan 227 A-31382-3M-1S/; Vernal (C. I. 3686); *Weibulls Sappo*; Weihenstephan St. M_1; 0224/52 (C. I. 245110); 36896 — G 542 × Y × 54 A; II 58.417.5.39.3; II-5514/2 II-60-105 II-64-33

Note: The varieties printed in italics have not proved any signs of powdery mildew infection (without fungal mycelium, chlorosis, necrosis).

DISCUSSION

From 1328 wheat samples tested, 90 varieties were resistant to powdery mildew race 57 (i. e. 6.8 %). There were 869 winter wheat samples there and 29 of them were resistant (i. e. 3.3 %). From 459 spring wheat samples only 61 varieties were resistant (i. e. 13.3 %). Only one-fourth of resistant samples was from the winter wheat collection and three-fourths from the spring wheat collection. Thus cca 3 samples from 100 winter wheat varieties and 13 samples from 100 spring wheat varieties possess the genes of resistance to powdery mildew race 57. From the races tested earlier (0, 1, 2, 3, 4, 18, 21, and 34) races 2 and 4 indicate a similar ratio of resistant winter and spring wheat varieties. When testing the other races, the numbers of resistant winter and spring wheat samples were nearly equal to the ratio of 1 to 1, only with mildew race 34 the ratio was inverse in comparison with race 57; two-thirds of resistant varieties are from the winter wheat collection and one-third from the spring wheat collection. In comparison with other mildew races the total number of wheat samples with resistance to mildew race 57 is small and on the whole it is on the same level with mildew race 34.

The resistance of varieties having the winter wheat variety Chancellor as one of the parents, is not derived from this variety, but from the other parent. Chancellor is susceptible to mildew race 57. It implies that the resistance in those samples is derived from spring wheat varieties which Chancellor had been crossed with. They are the varieties As II, Axminster, Khapli and Norka (they were tested too and are given in the list of resistant samples) and also varieties which were not tested with mildew race 57 (their seeds were not available), but they may be ranked among the resistant ones without testing on the basis of resistance of their crosses with Chancellor to race 57. They are the varieties C. I. 13836 and Khapli.

Varieties of Yugoslav origin (Biserka, Drina, Libellula, and Sava) are resistant to mildew race 57 in the one-leaf stage, but not to such a degree as most of wheat varieties from samples given in the list (their evaluation ranges from 1 to 2 of the classification scale).

References

MRÁZ, F. — ŠOLC, C.: Nová fyziologická rasa padlí travního (*Erysiphe graminis* DC. f. sp. *tritici* March.) na pšenici. [A new physiologic powdery mildew race (*Erysiphe graminis* DC. f. sp. *tritici* March.) in wheat.] Sbor. ÚVTIZ - Ochr. rostl., *12*, 1976 : 53-55.

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MRÁZ, F. (Výzkumný ústav obilnářský, Kroměříž): *Zdroje rezistence k padlí travnímu (Erysiphe graminis DC. f. sp. tritici Marchal) v ozimé a jarní pšenici.* Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 67-70.

Práce podává seznam odrůd ozimé a jarní pšenice, odolných k padlí travnímu, rase 57, objevené v Československu. Z ozimých pšenic bylo odolných 3,3 %, z jarních pšenic 13,3 % odrůd k této rase.

pšenice; odolnost; padlí travní

МРАЗ, Ф. (Научно-исследовательский институт зерновых культур, Кромержиж). **Источники устойчивости к мучнистой росе злаков** (*Erysiphe graminis D. C. f. sp. tritici Marchal*) **у озимой и яровой пшеницы.** .Sbor. ÚVTIZ - Genet. a Šlecht., *13*, 1977 (1) : 67-70.

В работе приводится перечень сортов озимой и яровой пшеницы, устойчивых к мучнистой росе злаков, к обнаруженной в Чехословакии расе 57. Из озимых пшениц устойчивы 3,3 %, а из яровых — 13,3 %.

пшеница; устойчивость; мучнистая роса злаков

MRÁZ, F. (Forschungsinstitut für Getreidebau, Kroměříž): *Quellen der Resistenz gegen Getreidemehltau (Erysiphe graminis D. C. f. sp. tritici Marchal) in Winter- und Sommerweizen.* Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 67-70.

Die Arbeit bietet ein Verzeichnis der Winter- und Sommerweizensorten, die gegen die in der ČSSR gefundene Getreidemehltaurasse 57 widerstandsfähig sind. 3,3 % von Winterweizensorten und 13,3 % von Sommerweizensorten waren resistent gegen diese Rasse.

Weizen; Resistenz; Getreidemehltau

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THE INHERITANCE OF VERTICAL RESISTANCE OF THE OAT CULTIVARS DODGE AND GARLAND TO CENTRAL EUROPEAN CROWN RUST RACES

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ŠEBESTA, J. (Institute of Plant Protection, Praha - Ruzyně): *The Inheritance of Vertical Resistance of the Oat Cultivars Dodge and Garland to Central European Crown Rust Races.* Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 71-79.

The resistance of oat cultivars Dodge and Garland to *P. coronata* Cda. var. *avenae* Fraser et Led., to races 201, 228, 229, 230, 232, 238, 239 and 240 is conditioned by two independent dominant and probably by one recessive gene. The resistance to races 216, 265 and CS 1 is established monofactorially, the factor effective against race 265 being probably derived from the cultivar Victoria while that effective against races 216 and CS 1 coming from the cultivar Landhafer. It was proved that at least a part of the genetic background of crown rust resistance is in the cultivars Dodge and Garland identical. Major-genes for crown rust resistance of the cultivar Dodge and probably Garland as well are non-allelic with the Pc-39 gene so that these can be accumulated in one genotype (cultivar). A question of breeding a multigenic cultivar by the use of these crown rust resistance sources is discussed.

hybridological analysis; non-allelism; multigenic resistant cultivar; multiline cultivar; crown rust resistance sources

The oat cultivar Dodge was considered, in general, as crown rust resistant on the North American continent in the time of its release (Shands, Crager, Forsberg, 1966). According to Coffman, Murphy and Stevens (1958, 1961) this oat cultivar was resistant to crown rust races 203, 216, 290 and 294 and it had a low attack severity.

Similarly the oat cultivar Garland was highly resistant to naturally occurring crown rust races in the USA at the beginning of its testing (Shands, Forsberg, Arawinko, 1966). Later on, however, it was more susceptible due to the occurrence of new crown rust races. It is assumed in general that the Garland cultivar is more susceptible to crown rust than the Dodge cultivar, but less susceptible than the Goodfield cultivar (Shands, Fosberg, Arawinko, 1966).

In Czechoslovak oat varietal trials (Šebesta, 1970a, b, 1972a) the cultivars Dodge and Garland were resistant to all the crown rust races (Šebesta, 1970c, d, 1972b, c, 1973) with the exception of race 264 (Šebesta, 1972b). Therefore, these cultivars belong to the most valuable resistance sources to oat crown rust in Central Europe.

For the above mentioned reasons the inheritance of vertical resistance to Central European races of *Puccinia coronata* Cda. var. *avenae* Fraser et Led. was analyzed. Simultaneously the identity of crown rust resistance factors of these oat cultivars was proved. The results obtained are treated of in this paper.

MATERIAL AND METHOD

The agronomical characteristics of both cultivars were already described (Shands, Cruger, Forsberg, 1966; Shands, Forsberg, Arawinko, 1966; Šebesta, 1975a). The reactions of parental cultivars to isolates of crown rust races used are given in Table I. The range of the virulence of races on crown rust standard differentials (Šebesta, 1970c, d; 1972b, 1973) is given in Table II.

The environmental conditions under which the analyses had been established (Šebesta, 1970b, c, d), the inoculation technique (Browder, 1972; Šebesta, 1972d) and the infection type evaluation (Finkner, 1954) were analogical to other rust investigations (Šebesta, 1975b).

I. Reaction of parent oat cultivars to the cultures of physiologic races of *P. coronata* Cda. var. *avenae* Fraser et Led. in seedling (K) and adult (D) stages (R = resistant, S = susceptible, — not tested)

Physiologic race/Culture	Growth stage	Cultivar				
		Dodge	Garland	Bento	Diadém	Tiger
201 42–73/2	K D	R —	R —	S —	S —	S —
216 58–67/1	K D	R R	R R	S —	S —	S —
228/ 32–72/1	K D	R —	R —	S —	S —	S —
228/ 73–73/1	K D	R —	R —	S —	S —	S —
229/ 34–73/3	K D	R —	R —	S —	S —	S —
230/ 12–73/2	K D	R —	R —	S —	S —	S —
232/ 67–67/2	K D	R —	R —	S —	S —	S —
238/ 128–72/2	K D	R —	R —	S —	S —	S —
239/ 44–73/1	K D	R R	R R	S S	S S	S S
240/ 9–71/2	K D	R R	R R	S S	S S	S S
240/ 34–74/1	K D	R —	R —	S —	S —	S —
240/ 3–71/2	K D	R —	R —	S —	S —	S —
265/ 66–66/1	K D	R R	R R	S S	S S	S S
265/ 48–72/1	K D	R R	R R	S S	S S	S S
265/ 83–72/1	K D	R —	R —	S —	S —	S —
CS 1/ 153–65/2	K D	R R	R R	S S	S S	S S

RESULTS AND DISCUSSION

The results of the F_2 hybridological analyses of the crown rust resistance of the oat cultivars Dodge and Garland in seedling and adult stages are given in Tables III, IV and V. From these data it is evident that the vertical resistance of both cultivars to crown rust races 201, 228, 229, 230, 232, 238, 239 and 240 is conditioned by two independent domi-

II. Range of virulence of the cultures of physiologic races of *P. coronata* Cda. var. *avenae* Fraser et Led., used in hybridological analyses

Physiologic race	Culture	Virulence on standard differentials
201₁)	42–73/2	Appler, Bond
216²)	58–67/1	Anthony, Victoria, Appler, Bond, Ukraine
228₁) 228₁)	32–72/1 73–73/1	Ukraine Ukraine
229₁)	34–73/3	Ukraine, Saia
230₁)	12–73/2	Appler, Ukraine
232₁)	67–67/2	Anthony, Ukraine, Saia
238₁)	128–72/2	Appler
239₁)	44–73/1	–
240₁) 240₁)	9–71/2 34–74/1	Anthony Anthony
265²) 265²) 265²)	66–66/1 48–72/1 83–72/1	Appler, Bond, Landhafer, Santa Fe, Trispernia, Bondvic Appler, Bond, Landhafer, Santa Fe, Trispernia, Bondvic Appler, Bond, Landhafer, Santa Fe, Trispernia, Bondvic
CS 1²)	153–65/1	Victoria, Appler, Bond, Ukraine, Saia

₁) Race of the first group
²) Race of the second group

III. Segregation of the F_2 generation of adult plants according to the reaction to *P. coronata* Cda. var. *avenae* Fraser et Led., physiologic race 239 and 265 in crosses of the resistant oat cultivars Dodge and Garland with the susceptible ones Bento and Tiger

Test/Cross	Race/Culture	Plants			Expected ratio	X^2	P
		R	S	n			
1. Dodge × Bento	239/ 44–73/1	317	13	330	61 : 3	0.41	0.7–0.5
2. Dodge × Tiger	265/ 66–66/1	216	70	286	3 : 1	0.042	0.9–0.8
3. Garland × Tiger	265/ 66–66/1	232	83	315	3 : 1	0.31	0.7–0.5

nant and probably by one recessive gene. These genes are effective in both adult (Table III) and seedling stages (Table IV). On the other hand the resistance to races 216, 265 and CS1 is monofactorially established, the

IV. Segregation of the F_2 generation of seedling plants according to the reaction to *P. coronata* Cda. var. *avenae* Fraser et Led., physiologic races 201, 228, 229, 230, 232, 238, 239 and 240 in the crosses of the resistant cultivars Dodge and Garland with the susceptible ones Bento and Diadém

Test/Cross	Race/ Culture	Plants			Expected ratio	X^2	P
		R	S	n			
1. Dodge × Bento	201/ 42–73/2	197	11	208	61 : 3	0.17	0.7–0.5
2. Dodge × Diadém	228/ 32–72/1	203	8	211	61 : 3	0.38	0.7–0.5
3. Bento × Dodge	229/ 34–73/3	109	4	113	61 : 3	0.33	0.7–0.5
4. Bento × Dodge	239/ 44–73/1	198	9	207	61 : 3	0.053	0.9–0.8
5. Dodge × Diadém	240/ 9–71/2	245	11	256	61 : 3	0,087	0.8–0.7
6. Bento × Garland	228/ 73–73/1 229/ 34–73/1	218	9	227	61 : 3	0.26	0.7–0.5
7. Bento × Garland	230/ 12–73/2 239/ 44–73/1	145	9	154	61 : 3	0.46	0.5
8. Bento × Garland	232/ 67–67/2	229	11	240	61 : 3	0.006	0.95–0.90
9. Diadém × Garland	238/ 128–72/2	128	5	133	61 : 3	0.26	0.7–0.5

factor (s) being effective against races of the first group as well. The data on the reaction of seedling plants of the F_3 families of the crosses Dodge × × Bento, Garland × Tiger and Dodge × Tiger (Table VII) are in accordance with these results. As the analyses of the F_3 families were performed in a limited number of plants, homozygous resistant lines and those segregating for 3 genes were grouped together and the X^2 value was calculated for a ratio of 45 resistant lines, 18 segregating and 1 susceptible.

The hybridological analysis of the F_2 generation of the crosses Dodge × Garland according to the reaction to the first and second group races indicates that both cultivars have identical at least a part of the genetical background effective against these races (Table VIII).

Although the resistance to races 216, 265 and CS 1 is conditioned by one gene, different genes are responsible for the reaction to them in separate cases. Whereas the gene effective against race 265 probably comes from the Victoria cultivar, the resistance of the cultivars Dodge and

V. Segregation of the F_2 generation of seedling plants according to the reaction to *P. coronata* Cda. var. *avenae* Fraser et Led., physiologic races 216, 265 and CS 1, in crosses of the resistant cultivars Dodge and Garland with the susceptible cultivars Bento and Diadém

Test/Cross	Race/ Culture	Plants			Expected ratio	X^2	P
		R	S	n			
1. Dodge × Bento	216/ 58–67/1	158	50	208	3 : 1	0.10	0.8–0.7
2. Dodge × Diadém	265/ 48–72/1	156	55	211	3 : 1	0.13	0.8–0.7
3. Dodge × Diadém	265/ 83–72/1	144	42	186	3 : 1	0.58	0,5–0.3
4. Dodge × Bento	265/ 66–66/1	158	54	212	3 : 1	0.025	0.9–0.8
5. Bento × Dodge	265/ 66–66/1	87	26	113	3 : 1	0.24	0.7–0.5
6. Bento × Dodge	CS 1 153–65/1	155	52	207	3 : 1	0.002	1.0–0.95
7. Bento × Garland	265/ 66–66/1	116	38	154	3 : 1	0.009	0.95–0.90
8. Bento × Garland	CS 1/ 153–65/1	169	58	227	3 : 1	0.037	0.9–0.8

Garland to races 261 and CS1 is probably derived from the Landhafer cultivar. The virulence of these races on standard differentials of oat crown rust supports this idea (Table II).

From a practical point of view very important is the fact that crown rust resistance genes of the Dodge cultivar, and probably the Garland cultivar as well, are non-allelic with the Pc-39 gene (Šebesta, 1975c), so that they can be accumulated in one genotype (Table IX).

A possibility of combining crown rust resistance factors of the cultivar Dodge or Garland with the Pc-39 gene creates a basis for the successful breeding of multigenic cultivars the resistance of which should not be easily overcome by a pathogen mutation (McKenzie et al., 1971).

According to McKenzie et al. (1971) the cultivation of a variety or a series of varieties with one and the same resistance gene on a large area gives to a pathogen an ideal host. Not yet identified virulence gene (s) can already be present in the population in a low frequency or a natural mutation for virulence can occur in the pathogen when the resistant cultivar (s) is widely grown. In any case this virulent strain (s) can be very quickly multiplied on this cultivar (s) and cause a breakdown of resistance (McKenzie et al., 1971; Šebesta, 1975d).

VI. Segregation of the F_2 generation seedling plants in crosses of the resistant cultivars Dodge and Garland with the susceptible cultivars Bento and Diadém according to the reaction to *P. coronata* Cda. var. *avenae* Fraser et Led. Relationship of the genetic background of resistance to the first and second group of physiologic races

Test/Cross	Race/ Culture	Plants with combination			
		R R	R S	S R	S S
1. Dodge × Diadém	228/ 32–72/1 265/ 48–72/1	156	47	–	8
2. Dodge × Diadém	240/ 9–71/2 265/ 48–72/1	139	42	–	8
3. Bento × Garland	228/ 73–73/1 CS 1/ 153–65/1	169	49	–	9
4. Bento × Garland	239/ 44–73/1 265/ 66–66/1	116	29	–	9

VII. Reaction of the seedling plants of the F_3 families of the crosses Dodge × Bento, Garland × Tiger and Dodge × Tiger to *P. coronata* Cda. var. *avenae* Fraser et Led., physiologic races 239 (44-73/1) and 265 (66-66/1)

Test/Cross	Race/ Culture	Number of families				Expected ratio	X^2	*P*
		R	Segr.	S	Total			
1. Dodge × Bento	239/ 44–73/1	67	32	1	100	45 : 18 : 1	0.89	0.7–0.5
2. Garland × Tiger	239/ 44–73/1	64	33	2	99	45 : 18 : 1	1.54	0.5–0.3
3. Dodge × Tiger	265/ 66–66/1	22	57	21	100	1 : 2 : 1	1.98	0.5–0.3

The long-lasting vertical resistance can be achieved by two breeding ways: 1. multiline cultivars (Browning, Frey, 1969; Šebesta, 1975d) or 2. multigenic cultivars (McKenzie et al., 1971; Šebesta, 1975d) which have incorporated several resistance genes with a wide spectrum of effectiveness. Each of these methods assumes the availability of series of effective resistance genes. Moreover, in the case of multigenic cultivar breeding only non-allelic genes can be combined in one genotype.

VIII. Relationship of the resistance of the Dodge and Garland cultivars to *P. coronata* Cda. var. *avenae* Fraser et Led. Hybridological analysis of the F_2 generation of the cross Dodge × Garland

Cross/ Check cultivar	Race/ Culture	Plants		
		R	S	Total
Dodge × Garland	240/ 34–74/1 265/ 66–66/1	309	–	309
Dodge	240/ 34–74/1 265/ 66–66/1	20	–	20
Garland	240/ 34–74/1 265/ 66–66/1	16	–	16
Tiger (susceptible check)	240/ 34–74/1 265/ 66–66/1	–	10	10

In a foregoing paper (Šebesta, 1975a) a proof was given that both Pg-2 and Pg-4 factors for stem rust resistance of the cultivars Dodge and Garland can be combined with the Pc-39 gene for crown rust resistance. In this study the proof is given that also crown rust resistance factors of these cultivars can be accumulated with Pc-39 in one genotype. The combination of these resistance factors enables to create very effective genotypes conferring resistance to all till now identified races of *P. graminis* Pers. f. sp. *avenae* Erikss et Henn. and *P. coronata* Cda. var. avenae Fraser et Led. as well.

IX. Relationship of the resistance of the oat cultivar Dodge and Pc-39 line to *P. coronata* Cda. var. *avenae* Fraser et Led. Segregation of the F_2 generation of the cross Pc-39 × Dodge

Cross	Physiologic race/ Culture	Segregation F_2	
		R	S
Pc-39 × Dodge	239/ 44–73/1	313	2

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References

BROWDER, L. E.: A multi-culture inoculation system for study of host: parasite relationships. Pl. Dis. Reptr., *56*, 1972 : 847-849.

BROWNING, J. A. – FREY, K. J.: Multiline cultivars as a means of disease control. A. Rev. Phytopyth., *7*, 1969 : 355-382.

COFFMAN, F. A. — MURPHY, H. C. — STEVENS, H.: Results from the National Cooperative Coordinated Oat Breeding Nurseries for 1957. USDA, ARS. Field Crops Res. Br. CR-24-58, 1958 : 207.
COFFMAN, F. A. — MURPHY, H. C. — STEVENS, H.: Results from the National Cooperative Coordinated Oat Breeding Nurseries for 1960. USDA, ARS. Crops. Res. Div. CR-32, 1961 : 120.
McKENZIE, R. I. H. — MARTENS, J. W. — GREEN, G. J.: The oat stem rust problem. In: Proceed. Mutation Dis. Resist., Vienna, Austria, IAEA et FAO, 1971 : 151-157.
SHANDS, H. L. — CRUGER, L. G. — FORSBERG, R. A.: Registration of Dodge oats. Crop Sci., *6*, 1966 : 388-389.
SHANDS, H. L. — FORSBERG, R. A. — ARAWINKO, Z. M.: Registration of Garland oats. Crop Sci., *6*, 1966 : 389.
ŠEBESTA, J.: Polní odolnost sortimentu ovsů k *P. coronata* Cda. var. *avenae* Fraser et Led. v ČSSR. (Field Resistance of an Oat Collection to *Puccinia coronata* Cda. var *avenae* Fraser et Led. in Czechoslovakia.) Sbor. ÚVTI - Ochr. Rostl., *6*, 1970a : 89-94.
ŠEBESTA, J.: Seedling resistance of oat assortment to oat crown rust (*P. coronata* Cda. var. *avenae* Fraser et Led.). I. Reaction to physiologic races 228, 231, 239, 240 and CS 1. In: Vědecké práce Výzk. úst. rostl. výroby, Praha - Ruzyně, 1970b, No. 16 : 55-64.
ŠEBESTA, J.: Fyziologické rasy rzi ovesné (*P. coronata* Cda. var. *avenae* Fraser et Led.) v Československu a odolnost ovsů k nim. (Physiological Races of *Puccinia coronata* Cda. var. *avenae* Fraser et Led. in Czechoslovakia and the Resistance of Oat to them). In: Sbor. věd. prací ze III. celostát. konference o ochraně rostlin, I. část, Praha, 1970c : 275-293.
ŠEBESTA, J.: Fyziologická specializace *P. coronata* Cda. var. *avenae* Fraser et Led. v ČSSR v letech 1965 a 1966. (Physiological Specialization of *Puccinia coronata* Cda. var. *avenae* Fraser et Led. in Czechoslovakia in the Years 1965 and 1966.) Sbor. ÚVTI - Ochr. Rostl., *6*, 1970b : 83-88.
ŠEBESTA, J.: Seedling resistance of oat assortment to oat crown rust (*P. coronata* Cda. var. *avenae* Fraser et Led.). II. Reaction to the second group of physiologic races identified in Czechoslovakia. In: Vědecké práce Výzk. úst. rostl. výroby, Praha - Ruzyně, 1972a, No. 17 : 181-188.
ŠEBESTA, J.: Physiologic races of oat crown rust in Czechoslovakia and their epidemic importance. In: Proceed. Europ. et Mediter. Cer. Rusts Conf. I. část, Praha, 1972b : 257-261.
ŠEBESTA, J.: International cooperation in oat rusts research. In: Proceed. Europ. et Mediter. Cer. Rust Conf., II. část, Praha, 1972c : 35-39.
ŠEBESTA, J.: Infektionsmethoden zur Selektion auf Rostresistenz des Getreides im Gewächshaus und im Freiland. In: Bericht Arbeitstagung 1972 Arbeitsgemeinschaft Saatzuchtleiter in Gumpenstein (Österreich) von 28.30. November, 1972d.
ŠEBESTA, J.: Fyziologické rasy *Puccinia coronata* Cda. var. *avenae* Fraser et Led. v Československu v letech 1967 a 1968. (Physiological Races of *Puccinia coronata* Cda. var. *avenae* Fraser et Led. in Czechoslovakia in 1967 and 1968.) Sbor. ÚVTI - Ochr. Rostl., *9*, 1973 : 89-94.
ŠEBESTA, J.: The inheritance of resistance in oats to Central European crown rust races. In: Proceed. Europ. et Mediter. Cer. Rusts Conf., Interlaken, Switzerland 1976 : 156-158.
ŠEBESTA, J.: O patogennoj specializacii *P. graminis avenae* i *P. coronata avenae* v Jevrope i meždunarodnom sotrudničestve v oblasti ich issledovanija. Sov. po probleme issled. pojavlenija fiziol. ras, v častnosti ržavčiny i mučnistoj rosy zlakov. 4.—7. marta 1975, Meisdorf (Aschersleben), NDR, 1975b.
ŠEBESTA, J.: Moderní způsoby boje proti obilním rzím. Vertikální a horizontální rezistence a tolerance. (Modern methods of cereal rusts control. Vertical and horizontal resistance and tolerance.) Studijní informace Ř. Ochr. rostl., No. 1, 1975c.
ŠEBESTA, J.: Dědičnost vertikální rezistence kultivarů ovsa Dodge a Garland ke rzi travní (*P. graminis* Pres. f. sp. *avenae* Erikss. et Henn.). [Inheritance of vertical resistance of oat cultivars Dodge and Garland to stem rust (*P. graminis* Pers. f. sp. *avenae* Erikss. et Henn.)]. Sbor. ÚVTIZ - Genet. a šlecht., *13*, 1977 (v tisku).

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ŠEBESTA, J. (Ústav ochrany rostlin VÚRV, Praha - Ruzyně): *Dědičnost vertikální odolnosti ovsa odrůd 'Dodge' a 'Garland' ke středoevropským populacím rzi ovesné.* Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 71-79.

Odolnost ovsa odrůd 'Dodge' a 'Garland' k *P. coronata* Cda. var. *avenae* Fraser et Led., rasám 201, 228, 229, 230, 232, 238, 239 a 240 je podmíněna dvěma nezávislými dominantními a pravděpodobně jedním recesivním genem. Rezistence k rasám 216, 265 a CS 1 je založena monofaktoriálně. Faktor účinný proti rase 265 je pravděpodobně odvozen z odrůdy 'Victoria', zatímco faktor účinný proti rasám 216 a CS 1 pravděpodobně pochází z odrůdy 'Landhafer'. Bylo dokázáno, že alespoň část genetického základu pro odolnost ke rzi ovesné je u odrůd 'Dodge' a 'Garland' identický. Major-geny pro odolnost ke rzi ovesné odrůdy 'Dodge' a pravděpodobně také odrůdy 'Garland' nejsou alelické s genem Pc-39, takže tyto je možné akumulovat v jedné odrůdě. Je diskutována otázka šlechtění multigenní odrůdy při využití těchto zdrojů odolnosti ke rzi ovesné.

oves; odolnost; rez ovesná; rasy

ШЕБЕСТА, Й. (Институт защиты растений НИИР, Прага - Рузыне): **Наследственность вертикальной устойчивости овса сортов 'Додж' и 'Гарланд' к среднеевропейским популяциям корончатой ржавчины овса.** Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 71-79.

Устойчивость овса сортов 'Додж' и 'Гарланд' к *P. coronata* Cda. var. *avenae* Fraser et Led.,, к расам 201, 228, 229, 230, 232, 238, 239 и 240 обусловлена 2 независимыми доминантными и, повидимому, 1 рецессивным генами. Устойчивость к расам 216, 265 и CS 1 носит монофакторный характер. Действенный против расы 265 фактор выведен, вероятно, из сорта 'Виктория', а действенный против 216 и CS 1 фактор — из сорта 'Ландгафер'. Доказано, что по крайней мере часть генетической природы устойчивости к корончатой ржавчине у сортов 'Додж' и 'Гарланд' идентична. Мажор-гены устойчивости к корончатой ржавчине сорта 'Додж' и, вероятно, 'Гарланд', не аллельны с геном Pc-39, ввиду чего их можно аккумулировать в одном сорте. Обсуждается вопрос селекции мультигенного сорта при использовании этих источников устойчивости к корончатой ржавчине.

овес, устойчивость; корончатая ржавчина овса; расы

ŠEBESTA, J. (Institut für Pflanzenschutz, Praha - Ruzyně): *Erblichkeit der vertikalen Resistenz der Hafersorten 'Dodge' und 'Garland' gegen mitteleuropäische Populationen von Kronenrost des Hafers.* Sbor. ÚVTIZ - Genet. a Šlecht., *13,* 1977 (1) : 71-79.

Die Widerstandsfähigkeit der Hafersorten 'Dodge' und 'Garland' gegen die Rassen 201, 228, 229, 230, 232, 238, 239 und 240 von *P. coronata* Cda. var. *avenae* Fraser et Led. ist durch zwei unabhängige dominante Gene und wahrscheinlich durch ein rezessives Gen bedingt. Die Resistenz gegen Rassen 216, 265 und CS 1 beruht auf einer monofaktoriellen Grundlage. Der gegen Rasse 265 effektive Faktor scheint von der Sorte 'Victoria' abgeleitet zu sein, indem der gegen die Rassen 216 und CS 1 wahrscheinlich von der Sorte 'Landhafer' stammt. Es wurde nachgewiesen, daß wenigstens ein Teil der genetischen Grundlage der Resistenz gegen den Kronenrost des Hafers bei den Sorten 'Dodge' und 'Garland' identisch ist. Die „Major"-Gene für die Resistenz gegen Kronenrost des Hafers bei der Sorte 'Dodge' und wahrscheinlich auch bei der Sorte 'Garland' sind nicht allel mit dem Gen Pc-39, so daß es möglich ist, diese in einer Sorte zu akkumulieren. Die Frage der Züchtung einer Polygensorte bei Ausnutzung dieser Quellen der Resistenz gegen Kronenrost des Hafers wird diskutiert.

Hafer; Resistenz; Kronenrost des Hafers; Rassen

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