# Watermelon germplasm bank for the Northeast of Brazil. An integrated approach

*M.A. De Queiroz, R.L. Romão, R. De C.S. Dias, J.G. De A. Assis, R.M.E. Borges, M.A.J. Da F. Ferreira, S.R.R. Ramos, M.S.V. Costa & M. da C.C.L. Moura. Agricultural Research Center for the Semi-Arid Tropics. Embrapa-Cpatsa, P.O. 23, Petrolina-PE, Brazil*

## Introduction

The watermelon production in Brazil, and particularly in Northeast, can be from irrigated or rainfed agriculture. Under irrigation it is grown an improved American cultivar, cv. Crimson Sweet. Although of good fruit quality, that cultivar presents susceptibility to four major watermelon diseases viz. powdery mildiew (*Sphaerotheca fuliginea*), gummy stem blight (*Didymella bryoniae*), PRSV-w and WMV-2 viruses.

In rainfed conditions there are traditional watermelon populations that came from Africa and were kept by small farmers through generations.

However, the traditional watermelon is prone to extinction since the small farmers tend to abandon their own place for several reasons viz. droughts, floods from big dams, expectations of better urban life near big towns. Extinction pressure can be found by introduction of improved cultivars in the traditional agriculture since farmers can get better price with improved material compared with local types. This kind of situation occurs when commercial farmers in dry land try to improve their income by offering a better product to consumers. In one case known, there is government incentive by distribuiting improved seeds to farmers and promoting special days to encourage suppliers and farmers, to increase the use of elite cultivars, such as in the county or Arari in the State of Maranhão where there is an annual watermelon feast.

Considering the narrow genetic basis of the improved cultivars available in the region, the non existence of watermelon germplasm in the region, and the risk of losses of valuable watermelon germplasm, it has been organized a watermelon germplasm bank for the Northeast of Brazil. It was set up at CPATSA (Agricultural Research Center for the Semi-Arid Tropics), a unit of EMBRAPA (Brazilian Corporation for Agricultural Research), located in Petrolina (State of Pernambuco).

On the other hand, as stated by (5) the use of germplasm in developing countries can be delayed by several reasons such as lack of tuning between curator and breders, lack of relevant information to breeders and the small number of available breeders. Thus, with these points in focus, a breeding research project was also established and linked to the germplasm bank project giving high priority to training young agronomists for developing post-graduate thesis in both genetic resources and breeding projects.

The genetic resource management involves several sequential phases as mentioned by (4) i.e., comprising collection, multiplication, characterization, evaluation, conservation, use and training. To improve germplasm use, the breeding activities were developed side by side in all genetic resource experiments.

## Material and methods

The target watermelon germplasm was the landraces used by the small farmers of the dry land agriculture of the semi-arid region of the Northeast of Brazil. However, wet zones were also included if their farmers used watermelon in their intercrops.

The expeditions were planned to cover different areas of the region, according to the watermelon importance and contrast in soil and rainfall characteristics. The area of collection is located between 3° and 12° S latitude and 34° and 46° W longitude.

The samples were collected in the farmers field or in open market fairs as fruits or as seeds from the farmers' stock. The number of fruits in each farm was determined by the occurrence of different types and the total number of plants available in the farm. When seeds were collected its number per sample, was determined by the availability in the farmer stock.

Identification of the place and farmer, for each sample, was made in an appropriate field book sheet. Additional relevant informations (farmer management, seed exchange, participation in the market, size of the plot, particular fruit traits, farmer selection) were also recorded.

The seeds were extracted manually from the fruits and were set to dry at shade. Then they were bagged and stored at dry cold chambers at 10 °C and 40% of relative humidity for short term period (five to six years). During this period, multiplication, preliminary and profound evaluation, and morphological characterization was performed in some special set of samples from different regions comprising about 20% of the total samples available.

Some introductions (12 accessions) from the United States Department of Agriculture, via the National Genetic Resource Center - CENARGEN-EMBRAPA, were also made.

For multiplication, different approaches have been used. One row of 20 plants from each sample was planted in field using one of the three mating systems, viz., sib crossing, selfing and crossing pairs of plants.

The controlled hand pollination in the field has been made by protecting the male and female flowers with a plastic cup which is attached to a stake to hold it in the ground. The device is used one day before anthesis. In the folowing day the male flower is removed and the petals are bendend back until they break leaving the stamens, with the anthers and their masses of sticky pollen prominently exposed. The anthers then were rubbed onto the stigmatic surface





of the pistillate flower. Protection of the female flower is kept for one more day. Tags were attached to the pedicel of the pistillate flower identifying the parents and indicating the date of pollination.

At harvest, several quantitative and qualitative data were recorded.

For morphological characterization a replicated trial accommodating a set of 39 accessions was established in a field experiment. A small number of quantitative traits were recorded (8). The characters are then submitted to multivariate analysis (principal component, canonic and clustering analysis).

An accession of the gene bank, of white flesh, locally know as horse´s watermelon and normally used as animal feed was studied at citogenetic level. This accession was also hybridized with ten commercial cultivars (Crimson Sweet, Charleston Gray, Congo, Omaru Yamato, Sugar Baby, Jubilee, Fairfax, Florida Gigante, Sunshade and Perola) in order to study the crossability relationship (1).

For evaluation, a set of accessions were submitted to a selection against powdery mildiew and gummy stem blight (2). For powdery mildiew selection, a set of 66 accessions was established in two field experiments without replication and without artificial infection, since in the growing conditions of our Experiment Station the fungus occurs in an endemic form.

Evaluation of 69 accessions for gummy stem blight has been made at green house, after producing the inoculum of *Didymella bryoniae* at controlled conditions of black light and temperature. The plants were inoculated with a suspension of conidia at a concentration of 3.18 x $10^5$ per ml and then submitted to a moisture-saturated atmosphere for 48 hours (2).

The accessions were accomodated in a randomized block with four replications.

Seven parents with contrasting characters (flesh color, sugar content, earliness, fruit size and shape, prolificacy) were crossed in a complete diallel model, with reciprocals, and the F1's were set in a randomized block in a field experiment with four replications, ir order to study F1's behaviour.

## Results and discussion

From the expeditions made between 1991 and 1995, it can be seen that the watermelon in the traditional agriculture is intercroped with other species such as maize, beans and rice, in different crop proportions depending of the farmer crop priority. It ranges from few plants per farm to hundreds and this situation generates implications with sampling strategies.

However, the local types have genes of breeding value, since they were grown in total absence of any chemical inputs, particularly pesticides.

Most of the farmers use the watermelon fruits for their own consumption, keeping some

seeds for next planting. But in some areas, they participate in the market with rainfed watermelon, although the price of traditional types are much lower than the improved cultivars. This gives space for improved types to erode the local populations.

**Collection**

There were 13 expeditions between 1991 and 1995 to different regions of production of rainfed watermelon in five States of Northeast of Brazil, collecting the following number of accessions: Maranhão (167), Bahia (302), Pernambuco (44), Piauí (32) and Rio Grande do Norte (3) giving 560 accessions in total. At a State level, only Maranhão is better covered, since it has been surveyed in six expeditions. Despite a higher number of accessions collected in the State of Bahia, there are many areas that need to be collected. Not only the States surveyed need to be includeded in future expeditions but also the other four States of semi-arid Northeast, since the rainfed watermelon is spread over many small farms of this entire region.

**Multiplication and preliminary evaluation**

The multiplication and preliminary evaluation has been done in 169 accessions, around 30% of the total. Apart from seeds for characterization and evaluation, the experiments gave the opportunity to identify characters that can be of interest for breeding purposes. A range of expression has been recorded for fruit size and shape; flesh, rind and seed color; prolificacy; sugar content, seed dormancy, days to male and female flowering, resistance to powdery mildew (7) and to gummy stem blight (2).

The hand pollination procedure used in the experiments has given a fruit set of 20% which implies in lot of unsuccessful work. More recently it was tried multiplication in a green house with a much higher fruit set, reaching more than 80% (3) in some cases.

**Characterization**

For watermelon descriptor lists are not available. However, from studies scattered in the literature (9) were able to prepare a descriptor list of 20 characters which after a multivariate analysis was reduced to eight characters, viz. length of cotyledon; weight, length and diameter of fruit; flesh width; weight and size of seed; and, diameter of the main vine (8). This methodology can be used in order to characterize the ramain accessions of the germplasm bank.

The citogenetic studies showed great similarity of the horse's watermelon with the commercial cultivars. Morphologically, however, this accession holds characteristics of





*Citrullus colocynthis*, such as white flesh and green seed color, although having no bitterness and much bigger fruits. The crossability studies revealed, in general, a high compatibility among horse's watermelon and the ten commercial cultivars used.

**Evaluation and use**

The results of evaluation for gummy stem blight showed that 15 accessions have resistance to the disease. Six accessions came from the semi-arid part of the State of Pernambuco and Bahia and nine from the wet part of the State of Maranhao. Similar susceptibility to the check Crimson Sweet was found in 14 accessions. Four accessions came from the semi-arid of Pernambuco, seven from the semi-arid of Bahia and three from the wet part of Maranhão. It seems that the wet zone favours the natural selection for gummy stem blight resistance. They have different plant and fruit charateristics.

These results provide the breeders with different options to incorporate gummy stem blight resistance into improved cultivars or hybrids, since only a PI 189225, or its derivatives - AU-Jubilant and AU-Producer, were available before.

For powdery mildew resistance among 66 accessions from different regions, it was found six sources of resistance, all from semi-arid areas of Pernambuco and Bahia. One of this sources was crossed to Crimson Sweet and segregant lines were screened in field conditions, givin rise to elite lines with good resistance and fruit quality, although segregating for flesh color and sugar content.

Resistance to powdery mildiew in the source used is dominant to susceptibility and is governed by one pair of aleles.

The F1's studies showed some characteristics such prolific small fruited parents that may represent a good potential for developing hybrids for exportation, since its size (around 3 kg) is similar to melons now exported for European and American market, what would allow very similar treatment.

**Evolutionary studies**

The farmers use their own seed as planting material, which in fact, as mentioned by (10), lead those farmers to contribute for the evolution of the crop in different soil, crop management and climatic conditions. In fact, some farmers use the watermelon fruits in the field as water source, leaving the seeds on the ground. These seeds that have dormancy can stay viable in the soil until the next rainy season and then, creating a natural seed bed. The farmers also exchange seeds with their neighbours, that in turn, allows migration into different watermelon

populations. Another source of dispersion of local watermelon populations is the guará-wolf (*Crysocyon brachyurus - Canidae*) which open a small hole in the fruit when it matures and eat the flesh with seeds, dispersing them (6). Considering that the watermelon samples came from different areas of Africa and they were put together according to the slave moviment they create a new evolutionary force for the watermelon in the region by allowing hybridization among types from different areas otherwise isolated in their centers of origin (8). These studies indicate that the Northeast of Brazil can be considered as a center of diversity for watermelon.

## Training

Apart from integrated experiments of genetic resources and breeding, trained personnel is a key factor to produce sound results. So far, five young agronomists were trained at post-graduate level, and are engaged in the research programme. New students are expected to join the research in future.

## Conclusions

a) The watermelon germplasm bank already have more than 550 accessions which display a great genetic variability for fruit and plant characteristics.
b) The accessions can be discriminated by few morphological characters easily measured in field experiments.
c) Some characters are of breeding value (e.g., disease resistance, small fruits) and can be transferred to commercial cultivars or synthesize hybrids.
d) The evolutionary studies indicate that the Northeast of Brazil can be considered as a center of diversity for watermelon.
e) The integration of genetic resources and breeding studies can improve the use of watermelon germplasm in the region.

## References

1. Assis, J. G. de A. 1994. Estudos genéticos no gênero *Citrullus*. Jaboticabal: UNESP-Faculdade de Ciências Agrárias e Veterinárias de Jaboticabal, 98p. (Tese de Mestrado).
2. Dias, R. de C. S. 1993. Características fisiológicas de *Didymella bryoniae* (Auersw) Rehm e fontes de resistência em melancia (*Citrullus lanatus*)(Thunb.) Mansf. Recife: Universidade Federal Rural de Pernambuco, 143p. (Tese de Mestrado).
3. Ferreira, M. A. J. Da F., Braz, L. T. & Queiroz, M. A. de. 1995. Fixação de frutos de melancia (*Citrullus lanatus*) via polinização artificial em casa-de-vegetação. Horticultura Brasileira, 13: 82.





4. Hawkes, J. G. 1981. Germplasm collection, preservation, and use. In: Frey, J. (ed.) Plant breeding II. New Delhi, Kalyani Publishers, pp. 57-83.
5. Marshall, D. R. 1989. Limitations to the use of germplasm collections. In: Brow, A. H. D., Marshall, D. R., Frankel, O. H. & Williams, J. T. (eds) The use of plant genetic resources. Cambridge: Cambridge University Press, pp. 105-120.
6. Queiroz, M.A. de. 1993. Potencial do germoplasma de cucurbitáceas no Nordeste Brasileiro. Horticultura Brasileira, 11:7-9.
7. Romão, R. L. 1992. Relatório Final de Pesquisa da FACEPE. Petrolina, PE: EMBRAPA-CPATSA. 31p.
8. Romão, R. L. 1995. Dinâmica evolutiva e variabilidade de populações de melancia *Citrullus lanatus* (Thunb.) Matsum & Nakai em três regiões do Nordeste brasileiro. Piracicaba: ESALQ-Escola Superior de Agricultura Luiz de Queiroz, 81p. (Tese de Mestrado).
9. Romão, R. L., Assis, J. G. De A., Queiroz, M. A. de. 1994. Proposta de lista básica de descritores para o gênero Citrullus. In: Encontro de genética do Nordeste, 10, 1994, João Pessoa, PB. Resumos... João Pessoa, UFPB/SBG(Regionais do Nordeste)/CNPA-EMBRAPA/CNPq, p. 104.
10. Simmonds, N.W. 1979. Principles of crop improvement. London: Longman, 408p. il.