

# Active

## Germplasm Bank

### of Citrus at

Embrapa Cassava & Fruits



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#### Description

The genus *Citrus* L. and related, especially *Poncirus* Raf., *Fortunella* Swingle, *Microcitrus* Swingle, *Eremocitrus* Swingle and *Clymenia* Swingle, constitute what is called for citrus, due to bear fruit similar to orange or lemon. This complex group of plants show wide variability of forms, which have increased over millennia, both for its cultivation since ancient times, by different civilizations, as a result of preservation by nature, mainly due to nucelar embryony. Citrus fruits ranging in size from small to very large. Among the smaller are the kumquats *Fortunella* spp. and acid limes *C. aurantifolia* (Christm.) Swingle, whose dimensions hardly exceed 5 cm. At the other extreme are pummelos *C. maxima* (Burm.) Merr. and citrons *C. medica* L., which can reach 30 cm in diameter or length. Other traits also show great diversity: the skin color ranges from yellow-green in acid limes to red-orange in some tangerines, as 'Dancy' *C. tangerina* hort ex Tanaka; the fruit pulp color allows to classified the oranges into two groups: white and the blood color or sanguine (Figure 1); the fruit shape also shows clear differences, from oblate to piriform; when ripe, the fruit of some species and varieties are very acid, while in others the acidity is almost zero; the leaves show variations in the length, width and leaf blade color, petioles of different types and the presence of variegation (Figure 2); the size of adult s trees , in turn, also show sharp variations; while all species of the genus *Citrus* keep their leaves throughout the year, the genus *Poncirus* in temperate and subtropical climates is deciduous.



Photo: Fernanda Vidinal Duarte Souza



**Figure 1.** 'Rubra Cara' orange fruit *C. sinensis* (L.) Osbeck with red pulp due to the presence of lycopene.



**Figure 2.** Variegated leaves in 'Variegado' lemon *C. limon*, (L) Burm.f., a characteristic that shows its ornamental potential.

Photo: Orlando Sampaio Passos



**Figure 3.** Biodiversity of species flower characteristics in the Active Germplasm Bank of Citrus at Embrapa Cassava & Fruits.

Photo: Karen Cristina Fialho dos Santos (A a G e I)  
e Orlando Sampaio Passos (H e J)



**Figure 4.** Biodiversity of species for fruit characteristics in the Active Germplasm Bank at Embrapa Cassava & Fruits.

Photo: Everton Hilo de Souza

The citrus cultivation is among the oldest agricultural practices of humanity and most of its species originating from Asia. Studies on citrus at Embrapa Cassava & Fruits (Embrapa Mandioca e Fruticultura) (National Research Center for Cassava and Fruit Crops), headquartered in the city of Cruz das Almas, Bahia state, 12° South latitude, date back to the early 1950s, at the Instituto Agrônômico do Leste – IAL.

To capture and preserve the greatest genetic variability it is necessary to establish effective strategies for *ex situ* conservation of genetic resources, making them available to breeding programs. Studies are being made in order to identify sources of genes of adaptive value, particularly for environments subject to stress caused by biotic (pests) and abiotic (related to climate and soil) agents.

The introduction, conservation, characterization, evaluation, documentation and exchange of citrus germplasm are fundamental activities to the agronomic exploitation of this important group of plants. For this reason, it has been deployed at Embrapa Cassava & Fruits, the Active Germplasm Bank of Citrus (BAG Citrus). Figures 3 and 4 illustrate the biodiversity of *Citrus* species and related genera, by presenting the flower buds and flowers, and fruits, with different botanical and morphological characteristics.

## Collection and Conservation

Currently, the BAG Citrus has 760 accessions from collections made in all Brazilian regions (North, Northeast, Midwest, Southeast and South), as well as from introduction of germplasm from other research institutions in Brazil and abroad (Table 1). These accessions are maintained in the field, in protected anti-aphid screen houses, and in vitro (Figure 5). In this case, 154 accessions are already preserved in vitro at tissue culture laboratory, cultivated in WPM (Wood Plant Medium) under minimal growth conditions (temperature  $22 \pm 1^\circ\text{C}$ , light intensity of  $20 \mu\text{mol} / \text{m}^2 / \text{s}$  and photoperiod of 12 hours). In these 154 accessions there are 22 oranges (16 sweets and 6 sour), 25 lemons (several species), 25 mandarins (several species), one Indian sweet lime, 32 hybrids, 26 related genera, and 10 other *Citrus* species. The accessions preserved in the field and in protected screen houses are maintained according to recommended agronomic practices for Citrus.



Photo: Antônio da Silva Souza

Photo: Antônio da Silva Souza



**Figure 5.** Accessions of the Germplasm Active Bank of Citrus at Embrapa Cassava & Fruits maintained in the field (A), in protected screen house (B) and in vitro (C).

## Characterization and Evaluation

The morphological characterization and agronomic evaluations are made based on descriptors related to vegetative traits of the inflorescence and fruit physical and chemical composition (Table 2 and Figure 6). Molecular characterization is also done using microsatellite markers (SSRs). These descriptors are used, among various purposes, to identify and document high heritability traits and molecular patterns, generating what is important information for the Citrus Breeding Program at Embrapa Cassava & Fruits (PMG Citros, acronym in Portuguese). Requests for exchange of materials for partner institutions are analyzed by the curators of the BAG Citrus and fulfilled according to the availability of materials, following the internal rules of Embrapa and the Brazilian legislation for plant material transfer.

**Table 1.** Accessions characterized and under characterization of the Active Germplasm Bank of Citrus (BAG Citrus) at Embrapa Cassava & Fruits, Cruz das Almas, BA, 2015.

Common name	Scientific name	# of accessions
Sweet orange	<i>Citrus sinensis</i> (L.) Osbeck	218
Tangerine and hybrids	<i>C. reticulata</i> Blanco, <i>C. tangerina</i> Tanaka <i>C. unshiu</i> Marcow. and <i>C. deliciosa</i> Ten.	7
Tahiti lime	<i>C. latifolia</i> (Yu. Tanaka) Tanaka	17
Lemon	<i>C. limon</i> (L.) Burm. f.	13
Pomelo	<i>C. paradisi</i> Macfad.	36
Pummelo	<i>C. maxima</i> Burm. (Merr.)	02
Hybrids of trifoliata		08
Related species	<i>C. obovoidea</i> hort. ex Tanaka	01
<b>Total</b>		<b>370</b>



**Figure 6.** Accessions of the Germplasm Active Bank of Citrus at Embrapa Cassava & Fruits characterized regarding vegetative traits of inflorescence and fruit. Cruz das Almas, BA, 2015.

## Use

The characterization and evaluation of germplasm has allowed the identification of superior genotypes in relation to their use as cultivars or potential use in plant breeding programs (Table 2 and Figure 7). In this context, the fruits of sweet oranges, acid limes, tangerines, grapefruits, among others, present attractive aroma.



Photo: Antônio da Silva Souza

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**Table 2.** Accessions of the Active Germplasm Bank of Citrus (BAG Citrus) at Embrapa Cassava & Fruits.

Species	# of accessions
Sweet orange <i>C. sinensis</i> (L.) Osbeck	347
Common	204
Navel orange (Bahia)	113
Sanguine	14
No acidity (lime)	16
Tangerine ( <i>C. reticulata</i> Blanco, <i>C. tangerina</i> Tanaka, <i>C. unshiu</i> Marcow., <i>C. deliciosa</i> Ten. and <i>C. clementina</i> hort. ex Tanaka) and hybrids	132
Hybrids of tangerine (rootstock)	29
True lemons ( <i>C. limon</i> Burm. f)	09
Lemons (rootstock)	22
Tahiti lime <i>C. latifolia</i> (Yu. Tanaka) Tanaka and <i>C. aurantiifolia</i> (Christm.) Swingle	34
Sweet lime <i>C. limettoides</i> Tanaka and <i>C. limetta</i> Risso	03
Grapefruit <i>C. paradisi</i> Macfad.	35
Pummelo <i>C. maxima</i> Burm. (Merr.)	09
Sour orange <i>C. aurantium</i> L.	09
Citron <i>C. medica</i> L.	06
<i>Poncirus trifoliata</i> (L.) Raf.	21
Hybrids of trifoliata	40
Related species ( <i>C. obovoidea</i> hort. ex Tanaka)	64
<b>Total</b>	<b>760</b>



Photo: Orlando Sampaio Passos

**Figure 7.** Variability of accessions in the Active Germplasm Bank of Citrus at Embrapa Mandioca e Fruticultura with potential of utilization in breeding programs.

In addition, there is a considerable variability in size, flavor, color and harvesting time, allowing selecting promising genotypes of commercial value for different purposes. The results obtained so far have allowed the indication of 26 accessions, selected by their physical and chemical properties of fruits.



## Documentation and Partners

Passport data of 646 accesses are available online via Embrapa's system named "Alelo". The inventory of the genebank collection is documented in the Embrapa curatorship system. Several collaborators are involved in the characterization and evaluation activities. To achieve these objectives, there is a multidisciplinary team of researchers (biologists, geneticists, breeders, plant pathologists, entomologists, physiologists, agronomists, and technicians in transfer of technology). There is also a network of partner institutions, which are important in carrying out activities of enrichment, conservation, characterization, evaluation, documentation, development of genetic resources, and human resources training. The following institutions are in this network: Estação Experimental de Limeira, Centro de Citricultura "Sylvio Moreira"; Universidade da Califórnia, Riverside, e Universidade da Flórida, Lake Alfred, EUA; Instituto Valenciano de Investigaciones Agrarias, Espanha; Empresa Colombiana de Pesquisa Agropecuária, Palmira, Colômbia; Instituto Nacional de Pesquisa Agropecuária, Salto, Uruguai; Instituto Nacional de Tecnologia Agropecuária, Concórdia, Argentina; Estação Experimental de Citricultura de Bebedouro, SP; Fundo de Defesa da Citricultura, SP; Universidade Federal do Recôncavo da Bahia, BA; Universidade Estadual de Santa Cruz, BA; Universidade Federal de Viçosa, MG; Embrapa Recursos Genéticos e Biotecnologia, DF; Embrapa Tabuleiros Costeiros, SE; Embrapa Semiárido, PE; Embrapa Agroindústria Tropical, CE; Embrapa Cerrados, DF; Embrapa Informação Tecnológica, DF; Secretaria de Defesa Agropecuária – Ministério da Agricultura, Pecuária e Abastecimento, DF; Embrapa Amazônia Ocidental, AM; Embrapa Amazônia Oriental, AM; Embrapa Acre, AC; Embrapa Agrobiologia, ex-Instituto de Pesquisas e Experimentação Agropecuárias do Centro-Sul, RJ; Embrapa Clima Temperado, RS; Fundação Estadual de Pesquisa Agropecuária, RS; Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina Instituto Agronômico do Paraná; Universidade Federal do Semiárido, Mossoró, RN; Universidade Estadual do Estado da Paraíba, Lagoa Seca, PB; Universidade Estadual de Santa Cruz, Ilhéus, BA; Agência de Defesa Agropecuária da Bahia, BA; Agência de Assistência Técnica e Extensão Rural, BA; Empresa de Desenvolvimento Agropecuário de Sergipe, SE; and Instituto Agronômico de Pernambuco, PE.

## Recognized Dedication

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