

## Wild Manihot Species of Central Brazil for Cassava Breeding

By  
Nagib M. A. Nassar

Instituto de Ciências Biológicas, Universidade Federal de Goiás  
Goiânia, GO, Brasil.

Seven wild *Manihot* species native to Central Brazil were collected from different localities, screened for tuber formation, HCN content and growth habit. The nature of their wild habitats was described. Several of the screened species showed characters that appeared to have a useful economic potential.

Sept espèces sauvages de manioc recueillies à différents endroits du Brésil central ont été étudiées pour l'aptitude à la tubérisation, pour la teneur en HCN et pour le port de la plante. L'auteur donne aussi une description de l'habitat naturel de ces espèces dont plusieurs semblent posséder des caractères intéressants du point de vue économique.

Cassava (*Manihot esculenta* Crantz) is the seventh largest source of staple food in the world (Food and Agriculture Organization of the United Nations 1970). Because of its tolerance to drought, weed and insect pests, its adaptation to severe temperature and its ability to thrive in sub-optimal soils, it is extremely important to developing nations in their war against hunger.

Central Brazil has about 40 wild species of *Manihot*, principally in Southern Goiás and Western Minas Gerais (Rogers and Appan 1973; Nassar 1977), but very little work has been done on evaluating the genetic resources of the wild species and incorporating them into commercial cassava.

The limited attempts in this field have focussed on three wild species, *M. saxicola* Lanjouw. (Bolhuis 1953), *M. melanobasis* Muell. (Jennings 1959) and *M. Glaziovii* Muell. (Storey and Nichols 1938; Nichols 1974). The latter authors discovered and successfully transferred a gene for resistance to common cassava mosaic from *M. glaziovii* Muell.; WHICH HAD BEEN DOMESTICATED AS CEARA RUBBER, TO CULTIVATED CASSAVA.

The work reported here is a part of a long-term international cassava improvement program to screen Brazilian wild *Manihot* species for economic characters and for their compatibility with cultivated cassava.

### MATERIAL AND METHODS

For location and identification of wild *Manihot* species, the Rogers and Appan monograph (1973) and *Martius Flora Brasiliensis* (Mueller 1874) were used. Seven species were collected from Cristalina, Goianesia, Corumba, and Goiania in Goiás state. The nature of the wild habitat and the tuber formation was noted for each species. Cuttings and/or seeds were collected and planted for further screening for compatibility with cassava. The amount of HCN in leaves and tubers was estimated colorometrically by the method adopted by Centro Internacional de Agricultura Tropical: The tissue is macerated in chloroform. A strip of filter tape is immersed in a 1:1 mixture of 1.2% picric acid and 1.2% sodium carbonate, and air-dried, then exposed to the chloroform vapor in a test tube for 2 h for leaf tissue, 12 h for tubers. The depth of color of the tape at the end of the exposure period indicates the concentration of HCN in the tissue.

### RESULTS AND DISCUSSION

Table 1 presents the results of the screening.

Table 1 – Concentration of HCN and other characteristics of wild *Manihot* species

Species	Locality of Collection	HCN Content	Tuber formation and other particular characters
			Forms abundant tubers with

<i>M. oligantha</i> Pax Emend. Nassar subsp. Nesteli	Cristalina, Fazenda Tavera; 30 km east Cristalina	-	high starch content, relished by horses and cows grazing in its natural habitat, ca. 30 cm. Tall, grows in sandy dry habitat.
<i>M. nana</i> Muell.	Cristalina, Fazenda Tavera	+	Does not form tubers, has a large woody root and very limited top growth, ca. 15 cm tall.
<i>M. tripartita</i> (Sprengel) Muell	Goiania, Serra Dourada, 2 km S. And W the Stadium	+	Forms tubers, well adapted to long dry periods by large woody roots, and die-back of stems in dry season.
<i>M. anomala</i>	Goiania, 5 km North Goiania on road to Inhumas	+	Forms very swollen tubers, grows in the shady and waterlogged places.
<i>M. zehntneri</i> Ule	Goianesia, Fazenda Fabrizio	+	Forms tubers, closely resembles <i>M. esculenta</i> , distinguished by ecotypes with various-shaped leaves in the same habitat.
<i>M. tomentosa</i> Pohl	Corumba, 12 km S. Corumba on sides of road to Anapolis	++	Does not form tubers, has a very very large woody swollen root, high content of HCN and latex, grows on steep sandstone slopes.
<i>M. gracilis</i> Pohl	Corumba 9,12 km S Corumba on sides of road to Anapolis	+	Rarely forms tubers, only in case of very old plants, grows on steep sandstone slopes, has a slender stem and limited vegetative growth.

+ - denotes no HCN; + denotes low HCN; ++ denotes high HCN in tubers.

As *M. oligantha* Pax emend. Nassar subsp. Nesteli is reported here for the first time, the following is a full description of this type: very short subshrub, ca. 30 cm tall, internodes less than 0.8 cm long; 3-5 swollen cylindrical roots per plant, tuber skin dark brown, rough, cortex white; stems glabrous; leaves borne more or less as a rosette; stipules setaceous, ca. 0.2 cm long, less than 0.1 cm wide, glabrous, margin entire; petioles ca. 10 cm long, glabrous, purplish-tinged on the distal 1/3; petiole attachment to lamina basal; lamina membranaceous to slightly coriaceous, upper surface dark green, lower surface slightly pubescent, with a wax pattern, smooth; palmately 3-lobed, occasionally 4 to 5 lobed; venation camptodromous; veins glabrous; midribs of lobes straight; median lobes oblong to lanceolate, ca. 9 cm long, ca. 1 cm wide, apex acuminate; base of lobes ca. 0.4 cm wide; lowest lobes slightly smaller than median lobes; inflorescence panicle, monoecious, ca. 25 cm long with pistillate flowers restricted to the base, all parts glabrous; bracteoles setaceous, ca. 0.7 cm long, less than 0.1 cm wide, margins entire; bractlets setaceous, ca. 0.3 cm long; pistillate flower buds conical, pedicels ca. 0.5 cm long, curved down, tepal ca. 0.6 cm long, cleft to 1/4 length, yellowish green with purple pigmentation on the basal, 1/3, all parts glabrous; pedicels ca. 0.6 cm long; capsules 1.2 cm long, subglobose, surface smooth, apex rounded; dehiscence septicidal; seeds 0.8 cm long, oblong; caruncle prominent.

This type is distinguished from *M. oligantha* Pax by its extremely monoecious, panicle inflorescence, its prominent seed caruncle, and 30-cm height. In the Pax type "inflorescence (is) usually dioecious, caruncle not prominent" (Rogers and Appan 1973, p. 209-210) and the height is 10 cm. According to article 24 of the International Code of Botanical Nomenclature, this type can be considered as an infraspecific one.

Pax did not refer to tuber formation in his type. As a classical taxonomist, he may not have noticed this character. It may also be that this character has been acquired through natural hybridization between Pax type and cassava. Anderson (1953), Anderson and Stebbins (1954), Rick (1958), and Harlan (1961) demonstrated the role of introgressive natural hybridization in evolving new species in cultivated crops. Rogers (1963) suggested that this phenomenon represents an important factor in formation of *Manihot* species. Later, he and Appan (1973, p. 102) stated. "There are clear indications that more intensive investigations and collections in South America will very likely uncover more new taxa in the genus."

The majority of the screened wild species of *Manihot* form tubers in different degrees, adapting to a wide range of habitats. Moreover, they cross easily with *M. esculenta*. The fertility of crosses of cassava with subspecies *nesteli* was more than 90%, with *M. tripartita* 22% (Nassar, unpublished). Rogers and Appan (1973), considering the compatibility of cassava with its wild relatives, suggested that definition of a species should be based on the "closed gene pool" concept: that is, individuals that freely exchange genes with a given population which is morphologically distinct from other populations. This definition is realistic, and facilitates dealing with groups of this genus which have not yet established strong genetic barriers.

As a source of genes desirable for cassava breeding, *M. oligantha* Pax emend. *nesteli* is the most promising of the seven wild species screened. Its very short vegetative growth, abundant tuber formation, high starch content, low HCN content and adaptation to dry habitats make it an important genetic source. The limited growth in proportion to abundant tuber formation indicates a very high harvest index and efficiency in transforming sun energy to carbohydrate. Its low height incorporated into cassava would facilitate

mechanical harvesting, enabling the establishment of large cassava farms. At present cassava is cultivated only as a house-yard crop.

Other species have genes that might contribute desirable qualities to varieties suitable for different soil and climate. *M. anomala*, with its adaptation to shaded habitats, serves well in synthesizing varieties adapted to humid conditions.

*M. zehneri* closely resembles cultivated cassava in growth habitat, reproductive organs, and even in its prominently ribbed fruit, a rare character in wild *Manihot* species. This species shows wide adaptability to different soil conditions, from sandstone slopes to fertile clay, rich in accumulated water. In response to its environment it displays different ecotypes. Rogers and Appan (1973) reported that many parts of this species are non-vidi. It seems that they are reluctant to consider it a robust species. They stated, "The only representation of this taxon in this study is a photo of the type and the inadequate representation precluded an accurate evaluation of this *Ule* species. The leaf and inflorescence structure closely resemble *Manihot esculenta*". All these observations indicate a close relationship of *M. zehneri* to cassava.

There are other reported cases of cassava-like wild species. Rogers and Appan (1970, 1973) indicated the close relationship to cassava of two Mexican wild species: *M. pringlei* Watson and *M. aesculifolia* Pohl. They assumed that the first species may have contributed some genetic material to the cultivated complex. The validity of this assumption is doubtful; it is not certain whether similarity between these two wild Mexican species and the cultivated complex is due to their being progenitors of cassava, or to natural hybridization between cassava and some wild species native to Mexico. Schmidt (1951) reported that cultivated cassava had been carried by immigrant Indians from North Amazon to Mexico 1,000 yr ago. Nassar (1977) pointed out that formation centers of diversity of *Manihot* species coincide with immigrations of indigenous Indian groups in South and Central America.

*M. tomentosa* grows on sandstone slopes. It has a large woody root in comparison to its subshrub structure, and seems well adapted to withstand drought. However, since this species does not form tubers, and furthermore has a high level of HCN, another species might be a better source of drought resistance.

*M. tripartita* not only has a large woody, drought-resistant root, but also its stems die back to soil level in dry seasons a character that may also preclude mosaic infections. Magoon (1967) suggested using such a character instead of an immune source to avoid mosaic.

*M. gracilis* and *M. nana* with their limited vegetative growth represent potential sources for breeding new varieties. They are characterized by limited vegetative growth and high harvest index.

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