

Grape selection for resistance to biotic and abiotic environmental factors

N. I. GUZUN, P. N. NEDOV, V. T. USATOV, I. A. KOSTRIKIN and L. F. MELESHKO

The Moldavian Research Institute for Viticulture and Enology 'Virul', 59, Virul Street, Kishinev, 277034, USSR

S u m m a r y: Most of the viticultural regions of the USSR are located under conditions of limiting biotic and abiotic factors, with frosts, drought, fungal diseases, phylloxera, mites, grape berry moths and some others being of primary importance. The main breeding organizations have been creating for more than 40 years new table and wine cultivars with complex resistance according to long-term programs. These cultivars are own-rooted and capable of wintering in outdoor culture with a limited amount of spray treatments, if any.

In crossing, Amur grape and its hybrids, cultivars Seibel and Seyve Villard and some others are used as donors of resistance. Using biophysical and cytoembryological methods, gametes are treated with physical and chemical mutagenic factors in order to increase the variability range of F_1 seedlings, aiming at higher efficiency of selection. The process of selection is accelerated if seedlings are grown hydroponically. Analysis of the F_1 hybrid population determines the nature of the inheritance of valuable agricultural characters and the selection of pairs. The *in vitro* method is used when seedlings are grown from non-vital seeds, callus embryoids and in accelerated propagation of valuable genotypes providing virus and bacteria elimination.

More than 50 cultivars with complex resistance have been bred during 35 years. More than 10 of them have been recommended for culture (Moldova, Lyana, Vostorg, Sukholimanski biely, Pervenets Magaracha, and others), while the remainder are being tested in different viticultural regions of the Soviet Union.

K e y w o r d s: genetics, breeding, selection, analysis, resistance, cold, drought, virus, bacteria, fungus, pest, Vitis, variety of vine, USSR.

Once in 10-12 years grapevines in the vineyards of the Black Sea regions are damaged by frosts and dangerous winters, leading to production losses in commercial plantings. During years with rainy summer outbreaks of diseases (downy mildew, oidium, anthracnose, grey rot) and pests (spider mites, grape berry moths etc.) are observed, which reduce yield quantity and quality. Under these conditions, classical varieties do not always produce stable yields. New varieties with improved resistance to limiting factors of biotic and abiotic nature are necessary.

In the scientific centres dealing with viticulture (Kishinev, Odessa, Yalta, Novochoerkassk, Erevan), more than 30 years of basic research and long-term grape breeding programmes have performed to meet requirements of modern industrial viticulture. A variety model is elaborated for each region. The requirements for new varieties depend on the consumer's needs and taste, the industry's plan and the cultivation methods to be used. Quality characters combined with characters of resistance to low temperatures, dangerous fungal diseases and pests, necessary for each region, are accounted for in the 'variety model' and the selection procedure. Selection criteria include: for table varieties – appearance, taste qualities, transportability, ability to long-term storage, short vegetation period; for wine varieties – high sugar content, short vegetation period, high juice yields, suitability for mechanized harvest, colour quality and stability of wines, combined with quality characters peculiar to varieties which are already recommended.

The next step of the programme is the identification of parent material for breeding new varieties. Successful selection of parent pairs provides with a high variability of characters, plasticity of hybrid progeny and results in elite selections. It has been determined that crosses involving the species *V. cordifolia*, *V. longii*, *V. cinerea*, *V. monticola*, *V. berlandieri*, *V. riparia*, *V. rupestris*, *V. amurensis* result in varieties which are bearers of complex characters of resistance. *V. vinifera* varieties of the Black Sea basin group are used as donors of physiological factors of high adaptation to growing conditions. Some varieties from Georgia have higher resistance to downy mildew, grey rot and phylloxera (E.I. CHAMAGUA, V.P. GOTSERYDZE). Varieties of the West European group are donors of high quality. Varieties of the eastern group are grown for transportable table grape

varieties suitable for storage. R. Seibel's and Seyve Villard's interspecific hybrids give the possibility of advancing the creation of complex resistant varieties (frost, fungal diseases, root phylloxera, etc.).

Analysis of our investigations demonstrated that the method of introgressive selection, application of interspecific hybridization, using physical and chemical mutagenic factors increase the variability spectrum in the F_1 generation. The following rules are used in hybridization:

- 1) Varieties obtained as a result of the latest selections are used as donors of resistance.
- 2) Selection of parent pairs is directed to growing new varieties for their use in special purpose (early table grape, champagne trend, cognac etc.).
- 3) Analysis of the F_1 generation (elements of genetics by economic valuable characters) is carried out using accelerated methods of growing seedlings in conditions of closed hydroponics (NPO 'Vierul'). On this basis, the combining ability of parent pairs is determined, allowing more effective selection.
- 4) Seedling (elite) selection is carried out on the basis of careful evaluation of plants in regards to quality (micro-vinification, organoleptic evaluation), resistance to winter frost, fungal diseases and phylloxera.
- 5) Production testing of candidates in varieties under different climatic conditions, transferring the best of them to state variety test.

The heritability of malvidin-diglucoside content shall be especially mentioned. Scientific work carried out in Novochoerkassk and Kishinev on this problem showed that heredity of oak and colouring properties in the berries of F_1 hybrids occurred with clear division into classes, which was evidence of discrete character heritability. Malvidine content is inherited independently. In some combinations, elite selections are obtained, which have no trace of malvidine. Variability amplitude of the given group of chemical combinations shows the polygenic character of inheritance. When crossing *V. vinifera* and *V. amurensis*, seedlings both with and without diglucosides are obtained in the first generation. It may be supposed that it depended from a 'dose effect', introduced by the European component and the possibility of partial or complete regression of a 'wild type' genes effect from the Amur grape.

In the past 25-30 years more than 500,000 seedlings have been obtained at the selectional centres of the USSR. 80 of these genotypes have been proposed to state for advanced testing and 25 varieties have been registered until 1989.

Grapevine resistance to pests and diseases

In 'Plant Immunity to Parasitic Diseases' by N. I. VAVILOV (1935) it was noted that the most effective control method against pests and diseases of agricultural plants is breeding and introduction of resistant varieties into production. The basic method of selecting agricultural plants for resistance in general and in grapevine especially includes determination of susceptibility of initial breeding material (species, present interspecific hybrids and cultured varieties) for use of resistant genotypes as donor parents.

For providing the resistance value of collection species, complex interspecific hybrids and *Vitis* varieties as well as progeny forms received from different crossing combinations it appeared possible to carry out investigations in the next basic ways:

- 1) Investigations on the nature of resistance (factors causing non-susceptibility) of grapevine to main harmful organisms.
- 2) Exposure of correlated connections between resistance factors and outer manifestation of resistance under field conditions.
- 3) Elaboration of methods for forming artificial and natural infectious background for carrying out resistance evaluation of parent components and hybrid progeny and creation of reliable score scales for determining the degree of resistance of species, varieties and selection elites of grapevine to pathogenic organisms and pests.

4) Investigations of resistance genetics exposing regularity of inheritance of characters of resistance and quality for their using in selection for resistance in future.

Above-mentioned investigations have been carried out and are being continued by scientific workers of Plant Protection Department, immunologists of Moldavian Institute of Viticulture NPO 'Vierul' and Phytopathology Department of Kishinev Agricultural Institute (D.D. VERDEREVSKY, K.A. VOITOVICH, I.N. NAIDYONOVA, P.N. NEDOV, A.P. GULER, G.E. VESMINSH, L.F. SUPOSTAT, E.A. KYABURU, O.S. REBEZA, PEREPELYTSA, and others). Investigations on grape selection are continued by scientific workers of Selection Department of Moldavian Research Institute of Viticulture and Enology NPO 'Vierul' (M.S. JURAVEL, G.M. KARADIJ, N.I. GUZUN, M.V. TSYPKO, G.M. BORZYKOVA, F.A. OLARI, G.A. SAVIN, A.D. POPOV, I.P. GAVRILOV, and others).

Investigations on resistance of grapevines to pathogenic organisms and pests during the last 10 years yielded the following principle results:

1) The presence of well expressed resistance of *Vitis* varieties to pathogens of main grapevine fungal diseases has been determined. These included: downy mildew (*Plasmopara viticola* BERL. et DE JONI), oidium (*Uncinula necator* BURR, *Oidium tuckeri* BERK.), grey rot (*Botrytis cinerea* PERS.), anthracnose (*Gloeosporium ampelophagum* SACC.), and brenner (*Pseudopeziza tracheiphila* MÜLL. THURG.). No resistance (at degree needed for selection) to spot necrosis pathogen (*Racodiella vitis* STERNB., *Mollisia vitis*) was discovered. All grapevine species and varieties presented in ampelographic collection are affected almost to an equal degree by this disease under conditions favourable for pathogen development.

Chronic diseases of bacterial and viral etiology occupy a special place. As to bacterial canker (*Agrobacterium tumefaciens* CONN.), it was determined that there are certain different qualities of resistance to this disease among *Vitis* species, leading to tumor formation. However, all species, interspecific hybrids and European grapevine varieties may be potential infection bearers. And analogy to harmful virus diseases of grapevine was noted. As to chronic diseases of viral and bacterial origin, phytosanitary selection methods may be applied for obtaining healthy clones to be used in breeding of virus and bacterium free plantings. Virus free and bacterial canker tested clones are widely planted and intensively bred.

2) Anatomical-morphological, physical-biochemical and antimicrobial factors responsible for non-susceptibility of grapevine to fungal diseases have been exposed. The principal ones are: activity of oxidation-reduction processes, identity of readily soluble protein fractions of plant tissue and parasites, as well as some antimicrobial tissue properties.

3) A method of resistance evaluation using 5-score scales of resistance to fungal diseases was developed and applied to determine the degree of resistance of approximately 2500 species, interspecific hybrids and European grapevine varieties. Several species, interspecific hybrids and a few varieties which were distinguished by resistance to fungal diseases are used successfully as donors in resistance selection.

4) Factors resulting in grapevine resistance to the principal pests were studied; these are: root and grape phylloxera (*Dactylosphaera vitifolii* SHIMER), red spider mite (*Panonychus ulmi* KOCH), grape berry moths (*Lobesia botrana* DEN. et SCHIFF. and *Eupoecilia ambiguella* HB.). It was determined that the character and intensity of rot process played a principal role in destruction of roots after phylloxera damage. We came to the conclusion that different (by virulence) grape phylloxera races are absent. Different damage degree of the same species is connected to the physiological-biochemical state of the plant but not to the presence of races differing in aggressiveness. Morphological leaf features and some biochemical factors, referring 'preference or non-preference' of tissues for feeding are the main factors of resistance to red spider mite. As to phylloxera (root and grape) and red spider, well evident resistance differentiation was shown. Investigations on the resistance to grape berry moths led to the conclusion that within the genus *Vitis* there are insignificant differences in susceptibility. It was also noted that an important factor in

comparable resistance of grapevine varieties to grape berry moths are aromatic constituents, which are contained in the flowers and act as attractants to these pests.

5) Laboratory, vegetative and field evaluation methods for selection of genotypes resistant to fungal diseases and to pests were developed; in this case 5-score scales were used for mathematical processing of the obtained data. The results showed that in the F_1 generation resulting from different crossing combinations of interspecific hybrids and high quality European grape varieties, resistances vary within wide limits and are inherited polygenic dominantly independently (in many cases) from each other exposing heterosis and transgression.

In general it may be concluded that there are no absolute genetic limits for obtaining varieties recombinants having complex field resistance to abiotic and biotic factors in combination with fruit quality similar to that of European varieties. Selection practice of resistant varieties which is carried out in different regions of the USSR and countries of Council for Mutual Economic Assistance (CMEA) testify to this. As a result of resistance breeding, the following varieties are being cultivated or undergoing advanced testing: table grape varieties: Moldova, Juravel's Jubilee, Kodryanka, Frumoasa alba, Suruchensky bely, Vierul-59, Vostorg, Agat donskey, Lanka, Tayr, Muscat odessky; wine varieties: Vioryka, Muscat de Yaloveny, Plai, Negru de Yaloveny, Golubok, Rubin tairovsky, Karin, Adysy, Pervenets Magaracha, Antey, etc. These varieties may be cultivated using one to two pesticide sprayings, or without chemical protection, are resistant to low temperatures down to -26°C , regenerate fruiting shoots after severe winters, have stable annual yields equal in quality to those of regionalized varieties, some of them are tolerant to root phylloxera and may be grown in own-rooted culture.

In the USSR, work in grapevine selection is done in close collaboration with scientists of Bulgaria, Hungary, Romania, Czechoslovakia. An active exchange of selection material and new varieties takes place.

The results of resistance improvement in Eger

L. BEREZNAI¹⁾ and L. OLAH²⁾

¹⁾ Research Institute for Viticulture and Enology, P. O. Box 25, H-6001 Kecskemét, Hungary

²⁾ Egervin Research Centre, P. O. Box 83, H-3301 Eger, Hungary

A b s t r a c t: The two-thirds of Hungary's vine-growing area is endangered by the winter and spring frosts. As far as the traditional varieties are concerned, the risk of production is rather great. Moreover, environmental conservation has become one of the key questions of the last few decades. Thus resistant and tolerant grapevine varieties are attracting more and more interest.

From 1948 within the frame of resistance improvement we have tested 125 crossing combinations in Eger. The interspecific hybrids are characterized as follows:

- good hardiness
- good resistance to *Plasmopara viticola*
- excellent tolerance against phylloxera
- loose clusters that make them less susceptible to botrytis
- good sugar production
- suitable for large-scale production and mechanical harvesting
- their wine quality corresponds to that of the traditional varieties.