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Cover: Women decorticate grains of *Pennisetum americanum*. See Loumerem Mohamed's article on pp. 8-12 for more information.

Couverture: Femmes décortiquant des graines de *Pennisetum americanum*. Voir l'article de Loumerem Mohamed en pages 8-12 pour plus de détails.

Portada: Mujeres mondando semillas de *Pennisetum americanum*. Ver el artículo de Loumerem Mohamed en las páginas 8 a 12 para más detalles.

ARTICLE Plant Genetic Resources Newsletter, 1998, No. 113: 1-3

Incidence of *Neothypodium* endophytes in Spanish perennial ryegrass (*Lolium perenne*) accessions

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Summary
Fifty-four accessions of perennial ryegrass (*Lolium perenne*) collected in northern Spain were examined for the presence of *Neothypodium*. One hundred seeds per accession were examined. Seventy-two per cent of the accessions examined harboured endophyte, showing the widespread incidence of infection. Infection rates were generally lower than 50% and rarely extreme. Infection levels above 50% were mainly present in accessions collected in the warmest and driest locations of our study. Relationships between endophyte infection and climatic characteristics were studied using Spearman's correlations. Significant correlations were found between endophyte infection, the water supply deficit ($r = 0.43$ at $P < 0.01$) and with the average absolute maximal temperature ($r = 0.34$ at $P < 0.05$).

Introduction
Perennial ryegrass (*Lolium perenne*) is an important species of forage grass and can harbour fungal endophytes, some of them belonging to *Neotyphodium* (formerly *Acremonium*). The endophytes of perennial ryegrass and tall fescue are important in New Zealand and the United States, respectively, where they have been studied for many years. It is now well established that they are mutualistic (Clay 1986) and that they improve resistances to abiotic and biotic stress in grasses (Van Heeswijck and McDonald 1992).

A survey of ryegrass endophyte was conducted by Lewis and Clements (1986). They found 14 out 61 endophyte-infected samples of a sward collected at 52 widespread sites in the United Kingdom. Latch *et al.* (1987) studied the incidence of endophytes in European wild accessions and commercial cultivars of *Lolium* and *Festuca*. These authors reported that wild accessions of *Lolium perenne* often harbour endophyte whereas infection is rare in cultivars of this species. At least 72% of French perennial ryegrass accessions harbour endophyte and infection levels within accessions are rarely extreme (Ravel *et al.* 1994). Regional variation in endophyte infection levels have been reported by White *et al.* (1993) for many grasses, and by Ravel *et al.* (1994) for perennial ryegrass. There is no information available about endophyte infection on wild accessions of *Lolium perenne* in Spain. The aims of this work were to assess the geographic distribution and level of infection of *Neotyphodium* endophytes in 54 wild accessions of perennial ryegrass in North Spain and to relate endophyte infection with some climatic characteristics.

Materials and methods
A sample of 54 accessions of perennial ryegrass collected as seeds in northern Spain (provinces of A Coruña, Lugo, Ourense, Pontevedra, Asturias, León, Cantabria, Vizcaya and Guipuzcoa) were examined for endophyte presence. The collecting and evaluation designs have been fully described by Oliveira and Charmet (1988) and by Arbones and Oliveira (1995). Samples were collected in the summers of 1985, 1991 and 1996. Collectors prospected the Galicia administrative region in the summer of 1985 and northern Spain in the summers of 1991 and 1996. Collectors sampled wild ryegrass as regularly as possible to obtain an extensive sample of the possible variation of the natural species. Geographic coordinates of the collecting sites are available on request. At each collecting site, seeds from at least 50 plants were taken from an ecologically homogeneous area of 10-1000 m^2. These conditions are supposed to yield a sample of seeds representative of the original panmictic accession (Tyler 1987). Information about sites was taken at the time of collecting: general habitat, grassland management, latitude, longitude and altitude. Seeds of all plants were bulked, without balancing for the contribution of each plant. Seed was stored in manila packets at 4°C and 45-50% relative humidity. Climatic data were obtained from the meteorological recording stations closest to the individual seed sampling sites (MAPA 1986). Climatic data were: 25-year average annual temperature (T), 25-year average absolute minimal temperature (TMIN), 25-year average absolute maximal temperature (TMAX), 25-year annual rainfall (P), evapotranspiration (cumulated data from March to October, noted ETP) and water supply deficits (WDEF).

One hundred seeds from each sample were soaked in 50 g/L NaOH for 16 h, rinsed with tap water, dehulled, stained with 5 g/L aniline blue, and then squashed with a coverslip. Each slide was examined under a microscope at 200x magnification. The number of seeds containing a *Neothypodium*-like endophyte (Hinton and Bacon 1985) was recorded as infection percentage of the sample. Examination of 100 seeds led to estimations of endophyte infection percentages with confidence intervals < 20%. These estimates could not be improved by examination of more seeds owing to the small quantity available.

After determining that the endophyte infection and the six climatic characteristics described above were markedly non-normal, Spearman's correlations were calculated between endophyte infection (EI) and every climatic characteristic.

Results and discussion

Of the 54 perennial ryegrass accessions examined, 39 (72%) were infected with endophyte at a mean infection frequency of 33.3% (SE = 3.9). The true infection frequency varied with 95% of confidence between 25.5 and 41.1%. This level of endophyte infection (72%) is similar to the level of 64% reported by Ravel *et al.* (1994) in French wild accessions of perennial ryegrass.

The infection level varied from 0% to 91%. Most infected accessions showed a low infection value: 42 accessions had an infection rate below 50% whereas 12 accessions had an infection rate above 50% (Fig.1). These results showed that most wild accessions from northern Spain harboured endophyte, although mostly at low to intermediate levels (0 to 50%). Infection levels above 50% were mainly present in accessions collected in the warmest and driest locations of our study (Fig. 2).

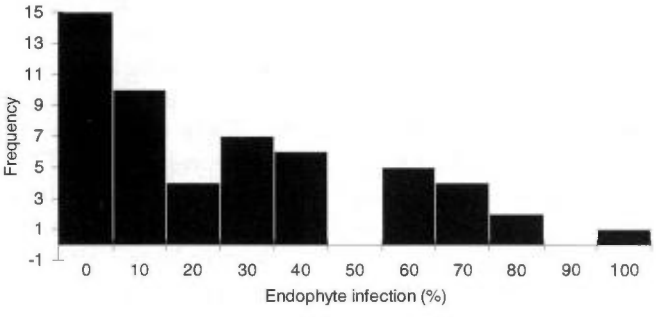

Fig. 1. Histogram of endophyte infection percentages in 54 Spanish wild accessions of perennial ryegrass.

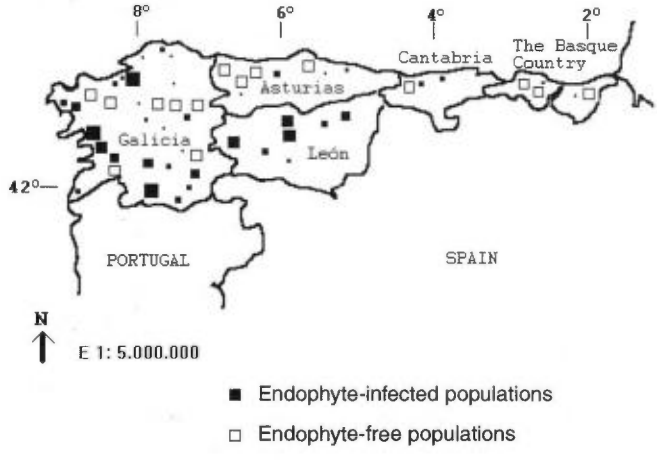

Fig. 2. Endophyte infection levels in 54 Spanish wild accessions of perennial ryegrass: symbol size is proportional to the infection levels.

Table 1. Spearman's correlations between endophyte infection (EI) and climatic variables: average annual temperature (T), average absolute minimal temperature (TMIN), average absolute maximal temperature (TMAX), annual rainfall (P), evapotranspiration (ETP) and water supply deficits (WDEF).

Variable	EI
EI	1.00
T	–0.01
TMIN	–0.26
TMAX	0.34*
P	–0.22
ETP	0.07
WDEF	0.43**

N = 39; $^{**}P < 0.01$, $^{*}P < 0.05$.

The Spearman's correlations between endophyte infection (EI) and climatic characteristics (Table 1) revealed two climatic variables that were significantly related to EI: WDEF (r = 0.43) and TMAX (r = 0.34). The former correlation was significant at $P < 0.01$ and the latter at $P < 0.05$. Correlations between endophyte infection and the other climatic characteristics were not significant. Work in the United States has shown that endophyte infection improves drought tolerance of tall fescue (West 1994). The mechanisms proposed to explain drought tolerance within the symbiosis are diverse. Early work suggests that root growth of tall fescue is greater in symbiotic plants (West *et al.* 1989). Symbiotic tall fescue has also been found to express enhanced osmotic adjustment and turgor maintenance under water stress compared with non-symbiotic fescue (Elmi *et al.* 1992). The high frequency of infected plants of perennial ryegrass in areas of high water deficit obtained in this study may confer a competitive advantage of infected plants in some areas of northern Spain where summer drought occurs regularly and is a severe restriction on the growth of perennial ryegrass. Further studies are necessary to determine whether high endophyte infection of perennial ryegrass in areas of high water deficit is related to drought survival.

As far as we are aware, this is the first report of endophyte infection on *Lolium perenne* wild accessions in Spain.

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Résumé

Incidence des endophytes Neothypodium *chez des accessions de ray grass pérenne* (Lolium perenne) *espagnols*

Cinquante-quatre accessions de ray grass pérenne (*Lolium perenne*) collectées dans le nord de l'Espagne ont été examinés pour la présence de *Neothypodium*. Cent graines par accession ont été examinées. Soixante-douze pour cent des accessions examinées présentaient l'endophyte, montrant ainsi l'incidence étendue de l'infection. Les taux d'infection étaient généralement inférieurs à 50% et rarement extrèmes. Des niveaux d'infection supérieurs à 50% étaient principalement présents dans des accessions collectées dans les sites les plus chauds et secs de l'étude. Les relations entre l'infection par l'endophyte et les caractéristiques climatiques ont été étudiées en utilisant les corrélations de Spearman. Des corrélations significatives ont été trouvées entre l'infection par l'endophyte, le déficit en eau ($r = 0.43$ pour $P < 0.01$) et avec la température moyenne maximale absolue ($r = 0.34$ pour $P < 0.05$).

Resumen

Incidencia de los endofitos Neothypodium *en accesiones españolas de raigrás inglés*

Se examinó la presencia de los hongos endofitos del género *Neothypodium* en 54 accesiones de raigrás inglés recogidas en el Norte de España. Se controlaron 100 semillas por accesión. El 72% de las accesiones del Norte de España examinadas contenían endofitos, mostrando la amplitud de la infección. Los porcentajes de infección fueron en general inferiores al 50% y raramente extremos. Niveles de infección por encima del 50% se encontraron en accesiones recogidas en las localidades más cálidas y secas de nuestro estudio. Se estudiaron las relaciones entre el nivel de infección y ciertas características climáticas, mediante las correlaciones de Spearman. Se encontraron correlaciones estadísticamente significativas entre el porcentaje de infección y el déficit hídrico ($r = 0.43$) a un nivel de significación del 1% y entre el porcentaje de infección y la temperatura media de las máximas absolutas ($r = 0,34$) al 5%.

Plant Genetic Resources Newsletter, 1998, No. 113: 4-7 ARTICLE

Tropical pumpkin (*Cucurbita moschata*) for marginal conditions: breeding for stress interactions

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Summary

To show the role of pumpkin (*Cucurbita moschata*) landraces as an important genetic resource for tolerance of marginal conditions, a simple selection was made by planting genotypes on a site characterized by drought, high temperature and biotic stress interactions. The pumpkin genotypes responded favourably, in spite of their high infection index for diseases and abiotic stresses. This phenomenon presumably is associated with genetic linkage response to biotic and abiotic stresses, which arises under marginal conditions.

Introduction

Plant breeding research often is dedicated to abiotic and biotic stresses, but sources of stress usually are studied separately. Breeders frequently select the best genotypes on the basis of one type of stress, under conditions in which the rest of the factors are controlled. Nevertheless, crops developed under marginal conditions must produce on the basis of stress interactions. Genetic improvement of crop yields under marginal conditions is limited by many practical problems, one of which is to find varieties that tolerate interactions among the different kinds of stresses resulting from temperature, drought, salinity, pests and diseases. Is it possible to select any varieties with these characteristics? How important are landraces in this process?

Cuban pumpkin [(*Cucurbita moschata* Duch. ex Lam) Duch. ex Poir] is an interesting model. This crop is popular for culinary and medical properties, taste, ß-carotene content and is also used in African religious ceremonies. However, yields have proportionally declined in Cuba as crop input levels have decreased over the last 10 years. That is why pumpkin has disappeared from virtually every market (Ríos *et al.* 1994, 1996), although one genotype has been cultivated all over the island, even though it was developed under high-input conditions.

The aim of this paper is to show the role of landraces as an important source of genetic material for tolerance to marginal growth conditions, and to show how a simple selection method was able to combine genes for a sustainable response to biotic and abiotic stress interaction under Cuban cultural conditions.

Materials and methods

Landrace variability analysis

Thirty-four landraces of *C. moschata* from different Cuban sources (Table 1) were sown under low-input conditions without chemical fertilizer or chemical pest and disease control. Filter cake was used as organic fertilizer at the rate of 6-8 kg to a pair of plants.

Table 1. Cuban pumpkin landraces (90% of landraces were collected during a programme of expedition to explore and collect plant genetic resource in Cuba reported by Hammer *et al.* 1992)

Genotype	Collecting site
P-909, P-900, P-1411, P-1345, P-1188, P-1388, P-1291, P-1377	Holguin
P-1523	Isla de la Juventud (Island of Youth)
P-21, P-1175, P-30, Crisostomo	La Habana
P-1130, P-550	Sancti Spíritu
P-1189, P-130, P-1029, P-40, P-39	Pinar del Río
P-1027, P-1043	Cienfuegos
P-1442	Guantánamo
P-711	Ciego de Avila
P-1118	Villa Clara
P-826, P-828	Las Tunas
P-1974, P-357, P-1461, P-20O2, P-278, P1994, P-1655, RG[†]	Unknown site

[†] Commercial variety.

The experimental design was 21 plants per genotype distributed in three replications, under a randomized block design , using plant spacing of 1 m and 8 m between rows. The plots were a single row, 8 m long and 8 m wide.

Factorial correspondence multivariate analysis was applied to cluster the landrace collection according to qualitative and quantitative characters. Traits observed were yield, its components, and selected characteristics of fruits and leaves, according to Esquinas and Gulick (1983).

Target environment

This experiment was carried out at the Research Institute of Fundamental Tropical Agriculture (Havana). On the basis of the results, the most promising genotypes (in terms of yield response) were selected. The seeds removed from two or three predominant fruits were considered as lines. Nine selected lines were cultivated without pollination control on farms with latosolic soils and different abiotic and biotic stresses (Table 2). Performance was determined on the basis of yield as well as the

Table 2. Site farming conditions used

Locations	Season (temp. °C)†	Stress type
Batabanó	Summer (25.9 ± 0.11°C)	High temperature
Batabanó	Winter (22.2 ± 0.36°C)	Drought
San José de Las Lajas	Summer (25.1 ± 0.23°C)	High temperature
San José de Las Lajas	Winter (21.7 ± 0.62°C)	Drought

† Temperature was calculated from the daily average.

percentage of occurrence of silvering leaves (Paris *et al.* 1987) and downy mildew index infection (Ciba Geigy 1984).

Taking into consideration the criteria of Fernández (1992), yield performance under drought stress and heat stress was observed. The stress tolerance index was determined as follows:

Stress tolerance index (STI) = [Yield under high-temperature stress × Yield under drought stress] / Average yield in high temperatures

The genotypes were classified according to their reaction to abiotic stress as follows:

Group A: Genotypes performing favourably under high-temperature and drought stresses.
Group B: Genotypes performing favourably under high-temperature stress and poorly under drought stress.
Group C: Genotypes performing poorly under high-temperature stress and favourably under drought stress.
Group D: Genotypes performing poorly under both abiotic stress conditions.

In addition, yield was plotted against genotype infection indexes for silvering leaves and downy mildew symptoms under naturally high disease conditions to characterize their biotic stress performance. Genotypes were classified according to the criteria as follows:

Degree 1: Genotypes having a high infection index for downy mildew and silvering leaves (Group A)
Degree 2: Genotypes having a high infection index for downy mildew and low infection index for silvering leaves (Group B)
Degree 3: Genotypes having a low infection index for downy mildew and high infection index for silvering leaves (Group C)
Degree 4: Genotypes having a low infection index for both diseases (Group D).

Results and discussion

Variability analysis. Mixture of low-income culture

Among 34 landraces, 25 were able to produce fruit, the majority between 80 and 110 days. Cuban germplasm can therefore be an important genetic source for earliness, since even in tropical areas it is common to find genotypes with a crop cycle longer than 110 days (Lyra 1992). Such lengthening could be associated with genetically determined adaptative or escape mechanisms relative to marginal conditions (Ceccarelli 1994).

Among the characters evaluated, primary skin colour and yield had the most important contribution to genotype clustering, and six clusters were identified (Table 3). The predominant fruit types were the piriform and crookneck type. Elongate, globular and flat shapes were scarce. Yield per plant showed a large variability between

Table 3. Clustering of 34 Cuban pumpkin landraces according to skin colour and yield

Cluster	Characteristics	Genotype clusters
1	High yield and green fruits	P-1388, P-828
2	High yield and yellow or brown fruits	P-550, P130
3	Medium yield and brown, yellow or gray fruits	P-1461, P-1118, P-30
4	Medium yield and green fruits	P-1523, P-1411 P-1043, Crisostomo, P-1029
5	Low yield and yellow or brown fruits	P-909, P-1175, P-900, RG†, P-826, P-1377
6	Low yield and green fruits	P-1188, P711, P-1974, P-1027, P-1189, P2002, P-1442, P-39

† Commercial variety.

landraces, ranging from 0.5 kg/ha to 18 t/ha. The principal yielding varieties had medium-sized fruits (2.5-3.0 kg) as well as more than 4-5 fruits per plant.

In general terms, the genetic variability found was within the species' boundary because no deviation was observed, even though *C. moschata* is cross-compatible with other species of *Cucurbita*. It may be that other *Cucurbita* species do not tolerate the Cuban climate, which is characterized by two periods: a high-temperature period with some rainfall and a low-temperature period with drought. The morphological variability under marginal conditions could be related to different low-input pumpkin genotypes brought to Cuba before Colombus (Pérez Guzmán 1992). Probably, they were brought to Cuba by indigenous tribes through the Caribbean Sea from Central and South America as has been theorized with other traditional crops such as beans (Castiñeiras 1992; Hammer *et al.* 1992).

In summary, germplasm variability among landraces of Cuban pumpkin could be an essential resource for breeding plants for low-input environments.

Site farming response

Nine promising lines selected from landrace clusters were grouped (Table 4). For abiotic stresses (i.e. heat and drought), Genotypes G2, G3 and G4 had the high value of stress tolerance and were included in Group A (Fig. 1).

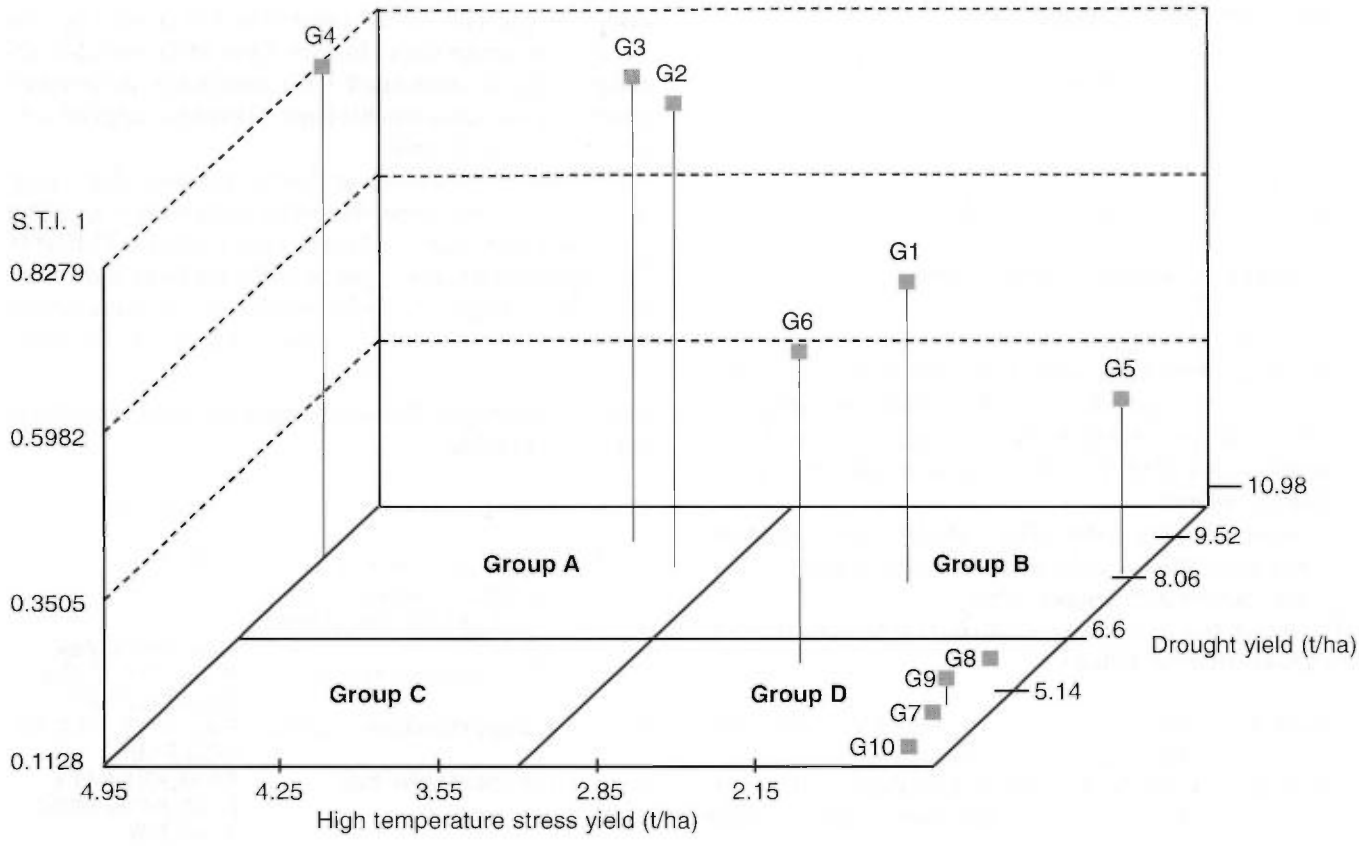

Fig. 1. Response of lines from landraces to different abiotic stresses.

Table 4. Selected lines and landrace source

Code	Selected lines	Landrace source
G1	P-1523A	P-1523
G2	P-1523B	P-1523
G3	P-130D	P-130
G4	P-130E	P-130
G5	P-828H	P-828
G6	P-1029H	P-1029
G7	P-828L	P-828
G8	P-550M	P-550
G9	P-550N	P-550
G10	RG (commercial variety used as control)	

Group B was represented by G1 and G5, the first genotype having a medium and the second a low stress tolerance index. No genotypes were included in the Group C cluster. Genotypes G6, G7, G8, G9 and G10 were included in the D cluster, characterized by low tolerance to heat and drought stresses. G10 has been marketed by a Cuban seed company nearly everywhere as a unique commercial variety.

Variations in yield performance were evident for genotypes G1 and G2 (selected from landrace P-1523) and G3 and G4 (selected from landrace P-130). Landrace P-1523 was collected in the Isle of Youth and P-130 in San Juan y Martínez, Pinar del Río. Both places have dry soils and a rainfall regimen similar to the Cuban average. Thus, presumably, different allele series were linked and arose from natural selection to biotic and abiotic stress interactions under marginal conditions.

Consequently when breeding plants for marginal conditions it is important to test not only landraces coming from that particular location, but also those from other marginal environments. Evolution may have proceeded differently in the different locations, but has contributed to broadening the genetic basis of pumpkin, which is assumed to be essential for its survival under marginal conditions.

Surprisingly, genotypes G2 and G4 had the highest yields (Fig. 2) despite their high infection index for silvering leaves and downy mildew. Previously, both genotypes had performed well under abiotic stress conditions. Thus, it is also important in a breeding programme to look for this response to marginal conditions, as a sustainable linkage to biotic and abiotic stresses would be one means of increasing yields and revealing responses that might be very difficult to observe under high-input agriculture.

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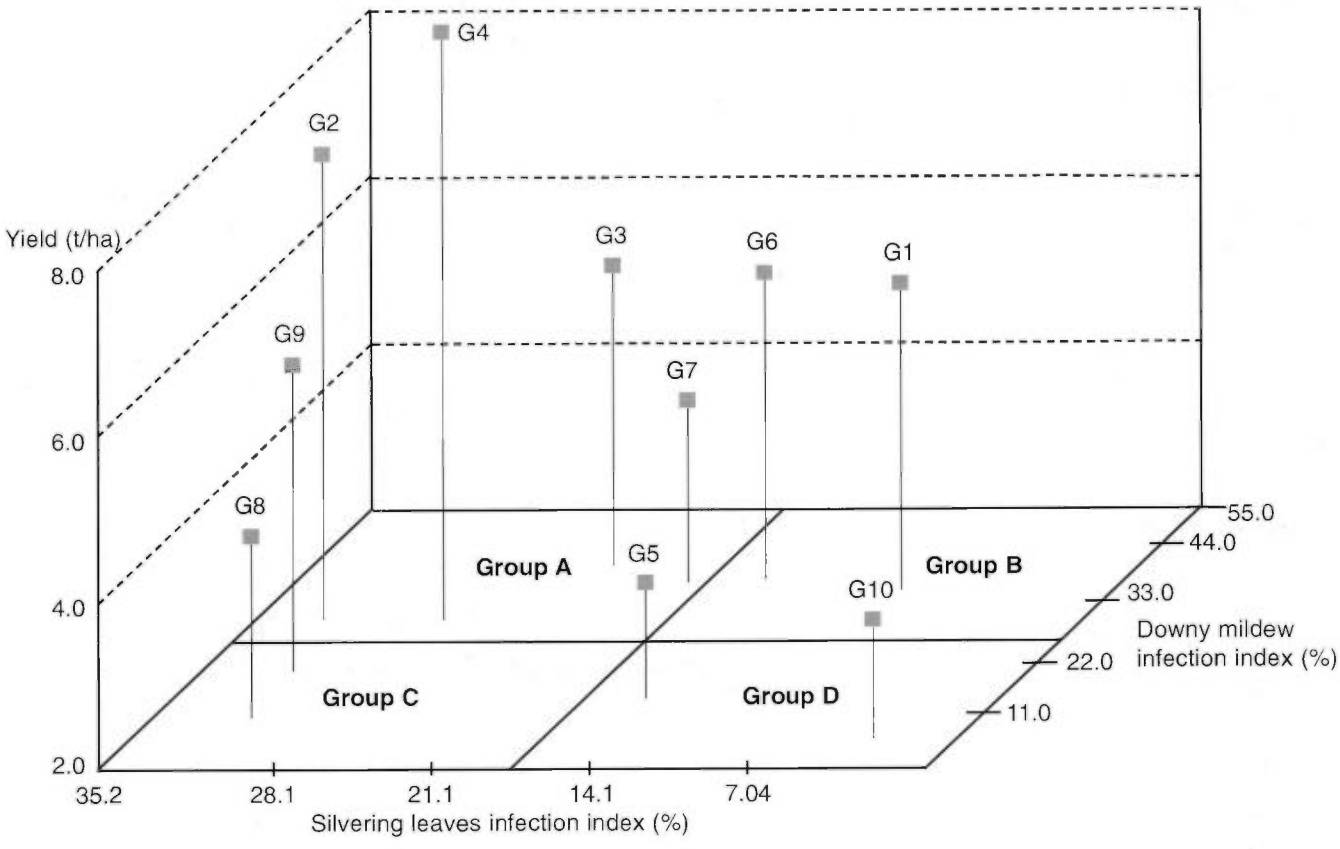

Fig. 2. Response of lines from landraces to different biotic stresses.

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Résumé

Un potiron tropical (Cucurbita moschata) *pour des conditions marginales: amélioration pour l'interaction avec les stress*

Pour montrer le rôle des races locales de potiron (*Cucurbita moschata*) en tant que ressources génétiques importantes pour la tolérance aux conditions marginales, une simple sélection a été effectuée en plantant des génotypes sur un site caractérisé par sa sécheresse, une température élevée et des interactions avec les stress biotiques. Les génotypes de potiron ont répondu positivement, malgré leur index d'infection élevé pour les maladies et les stress abiotiques. Ce phénomène est probablement associé à une liaison génétique dans les réponses aux stress biotiques et abiotiques, qui est révélée dans des conditions marginales.

Resumen

Calabazas tropicales para condiciones marginales: mejoramiento genético para la interacción de estreses

Con el objetivo de demostrar el papel de las variedades autóctonas como fuente de tolerancia genética para las condiciones marginales, se desarrollaron un conjunto de experimentos en condiciones de cultivo típicamente campesina, caracterizadas por la interacción de los estrés hídrico, alta temperatura y bióticos. Se concluye que genotipos de calabaza fueron capaces de responder favorablemente a pesar de los altos índices de infección a las enfermedades y a los estrés abióticos. Este fenómeno está probablemente asociado a un mecanismo de ligamiento genético, el cual se manifiesta en condiciones marginales.

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Inventory of some cultivated landraces threatened by genetic erosion in southern Tunisia

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Summary
In southern Tunisia, important plant genetic resources have not yet been studied but genetic erosion in crop landraces is increasing. During the cropping seasons 1995/96/97, a collecting campaign for *Vicia faba*, *Pennisetum americanum* and *Eleusine coracana* was conducted in the main agro-ecological zones of southern Tunisia (oases and the coast zones). During the survey, 27 samples of *V. faba*, 283 samples of *P. americanum* and 4 samples of *E. coracana* of southern region landraces were collected. The evaluation of those samples showed differences in most of the characteristics, among both genotypes and environments. Future strategies of variety improvement involving exploitation of genetic resources of those regions and the removal of the constraints are suggested.

Introduction
In 1993, a collecting mission was carried out by a joint team from the Institut des Régions Arides, Médenine and the Institut für Pflanzen genetik und Kulturpflanzenforschung, Gatersleben, to study the indigenous cultivated plants. This mission showed that there are important plant genetic resources which are increasingly threatened by erosion due to many different agronomic, economic and social factors (Pistrick *et al.* 1994).

During the 1995/96/97 growing seasons, collecting of three promising species (*V. faba*, *P. americanum* and *E. coracana*) was conducted in the main regions of southern Tunisia, to conserve the genetic diversity of existing local crop landraces. Field work was concentrated on the island of Jerba, the coast (Médénine, Zarzis and Benguerdane), the oases (Gabes, Mareth and Tataouine) and parts of the Matmata mountains (Fig. 1). These regions represent an enormous contrast in natural conditions and agricultural practices (Neffati and Pistrick 1993). The survey was started in February 1996, an exceptional growing season in which rainfall reached 360 mm (as recorded at the meteorological station of IRA), whereas the mean annual rainfall varies between 100 and 200 mm.

The present study was started in order to identify germplasm suited for direct utilization or for breeding superior varieties and to save some material for *ex situ* conservation to combat genetic erosion. We chose *V. faba*, *P. americanum* and *E. coracana* for their great potential to thrive in some of the driest agricultural conditions found in southern Tunisia.

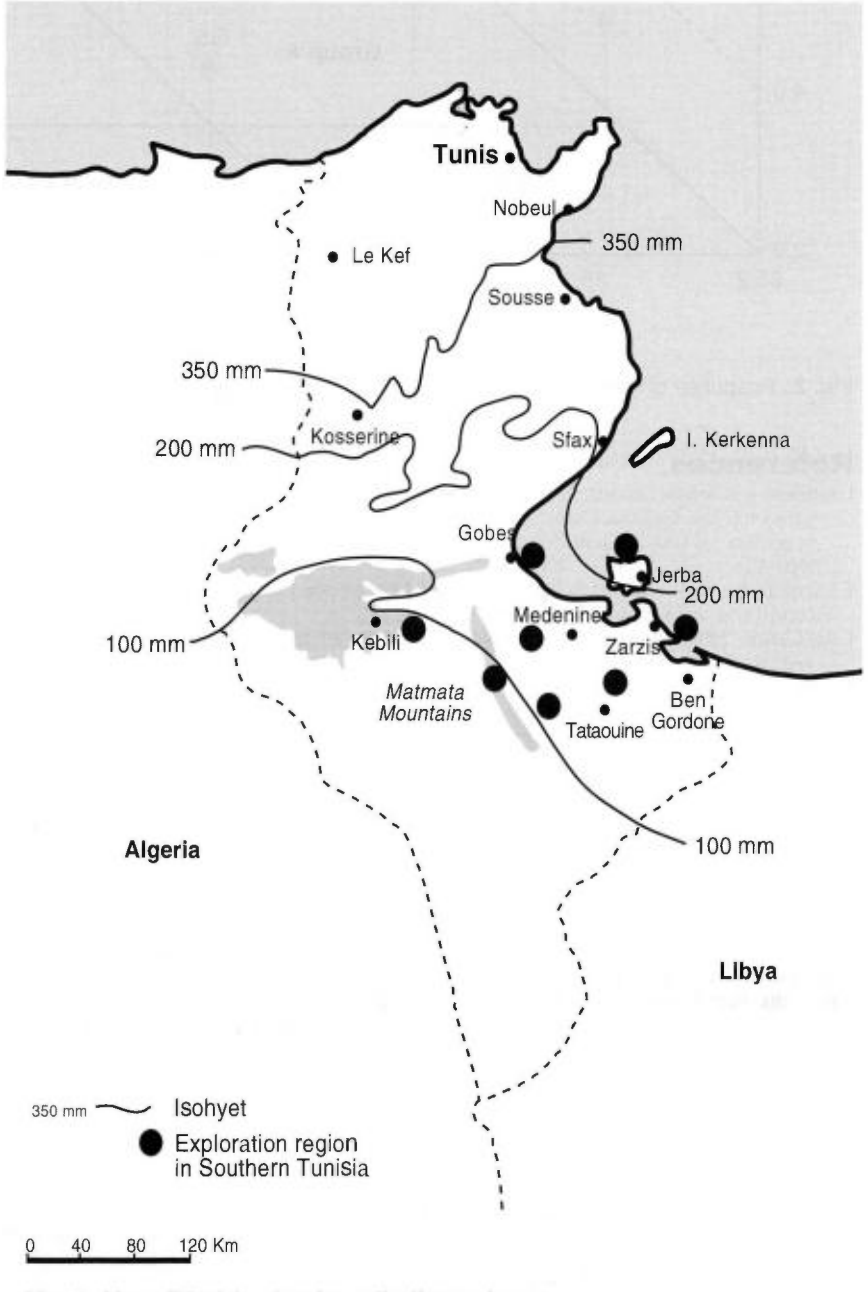

Fig. 1. Map of Tunisia, showing collecting regions.

They are traditional crops in the region. *Vicia faba* is a major food legume crop in Tunisia (Kamel *et al.* 1989; Karrat *et al.* 1992). It is consumed as immature green pods or mature seeds. In some regions of the country and particularly in the south, *P. americanum* ranks second after oat as a cereal crop for human food. It is one of the most tolerant species to dry conditions (Warren and John 1963; Spencer and Sivakumer 1987; David 1995), growing where it would be almost impossible to grow any other cereal crop profitably.

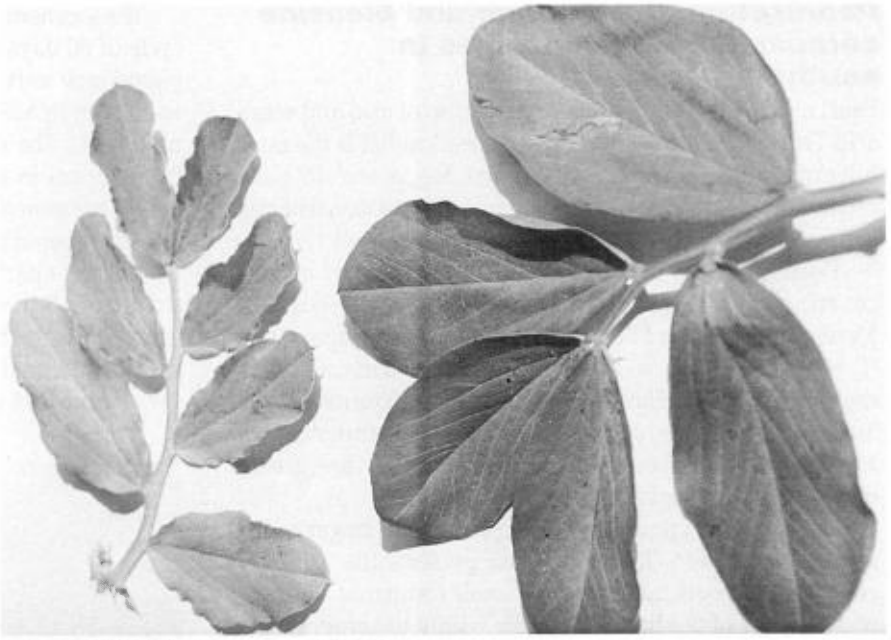

Fig. 3. Variation in leaflet shape of *Vicia faba*.

Vicia faba production zones in southern Tunisia

In the south of Tunisia, *V. faba* is cultivated under different agro-ecological conditions, ranging from the foothills of the Matmata mountains behind the 'jessour' to the island of Jerba (Fig. 1). It is suited for cultivation in those regions with diverse agroclimates and edaphic conditions at various altitudes. It is produced on a wide range of soils (sandy, sandy loam soils in the Oasis and the island, alluvial soils in the mountains). In all the regions of southern Tunisia *V. faba* is grown as a winter crop under both rain-fed and irrigated conditions. The major *Vicia*-producing regions of southern Tunisia can be grouped into two agroclimatic zones: oases and coastal areas.

Cropping systems

Vicia faba is mostly grown during the winter season (October- March). The landraces are traditionally grown under marginal conditions such as poor soil moisture and low fertility, and the farmers do not use any inputs or improved management practices (Halila *et al.* 1990). In general, *Vicia* is grown as a monocrop, but mixed cropping and intercropping of *Vicia* with other species (*Coriandrum sativum* and *Allium* spp.) are practised in the oases (Fig. 2).

Fig. 2. Intercropping of *Vicia faba* with *Coriandrum sativum*.

The choice of a particular system depends upon irrigation potential, annual rainfall and its distribution, and edaphic conditions.

Genotypes

During the survey, 27 samples of *V. faba* landraces were obtained and the following characteristics were recorded for 10 randomly selected plants per evaluated field: plant height (cm) as an average height of the plants from the ground to the tip of the foliage at green ripeness, number of stems per plant, colour of the flower, shape and number of leaflets, number of nodes from the ground to the lowest pod, number of fresh pods/kg, 100-seed weight. Differences in all characteristics were shown among genotypes and among environments. Weight of 100 dry seeds ranged from 172.50 to 260.53 g, plant height from 70 to 138 cm. Figure 3 shows the scale of variation in the shape of the leaflet.

Uses of Vicia faba *in southern Tunisia*

The total production of *V. faba* in the south of Tunisia is consumed as immature green pods or seeds. The first beans that come on to the market are sold green in the pod, the whole pod being sliced and eaten. They are a frequent ingredient in the popular dish couscous. Later in the season when lignification makes the pod walls woody, only the green seeds are eaten. Mature beans are an important component of the diet and they are a common ingredient in dishes such as 'tubikha', which is a favoured dish for women after childbirth. Mature beans are soaked in water and then boiled with spices and cereals to make soup. In the holy days of Achoura, most of the families in southern Tunisia consume beans boiled in water with spices.

Pennisetum americanum and *Eleusine coracana* production zones in southern Tunisia

Pearl millet (*P. americanum*) is a food crop of arid and semi-arid Tunisia. "Of the major cereals, pearl millet is the most tolerant to heat and drought; it has the power to yield reliably in regions too arid and too hot to consistently support good yields of other major grains" (Noel 1996).

Pearl millet is grown outside the oases, in a zone covering the coastal belt of Jerba and all the coast of Médenine, Zarzis and Benguerdane. However, finger millet (*E. coracana*) grows well inside the oases, particularly in the oasis of Gabès. Those millets are minor in terms of total Tunisian cereal production, but important components of agriculture in the south of the country. They are grown under primitive agricultural conditions.

Despite their importance, pearl millet and finger millet can be considered 'lost' crops. At present, the Tunisian collection of pearl millet is very small compared with the wide variety of landraces available within the crop. Finger millet is almost 'lost', being grossly neglected both scientifically and agronomically. Most Tunisian young people have never heard of it.

Cropping system

As semi-arid and arid crops, pearl and finger millets are traditionally a component of the dryland system, usually grown in soils with depleted fertility which receive 150-200 mm of rainfall per year, but they are also very well adapted to irrigated farming. Traditional farming practices include the use of locally adapted landraces, little application of manure and chemical fertilizers, minimum tillage and limited intercropping operations.

Genotypes

During the survey, 283 samples of *P. americanum* landraces were obtained (Table 1). As noted earlier, *E. coracana* is almost 'lost'. Only four samples were obtained (Table 1) and most of the older farmers commented on the disappearance of a large number of very interesting landraces of *E. coracana*. This genetic erosion in crop landraces is the result of irregular droughts and the introduction of new crops.

Table 1. Prospecting regions and number of samples

Species	Region	No. of farmers	No. of samples
P. americanum	Jerba	5	74
	Médenine	9	163
	Zarzis and Benguerdanne	4	46
	Total	18	283
E. coracana	Gabes	2	2
	Kebili	1	1
	Tataouine	1	1
	Total	4	4

The southern Tunisian *P. americanum* has a short cropping cycle of 60 days, and is characterized by a short head. The plants may vary in height from 50 to 200 cm. The highest were seen in Médenine and Zarzis (some plants are over 2 m) (Fig. 4). The mean length of the spikes (panicles) ranges from 7.9 cm in Médenine to 25.63 cm in Zarzis (Table 2). Spikes are generally cylindrical throughout their length but may be tapered at one or both ends. The mean diameter of the different parts of the spikes gives a good idea about the shape found in the fields (Table 2). Seeds range in colour from white to brown, blue or almost purple. They are generally tear-shaped and the average 100-grain weight varies from 0.78 g in Jerba to 1.19 g in Zarzis.

Fig. 4. Zarzisian farmers holding samples of *Pennisetum americanum*. As the picture shows, plants are over 2 m high.

Birds are a threat to crops in most of regions of southern Tunisia. Their incidence varies each year, but they can cause yield losses of up to 50%. Certain hairy pearl millet spikes found in the fields are supposed to be relatively tolerant to bird attack. The farmers select the good ones, in order to increase the hairy spikes in their fields and then grow the plants near their houses (Fig. 5). Maximum diversity was found at the coast of Médenine; the combinations of morphological types are often grown together in the same field.

Finger millet is an annual oases crop in southern Tunisia. Its cropping season is between 3 months (in Tataouine and Kebili) and 6 months in the oases of Gabes. The plants vary in height from 30 to 70 cm. The head consists of a group of 3-8 arranged spikes. The mean length of spikes ranges from 6.21 to 7.01 cm (Table 2). The small grains, only 1-2 mm in diameter, are usually reddish-brown, although a yellow form is known. Most of the yellow forms have disappeared in southern Tunisia.

Uses of pearl and finger millets in southern Tunisia

Pearl and finger millet grains are traditionally decorticated by women, who pound grain in a mortar with a pestle to remove the pericarp. The decorticated grain is later crushed to grits, flour, etc. as desired. The traditional grain-processing

Table 2. Characteristics of the spikes of *Pennisetum americanum*

Region	No. of accessions	Length of spikes (cm)	Diameter (cm) at: bottom	middle	top	Weight of spikes (g)	Weight of grains (g)
Jerba	1	8.94	1.92	2.48	1.82	9.51	0.96
	2	8.76	2.18	2.37	1.92	10.24	0.78
	3	10.04	2.35	2.92	2.29	20.36	1.05
	4	8.5	1.74	2.03	1.63	8.44	1.02
	5	15.92	2.99	3.37	2.56	31.71	1.04
Médenine	1	9.36	1.44	2.38	1.89	12.32	0.81
	2	8.18	1.64	2.05	1.71	7.54	1.00
	3	13.64	2.77	3.32	2.51	31.31	1.02
	4	7.97	1.74	1.92	1.72	5.06	1.03
	5	14.72	2.59	3.12	2.32	27.68	1.01
	6	11.75	2.19	2.61	2.02	18.14	1.06
	7	13.36	2.02	2.45	1.91	15.27	0.86
	8	9.68	1.90	2.26	1.81	11.47	1.11
	9	8.96	2.01	2.40	1.97	12.489	1.07
Zarzis and Benguerd	1	12.5	2.08	2.44	1.89	16.08	1.03
	2	14.27	2.62	3.07	2.52	23.57	0.99
	3	25.63	2.71	2.85	1.86	45.14	1.19
	4	17.22	1.84	2.22	1.72	14.49	0.98
Gabes	1	6.54	—	—	—	5.31	0.135
	2	7.01	—	—	—	6.78	
Kebili	1	6.38	—	—	—	4.62	0.148
Tataouine	1	6.21	—	—	—	4.39	0.126

Fig. 5. To avoid bird attacks, farmers grow pearl millet plants near their houses.

Fig. 6. Women decorticate grains of *Pennisetum americanum*.

technique is a slow and strenuous job for the women every day during the harvesting (Fig. 6). Nutritionally superior to wheat (David 1996; Noel 1996), pearl millet is ground into flour and used for porridge and various other baked products. Two popular dishes are made from finger millet: steam-cooked dishes (couscous) and soup. They are widely consumed in the oases regions.

Control measures

Vicia faba, *P. americanum* and *E. coracana* are generally grown on marginal lands, with a minimal level of management. In general, no chemicals are used by the farmers for controlling diseases and insects in standing crops.

Conclusion and suggestions for future studies

There is no doubt that agroclimates and socioeconomic conditions of southern Tunisia are suitable for growing *V. faba*, *P. americanum* and *E. coracana*. However, demand is outstripping local production and it is necessary to import the needed quantities from the other governorates. Numerous constraints limit yields in all the regions. These include absence of agronomic information about cultural practices; diseases and insect pests; weed infestation; absence of high-yielding varieties (in general, average and potential yields of the existing cultivars are smaller than those of other governorates); absence of genetic improvement activity in those regions; fertilizer use and water management.

To protect genetic diversity, to increase yield and production in those regions of southern Tunisia, a systematic programme, with a clearly defined strategy and methodology for species improvement is necessary in order to identify germplasm suited for direct utilization or for breeding superior varieties (varieties that are highyielding and resistant to biotic and abiotic stresses). The removal of agrobiological constraints needs the urgent attention of researchers and policy-makers:

1. new collections need to be gathered from unexplored areas;
2. all available germplasm at different regions should be pooled, evaluated and catalogued;
3. efforts should be made to strengthen screening of germplasm against diseases;
4. appropriate technologies and agronomic practices should be identified for different cropping systems.

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Résumé

Inventaire de certaines races locales de plantes cultivées menacées d'érosion génétique dans le sud de la Tunisie.

Dans le sud de la Tunisie, d'importantes ressources génétiques n'ont pas encore été étudiées, mais l'érosion génétique augmente chez les races locales de plantes cultivées. Pendant les saisons de production en 1995/96/97, une campagne de collecte de *Vicia faba*, *Pennisetum americanum* et *Eleusine coracana* a été conduite dans les principales zones agro-écologiques du sud de la Tunisie (oasis et zones côtières). Pendant cette étude, 27 échantillons de races locales des régions australes de *V. faba*, 283 de *P. americanum* et 4 d'*E. coracana* ont été collectés. L'évaluation de ces échantillons a montré des différences dans la plupart de leurs caractéristiques, à la fois parmi les génotypes et les environnements. Des stratégies futures d'amélioration des variétés incluant l'exploitation des ressources génétiques de ces régions et la levée des contraintes sont suggérées.

Resumen

Inventario de algunas variedades locales de cultivo amenazadas de extinción por la erosión genética en el sur de Túnez

En el sur de Túnez aún no se han estudiado algunos importantes recursos genéticos de plantas, aunque está aumentando la erosión genética de las variedades locales de cultivo. Durante las temporadas de cultivo de 1995/96/97 se llevó a cabo una campaña de recogida de *Vicia faba*, *Pennisetum americanum* y *Eleusine coracana* en las principales zonas agroecológicas del sur de Túnez (las zonas costeras y de oasis). Durante el estudio se recogieron en las regiones del sur 27 muestras de variedades locales de *V. faba*, 283 de *P. americanum* y cuatro de *E. coracana*. La evaluación de estas muestras mostró la existencia de diferencias en casi todas sus características, en lo que atañe a tipos de genes y entornos. Se sugiere la adopción en el futuro de estrategias para la mejora de variedades que conlleven la explotación de los recursos genéticos de estas regiones y la eliminación de las restricciones.

Analysis of genetic diversity in Chinese sweetpotato [*Ipomoea batatas* (L.) Lam.] germplasm using DNA amplification fingerprinting

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Summary

The genetic diversity and evolutionary relationships in a representative sample of Chinese sweetpotato collection were assessed using the DNA amplification fingerprinting approach. DNA fingerprint profiles were developed for all 42 accessions tested. There were 19-26 bands for each accession and an average of 20.7 such bands were polymorphic. Chinese sweetpotato germplasm tested exhibited a high degree of genetic diversity. Phenetic analysis revealed five major clusters with the following components: (1) landraces from Guangdong Province, (2) landraces from Fujian province, (3) Chinese cultivars, (4) those closely related to Japanese sweetpotato cultivars, and (5) those closely related to the US sweetpotato cv. Nancy Hall. The genetic association observed between accessions was largely consistent with the known pedigree records. The DNA amplification fingerprinting may provide reliable insights into the domestication history of the sweetpotato crop and may be useful in germplasm enhancement.

China is the largest sweetpotato producer in the world and accounts for nearly 85% of world production. Sweetpotato is believed to have been initially introduced into China about 400 years ago and now ranks fourth in cultivated area among crop plants in China after rice, wheat and maize (Sheng *et al.* 1992).

About 2000 accessions of sweetpotato are maintained in China, composed of Chinese landraces, new introductions, breeding lines and cultivars.

Among the various genetic markers currently used for the analysis of genetic diversity, the DNA markers provide powerful and reliable tools for discerning variation within crop germplasm, identifying genotypes and studying systematic relationships (Gepts 1993; Caetano Anolles 1996). Polymerase chain reaction (PCR) based approaches using arbitrary primers are increasingly being employed owing to their speed and simplicity (Williams *et al.* 1990; Welsh and McClelland 1990; Caetano-Anolles *et al.* 1991). Random amplified polymorphic DNA (RAPD) markers and DNA amplification fingerprinting (DAF) markers have been employed in genetic and germplasm studies on sweetpotato (Connolly *et al.* 1994; Jarret and Austin 1994; He *et al.* 1995; Prakash *et al.* 1996).

This study analyzed the genetic diversity and assessed the systematic relationship within a random selection of 42 accessions from the Chinese sweetpotato germplasm collection, using the above techniques.

Materials and methods

Forty-two accessions of sweetpotato were used in this study: 14 Chinese landraces of Guangdong and Fujian provinces in the south of China obtained from the *in vitro* germplasm collection in Beijing National Germplasm Bank, 22 cultivars from across China, and 6 introduced accessions. Two clones of the US cultivar Nancy Hall were employed – one was from the Beijing Agricultural University while another was obtained from the USDA Plant Introduction Center, Griffin, GA.

Total genomic DNA was isolated as described by Chen and Dellaporta (1994). Ten 10-mer primers of arbitrary sequence obtained from the University of British Columbia (Canada) were employed (Table 1). A single primer was used in each PCR reaction (10 µl). Reaction mixtures contained template DNA (10 ng/µl), primer (0.1 µM), $MgCl_2$ (5 µM), Stoffel fragment *Taq* polymerase (2 units) (Perkin Elmer Cetus), and dNTPs (200 µM each) (Promega Co., Madison, WI) with Cetus-supplied buffer (10 mM KCl and 10 mM Tris-HCl). Reaction mixtures were overlaid with one drop of mineral oil. Amplifications were performed using 96-well plates in an MJ Research thermal cycler for 35 cycles or 45 cycles (depending on the primer; Table 1) after an initial denaturation at 94°C for 5 minutes and a final extension at 72°C for 5 minutes. Each cycle consisted of 5 seconds at 94°C, 20 seconds at either 35°C or 45°C (depending on the primer; Table 1) and 30 seconds at 72°C.

Table 1. Primers detecting polymorphic DNA in Chinese sweetpotato accessions

Primer code	Primer sequence (5'-3')	Anneal temp.	No. of bands	Polymorphic bands No.	Polymorphic bands %
UBC 302	CGG CCC ACGT	35	22	21	95.5
UBC 306	GTC CTC GTAG	35	26	26	100
UBC 332	AAC GCG TAGA	35	24	24	100
UBC 346	TAG GCG AACG	45	24	22	91.7
UBC 348	CAC GGC TGCG	45	25	20	80.0
UBC 355	GTA TGG GGCT	45	20	19	95.0
UBC 391	GCG AAC CTCG	35	20	19	95.0
UBC 400	GCC CTG ATAT	35	20	19	95.0
UBC 776	CTT CCC TCCT	35	23	22	95.7
UBC 788	CCT TCC CTCT	35	19	15	78.9

Amplified DNA fragments were separated on a polyacrylamide-based vinyl polymer (GeneAmp®, Perkin Elmer, Norwalk, CT) and electrophoresis was conducted in a vertical gel apparatus (Mini-Protean®; Bio-Rad). Gels (0.7 mm) were as described in He *et al.* (1994). Gels and electrophoresis buffers were prepared in 1 x TBE (100 mM Tris-HCl, 83 mM boric acid, 1 mM Na_2EDTA (pH 8.3). Gels were silver-stained using the procedure of Bassam *et al.* (1991) modified to include an oxidization step with an oxidizer solution (Bio-Rad No. 161-0444) for 5 minutes at room temperature. Bands were scored for the presence (1) or absence (0) of major bands using enlarged pictures of gels through an image analyzer. NTSYS_pc software (version 1.7) was used to compute Jaccard's coefficients of similarity and to construct phenograms using the unweighted pair group method with arithmetic averages (UPGMA).

Results and discussion

DNA fingerprint profiles were developed for all 42 sweetpotato accessions tested using the 10 primers. Each genotype showed 19-26 DNA bands with each of the 10 primers employed (Fig. 1). A total of 207 polymorphic bands was scored, with an average of 20.7 bands per primer. Overall, the Chinese sweetpotato genotype exhibited a high level of genetic variation. The Jaccard's similarity coefficients ranged from 0.32 to 0.80 among the accessions (Fig. 2). Thus, Chinese sweetpotato germplasm appears to possess substantial genetic diversity and the level of variation was much higher than observed for other crops using DNA markers (cf. Gepts 1993). He *et al.* (1995) observed similarity coefficients ranging from 0.2 to 1.0 in a global germplasm sample while Jarret and Austin (1994) observed coefficients ranging from 0.16 to 0.80 among the sweetpotato accessions from Oceania, Peru, the Philippines and the USA. The similarity coefficients observed in the Chinese collection in our study are comparable to those observed among the U.S. cultivars (0.48-0.96) by Prakash *et al.* (1996).

While archaeological evidence from Peru indicates that the crop may have been domesticated 8000 years ago (Ugent and Peterson 1988), sweetpotato has been cultivated in China only for 400 years (Sheng *et al.* 1992), and has been grown in the United States for about 300 years (Bohac *et al.* 1995). Nevertheless, the Chinese collection exhibits considerable genetic variation. This may be due to the high rate of somatic mutation, outcrossing nature and high heterozygosity in this crop (Hernandez *et al.* 1964; Love *et al.* 1978).

Phenetic analysis of the Chinese sweetpotato lines based on the DAF data revealed five major clusters (Fig. 2). Landraces from the Guangdong province clustered closely together while those from the Fujian province grouped together. The two landraces from Zhejiang and Sichuan provinces did not cluster with these two groups but were grouped with Chinese sweetpotato cultivars. Historical records indicate that sweetpotato was introduced into the south of China including Guangdong, Fujian, and Yunan provinces by sea or land during 1563-1594. These geographic areas in China have hundreds of sweetpotato landraces with a long history of cultivation (Sheng *et al.* 1992). The distinct clustering of the landraces from Guangdong and Fujian provinces indicates that sweetpotato may have been introduced independently into these two areas.

Overall, most of the Chinese cultivars studied grouped into three distinct clusters. One cluster (at the top of the phenogram) consisted of only the Chinese cultivars. The close association between these cultivars is not surprising as they share common ancestry. For instance, cv. BAU601 (also known as NongDa 601) is a radiation mutant of Xushu-18, selected for black rot (*Ceratocystis fimbriata*) disease resistance (Lu *et al.* 1989).

The second group containing 10 accessions had four Japanese introductions, four Chinese cultivars and two breeding lines (mutants). The Okinama 100 introduced to China in 1941 (Sheng *et al.* 1992) from Japan has been widely employed as a parent for many Chinese cultivars and was closely associated in our results with cv. Yi Wuohong, its progeny (Fig. 2). The BAU 324-1-2-2-2-2 and BAU 324-1-2-2-2-3 are mutant lines developed by the irradiation of cv. Ning 12-17 and are genetically similar except for skin colour variation. Our DAF results also identified these two mutants as genetically very close.

The third group consisted of US cultivar Nancy Hall (introduced to China in 1936) and some Chinese cultivars known to have Nancy Hall in their parentage. Lizixiang was directly selected from

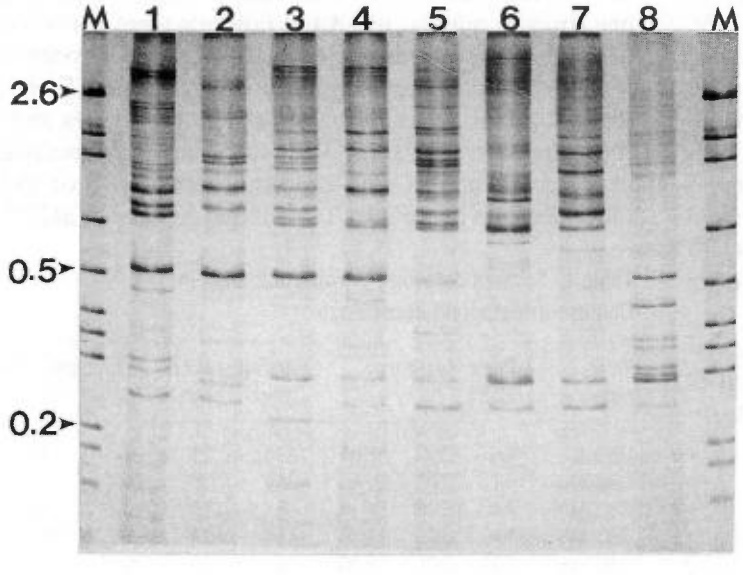

Fig. 1. Fingerprint profiles of eight sweetpotato genotypes developed through DNA amplification fingerprinting. Border lanes (M) show molecular weight markers. Lanes 1-8: Yan-6, Ning-2, BAU601, Li Zixiang, Hong Kong-1, Nanjing-92, Nong Dahong and Peng Wei respectively.

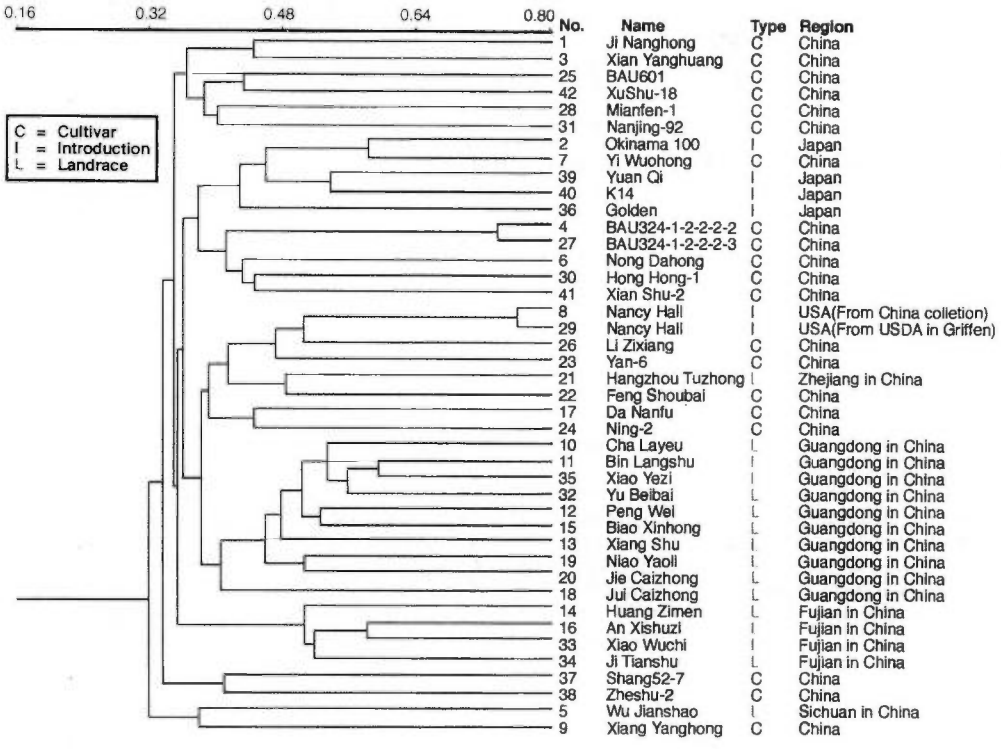

Fig. 2. Phenogram of 42 sweetpotato accessions from the Chinese germplasm collection obtained using Jaccard's coefficient derived from the DNA amplification fingerprinting data.

the F_1 hybrid of Okinama 100 X Nancy Hall, and clustered closely with Nancy Hall. Interestingly, cv. Yiwuohong, a progeny of Okinama 100 X Nancy Hall, clustered closely with Okinama 100 while its sibling Lizixiang clustered with Nancy Hall (Fig. 2). In terms of morphology and growth habits, cv. Yiwuohong does appear closer to Okinama 100 while Lizixiang resembles Nancy Hall. Da Nanfu, another progeny of Nancy Hall was also clustered in the same group. Fen Shoubai is a selection from an F_1 hybrid of Peng Wei and Li Zixiang and appeared closely related to its paternal parent in our study (Fig. 2). The two Nancy Hall samples in our study showed the closest association among all the genotypes studied. While this was not surprising as both represent a single clone, and underscores the reliability of the DAF approach in establishing genetic relationships, the minor variation among the two samples suggests a degree of divergence between the clones of a same cultivar. Sweetpotato has a high rate of somatic mutation (Hernandez *et al.* 1964; Love *et al.* 1978), and this may have contributed to the observed differences between Chinese and U.S. samples of Nancy Hall.

From these DAF results it appears that Chinese sweetpotato cultivars could be divided into three major sections. The first section consists of genotypes closely related to the Japanese introduction, the second section is related to US sweetpotato cultivar Nancy Hall, the third section consists of a divergent group without a distinct relationship to Japanese or American cultivars or with any landraces. The two cultivars Shang 52-7 and Zheshu-2 clustered together but separate from other genotypes. Xiang Yanghong grouped closely with Wu Jianshao, a landrace from Sichuan Province.

In conclusion, there is substantial genetic variation in the Chinese sweetpotato collection. Many recently developed Chinese sweetpotato cultivars appear to be more closely related to the Japanese or US cultivars than Chinese landraces. The distinct clustering of landraces suggests multiple introductions of sweetpotato into China.

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Résumé

Analyse de la diversité génétique de germoplasme chinois de patate douce [Ipomoea batatas *(L.) Lam.] au moyen des empreintes génétiques des produits d'amplification de l'ADN*

La diversité génétique et les relations dans l'évolution d'un échantillon représentatif d'une collection chinoise de patate douce ont été évaluées en utilisant l'approche des empreintes génétiques des produits d'amplification de l'ADN (DAF). Des profils d'empreintes d'ADN ont été établis pour l'ensemble des 42 accessions testées. Chaque accessionétait représentée par 19 à 26 bandes et une moyenne de 20.7 de ces bandes était polymorphe. Le germoplasme chinois de patate douce a montré un haut degré de diversité génétique. L'analyse phénétique a révélé cinq groupes majeurs avec les constituants suivants: (1) races locales de la province de Guangdong, (2) races locales de la province de Fujian, (3) cultivars chinois, (4) cultivars étroitement rattachés aux cultivars japonais de patate douce, (5) cultivars étroitement rattachés au cultivar américain Nancy Hall. L'association génétique observée entre les accessions était largement en accord avec les enregistrements de pedigree connus. Les empreintes des produits d'amplification de l'ADN pourraient permettre de comprendre de manière fiable l'histoire de la domestication de la patate douce et pourraient être utile pour l'amélioration génétique.

Resumen

Análisis de diversidad genética del germoplasma de la batata china [Ipomoea batatas *(L.) Lam.] empleando la técnica de caracterización para amplificación del ADN*

Se estudió la diversidad genética y relaciones evolutivas de una muestra representativa de una colección de batatas chinas empleando la técnica de caracterización para amplificación del ADN. Se desarrollaron perfiles de caracterización del ADN para las 42 accesiones ensayadas. Había entre 19 y 26 bandas para cada muestra, y una media de 20,7 de ellas eran polimórficas. El germoplasma de las batatas chinas que se ensayaron demostraron un alto grado de diversidad genética. Los análisis fenéticos revelaron cinco grupos principales con los siguientes componentes: 1) variedades locales de la provincia de Guangdong, 2) variedades locales de la provincia de Fujian, 3) variedades chinas, 4) las estrechamente relacionadas con las variedades japonesas de batatas y 5) las estrechamente relacionadas con la batata estadounidense conocida como Nancy Hall. La asociación genética observada entre las accesiones coincidía en gran parte con los registros de linajes conocidos. La dactiloscopia de amplificación del ADN puede contribuir a una compensación segura del historial de domesticación del cultivo de la batata y puede ser útil para la mejora de su germoplasma.

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Evaluation and selection of tropical maize (*Zea mays* L.) accessions in low-fertility soils with phosphorus limitations

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Summary

Extensive areas in Brazil have severe problems of mineral deficiencies and maize is a genetically diverse cereal species that represents an important option to help maintain the sustainability of agriculture in these areas. The objective of the present study was to characterize and evaluate maize germplasm in low-fertility soil with severe phosphorus (P) limitations and to select promising accessions to be incorporated into breeding programmes. The 269 accessions collected in northeastern Brazil, between 1980 and 1985, were evaluated in two experiments during the 1994/95 season in two locations. Varieties BR 106 and BR 136, selected under conditions of good soil fertility, were added as between-plot checks. The soil was not fertilized and none of the experiments was stressed with drought. The results of combined analysis of variance showed significant differences between treatments ($P<0.01$) and significant accessions x locations interaction in the trials with accessions from different sites, but not in the trials with accessions collected in the same site in the northeastern region. In both locations several accessions were more productive than the best check, indicating that selection in good environments may not be efficient in improving performance in low-fertility environments. The wide range of variation exhibited by the accessions indicates that it is possible to select and utilize genetic resources in less-developed regions in order to maintain sustainable agriculture.

Introduction

In Brazil, extensive areas have problems of low natural soil fertility and in some regions phosphorus availability to plants is low. The exploitation of these soils for agricultural purposes is limited and, in general, research is directed at modifying the environment (Stangel 1976; Christiansen 1982). This tendency, however, could be changed to make production more economically viable (Clark 1982), and is a high priority in the process of achieving sustainable agriculture (National Research Council 1991).

Genotypic differences among local landraces in environments with nutrient stress have been reported by Ceccarelli *et al.* (1987, 1992) and Ceccarelli and Grando (1989), showing that they can be potentially utilized and that they present advantages for sustainable agriculture. In this respect, genetic resources can significantly contribute to production systems and breeding programmes since they may permit the detection of germplasms that will efficiently use the nutrients available in soil (Francis 1990).

Fertilizers can correct soil limitations but their high cost and the uncertain economic return in tropical regions are a factor of high risk for producers. The situation is further aggravated by the poverty prevailing in some Brazilian regions where small producers have no resources or access to financing for their crop (EMBRAPA 1993).

As maize presents genetic variability for many traits (Hallauer and Miranda Filho 1988), it is necessary to identify accessions that are tolerant to stress within the genetic resources that are available to breeders at genebanks. These potentially useful germplasm resources cannot be utilized unless they are evaluated and characterized in terms of traits of interest to breeders in the target environments (Salhuana 1987; Marshall 1989).

Although evaluation and characterization data are vital for the use of germplasm, this information does not guarantee that they can be used since most of the collected accessions are not specifically adapted to a given environment and usually present low productivity (Iwanaga 1993). According to Nass *et al.* (1993), the major reason for the limited use of genebanks in Brazil is the lack of information about traits of interest for breeding programmes. Exploiting the genetic variability available at genebanks is a strategy that may identify valuable materials for immediate use or as a source of new genes (Santos and Miranda Filho 1992; Pollak 1993).

The objective of the present study was to characterize accessions in low-fertility soils where phosphorus is one of the limiting factors and to select the most promising accesions for incorporation into breeding programmes.

Materials and methods

A total of 269 maize accessions was collected in the northeastern region of Brazil between 1980 and 1985 by Centro Nacional de Pesquisa de Milho (CNPMS, National Research Center of Maize and Sorghum) and by Centro Nacional de Recursos Genéticos (CENARGEN, National Center of Genetic Resources). These accessions have been deposited at the active genebank of CNPMS and are conserved under appropriate control for the maintenance of their genetic identity. In the cropping season 1994/95, two experiments were conducted using lattice designs of 10 x10 and 13 x 13 in the municipalities of Lagarto, State of Sergipe (SE) and Janauba, State of Minas Gerais (MG), in low-fertility soils in which phosphorus is one of the critical factors.

The 100 accessions tested in the first experiment were collected in the States of Sergipe (31), Pernambuco (27),

Alagoas (19), Paraiba (12), Ceará (4), Rio Grande do Norte (4) and Bahia (3), and the 169 accessions tested in the second experiment were collected in the State of Bahia. The maize varieties BR 106 and BR 136, selected under conditions of good fertility and in fertilized soil covered with "cerrado" vegetation, were used as between-plot checks.

Table 1 shows the results of chemical analysis of the soils at the locations where the trials were conducted. In Lagarto, SE, the soil is classified as dystrophic yellow latossol of medium texture; in Janauba, MG, it is classified as dystrophic red latossol of medium texture. At both locations, the plots consisted of a 5-m row with 1-m spacing between rows and 0.20-m spacing between plants within rows. No fertilizer was added and none of the trials was submitted to drought stress.

The following traits were measured in Janauba, MG: 50% male flowering (days), plant height (cm), ear height (cm), percent lodging (LR%), percent of broken plants (B%) and ear weight as kg/ha (EW). EW was determined at both locations. The EW measurements from the checks were not used in the analysis of variance. The mean values were utilized to compare with the best 20% selected accessions in low-fertility soils.

Analysis of variance was first performed for each location and each experiment as recommended by Cochran and Cox (1957), only considering ear weight. Combined analysis of variance was then performed for each experiment to determine the magnitude of treatment x location interaction and select the 20% best treatments.

A repeatability index was calculated using the procedure: (1) select the best 10 accessions from each individual experiment; (2) verify among these 10 accessions how many show coincidence with the 20% selected from the combined experiment analysis; (3) divide the number of accessions with coincidence by the total number of the 20% selected accessions and multiply by 100.

Results and discussion

In Janauba, MG, fertility may be considered medium-high, except for phosphorus (P) whose level was very low (Table 1); in Lagarto, SE, soil fertility was medium in terms of Ca, Mg and K levels, whereas soil fertility in terms of P, nitrate and ammonium was low (Comissão 1989).

Table 2. Values and level of significance of the mean squares obtained by combined analysis for ear weight (kg/ha) and coefficient of variation (CV%), Lagarto, SE, and Janauba, MG, cropping season 1994/95

Source of variation	First experiment d.f.	First experiment MS	Second experiment d.f.	Second experiment MS
Locations (L)	1	143155.20**	1	690232.13**
Accessions (A)	99	2364.09**	168	1529.77**
L x A	99	1678.06**	168	976.63^{ns}
Mean error	198	859.12	336	1072.28
	CV: 22.85%		CV: 26.98%	

Table 2 shows the results of the combined analysis of variance for ear weight in the two experiments. The significant mean squares for accessions ($P<0.01$) in both experiments indicate that there are significant genetic differences among accessions evaluated under conditions of low soil fertility, in agreement with data reported by others (Ceccarelli *et al.* 1987 1992; Ceccarelli and Grando 1989; Lafitte and Edmeades 1994). The range of ear weight was from 2079 to 5704 kg/ha among the 100 accessions tested in the first experiment, and from 2452 to 5547 kg/ha among the accessions tested in the second experiment, with coefficients of variation (CV) of 22.85% and 26.98%, respectively. In environments presenting problems of stress, these values may be considered normal (Blum 1988) and similar results have been obtained by Machado *et al.* (1992) and Gama *et al.* (1994).

Table 2 also shows that accessions x location interaction was significant in the first experiment ($P<0.01$) and not significant in the second experiment. From a breeding viewpoint, significant genotype x environment interactions impair selection since the materials change their behaviour from one location to another (Vencovsky and Barriga 1992). The interaction observed here may be considered predictable (Allard and Bradshaw 1964) since the accessions tested were collected in different states in a region characterized by marked environmental variations. Considering that the objective of the present study was to characterize and select the most promising accessions for incorporation into breeding programmes, the interaction observed will have no significant effects since, as shown in Table 3, among the

Table 1. Results of chemical analysis of soils in Janauba, MG and Lagarto, SE, where the trials were conducted, cropping season 1994/95

Depth	pH	Ca (eq. mg/100 ml)	Mg (eq. mg/100 ml)	K (ppm)	P (ppm)	OM† (%)	NH_4 (ppm)	NO_3 (ppm)
Janaúba – MG								
0 - 20 cm	6.4	5.5	0.95	210	4.4	2.1	2.61	9.29
20 - 40 cm	6.5	5.4	0.86	118	2.0	1.1	2.92	4.16
Lagarto – SE								
0 - 20 cm	6.1	1.68	0.82	56	14.0	1.1	1.26	2.68
20 - 40 cm	5.7	1.03	0.38	60	6.0	0.7	1.57	1.15

† OM = organic matter.

Table 3. Mean values obtained in the two environments for the 20% best accessions in the first experiment and for a number of traits†, Janauba, MG and Lagarto, SE, cropping season 1994/95

Accession	MF‡	PH‡	EH‡	LR‡	B‡	EW§
PB 003 ¶	60	288	192	8	0	5704
PE 026	60	285	176	0	8	5637
AL 010 ¶	62	268	185	4	4	5381
SE 003 ¶	59	255	131	16	7	5236
PB 004	59	260	165	12	6	5157
CE 001 ¶	59	271	169	5	3	5142
PB 011	60	250	141	28	0	5088
PB 005	60	277	180	21	8	5077
PE 027 ¶	59	261	157	10	3	5069
SE 025	59	262	168	2	0	4931
AL 013	58	274	179	15	14	4927
SE 002	61	258	150	8	16	4835
PB 009	60	277	172	11	5	4765
PE 024	59	260	151	8	20	4750
AL 018	61	298	201	23	5	4733
SE 024	59	286	184	6	7	4726
PB 008	60	286	177	0	5	4720
RN 002	60	273	186	18	12	4697
SE 029	60	272	172	10	5	4681
PE 023	62	274	172	11	3	4668
BR 106 (C)	58	241	123	7	4	4301
BR 136 (C)	59	240	141	7	9	3927

† MF = 50% male flowering, PH = plant height in cm, EH = ear height in cm, LR = percent lodging plants, B = percent broken plants, EW = ear weight in kg/ha.
‡ Mean for one location (Janauba - MG).
§ Mean for the two locations.
¶ Accessions selected from the best 20% within each environment.
C = check.

Table 4. Mean values obtained in the two environments for the 20% best accessions in the second experiment and for a number of traits†, Janauba, MG, and Lagarto, SE, cropping season 1994/95

Accession	MF‡	PH‡	EH‡	LR‡	B‡	EW§
BA 031 ¶	59	282	178	11	6	5547
BA 049 ¶	59	252	161	5	5	5486
BA 147 ¶	63	272	167	9	4	5203
BA 155	61	298	194	0	2	5106
BA 119 ¶	58	292	175	4	7	5068
BA 183	59	293	193	0	0	5017
BA 038	60	235	143	3	0	4993
BA 097 ¶	61	239	136	4	2	4989
BA 032	58	233	134	0	12	4939
BA 159	58	277	191	4	9	4869
BA 165	59	262	142	12	12	4843
BA 196 ¶	61	300	183	8	4	4837
BA 114	63	295	200	0	4	4836
BA 095	61	288	178	10	3	4821
BA 064 ¶	62	274	176	9	4	4793
BA 115	59	266	163	2	0	4750
BA 068	65	274	150	9	5	4708
BA 054	59	277	168	12	4	4697
BA 142	61	278	160	4	4	4662
BA 181	61	281	179	2	7	4636
BA 036	59	266	162	3	11	4576
BA 092	61	280	180	9	4	4563
BA 116	59	279	166	9	9	4556
BA 096	63	282	165	19	0	4546
BA 094	60	261	160	9	3	4546
BA 189	61	279	173	2	9	4545
BR 106 (C)	59	247	132	2	2	4893
BR 136 (C)	58	249	142	5	5	4176

† MF = 50% male flowering, PH = plant height in cm, EH = ear height in cm, LR = percent lodging plants, B = percent broken plants, EW = ear weight in kg/ha.
‡ Mean for one location (Janauba - MG).
§ Mean for the two locations.
¶ Accessions selected from the best 20% within each environment.
C = check.

best selected accessions there was 25% repeatability and the most promising accessions ranked among the 10 most productive ones. The tables show the best 20% accessions selected in the combined analysis with 26.9% repeatability for the second experiment (Table 4). It can be seen that the mean yield of the better check (BR 106) was 4301 kg/ha and 4893 kg/ha, whereas many accessions presented higher yields.

The exploitation of the genetic variability of accessions stored at genebanks is a strategy that may make feasible the production systems of small producers in view of the high price of fertilizers (Dobereiner 1990) and the risks inherent in agriculture in tropical regions.

Although the values obtained for the remaining traits were obtained at only one location, it can be seen that the accessions in general showed higher plant and ear height than BR 106, but similar mean values with respect to male flowering, percent lodging and percent of broken plants. It should be emphasized that BR 106 was selected in soils with no problems of mineral stress where it presented a yield potential of 7000 to 8000 kg/ha (Santos *et al.* 1994) and higher mean values for the remaining agronomic traits. These data appear to confirm the hypothesis of Clark and Duncan (1991) that it is doubtful whether the strategy of selecting plants for favourable environments is also optimum for stressed environment. These preliminary results show that if selection is directed at the development of cultivars to be utilized in stressed environments, breeding should be developed in soils with deficiencies to satisfy this requirement (Clark 1982), since, in addition to the many factors that influence plant adaptation to stress conditions (Epstein 1976), there is also an interaction between nutrient availability and deficiency and climatic factors (Dudal 1976).

On the other hand, the fact that the accessions tested showed a wide range of variation for ear weight and yields superior to those of BR 106 indicates that these genetic resources can be used in breeding programmes since the key to the conservation of these traits is the utilization of the accessions (Sastrapradja 1993). The development of cultivars adapted to conditions of low soil fertility may also be a factor of success for sustainable agriculture (Flores *et al.* 1991) and should become one of the world priorities over the next years (National Research Council 1991).

Thus, the development of cultivars for these marginal areas is of fundamental importance for Brazilian agriculture in regions with high levels of poverty (EMBRAPA 1993) where there is a high concern about the sustainability of production systems (Flores *et al.* 1991).

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Résumé

*Evaluation et sélection d'accessions de maïs (*Zea mays *L.) tropical dans des sols à faible fertilité avec des limitations en phosphore*

De larges zones du Brésil présentent de sévères problèmes de déficience en minéraux et le maïs est une espèce de céréales génétiquement diverse qui représente une option importante pour aider à maintenir la durabilité de l'agriculture dans ces zones. L'objectif de la présente étude était de caractériser et d'évaluer du germoplasme de maïs sur des sols présentant de sévères limitations en phosphore (P) et de sélectionner les accessions prometteuses à incorporer dans les programmes d'amélioration. Les 269 accessions collectées dans le nord-est du Brésil entre 1980 et 1985 ont été évaluées au cours de deux essais pendant la saison 1994/95 sur deux sites. Les variétés BR 106 et BR 136, sélectionnées sous des conditions de bonne fertilité de sols ont été ajoutées comme témoins inter-sites. Le sol n'a pas été fertilisé et aucun des essais n'a été stressé par la sécheresse. Les résultats de l'analyse de variance combinée ont montré des différences significatives entre traitements ($P<0.01$) et une interaction accessions x site significative dans les essais avec des accessions de différentes sites, mais pas dans ceux avec des accessions collectées dans le même site dans la région du nord-est. Sur les deux sites, plusieurs accessions ont été plus productives que le meilleur témoin, ce qui indique que la sélection dans de bons environnements n'est peut-être pas efficace pour améliorer les performances dans des environnements à basse fertilité. La large gamme de variation montrée par les accessions indique qu'il est possible de sélectionner et d'utiliser des ressources génétiques dans des régions moins développées afin de d'y maintenir une agriculture durable.

Resumen

*Evaluación y selección de accesiones de maíz tropical (*Zea Mays *L.) en suelos de bajo nivel de fertilidad con limitaciones de fósforo*

Amplias zonas del Brasil sufren serios problemas de deficiencias de minerales y el maíz es una especie cereal genéticamente diversa que representa una importante opción para ayudar a mantener la capacidad de sustentación de la agricultura en esas zonas. El objetivo del estudio era caracterizar y evaluar el germoplasma del maíz en suelos de bajo nivel de fertilidad con serias limitaciones de fósforo (P) y seleccionar accesiones prometedoras para incorporarlas en los programas de mejoramiento fitogenético. Se han evaluado las 269 accesiones recogidas en el nordeste de Brasil entre 1980 y 1985 mediante dos experimentos realizados en la temporada 1994/95 en dos localizaciones. Para servir de testigos entre parcelas se añadieron también las variedades BR 106 y BR 136, seleccionadas en condiciones de buen nivel de fertilidad del suelo. No se fertilizó el suelo ni ninguno de los experimentos estuvo sujeto a estrés por sequía. Los resultados de los análisis combinados de variación registraron notables diferencias entre los tratamientos ($P < 0,01$) y una interacción importante de las accesiones en ensayos con las de lugares diferentes, pero no con las recogidas en el mismo lugar en la región nordeste. En las dos localizaciones, algunas accesiones resultaron ser más productivas que el mejor testigo, lo que indica que la selección en entornos óptimos podría no ser eficaz en lo que atañe a mejorar el rendimiento en circunstancias de bajo nivel de fertilidad. La amplia gama de variación que ostentaron las accesiones da a entender que es posible seleccionar y utilizar recursos genéticos en las regiones menos desarrolladas para mantener una agricultura sostenible.

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Recolección de especies cultivadas en la ecorregión del Río Atabapo del Estado Amazonas, Venezuela

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Resumen
Se realizó un viaje de expedición en los alrededores de la localidad de San Fernando de Atabapo, Estado Amazonas, Venezuela, para la colecta de germoplasma de especies nativas cultivadas. Se recolectó un total de 63 muestras de 15 especies tanto cultivadas como potenciales, en un total de nueve comunidades indígenas correspondientes a cinco etnias indígenas de la región. En general se observó poca variabilidad en los recursos fitogenéticos de las especies cultivadas en la región visitada.

Introducción
El Estado Amazonas representa una región de incalculable valor geoestratégico por las especies que en ella se encuentran, el valor cultural de las etnias de la región y por ser el mayor reservorio de recursos hídricos del país. Esta zona tan particular ha sido visitada por numerosos científicos y exploradores, así como por cronistas de indias y misioneros. Destacan entre tanto los valiosos aportes de las expediciones de Humboldt y Bonpland en 1800 (fines geográficos y florísticos), Codazzi en 1838 (fisiografía y flora), Schomburgk en 1839-1854 (flora del Alto Orinoco), Rice en 1921 (flora del río Negro, Casiquiare y Alto Orinoco), la 'expedición franco-venezolana' en 1951 (Risquez 1962) y otras expediciones financiadas por entidades nacionales e internacionales (Huber y Wurdack 1982). Texera (1991) sintetiza la historia de las exploraciones botánicas en Venezuela desde 1754 a 1950, señalando únicamente a Araque y Barckley en 1928 como exploradores botánicos de la región del río Atabapo.

Al revisar los objetivos de estas expediciones se evidencia la tendencia de ser exploraciones botánicas que muy poco tomaron en consideración las especies agrícolas cultivadas por las comunidades indígenas de la región. En los últimos años ha habido mucho interés por recolectar este tipo de material biológico, destacando los trabajos de Segovia *et al.* (1988) y Mantilla *et al.* (1997). Este tipo de actividad asegura el mantenimiento de la diversidad genética, disminuyendo el riesgo de pérdida, posibilitando la reinserción del recurso genético en su lugar de origen o su incorporación en otros ambientes similares.

Muchas comunidades indígenas de la región poseen en sus siembras de subsistencia materiales valiosos de especies cultivadas (variedades y razas) que siembran y utilizan para su sustento y costumbres ancestrales y las cuales pueden ser importantes reservorios de genes para su aprovechamiento en futuros programas de mejoramiento genético.

El presente trabajo tuvo como objetivo explorar algunas comunidades indígenas de los ríos Orinoco y Atabapo en el Estado Amazonas de Venezuela con el fin de recolectar material autóctono cultivado de diversas especies alimenticias y de interés actual y potencial para la agricultura. Estos materiales fueron incorporados en los bancos de germoplasma que se mantienen en el Fondo Nacional de Investigaciones Agropecuarias (FONAIAP, Venezuela), para su estudio y posterior utilización.

Entorno etnológico de la zona
La zona de recolección (cuadro 1) está ubicada en el antiguo Departamento Atabapo, hoy Municipio Atabapo del Estado Amazonas. De acuerdo con la propuesta del Museo Etnológico de Amazonas, la zona tiene una gran importancia geoestratégica. El río Atabapo ha tenido un gran dinamismo en la navegación para el transporte de carga de caucho (*Hevea brasiliensis*) y de la fibra de chiquichiqui (*Leopoldinia piassaba*).

Cuadro 1. Localidades visitadas en colecta realizada en el Municipio Atabapo del Estado Amazonas, Venezuela, 1994

Identificación	Localidades	Etnia	Latitud	Longitud	Altitud
1	Caño Magua	Kurripaco	3°57´N	67°36´W	95
2	Caño Mure	Piaroa	4°26´N	67°47´W	120
3	Caño Cupaven	Piapoco	4°07´N	67°37´W	130
4	Carana Ven	Puinabe	4°11´N	67°46´W	105
5	Cáscara Dura	Kurripaco	4°02´N	67°38´W	95
6	Comunidad Primavera	Guajibo Piapoco	4°10´N	67°43´W	140
7	Laja Lisa	Piapoco	4°43´N	67°47´W	145
8	Sta. Teresa	Piapoco	4°05´N	67°42´W	145
9	Siguita	Comunidad mixta	4°12´N	67°48´W	145

La población indígena del Municipio Atabapo está formada por las etnias Baniva (447 personas), Baré (409), Guajibos (179), Kurripacos (1280), Makos (182), Piapocos (87), Piaroas (1232), Sanimas (393), Puinaves (233), Warekenas (92), entre otras, y por una minoría de población no indígena (Morón 1994; Museo de Atabapo 1994).

Los cronistas de indias, los misioneros jesuitas y los antropólogos actuales han contribuido mucho para conocer el tipo de agricultura que se practicaba a la llegada de los europeos y la que ha evolucionado a través de los años por el contacto de la cultura occidental con la amerindia.

Gumilla (1791) en su obra 'El Orinoco ilustrado y defendido' detalla con precisión las costumbres, el modo de cultivar las tierras y los frutos que se recogen en áreas ribereñas del Orinoco. Al respecto indica lo siguiente: 'Todos los indios otomacos que viven en las lagunas, que las hay muchas y muy grandes, al tiempo que éstas van bajando, después de la fuerza de las aguas, van sembrando toda aquella tierra limpia de que se retira el agua; y aquí sí recogen abundante fruto, porque desfoga y prorrumpe aquella tierra holgazana y podrida en copiosos frutos. En el contorno de estas lagunas siembran los dichos otomacos guamos, paos y saruros, una singular especie de maíz, que no se ha extendido ni he visto en otras naciones; llámanle en su lenguaje maíz de los dos meses... Ni pierden palmo de tierra, porque entre dicho maíz siembran matas de caña dulce, mucha variedad de raíces, gran diversidad de calabazas'...

Por mucho tiempo, las prácticas de cultivo han permanecido invariables, con incorporación de algunos elementos tecnológicos como el uso de herramientas de hierro. Triana (1982) indica que las comunidades indígenas se localizan en un ambiente ribereño, apto para aprovechar los recursos acuáticos, y desarrollan un conjunto de prácticas agrícolas denominadas agricultura itinerante, de tumba y quema o 'conuco'.

Este tipo de agricultura se caracteriza por desarrollarse en pequeñas parcelas (1 hectárea en promedio) y depender de un cultivo predominante. Este cultivo principal es en muchos casos la yuca amarga (*Manihot esculenta* Crantz.), el cual es sembrado con otros secundarios (maíz, ñame, piña, ají, entre otros), cuyas épocas de cosecha son diferentes. En muchas ocasiones estas parcelas pueden continuar produciendo después del abandono de la misma. La selva virgen es tumbada y quemada en los meses de noviembre a diciembre. Siembran con las primeras lluvias, en el mes de marzo o abril; después de un período de tres años, la parcela es abandonada y sólo se vuelve a cultivar en los campos que recuperan la vegetación boscosa.

El mantenimiento de los 'conucos' necesita poco trabajo. Las labores de plantación y cosecha están a cargo de las mujeres, las cuales normalmente salen en la mañana con sus cestas grandes (catumares) para volver cargadas al mediodía. La yuca se elabora por la tarde (Wilbert 1958).

Las siembras se ubican en tierra firme, alejadas de los ríos y caños para evitar inundaciones. La fertilidad del suelo es mantenida por la rotación de los campos, no por rotación de cultivos.

Triana (1982) señala que los productos cultivados en una parcela son propiedad exclusiva de la familia que los plantó, y en ellos no se presentan repartos colectivos como se da el caso de excedentes provenientes de la caza y de la pesca.

Sánchez y Jaffé (1992) señalan la existencia de civilizaciones complejas en las cuencas del Amazonas y el Orinoco, con explotaciones agrícolas sustentadas en la yuca y el maíz (*Zea mays* L.).

Strauss (1992) presenta una acabada exégesis del poblamiento e historia del territorio venezolano planteando una tricotomía cultural, considerando a la yuca y al maíz como los dos productos agrícolas más importantes de las etnias venezolanas. Este autor indica que las culturas básicas de la selva tropical se encuentran principalmente en las áreas accesibles por vía fluvial, mientras que las culturas marginales tienden a distribuirse en torno a la periferia de la cuenca Orinoco-Amazonas.

Las comunidades indígenas de la región han recibido apoyo del estado venezolano y se han sedentarizado en las márgenes de los ríos, trayendo esto como consecuencia un marcado deterioro de las áreas aledañas a las comunidades por no cumplirse el tradicional ciclo de tumba-quema- conuco-rastrojo-sotobosque-bosque. Las comunidades mantienen sus tradiciones pero hay una marcada influencia del componente cultural occidental. Durante la ejecución de este trabajo se tomó información sobre hábitos alimenticios, preparación culinaria, utilización de nombres autóctonos de los productos, entre otros.

Descripción de la zona visitada

El Estado Amazonas representa la zona más al sur de Venezuela; está localizado entre los paralelos 0°40'N - 6°15'N y los meridianos 63°20'W - 67°50'W. Tiene una extensión de 178.095 km^2 y administrativamente posee cuatro municipios: Atures, Atabapo, Casiquiare y Río Negro (Venezuela-OCEI 1995).

La región visitada está ubicada en la cuenca del río Atabapo en la región centro occidental del Estado Amazonas (Municipio Atabapo) entre las latitudes 3°57' N hasta 4°43' N y longitudes de 67°36' W hasta 67°48' W, con alturas comprendidas entre 95 y 145 m.s.n.m. En la población de San Fernando de Atabapo confluyen tres grandes ríos: el Orinoco, el Atabapo y el Guaviare.

Esta región pertenece al Bosque Húmedo Tropical con precipitaciones entre 1800 y 3800 mm, y temperatura promedio anual superior a los 24 grados centígrados. Las zonas visitadas están ubicadas en las planicies aluviales, con topografía plana o suavemente ondulada y suelos ultisoles (Ewel y Madriz 1968).

Debido a las elevadas precipitaciones y temperaturas, al eliminarse el bosque, cuando se prepara el suelo para la siembra, aún cuando el declive es bajo, se causa deterioro del mismo, el cual es evidente por la pérdida de humus y la fuerte lixiviación.

Colecta

Del 02 al 10 de Octubre de 1994 se llevó a cabo un viaje de colecta en el Estado Amazonas, visitando las comunidades indígenas localizadas en los alrededores de San Fernando de Atabapo.

La exploración fue de naturaleza general, es decir, además de las especies cultivadas por las etnias se recolectaron también otras especies utilizadas por ellos de importancia tanto actual como potencial.

La metodología de muestreo fue la siguiente: se seleccionó previamente la localidad de San Fernando de Atabapo como el punto de partida de movilización por vía fluvial a comunidades indígenas previamente identificadas. Se trató de muestrear el mayor número de sitios en el tiempo estipulado, más que un número teórico de plantas por localidad. Sin embargo, se mantuvo el criterio de que las muestras fueran de cinco plantas para el caso de la yuca, por lo menos veinte mazorcas para el maíz, cinco a diez plantas para el caso de *Ananas* y Dioscoreacea, cincuenta frutos para *Capsicum*.

Al llegar a la comunidad se solicitaba la colaboración del 'Capitán' de la aldea para proceder a visitar los 'conucos' donde se recolectaban las muestras que estuvieran disponibles. En general, la acogida por parte de las etnias fue favorable, suministrándonos tanto el material como la información adicional requerida.

Resultados

Se visitó un total de 9 comunidades indígenas correspondientes a las etnias Piaroas, Kurripacos, Piapocos, Puinabes y Guajibos.

Fueron recolectadas en total 63 muestras de 15 especies. El número de muestras recolectadas de cada especie y las localidades visitadas se presentan en los cuadros 2 y 3.

El mayor número de muestras corresponde a especies de raíces y tubérculos, de las cuales la más importante fue la yuca (*Manihot esculenta* Crantz). De esta especie la forma mas común fue la yuca amarga, con la cual los indígenas de la región elaboran alimentos básicos denominados casabe y mañoco.

El casabe lo preparan rallando la yuca, exprimiendo las raíces en una cesta denominada 'sebucán' para eliminar el ácido cianhídrico, al cual denominan 'yare'. Luego tuestan el polvo que queda sobre una piedra plana o sobre una chapa de hierro, llamada 'budare'; generalmente no usan sal.

La yuca amarga recolectada fue de tres tipos según información recabada al momento de la colecta: amarilla, blanca y amarillo blanca (de coloración intermedia), referidos básicamente a la coloración interna de la raíz.

En la lengua de los Kurripacos llaman a la yuca amarga 'caini', y en la de los Piapocos 'queriquei'. En las comunidades de la etnia Piapoco fue donde se encontró la mayor cantidad de muestras de yuca dulce y la llaman en su lengua 'kapiali'.

La otra raíz de importancia fue el 'ñame' (*Dioscorea* sp.), de la cual fueron recolectadas siete muestras en cinco comunidades visitadas. Los Kurripacos nos indicaron que el consumo de esta raíz no era costumbre.

La segunda especie de importancia, con base en el número de muestras recolectadas fue la piña (*Ananas* spp.), con 11 ejemplares, dentro de los cuales prevalecieron los tipos espinosos. La única etnia que nos suministró el nombre indígena de esta especie fue la de los Kurripacos, que la denominan 'mabirro'.

Cuadro 2. Especies cultivadas recolectadas en expedición realizada en Atabapo, Estado Amazonas, Venezuela, 1994

Especies	N° de entradas	Localidades[†]	Etnia	Uso
Zea mays	7	1-2-4-6	Piaroa, Guajibo, Piapoco, Puinabe	Carato Reventón
Manihot esculenta	18	1-2-3-4-5-7-8	Kurripaco, Piapoco, Puinabe	Casabe, mañoco Consumo fresco
Ananas sp.	11	1-2-3-5-8	Kurripaco, Piapoco, Puinabe, Piaroa	Consumo fresco
Dioscorea sp.	7	1-2-4-6-8	Piaroa, Kurripaco, Guajibo, Piapoco, Puinabe, Piaroa	Consumo fresco
Capsicum sp.	5	1-3-4-8	Piapoco, Puinabe	Polvos, preparados líquidos
Curcubita sp.	2	7-9	Piapoco, no indígena	Consumo fresco
Xanthosoma sp.	1	5	Guajibo, Piapoco	Consumo fresco
Ipomoea sp.	1	4	Puinabe	Consumo fresco
Phaseolus vulgaris	1	5	Kurripaco	Consumo fresco
Theobroma sp.	1	6	Guajibo, Piapoco	Consumo fresco

[†] ver cuadro 1.

Cuadro 3. Especies de interés potencial recolectadas en la región de Atabapo, Estado Amazonas, Venezuela, 1994

Especies	N° de entradas	Localidad	Etnia	Uso
Bixa orellana	2	Caño Magua Primavera	Kurripaco Guajibo, Piapoco	Colorante de alimento
Leopoldinia piassaba	1	Santa Teresa	Piapoco	Fibra para escoba y cepillos
Solanum stramonifolium	3	Carana Ven, Laja Lisa	Puinabe, Piapoco	Jugos y consumo fresco
Annona squamosa L.	2	Carana Ven, Siquita	Puinabe, no indígena	Consumo fresco
Pouteria caimito	1	Cáscara Dura	Guajibo, Piapoco	Consumo fresco

Fig. 1. Maíces típicos de la zona visitada.

Fig. 2. Biotipo de *Solanum stramonifolium* (tupirito) usado para la elaboración de jugos y consumo fresco.

También fueron recolectadas siete muestras de maíz, en cuatro comunidades. Cuatro de tipo harinoso, con granos de color amarillo claro hasta rojo púrpura. Los otros tres tipos correspondieron a un maíz 'cariaco', un maíz tipo reventón y uno blanco de la zona. Todas las muestras de maíz provenían de material almacenado en las viviendas, guardado para consumo y/o semilla para la próxima época de siembra (Fig. 1). Por estas razones, no se pudo recolectar el número teórico estipulado de mazorcas, motivado a que nos suministraban las mazorcas que les era posible.

El maíz lo siembran en 'tierra firme', es decir en zonas distantes a las riberas de los ríos. Esta especie es sembrada normalmente en febrero y marzo pero también la siembran en plena época lluviosa en el mes de agosto, lo que denominan 'siembra de travesía' (sin limpiar, ni quemar).

Al maíz le dan el nombre de 'ñamú', 'canai' y 'can' en las lenguas de los Piaroas, Piapocos y Puinabes, respectivamente. El consumo del maíz es básicamente para preparar bebidas fermentadas y atoles.

Una especie de mucha importancia en la región es el ají picante (*Capsicum* spp.). Los indígenas lo consumen en la elaboración de polvos y preparados líquidos picantes con vinagre de yuca, que utilizan en todas las comidas. Esta especie es normalmente sembrada en los patios caseros. La etnia Kurripaco lo denomina 'ate'.

Otras especies recolectadas aunque no sembradas en los 'conucos' (cuadro 3) fueron en su mayoría frutales autóctonos de la región: 1 muestra de *Pouteria caimito* (Temare montañero); 2 de *Annona squamosa* (Riñón ó anón), 3 de *Solanum stramonifolium* (túpiro y tupirito), dos biotipos de la misma especie con alto potencial para consumo fresco y elaboración de jugos (Fig. 2). Además se recolectó una muestra de chiquichiqui, palma de donde se extrae fibra para la elaboración de escobas, cepillos y otros objetos, de importante explotación y comercio en la región.

La información recabada constó de 34 datos de pasaporte, con los registros normalmente tomados en colectas de este tipo.

Las comunidades indígenas de la región, así como su entorno ecológico, están fuertemente influenciadas por la dinámica de los tres ríos (Orinoco, Atabapo y Guaviare). Esta afecta la agricultura y la alimentación de las etnias visitadas. En general, hay una marcada influencia de la caza y de la pesca en los hábitos alimenticios.

La cultura occidental está influenciando el compor-

tamiento sociocultural de estos grupos humanos, evidenciándose actividades de siembras excedentarias para comercializar al exterior de sus comunidades. Sin embargo, no hay costumbre de almacenar estos excedentes, vendiendo solamente cuando la demanda es conocida. En general, cada familia provee con la producción del 'conuco' el sustento diario.

Los recursos fitogenéticos de especies cultivadas en la región visitada son escasos y con poca variabilidad, encontrándose principalmente raíces y tubérculos, frutales autóctonos y en menor grado maíz. Aún no está claro cómo ocurre el movimiento de germoplasma entre las diferentes etnias ni el origen de los materiales utilizados por éstas.

El papel de la mujer en esta agricultura migratoria es particularmente importante. Ya Gumilla, en 1791, preocupado por la fatiga de las mujeres, reclamaba el concurso de los hombres en las faenas de siembra, a lo cual le contestaban: "Tú, padre — respondían ellos — no sabes de estas cosas y por esto te dan lástima; has de saber que las mujeres saben parir y nosotros no; si ellas siembran, la caña de maíz da dos o tres mazorcas; la mata de yuca da dos o tres canastos de raíces, y así multiplica todo. Por qué? Porque las mujeres saben parir y saben cómo han de mandar parir el grano que siembran". Esta costumbre es mantenida en todas las etnias visitadas, donde la mujer se hace cargo de la siembra, el cuidado y la cosecha de los cultivos.

Las muestras colectadas fueron incorporadas a los respectivos bancos de germoplasma del FONAIAP, ubicados en Maracay, Estado Aragua, Venezuela. Las mismas fueron previamente regeneradas a objeto de tener suficiente cantidad de semilla para futuras siembras de caracterización y evaluación. Un duplicado de las accesiones de yuca y piña se conserva en la Estación Experimental del Amazonas (FONAIAP). Las muestras de maíz fueron regeneradas y se dispondrá de un duplicado en el CIMMYT, México.

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Summary

Collecting germplasm of cultivated plants in the ecoregion of the Atabapo river in the Amazon State, Venezuela

An expedition to collect germplasm of cultivated autochthonous plants was made to a region of the Venezuelan Amazon (San Fernando de Atabapo). In this expedition, 63 samples of 15 cultivated and potential species were collected in nine different local communities. Very little variability of cultivated genetic resources was found.

Resumen

Collecte de germoplasme de plantes cultivées dans l'éco-région de la rivière Atabapo dans l'état de l'Amazone au Vénézuela

Une expédition dans une région de l'Amazonie vénézuelienne (San Fernando de Atabapo) a été effectuée pour collecter du germoplasme de plantes cultivées autochtones. Au cours de cette expédition, 63 échantillons de 15 espèces cultivées et potentiellement cultivables ont été collectés dans neuf communautés locales. On a trouvé une très faible variabilité dans les ressources génétiques des espèces cultivées.

Development and characterization of trait-specific genepools in pearl millet

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Summary
The development of trait-specific genepools (TSGPs) in pearl millet [*Pennisetum glaucum* (L.) R. Br.] was aimed at conserving diverse genetic material, and providing researchers with the widest variability in germplasm accessions in this crop. Based on evaluation of over 21 000 accessions maintained at ICRISAT Asia Center, Patancheru, 803 to 1143 accessions were selected to constitute four separate TSGP in pearl millet. These accessions differed considerably for several other characters including geographic diversity. Selected accessions were random-mated for several generations in separate isolations, six in the early genepool and four random-mating generations in the large-grain, large-spike and high-tillering genepools. After mating, these genepools appeared to be phenotypically more uniform while the range of expression was considerably narrowed. Some of the easily identifiable recessive characters such as dwarfness, glabrous leaves, etc. were masked. These genepools are potentially extremely useful in pearl millet improvement.

Introduction
With a view to conserving the fast-eroding traditional cultivars of pearl millet [*Pennisetum glaucum* (L.) R. Br.], the Genetic Resources Division (GRD) at ICRISAT Asia Center (IAC), Patancheru, has assembled 24 600 cultivated accessions from 48 countries. The germplasm accessions were evaluated at IAC during rainy and postrainy seasons as per the descriptors for pearl millet (IBPGR and ICRISAT 1993). The germplasm conserved in the IAC genebank is freely available to pearl millet researchers worldwide. So far, the GRD has supplied 90 927 pearl millet germplasm samples in response to specific requests. Most of the seed requests received at IAC are for early maturity, large grain size, large spike and high-tillering landraces. A major problem with germplasm material is a high level of duplication with little difference between many of the accessions (Brown 1989). Burton (1978) and Witcombe (1984) suggested developing trait-specific genepools (TSGPs) to reduce effective accession numbers drastically.

In pearl millet, the development of TSGPs was aimed not only at conserving diverse genetic resource material, but also at providing pearl millet scientists with the widest variability available in germplasm accessions. Four genepools designated as early, large spike, large grain and high tillering were developed by random-mating selected pearl millet germplasm accessions originating from diverse agroclimatic regions with considerable diversity. This paper describes the criteria used for selection of accessions to develop four different genepools, random-mating them to achieve equilibrium, and comparing the diversity in the component accessions that went into making the genepools and diversity observed after four or six random matings.

Materials and methods

Method used for selection of accessions
Accessions were selected to develop genepools from the rainy season evaluation data of 21 000 germplasm accessions from IAC. The criteria used were trait-specific. For example, while selecting constituents for the early maturing genepool (EMGP), we selected all accessions which flowered within 49 days after sowing, ignoring other characters. Similarly, while selecting constituents for large grain genepool (LGGP), only grain size was considered, ignoring all other characters. To identify components for the EMGP, 1143 accessions which flowered within 49 days were identified. For the high-tillering genepool (HTGP), 1093 accessions that produced between 5 and 35 effective tillers per plant were selected. For the large-spike genepool (LSGP), 804 accessions that produced spikes which are longer than 55 cm and thicker than 35 mm (diameter) were selected. To develop the LGGP, 887 accessions in which the 1000-grain weight was more than 8 g were selected. While selecting accessions, we did not consider variability for other characters and also ignored the country of origin. Hence, there was considerable geographic diversity and genetic variability for several characters in the accessions that were selected for each genepool (Table 1).

Table 1. Diversity in the germplasm accessions selected to develop trait-specific genepools in pearl millet

Character		Early maturity	High tillering	Large spike	Large grain
No. of accessions bulked		1143	1093	804	887
No. of random matings completed		6	4	4	4
Time to flower (days)	Range	33-49	33-151	36-152	36-152
	Mean±SE	46±0.1	77±0.5	74±0.5	84+1.0
Plant height (cm)	Range	45-270	14-420	50-380	100-455
	Mean±SE	174±1.1	223±2.0	265±1.1	274+2.0
Total tillers (no.)	Range	1-28	5-35	1-9	1-9
	Mean±SE	4±0.1	7±0.1	2±0.0	3+0.0
Spike length (cm)	Range	5-50	5-67	55-114	12-114
	Mean±SE	20±0.1	22±0.2	65±0.0	27+0.2
Spike thickness (mm)	Range	13-47	10-37	35-55	12-42
	Mean±SE	24±0.1	20±0.2	37±0.4	26+0.2
1000-grain weight (g)	Range	4-19	2-21	4-17	8-21
	Mean±SE	9±0.1	7±0.1	9±0.2	13+0.0

Methodology for random mating

Time to flowering varied considerably from 33 to 152 days in the components of the three genepools, except in the EMGP. Hence, to achieve random mating, planting was staggered at 14-day intervals in the isolation fields. To encourage photoperiod-sensitive lines to contribute to random mating, accessions were planted during short days in September so that even photoperiod-sensitive accessions would flower early and so the majority of the constituents come to flowering more or less at the same time. For effective recombination between the constituent genotypes of each pool, based on time to flowering, we developed 3-5 pollinator bulks by mixing equal quantities of seed of the constituent genotypes. Each of these pollinator bulks flowered within 10 days. The pollinator bulk was planted for every four rows of each constituent genotype and four rows all around the field during the first random mating. We collected bulk pollen from the early flowering plants to pollinate the late-flowering accessions. To avoid gene losses while advancing the generation, at least a 2-cm top portion of one head per plant was sampled from each constituent row, and bulked to provide constituent genotypes for the next cycle of recombination. To achieve effective recombination, 4-6 cycles of random matings were made.

Results and discussion

After the fourth random mating, the constituent accessions and pollinator bulk could not be distinguished morphologically, indicating the occurrence of sufficient recombination among the component genotypes. The range in variation was considerably reduced after random mating compared with the original constituent components except for time to flowering in the EMGP (Table 2). In the EMGP, there was an increase not only in the range for the number of days to flower but also in the mean days to flower. This may be due to interaction of early flowering genes to produce late-maturing genotypes. In the EMGP, the range in plant height, tiller number, spike length, spike width and grain size was reduced but there was an increase in mean plant height, tiller number and grain size which might be due to recombination among diverse types.

In the HTGP there was a reduction in the range of flowering, spike length, spike thickness and grain size but an increase in the mean days for flowering, plant height, tiller number, spike length, spike thickness and grain size. There was a considerable shift in the mean plant height and narrowing of the range in plant height, probably due to the masking of the short stature recessive dwarfing gene d_3 (Appa Rao *et al.* 1986). Not only the dwarfing gene but also hairs on the leaves, which is a recessive trait, was also masked.

In the LSGP, there was a reduction in the range for flowering, plant height, spike length, spike thickness and grain size; a reduction in mean days to flowering, spike length and spike thickness, but an increase in plant height, number of tillers and grain size. The increase may be due to heterotic effect and/or recombination. In the LGGP there was a reduction in the range for time to flowering, plant height, spike length, spike thickness and grain size but an increase in the mean for plant height, tiller number, spike thickness and grain size.

Table 2. Diversity in four trait-specific genepools of pearl millet after 4-6 random matings

Character		Early maturity	High tillering	Large spike	Large grain
No. of accessions bulked		1143	1093	804	887
No. of random matings completed		6	4	4	4
Time to flower	Range	33-59	81-94	64-74	55-65
	Mean±SE	46±0.9	85±1.6	68±2.1	60±2.0
Plant height (cm)	Range	125-245	220-445	250-420	190-400
	Mean±SE	196±4.0	334±11.8	349±11.16	298±4.0
Total tillers (no.)	Range	2-17	1-19	1-17	2-13
	Mean±SE	9±0.6	8±1.6	3±0.5	6±0.6
Spike length (cm)	Range	12-26	17-33	21-70	18-35
	Mean±SE	19±0.5	25±0.6	51±2.7	26±0.7
Spike thickness (mm)	Range	18-32	16-37	16-50	17-40
	Mean±SE	24±0.4	24±0.6	27±0.9	30±1.0
1000-grain weight (g)	Range	8-12	5-12	6-15	12-21
	Mean±SE	10±0.1	8±0.1	11±0.6	16±1.0

After 4-6 generations of random mating, the range in days to flowering was narrowed in all genepools except EMGP. Days to flowering, which ranged from 33 to 151 days in the original HTGP, was narrowed down to 81-94 days with a slight delay in mean time to flowering. In pearl millet, flowering was reported to be intermediate when photoperiod-sensitive late lines were crossed with early flowering lines (Bhardwaj and Webster 1971). Hence, for the reduction in days to flower it could be assumed that late-flowering lines were converted to early flowering, which is useful in millet improvement. It is interesting to see that in LGGP and LSGP not only was the range narrowed down but also the mean flowering was reduced, indicating a shift in the desired direction.

In other crops, TSGPs are formed from accessions of a country or region, since they tend to be similar, thus ensuring that only accessions of similar daylength sensitivity are pooled (Witcombe 1984). In pearl millet, accessions differ considerably for daylength sensitivity and farmers grow early and late-maturing forms together. To include diversity for several characters, country of origin was ignored in the present genepools. We included accessions originating from diverse agroclimatic regions with considerable variation for spike length, spike shape, grain size and maturity.

Different methods are used to develop genepools (Burton 1978; Witcombe 1984; Singh and Jika 1988). Generally genepools are constituted by mixing together seed from a number of similar-looking accessions and the mixture is planted in an isolated field to intermate, and the seed is harvested from a part or all of the plants (Burton 1979; Witcombe 1984). A pollinator bulk was developed using equal quantities of seed of the constituent genotypes, planting rows of each constituent genotype alternatively with

rows of bulk, harvesting in the constituent genotype row and repeating the procedure (Singh and Jika 1988). This is a laborious routine. We followed a method in which we used the pollinator bulk in the first random mating only along with staggered planting which enhanced random mating. As our major interests are conserving genetic resources, and facilitating utilization, TSGPs were maintained by subjecting them to minimum selection pressures. By allowing natural selection to operate, adaptation to local conditions is improved and locally less adapted lines were not eliminated or fewer genotypes were eliminated.

The genepools should conserve variability for various agronomic characters. Within each genepool, linkages must have been broken so that the variance and total phenotypic variance may even increase. Recessive gene characters are more likely to be exposed within each trait-specific genepool than when a single genepool is created from the entire material. TSGPs can be distributed and used as source populations for improvement by single plant selection, recurrent selection and mass selection (Rai and Anand Kumar 1994). By allowing natural selection to take place, adaptation to local conditions is improved. It must be pointed out that as TSGPs were developed by intercrossing, they may have a lower frequency of homozygous loci, making screening for recessive characters more difficult, but having the advantages of allowing gene recombination and being easier to maintain. Developing genepools has distinct advantages when it is realized that variability is distributed non-randomly throughout the distribution range of a crop plant. Combining all early maturing varieties from Syria into a single genepool did not lose much variability, but it reduced the number of accessions enormously (Witcombe 1984) and daylength sensitivity could have been broken or transferred into new genetic background.

Advancing five germplasm pools of pearl millet for three generations narrowed the phenotypic variability of the original pool, lost genes, and obscured hard to recover characteristics (Burton 1979). Genepools do not avoid the necessity of maintaining individual accessions in base collections. The original accessions are the source material from which the genepools are developed and contain the entire range of genes. Hence, we also conserve all the individual germplasm accessions in the genebank. Landraces often possess characteristics controlled by a combination of genes that are hard to recover in hybrid populations. The Zongo landrace from Nigeria which produces 125-cm long heads in its native habitat (Appa Rao *et al.* 1994) could not be completely recovered when grown at IAC. Such a characteristic probably would not have been lost in a germplasm pool. These TSGPs are useful not only in crop improvement but also useful to conserve germplasm. As more than 800 accessions were used to develop the genepools, they have a broad genetic base which enables them to adapt to diverse agroclimatic conditions. In fact the early genepool was found to produce stable yields over several locations in India (K.N. Rai, pers. comm.). The high-tillering genepool was found to be suitable for summer multi-cut fodder pearl millet in All-India trials (G.P. Shukla, pers. comm.).

The genepools are excellent tools to understand farmer-based conservation (Mooney 1992) as the landraces vary considerably for several characters (Appa Rao *et al.* 1992) just as the genepools do. After random mating, the genepools are in an equilibrium just as the landraces are and a comparison of changes in gene frequency in different random matings will provide some insight into the maintenance of diversity in the landraces. Though there is reduction in the range of variability due to gene interaction, they are more useful in crop improvement as the TSGPs are broad-based, heterogeneous and homozygous. These TSGPs are better than individual accessions because of their diversity and broad genetic base. These genepools will be useful to study adaptation when evaluated under diverse agroclimatic conditions besides facilitating identification of locally adapted genotypes. As the number of accessions is reduced without any loss of genetic material, it will be easy to handle fewer numbers for conservation and utilization.

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Résumé

Développement et caractérisation de pools géniques à caractères spécifiques chez le millet à chandelles

Le développement de pools géniques à caractères spécifiques (PGCS) chez le millet à chandelles [*Pennisetum glaucum* (L.) R. Br.] vise à conserver du matériel génétique diversifié et à fournir aux chercheurs la variabilité la plus large possible d'accessions chez cette espèce. En se basant sur l'évaluation de plus de 21.000 accessions conservées au Centre pour l'Asie de l'ICRISAT, à Patancheru, de 803 à 1143 accessions ont été sélectionnées pour constituer quatre PGCS chez le millet à chandelles. Ces accessions différaient considérablement pour plusieurs autres caractères, dont la diversité géographique. Les accessions sélectionnées ont été croisées au hasard pendant plusieurs générations en isolation, six générations pour le pool génique précoce et quatre générations pour les pools géniques à gros grains, gros épis et tallage élevé. Après les croisements, ces pools géniques sont apparus phénotypiquement plus uniformes et l'étendue de la variation s'était considérablement restreinte. Certains des caractères récessifs facilement identifiables tels que le nanisme ou les feuilles glabres, etc. étaient masqués. Ces pools géniques sont potentiellement extrêmement utiles pour l'amélioration du millet à chandelles.

Resumen

Desarrollo y caracterización de los acervos genéticos con rasgos específicos del mijo perla

Con el desarrollo de acervos genéticos con rasgos específicos del mijo perla [*Pennisetum glaucum* (L.) R. Br.] se pretendía conservar material genético diverso y proporcionar a los investigadores la más amplia variabilidad de lotes de germoplasma en este cultivo. Sobre la base de la evaluación de más de 21 000 accesiones mantenidas en el Centro asiático del ICRISAT, Patancheru, se seleccionaron entre 803 y 1143 accesiones para constituir cuatro acervos específicos diferentes de mijo perla. Estos lotes de accesiones se diferenciaban considerablemente en varios aspectos, incluida su diversidad geográfica. Las accesiones seleccionadas se cruzaron aleatoriamente durante varias generaciones en aislamientos diferentes, seis en el acervo genético inicial y cuatro generaciones de cruce aleatorio en los acervos genéticos de grano grande, espiga gruesa y tallo alto. Después de su cruzamiento, estos resultaron ser más fenotípicamente uniformes mientras se estrechaba considerablemente su territorio de expresión. Quedaron encubiertos algunos de los caracteres recesivos de más fácil identificación como su enanismo, hojas lampiñas, etc. Estos acervos genéticos son en potencia sumamente útiles para la mejora del mijo perla.

Premiers clones selectionnés dans les descendants des cacaoyers (*Theobroma cacao*) autrefois cultivés en Guyane

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Résumé
L'article présente les caractéristiques morphologiques et agronomiques de dix clones sélectionnés à la station de Paracou-Combi (CIRAD) dans les survivants des cacaoyers autrefois cultivés en Guyane: huit de type Amelonado et deux Trinitarios. Les descripteurs qualitatifs et quantitatifs étudiés sont ceux préconisés par l'IPGRI, quant aux fruits (cabosses), aux graines (fèves) et aux ovules. D'autres descripteurs sont utilisés, comme le rapport production/vigueur, la fertilité apparente et le taux de "fèves plates". La discussion traite de l'intérêt de ce matériel, de son origine possible, et apporte certains éléments de comparaison avec les Amelonados d'Afrique de l'ouest. Des compléments de la description pourront être recherchés dans la banque de données internationale du cacao (International Cocoa Genebank Database).

Introduction
L'histoire de la cacaoculture guyanaise se déroule de 1734 au début du XXème siècle, et connaît son apogée vers 1840, où quelques 50 tonnes d'un cacao réputé de qualité supérieure étaient produites annuellement (Guisan 1825; Lecomte et Challot 1897). La provenance du matériel végétal utilisé dans les plantations reste inconnue, même si une origine vénézuelienne, via la Guyana et le Suriname, est probable (Lachenaud et Sallee 1993). L'utilisation des cacaoyers spontanés locaux, s'il elle ne peut être totalement exclue, est sans aucun doute restée marginale (Lanaud 1987). Si les origines restent imprécises, on peut cependant être assuré que, à l'instar du Suriname voisin, la variabilité du matériel végétal utilisé par les planteurs était importante: Criollos (Chevalier 1946), Trinitarios et autres Forasteros étaient cultivés. Les survivants de ces cacaoyers (*Theobroma cacao*), dans les reliques des anciennes plantations, principalement à proximité et à l'est de Cayenne, ou disséminés dans le nord du pays, donnent une idée de la variabilité d'autrefois: de nombreux types peuvent être observés, allant des Trinitarios rouges à toutes les formes connues de Forasteros, avec comme caractéristique principale un remarquable état sanitaire (Braudeau 1962; Clement 1986; Lachenaud *et al.* 1994).

Des représentants de ce matériel ont été rassemblés en collection, à la station CIRAD de Paracou-Combi, près de Sinnamary, sous forme surtout de descendances libres (Clement 1986) qui ont été étudiées pendant une dizaine d'années, puis les individus les plus prometteurs ont été clonés. Nous présentons ici les caractéristiques des clones sélectionnés.

Matériel et méthodes

Matériel végétal
Le matériel de base a été collecté entre 1979 et 1981, sous forme de cabosses, dans la moitié nord de la Guyane (Clement 1986). Les zones d'origine sont les environs de Cayenne (Crique Gabrielle, Roura, Pont de la rivière de Cayenne), d'Iracoubo (PK 136, Dégrad Savane) et de Saül (Saül, Patience). Ce matériel a été planté dans deux parcelles de Paracou-Combi, C1 (janvier 1980) et C2 (décembre 1981), à raison de 255 plants par origine géographique en C1 et 10 plants par arbre-mère en C2 (tableau 1). La densité adoptée était de 1667 (écartements de 3 x 2 m) et les conditions de culture étaient le plein soleil en C1 et un ombrage d' *Inga* sp. en C2.

Tableau 1. Origine des pieds-mères et localisation des descendances à Paracou-Combi

Origine géographique	Parcelle
Iracoubo	
Dégrad Savane	C2
PK 136	C1
Saül	
Saül	C1 et C2
Patience	C2
Cayenne	
Pont Rivière Cayenne	C2
Roura	C2
Crique Gabrielle	C2

Méthodes
Les arbres ont été récoltés individuellement (nombre et poids de cabosses) de novembre 1984 à mars 1988 en C1, et du début des récoltes en 1986 à avril 1990 en C2.

Une première sélection des candidats têtes de clones a été effectuée sur les chiffres de récolte et du rapport production/ vigueur, qui est un critère de sélection important (Lotode et Lachenaud 1988). Dans ce travail, il est exprimé en kg de cacao marchand par arbre et par an par cm^2 de section du tronc.

Pour chaque cabosse étudiée, les descripteurs morphologiques suivants ont été notés:

- qualitatifs:
  - la forme (F) de la cabosse (voir Braudeau 1969)
  - la forme de l'apex (Ap)
  - la forme du collet, ou constriction basale (Cb)
  - la verrucosité (Vr).

Pour les trois premiers, nous avons adopté les échelles de notation de l'IPGRI (IBPGR 1981). Pour la verrucosité, nous avons utilisé une classification simplifiée (0 = cabosse lisse; 1 = verruqueuse; 2 = très verruqueuse).

- quantitatifs:
  - la longueur de la cabosse (L)
  - la plus grande largeur de la cabosse (Θ)
  - le poids total de la cabosse (Pc)
  - le poids de la cabosse vide (cortex + placenta = Pv)
  - le nombre de fèves normales (Fn)
  - le nombre de fèves plates (Fp), dans certains cas.

Pour ces descripteurs de cabosses, les effectifs utilisés étaient de 30 au moins.

D'autres descripteurs quantitatifs ont été étudiés:

- la longueur d'une fève (Lf)
- la largeur d'une fève (lf)
- le nombre d'ovules (O).

Lf et lf ont été mesurés sur 50 fèves démucilaginées, a raison de 5 par cabosse. Les comptages d'ovules ont été effectués sur 10 fleurs épanouies, à la loupe binoculaire sur fond noir, après cuisson des ovaires pendant 20 mn et écrasement entre deux lames (Lachenaud *et al.* 1994).

Les données brutes ont permis de calculer les diverses moyennes, les écart-types, et d'autres descripteurs comme le poids de fèves fraîches (Ff = Pc -Pv), le poids moyen d'une fève fraîche par cabosse (pfm = Ff / Fn), puis par clone (Pfm = Σ pfm / N), la fertilité apparente (Fa = Fn / O, Lachenaud 1994) et, dans certains cas, le pourcentage de fèves plates (% Fp = 100Fp / (Fp +Fn)).

Résultats

D'après les critères agronomiques de productivité (donc de précocité) et du rapport production/vigueur, 10 clones avaient été pré-sélectionnés en C1, et 10 en C2. A la suite des travaux de caractérisation, la moitié a été retenue pour les étapes suivantes (distribution et confirmation), ce qui correspond à un taux de sélection de 1%. Les caractéristiques agronomiques, dans les conditions guyanaises, de ce nouveau matériel clonal, préfixé GF (pour Guyane française) figurent dans le tableau 2, et sa caractérisation morphologique dans les tableaux 3, 4 et 5 suivants.

Les variances des paramètres du tableau 4 figurent dans la banque de données internationale du cacao, ICGD (Wadsworth *et al.* 1997, p.297). Nous présentons les valeurs du coefficient de variation du nombre de fèves normales pour les différents clones (tableau 5).

Discussion

Le tableau 2 montre que la productivité des clones sélectionnés est largement supérieure à celle de leur famille d'origine. Les clones GF 23, 25, 32 et 34 sont de hauts producteurs, avec un rapport production / vigueur 1,9 à 6,4 fois supérieur à la moyenne familiale. Notons la valeur élevée de GF 34, dans une famille déjà supérieure à la moyenne de la parcelle C2.

Huit parmi les clones sélectionnés sont des Amelonados, les deux autres étant des Trinitarios00 rouges. Ceux-ci sont lisses et de forme Amelonado allongée; cependant leur nombre moyen de fève et la taille moyenne de celles-ci sont de nature Trinitario.

A l'exception de GF 27 (Trinitario), tous les clones sélectionnés présentent une fertilité apparente voisine ou supérieure à 0,80, limite observée en Côte d'Ivoire pour un bon remplissage des cabosses (Lachenaud 1994). Certains clones (GF 29, 32 et 34) atteignent même pour ce critère des valeurs très élevées, allant de pair avec des pourcentages de fèves plates vraiment négligeables. Cependant, les coefficients de variation du nombre de fèves normales sont plus elevés qu'en Côte d'Ivoire, à fertilité apparente équivalente, traduisant un remplissage moins homogène, dû vraisemblablement à des conditions de nutrition moins favorables et très contraignantes pour

Tableau 2. Les caractéristiques agronomiques des clones GF, comparées à celles de leurs familles d'origine (valeurs entre parenthèses). La productivité est extrapolée en kg de cacao marchand par ha et par an, le rapport production/vigueur est en kg de cacao marchand arbre^{-1} an^{-1} cm^{-2} (les valeurs de GF 23 et GF 25 ne doivent pas être comparées aux autres, car obtenues à des âges différents)

Clones	Productivité	Rapport	Prod/Vigueur
GF 23	3069 (951)	10,5 10^{-3}	(5,0 10^{-3})
GF 25	3163 (951)	9,5 10^{-3}	(5,0 10^{-3})
GF 26	594 (261)	5,0 10^{-3}	(2,4 10^{-3})
GF 27	608 (63)	11,0 10^{-3}	(2,0 10^{-3})
GF 29	1033 (345)	6,8 10^{-3}	(2,4 10^{-3})
GF 30	974 (370)	7,7 10^{-3}	(2,9 10^{-3})
GF 31	739 (181)	4,7 10^{-3}	(1,7 10^{-3})
GF 32	1848 (239)	12,1 10^{-3}	(2,4 10^{-3})
GF 34	2280 (481)	35,5 10^{-3}	(5,5 10^{-3})
GF 35	842 (302)	4,2 10^{-3}	(2,1 10^{-3})

Tableau 3. Caractérisation qualitative des clones GF, avec: C.G. = Crique Gabrielle, P.R.C. = pont Rivière Cayenne, 3 = A = Amelonado, 4 = C = Calabacillo, T = Trinitario

Clone	Origine	Type	F	Ap	Cb	Vr
GF 23	Saül	A	3	3,0	1,6	0,1
GF 25	Saül	A	3	2,6	1,8	0,7
GF 26	C.G.	A	3	3,7	1,1	0,0
GF 27	C.G.	T	3	2,7	2,1	0,0
GF 29	P.R.C.	A	3	1,3	0,8	0,0
GF 30	C.G.	A	3	3,1	1,7	0,0
GF 31	Saül	A-C	3-4	3,8	1,4	0,0
GF 32	C.G.	A	3	2,9	1,8	0,0
GF 34	C.G.	A	3	3,0	1,8	0,0
GF 35	C.G.	T	3	3,1	1,3	0,0

Tableau 4. Caractérisation quantitative des clones GF (* = valeurs évaluées sur 25 cabosses)

GF Unité	L (cm)	Θ (cm)	Pc (g)	Pff (g)	Fn	Pmf g	Lf mm	lf mm	O	Fa	%fp
GF23	12,1	8,2	345,6	87,7	36,8	2,41	22,5	10,8	46,3	0, 79	2,3
GF25	12,9	8,2	378,1	98,4	39,4	2,49	21,9	11,3	46,2	0,85	2,0
GF26	12,4	8,0	345,8	91,4	39,7	2,30	24,6	11,3	47,7	0,83	
GF27	20,2	9,3	722,3	130,9	33,3	3,97	25,5	13,8	44,0	0,75	7,5
GF29	14,7	8,3	426,3	124,5	39,6	3,15	22,8	13,3	41,4	0,96	
GF30	14,5	8,4	458,6	106,8	40,3	2,66	24,3	11,9	46.1	0,87	
GF31	11,4	7,9	317,8	95,4	38,7	2,49	25,2	12,0	44,4	0,87	
GF32	14,2	8,3	432,5	110,7	42,1	2,63	24,6	12,6	42,8	0,98	0,3 *
GF34	15,6	9,1	593,8	130,7	37,8	3,48	25,7	13,9	40,7	0,93	0,3 *
GF35	15,2	8,4	472,6	111,0	33,4	3,45	24,5	12,8	41,2	0,81	

Tableau 5. Coefficients de variation (CV) du nombre de fèves normales par cabosse pour les dix clones GF

GF	23	25	26	27	29	30	31	32	34	35
CV	26,5	25,1	19,4	34,4	17,2	15,8	20,4	12,5	16,3	31,3

l'agriculture (Alexandre 1989). Sur ce point, nous confirmons donc nos résultats précédents (Lachenaud *et al.* 1994).

Pour les critères de fèves, Ff et Pfm, les plus intéressants parmi les clones sélectionnés sont GF 27, 29, 32, 34 et 35.

Parmi les clones Amelonados, le plus prometteur semble être GF 34, en raison d'une bonne productivité, d'un rapport production / vigueur très avantageux, d'excellents niveaux pour les critères de fèves, d'une fertilité apparente élevée et d'un très faible taux de fèves plates.

Il faut d'autre part rappeler que le matériel anciennement cultivé en Guyane présente de faibles taux d'attaques par pourritures (Lachenaud *et al.* 1994), dont celle causée par *Phytophthora palmivora* présent à Paracou-Combi (Berry, comm. pers.).

Lanaud (1987) a montré dans une étude du polymorphisme de l'espèce *T. cacao* à l'aide de 9 marqueurs, que les cacaoyers anciennement cultivés en Guyane étaient relativement éloignés des Amelonados ouest africains, et plus proches des cacaoyers vénézueliens (distance génétique de NEI). Ils présentent 41,7% de loci polymorphes contre 16,7% pour les Amelonados d'Afrique, avec une hétérozygotie moyenne de 0,065 contre 0,040. Les différences se notent surtout pour les systèmes ADH2 (alcool déshydrogénase), MDH1 (malate déshydrogénase), PAC (phosphatases acides) et PGM2 (phosphoglucomutase).

Ces clones sont disponibles au CIRAD-Montpellier (France), sur commande, ainsi que dans les stations de quarantaine de Reading (UK) pour le clone GF 32, et de Barbados, pour les clones GF 23, 25, 29, 32 et 34.

Conclusion

Les clones Amelonados décrits sont très probablement d'origine vénézuelienne. Ils pourraient donc être des représentants des véritables "Forastero", appelés ainsi au Vénézuela parce qu'ils étaient originaires d'autres régions que les Criollo (peut-être de la vallée de l'Orénoque). Ces véritables Forastero, introduits à Trinidad, auraient donné naissance par hybridation avec les survivants des Criollo "locaux", aux Trinitario Wood et Lass 1985). Par la suite, en 1825, des Trinitario furent introduits de Trinidad au Vénézuela, où, par confusion, il reçurent également l'appellation de Forastero (Cheesman 1944). Dans ce cas, les Amelonado décrits dans cette étude seraient les parents des premiers Trinitario.

On peut penser qu'ils sont le résultat d'une longue sélection dans le nord-est de l'Amérique du sud. Il est en effet vraisemblable que pour l'introduction du matériel dans les zones côtières des trois Guyanes, le hasard n'ait eu qu'un faible rôle et que les cabosses aient été soigneusement choisies au préalable. A cette sélection massale, il faut ajouter des dizaines d'années de sélection "passive" en Guyane française, plus la sélection effectuée par nous dans les descendances libres. Quant aux deux Trinitario, leur origine est plus floue; elle peut également être vénézuelienne, mais une origine antillaise n'est pas à exclure.

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Summary

First clones selected in the descendants of the cacao (Theobroma cacao) *trees cultivated in Guyane in the past*

This paper presents the morphological and agronomic characteristics of ten clones selected at the CIRAD Paracou-Combi station from the survivors of the cacao trees cultivated in Guyane: eight from the Amelonado type and two Trinitarios. The qualitative and quantitative descriptors studied are those recommended by IPGRI as regards the fruits (pods), seeds (beans) and ovules. Other descriptors are used, such as the production/vigour ratio, the apparent fertility and the "flat bean" rate. The discussion addresses this material's interest and its possible origin, and provides several elements of comparison with the Amelonados of west Africa. Additional description can be obtained by searching the International Cocoa Genebank Database.

Resumen

Primeros clones seleccionados entre los descendientes del cacao (Theobroma cacao) *cultivados antiguamente en Guayana*

En el artículo se presenta las características morfológicas y agronómicas de diez clones seleccionados en la estación de Paracou- Combi (CIRAD) entre los supervivientes de los árboles de cacao que se cultivaban antes en Guayana: ocho del tipo amelonado y dos del trinitario. Los descriptores, tanto cualitativos como cuantitativos, estudiados son los postulados por el IPGRI por lo que atañe a los frutos (piñas), granos y óvulos. Se utilizan otros descriptores como la relación producción/vigor, la fertilidad aparente y el porcentaje de «granos insípidos». En dicho estudio se habla del interés de este material y de su posible origen, ofreciendo algunos elementos comparativos con los amelonados de África occidental. Se pueden buscar los aspectos complementarios en el Banco internacional de datos sobre el cacao (International Cocoa Genebank Database).

Collecting in northeastern Austria, 1997

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Introduction

Highly industralized European countries have lost most of the biodiversity of their cultivated plants. Monoculture and farmers' dependency on market and economic pressures have led to the extinction of most traditional crop plant varieties. It is more remunerative to board tourists than to stable cattle, or to keep pigs. As a result, fodder crops are not grown, and die out. Herbs and spices are as easily and cheaply available in supermarkets as exotic vegetables, fruits and ornamental plants from all parts of the globe.

The 'Weinviertel', the northeastern region of Lower Austria, is characterized by fields of grains, pumpkins, sunflowers and vineyards. Viticulture is limited by climate and altitude. In higher regions, the farms are few and far between and a large portion of the area is wooded. The area chosen for the collecting mission is near the Czech and Slovakian border, in a relatively flat area which is characterized by lack of trees and large fields. The last collecting missions in Austria were done by Mayr (1951), Hammer, Lehmann and Schachl between 1980 and 1986 (Hammer 1997, pers. comm.). The present short expedition was undertaken to see what could be found in a region considered to be completely eroded in terms of genetic resources, 20 years after the last collecting activities. Since fields in this area are only planted with commercial varieties, the small gardens in the villages surrounding Poysdorf, one of the 'capitals' of this region, were the main target of interest. This town, about 50 km north of Vienna, was selected as a base for collecting activities, and small trips were conducted in all directions from there.

Fig. 1. Field structures in the 'Weinviertel' with a typical road garden.

Table 1. List of samples collected

Crop	No. of accessions	Total
Cereals (*Zea mays*)	2	2
Phaseolus vulgaris	13	
Other legumes	2	15
Allium spp.	8	
Cucumis spp.	5	
Cucurbita spp.	4	
Lycopersicon esculentum	16	
Other vegetables	4	37
Beta vulgaris	3	
Other roots and tubers	2	5
Herbs	2	
Technical plants	3	
Ornamental plants	9	
Fruit (*Rubus idaeus*, yellow)	1	
Total samples	74	

Results

The area is characterized by industrial farming methods, with few fallow fields. Tourism is not very dominant, with the exception of Viennese who come to buy wine in the region and visit the many 'Heurigen', which sell wine from the current year's harvest. The gardens in the villages are often cultivated by weekend gardeners from Vienna, who follow all the modern trends. But another, more traditional form of gardening has survived. The fields near villages and towns are often divided into very long and thin strips. Avid gardeners with a large family to support traditionally grew 'road gardens' as close to the road as possible (Fig. 1). Since customs die hard, the old people continue to cultivate these strips, even when their family has moved to the city and they have to give away their produce. The gardens are not surrounded by fences or hedges, but contain a broad spectrum of ornamentals, vegetables and fruit, sometimes even a non-commercial white corn with short ears (Table 1). In the vicinity of the roads, ornamentals predominate, and vegetable crops can be found in the further reaches of the strips. In some cases, the presence of seed-bearing fodder beets, salads and onions indicated that seed-harvesting was being practised, proof enough that some local varieties are being maintained. One farmer explained how he maintains an old variety of fodder beets and provides seed to all interested farmers in his community. Other farmers in the vicinity of Laa on the Thaya maintain several varieties of onions and leeks, isolating them at one end of their strip gardens to reduce intercrossing. The occurrence and utilization of *Bassia scoparia*, the summer cypress, as a broom plant, was an unexpected find. This plant is not traditionally grown as an ornamental, as in other regions, but instead the plants are selected and dried to prepare indoor brooms (Fig. 2). Several strains were found, roughly grouped into smaller or taller plant types. For outdoor brooms, birch twigs (*Betula pendula*) are used in this region.

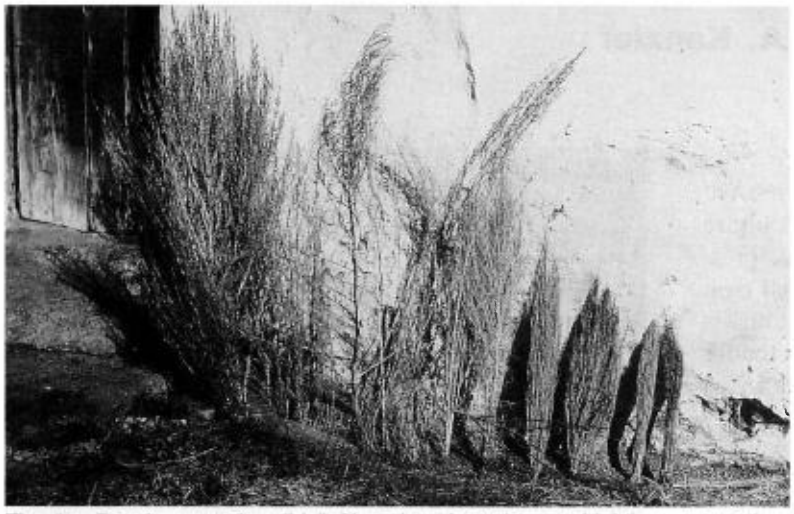

Fig. 2a. *Bassia scoparia*, wild (left) and cultivated types (right) grow together if selection does not continue.

Fig. 2b. *Bassia scoparia* as indoor brooms; birch or *Sorghum* brooms are used outdoors.

Within the villages, there are many fenced gardens, which are smaller than the road gardens. The gardeners are not organized into community or other gardening groups, but are individualistic in their approach to their gardens. They cultivate pole and bush beans, and up to eight different tomato varieties per family. Several graft apple and pear varieties and plant them in their village gardens or sometimes in orchards outside the villages. Some plant species are sadly under-represented: basil, broad beans, cabbages, chicory, fennel. Carrot, Swiss chard and celeriac varieties are seldom saved for seed. These biennial plants are more difficult to reproduce and to maintain than the annuals, although seed stalks of fodder beets could be found in more than one locality. At least one regional variety of radish could be found, one pea and two lettuces, as well as one dock (*Rumex patientia*), which had been left to grow in one garden, although the owner did not know what it was used for anymore. Poppies and flax, frequently grown in other regions of Lower Austria, could not be found. Among the ornamentals, *Vaccaria pyramidata* should be mentioned. Formerly occurring as a rare weed, this plant is sometimes grown as a lovely annual bearing pink flowers.

The influence of current fashions could be seen in the case of the cucurbits. Pumpkin and squash exhibitions have been established in the region within the last few years, leading to the proliferation of new squash varieties. Another interesting find was a garden cucumber with black spines. The area around Znajm, across the border in the Czech Republic, was once famous for its cucumber production. This cucumber of the Weinviertel region was one of the most common local varieties found on the trip, often grown side by side with modern varieties, which will inevitably lead to introgression. But the seeds are harvested nonetheless, and the farmer will collect the seeds again next year. In this way, landraces were probably developed in the past. The farmer compared his plants with varieties bought at a market, then selected the resulting crosses according to his or her personal preferences, collected seed from the best plants and distributed it to friends and neighbours. This process was continued year after year until the gardener himself passed away. As long as his or her heirs cared for the plants, the tradition was passed on. Farmers' landraces have never been as standardized or homogenous as breeders' varieties. This tradition is still being followed, even in such areas with so little biological diversity as in the Weinviertel. Many gardeners do not blindly believe in the blandishments of colourful seed packets, and they are aware of the value of their traditional seeds. They are also willing to try new varieties to test them, as seen in the example of squash.

The people we met on our travels were very old farmers and gardeners, most of them over 80 years old, and predominantly women (Fig. 3). Their children have left to work in larger towns or in Vienna and have lost interest in farming and in farming traditions. But these old people continue to do the work they always did: they sow, graft, harvest and collect plants in their gardens, even though they are not dependent upon their gardens any more for their food. Most of their neighbours have uniform gardens filled with lawns and evergreen coniferous trees, shrubs, etc. The neighbours do not spend as much time working in their gardens, preferring to spend

Fig. 3. Woman cleaning bean seed.

their leisure in an accurately arranged, artificial, modern environment. The equipment and plant material used to construct these gardens is available in every garden market throughout Europe. The traditional exchange of seeds and plants between neighbours has been discontinued. There is less communication between them, at least on this level.

This is not the only example of finding unexpected local varieties in industrialized regions where seed distribution companies are the predominant source of seeds (Hammer *et al.* 1977; Zeven 1979; Dambroth and Hondelmann 1981; Gladis 1996). Of course, there is much less diversity here than there was a few decades ago. But this has always been the case in evolution: phases of reduction follow those of spreading diversity and *vice versa*. We cannot legitimately neglect those regions with fewer genetic resources, their traditions and their remaining crops on our collecting expeditions. And monitoring the process of crop evolution should always be connected with watching the development of new social structures.

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A Peruvian maize (*Zea mays* L.) ear 1000 years old

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A maize ear wrapped in wool cloth was found in 1971 on the sand near a mummified child, close to a looted grave of Paracas Nacropolis, a Peruvian funerary centre in the coastal desert of Paracas Peninsula (Southern Peru), which flourished about 2000 years ago, the earliest Nazca period. That society was mainly agricultural and grew maize, among other crops. Funerary practices included mummification of high-ranking people, wrapping mummies inside baskets in long patterned cotton and wool cloaks as funerary bundles. Inside the bundles were offerings, including food. The bundles were placed inside baskets in an underground huaca (tomb) (Ramos and Blanco 1988). In mountains nearby, maize was used as a food offering (Alonso 1991). Carbon-14 dating was applied in 1997 to 790 µg from the tip of the ear cob by accelerator mass spectrometry, carried out by the Van de Graaff laboratorium of the University of Utrecht (sample number 5567). This rapid method, which only required a small sample, was chosen to avoid ear damage. It revealed that the ear was harvested from 883 to 976 AD, corresponding to the Huari culture in that area (latest Nazca period), after agriculture lost importance (Ramos and Blanco 1988). This culture respected extant funerary practices of the coast (Ramos and Blanco 1988; Alonso 1991).

Fig. 1. Peruvian maize ear (upside down) 1000 years old on ancient wool cloth and two grains placed on moist filter paper in a Petri dish.

The ear is dark red, small (6.6 cm long, with a diameter of 3.1 cm in its middle part), with 14-grain rows not well delimited and about 11 grains per row (Fig. 1). Ear shape is cylindrical, with a conicity of 0.05% (Ordás and de Ron 1988). Rows are straight but grain clusters form sometimes at the end, as seen in the figure. The ear has 122 flint grains plus some empty cupules. Ear weight (with 120 grains) was 20.05 g. Weight of a representative grain was 0.1 g. One of the grains was 8 x 6.5 x 3 mm, and another was 7 x 6.5 x 5 mm. Grains are dry, have white endosperms and are smaller and rounder at the tip.

Three grains were placed on moist filter paper in a Petri dish and incubated in the dark at 25°C (two of them are seen in Fig. 1, just before incubation). Although some anthocyanin from the pericarp was dissolved and stained the filter, no seed germinated. Loss of seed viability is usual in archeological maize (Mangelsdorf 1974). No primitive Peruvian race of maize is known to have 14-grain rows, although Mexican flints do (Galinat 1988).

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The geographic distribution of sampling sites of local maize (*Zea mays* L.) varieties in Yugoslavia[1]

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Various patterns of introduction of maize

The introduction of maize types has been traced according to historic and linguistic data (Fig. 1). The first maize types brought to Europe by Columbus are thought to have been flints from the Caribbean Islands and West Indies. Although limited in growth, these maize types spread throughout Spain and Italy towards the other Mediterranean countries at the beginning of the 16th century (Pavlièiæ and Trifunoviæ 1966). The second introduction occurred shortly after the first. Crosses of these types to types from the Mexican plateau and the mountains of Andes resulted in increased adaptability to new climatic and soil conditions. Yugoslav maize biotypes have been developed from hybrids of these races, and in the process of evolution consequently differentiated into very early and medium early flints.

In the 18th century, the flints of different genetic origin were carried over from Canada and New England to northern France and thence spread throughout Central Europe, reaching Croatia and Slovenia (Brandolini 1968). These materials were adapted to cooler growing conditions. The early maturity flints, which were developed from this material, were originally different from the ones derived from the first introduction.

During the last decades of the 19th century and at the beginning of the 20th century, dent maize types were introduced into certain parts of Yugoslavia. Originating from the US Corn Belt through natural crossings of northern flint and southern dent types, they were the most productive maize varieties introduced into Europe and therefore rapidly expanded over the Balkans. Natural crossing of the American dents to the flints already grown at that time resulted in the development of the European dent type, which has completely replaced the flint types in the optimal maize-growing regions. This was the last large-scale natural hybridization to take place in the evolution of maize varieties in Europe (Trifunoviæ 1978).

Variability of the local maize germplasm

The interest in studying the variability of maize went along with maize breeding, and particularly with the use of heterosis in the breeding process. In the beginning, only populations intended for field production were observed and described. The description, however, was only of agronomic traits. The most comprehensive studies were performed when these populations were collected and stored in the genebank, where morphological, phenological, phytopathological, agronomic and genetic traits of accessions were studied in detail.

A total of 2178 accessions of local populations is stored in the genebank of the Maize Research Institute 'Zemun Polje'. They are systematically evaluated and classified. The database resulting from the work has systematized variability from geographic origin (Fig. 2). All these accessions had been collected from 1200 sites, very regularly distributed over the whole territory of Yugoslavia. The representation of every agro-ecological region leads to the conclusion that the Yugoslav local maize collection is complete.

The great variability of local germplasm is also indicated by the distribution of the collecting sites' altitudes. The majority of varieties were collected at the altitude range of 100-300 m. The number of accessions collected in the areas below 100 m is almost the same as of those collected between 300 and 500 m asl. With the increase in altitudes over 500 m the number of varieties gradually decreases. Thus only 48 collected accessions could be grown at the heights over 900 m. The maize growing limit in Yugoslavia is 1200 m above sea level.

Maize types are distributed in Yugoslavia as follows: Dent types of the USA Corn Belt, Derived dents, Dent types of Southern areas of the USA and Serbian dents. These types were collected in the northern plains of Yugoslavia, Vojvodina and Slavonija, and also in Istria and river valleys, mostly in typical temperate regions. Semi-dents and long-eared flints, such as the Kosmet flinty dent or eight-rowed corn type of northeastern America, were also collected in the temperate regions at lower altitudes in the southern parts of Yugoslavia. Early maturity short-eared flints, such as Montenegrin flints, Bosnian early dent, Macedonian flints and Small-kerneled flints, were collected at higher altitudes further west or in the northwestern parts of Yugoslavia (Slovenia), i.e. in cooler regions.

The group of dent maize has been used to a certain extent in maize selection owing to its extraordinary variability and heterotic potential (Radoviæ and Jelovac 1995), as well as its resistance to diseases (Leviæ *et al.* 1993). Conversely, the groups of flints have been used less even though their variability and divergence are higher.

The variability pattern of local germplasm points to a type of hybrid which might replace the local variety of a particular region. The type of hybrid fitting a particular ecosystem should therefore be similar to the dominant type of population which used to be grown there.

[1] Refers to the Socialist Federal Republic of Yugoslavia

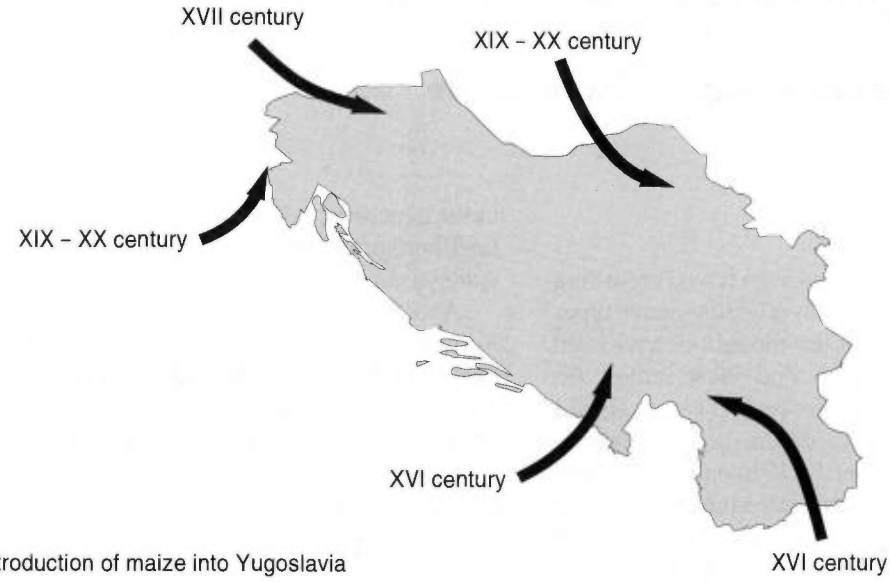

Fig. 1. The introduction of maize into Yugoslavia

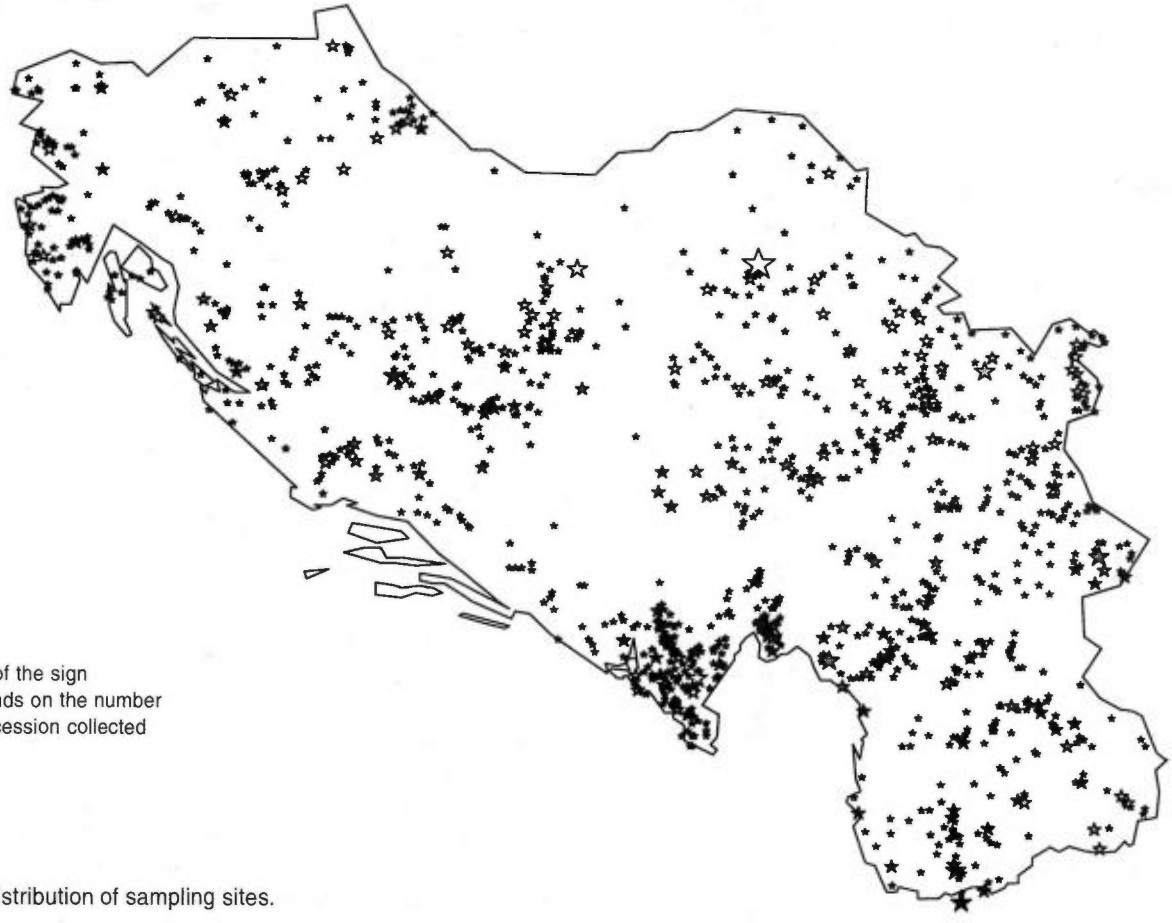

Fig. 2. Distribution of sampling sites.

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Causes of the slow progress in improvement of Cuban sugarcane commercial varieties in recent years

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Introduction

The complex origin of sugarcane (*Saccharum* spp.) has given the species exceptional cytogenetic characteristics, in comparison with other plant species. Phenomena such as polyploidy, aneuploidy, chromosomic mosaicism and anomalies in meiosis make this crop a complex heterozygote (Campo Zabala 1987). These characteristics make breeding difficult when environmental effects are added (Skinner 1971; Mariotti 1977; Bernal 1986). There have been limited attempts to use new genetic variability sources without a defined strategy, an extensive problem in the majority of sugar-producing countries. This problem was reviewed by Arceneaux (1967), Price (1967) and Roach and Daniels (1987).

Sugarcane crosses for commercial purposes have been evaluated by many researchers (Brett 1960; Coleman *et al.* 1962; Bond 1977). However, the advances achieved so far in attaining new varieties fall far short of the expectations.

In Cuba, 95.6% of the cultivated sugarcane area is planted to national varieties. In recent years, after the appearance of rust (*Puccinia melanocephala* H. and P. Sydow) and smut (*Ustilago scitaminea* Sydow), no great advances have been achieved with the introduction of new varieties arising from the national breeding programme. Introducing new foreign varieties has not increased production either. New varieties have not been able to surpass the sugar yield level of those under exploitation, despite the extensive efforts made. Such a problem led us to make an analysis of the genetic basis with which we have been working all these years in Cuba.

Materials and methods

A retrospective analysis was made of the main varieties obtained and recommended in Cuba during the last 40 years through the national breeding programme. The agronomic, sugar and phytopathology data were taken from the National Sugarcane Germplasm Data Base of the National Sugarcane Research Institute of Cuba. With the objective of obtaining more complete information on the varieties, their genealogical trees were determined to summarize the degree of participation of the different species of the *Saccharum* complex, and their relationship to the origin of the principal Cuban varieties that were exploited or are in use today.

Results and discussion

Table 1 shows discrete improvements in sugar content and resistance to diseases of the hybrids recommended in recent years. If we analyze the parents which gave rise to these varieties, a high degree of usage of some genotypes

Table 1. Sugar characters[†], yield[‡] and resistance to diseases[§] of the main Cuban commercial varieties

Varieties	Parents	ppc	ppc	t/ha	t/ha	tpol/ha	tpol/ha	Disease resistance to:		
								Rust	Smut	SCMV
C87-51	Co281 X POJ2878	18.63	18.95	68.20	59.30	12.70	11.24	R	I	R
My54129	B42231 X Co453	17.34	17.76	94.65	87.18	16.36	15.48	MS	AR	R
My5514	CP34-79 X B45181	16.70	16.84	89.11	81.40	14.88	13.71	S	AR	R
My5715	Co453 X B42231	17.61	16.17	81.71	77.95	14.39	12.60	R	S	R
Ja60-5	Ja55-663 X B42231	17.74	18.10	90.40	85.40	16.04	15.46	I	S	R
Ja64-11	POJ2878 X Co356	18.38	17.41	82.72	55.40	15.20	9.65	MR	R	R
Ja64-19	Ja55-663 X Ja54-309	17.94	17.90	87.50	57.34	15.70	10.26	R	R	R
C187-68	C236-51 X MPR341	17.47	17.23	75.10	56.53	13.10	10.31	R	MR	AR
C323-68	B4362 X C87-51	18.23	18.11	93.20	91.50	16.99	16.57	S	R	R
Ty76-16	C87-51 X Ja60-5	18.01	18.21	70.11	65.25	12.63	11.88	R	R	R
C266-70	Co281 X POJ2878	17.95	18.05	99.45	90.98	17.85	16.42	R	AR	AR
C294-70	B42231 X C87-51	17.21	17.20	90.20	90.05	15.52	15.49	R	R	R
C290-73	C236-51 X B42231	16.84	17.93	91.50	90.10	15.41	16.15	R	MR	R
C1051-73	B42231 X C431-62	18.61	18.93	91.10	95.40	16.95	18.05	R	MR	R
C1616-75	C389-52 X C79-54	15.94	17.06	93.36	88.19	14.88	15.05	R	R	R
C568-75	C236-51 X B45181	16.21	16.05	91.70	90.30	14.86	14.49	R	AR	R
C120-78	Co421 X C87-51	17.75	17.90	97.10	91.40	17.24	16.36	R	AR	R

[†] ppc = pol percent in cane.
[‡] t/ha = tonne of cane per hectare; tpol/ha = tonne of pol per hectare.
[§] AR = Highly resistant; R = Resistant; MR = Medium resistant; S = Susceptible; I = Immune.

Table 2. Sugar characters[†], yield[‡] and resistance to diseases[§] of the foreign varieties recommended in Cuba

Varieties	Parents	ppc	ppc	t/ha	t/ha	tpol/ha	tpol/ha	Disease resistance to:		
								Rust	Smut	SCMV
POJ2878	POJ2364 X EK28	16.04	16.40	71.40	64.30	11.45	10.55	R	AR	R
Co421	POJ2878 X Co285	17.01	17.45	77.70	68.13	13.22	11.89	R	AR	R
B42231	B3354 X CP28-11	14.38	15.10	69.50	65.20	9.99	9.85	R	AS	R
B4362	B37161 X POJ2878	14.00	13.82	70.30	78.75	9.84	10.88	AS	R	R
CP52-43	CP43-64 X CP38-34	17.05	16.75	79.83	70.00	13.61	11.73	R	I	R
CG127-45	Co281 X POJ2878	17.40	18.05	84.50	85.38	14.70	15.41	R	AR	R
PR980	Co281 X POJ2878	15.40	14.55	87.30	80.20	13.44	11.67	R	R	R

[†] ppc = pol percent in cane.
[‡] t/ha = tonne of cane per hectare; tpol/ha = tonne of pol per hectare.
[§] AR = Highly resistant; R = Resistant; MR = Medium resistant; S = Susceptible; I = Immune.

like B42231 and POJ2878 is observed. This means a poor utilization of the variety in the available germplasm and the emphasis on the use of these parents for a long time. A similar situation exists for the foreign varieties recommended in the country (Table 2).

After the 1970s, a slow increase in agricultural yield was achieved, but the gain did not reflect the considerable efforts and resources expended in work done to obtain new varieties. We may refer to the representation of the original forms in the Cuban varieties on the basis of the results shown in Tables 3 and 4. These are hybrids used on a limited genetic basis without taking into account the misuse of other genera related to sugarcane. Cuban breeding work has been secondary, almost exclusively, to the work initiated in India and Java more than 50 years ago. Heinz (1980) has pointed out that the majority of the achievements obtained in sugarcane breeding all over the world has been due to hybrid crossing. Berding and Roach (1987) had the same opinion and emphasized that it is difficult to achieve new advances following these lines. This has also happened in Cuba.

Table 3. Original forms of the Cuban varieties

Varieties	*Saccharum officinarum* L.	*Saccharum spontaneum* L.	*Saccharum sinense* Roxb.	*Saccharum barberi* Jeswiet	*Saccharum robustum* Brandes et Jeswiet
C87-51	6	2	1	-	-
My54129	8	2	1	1	-
My5514	8	1	1	1	1
My5715	8	2	1	1	-
Ja60-5	7	2	1	1	-
Ja64-11	6	2	1	1	-
Ja64-19	6	2	1	1	-
C187-68	6	2	1	-	-
C323-68	7	2	1	1	-
Ty76-16	7	2	1	1	-
C266-70	6	2	1	-	-
C294-70	6	2	1	1	-
C290-73	7	2	1	-	-
C1051-73	7	2	1	1	-
C1616-75	8	2	1	1	-
C568-75	6	2	1	-	-
C120-78	7	2	1	1	-

Table 4. Original forms that have given rise to the main Cuban varieties

Species	Varieties
Saccharum officinarum L.	B. Hitam, Loethers, B. Cheribon, Fiji, Lahaina, Badila, D74, Ashy Mauritius, Striped Mauritius, Vellai, Cristalina, Korpi, Kaludai Boonthan.
Saccharum spontaneum L.	Glagah and Coimbatore of India
Saccharum sinense Roxb.	Chunnee
Saccharum barberi Jeswiet	Kansar
Saccharum robustum Brandes et Jeswiet	28 NG 251

Cuban variety genealogy incorporates the varieties POJ2878, Co206, Co213, Co244, Co281, Co285, Co290 and CP34-64 in a predominant way with some backcrosses with the noble forms of *S. officinarum* L. – D74, Badila, Korpi and Striped Mauritius. A poor advance in breeding new varieties has been observed in Cuba, as in other parts of the world (Arceneaux 1967; Price 1967; Roach and Daniels 1987). One of the main causes of this phenomenon is the low return of the genetic variability that our breeders, phytopathologists and biologists have been able to evaluate and characterize from a total of 2575 genotypes present in the Cuban genepool. This characterization involves the evaluation of 49 traits of great agronomic and sugar importance, as well as for disease resistance and eight characters of general data of the individuals, which are input to the automatic system BANCOGER, making possible the storage, handling and analysis of the information in a fast and exact way.

After 1977, INICA started intensive work with the search for parents resistant to different diseases, a recurrent selection cycle which started in 1987, an *in vitro* selection programme for resistance to smut which began in 1988, and the selection of germplasm with different objectives (Table 5). All this has brought forth certain breeding advantages.

Some constraints which have not allowed major progress in the resistance to diseases – among which the

Table 5. Selected genotypes of the germplasm pool identified as sources for various breeding objectives

Objectives	Quantity
Active parents	256
Development	168
High sugar yield	309
High pollen fertility	71
Resistance to diseases	484
Potential reservoir for:	
Sugar production	112
High wax content	7
High forage production	25
Energy purposes	50

poor flowering, synchronization of flowering and lack of parent compatibility – are to be analyzed. Successive studies through traditional breeding or new biotechnological techniques have succeeded in breaking these barriers. The sugar industry in Cuba has depended on varieties with a medium sugar content, and medium to late maturity. Thus the work in recurrent selection to seek varieties with high sucrose content and early maturity has created new expectations for the Cuban sugarcane agriculture.

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Plant Genetic Resources Newsletter, 1998, No. 113: 44-46 SHORT COMMUNICATION

Morphometric studies of *Gossypium herbaceum* cultivars in the Iran National Genebank

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Introduction

Cotton (*Gossypium herbaceum*) is one of the most important crops of Iran. Although there are good collections of *G. herbaceum* cultivars in the Iran National Genebank (stored in a coldroom) and Varamin cotton research centre (fresh seeds stored), no information is available on their morphology or cytogenetics. The present paper reports the analysis of 42 *G. herbaceum* cultivars in the genebank using multivariate statistical methods.

Materials and methods

Forty-two *G. herbaceum* cultivars collected from different regions of Iran were planted in a randomized complete block design (RCBD) with three replications in an experimental field of the Varamin cotton research centre located close to Tehran, during 1994-95. Cultivars were planted in two lines of 11 m length with 80 cm inter-row and 20 cm interplant distances. Ten plants were selected randomly from each cultivar and morphological characters were analyzed according to IBPGR descriptors (1985). (Seeds of the cultivars are available from Varamin cotton research centre on request.)

The Numerical Taxonomic System (NTSYS) - pc version 1.40 (Rolf 1987) was used for multivariate statistical analysis. Cluster analysis using unweighted paired group mean average (UPGMA) method grouped the morphologically similar cultivars (Waycott and Fort 1994). Goodness of fit of the clusters to the original data was determined using cophenetic correlation (Stanton *et al.* 1994). Data were standardized (mean = 0, variance = 1) for principal component analysis (PCA). Product-moment correlation and eigen values were determined from these data (Sneath and Sokal 1973). Cultivars were ordered on the first two PCA axes (McClintock and Waterway 1994), and taxonomic distances were determined from standardized data. Eigen values were determined. Cultivars were ordered using principal coordinate analysis (Pickersgill *et al.* 1976). Goodness of fit of eigen values in both analyses was determined using cophenetic correlation (Rolf 1987).

Results

Six characters differed significantly among the cultivars, including yields at first and second harvests. The coefficient of correlation determined for morphological characters showed a significant positive correlation between internode length with number of balls and ball diameter, number of nodes with ball diameter, number of glands and the height of plant and pedicel length with 20-pod weight. A significant negative correlation was noted for pedicel length with internode length and ball diameter.

UPGMA cluster grouped the cultivars into five clusters (Fig. 1). The first cluster contained 29 cultivars, the second 9, the third 2 and the fourth and fifth clusters, 1 cultivar each. Cophenetic correlation of the cluster was >0.80, indicating a good fit of the clusters to the original data. Cultivar 1 (Kerman), 24 (Marvast Mehriz green) and 42 (Marvast Mehriz red boll) are placed in more distant clusters and so can be used in hybridization programmes to produce heterosis.

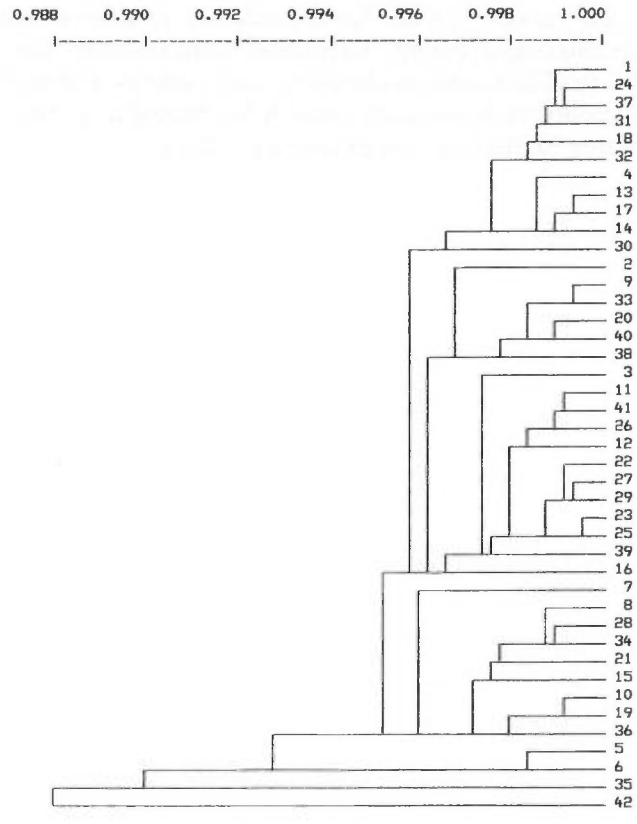

Fig. 1. UPGMA cluster of morphological characters.

Principal component analysis (PCA) based on morphological characters showed that the first six axes make up 73.2% of the total variance. On the first axis height of the plant, weight of 20 pods, number of vegetative branches and pod diameter possess the highest variance. The length of the internode in the first vegetative branch had the highest variance along the second axis.

The phenogram produced from UPGMA cluster analy-

sis based on characters showing the highest variation by PCA (Fig. 2) is nearly the same as the original cluster analysis (Fig. 1). It is also interesting to note that characters separated by PCA are mainly those morphological characters that showed significant differences among the cultivars.

Plotting the cultivars on the first two PCA axes showed cultivars 6, 12, 8 and 31 standing apart from the other cultivars. However, other cultivars were positioned similarly to clusters produced from UPGMA analysis. The same results were obtained from principal coordinate analysis, confirming earlier results.

High cophenetic correlations (>0.8) were obtained for values in PCA and principal coordinate analysis. Principal component analysis and principal coordinate analysis showed that the height of plant, weight of 20 pods, number of vegetative branches, pod diameter and the length of internodes in the first sympodial branch are the most variable characters among the cultivars studied.

Discussion

Gossypium herbaceum is one of the A-genome cottons which is a potentially important genetic resource for cotton breeding programmes (Stanton *et al.* 1994). Collecting native cultivars of this species growing in different regions is an immediate step in broadening variability of the genepool. Several studies have indicated the presence of infraspecific variations in *G. herbaceum* (Wendel *et al.* 1992; Stanton *et al.* 1994). The present investigation clearly shows considerable morphological and cytological variations (Sheidai *et al.* 1996) among the cultivars in the genebank.

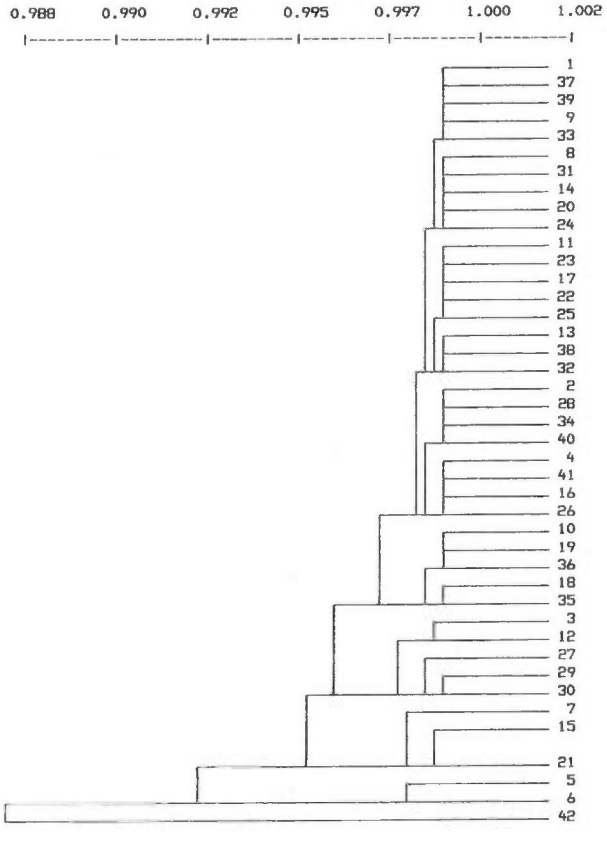

Fig. 2. UPGMA cluster based on characters separated in PCA.

Use of A-genome cotton as a source of genetic diversity for gaining stress tolerance, fibre quality and earlier maturity has been suggested by several workers (Meredith 1991; Steward 1992). Moreover, *G. herbaceum* cultivars growing in Iran show disease tolerance, and hence such variability could be used in crossing programmes. Saleem and Buxton (1976) divided morphological characters into vegetative and generative and showed the impact of those characters on yield. Other studies also indicate the effect of the morphological characters as in the present investigation and some others on the yield of cotton plant (Fry 1985). Data from such morphological characters along with cluster analysis could be used in crossing programmes. For example, the presence of a positive correlation between internode length with number of balls and ball diameter is interesting since internode length is one of the characters showing high variation among the cultivars studied (PCA analysis). Thus, crossing cultivars placed in distant clusters and possessing high internode length may be suggested (cultivars 9, 8, 23, 28, 37 and 41 all possess high internode length and belong to different clusters).

Percy and Wendel (1989) further emphasize that wild forms as well as earlier cultivated forms possess more variation with regard to vegetative and generative characters than modern forms. In the *G. herbarium* cultivars studied, variations were observed in both vegetative and generative characters. They showed the presence of a significant difference in characters such as: plant height, yield in the first harvest, weight of 20 pods, pod diameter and internode length in the first sympodial branch.

The cytological variations observed in these cultivars also support morphological studies. A significant difference was observed in the size of chromosomes among the *G. herbaceum* cultivars. There were also variations with regard to number of chromosomes, karyotypic formulae, etc. Cluster analysis obtained from chromosomal data grouped cultivars nearly similar to morphological characters. For example, cultivars 1, 24, 18, 4, 30 and 2 are grouped together in both analyses, cultivars 11, 12, 23 and 29, cultivars 7, 16, 8 and 15 and cultivars 5, 6, 5 and 36 are grouped together in both cytological and morphological analyses (Sheidai *et al.* 1996). These all help hybridization programmes which are in progress in the country. The results obtained here and other similar investigations are of immediate importance to our agriculture because they provide a better insight into the genomic variation and potential of the cotton species and their cultivars available in Iran.

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Plant Genetic Resources Newsletter, 1998, No. 113: 47-49 SHORT COMMUNICATION

Evaluation and variation in agronomic characters and incidence of powdery mildew in Israeli barley landraces

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Worldwide, powdery mildew (*Erysiphe graminis* DC Ex. Merat f.sp. *hordei* em. Marchal) is one of the most important diseases of barley (Brooks 1970; Slootmaker 1974). This disease causes serious yield losses in barley in many countries including those in the region of its primary diversity – the Mediterranean basin – and also in North America (Jana and Nevo 1991). Yield losses from the disease in Europe have exceeded 20% (Jenkyn and Bainbridge 1978).

Major genes for resistance against powdery mildew of barley have been found and introduced, mostly from landraces into cultivated barley, in the last 60 years (Wiberg 1974; Torp *et al.* 1978; Schwarzbach and Fischbeck 1981). A continuous flow of resistance genes into European barley cultivars is necessary, either by introducing new sources of resistance or by recycling already used genes. Many genes carried by new cultivars have been overcome in a relatively short time after their release by new virulence genes emerging from selective changes in the pathogen populations (Fischbeck *et al.* 1976). In this context, the significant contribution of foreign landraces and wild forms of barley to the European barley breeding programmes for resistance has been frequently reported (Kintzios and Fischbeck 1996).

The local, primitive landraces are of great significance as a reserve for broadening the narrow genetic basis of new agricultural cultivars. Their value lies in their wide range of variability, specific adaptation to different conditions in their regions of growth, and resistance or tolerance to various plant diseases and pests. The genetic diversity of landraces is particularly high in Israel, which is part of the Near East Fertile Crescent, an area of natural distribution of the wild relatives of wheat and barley (Harlan and Zohary 1966).

With the onset of modern plant breeding, the old endemic barley varieties were not preserved and only remnant representatives were available until 1978. Seed samples of local cultivars of barley were collected by Mattatia (1982) during 1978-81. The main objective of the study reported here was to identify the botanical variety of these local landraces held in the Israel Gene Bank, to evaluate them for basic characters and to screen them for the incidence of powdery mildew under natural inoculation conditions.

Materials and methods

Plant material

The samples of local landraces of barley (*Hordeum vulgare* L. subsp. *vulgare*) tested in this study were collected from local and Bedouin farmers by Dr J. Mattatia during 1978-81 throughout the Galilee, Mt. Gilboa, Judean Mountains and Judean Desert. For details on the distribution of sites, see the map in Nevo *et al.* (1979). The samples were generally collected after harvesting, without any information on the botanical variety of each landrace, and were not evaluated. Seeds were stored at the seed storage facilities of the Israel Gene Bank, in sealed aluminium cans, until needed for maintenance and evaluation.

Experimental procedures

Seventy-nine accessions of *H. vulgare* were studied in 1995/96 at the Bet Dagan Experimental Farm, The Volcani Center, located in the coastal plain at latitude 32°01'N and an elevation of 50 m. The soil type of the farm is a deep fertile vertisol. The field was fertilized with N and P_2O_5 at 120 kg/ha and 80 kg/ha, respectively, before planting and was kept free of weeds. Seasonal rainfall and irrigation amounted to 540 mm. One 100-cm long row of each accession was sown on 30 November at a spacing of 60 x 2 cm between and within rows, respectively; hence 45-50 plants were included in each row. Seedling emergence occurred on 10-12 December.

Screening for natural infection of powdery mildew was conducted on 11 March. The infection types (IT) were scored on a 0 to 9 scale from free of infection to very susceptible, according to Saari and Prescott (1975). The ITs were combined into six categories, recorded as 0 = free from infection , R (resistant)= 1 to 3, MR (moderately resistant) = 4, MS (moderately susceptible) = 5 to 6, S (susceptible) = 7 to 8, and VS (very susceptible) = 9.

Results and discussion

The determination of the botanical variety of each accession showed that most consisted of a mixture of var. *distichum* and *hexastichum* plants, where one of the two types was predominant (Table 1). Farmers maintain diversity in their fields as a result of their belief that mixed forms of barley ensure stability of production in their environments.

The first botanical variety recorded for the mixed accessions (Table 1) is the predominant type in the corresponding landrace. The findings showed that 43 and 36 accessions from this collection represented *H. vulgare* var. *distichum* and var. *hexastichum* Israel landraces, respectively.

Large variability was found for all the characters examined. All the data in Table 1 were recorded for the predominant botanical variety of each accession. Therefore,

Table 1. The botanical variety, plant height, days to heading and infection type (IT)[†] of powdery mildew under natural inoculation in 79 Israel barley landraces

Catalog number	Botanical variety	Plant height (cm)	Days to heading	Powdery mildew
39367	*distichum*	83	103	0
39382	*distichum*	92	105	0
39387	*distichum*	98	106	MS
39397	*distichum*	73	107	S
39337	*distichum+hexastichum*	90	105	0
39339	*distichum+hexastichum*	98	105	0
46239	*distichum+hexastichum*	94	106	0
39340	*distichum+hexastichum*	87	105	0
39341	*distichum+hexastichum*	97	106	0
39342	*distichum+hexastichum*	98	106	0
39343	*distichum+hexastichum*	94	106	0
39344	*distichum+hexastichum*	97	105	0
39345	*distichum+hexastichum*	90	106	0
39346	*distichum+hexastichum*	98	106	0
39347	*distichum+hexastichum*	78	106	0
39348	*distichum+hexastichum*	83	106	0
39349	*distichum+hexastichum*	112	106	0
39350	*distichum+hexastichum*	98	106	0
39351	*distichum+hexastichum*	97	106	0
39352	*distichum+hexastichum*	102	106	0
39357	*distichum+hexastichum*	99	106	MS
39360	*distichum+hexastichum*	94	106	0
39365	*distichum+hexastichum*	92	101	0
39366	*distichum+hexastichum*	87	103	S
39368	*distichum+hexastichum*	103	103	0
39369	*distichum+hexastichum*	84	103	0
39370	*distichum+hexastichum*	87	106	0
39371	*distichum+hexastichum*	103	105	0
39372	*distichum+hexastichum*	92	105	MS
39373	*distichum+hexastichum*	87	106	MS
39374	*distichum+hexastichum*	88	106	MS
39375	*distichum+hexastichum*	94	106	MS
39376	*distichum+hexastichum*	101	106	0
39377	*distichum+hexastichum*	88	105	MS
39379	*distichum+hexastichum*	92	105	0
39380	*distichum+hexastichum*	87	105	MS
39381	*distichum+hexastichum*	94	105	MS
39383	*distichum+hexastichum*	94	105	0
39384	*distichum+hexastichum*	101	107	MS
39385	*distichum+hexastichum*	106	106	0
39388	*distichum+hexastichum*	92	106	MS
39404	*distichum+hexastichum*	102	107	MS
39171	*distichum+hexastichum*	97	115	MS
39336	*hexastichum*	78	105	0
39338	*hexastichum*	92	105	0
39355	*hexastichum*	97	106	0
39356	*hexastichum*	103	106	0
39358	*hexastichum*	104	106	MS
39359	*hexastichum*	96	106	0
46237	*hexastichum*	90	106	MS
39361	*hexastichum*	87	106	0
39362	*hexastichum*	90	106	0
39363	*hexastichum*	82	109	0
39364	*hexastichum*	93	109	0
39378	*hexastichum*	93	104	0
39386	*hexastichum*	102	107	MS
41625	*hexastichum*	80	100	0
39389	*hexastichum*	95	104	MS
39390	*hexastichum*	101	106	MS
39392	*hexastichum*	95	98	0
39394	*hexastichum*	91	115	MS
39395	*hexastichum*	101	115	MS
39398	*hexastichum*	106	119	MS
39399	*hexastichum*	94	121	0
39405	*hexastichum*	90	106	MS
39406	*hexastichum*	71	105	MS
39407	*hexastichum*	74	105	MS
39410	*hexastichum*	84	115	S
39412	*hexastichum*	100	105	MS
39413	*hexastichum*	98	106	MS
39391	*hexastichum+distichum*	103	107	MS
39393	*hexastichum+distichum*	92	107	MS
39400	*hexastichum+distichum*	84	113	0
39170	*hexastichum+distichum*	99	111	0
39401	*hexastichum+distichum*	100	108	MS
39402	*hexastichum+distichum*	88	114	0
39408	*hexastichum+distichum*	101	105	MS
39409	*hexastichum+distichum*	93	107	S
39414	*hexastichum+distichum*	101	108	MS

[†] Infection type recorded as: 0 = free from infection, R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible and VS = very susceptible.

the values for mean plant height (from soil until the end of the spike) were in the range 73-112 cm and 71-106 cm, respectively, within the var. *distichum* and var. *hexastichum* populations, while the values for days to heading (from planting to heading of about 70% of the plants) were in the range 101-115 days and 98-121 days, respectively, within the var. *distichum* and var. *hexastichum* populations.

Sixty-five percent of the var. *distichum* accessions did not show any visible infection of powdery mildew on the plants, owing to immunity or escape from natural infection, 30% were moderately susceptible, while 5% (2 accessions) were susceptible. In the var. *hexastichum* 44% accessions did not show any visible infection of powdery mildew on the plants, 50% were moderately susceptible, while 6% (2 accessions) were susceptible. No accession of either population was classified in the categories R, MR or VS (Table 1).

In conclusion, it can be stated that Israeli landraces of barley may serve as a useful source for genes affecting agronomic characters such as plant height and heading date, and for resistance genes to powdery mildew.

Seed requests

Seeds of the barley landraces used in this study may be obtained from Mrs Myra Manoah, Seed Exchange Officer, The Israeli Gene Bank for Agricultural Crops, The Volcani Center, PO Box 6, Bet Dagan 50250, Israel.

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Plant Genetic Resources Newsletter, 1998, No. 113: 50-52 SHORT COMMUNICATION

Variability in *Coleus forskohlii* Briq. – an endangered medicinal plant

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Coleus forskohlii Briq. is a perennial aromatic herb with fasciculated tuberous roots. These roots are a rich and exclusive source of forskolin (diterpenoid), which is used in the preparation of drugs against cardiomyopathy, glaucoma and certain cancers (de Souza and Shah 1988). As commercial exploitation of the tuberous roots of this species from wild stands has increased in response to a growing demand for forskolin, this indigenous species of India has become endangered (Vishwakarma *et al.* 1988).

Coleus forskohlii belongs to the family Lamiaceae, a family of mints and lavenders known to have predominantly diterpene constituents. *Coleus forskohlii* Briq., *Plectranthus barbatus* Andr. and *P. forskohlii* Ait. are synonyms of the plant, for which the legitimate name is *Coleus barbatus* Benth. (de Souza 1991). *Coleus forskohlii* grows on the sun-exposed dry hill slopes between an altitude of 300 and 1800 m. It is distributed over the subtropical, warm temperate climatic zone in the mountains of India, Nepal, Sri Lanka, Africa, Burma and Thailand.

Domestication and genetic upgrading to a commercially viable crop are two means of stemming the genetic erosion resulting from ruthless exploitation of wild stands. Although earlier studies in natural populations revealed genetic diversity for characters such as tuber yield, forskolin content and several other characters, such diversity has not been critically evaluated. The present communication assesses natural variability for genetic conservation and utilization in a breeding programme.

Materials and methods

The experiment was conducted during 1990-91 as a follow-up of an earlier trial (Hegde and Krishnan 1992), using 13 entries received from Hoechst (India) Ltd., consisting of seven tuber-bearing (A, As, B, C, D, K and L) and six non-tuber bearing (E, G, H, I, J and M) accessions collected from north, west and southern regions of India. The accession denoted as As was in the form of seedlings, which were raised from accession A and propagated vegetatively. They were evaluated in a replicated trial using a completely randomized design. Each collection was represented by 22 plants (replications). To avoid interplant competition, a spacing of 1.2 x 1.2 m was adopted while planting the polybag-rooted shoot-tip cuttings.

Data on morphological and yield characters were recorded at 190 days (Tables 1 and 2). Growth parameters like leaf area index (LAI) and harvest index (HI) were computed using standarad formulae (Redford 1967). To assess the critical time of harvest for higher yield in tuber-bearing types, harvesting was done at 160, 190 and 230 days. Data were analyzed statistically using analysis of variance technique in randomized block design. Since there is no ready-made scale available to classify tuberous and non-tuberous types in *C. forskohlii*, the following was used, which was prepared based on several observations taken on underground parts.

Root diam. (mm)	Nature of root	Remarks
more than 15	succulent, swollen	tuberous
less than 10	hard, fibrous	non-tuberous

Results and discussion

Data recorded on morphological, growth and yield characters showed significant difference between the accessions and also showed the superiority of non-tuberous accessions over tuberous accessions for number of branches and leaves (Table 1).

Table 1. Morphological and growth characters in tuberous and non-tuberous accessions of *Coleus forskohlii*

Characters	Tuberous (n=7) A,As,B,C,D,K,L	Mean	Non-tuberous (n=6) E,G,H,I,J,M	Mean	CD (5%)
Plant height (cm)	10.3 - 67.8	31.5	31.3 - 48.8	43.0	8.4*
No. of branches	13.3 - 65.3	38.3	73.5 - 210.0	138.0	69.5*
Plant spread E-W (cm)	44.3 - 123.3	90.3	78.5 - 164.0	128.5	30.6*
Plant spread N-S (cm)	45.3 - 133.5	94.7	81.3 - 160.3	126.8	20.8*
No. of leaves	299.5 - 6146.3	2845.3	3070.3 - 12737.8	8540.5	3050.2*
Stem diameter (mm)	19.0 - 42.3	32.0	20.8 - 29.3	25.3	9.8*
Laminar length (cm)	5.4 - 11.1	7.6	4.8 - 7.5	5.8	0.8*
Laminar breadth (cm)	2.5 - 5.9	3.9	2.1 - 5.0	3.4	0.4*
LAI	0.1 - 2.5	1.11	0.1 - 6.0	4.0	1.4*
HI (%)	8.1 - 55.6	24.9	1.5 - 7.0	5.0	7.1*

* = significant at 5%.

Table 2. Yield characters in different accessions of *C. forskohlii*

Access.	Tuberous							Non-tuberous						Mean	CD(5%)
	A	As	B	C	D	K	L	E	G	H	I	J	M		
Dry weight of leaves (g)															
1	182.1	145.8	82.3	20.0	23.8	248.3	280.1	356.0	691.0	102.3	781.3	212.1	450.5	275.1	167.6*
Dry weight of stem (g)															
2	276.6	219.6	241.1	35.4	52.0	650.7	563.5	912.6	875.5	261.0	791.0	334.7	515.9	441.2	236.3*
Total dry matter (g)															
3	577.9	398.9	438.8	82.6	169.8	1093.0	944.7	1384.9	1615.1	351.5	1813.6	585.1	1127.8	814.1	273.1*

* = significant at 5%.

The collections of both tuberous and non-tuberous types exhibited wide variation for total dry matter (TDM) production per plant (Table 2). Among tuberous types, K recorded the highest TDM (1093 g) and C the least (82.6 g). A comparison of component characters to TDM in C and K indicates that C had poor values for dry weight of leaves (20 g), stem (35.4 g) and tubers (27.1 g) compared with K. The stem diameter was also high in K (42.3 mm). Accession C had a very compact growth habit. The contributing characters to the high dry matter production in K are the better plant spread in all directions, taller growth and higher number of leaves excelling in both breadth and length over C. Accession K, by virtue of its luxuriant growth in all three dimensions, was well equipped to intercept more solar energy, which resulted in higher dry matter production.

Among non-tuberous accessions, H recorded the least value and G and I the highest for TDM. A comparison of component characters of these collections indicates that accessions G and I recorded higher values for dry weights of leaves and stem than H. The characters contributing to the higher dry matter production in G and I are the better plant spread in both directions and higher number of broader leaves. These accessions had more branches than other accessions in this group.

Effective interception of solar energy and its utilization are the main factors contributing to biomass production. In *C. forskohlii* both tuberous and non-tuberous accessions recorded a positive relationship between leaf area and TDM (Hegde 1993). Higher LAI is favourable for interception of solar radiation which in turn would contribute to high dry matter production. The higher LAI values (in non-tuberous collections) were not attended by a proportionate increase in dry matter production because maximum light interception reaches a plateau when LAI exceeds 4 or 5 (Kanda 1975). This was clearly shown among non-tuberous collections, where a linear realationship between LAI and TDM was seen (Hegde 1993).

Since roots contribute economic yield in this crop, higher root weight alone can fetch good returns to farmers. Significant differences in dry weight of roots/tubers were observed among the accessions (Table 3) which confirm the earlier observations of Vishwakarma *et al.* (1988) on the presence of genetic variability for root yield. Among the tuberous accessions, K was outstanding. A high harvest index (HI) in a higher dry matter producing genotype is an ideal combination which is rarely achieved. The tuberous accessions had higher HI than non-tuberous accessions (the exception was As). Accession D recorded the highest HI (55.6%). Nasyrov (1978) pointed out that 50% harvest index is an index of rational partition and utilization of assimilates. In this respect, accession D is unique in having HI above 50%. The accession could serve as a donor parent in breeding experiments aimed at incorporating high HI in improved varieties of *C. forskohlii*. This will commend itself as a priority breeding objective in increasing economic yield, as a favourable combination of dry matter production and harvest index alone can help to achieve high economic yield per unit area.

The appropriate crop duration for *C. forskohlii* tuberous types has not been determined. The published information on harvesting of the crop shows a wide variation with respect to time of harvest (Srivastava 1986; Veeraraghavathatham *et al.* 1985, 1988; Valdes *et al.* 1987). The data recorded on dry weights of tubers at 160, 190 and 230 days in the present study also indicate wide differences for crop duration (Table 3). Among tuberous types,

Table 3. Dry weights of roots (g) at 160 (1), 190 (2) and 230 (3) days in *C. forskohlii*

Access.	Tuberous							Non-tuberous						Mean	CD (5%)
	A	As	B	C	D	K	L	E	G	H	I	J	M		
1	58.9	32.1	157.8	80.0	103.9	114.5	71.3	118.0	39.4	11.7	44.2	28.4	148.9	77.6	69.3*
2	119.1	33.5	115.1	27.1	94.0	190.3	101.1	116.4	48.0	13.2	35.3	37.5	106.5	80.1	46.1*
3	104.4	–	222.8	–	125.8	280.0	75.1	91.4	35.5	7.4	50.3	41.3	131.6	97.1	55.4*

* = significant at 5%.

accession K, which registered the highest tuber yield, showed a continuous increase in tuber yield with crop age. In accession L, tuber yield increased marginally beyond 160 days up to 190 days. Further, accessions A, As, B, C and D did not show appreciable increase in tuber yield beyond 190 days. This clearly showed genotypic differences in tuber yield.

Estimation of forskolin in the accessions was not done. However, the forskolin analysis carried out at the user industry in accesssion K revealed that it had 0.4% forskolin which is highest among the collections analyzed.

Conclusions

The present study has revealed the presence of wide variability among the accessions studied for morphological, growth and root/tuber yield characters. Among the tuberous accessions, K was found to be promising for both tuber yield and forskolin content and deserves promotion as a commerical variety. Accession D had a higher harvest index. Among the non-tuberous accessions, G and I produced the highest total dry matter per plant. These two accessions hold promise as donor parents in an intervarietal hybridization programme aimed at increasing total dry matter production in tuberous accessions. A judicious use of available genetic variability through a breeding programme to enhance commercial viability of *C. forskohlii* has been carried out in our laboratory using intervarietal hybridization and induced autotetraploidy (Nanaiah 1993; Hegde and Krishnan 1994a, 1994b; Prakash 1994).

Acknowledgements

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Collecting and evaluating rice germplasm from Orissa, India

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Introduction

The Jeypore tract of Orissa State was first investigated for primitive cultivars and landraces of rice during the late 1950s (Govindaswami *et al.* 1966). This was the first mission ever organized in the world to collect rice germplasm (Chang 1989). On the basis of their observations on the tremendous amount of variability present in this Jeypore tract, Ramiah and Ghose (1951) suggested it as a secondary centre of origin of cultivated rice. The districts of Dhenkanal and Balasore in the state of Orissa resemble the Jeypore tract in topography and tribal inhabitants, such as the Juang and Bhuinya peoples. These tribes practise shifting cultivation with the landraces. The landraces give a stable but low yield (Oka 1991). They are regarded as natural composite varieties that have an array of resistant genes so that no single race or biotype of plant pests can attack the crop at an epidemic level.

An electrophoretic survey of isozyme loci showed that indica and japonica types were domesticated independently (Second 1982, 1991). The large diversity is primarily due to introgressions between the ancestral cultivated types and genes from the wild rices. Glaszmann (1987) explained the southeast Asian hill rices through isozyme analysis and made 6 enzymatic groups. When the groups were compared with the varieties classified by morphological characters, group I corresponded to indica and group VI to japonica, whereas the rest were atypical but also classified as indicas in the conventional classification. Oka (1988) is also of the opinion that indicas are distributed in the tropical and subtropical zones. The diversity is more prevalent in the area extending from Assam in India to Yunan in China. But the domestication of rice cultivation has differed from its centre of diversity. Archaeological evidence suggests that rice culture occurred long ago in northern India, Thailand and China.

The tremendous amount of variability of these landraces, particularly for the aus ecotype of the whole southeast India, prompted Tripathy (1994) to suggest the possibility of considering this region as the centre of origin for this ecotype. In recognition of the importance of this region and the danger of rapid spread of a few high-yielding varieties like Savitri, Utkalprabha, Swarna, etc., efforts were started by the Central Rice Research Institute, Cuttack to collect and conserve the rice genetic resources from the entire state of Orissa, treating the district as one unit. Initially, the undivided Dhenkanal and Balasore districts were explored during 1994. This area measures about 16 308 km^2 and lies approximately between 20°22′N and 21°42′N and 84°16′E and 86°2′E. This area has several hill ranges from 70 to 1200 m asl. Quartzites and granite rocks predominate, and the soil varies from rich loam in the fertile valleys to gravelly detritus on the hill slopes.

The climate of the explored regions is tropical and monsoonal, the major precipitation is received from July to October. This is the period when the landraces are mostly grown under rain-fed condition. Recently, with the availability of irrigation water, the farmers are switching over to the high-yielding varieties and thereby causing rapid erosion of the genetic diversity of rice.

The landraces are mostly grown under direct seeded condition. However, introgression of the wild rice into the cultivated rice fields causes a major weed problem, mainly in the valleys, and this encourages the farmers to grow their crop through puddling and transplanting.

Exploration and collecting

The mission reported here was undertaken in December 1994, spanning a period of 11 days and covering a road distance of over 1700 km. The route covered during the exploration is shown in the map, which is not to scale (Fig. 1). The collecting sites were on the roadside villages of the traversed route. Only the primitive cultivars and the traditional varieties from each block of districts were collected. Seed samples of 200-250 g each were collected from the fields or from the farmers' stores. Attention was paid to avoid duplicates and the passport characters were recorded. A total of 307 samples was collected, of which 214 were from Dhenkanal district and 93 were from Balasore district. The samples were mostly collected from the rain-fed uplands, shallow lowlands, intermediate lowlands and deepwater ecosystems. A few widespread cultivars like Suvnapani, Ratnachudi and Jangalijhata were found growing across the different ecosystems. The resource-poor tribal farmers are mostly the custodians of the landraces in this region, whereas the so-called progressive farmers have abandoned their age-old cultivars for the modern varieties. The landraces, especially of the short-duration group, had a greater heterogenity and introgression with *Oryza nivara*, which grows in the seasonal ditches along the roadside near the cultivated fields. Similarly, the landraces of intermediate lowlands and deepwater ecosystem also had some degree of heterogenity and populations of *Oryza rufipogon* were found growing very close to the cultivated fields. Farmers sometimes maintain purity of the grains in the field. However, during this collecting trip a few varietal mixtures were collected.

Incidence of disease was relatively low in this region whereas insect infestation was high. Preliminary evaluation data were obtained by visual observation while collecting the samples, whereas screening for a major pest of the area (brown plant hopper, BPH) was made in a net house. False smut, a recently spreading disease, caused severe damage in the areas of Bhadrak, Chandbali, Khamar, Pallahara and

other places where the high-yielding variety Utkal Prabha is grown. However, this had never affected any traditional or primitive cultivars, showing their inbuilt resistance. The traditional varieties Ratnachudi and Suvnapani were grown extensively in Hindol and Angul subdivisions and were free from any pest or disease. Mugei, another traditional variety, was also grown throughout northern Orissa for its resistance to major pests and diseases as well as quality rice and yield potential. Mahumachi, Jaladubi and Pathara are the traditional varieties mainly cultivated in the lowlands and under occasional submergence.

As many as 18 accessions were found to possess aroma. They had short slender grains of black or straw colour. Some accessions, like Baudia, Latamoh and Kaduakhunchi, were said to be good for breakfast preparations like making of parched rice ('mudhi'). Similarly, the varieties like Kolama and Seulapana are cultivated exclusively for preparing the parched paddy ('khoi').

Evaluation of morpho-agronomic characters

The samples after collecting were processed for cleaning and drying to 9% seed moisture content in the seed laboratory and then were grown in the field during 'kharif' (wet season) of 1995 at the Institute's farm under irrigated condition. The seedlings were raised in the nursery and transplanted 30 days after sowing. Each sample was grown in incomplete blocks with two replications. The accessions were grown in 3-row plots of 5-m length. Single seedlings were transplanted at a spacing of 20 x 20 cm. A basal dose of fertilizer at 30:15:15 kg/ha of N:P:K was applied.

The morpho-agronomic characters of each accession were recorded during different growth stages of rice plants, starting from the seedling height to post-harvest characters of the grain. The mean value of five observations for each character of total 48 characters has been taken as per the IRRI-IBPGR descriptor (IRRI 1980). While taking observations on the varietal mixture collections, the smaller population of the plants was rogued out.

Seedling height on the 15th day after sowing in a seed bed was recorded and wide variability was noticed. Most of the vegetative characters showed less variation, such as the type of leaf blade pubescence, leaf blade colour, leaf angle, ligule colour and ligule shape. Almost all had pubescence in leaf blade, green in colour, leaf angle erect to horizontal and ligule shape mostly 2-cleft. Not much variability was observed in flag leaf angle, basal leaf sheath colour, collar, auricle and internode colour. Significant differences for panicle branching, panicle exsertion, awning, stigma colour and other agronomic characters were observed. Days to 50% flowering was recorded in order to differentiate the late and the early varieties. Farmers cultivate the early and late varieties depending upon their land situation. Most varieties of the early maturing group possess the characters of the aus ecotype and are not sensitive to photoperiod. Forty-five percent of the total collections had white stigma while the rest were purple. Twelve percent of the total collections had awns, of which six were long fully awned, two were long partially awned and 30 were short fully awned. Five varieties were found to have long glumes in their spikelets: Jangalijhata, Ramboiti, Ratnakantha, Rampaita and Ramachandrboita. One variety named Nadiachapa collected from Gop village of Jaleswar Tahsil is characterized by its clustered type of spikelets in a panicle. Variability was also observed in grain colour – from black to brown, red, straw or

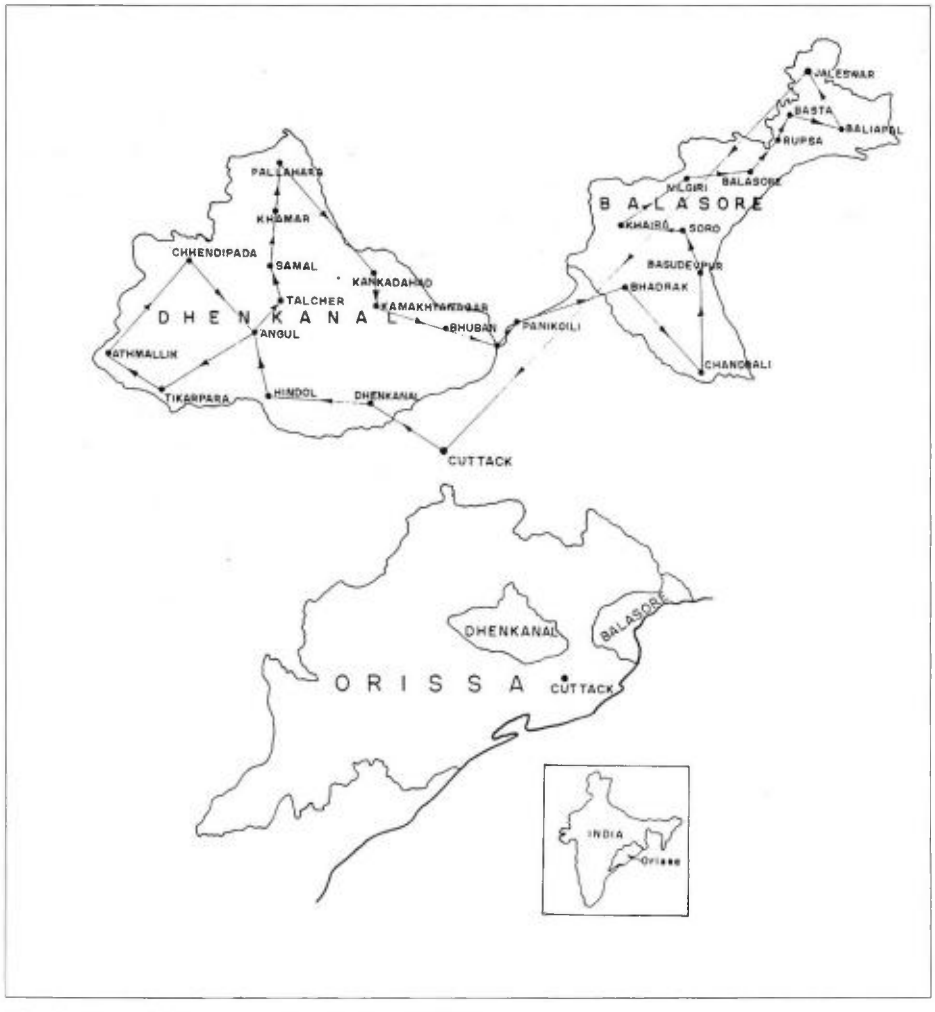

Fig. 1. Map of Orissa, showing the two districts surveyed.

with brown furrows. The range, mean, standard error of mean, coefficient of variation (cv) and some of the morpho-agronomic traits are presented in Table 1.

As many as 10 varieties had very long and heavy panicles with more than 30 cm length and 5 g in weight. About 15% of the total collections had the 1000-grain weight with more than 25 g. The grain shape, which was determined by taking the length and breadth ratio of the grain showed wide variability with more than 70% short-bold, 18% medium-bold and the rest short-slender with aroma.

The present collections were also evaluated against brown plant hopper under net house conditions in 'rabi' (dry season) 1996 with standard screening technique. The varieties Seulapana and Kakudimanji were fully resistant to BPH and seven varieties were moderately resistant. The rest of the varieties were susceptible to this insect pest.

Table 1. Statistical analysis of major characteristics of *Oryza* landraces

Character	Range	Mean	SEM (±)	CV (%)
Seedling height (cm)	14.7 - 40.4	27.1	0.245	16.33
Leaf length (cm)	35.3 - 67.2	52.08	0.284	13.97
Leaf width (cm)	0.6 - 1.8	1.01	0.011	12.82
Ligule length (cm)	0.7 - 2.6	1.4	0.014	6.23
Culm length (cm)	87.0 -176.0	143.7	0.658	9.79
Culm number	4 - 19	9.3	0.097	26.71
Panicle length (cm)	18.6 - 32.3	25.3	0.137	9.76
Panicle weight (g)	1.02 - 6.24	3.1	0.062	31.86
100-grain weight (g)	10 - 32	21.2	0.022	18.91

Conclusion

During the present survey 307 samples of rice germplasm, i.e. 214 from Dhenkanal and 93 from Balasore districts, were collected and conserved to enrich the genetic stock in the national active collection at this Institute. Samples are available upon request. From the characterization and preliminary evaluation it is concluded that some elite materials from the genetic diversity can be utilized as donors in future research programmes.

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News and Notes

Molecular biodiversity analysis in sub-Saharan Africa

During 1996 and 1997, the International Plant Genetic Resources Centre (IPGRI) and the International Centre for Research in Agroforestry (ICRAF) complied a list of laboratories carrying out molecular biodiversity analysis of plants and animals in sub-Saharan Africa. This exercise was to identify common themes in research, research gaps, areas for collaboration and the capacity for such analysis in the region. Information was summarized in tabular form. If you are interested in finding out more about this, please contact Ian Dawson at ICRAF (i.dawson@cgnet.com or l.guarino@cgnet.com).

Multicrop passport descriptors

A list of multicrop passport descriptors has been developed jointly by IPGRI and FAO to provide consistent coding schemes for common passport descriptors for all crops. These descriptors aim to be compatible with future IPGRI crop descriptor lists and with the descriptors used for the FAO World Information and Early Warning System (WIEWS) on plant genetic resources. Several crop working groups in Europe have already adopted this list as the basis to develop central crop databases.

The list should NOT be regarded as a minimum descriptor list, since many additional passport descriptors are essential for the description of crops and need to be recorded. Instead, it provides an initial set of common passport descriptors at the multicrop level, which in the future could be expanded to include additional multicrop descriptors. For example, descriptors dealing with the use of germplasm are currently not included, but their suitability for inclusion at the multicrop level will be further investigated. Future expansion could result in the development of more specialized lists of common descriptors at the crop group level.

This list can be obtained from IPGRI's Internet site: (**http://www.cgiar.org/ipgri/DOC/DOWNLOAD.HTM**).

For more information contact Th. Hazekamp, Germplasm Documentation Officer, IPGRI, Via delle Sette Chiese 142, 00145 Rome, Italy (t.hazekamp@cgnet.com).

Biodiversity policy and law

The first edition of the 1998 directory of web sites on biodiversity policy and law is available. BIONET distributes the list of web sites on a quarterly basis, and includes it in the Biodiversity Bulletin newsletter. In an effort to balance the importance of current issue-oriented sites with the utility of maintaining relevant institutional sites, the directory is divided into two sections: one section containing timely issue-specific web addresses, which will be updated with each addition; and one permanent section listing the addresses of relevant institutions, organizations and other stakeholder groups working around the CBD. Contact Stas Burgiel or Juliette Moussa at bionet@igc.apc.org.

International plant protection ready for the new century

(This information courtesy of FAO: **http://www.fao.org/News/1998/**)

The adoption by the FAO Conference in November of revisions to the International Plant Protection Convention (IPPC) promises to have far-reaching effects on trade and food security for both developed and developing countries. The revisions have transformed the Convention from a relatively little-known agreement into an active and important organization with a significant role in international trade.

The Convention, which came into force in 1952 and now has 106 member countries, established the concept that exporting countries have an obligation to protect importing countries by ensuring that the agricultural goods that they export are free from plant pests. A system of certification, based on a model format described in the Convention, has long been the global standard. Highlights of the revisions include:

- the establishment of a Commission on Phytosanitary Measures recognition of the Secretariat, located in FAO's Plant Protection Service (AGPP)
- recognition of standard-setting responsibilities
- the designation of an official national contact point
- establishing pest risk analysis as the basis for technically justified measures
- improved dispute-settlement mechanism
- recognition of regulated non-quarantine pests
- clarification of the relationship to other international agreements
- clarification of obligations for risk analysis, surveillance and information sharing
- the possible membership of the European Community.

Plant quarantine regulations continue to be the most important non-tariff barriers to the free movement of agricultural products. The justification for such barriers has often been absent or dubious. Under the revised IPPC, mechanisms are identified to provide justifications, and the responsibilities of countries are emphasized while respecting their sovereign right to take measures to protect their agriculture and wild flora from new pest incursions.

The IPPC took on new importance when the World Trade Organization nominated it as one of three key international standard-setting organizations under the Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement). This agreement, which came into force for most member governments in 1995, recognizes a country's right to protect plant, animal and human health with restrictions on trade that are deemed necessary to provide an appropriate level of protection. However, these restrictions must be based on international standards or be scientifically justified.

The IPPC was cited in the SPS Agreement as being responsible for international standard-setting in the area of plant health. To meet these obligations, the FAO Conference in 1993 established an IPPC Secretariat, located in the Plant Protection Service (AGPP), and interim standard-setting procedures. In November 1997, the Conference went further, accepting the need to establish a Commission to supersede FAO governing bodies as the mechanism for standard approval and direction-setting in the IPPC.

Developing countries, in particular, are highly dependent upon the import and export of raw and semiprocessed agricultural products. They not only need to have access to commodities and markets, but also to be competitive and, under the IPPC, to be able to adequately protect themselves from damaging pests without unduly restricting trade. It is a vitally important balance which is now strongly linked to international standards and, where plant health is concerned, with the activities of the IPPC.

New FAO Deputy Director-General

David A. Harcharik has been appointed as FAO's new Deputy Director-General. He is qualified in forest genetics and has some 30 years experience of international work.

Born in Illinois, USA, Harcharik, 54, had a two-year Peace Corps assignment in Peru early in his career when he served as a visiting professor with the Agrarian University in Lima. He later joined FAO and worked from 1972 to 1978 as Forestry Officer in the Forest Resources Division. He joined the United States Department of Agriculture Forest Service in 1981 and held increasingly responsible positions, becoming the Director of International Forestry in 1984 and Associate Deputy Chief of the Service in 1992. He returned to FAO in 1995 as Assistant Director-General of the Forestry Department.

Harcharik took up his new post as number two in the Organization on 1 January 1998.

Progress Reports

Copies of these unpublished reports on IPGRI research may be obtained on request, quoting the report number and title, from the Librarian, IPGRI Headquarters, Via delle Sette Chiese 142, 00145 Rome, Italy; Fax: (39-6) 5750309; Email: J.Dearing@CGNET.COM.

(97/2)
Study on breeding systems. The case of a short-living perennial, alternatively outbreeder-inbreeder species, *Phaseolus lunatus* L. and its consequences for germplasm conservation. Annual report, January-December 1996.
by: Rocha Nunez, O., Universidad de Costa Rica, San Jose (Costa Rica), Escuela de Biologia.
(En) 1997

(97/3)
Investigation of an ultradry seed packaging method. Final report.
by: Gomez-Campo, C., International Plant Genetic Resources Institute, Rome (Italy), Universidad Politecnica, Madrid (Spain), Departamento de Biologia Vegetal.
(En) 1997

(97/4)
Coconut germplasm in Tanzania, Sri Lanka and India. October and November 1996.
by: Bourdeix, R., Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement, Paris (France).
(En, Fr) 1997

(97/10)
Final report for research on establishment of sesame germplasm core collection in China (1 January - 31 December 1996).
by: Zhang Xiurong; Zhao Yingzhog, Chinese Academy of Agricultural Sciences, Baojian (China), Oil Crops Institute.
(En) 1997

(97/14)
Updating of the European database of *Dactylis* and *Festuca*, and computerized inventory of the field collections of forages held at Bydgoszcz.
by: Zurek, G., Plant Breeding and Acclimatization Institute, Bydgoszcz (Poland), Botanical Garden.
(En) 1997

(97/21)
Report on the crypreservation of apple *in vitro* culture shoot tips.
by: Wu Yongjie, Hebei Academy of Agriculture and Forestry Sciences, Changli (China), Changli Institute of Pomology.
(En) 1997

(97/34)
SINGER final development report.
by: Perry, M.
(En) 1997

(97/35)
SINGER final technical and status report and maintenance guidelines.
by: Perry, M.
(En) 1997

(97/40)
Genetic diversity among and within diploid and tetraploid wild wheats from Iran. Part 1: using seed storage protein markers.
by: Bahraei, S., Seed and Plant Improvement Institute, Karaj (Iran).
(En) 1997

(97/42)
Establishment of core collection in Sesame (*Sesamum indicum* L.). Annual progress report (July 1996 to June 1997).
by: Mahajan, R.K.; Bisht, I.S.; Agrawal, R.C., National Bureau of Plant Genetic Resources, New Delhi (India).
(En) 1997

(97/44)
Optimizing seed water content to improve longevity in *ex situ* genebanks. Year 2 progress report.
by: Chen Shuping; Hu Xiaorong, Chinese Academy of Agricultural Science, Beijing (China), Institute of Crop Germplasm Resources.
(En) 1997

(97/46)
The impact of habitat fragmentation on genetic diversity, mating systems and effective population sizes of tropical forest fragments in Costa Rica. Progress report to CIFOR/IPGRI/SWGRP.
by: Cornelius, J.
(En) 1997

Book Reviews

Pollen Biotechnology for Crop Production and Improvement

K.R. Shivanna and V.K. Sawhney
1997. Hardback. ISBN 0 521 47180 X. Price £50 (US$79.95). 448+xiv pages. Cambridge University Press, UK

Pollen Biotechnology for Crop Production and Improvement consists of 21 papers divided into four chapters including the topics 'Pollen biology: an overview', 'Pollen biotechnology and optimization of crop yield', 'Pollen biotechnology and hybrid seed production' and 'Pollen biotechnology and plant breeding'. In the introduction the editors define pollen biotechnology as 'the manipulation of pollen development and function, including alteration of its genome, for the production and improvement of crops and related products'. The key idea in this book is to show how pollen biotechnology offers today a powerful tool for (1) the optimization of crop production, (2) exploitation of hybrid vigour, and (3) crop breeding. Most of the papers deal with the normal male gametophytic function of pollen, but also the recent knowledge of converting microspores to sporophytic development of haploid plants and the use of microspores in direct gene transfer has been described.

The book focuses mainly on the applied aspects of pollen but it also contains parts of more basic pollen biology. Therefore this volume serves equally well as either an introductory text for a newcomer or as a reference book for more specialized experts. The papers give a comprehensive picture of what is currently known about pollen and also egg cell development, pollination and fertilization, the key natural processes behind normal plant seed and fruit formation and also behind the maintenance of the versatile genetic variation in important agricultural crops. In the first chapter an overview of the current knowledge of basic pollen biology is given. Developmental phases of pollen and egg cell, pollen-specific gene expression during development and the different stages of the pollination and fertilization events have been characterized in detail. The second chapter illustrates the use of pollen in improving crop production, especially optimizing crop yield through improved pollination efficiency. This chapter shows the interesting interactions between plants and their pollinating insects. There are several factors that determine the pollination efficiency and yields. It is stated that for a large number of crops, improvements in pollination increase crop value by decreasing the time to crop maturity and by increasing the crop uniformity, quality and quantity. This chapter also descripes the intersting co-evolution of plants

with their respective pollinating insects. In the third chapter the key role of pollen in hybrid seed production is illustrated in five papers. Both natural and chemical means to induce male sterility and exploit hybrid vigour have been described.

Recent understanding of the mechanisms of cytoplasmic and genic male sterility, self-incompatibility ('the inability of a fertile hermaphrodite seed plant to produce zygotes after self-pollination') and its consequences are well characterized. Chemical hybridization agents to induce male sterility have also been summarized in one paper. In the fourth chapter a total of 10 papers concentrate on various specific aspects of pollen in plant breeding by means of introducing new recombinants and hybrids. Efficient use of hybridization in breeding requires that breeders can control the events in pollination and fertilization processes. The papers in this chapter introduce methods to overcome interspecific crossing barriers, pollen storage, mentor effect in wide hybridizations, *in vitro* fertilization, isolation and manipulation of sperm and egg cell, induction of pollen-derived embryos through tissue culture and pollen as target to direct gene transfer.

Pollen Biotechnology for Crop Production and Improvement is an important contribution to the plant science literature. It makes pollen knowledge accessible to students, teachers, researchers and to those involved in other fields of biotechnology. The major emphasis has been put on breeding applications and the information presented is very useful to all those using hybridization in producing improved intra- or interspecific hybrids. The book is well constructed and the papers contain updated lists of references. Another comment about the contents should also be made. Even though not directly brought up in any of the papers, this book carries a lot of useful information on plant genetic biodiversity - one of the most popular areas of plant genetic research today. As the plant breeding programmes have narrowed the genetic variability behind modern cultivars, a progressive step in the future crop breeding will be highly dependent on the breeders' efforts to introduce new genes and alleles to many crop species. This book, no doubt, will contribute to those efforts.

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Principles of Genetics

D.P. Snustad, M.J. Simmons and J.B. Jenkins
1997. Hardback. ISBN 0-471-31196-0. Price £24.95, $26.95. 829 pages. John Wiley & Sons, Inc., New York

Principles of Genetics is far more than a book. It is a comprehensive genetics course for both students and professionals or indeed anyone wishing to refresh their knowledge, keep abreast with recent developments or who is just interested in the rapidly expanding field of genetics. The book is supplemented by a database of instructor's materials in CD-ROM form (free to adopters of the text), which includes illustrations, handouts and lecture notes, all of which can be downloaded to a PC or printed to acetates. In addition to the text book there are associated products: ***A Problems Workbook and Study Guide***, designed to improve genetics problem-solving skills and reinforce concepts and the book has its own homepage (http://www.wiley.com/genlink), which includes information about the book plus a significant quantity of extra helpful text.

The book itself takes a holistic approach to the science of prokaryotic and eukaryotic genetics, and does so through a very varied and interesting format. The basic principles are clearly explained and then explored in an experimental context. The reader is led through the experimental process, the analysis of observations and critical examination of results and ultimately to how the results may lead to new scientific discoveries. The book incorporates interesting anecdotes and conversations with eminent geneticists to emphasize the human component of science. Throughout the text, several topics are presented in separate "Sidelights" covering technical, historical and human genetics aspects. Each chapter begins with a brief anecdote, usually related to human genetics or historical developments, that emphasizes the relevance of the topics discussed. "Key points" at the end of every major topic provide useful summaries and each chapter culminates in a section for "Testing your knowledge". In all approximately 700 figures and 200 photographs are included.

The authors recognize that the impressive accomplishments in the exploding field of molecular genetics over the past 50 years are all rooted in the basic principles of genetics elucidated by Gregor Mendel in 1866 and by his successors. These principles are therefore carefully and thoroughly developed. Starting with an introduction to the science of genetics, its uses and misuses, and the basic features of living organisms (Chapters 1 and 2), Chapters 3-8 cover Mendelian classical genetics. They are followed by six chapters covering DNA, RNA and proteins, the core concepts of molecular genetics. Chapters 15-18 then deal with the genetics of viruses, bacteria, transposable elements and eukaryotic organelles and are followed, up to Chapter 24, by more advanced topics in molecular genetics, including an overview of some of the most common techniques. Chapters 25-28 provide useful introductions to topics on population, quantitative, evolutionary and behavioural genetics.

The book is a must for anyone interested in general genetics, although unfortunately for those specifically interested in the conservation or utilization of plant genetic resources the text barely introduces the subjects and would be of little use. The vast majority of examples concern human or animal genetics, although for the plant geneticist, there are useful sections covering polyploidy and chlo-

roplast genetics. A background to some currently important and controversial issues such as transgenic plants and herbicide resistance is also provided. If our efforts in plant genetic resource conservation are to have an impact on the seemingly relentless loss of biodiversity, we must harness recent techniques and base our conservation strategies on sound genetic principles. As a general reference book, *Principles of Genetics* is an up-to-date accessible and valuable text to help us achieve this goal.

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Edgbaston, Birmingham, B15 2TT, UK

Technical Guidelines for the Safe Movement of *Allium* spp. Germplasm

The most recent issue in the FAO/IPGRI series 'Technical Guidelines for the Safe Movement of Germplasm' is on *Allium* spp. Considering that the movement of germplasm involves a risk of accidentally introducing plant pests along with the host plant, FAO and IPGRI launched a collaborative programme to develop these guidelines. They provide relevant information on disease-indexing and other procedures that will help to ensure phytosanitary safety when germplasm is moved internationally. The recommendations in these guidelines are intended for germplasm used for research, conservation and basic plant breeding programmes and not for commercial consignments. When collecting germplasm, local plant quarantine procedures, for example pest risk assessment, should be followed.

The guidelines are written in a concise style, with suggestions for further reading given at the end. The first part makes general recommendations on how best to move the germplasm. The second part covers important pests which may infect, infest or contaminate germplasm that is moved following the general recommendations. The information given on a particular pest or disease is not exhaustive but concentrates on those aspects that are most relevant to the movement of germplasm. Among others, the following pathogens are covered: garlic common latent carlavirus (GCLV), garlic dwarf reovirus, leek yellow stripe potyvirus (LYSV), leek yellows luteovirus, onion yellow dwarf potyvirus (OYDV), shallot yellow stripe potyvirus (SYSV), *Alternaria porri, Botryotinia squamosa, Botrytis allii, Peronospora destructor, Sclerotium cepivorum.*

In addition to *Allium* spp., guidelines have been published for cocoa, edible aroids, *Musa* spp., sweet potato, yam, legumes, cassava, citrus, grapevine, vanilla, coconut, sugarcane, small fruit, small grain temperate cereals, stone fruits and *Eucalyptus* spp. In preparation are guidelines for potato and *Pinus* spp. Individual copies are available from IPGRI, Head of the Editorial and Publications Unit, Via delle Sette Chiese 142, 00145 Rome, Italy, fax +39-6-5750309, e-mail <p.stapleton@cgnet.com>.

IN THE NEXT ISSUE OF THE NEWSLETTER:

Collecting and evaluation of sorghum germplasm from Rwanda
S. Appa Rao, M.H. Mengesha, V. Gopal Reddy and K.E. Prasada Rao

Collecting crop genetic resources in Italian towns of Albanian origin. 1. Basilicata region
G. Laghetti, L. Xhuveli, P. Perrino, G. Olita and K. Hammer

Conservation et valorisation des ressources génétiques du grenadier (*Punica granatum* L.) en Tunisie
M. Mars et M. Marrakchi

Genetic variation of crop resources in Yunnan Province, China
Zeng Yawen, Wang Jianjun, Li Xuelin, Yang Zhongyi and Chen Liangzheng

Genetic variability for resistance to maize weevil in exotic X adapted maize (*Zea mays* L.) germplasm
Ruming Li, Manjit S. Kang, O.J. Moreno and L.M. Pollak

Preliminary report on seed germination and cryopreservation of rocket (*Eruca vesicaria* (L.) Cav. (Cruciferae)
J.B. Martínez-Laborde, J.M. Pita and F. Pérez-Garcia

Spatial dynamics of *in situ* conservation: handling the genetic diversity of Andean tubers in mosaic systems
F. Terrazas and G. Valdivia

Information resources on the Internet

The Internet is a vast collection of information, which has been described as a huge library with all the books thrown on the floor. This makes it difficult to obtain information quickly, even with the increasingly sophisticated search engines and web crawlers that are available. Below are listed some interesting addresses related to genetic resources, botany, etc. Please send information on other interesting sites via Email to the Managing Editor of the *Newsletter* (p.stapleton@cgnet.com).

The addresses given here were operating at the time of this issue of the *Newsletter* going to press (March 1998), but as the Internet is a volatile medium, they may not continue to be accurate.

New Agriculturist – on line

A new interactive magazine is on the Internet, designed for people who are directly involved in agriculture and rural development. Produced by staff of World Radio for the Environment, the site is updated every month with news, articles and reviews of developments on the international scene. Visit the site at:
http://www.new-agri.co.uk/

ICONS International Conservation Networking System

The ICONS Project Team has announced the availability of ICONS for Windows (beta), software produced by a team of conservation and information professionals supported by the Information Management Group of the World Conservation Union, the International Development Research Center and the Norwegian Agency for Development Cooperation. ICONS is an easy-to-learn software programme designed in support of community-based conservation, biodiversity information management and networking. ICONS provides modules for managing conservation-related information for the following categories: Organizations Persons Peoples Sources (bibliographies; metadatabases; etc.). ICONS is effective for managing bibliographies, email and personal notes; organization and expertise data; detailed project histories; legal information, species life history data and their uses; and for the other categories listed above. ICONS web site:
http://iucn.org/icons

Biotechnology resource

The Task Group on Public Perceptions of Biotechnology of the European Federation of Biotechnology is publishing a series of briefing papers on issues of particular interest to decision makers (see also *Newsletter* No. 109, March 1997, pp. 30-33). The latest paper is titled 'Dialogue in Biotechnology', highlighting important issues for the general audience. The Task Group has recently made all of its paper available on:
http://www.kluyver.stm.tudelft.nl/efb/tgppb/home.htm

Biotechnology Bulletin on the Web

The Agbiotech Bulletin, which is published in Canada, is moving to electronic publication. In an expanded website, the publishers make available downloadable versions of the *Bulletin*, and many other articles and information on agrobiotechnology. See:
http://www.agwest.sk.ca

Instructions to authors

Typescripts should be prepared in English, French or Spanish and submitted in duplicate to the Managing Editor. Typescripts should be double-spaced throughout, with generous (3-5 cm) margins. All pages (including tables, figures, legends and references) should be numbered consecutively.

Title

The title should be as short as possible and should contain the common and full generic name of any species featured in the paper, as well as the main countries visited during, for example, collecting trips.

Authors/addresses

Include the full names of all authors of the paper, together with the addresses of the authors at the time of the work reported in the paper. Indicate current or postal addresses as a footnote on the first page of the paper; indicate also the author nominated to receive correspondence and proofs.

Abstracts

Articles and reviews will be published with abstracts in English, French and Spanish. Supply an abstract not exceeding 200-250 words in the same language as the typescript, as well as translations (including the title) into the other two languages, if this is possible. Include these at the end of the paper, after the references and before the tables. The abstracts of articles should mention the objective of the investigation (hypothesis and aims), the experimental material and/or methods, a summary of the results and the conclusions drawn from the results.

Key words

Provide a maximum of six key words for use in indexing purposes, in alphabetical order, below the native-language abstract at the start of the typescript.

Main text

The relative importance of headings and subheadings should be clear, but avoid using more than three levels of headings. Do not number headings or paragraphs, which should be indented.

Use simple clear language in the text. A native speaker of the language should preferably edit the paper before submission.

Acknowledgements

These (also grants, support, etc. if any) should follow the text and precede the references.

References

The references to the literature should be arranged alphabetically, typed double-spaced and in text referred to as: author and year of publication, e.g. (Dawsib, 1987). Citations of personal communications and unpublished data should be avoided. Such citations should in text appear in the text only, as (E.D. Smith, personal communication), and not in the reference list. Abbreviate titles of periodicals according to the style of the Bibliographic Guide for Editors and Authors (Biosis, Chemical Abstract Service and Engineering Index, Inc., 1974). Follow the style shown below:

Periodicals

Molina-Cano, J.L., P. Fra-Mon, G. Salcedo, C. Aragonicillo, F. Roca de Togores and F. Gardia-Olmedo. 1987. Morocco as a possible domestication center for barley: biochemical and agromorphological evidence. Theor. Appl. Genet. 73:531-536.

Books (edited by someone other than the author of the article)

Hanelt, P. 1986. Cruciferae (Brassicaceae). Pp. 272-332 *in* Rudolf Mansfelds Verzeichnis landwirtschaftlicher und gärtnerischer Kulturpflanzen (ohne Zierpflanzen), Vol. 2. (H. Schultze-Motel, ed.). Akademie-Verlag, Berlin, Germany.

Books (identical author and editor)

Chapman, C. 1985. Genetic Resources of Wheat. A Survey and Strategy for Collecting. IBPGR, Rome, Italy.

Nomenclature

Taxonomical: in line with *Index Kewensis*. *Genetic*: applications of the terms phenotype and genotype should be in accordance with Demerec *et al.* (Genetics 54:61-74, 1966); for summaries of genetic abbreviations, consult the *Journal of Bacteriology* Instructions to Authors.

Units: express all quantities in terms of SI. If a traditional or local unit is used, or a unit that may be well known in one country only, always include an SI equivalent so that other workers can fully understand the amounts.

Preparing figures and tables

Tables and figures support the text and must be organized logically, appearing where they are mentioned. If there is a large amount of information in a table, it may be better to include it as an appendix at the end of the paper. Figures and tables should be clear and simple. Their major purpose is to present complex material in a form that is easily understood. Present data in the text, or as a figure, or a table, but never in more than one of these ways.

Conseils aux auteurs

Les textes dactylographiés seront préparés en anglais, en espagnol ou en français et envoyés en deux exemplaires au directeur de rédaction. Ils seront présentés en double interligne, avec de grandes marges (3 à 5 cm). Toutes les pages (y compris les tableaux, figures, légendes et références) seront numérotées à la suite.

Titre

Le titre sera le plus court possible et devra contenir le nom commun de toutes les espèces dont il est question dans le document, et le nom des principaux pays visités durant, par exemple, un voyage de collecte de matériel.

Nom et adresse des auteurs

Mentionnez le nom complet de tous les auteurs du document, ainsi que leur adresse à l'époque de l'étude. Indiquez leur adresse actuelle et leur adresse de contact en bas de page sur la première page du document; indiquez également l'auteur auquel doivent être adressées la correspondance et les épreuves.

Résumés

Articles et études doivent être accompagnés d'un résumé en anglais, en espagnol et en français. Envoyez un résumé de 200 à 250 mots au maximum dans la même langue que le texte dactylographié, ainsi que la traduction (y compris le titre) dans les deux autres langues, si possible. Placez-les à la fin de votre texte, après les références et avant les tableaux. Les résumés d'articles devraient mentionner l'objectif de l'étude (hypothèse et buts), le matériel et/ou les méthodes utilisés pour l'expérience, un résumé des résultats et les conclusions tirées de ces résultats.

Mots-clés

Indiquez au maximum six mots-clés qui serviront pour un index, par ordre alphabétique, au-dessous du résumé dans la langue de rédaction au début du texte dactylographié.

Texte principal

Faites bien ressortir les titres et les sous-titres, mais évitez les titres de plus de trois lignes. Ne mumérotez-pas les titres ou les paragraphes, qui devraient être mis en retrait.

Utilisez un langage simple. Il serait préférable qu'avant d'être soumis, le document soit mis en forme par une personne dont la langue maternelle est celle de la langue de rédaction.

Remerciements

Ceux-ci (de même que les dons ou l'aide, etc. éventuellement reçus) devraient figurer à la fin du texte et avant les références.

Références

Les références seront présentées par ordre alphabétique, dactylographiées en double interligne et indiqueront: auteur et année de la publication, par exemple (Dawsib, 1987). On évitera les citations de communications personnelles ou de données inédites. Ces citations ne devraient figurer que dans le texte, comme (E.D. Smith, communication personnelle) et non dans la liste des références. Abrégez les titres des périodiques comme il est indiqué dans le Bibliographic Guide for Editors and Authors (Biosis, Chemical Abstract Service and Engineering Index, Inc., 1974). Adoptez la présentation ci-dessous:

Périodiques

Molina-Cano, J.L., P. Fra-Mon, G. Salcedo, C. Aragonicillo, F. Roca de Togores et F. Gardia-Olmedo. 1987. Morocco as a possible domestication center for barley: biochemical and agromorphological evidence. Theor. Appl. Genet. 73:531-536.

Livres (édités par quelqu'un d'autre que l'auteur de l'article)

Hanelt, P. 1986. Cruciferae (Brassicaceae). Pp. 272-332 *in* Rudolf Mansfelds Verzeichnis landwirtschaftlicher und gärtnerischer Kulturpflanzen (ohne Zierpflanzen), Vol. 2. (H. Schultze-Motel, ed.) Akademie-Verlag, Berlin, Allemagne.

Livres (même auteur et même éditeur)

Chapman, C. 1985. Genetic Resources of Wheat. A Survey and Strategy for Collecting, IBPGR, Rome, Italie.

Nomenclature

Taxinomique: suivre l'*Index Kewensis*. *Génétique:* les applications des termes phénotype et génotype devraient être conformes à Demerec *et al.* (Genetics 54:61-74, 1966); pour des résumés des abréviations génétiques, consultez le *Journal of Bacteriology* qui contient des conseils aux auteurs.

Unités: exprimez toutes les quantités en unités du système international. Si une unité traditionnelle ou locale est utilisée, ou une unité qui pourrait être connue dans un pays seulement, indiquez toujours l'équivalent en unités du système international afin que d'autres chercheurs puissent comprendre les quantités indiquées.

Préparation des figures et des tableaux

Figures et tableaux servent à étayer le texte et doivent être organisés logiquement, apparaissant là où ils sont mentionnés. S'il y a une grande quantité d'informations dans un tableau, il vaudrait mieux l'inclure dans une annexe à la fin de l'article. Les figures et les tableaux doivent être clairs et simples. Il s'agit de présenter un matériel complexe sous une forme facile à comprendre. Présentez les données dans le texte, dans une figure ou dans un tableau mais jamais dans les trois à la fois.

Instrucciones para los autores

Los textos deben redactarse en inglés, francés o español y entregarse por duplicado al director de redacción. Deben presentarse mecanografiados a doble espacio, con amplios márgenes (3-5 cm). Todas las páginas (incluidos los cuadros, figuras, leyendas y obras consultadas) se deben enumerar consecutivamente.

Título

El título ha de ser lo más corto posible y debe incluir los nombres común y genérico completos de las especies descritas en el documento, así como los principales países visitados, por ejemplo, durante el viaje de colección.

Autores/direcciones

Incluir los nombre completos de los autores del documento, junto con las direcciones de los autores en el momento de la realización del trabajo presentado. Indicar las direcciones actuales o postales como nota al pie de la primera página del documento. Indicar también el autor designado para recibir la correspondencia y las pruebas.

Resúmenes

Los artículos y recensiones se publicarán acompañados de resúmenes en inglés, francés y español. Entregar un resumen que no exceda las 200-250 palabras en el mismo idioma empleado en el texto mecanografiado, así como, de ser posible, las traducciones (incluido el título) a los otros dos idiomas. Incluir estas traducciones al final del documento, después de la bibliografía y antes de los cuadros. En los resúmenes de los artículos se debe mencionar el propósito de la investigación (hipótesis y objetivos), el material y/o los métodos experimentales, un resumen de los resultados y las conclusiones.

Palabras claves

Para facilitar la inclusión del documento en el índice, deberá incluirse un máximo de seis palabras claves, en orden alfabético, después del resumen en el idioma original y antes del texto mecanografiado.

Texto principal

La importancia relativa de los títulos y subtítulos debe distinguirse claramente, pero hay que evitar el empleo de más de tres niveles de encabezamiento. No enumere títulos o párrafos que se han de sangrar.

Utilizar un lenguaje sencillo y claro en el texto. Se aconseja que una persona cuyo lenguaje materno sea el empleado en el documento, revise el trabajo ante de presentarlo.

Reconocimientos

Los reconocimientos (al igual que las subvenciones, ayudas etc.) deberán incluirse después del texto y antes de la bibliografía.

Bibliografía

Las referencias bibliográficas deben presentarse en orden alfabético, mecanografiadas a doble espacio, e indicar autor y año de publicación, por ejemplo (Dawsib, 1987). Se deben evitar las citas de comunicaciones personales y datos no publicados. Estas citaciones han de aparecer sólo en el texto (E.D. Smith, comunicación personal), y no en la bibliografía. Abreviar los títulos de revistas de conformidad con el estilo de la Bibliographic Guide for Editors and Authors (Biosis, Chemical Abstract Service and Engineering Index, Inc., 1974). Seguir el modelo siguiente:

Revistas y periódicos

Molina-Cano, J.L., P. Fra-Mon, G. Salcedo, C. Aragonicillo, F. Roca de Togores y F. Gardia-Olmedo. 1987. Morocco as a possible domestication center for barley: biochemical and agromorphological evidence. Theor. Appl. Genet. 73:531-536.

Libros (editados por alguien que no es el autor del artículo)

Hanelt, P. 1986. Cruciferae (Brassicaceae). Pág. 272-332 *en* Rudolf Mansfelds Verzeichnis landwirtsschaftlicher und gärtnerischer Kulturpflanzen (ohne Zierpflanzen), Vol. 2. (H. Schultze-Motel, ed.). Akademie-Verlag, Berlin, Germany.

Libros (del mismo autor y editor)

Chapman, C 1985. Genetic Resources of Wheat. A survey and Strategy for Collecting. IBPGR, Rome, Italy.

Nomenclatura

Taxonómica: de conformidad con el *Index Kewensis*. *Genética*: los términos fenotipo y genotipo se deben aplicar de acuerdo con Demerce *et al.* (Genetics 54:61-74, 1966); para los resúmenes de las abreviaturas genéticas, consultar las Instrucciones para los Autores contenidas en el *Journal of Bacteriology*.

Unidades: expresar todas las cantidades con arreglo al sistema internacional. Si se emplea una unidad tradicional o local, o una unidad que tal vez se conozca sólo en un país, incluir siempre el equivalente en el sistema internacional para que los demás puedan entender perfectamente las cantidades.

Preparación de figuras y cuadros

Los cuadros y las figuras complementan el texto y deben presentarse de modo lógico, apareciendo cuando se mencionan. Si un cuadro contiene una gran cantidad de información, tal vez sea mejor incluirlo como apéndice al final del documento. Las figuras y los cuadros deben ser sencillos y claros. Su propósito principal es presentar información compleja en un modo fácilmente comprensible. Presentar los datos ya sea en el texto, en un cuadro o en una figura, pero nunca en las tres formas a la vez.

Plant Genetic Resources Newsletter

Aims and scope: The *Plant Genetic Resources Newsletter* publishes papers in English, French or Spanish, dealing with the genetic resources of useful plants, resulting from new work, historical study, review and criticism in genetic diversity, ethnobotanical and ecogeographical surveying, herbarium studies, collecting, characterization and evaluation, documentation, conservation, and genebank practice.

Management: The *Plant Genetic Resources Newsletter* is published under the joint auspices of the International Plant Genetic Resources Institute (IPGRI) and the Plant Production and Protection Division of the Food and Agriculture Organization of the United Nations (FAO).

Availability: The *Plant Genetic Resources Newsletter* appears as one volume per year, made up of four issues, published in March, June, September and December. Plant Genetic Resources Newsletter is available free of charge to interested libraries of genebanks, university and government departments, research institutions, etc. The periodical may also be made available to individuals who can show that they have a need for a personal copy of the publication.

Types of paper

Articles: An article will publish the results of new and original work that makes a significant contribution to the knowledge of the subject area that the article deals with. Articles, which should be of a reasonable length, will be considered by the Editorial Committee for scope and suitability, then assessed by an expert referee for scientific content and validity.

Short communications: A short communication will report results, in an abbreviated form, of work of interest to the plant genetic resources community. Short communications in particular will contain accounts of germplasm acquisition missions.

Other papers: The *Plant Genetic Resources Newsletter* will publish other forms of reports such as discussion papers, critical reviews, and papers discussing current issues within plant genetic resources. Book reviews will be printed, as well as a News and Notes section. Suggestions for books to review are invited, as are contributions to News and Notes.

Submission: In the first instance papers may be submitted in typescript form or as an Email message. The final version may be submitted as an Email file or as an MS-DOS-readable file on diskette. Manuscripts submitted for publication and other communications on editorial matters should be addressed to IPGRI's Editorial and Publications Unit.

Bulletin des ressources phytogénétiques

Domaine d'intérêt: Le *Bulletin des ressources phytogénétiques* publie des articles en anglais, en espagnol et en français, sur les ressources génétiques de plantes utiles, fruit de nouvelles recherches, d'études historiques, d'examens et de critiques concernant la diversité génétique, d'études ethnobotaniques et écogéographiques, d'études d'herbiers, d'activités de collecte, de caractérisation et d'évaluation, de documentation, de conservation et les pratiques des banques de gènes.

Parrainage: Le *Bulletin des ressources phytogénétiques* est publié sous les auspices de l'Institut international des ressources phytogénétiques (IPGRI) et de la Division de la production végétale et de la protection des plantes de l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO)

Distribution: Le *Bulletin des ressources phytogénétiques* paraît une fois par an en un volume regroupant quatre numéros publiés en mars, juin, septembre et décembre. Il est distribué gratuitement aux bibliothèques des banques de gènes, universités, services gouvernementaux, instituts de recherche, etc. s'intéressant aux ressources phytogénétiques. Il est aussi envoyé sur demande à tous ceux pouvant démontrer qu'ils ont besoin d'un exemplaire personnel de cette publication.

Types de documents publiés

Articles: Un article contient les résultats de travaux nouveaux et originaux qui apportent une contribution importante à la connaissance du sujet dont traite l'article. Les articles, qui doivent être d'une longueur raisonnable, sont d'abord examinés par le Comité de rédaction qui en évalue la portée et la validité, puis par un expert qui en examine le contenu et l'intérêt scientifiques.

Brèves communications: On entend par brève communication un texte contenant, sous une forme abrégée, les résultats de travaux présentant un intêrêt pour tous ceux qui s'occupent de ressources phytogénétiques. Elle contient en particulier des comptes rendus des missions d'acquisition de matériel génétique.

Autres documents: Le *Bulletin des ressources phytogénétiques* publie d'autres types de rapport tels que des documents de synthèse, des études critiques et des articles commentant des problèmes actuels concernant les ressources phytogénétiques. Le Bulletin publie une revue de livres ainsi qu'une section intitulée Nouvelles et Notes. Les auteurs sont invités à envoyer leurs suggestions pour les livres à passer en revue ainsi que des contributions aux Nouvelles et Notes.

Présentation: En premier lieu, les documents doivent être soumis dactylographiés ou par courrier électronique. La version définitive doit être présentée en fichier de courrier électronique ou sur disquettes compatibles MS-DOS. Prière d'adresser les manuscrits présentés pour être publiés et d'autres communications sur des questions de rédaction au Bureau de rédaction de l'IPGRI.

Boletín de Recursos Fitogenéticos

Objetivos y temas: El *Noticiario de Recursos Fitogenéticos* publica documentos en inglés, francés y español que tratan de los recursos genéticos de plantas útiles, fruto de nuevos trabajos, estudios históricos, revisiones y análisis críticos relacionados con la diversidad genética, investigaciones etnobotánicas y ecogeográficas, estudios de herbarios, actividades de colección, caracterización y evaluación, documentación, conservación, y prácticas en bancos de germoplasma.

Dirección: El *Noticiario de Recursos Fitogenéticos* se publica bajo los auspicios conjuntos del Instituto Internacional de Recursos Fitogenéticos y la Dirección de Producción y Protección Vegetal de la Organización de las Naciones Unidas para la Agricultura y la Alimentación.

Distribución: El *Noticiario de Recursos Fitogenéticos* aparece como un volumen anual compuesto por cuatro números, que se publican en marzo, junio, septiembre y diciembre. Se distribuye gratuitamente a las bibliotecas de bancos de germoplasma, facultades universitarias y servicios gubernamentales, centros de investigación, etc. que se interesan en los recursos fitogenéticos. También pueden obtener este noticiario las personas que demuestren necesitar una copia personal.

Tipos de documentos

Artículos: Los artículos divulgarán los resultados de trabajos nuevos y originales que contribuyan de modo importante al conocimiento del tema tratado. Dichos artículos, que deberán tener una longitud razonable, serán examinados por el Comité de Redacción en cuanto a su pertinencia e idoneidad y posteriormente un experto juzgará su contenido y validez científicos.

Comunicaciones breves: Las comunicaciones breves informarán de modo conciso sobre los resultados de trabajos de interés para las personas que se ocupan de los recursos fitogenéticos. Las comunicaciones breves incluirán, en particular, resúmenes sobre las misiones de adquisición de germoplasma.

Otros documentos: El *Noticiario de Recursos Fitogenéticos* publicará otros tipos de informes, como documentos de trabajo, análisis críticos, y documentos que examinen cuestiones de actualidad relacionadas con los recursos fitogenéticos. El Noticiario publicará una reseña de libros así como una sección de Noticias y Notas. Las propuestas de libros para reseñar y las contribuciones a la sección de Noticias y Notas serán bien acogidas.

Presentación: Los documentos deben entregarse, incialmente, en forma de texto mecanografiado o a través del correo electrónico. La versión final debe presentarse como un archivo de correo electrónico o en disquete compatible con el sistema operativo MS-DOS. Los manuscritos para publicar y otras comunicaciones sobre asuntos relativos a la redacción deberán dirigirse a la Oficina de Redacción del IPGRI.

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