

# The Role of the GRIN Database in Promoting Stabilization of Economic Plant Names

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## Abstract

The taxonomic portion of the Germplasm Resources Information Network (GRIN) of the United States Department of Agriculture (USDA), Agricultural Research Service provides the scientific nomenclature for ca. 450,000 accessions of the National Plant Germplasm System. Most plants of agronomic or horticultural importance are represented among these accessions. Recently, we have extended coverage to many other plants of economic importance throughout the world, such as poisonous plants, ornamentals, weeds, and medicinal or rare plants, not represented among germplasm accessions. GRIN Taxonomy now provides accurate scientific names for nearly 36,000 species of vascular plants. For nearly two decades USDA botanists have surveyed the botanical literature and compiled extensive data relating to nomenclature, synonymy, classification, distribution, economic uses, and common names, and a bibliography of taxonomic resources for the included plants. Since 1994 these data have been freely available to internet users, and about a thousand queries are now answered daily. Direct consultation for complex nomenclatural issues is also often provided. Many agricultural organizations rely on GRIN Taxonomy as a dependable source of accurate scientific names. Included among these are international seed-testing organizations, which have used GRIN Taxonomy to promote stabilization of nomenclature in the seed industry.

## INTRODUCTION

The United States Department of Agriculture (USDA), Agricultural Research Services (ARS) National Plant Germplasm System (NPGS) currently maintains over 450,000 accessions of mostly economically important vascular plants. It also coordinates the activities of 25 USDA seed and clonal germplasm sites, and interacts with the international germplasm community and scientific public through the Germplasm Resources Information Network (GRIN). The GRIN database contains information on all genetic resources preserved by NPGS, including accessions of both domestic and foreign origin. Traditionally the focus for germplasm acquisition has been on crops and their wild and weedy relatives, and a range of data - including passport, taxonomic, descriptor, observation, evaluation, and inventory data - for each germplasm accession is available in GRIN. It is the taxonomic data, which provide the overall organization for germplasm accessions in GRIN, that are the focus of this paper. For information on other aspects of GRIN or NPGS see Janick (1989) or consult the GRIN database at <http://www.ars-grin.gov>.

In recent years a concerted effort has been made to expand GRIN Taxonomy to include all economically important vascular plants worldwide, thereby making available accurate and up-to-date information on these plants. The stature of GRIN Taxonomy, as a global reference for economic plant names, has continued to grow for several principal reasons, namely the breadth of taxonomic and geographic coverage, data content, scientific accuracy and currency, availability on the internet, and responsiveness to users.

## HISTORY OF GRIN TAXONOMY

GRIN taxonomic data originated with the Nomenclature File of the former Plant Exploration and Taxonomy Laboratory (PETL) of USDA, ARS. The origin of the

Nomenclature File and its relationship to the USDA Plant Introduction Office (PIO) since 1898 were described at the First International Symposium on Cultivated Plants (Terrell, 1986). The purpose of the File from the beginning was to provide correct scientific names for USDA plant introductions, many of which are now maintained in NPGS. Many of these germplasm introductions were received through exchange with foreign institutions, and others were collected throughout the world by American plant explorers. For each accession a determination of the correct taxonomic nomenclature was made by taxonomists maintaining the Nomenclature File. While most scientific names in the File were the result of these plant introductions, many names, mainly of economic plants, were added by USDA taxonomists for other reasons. Some were derived from the publication of ARS Agriculture Handbook 505 (Terrell, 1977), for which a second edition appeared in 1986 (Terrell et al., 1986). The content of the original card and later computerized File was readily available only to PETL taxonomists, but its transfer to GRIN in 1987 made its taxonomy directly accessible to the entire NPGS community.

Since its assimilation into GRIN, the taxonomic data, now maintained by botanists of the Systematic Botany and Mycology Laboratory (SBML), has continued to expand in response to the needs of NPGS and ARS. An SBML project completed in 1992 (Gunn et al., 1992) completed GRIN Taxonomy's treatment of family and generic names. An extensive survey of world economic plants, published by Wiersema and León (1999), greatly enhanced GRIN's coverage of commercially important plants. With the availability of GRIN on the World-Wide-Web since 1994, access to GRIN taxonomic data has expanded both nationally and internationally. Many individuals and organizations worldwide now routinely utilize the information in GRIN Taxonomy.

### **SCOPE OF GRIN TAXONOMY**

The diversity of American agriculture and the foreign origin of most U.S. crops underlies the broad coverage of GRIN Taxonomy. By necessity all 10,274 species of the ca. 1,600 genera represented in the NPGS are included in this taxonomy, although that comprises only about a quarter of all accepted names in GRIN, so many additional species not represented by germplasm are also present. A broad range of economically important plants from all over the world are now treated, including over 1,500 food or spice, 1,000 timber, 200 fiber, 1,200 drug or folklore medicine, 700 forage, 500 soil-building or erosion control, 1,800 weedy, 1,300 poisonous, and 4,600 ornamental plants. Many conservation plants, including those of CITES, also receive treatment. Coverage of GRIN Taxonomy is truly global, with over 4,800 African, 8,400 temperate Asian, 4,400 tropical Asian, 2,600 Australasian, 3,700 European, 5,900 northern American, and 5,300 southern American species included among these. GRIN Taxonomy includes all accepted family and generic names from throughout the world, with a number of families and genera now also provided with infrafamilial or infrageneric treatments as well.

The taxonomy area encompasses names governed by the International Code of Botanical Nomenclature (ICBN; Greuter et al., 2000) at the customary ranks of family, genus, species, subspecies, variety, or forma. Other ICBN categories, such as subfamily, tribe, subtribe, subgenus, section, subsection, series, subseries, and subvariety may also be delineated. Names treated under the cultivated code (ICNCP; Treharne et al., 1995) i.e. cultivars, may appear in the accession area of GRIN. Their inclusion and verification is the responsibility of the germplasm maintenance site. Expansion to accommodate cultivar-group names, as defined in the ICNCP, is now under consideration.

### **CONTENT OF GRIN TAXONOMY**

Several types of data records are contained in GRIN Taxonomy. These include accepted or synonym scientific names, common names, distributions, literature references, and economic impacts. A more detailed discussion of these appears in Wiersema (1995), which is updated and highlighted in the version below.

## Scientific Names

Accepted name records are searchable at the level of family and genus or species and infraspecies. Some 450 vascular plant families are currently accepted in GRIN and linked to their constituent genera, and an additional 250 alternatively accepted families also have their included genera identified. Family records provide links to other web data resources, and 12 of these families, including the Fabaceae and Poaceae, have an infrafamilial classification of the genera. The generic records include all of the ca. 14,000 accepted spermatophyte genera in the world and an additional 4,500 synonym genera. For each the author is cited in accordance with Articles 46-50 of the ICBN (Greuter et al., 2000), and conserved or rejected names are indicated. The family to which each genus is assigned is provided, and any alternative family classifications are indicated. For doubtful or disputed genera an alternatively accepted genus may be indicated. Many genera are provided with literature references to document acceptance, family placement, or a recent taxonomic revision or monograph. Nomenclature comments are provided for problem genera and some genera (ca. 30) are provided with infrageneric classifications.

Species and subspecific records now total ca. 41,000 accepted and 26,500 synonym names in GRIN. Binomials (58,000 with 36,000 accepted) and trinomials (9,700 with 5,200 accepted) are included among these. All such names are assigned a unique identifying number, the nomen number or "taxno." Names can be queried using these numbers at <http://www.ars-grin.gov/cgi-bin/npgs/html/taxsearch.pl>. Inclusion of infraspecific names for a given species is selective and not necessarily exhaustive. Each name at whatever rank is accompanied by its author and place of original publication. Comments relating to nomenclatural matters, parentage for hybrid taxa, or alternative cultivar-group names under the cultivated code (Trehane et al., 1995) are provided for many names.

Each nomenclature record, and most other record types, contains the date of and individual responsible for the most recent modification. Since a change could be strictly editorial, a special field indicates if the name has been verified recently. Usage of GRIN taxonomic information should be confined to records that have been verified. Currently all generic names and about 87% of species and infraspecific names meet this criterion.

## Common Names

Presently about 26,000 common names for ca. 10,500 taxa, including over 9,400 of non-English origin, exist in GRIN. We have attempted to standardize treatment of English common names in GRIN by adopting the rules of Kartesz and Thieret (1991), on matters of union or hyphenation of group names and modifiers. Further decisions on joining or separating the elements of common names follow usage in *Webster's Third New International Dictionary* (Gove et al., 1961). These rules dictate that group names are correctly applied only to certain genera or families. Over 480 true group names are provided in GRIN for genera. Usage of these true group names for plants in other genera or families requires hyphenation or adjoining to preceding modifiers.

Common names have been extracted from a variety of sources. Although some names appear in several sources, at least one source is presented in GRIN for each common name. Sources are frequently indicated using GRIN literature abbreviations, with links to the full bibliographic reference provided for most sources. No effort has been made to include every locally used common name appearing in the literature; instead the focus has been to record those in wider usage.

## Economic Importance

Over 14,800 economic impact records appear in GRIN for some 10,500 taxa. GRIN economic plant data are classified to two levels adapted from the *Economic Botany Data Collection Standard* (Cook, 1995). A total of 17 classes are recognized, including 13 from this Standard: food, food additives, animal food, bee plants, invertebrate food, materials, fuels, social uses, vertebrate poisons, non-vertebrate poisons, medicines, environmental uses, and gene sources, with the addition of classes for weeds, harmful organ-

ism hosts, and CITES-regulated plants. Two of these categories plus vertebrate poisons do not represent beneficial uses, but are mostly negative in their economic impact. The 17 classes are further subdivided into 96 subclasses. Sources of economic data are referenced in GRIN. A thorough discussion of GRIN economic data appeared in Wiersema and León (1999) and can be found at <http://www.ars-grin.gov/~sbmljw/introd.htm>.

### **Geographical Distribution**

Over 235,000 distribution records exist in GRIN for the 31,800 taxa for which distributional data are provided. Each record is a linkage between a continent, country, or state occurrence and a taxon name. GRIN distribution records are grouped into areas and regions according to the standard publication *World Geographical Scheme for Recording Plant Distributions* (Hollis and Brummitt, 1992), which divides the terrestrial world into nine areas: Africa, Antarctic, Asia-Temperate, Asia-Tropical, Australasia, Europe, Northern America, Pacific, and Southern America.

Distributions are given as reported in the literature or by consulted specialists. Only native or potentially native distributions are recorded, with cultivated or naturalized distributions provided as a separate comment. For weedy species this distinction is sometimes obscure, and some widespread taxa may have their entire distributions summarized as a comment. Similarly, state distributions for most countries are not itemized for taxa widespread within those countries. However, a distributional report for a taxon in a geographical or political region does not necessarily imply widespread occurrence in that region, but only indicates that some basis exists for that report. When available more specificity in GRIN distributional reports is given as comments, but the available information may vary greatly from one taxon or region to another. Among regions, the greatest gaps in information exist mainly for tropical regions.

For species with subspecies or varieties in GRIN, the main entry for the species provides the overall distribution, including distributions for any subspecies or varieties absent from GRIN. Autonym entries provide distributions of only the typical subspecies or variety, which occupies all or only a portion of the total distribution for the species.

### **Literature References**

For ease of computerization, over 1,450 literature abbreviations have thus far been developed in GRIN for standard references, florae, and serial publications commonly seen in the database. They are employed for the 217,000 literature citations in GRIN which link to 33,300 accepted and 18,300 synonym species names. An additional 9,000 are provided for 5,800 different genera. Though the number of references presented for a given taxon may be extensive, the listings should not be considered exhaustive. If all reported information (taxonomy, nomenclature, distribution, etc.) is documented in a few references, these might be the only ones cited. Other references may treat the taxon, but add no new information, so these may not be entered in GRIN. This is particularly true for genera with recent comprehensive monographic treatments that are the source of most GRIN taxonomic data for those genera. Other references may be included only to document alternative taxonomic treatments, orthographies, or authorship for a name.

### **Other Data Sets in GRIN**

A number of specialized data sets are incorporated into GRIN taxonomy. These include the scientific names endorsed by seed-testing associations such as Association of Official Seed Analysts (AOSA) and International Seed Testing Association (ISTA) from AOSA Contribution No. 25 to the Handbook on Seed Testing, *Uniform classification of weed and crop seeds* (Meyer and Wiersema, 2001) and *ISTA List of Stabilized Plant Names* (Wiersema, 2001), for which the nomenclature has been verified in GRIN. Two other data sets are also present, one for noxious weeds and the other for conservation plants. The first identifies those plants regulated as noxious weeds or noxious-weed seeds at the federal and state level in the United States. The second delineates the federal list of endangered and threatened plants maintained by the United States Fish and Wildlife

Service (US-FWS), Department of the Interior; the list of rare plants maintained by the Center for Plant Conservation (CPC); and the plants listed in the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). All taxa of both of these two groups are fully treated in GRIN taxonomy.

## **INTEGRITY OF GRIN NOMENCLATURE**

### **Accuracy of Data**

One strength of GRIN Taxonomy derives from the substantial investment by ARS in the taxonomic resources and expertise necessary to accumulate, evaluate, and defend the information presented. SBML botanists are now responsible for maintaining the integrity of the scientific names and the associated information in GRIN. This information has been garnered during more than three decades of nomenclature research on economic plants by USDA vascular plant taxonomists experienced in the intricacies of botanical nomenclature and the interpretation of taxonomic data and with excellent available library resources (Wiersema, 1995) providing ready access to current and historical botanical literature. Likewise, reviews from hundreds of taxonomists throughout the world have been sought for portions of GRIN taxonomic data, and for major crop genera interaction with other USDA crop scientists is possible. When complex nomenclature problems arise, the opinions of other nomenclature specialists are routinely solicited. GRIN Taxonomy thus conforms to international rules of botanical (Greuter et al., 2000) and cultivated plant (Trehane et al., 1995) nomenclature.

It also adheres to the various standards for plant taxonomic databases of the International Working Group on Taxonomic Databases (<http://www.tdwg.org>). Author abbreviations conform to the standard reference *Authors of Plant Names* (Brummitt and Powell, 1992). Nonserial botanical works (pre-1950) have been abbreviated according to the standard reference *Taxonomic Literature* (Stafleu and Cowan, 1976-1988) and its supplements (Stafleu and Mennega, 1992-2000), and publication dates have been verified using that work. Serial publications are abbreviated according to *Botanico-Periodicum-Huntianum* and its *Supplementum* (Lawrence et al., 1968; Bridson and Smith, 1991).

### **Basis of Taxonomic Decisions**

The taxonomic decisions accepted in GRIN are based on various considerations. Ideally, the taxonomy reflects the views of recognized taxonomic specialists for various plant groups as determined from published literature, such as monographs, revisions, or contributed treatments to floras, or from direct consultation for review of GRIN taxonomic information. When a specialist or specialist-generated literature is lacking, taxonomic decisions must be based on the floristic literature. Floras are generally assigned greater weight than checklists, and modern floras are given greater consideration than older ones in preparing the GRIN treatment. Other considerations being equal, when there are differences in taxonomic treatment or nomenclature disputes, the GRIN treatment would generally be guided by current usage, including usage among agronomists and horticulturalists in addition to that of taxonomists.

However, the field of plant systematics is increasingly dynamic, with the emergence of molecular evidence and cladistic analysis of these and other data. We are routinely confronted with proposals to change existing classifications based on new phylogenetic information. On occasion, our desire to represent a phylogenetically meaningful classification must be balanced against our overriding philosophy to preserve existing nomenclature. However, when compelling taxonomic or nomenclatural arguments contradict this philosophy, names have often been changed. The weight of evidence necessary to convince us to change a name varies directly with the impact of the change i.e., with the economic importance or number of species involved. Where controversy in taxonomy or nomenclature exists among plant systematists, we would prefer to remain conservative in our nomenclature until the controversy is resolved.

## **ACCESS TO GRIN TAXONOMY**

A web interface for GRIN Taxonomy appeared in 1994, enabling global users to access this information easily and efficiently. GRIN data can be queried by scientific name (family, genus, or species), common name, economic uses, or distribution. Specialized searches on data relating to economic plants, rare plants, noxious weeds, or nomenclature of seed associations are also possible. Economic plants can be queried for economic use classes and subclasses in addition to taxonomy and distribution. Regulated noxious weeds are searchable by taxonomy, distribution, and also by federal or state jurisdictions. Translated versions of most query screens now exist in Portuguese and Spanish, and French and German versions are under preparation. Downloads of all data from the GRIN family, genus, and species nomenclature tables can be obtained as well.

Currently about 25,000 searches of GRIN Taxonomy are performed monthly and nearly 50,000 reports per month of GRIN taxonomic data are output to users as a result of these searches. This usage has steadily increased each year since GRIN first came online. A total of 29 different reports of varying content are possible from GRIN taxonomic data. The most often requested report, of an individual taxon, provides information on classification, nomenclature, NPGS accessions, noxious weed or conservation status, common names, economic importance, native range, literature references, synonymy, linkage to other taxonomic databases, or linkage to images. Sources are provided for common name and economic importance data. For infraspecific taxa, direct linkage to other conspecific records is provided. This interlinking of all GRIN Taxonomy reports through scientific names at each rank provides easy navigation between reports.

In collaboration with the International Plant Genetic Resources Institute, a Taxonomic Nomenclature Checker has recently been developed for comparing lists of scientific names against GRIN Taxonomy. A step-by-step procedure is fully detailed for making such comparisons, and allows for easy checking of the acceptance of a name, its spelling, or its synonymy. This utility is available at [pgrdoc.ipgri.cgiar.org/taxcheck/grin](http://pgrdoc.ipgri.cgiar.org/taxcheck/grin).

## **RESPONSIVENESS TO GRIN USERS**

Users of GRIN Taxonomy are encouraged to provide feedback to assist us in improving user access and data presentation or to alert us to any necessary corrections of its content. Links are provided from all web pages to facilitate this communication, and incoming messages are regularly monitored and answered. Report or query software is often altered to accommodate user suggestions. Data problems uncovered by users are corrected or resolved in a timely fashion and the informants alerted that such action has been taken. When no correction is necessary, the GRIN treatment is defended. If complex nomenclature interpretations are involved, these are explained to users and supporting commentary placed in GRIN Taxonomy for public display.

## **FUTURE OF GRIN TAXONOMY**

The GRIN database and its taxonomic data are an integral part of the NPGS, and can be expected to continue in this role for many years to come. Continued improvement to the website can be expected, allowing users more flexible and easier access to the information they seek and additional linkage to other relevant web resources, such as the recently linked Mansfeld's World Database of Agricultural and Horticultural Crops ([mansfeld.ipk-gatersleben.de/Mansfeld](http://mansfeld.ipk-gatersleben.de/Mansfeld)). An expansion of GRIN Taxonomy data will also occur, in treating additional economic species, providing more classification information, and incorporating information from new literature. The Agricultural Research Service invites and encourages those interested to access and utilize GRIN data over the Internet. Errors or discrepancies in the taxonomic data that are uncovered should be reported to SBML to ensure their correction. We would like to cooperate with other individuals and organizations active in the taxonomy of cultivated plants to further our common interests in arriving at a more stable, scientifically accurate, nomenclature.

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