

Grapevine breeding for tropical and subtropical environments in Brazil

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Key words: *Vitis* spp., Hybrid, Variety, Table Grapes, Wine Grapes, Juice Grapes, Tropical Grapes, Disease Resistance, Grape Quality.

Summary

Since the decade of the 1960s, viticulture has gained significance in different hot climate regions. The quality of table grapes, wines and juices produced under tropical and subtropical conditions in countries such as Brazil, Venezuela, India and Thailand has begun receiving international recognition. Since tropical viticulture allows programming harvests for any day of the year, it offers prospects for great expansion, be it for a continuous market supply with table grapes, be it for making possible the production of large amounts of wines and juices in small industrial plants. In tropical viticulture, usually traditional grape varieties of the temperate zones are used, which, generally, present adaptation problems in hot climates (bud dormancy, apical dominance, low fertility, susceptibility to diseases, unbalanced vigor), limiting the number of varieties suitable for cultivation in these regions. In order to foment the development of the Brazilian tropical viticulture, the National Research Center for Grape and Wine of the Brazilian Agricultural Research Agency (Embrapa) carries out a genetic grape breeding program, aiming at creation of new cultivars which combine adaptation to tropical environments, fruit quality according to its purpose (table grapes, juice, wine), productivity and disease resistance. The classic breeding method consisting of crossings and selection is used, combined with biotechnological techniques in both the process of generating populations and the selection procedures. In this paper the methodological procedures and the seven new, already released varieties for tropical climates are presented, three of which are seedless table grapes, two are grapes for wine and two for juice.

Introduction

Tropical viticulture has only been practiced commercially since approximately 50 years. Countries such as Brazil, India, Thailand and Venezuela play a leading role in the tropical grape production. However, it can be noted that there is a trend towards the expansion of tropical viticulture in the world, since there are vineyards being implemented in different countries in America (Bolivia, Colombia, Peru, Guatemala), in Africa (Madagascar, Namibia, Tanzania) and Asia (Vietnam, China). The production technology in the tropical regions differs significantly from the one employed in the traditional temperate regions. The absence of a dormancy period allows for successive cycles and harvest programming throughout the year. The cultivars adopted in the tropical viticulture, however, have their origins mainly in temperate regions, this being the cause of physiological and sanitary problems of the grapevine. It is necessary to break the bud dormancy in order to foster bud burst, and special management techniques have to be employed to overcome problems of low fertility and to control vigor. In tropical zones, viticulture has become an activity of high risk due to the aggressiveness of traditional diseases such as mildew (*Plasmopara viticola*), anthracnose (*Elsinoe ampelina*) and powdery mildew (*Uncinula necator*). Other fungal diseases which do not exist or which are uncommon in temperate regions are

relatively important problems under tropical conditions. Among the main agents are: *Isariopsis clavispora*, *Glomerella cingulata*, *Guinardia bidwelli*, *Cercospora viticola* and others. Bacterial canker (*Xanthomonas campestris* pv. *Viticola*) and Pierce's disease (*Xylella fastidiosa*) are outstanding among bacterial diseases. Breeding results already obtained by Fennel (1945; 1948), Santos Neto (1955; 1971), Mortensen (1971; 1977) and Mortensen & Stover (1982; 1983) show that it is possible to obtain new grapevine cultivars which are adapted to the tropical environment through crossings of commercial cultivars, interspecific hybrids and tropical species of *Vitis*. In this study the methodological procedures and seven new grapevine cultivars created by the genetic breeding program of the Brazilian Agricultural Research Agency – Embrapa/ National Center for Research on Grape and Wine are presented.

Material and methods

According to the traditional breeding method, parents are crossed and the populations are evaluated on the field. The germplasm used can be divided into four categories, as follows:

- a) *V. vinifera* cultivars to obtain the specific quality requirements for wine and table grapes;
- b) *V. labrusca* cultivars as a source of aroma and flavor for juice and of table grapes with the organoleptic characteristics of this species, besides as a source for diseases resistance;
- c) interspecific hybrids, combining defined specific attributes of quality, productivity and resistance to fungal diseases, especially to downy mildew (*Plasmopara viticola*), powdery mildew (*Uncinula necator*), and grey rot (*Botrytis cinerea*); and,
- d) wild species of *Vitis*, particularly *V. shuttleworthii* and *V. gigas*, besides *V. caribaea*, *V. candicans*, *V. smalliana* and others as basic material to obtain adaptation and resistance to diseases.

According to the specific objectives of the program, basic combinations between the following crossings are used: a) *V. vinifera* and *V. labrusca* x interespecific hybrids, for wine grapes; b) *V. vinifera* x *V. labrusca*, *V. vinifera* and *V. labrusca* x hybrids and hybrids x hybrids for juice grapes; *V. vinifera* x *V. labrusca*, *V. vinifera* and *V. labrusca* x hybrids and hybrids x hybrids for tables grapes.

To obtain new seedless table grapes, the technique of embryo rescue and culture adapted from Cain et al (1983) and Emershad & Ramming (1984) is used. In case of seeded x seedless crossings assisted selection using the SCAR marker SCC8 is used according to Revers et al. (2006).

For evaluation a hierarchical order of the required characteristics, previously established for each crossing, is followed, which prioritizes the attributes of quality, production potential and resistance to diseases. The quality is evaluated according to the objective of each crossing, and the evaluation of the production potential is performed based on the bud fertility and the characteristics of the bunch. The resistance to fungal diseases is assessed after periods which are favorable to their incidence, on untreated plants. The evaluation scales recommended by IPGRI (1997) are used.

The selection is carried out in tropical environment, using two vegetative cycles each year and special technical procedures in order to reduce the juvenile phase and to speed up the selection process according Huglin & Julliard (1964). The final evaluations are done, as well as the selection, in cooperation with growers on the viticultural regions, having two harvests each year at each vineyard.

The new varieties are protected and characterized by molecular markers SSR.

Results and discussion

Throughout the 30 years of work, 1240 crossings which have originated more than 40 000 plants have been performed. More than 600 plants including table grapes with and without seeds, grapes for wine, grapes for juice have been selected, as well as F1 crossings with wild, mainly tropical species. Eighty five selections from this material have been incorporated into the germplasm bank due to the importance of their genetic combinations. Approximately 500 selections which combine desirable features of quality, productivity and resistance to diseases are kept and assessed to be used in the crossing program. Up to this moment, 24 selections have been taken to the final evaluation in cooperation with the winegrowers in different winegrowing regions of the country, and seven new cultivars which are adapted to tropical and subtropical environments have been released.

In the basic crossings, which involve wild species, it was observed that the populations deriving from tropical species possess great vigor as a general feature, however, low fruit quality. Except for the hybrids of *Vitis shuttleworthii*, which have berries of reasonable size, though of poor texture, the descendants of the other species, such as *V. gigas*, *V. smalliana*, *V. candicans*, e *V. caibaea* have small berries. In the second generation, however, obtained through back-crossing with commercial grapes the fruit has gained significantly in quality. As regards grapes for wine, it was possible to select new cultivars from crossings between already existing interspecific hybrids with commercial *V. vinifera* cultivars already in the first generation, and thus to achieve the combination of commercial quality, productivity, resistance to diseases and adaptation to the tropical environment. Yet, as regards table grapes and grapes for juice, it was only possible to select new cultivars from the second generation. The selections which derive from tropical species are considered to be of great genetic value due to the features adaptation and resistance to various diseases.

The seven cultivars released for tropical and subtropical conditions in Brazil are reported on in the following.

1. Table grapes

Three new seedless grape cultivars developed from crossings performed in 1997 were released in 2003. The three cultivars were evaluated in the different Brazilian production regions, in experiments in the states of Rio Grande do Sul (31°32'S), Paraná (23°22'S), São Paulo (20°15'S), Minas Gerais (17°15'S), Pernambuco (09°22'S) and Ceará (05°07'S). Their productivity in tropical climates range between 20 and 35 t/ha, whereas the productivity of the traditional seedless grape cultivars, such as Thompson seedless, Flame seedless, Sugraone and others, on the average, do not surpass 10 t/ha. Their specific features are described in the following.

BRS Morena was obtained from the crossing Marroo seedless x Centennial seedless. Its bunch size is medium, 450-500g, loose, black berries, crisp, high sugar content, easily reaching 20 °Brix. It is a cultivar of high fertility, generally with two bunches per shoot, allowing for harvests of 20 to 25 t/ha. The natural berry size is 16mm x 20mm, however, it responds well to the application of gibberellic acid, reaching 20mm x 22mm, when treated adequately.

BRS Clara derives from the crossing CNPUV 154-147 (SV 12327 x CG 87746) x Centennial seedless. Its bunch is medium, 500-600g, loose, yellowish berry, crisp, muscat flavor, sweet, reaching 20°Brix. It is a cultivar of high natural fertility in hot climates, one or two bunches per shoot, with medium productivity of 30 t/ha. The berry is elliptic, 15mm x 20mm, reaching 18mm x 22mm with the use of gibberellic acid.

BRS Linda was obtained from the crossing CNPUV 154-90 (SV 12327 x CG 87746) x Saturn. The bunch is medium-sized, 450 -600g, the berry is green, crisp, the sugar content reaches 14

°Brix, however, due to the low acidity, the flavor is balanced, agreeable. It could be a diet grape. BRS Linda is a highly fertile cultivar with two bunches per shoot. It is recommendable to limit the productivity to 30 t/ha in order to guarantee grape quality. The natural berry size is 19mm x 24mm, however, it reaches 22mm x 27mm with the use of gibberellic acid.

2. Grapes for wine

Two new white grape cultivars have been released, Embrapa 131- Moscato Embrapa and BRS Lorena, tested with good results in the states Rio Grande do Sul (29°11'S), São Paulo (20°15'S), Mato Grosso (13°52'S), and Pernambuco (09°22'S). Main characteristics of both cultivars are adaptation to the tropical and subtropical regions of Brazil, muscat flavor and resistance to downy mildew (*Plasmopara viticola*) and to grey rot (*Botrytis cinerea*).

Embrapa 131- Moscato Embrapa was obtained from the crossing Couderc 13 x July Muscat. It is a highly fertile cultivar, reaching easily 40 t/ha. Its flavor is muscat and its acidity is moderate. It is used to make dry and soft white table wine. The sugar content is, on average, 19 °Brix.

BRS Lorena was obtained from the crossing Malvasia Bianca x Seyval. It has high sugar content, 22 °Brix, with a productivity of 30t/ha. BRS Lorena has muscat aroma and flavor and balanced acidity, being a good choice for the preparation of dry and soft table wines, as well as for sparkling wines produced by the Asti procedure.

3. Grapes for juice

Two new cultivars were developed for juice production under tropical conditions in Brazil: BRS Cora and BRS Violeta. Both are hybrids of *V. labrusca* and possess great adaptation in tropical climates, with successful evaluation in the states of Rio Grande do Sul (29°11'S), São Paulo (20°15'S), Minas Gerais (19°33'S), Mato Grosso (13°52'S) and Pernambuco (09°22'S). The intensive violet coloration of the juice and the high sugar content of the grape are distinguishing features of these cultivars.

BRS Cora is a hybrid *labrusca-aestivalis-vinifera* resulting from the crossing Muscat Belly A (*labrusca-aestivalis-vinifera*) x BRS Rúbea (*labrusca*). It has moderate vigor and very high fertility, with 3-4 bunches per shoot, its resistance to downy mildew (*Plasmopara viticola*) is moderate and to grey rot (*Botrytis cinerea*) high. The sugar content, with productivity close to 30t/ha, is around 19 °Brix, with acidity of 100 mEq/L. BRS Cora produces intensively colored juice, with a flavor that is characteristic for *V. labrusca*.

BRS Violeta is a complex hybrid resulting from the crossing Traviú (*vinifera-labrusca-rupestris-aestivalis-riparia-berlandieri-cinerea*) x BRS Rúbea (*labrusca*). Its vigor is medium and its fertility high, it bears two bunches per shoot, allowing yields of 25 to 30 t/ha of grapes with a sugar content around 20 °Brix. Its resistance to downy mildew (*Plasmopara viticola*) is good, and to grey rot (*Botrytis cinerea*) high. The juice has a characteristic labrusca flavor, is intensively colored and has low acidity, between 50 and 60 mEq/L.

Conclusions

The grape germplasm possess variability for the obtention of new cultivars, combining the characteristics adaptation to tropical environment, resistance to diseases and quality for the production of wine, juice or table grapes.

Two generations are not sufficient to obtain an adequate quality in hybrids of wild tropical species.

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