

30 Years VIVC - *Vitis* International Variety Catalogue (www.vivc.de)

E. Maul, K. N. Sudharma, A. Ganesh, M. Hundemer,
M. Walk, S. vom Weg, A. Mahler-Ries, U. Brühl,
R. Töpfer
Julius Kühn-Institut
Institute for Grapevine Breeding Geilweilerhof
76833 Siebeldingen
Germany

S. Kecke, G. Marx, T. Schreiber

Julius Kühn-Institut
Erwin Bauer Str. 27
06484 Quedlinburg
Germany

Keywords: grapevine, genetic resources, preservation, database, documentation, characterization, identification, synonymy, homonymy, microsatellites

Abstract

The concept of a database on grapevine genetic resources was supported by IBPGR (today called Bioversity) and the International Organisation of Vine and Wine (OIV). In 1984 the establishment of the *Vitis* International Variety Catalogue (VIVC) took place at the Institute for Grapevine Breeding Geilweilerhof. Today VIVC is an encyclopedic database with around 23000 cultivars, breeding lines and *Vitis* species, existing in grapevine repositories and/or described in bibliography. It is an information source for breeders, researchers, curators of germplasm repositories and interested wine enthusiasts. Besides cultivar specific passport data, comprehensive bibliography and photos are to be found. Further search sections were implemented: “genetic resources monitoring”, “microsatellites by varieties”, “microsatellites by profiles”, “data on breeding and genetics” and “degree of resistance to diseases”. “Genetic resources monitoring” aims at pointing at the endangered grape germplasm maintained in only one place, to indicate where efforts for duplication of the material are required. “Microsatellites by varieties” and “microsatellites by profiles” support cultivar identification by providing genetic profiles of the nine Genres081/GrapeGen06 SSR-markers VVS2, VVMD5, VVMD7, VVMD25, VVMD27, VVMD28, VVMD32, VrZAG62 and VrZAG79 for more than 2000 cultivars. “Data on breeding and genetics” imparts knowledge on activities and achievements in the field of QTL research, to avoid unnecessary duplication of work and to provide valuable data for users. “Degree of resistance to diseases” aims at indicating susceptibility respectively tolerance of cultivars mainly against fungal diseases. Altogether the new sections contribute to preserve and valorize grape germplasm for future generations. VIVC is perpetually supplemented. New findings from scientific publications are incorporated and new bred cultivars are added. Inventories of germplasm collections are updated and new ones are included. About 2.500 to 3.200 distinct users per month are counted, whereas the number of total visits per month varies between 5.000 and 8.000.

INTRODUCTION

In 1979 the vice-president of the OIV expert group “Vine selection”, Professor Gerhard Alleweldt, expressed his concern about safeguarding of genetic diversity (of *Vitis*). Owing to his endeavors in 1982 a Working Group on *Vitis* Genetic Resources met in Thessaoloniki, convened by the International Board for Plant Genetic Resources (today called

Bioversity). In the same year the expert group “Grapevine Breeding” of the Organization for Vine and Wine (OIV) adopted a resolution in the same context. Both groups recommended collection, description and preservation of the grapevine genetic resources and the development of international cooperation between gene banks (IBPGR, Maul-Newsletter 1). In addition a database was needed for grape germplasm documentation. Its establishment took place at the Institute for Grapevine Breeding Geilweilerhof in 1984. As database management system dBASE was used.

At that time the database comprised of:

- Multi Crop Passport Descriptor (MCPD) data of grapevine cultivars, breeding lines and *Vitis* species maintained in grapevine collections and described in literature. The MCPD comprised of the prime name, synonyms, berry color, country of origin, breeder, parentage, year of cross, *Vitis* species, use and holding institutions.
- Worldwide existing grapevine collections

Prior to establishment of the Web site *Vitis* International Variety Catalogue (VIVC) in 1996, database content was printed. “The Genetic Resources of *Vitis*”, part I and II first appeared in 1987 (Alleweldt 1987a, Alleweldt 1987b), the 2nd edition was made in 1988 (Alleweldt 1988a, Alleweldt 1988b) and the 3rd in 1992 (Alleweldt and Dettweiler 1992a, Alleweldt and Dettweiler 1992b). The “World List of Grapevine Collections” was published in 1988 (Alleweldt 1988c) and the 2nd edition came out in 1994 (Alleweldt and Dettweiler 1994). In 1996 the Web presence of VIVC immediately opened the possibility to show photos of shoot tips, leaves and bunches.

Overall European cooperation in the field of grapevine genetic resources maintenance started in 1997, when Genres081-project was adopted by the European Commission (Maul and This 2008). Cooperation thus began 15 years after its recommendation by OIV in 1982. Due to the experience of grape documentation in VIVC the Institute for Grapevine Breeding Geilweilerhof took over to establish the European *Vitis* Database (www.eu-vitis.de) as an accession related database. Since then tree further European Projects followed which all supported the improvement of both the European *Vitis* Database and VIVC.

Today VIVC is an encyclopedic database with around 23000 cultivars, breeding lines and *Vitis* species. It is an information source for breeders, researchers, curators of germplasm repositories and interested wine enthusiasts.

MAIN OBJECTIVES

The VIVC encompasses cultivar/breeding line/species specific information serving multiple purposes. Main objectives are:

- Registration of the worldwide existing and/or documented grape germplasm
- Its comprehensive description
- Solution of synonymy, homonymy and misnaming
- Contribution in monitoring endangered germplasm preservation
- Recording of cultivar describing bibliography

Registration of the worldwide existing and/or documented grape germplasm

First activities were supported by OIV and Bioversity in 1983/1984. OIV initiated (a) a survey of worldwide existing collections and (b) provision of the collections’ inventories, listing accession names, synonyms, *Vitis* species, parentage and use (Töpfer et al. 2009). Bioversity funded the first year of database establishment. Simultaneously cultivar names and their passport data were retrieved from collections and taken from literature. This information was entered into the database and recorded on file cards. This was done according to principles agreed upon by the OIV Expert Group “Grapevine Breeding” in 1984, e.g. defining determination of prime names (Töpfer et al. 2009). Guidelines were established for standardization of cultivar name syntax. In 1987 the database comprised approximately

12.000 prime names. The difficulties caused by synonymy and homonymy were unexpectedly high, due to the fact that identical grapevine cultivars, especially older ones, were named differently or distinct grapevines were known under the same or a similar name. To overcome confusion of designations, description of grapevine cultivars was started. Eight characteristics recommended by Bioversity were applied. Comparison of notations revealed difficulties in standardized description and the presence of misnomers. For that reason a global identification of accessions was not achieved. Nevertheless in 1987 approximately 10.000 synonyms had been assigned to prime names. In 1984, to facilitate database management while memory capacity was limited, prime names received consecutive numbers as unique identifiers, called “variety number VIVC”. They became the key field of the database to which all prime name specific information was assigned. In the European Vitis Database “variety number VIVC” serves in joining synonymous designations belonging to the same prime name.

Today around 23.000 prime names and 42.000 synonyms are registered in VIVC. This increase was mainly due to intense cooperation between curators of grapevine repositories, improved accessibility to Eastern European germplasm and further acquisition of bibliography.

Comprehensive description of grape germplasm

The description of germplasm serves (a) for the distinction and identification of cultivars and (b) for the selection of appropriate genotypes for breeding, research and growers. In VIVC besides the cultivars’ Multi Crop Passport Descriptor data further information is provided like sex of flower, taste and formation of seeds. Photographs of 3708 shoot tips, 2123 leaves and 2717 bunches illustrate morphology from approximately 2000 registered prime names. Genetic profiles of more than 2000 cultivars are available, displaying allele sizes of the nine loci VVS2, VVMD5, VVMD7, VVMD25, VVMD27, VVMD28, VVMD32, VrZAG62 and VrZAG79. The use of these markers as a standard set was recommended by the participants of the European project Genres081 (This et al. 2004). Subsequently they were employed in most scientific analyses dealing with grape germplasm investigation. Until now allele sizes from almost 300 articles (<http://www.vivc.de>) were gathered, standardized according to reference varieties and compared. Matching fingerprints of the same cultivar from distinct sources and unique profiles were marked with different background colors (Fig. 1). For 996 prime names parent-offspring relationships uncovered by nuclear microsatellite analysis were added. Some of the new published parentages were in contradiction to breeders’ declarations. Bibliography confirming pedigrees by marker analysis are available on the cultivars fact sheet. Recently data on degree of resistance to diseases were uploaded for 2320 cultivars. Evaluation of degree of resistance was carried out according to OIV descriptor scales. The data were extracted out of 82 publications. Fourteen diseases e.g. *Alternaria* (*Alternaria alternata*), Black Rot (*Guignardia bidwellii*), Botrytis bunch rot (*Botrytis cinerea*), Downy mildew (*Plasmopara viticola*) and Powdery mildew (*Erysiphe necator*) were included.

Solution of synonymy, homonymy and misnaming

Old and widespread grapevine cultivars are often known under several local names. This is the reason why the same cultivar occurs under different designations in literature and in grapevine collections. It can also happen that the same name is used to designate different varieties. In addition misnaming is estimated at between 5 and 10% in the worldwide grapevine collections (Maul 2008). If not clarified all three phenomenon could contribute to loss of genetic resources. Hence since the early beginning of VIVC establishment, trueness to type assessment and appropriate cultivar designation were the most challenging tasks. At that time, besides description of the eight morphological characteristics, further tools were used in particular ampelometry, computerized leaf recognition programs and isoenzyme systems

(Dettweiler 1991). These methods assisted to sort out regional and sometimes international confusion, but were not applied on a large scale to whole grapevine collections or to international comparison studies.

After all nuclear microsatellites in combination with ampelography revolutionized cultivar recognition. In numerous grapevine collections preserved accessions were genotyped and variety identity was stated, which was most useful for validation of VIVC records. In addition fingerprints were generated within the European projects Genres081 (duration 1997 – 2002), Grapegen06 (duration 2007 – 2011) (Maul et al. 2012) and COST Action FA1003 (duration 2010 – 2014), which are accessible via the European *Vitis* Database by subscription. Furthermore allelic profiles were published in more than 300 articles. All that information is contributing to sort out VIVC. In the following some examples are given to illustrate the approach. Malvasia di Sardegna, Malvasia di Lipari, Greco bianco, Malvasia di Sitges, Malvazija Dubrovacka and Malvasia di Bosa were registered as six distinct prime names in VIVC. All six revealed to be the same cultivar, confirmed by fingerprint and ampelography (Crespan et al. 2006). Hence the latter five prime names were assigned to Malvasia di Sardegna. Likewise prime names Preveiral and Liseiret in use in Northwestern Italy were assigned to Heunisch Weiss (Schneider et al. 2001). The Portuguese Aragonéz was attributed to the Spanish Tempranillo and Mammolo to Sciacarello (di Vecchi Staraz et al. 2007). Blanc de Morgex, Danijela, Madeleine Salomon and Prie blanc turned out to be Agostenga (Schneider et al. 2011) and Borba from Spain was the same as Welschriesling (Maul unpublished). Regarding accessions which turned out to be misnomers “non identified” is placed behind the prime name. This was e.g. the case for misnomer Balsamina a direct Heunisch-offspring (Maul et al. 2015), which did not match with any Balsamina cultivar registered in VIVC. With respect to homonymy or similar naming VIVC prime names are modified to avoid confusion. For example the prime name Corinto nero a seedless Sangiovese was renamed in Sangiovese Seedless because of possible confusion with Corinthe noire=Korinthiaki. Two distinct Heunisch Rot cultivars exist. No reference is proposing an alternative designation. For discrimination Heunisch Rot No 1 and Heunisch Rot No 2 were chosen as prime names (Maul et al. 2015).

Contribution in monitoring endangered germplasm preservation

The three main objectives of VIVC, which were described above, are prerequisites for monitoring germplasm preservation, because they are leading to trueness to type ascertainment in holding institutions, appropriate cultivar designation and documentation of all that information in VIVC and European *Vitis* Database. For that aim the cultivar specific “variety number VIVC” is most useful. With that number, independent of their designation, identical genotypes (= clones of cultivars) are retrievable. In anticipation of germplasm monitoring by the European *Vitis* Database the search module “Genetic Resources Monitoring” was implemented in VIVC. It aims to identify cultivars existing in only one grapevine collection, which thus require duplicate preservation. The same search module offers the possibility to determine the number of cultivars maintained in repositories (58%) and the number of cultivars described or mentioned in literature (75%), see Table 1. One fifth of the accessions/cultivars maintained in collections were not documented until now. One main reason is that accessions were registered from countries for which no ampelographies were available, e. g. from the Near East and Caucasus. Other arguments are not solved synonymy or new cultivars and breeding selections existing in repositories without any published description. Inversely new cultivars were often described without indication of holding institution. These are to be found under the 38% registered prime names which are described or mentioned in bibliography but which are not maintained in a registered collection of VIVC. However the main part of the 38% is due to 22% crossbreeds from which 11% are French and 4,6% are American hybrids which disappeared and a high percentage of cultivar

names gathered from ancient European ampelographies and recent scientific publications. Of course loss of germplasm is another factor. But for the time being genetic erosion is difficult to estimate. One half of the 4% not documented and not maintained prime names are due to pulled out accessions/crossbreeds in grapevine collections.

Recording of cultivar describing bibliography

Ampelographies encompass a cultivar's history, synonymy, description of morphology and aptitudes, drawings, photos, wine growing area and the qualities presented by the fruit or the wine. Furthermore ampelographies from the 19th and some of the 20th century cite bibliography of earlier descriptions. All that information is essential for variety recognition, as well as confirmation and documentation of trueness to type. More than 1500 ampelographies and cultivar describing bibliography were gathered. From these oeuvres cultivar specific data were extracted and recorded in VIVC. All bibliographical sources are retrievable, even the page of description is indicated. This is particularly helpful if cultivars were described under synonymous designations or in distinct alphabets like Cyrillic or Greek script. The more than 300 articles providing SSR-marker data can be retrieved separately.

CONCEPT OF THE DATABASE

All database search options are given on the menu bar on the left side of the homepage. At the end they all guide to the cultivars fact sheets. Basically the database is subdivided into two parts with two main search functionalities: "Search" for single criteria, useful for quick search and "Advanced Search", where multiple criteria can be combined. The following criteria are retrievable by single field "Search" (in brackets the number of entries are given): **Vitis species** (*Ampelopsis* (13), Intergeneric crossing, Interspecific crossing, *Muscadinia* (3), *Parthenocissus* (2) and *Vitis* species (83)), **cultivar name** (24.039 prime names and ca. 42.000 synonyms), **photos** (9386), mainly of the three categories shoot tips, leaves and bunches, **pedigrees** (8.876), **holding institutions** (142) and **bibliographical references** (1989). Photos and bibliography are divided in two parts (A) display of all photos, respectively all bibliography and (B) specific search modules for refinement of search. "Advanced search" comprises four sections. Via **Passport data** combination of 13 Multi Crop Passport Descriptors is possible. **Resistance data** module informs about cultivars degree of resistance to fourteen diseases. Via the entry of a range or a definite expression level genotypes with corresponding degrees of resistance are listed. The following two microsatellite sections are based on fingerprints from almost 300 articles and genetic profiles obtained at the Institute for Grapevine Breeding Geilweilerhof. With section **Microsatellites by profiles** identification of cultivars is intended. To search for matching profiles, before entering the SSR-marker data, allele sizes need to be adapted according to those of the given reference varieties (Fig. 1). **Microsatellites by varieties** display genetic fingerprints of 750 cultivars. Cultivars can be selected via drop down menus.

Although Multi Crop Passport Descriptor data registered in VIVC are not complete "Statistical information" based on MCPD data was implemented. An approximate distribution of records is given, e.g. the proportion of berry colors, the number of offsprings created by involvement of a specific cultivar or by a breeder, etc., see Fig 2. "Genetic resources monitoring" module assists to identify endangered germplasm. "Data on breeding and genetics" provide (1) information on populations, respective references and genes of interest and (2) traits and alleles relevant for breeding and genetics, encompassing associated markers, their chromosomal localization and the donor genotype/species. This chapter imparts knowledge on activities and achievements in the field of QTL research, to avoid unnecessary duplication of work and to provide valuable data for users.

The most individual part represents the prime names fact sheet encompassing all records described above. It comprises the prime names MCPD-data, a photo gallery, SSR-

marker data, resistance data, accession names and others. These data are followed by bibliography, bibliography confirming pedigree by marker analysis, synonyms, holding institutions and use.

CONCLUSION

Thanks to the vision of Professor Gerhard Alleweldt VIVC was established at the Institute for Grapevine Breeding Geilweilerhof in 1984. In the meanwhile VIVC developed to an encyclopedic database which is worldwide acknowledged and unique. Thanks to the input in kind of Julius Kühn-Institut and Institut für Rebenzüchtung Geilweilerhof VIVC is maintained, improved and continuously updated. Findings from scientific publications are constantly incorporated and further criteria supplemented like chlorotypes in the near future. New bred cultivars are added. Inventories of germplasm collections are updated and new ones are included. In accordance database structure and the web site are permanently adapted to new requirements.

Since January 2011 the number of visitors of the database is counted. 2.500 to 3.200 distinct users per month access VIVC and the number of total visits per month vary between 5.000 and 8.000. For detailed information see “Visitors: Statistics” on the home page of VIVC.

Literature cited

- Alleweldt, G. 1987a. The Genetic Resources of Vitis. Table 1. Prime names and synonyms in alphabetic order. Institut für Rebenzüchtung Geilweilerhof. 1st edition.
- Alleweldt, G. 1987b. The Genetic Resources of Vitis. Table 2. World list of grape cultivars and Vitis species: Prime names, synonyms, origin, parentage, collections, literature. Institut für Rebenzüchtung Geilweilerhof. 1st edition.
- Alleweldt, G. 1988a. The Genetic Resources of Vitis. Genetic and geographic origin of grape cultivars, their prime names and synonyms. Part I. Institut für Rebenzüchtung Geilweilerhof. 2nd edition.
- Alleweldt, G. 1988b. The Genetic Resources of Vitis. Prime names and synonyms in alphabetic order. Part II. Institut für Rebenzüchtung Geilweilerhof. 2nd edition.
- Alleweldt, G. and Dettweiler-Münch, E. 1992a. The Genetic Resources of Vitis. Genetic and geographic origin of grape cultivars, their prime names and synonyms. Part I. Institut für Rebenzüchtung Geilweilerhof. 3rd edition.
- Alleweldt, G. and Dettweiler-Münch, E. 1992b. The Genetic Resources of Vitis. Prime names and synonyms in alphabetic order. Part II. Institut für Rebenzüchtung Geilweilerhof. 3rd edition.
- Alleweldt, G. 1988c. The Genetic Resources of Vitis. World List of Grapevine Collections. Institut für Rebenzüchtung Geilweilerhof. 1st edition.
- Alleweldt, G. and Dettweiler-Münch, E. 1994. The Genetic Resources of Vitis. World List of Grapevine Collections. Institut für Rebenzüchtung Geilweilerhof. 2nd edition.
- Crespan, M., Cabello, F., Giannetto, S., Ibanez, J., Karoglan Kontic, J., Maletic, E., Pejic, I., Rodriguez-Torres, I. and Antonacci, D. 2006. Malvasia delle Lipari, Malvasia di Sardegna, Greco di Gerace, Malvasia de Sitges and Malvasia Dubrovacka-Synonyms of an old and famous grape Cultivar. *Vitis* 45 (2), 69-73.
- Dettweiler, E. 1991. Ampelography – an international course in San Michele/Italy. *Vitis* 30:265-267, Newsletter 3.
- Di Vecchi Staraz, M., Bandienli, R., Boselli, M., This, P., Boursiquot, J.-M., Laucou, V., Lacombe, T. and Vares, D. 2007. Genetic Structuring and Parentage Analysis for Evolutionary Studies in Grapevine: Kin Group and Origin of the Cultivar Sangiovese Revealed. *Journal American Society Horticultural Sciences* 132 (4) 514-524.

- Maul, E. and This, P. 2008. GENRES081 – a basis for the preservation and utilization of *Vitis* genetic resources. In: Maul, E., J.E. Eiras Dias, H. Kaserer, T. Lacombe, J.M. Ortiz, A. Schneider, L. Maggioni and E. Lipman, compilers. 2008. Report of a Working Group on *Vitis*. First Meeting, 12-14 June 2003, Palić, Serbia and Montenegro. Bioversity International, Rome, Italy, 13-22.
- Maul, E. 2008. Synonymy, homonymy and misnaming are obstacles for an international network on the conservation of *Vitis* germplasm in Europe. In: Maul, E., J.E. Eiras Dias, H. Kaserer, T. Lacombe, J.M. Ortiz, A. Schneider, L. Maggioni and E. Lipman, compilers. 2008. Report of a Working Group on *Vitis*. First Meeting, 12-14 June 2003, Palić, Serbia and Montenegro. Bioversity International, Rome, Italy, 109-115.
- Maul, E., Sudharma, K. N., Kecke, S., Marx, G., Müller, C., Audeguin, L., Boselli, M., Boursiquot, J-M., Bucchetti, B., Cabello, F., Carraro, R., Crespan, M., de Andrés, M.T., Eiras Dias, J., Ekhvaia, J., Gaforio, L., Gardiman, M., Grando, S., Agyropoulos, D., Jandurova, O.; Kiss, E.; Kontic, J.; Kozma, P.; Lacombe, T.; Laucou, V.; Legrand, D.; Maghradze, D., Marinoni, D., Maletic, E., Moreira, F., Muñoz-Organero, G., Nakhutsrishvili, G., Pejic, I., Peterlunger, E., Pitsoli, D., Pospisilova, D., Preiner, D., Raimondi, S., Regner, F., Savin, G., Savvides, S., Schneider, A., Sereno, C., Simon, S., Staraz, M., Zulini, L., Bacilieri, R. and This, P. 2012. The European *Vitis* Database (www.eu-vitis.de) – a technical innovation through an on-line uploading and interactive modification system. *Vitis* 51 (2), 79-86.
- Maul, E.; Eibach, R.; Zyprian, E.; Töpfer, R.; 2015: The prolific grape variety (*Vitis vinifera* L.) ‘Heunisch Weiss’ B (= ‘Gouais blanc’): bud mutants, “colored” homonyms and further offsprings. *Vitis* 54, 79–86
- Pinto-Carnide, O., Martin, J.P., Leal, F., Castro, I., Guedes-Pinto, H. and Ortiz, J.M. 2003. Characterisation of grapevine (*Vitis vinifera* L.) cultivars from northern Portugal using RAPD and microsatellite markers. *Vitis* 42 (1), 23-25.
- Schneider, A., Carra, A., Akkak, A., This, P., Laucou, V. and Botta, R. 2001. Verifying synonymies between grape cultivars from France and Northwestern Italy using molecular markers. *Vitis* 40 (4), 197-203.
- Schneider, A.; Torello Marioni, D., De Andres, M.T., Raimondi, S., Cabello, F., Ruffa, P., Garcia-Munoz, S. and Munoz-Organero, G. 2010. Prie blanc and Legiruela: a unique grape cultivar grown in distant European regions. *Journal International des Sciences de la Vigne et du Vin* 44 (1), 1-8.

Table

Table 1: Comparison of the number of prime names described/mentioned in bibliography and maintained in grapevine collections.

%	Bibliography available:		sum
	yes	no	
Accessions maintained: yes	37	21	58
Accessions maintained: no	38	4	42
sum	75	25	100

