Additional storage does not improve the quality of the seeds and increases the risk of bacterial and fungal infections, which may significantly reduce the quality of the seeds and their ability to resist adverse storage conditions.

3) Further ripening of the fruits in the field does not improve the seed quality either. Fruits should be harvested as soon as the peduncle has dried out completely.

Further experiments should be carried out to define the ripening stages of *Cucurbita* spp. fruits and on their complex interactions with seed quality. Seed maturity, initial germination and storability are all related to fruit maturity at harvest.

Summary

Cucurbita moschata fruits were harvested at three different ripening stages. Two fruits of each stage were stored 5 to 6 weeks in an air-conditioned room (50% RH, 23°C ± 3°C). Germination and seed vigor as indicated by the accelerated ageing test, was determined for seeds of fresh and stored fruits at each stage. The best quality seeds were obtained of fresh fruits at stage II (peduncle dry, fruit color partially changing from green to yellow/light-brown). Afterripening of stage I fruits for further 6 weeks improved initial germination and (to a smaller extent) their resistance to accelaterad ageing conditions. Storage of stage II and III fruits resulted in a loss of seed vigour and/or germination.

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Microcenters of wild cassava, Manihot spp. **diversity in Central Brazil**

Resumo. Das 26 especies selvagems da mandioca (yuca) que ocorrem no Brasil Central, 20 especies foram coletadas em duas areas limitadas, cada uma com menos de 100 km de diametro. Estas duas areas são: Goias Velho e Corumba de Goias.

Considerando o conceito de Harlan sobre padrões geográficos de variação das plantas cultivadas, foi suposto que estas duas areas são microcentros da diversidade da mandioca. Evidencias topograficas, de solo, e etnologicas são discutidas.

Introduction

Since the exposition of Vavilov theory on centers of diversity in 1926, many inquiries arose which still receive attention from plant breeders. Vavilov (12) explained the distribution patterns of variation in cultivated crops assuming that the area of maximum diversity of a given crop is its place of origin. In the beginning, he assumed the existence of 6 main geographic centers for cultivated plants all over the world; later in 1936, he increased them to ten. One of the several puzzling problems in Vavilov theory is that some cultivated crops have their centers of diversity far from these ten defined centers. For example, sorghum, yam and many others.

Harlan, in a series of papers, explained a number of topics as that centers of diversity for a given crop may occur far from its center of origin. He also showed that domestication of some crops had taken place far away from these limited determined centers; moreover, it happened along a vast area, something that cannot be called "center". These were called by Harlan (4) "nonecenters". In the case of these nonecenters there is neither an evidence for a center in which agriculture originated nor an evidence for the kind of center described by Vavilov. In centers of diversity as well as the so-called nonecenters, it is common for a crop to show enormous diversity in very small regions. These are the microcenters as defined by Harlan (3), and applied by him afterwards to Sorghum (4). Microcenters were observed by Harlan for wild plants as well as for land races. They appear to be fairly common in the variation of plant species. Geographic pattern of variation of so-called microcenter seems to be applicable for wild cassava distribution in Central Brazil.

Table 1.—Variation of altitude of natural habitats of some *Manihot* species in the two microcenters

Species	Locality of collection	Altitude
M. gracilis	28 Km South Corumba	1050 m
M. peltata	9 Km South Corumba	940 m
M. falcata	10 Km North Corumba	890 m
M. paviaefolia	21 Km North Corumba	1150 m
M. procumbens	24 Km North Corumba	1030 m
M. zehntneri	44 Km South East Goias Velho	715 m
M. pruinosa	31 Km South Goias Velho	890 m
M. reptans	12 Km South East Goias Velho	800 m
M. alutaceae	6 Km South East Goias Velho	1200 m
M. anomala	2 Km South East Goias Velho	720 m

Materials and Methods

Through the project of evaluation of genetic resources of wild cassava, *Manihot spp.* at the Instituto de Ciencias Biologicas, Goiania, localities of wild *Manihot* species were determined according to Rogers and Appan monograph (10), and Mueller (5). Seeds, cuttings or the whole plant of the *Manihot* species were collected from their natural habitats. Altitudes was recorded, and soil was analized according to Black *et al.* (2). History of indigenous and etnological groups of these regions was also studied.

Results and discussion

Two regions in Goias state, each of about 100 km diameter, were found to have majority of wild *Manihot* species known to occur in Central Brazil. These regions are:

1—Goias Velho, which was found to have: *M. tripartita* Muell. Arg., *M. anomala* Pohl, *M. pentaphylla* Pohl, *M. zehntneri* Ule, *M. pruinosa* Pohl, *M. reptans* Pax, *M. divergens* Pohl, *M. mossamedensis* Taubert, *M. sparsifolia* Pohl, *M. alutacea* Rogers & Appan.

2—Corumba de Goias which was found to have: *M. peltata* Pohl, *M. gracilis* Pohl, *M. oligantha* Pax, *M. fruticulosa* Rogers & Appan, *M. paviaefolia* Pohl, *M. procumbens* Muell. Arg., *M. falcata* Roger & Appan, *M. stipularis* Pax, *M. irwinii* Roger & Appan, *M. reptans* Pax, *M. violacea* Pohl, *M. anomala* Pohl, *M. tripartita* Muell. Arg.

Out of 98 species recognized by Rogers and Appan (10) for the genus *Manihot*, 26 species were found to occur in Central Brazil (8). This leads to the belief that this region is one of four principal centers of diversity of cassava. Over extensive areas in Goias state few *Manihot* species occur, while in the two mentioned areas, aggregates of 20 wild *Manihot* species were encountered by the author.

Vavilov (12) observed in the 20's that centers of variation he encountered occured mainly in mountaneous regions. Such a topography is encountered in Goias state particularly in these two regions (Table 1) providing heterogeneous environments that would lead to evolution of new subspecies and species. As Sewal Wright pointed out in the 30's, the most rapid divergence of a biological group can be obtained by its fragmentation to small populations partially isolated from one another and each occupies its specific niche. The large amount of variation in soil constituents in the two limited areas of Goias Velho and Corumba de Goias (Table 2) would provide such specific niches for these populations.

Evolving such a number of *Manihot* species is believed to be a matter of hundreds of years. It need not be a period of Pre-historic ages. A similar case was explained by Stemler *et al* (12) on Sorghum. Historical and archeological evidences encountered in Goias state support this assumption. Archeological study

Table 2.—Analysis of soil from natural habitat of some *Manihot* species in the two microcenters.

Species	Depth cm	PH	$Ca^{++}+Mg^{++}$ mg/100g	P ppm	K^{+} ppm	Al^{+++} mg/100g
M. peltata	0-15	4.9	1.0	1	83	0.8
M. procumbens	0-15	4.9	0.2	—	18	0.5
M. stipularis	0-15	5.0	0.3	1	28	0.6
M. zehntneri	0-15	6.1	3.0	—	87	—
M. pruinosa	0-15	5.5	19.0	1	136	—
M. alutacea	0-15	5.2	1.5	2	36	0.8

Fig. 1. *The map shows Central Brazil occupied by Indian cultivators of cassava on the XI century. After Schmidt (11).*

shows that Goias had been inhabited by indigenous Indian groups who cultivated cassava. This is seen from the technique of pottery style (1).

Study of history of Indian groups in Pre-Columbian age shows that cassava cultivating tribes of Aruak and Guarani had immigrated from the Amazon Basin to Central Brazil (Fig. 1). North Amazon is reported early by Schmidt (11) and assumed by Nassar (8) to be the place of domestications of cassava. Cassava carried by these immigrant Indians could have come to close contact with indigenous wild Manihot species resulting in an extraordinary large gene pool. By fragmentation of this large gene pool, isolated small populations in specific niches could have developed giving rise to new species

These two microcenters in which enormous diversity is found in a restricted geographic area represent a valuable source of genetic variability. Wild *Manihot* species collected by the author from these microcenters were found to have many valuable attributes that may be useful in breeding programs such as resistance tc drought and soil toxicity (6, 7) and very low HCN content (9)

Summary

Out of 26 wild *Manihot* species reported to occur in Central Brazil, 20 species were collected from two limited areas each of less than 100 km diameter. These two areas are: Goias Velho and Corumba de Goias. Considering Harlan concept of geographic patterns of variation of cultivated crops, it is assumed that the two areas are microcenters of cassava diversity. Topographic, soil, and ethnological evidence are discussed

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