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MEMORANDUM

TO: AID/PPC/CDIE/DI, room 209 SA-18

FROM: AID/SCI, Victoria Ose

SUBJECT: Transmittal of AID/SCI Progress Report(s)

Attached for permanent retention/proper disposition is the following:

AID/SCI Progress Report No. C5-228
Annual Report - Sept 86 - Aug 87

Attachment

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PD-AAW-653

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THE INSTITUTES FOR APPLIED RESEARCH

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OF THE NEGEV

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C5-218

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Beer-Sheva, Israel

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THE INSTITUTES FOR APPLIED RESEARCH
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NEW SUBTROPICAL FRUIT AND NUT CROPS FOR ARID LANDS

Annual Report
September 1986 - August 1987

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The report was edited by Ms. A. Sen and typed by Ms. M. Milner and Ms. S. Shemesh.

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ABSTRACT

Introduction activities were continued during the period of October 1986 - August 1987. They included: seed collection, propagation, establishment of experimental plots, field observations, and collection of environmental data.

KEY WORDS:

subtropical fruit crop, subtropical nut crop, propagation, experimental plot, plant development, climatological data, soil data, Botswana, Israel.

Israel

A. Working list of candidate species

The list of candidate species was revised. Plants under investigation are presented in Table 1. Cardon borbon (*Pachycereus pecten aboriginum*) was excluded since new information revealed low fruit quality. The fruit skin is very thorny and cracks upon ripening.

Table 1. Working list of candidates species

Common name	Botanical name	Family	Distribution
African Plum	*Harpephyllum caffrum*	ANACARDIACEAE	Southern Africa
Ber	*Ziziphus mauritania*	RHAMNACEAE	Old World Tropics
Cardon pelon	*Pachycereus pringlei*	CACTACEAE	Sonoran Desert
Ciruelo	*Cyrtocarpa edulis*	ANACARDIACEAE	Baja Ca., Mexico
Guava	*Psidium guava*	MYRTACEAE	Tropical America
Kei Apple	*Dovyalis caffra*	FLACOURTIACEAE	Southern Africa
Marula	*Sclerocarya birrea subsp. caffra*	ANACARDIACEAE	Southern Africa
Mongongo	*Ricinodendron rautanenii*	EUPHORBIACAE	Southern Africa
Mmilo	*Vangueria infausta*	RUBIACEAE	Southern Africa
Pitahaya agria	*Stenocereus gummosus*	CACTACEAE	Sonoran Desert
Pitahaya dulce	*Stenocereus thurberi*	CACTACEAE	Sonoran Desert
Prickly Pear	*Opuntia ficus-indica & spp.*	CACTACEAE	Trop. America
Yehib	*Cordeauxia edulis*	CAESALPINIACEAE	NE Africa

B. Seed collection

At the present stage of the research a large sample of seeds was collected. Data on seeds collected in the last period of research are presented in Table 2.

C. Plant propagation (Summary)

Plant propagation by seeds was carried out in two stages. In the first stage seeds were germinated and the young seedlings were grown in a greenhouse adapted to serve as a quarantine facility. In the second stage the seedlings were allowed to harden off in an open nursery or greenhouse. In the quarantine house, seeds were sown in vermiculite moistened with tap water and mixed with the fungicide Captan (0.1%, w/v). After germination the seedlings were transferred to pots containing peat moss, vermiculite and perlite (1:1:1, v/v). In winter the propagation benches were heated to about 20°C, and air temperature was allowed to fluctuate between 17 and 35°C. In summer air temperature fluctuated between 17 to 39°C. In the nursery the potting medium was either loam:compost (2:1, v/v) loam:peat moss (2:1, v/v) or sand:peat moss (3:1, v/v).

Seeds of three species - marula, mmilo and mongongo - were pretreated before sowing in order to enhance germination. In marula the plug closing the orifices in the stone shell was removed, in mmilo the stone shell was cracked, and in mogongo the seeds were treated with Ethrel. Seeds of other species germinated without any special treatment.

Prickly pear was principally propagated by cuttings. Detached cladodes were dried in the shade for 2 weeks until planting in the nursery.

Research on vegetative propagation was restricted to ber (*Ziziphus mauritiana*). Techniques for propagating ber by cutting, air layering and grafting were explored. Semi-hard wood cuttings (3-4 nodes) were prepared in June 1986 and in April and June 1987 from trees growing in Beer-Sheva. Their bases were dipped for 30 seconds in solutions of IBA in

Table 2. New seed collections

I.D. No.	Botanical Name	Collection Site	Collectors
86-135	*Cordeauxia edulia*	Voi, Kenya	M. Forti
87-060	*Cordeauxia edulia*	Voi, Kenya	Y. Mizrahi
56-508	*Dovyalis caffra*	S. Africa	F. Horenburg
86-546	*Harpephyllum caffrum*	Durban, S. Africa	A.S. Wehmeyer
87-004	*Harpephyllum caffrum*	Durban, S. Africa	A.S. Wehmeyer
86-507	*Harpephyllum caffrum*	Durban, S. Africa	F. Horenburg
86-808	*Psidium guava*	Mexico	A. Nerd
87-207	*Ricinodendron rautanenii*	Pandamatenga, Botswana	A. Nerd
87-028/9	*Ricinodendron rautanenii*	Kazungula, Botswana	Bangerth and Mizrahi
87-501	*Ricinodendron rautanenii*	Pandamatenga, Botswana	Bangerth and Mizrahi
86-223	*Sclerocarya birrea**	Gaborone, Botswana	Aronson & Mizrahi
86-224	*Sclerocarya birrea*	Molepolole, Botswana	Aronson & Mizrahi
86-229	*Sclerocarya birrea*	Mogadishane, Botswana	F. Taylor
86-230	*Sclerocarya birrea*	Arbane, Botswana	I. Robertson & F. Horenburg
86-509	*Sclerocarya birrea*	Arbane, Botswana	F. Horenburg
86-511	*Sclerocarya birrea*	Mogadishane, Botswana	F. Horenburg
87-034	*Sclerocarya birrea*	Nata, Botswana	A. Nerd
87-035	*Sclerocarya birrea*	Kruger Park, S.A.	A. Nerd
87-055	*Sclerocarya birrea*	Botswana	Y. Mizrahi
87-057	*Sclerocarya birrea*	Botswana	Y. Mizrahi
86-554	*Vangueria infausta*	Botswana	Mizrahi & Aronson
87-024	*Vangueria infausta*	Tosego, Botswana	A. Nerd
87-025	*Vangueria infausta*	Sirawa, Botswana	A. Nerd
86-266	*Vangueria infausta*	Gabarone, Botswana	Mizrahi & Aronson
86-296	*Vangueria ssp.*	Ovambo, Namibia	J. Aronson

*Subsp. caffra

water-ethanol, 1:1 (v/v). IBA concentrations were used 0, 500, 2500 and 5000 ppm in 1986 and 0, 1000, 5000 and 10000 ppm in 1987. The cuttings, ten per treatment, were planted in vermiculite and misted for 15 seconds every 15 minutes. After 2 months all the cuttings were found to have degenerated. Since this may be linked to a seasonal effect on rooting tendency, experiments with ber cuttings will be extended until the spring.

Air layering was studied in the summer of 1986. Although callus developed in the treated shoots, no roots were initiated during the three-month period of observation.

Grafting, which is the common method of propagation of ber in India, is now under study. Three species of *Ziziphus* were selected for rootstocks: *Z. spina Christi* (Israel), *Z. mucronata* (Botswana), and *Z. mauritiana* (India). Seeds were germinated during the past year, and grafting will be attempted as soon as seedlings develop to a height of 40-50 cm. The effect of rootstock, season, and grafting method on plant development will be investigated.

D. Plant establishment in the different introduction orchards

Five plots were established in the Negev, in some of the hottest and driest parts of Israel. Four of the sites, Yotvata, Qetura, Ein Yahav and Neot Hakikar, are located in the Arava Valley, which lies between the Dead Sea in the north and the gulf of Elat in the south. Yotvata and Qetura are situated in the southern Arava at an elevation of 120 meters above sea level, Ein Yahav at elevation of 86 below sea level , and Neot Hakikar in the northern Arava (Kikar Sedom) at about 350 meters below sea level. The fourth site, Besor, lies in the western Negev at an elevation of about 30 m above sea level. Together these stations cover most of the range of conditions to be found in the Negev region with respect to the climate, water-quality and soil. Originally we planned to establish a plot at Ein Gedi on the Dead Sea, but damage by wild animals in the adjacent nature reserve let us to abandon this

idea. The Besor plot was established to replace that of Ein-Gedi. The plot at Ein Yahav was dedicated to *Opuntia* spp. and will serve as a source of plant material (cuttings) to the other plots. The other four plots were planted with seedling of the other species of the project. A sixth plot was recently established at Ramat Negev (Negev heights). Data on environmental conditions and planting will be presented in the next report.

Planting was carried out in the spring of 1987 (Table 3). The young plants were surrounded with a cylinder of a coarse net to create a more favorable microclimate. (When the plants reach a height of about 1 m, this protection will be removed.)

E. Plant development in the introduction orchards

Data on planting, survival, and size in the various plots are presented in Table 4. The species listed showed good or fair adaptation to the local conditions of the experimental plots. It is too early to conclude about the long-term adaptation of the plants to the various sites. Only yehib suffered high mortality; however, few of the plants that survived developed well. Mortality of young yehib plants in the field may be due to planting of low-grade seedlings, sensitivity to salinity, or other limiting environmental conditions.

To solve the problem of the poor establishment of young plants, we will devote ourselves in the next few months to the development of large successful seedlings in the nursery. Different potting mixtures will be tested, most of them based on combinations with sand, which is yehib's natural soil.

TABLE 3. Planting at the introduction orchards, October-May 1986/7

Name	Month of planting	No. planted	I.D. No.
a) Getura			
African plum	5.87	5	86-507
Guava	5.87	10	86-908
Kei apple	5.87	21	86-508
Mmilo	5.87	15	86-226
b) Yotvata			
Cardon pelon	5.87	30	86-248
Kei apple	5.87	10	86-508
Pitahaya agria	10.86	20	84-271
Pitahaya dulce	5.87	5	86-241
c) Neot Hakikar			
Ciruelo	10.86	27	84-812
Guava	5.87	5	86-908
d) Besor			
African plum	5.8	9	86-429 86-507 86-546 87-004
Cardon pelon	5.87	14	86-242
Ciruelo	10.86	9	86-812
Kei apple	5.86	15	85-216
Mongongo	5.86	30	86-574 86-230
Pitahya agria	5.86	30	84-271

TABLE 4. Plant survival and size, July 1987, at Yotvata, Qetura, Neot Hakikar and Ein Yahav (Plantings 1985-1986)

Common name	Botanical name	Year planted	No. planted	No. of established plants	Average height (cm)	I.D. No.
a) Qetura						
African plum	*Harpephyllum caffrum*	1985	30	25	205±57	85-248
Cardon pelon	*Pachycereus pringlei*	1985	21	21	30±9	84-275
Ciruelo	*Cyrtocarpa edulis*	1984	2	2	340	84-358
		1985	5	5	148±8	84-358
		1986	13	12	71±13	86-812
Kei apple	*Dovyalis caffra*	1986	10	10	80±20	85-216
Marula	*Sclerocarya caffra*	1985	10	7	226±80	85-230
		1986	30	30	90±20	86-221
						86-224-9
Mongongo	*Ricinodendron rautanenii*	1986	29	29	93±20	86-230
						86-437
						86-874
Pitahya agria	*Stenocereus gummosus*	1985	30	27	75±23	84-271
Pitahya dulce	*Stenocereus thurberi*	1986	30	28	15±3	84-286
Yehib	*Cordeauxia edulis*	1985	15	3	45±5	86-135
		1986	9	0		86-135
b) Yotvata						
African plum	*Harpephyllum caffrum*	1985	10	10	272±70	85-248
Ciruelo	*Cyrtocarpa edulis*	1986	17	15	51±20	86-812
Kei apple	*Dovyalis caffra*	1986	10	10	79±18	85-216
Marula	*Sclerocarya caffra*	1986	30	30	95±34	86-222
						86-223
						86-229
Mongongo	*Ricinodendron rautanenii*	1986	15	15	36±14	85-172
						86-230
						86-437
Pitahya agria	*Stenocereus gummosus*	1985	10	10	110±48	84-271
		1986	20	20	20±4	86-271

Table 4 cont'd

Common name	Botanical name	Year planted	No. planted	No. of established plants	Average height (cm)	I.D. No.
Pitahya dulce	*Stenocereus thurberi*	1986	25	25	15±3	86-286
Yehib	*Cordeauxia edulis*	1985 1986	15 3	1 0	30	86-135 86-135
c) Neot Hakikar						
African plum	*Harpephyllum caffrum*	1985	8	3	102±23	85-248
Cardon pelon	*Pachycereus pringlei*	1986	21	20	19±5	84-275
Ciruelo	*Cyrtocarpa edulis*	1984 1986	2 28	1 26	300 33±16	84-358 86-812
Kei apple	*Dovyalis caffra*	1985	15	14	99±20	85-216
Marula	*Sclerocaria caffra*	1986	30	30	42±19	86-22 86-224 86-229
Pitahya agria	*Stenocereus gummosus*	1986	21	21	28±16	84-271
Pitahya dulce	*Stenocereus thurberi*	1986	15	14	10±3	84-286
Yehib	*Cordeauxia edulis*	1985	15	1	15	86-135
d) Besor						
Cardon pelon	*Pachycereus pringlei*	1986	17	17	24±7	84-275
Ciruelo	*Cyrtocarpa edulis*	1986	9	9	32±16	86-812
Marula	*Sclerocaria caffra*	1986	30	30	36±10	86-229
Pitahaya agria	*Stenocereus gummosus*	1986	30	30	20±6	84-271
Pitahaya dulce	*Stenocereus thurberi*	1986	14	14	10±2	84±286

e) Ein Yahav
Plot dedicated to prickly pear (Opuntia species)

Botanical name	No. planted	Average no. of cladodes	Average height (cm)	I.D. No.
O. fusiculatis	4	5	50	1239
O. maxima	4	5	60	1259
O. ficus indica (Mexico)	4	14	60	1301
O. megacantha	4	8	66	1288
O. ficus indica (Algeria)	3	13	58	1252
O. ficus indica (Chile)	4	6	58	1315
O. megacanta	3	10	57	1299
O. streptacantha	4	8	55	1248
O. ficus indica (Algeria)	3	16	43	1260
O. streptacanta	3	9	72	1256
O. ficus-indica (Chile)	4	8	72	1314
O. ficus indica (Mexico)	3	6	63	1300
O. ficus indica (Chile)	4	6	46	1118
O. ficus indica (Algeria)	3	34	76	1251
O. ficus indica (Mexico)	3	10	65	1294
O. ficus indica (Algeria)	3	22	72	1252
O. undulata	2	6	67	1267
O. rastrera	1	6	30	1257

Table 4 cont'd

Botanical name	No. planted	Average no. of cladodes	Average height (cm)	I.D. No.
O. robusta	3	6	56	1240
O. robusta	3	4	43	1241
O. spp. Nopalea	3	88	68	1308
O. ficus indica (Ofer, Israel)	4	9	59	1117
O. ficus indica (Direkteur, SAR)	3	10	80	85-313
O. ficus indica (Niagra, SAR)	3	15	77	85-312
O. ficus indica (Wg, SAR)	1	7	85	85-31
O. ficus indica (Blue mottle, SAR)	3	11	97	85-311
O. ficus indica (Guayaquil, SAR)	4	8	63	85-314
O. ficus indica (Santa Rosa, SAR)	1	20	55	85-315

Botswana

The plot is located at Thusego, 40 km west of Gaborone and about 10 km from Kumakwane, at an elevation of about 1000 m above sea level. It lies on a moderate slope and is about 2 hectares in size.

F. Environmental conditions

1. Climate

The climatic data presented here were collected in the meteorological station of Gaborone. Other detailed climatic data for the region of Thusego are not yet available.

Rain: Rain may occur throughout the year, but the main wet season is summer (November-March) which receives about 76% of the average annual rainfall (538 mm, see Fig. 1). Fluctuations in the annual rainfall are very severe, and some years are almost dry.

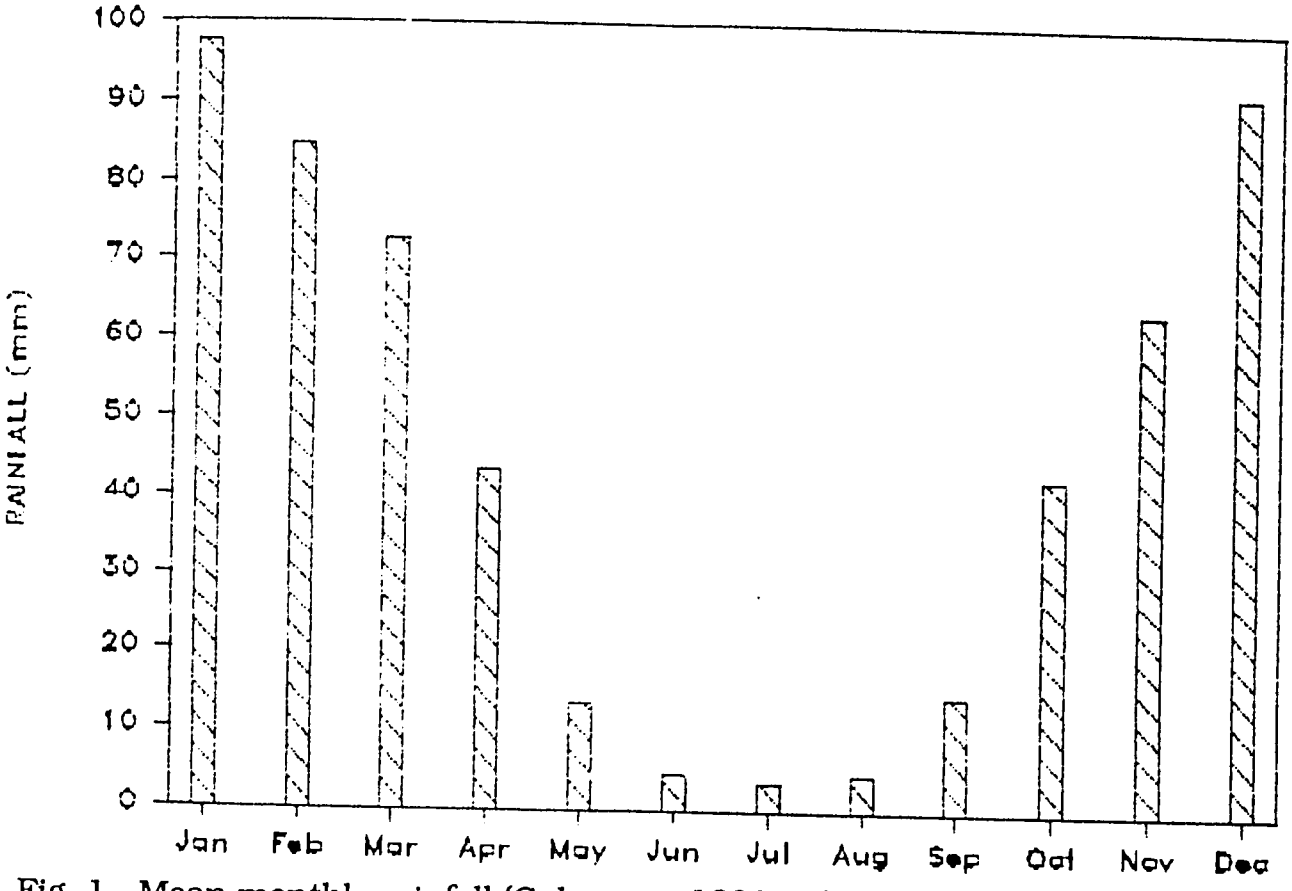

Fig. 1. Mean monthly rainfall (Gaborone, 1922-80). Average annual rainfall is about 538 mm.

Temperature: Mean daily temperatures are presented in Fig. 2. The temperatures in the hottest season (November through March) are moderate, daily temperatures ranging from a maximum of 31.2-32.6°C to a minimum of 17.5-19.7°C. June and July are the coldest months, with mean daily temperatures of 22°C (maximum) and 4°C (minimum); Recorded extremes are 44°C (summer) and -6.5°C (winter).

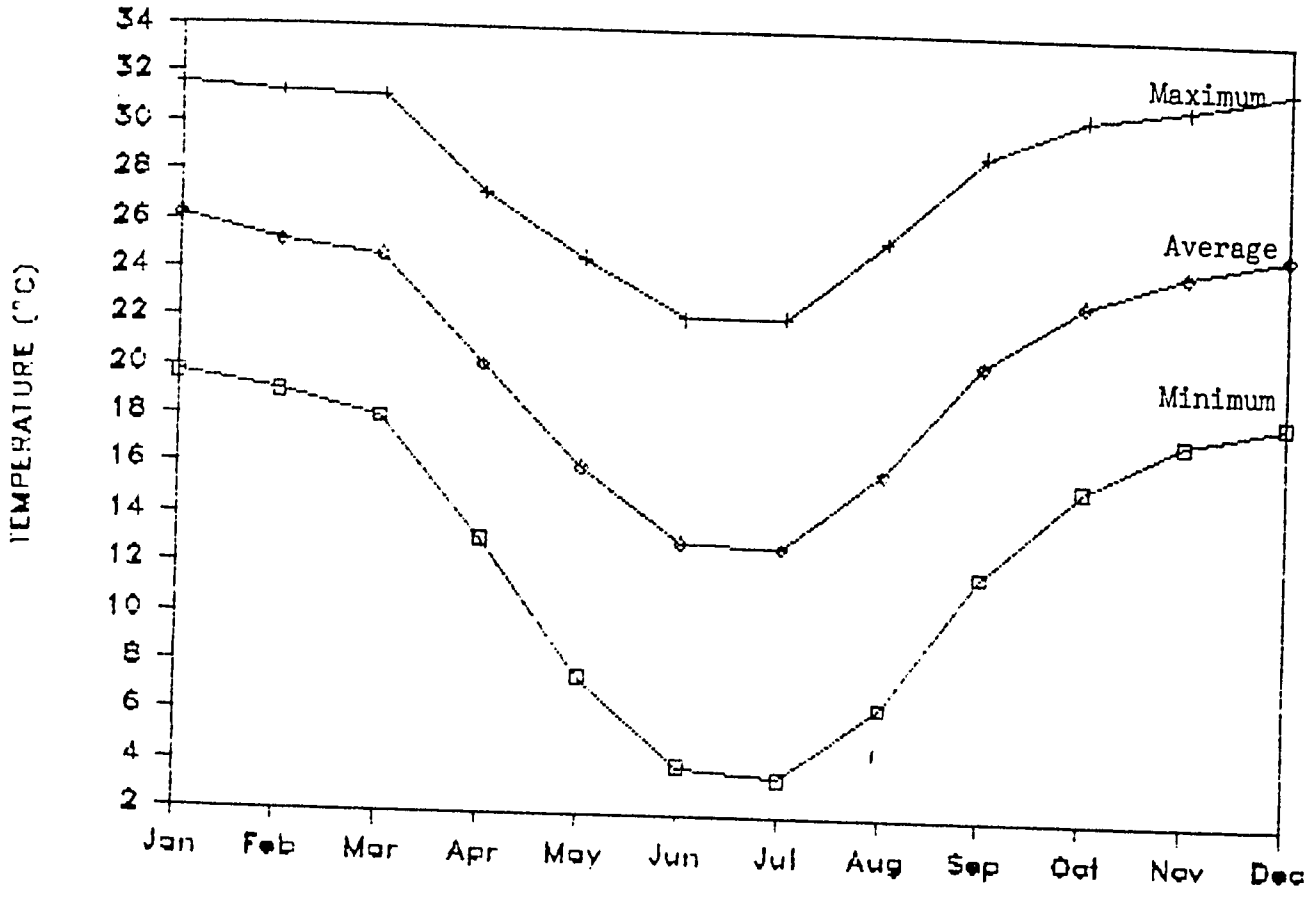

Fig. 2. Mean daily temperatures, average, maximum and minimum (Gaborone, 1958-80).

Relative humidity: Generally mean morning (08^{00}) values were high throughout the year. Mean noon (14^{00}) values were lower than mean morning values, and considerably lower in the dry cold season (May-September) (Table 5).

Table 5. Mean daily relative humidity for Gaborone (1960-79).

Month	Average at	
	08^{00}	14^{00}
January	68	41
February	70	42
March	71	42
April	75	41
May	73	33
June	72	28
July	67	26
August	57	24
September	48	23
October	52	29
November	58	34
December	61	37

Evaporation (Fig. 3): Daily pan evaporation was high during the hot season (max. about 9.5 mm/day) and low during the cold season (min. about 3.5 mm/day).

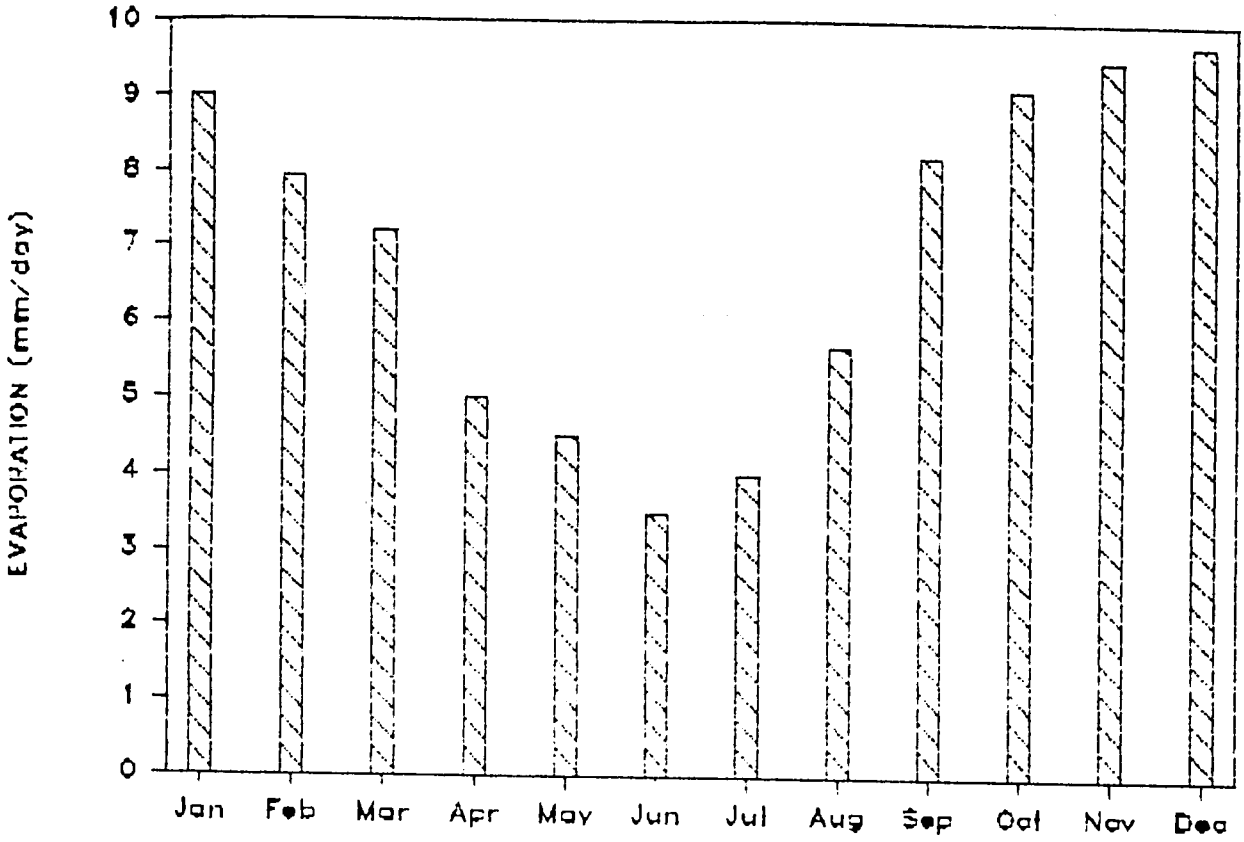

Fig. 3. Average daily pan evaporation (Gaborone, 1956-75). Average annual evaporation is 2550 mm.

2. Soil and water

Soil and water analyses were carried out by the Soil Analytical Laboratory of the Agricultural Research Department and by the Water Laboratory of the Botswana Department of Water Affairs, respectively.

The soil properties of the introduction plot in Botswana are given in Table 6. The soil is acidic with low cation-exchange capacity and a low content of phosphorous and organic matter. It is a red soil with a high sand content. (The distribution of soil particles was not analyzed quantitatively.) Further data on soil will be published in the next report.

Data on water quality are given in Table 7. The water was acidic, with low conductivity and low chloride content.

Table 6. Soil properties of plot at Thusego, Botswana. Soil was sampled at two points to depth of about 120 cm. The values are the highest and the lowest at each depth.

Depth, cm	pH	Cation exchange capacity, meq/100 g soil	Exchangeable cations, meq/100 g soil					Organic carbon, wt %
			Na	K	Ca	Mg	P (ppm)	
0-30	3.3-4.4	2.16-3.00	0	0.02-0.11	0.60-1.98	0.06-0.44	[illegible]-1.66	0.18-0.84
30-60	3.5-4.8	0.68-1.72	0.05-0.26	0-0.05	0.43-1.29	0.06-0.51	0.40-1.08	0.14-0.38
60-90	4.1-4.7	0.52-3.32	0	0-0.12	0.43-2.15	0.13-1.19	0.40-0.48	0.04-0.22
90-120	4.5	0.48-2.92	0	0	0.09-0.26	0.06-0.57	0.03-0.11	0.2

Table 7. Quality of water from a borehole near the plot at Thusego (average of 2 samples).

pH	4.6
Conductivity, dS/m	1.2
Cl^-, mg/L	4.5
NO_3^-, mg/L	2.2

G. Propagation

a. Seedtray medium (used for cacti seed) : 75% crushed granite stone, 0.2-4.0 mm grade, and 25% sterilized garden compost. All other species were grown by sowing directly into 1-liter cartons of 100% local river sand. Fertilizer was used as specified in individual sowing records, using "Chemicult", containing 6.5% N, 2.7% P, 13% K, 7% Ca, 2.7% Mg, 7.5% S, 0.15% Fe, 0.024% Mn, 0.005% Zn, 0.002% Cu, 0.001% Mo.

Details on sowing of individual species

Opuntia ficus-indica cvs

Stem sections of cultivars: from the R.S.A.; brought by Y. Mizrahi and A. Aronson, Feb. 1986 from the collection at B.G.U.

On 87-06-20: all plants healthy, and new stem cuttings taken from parent cuttings

Mimusops angel

Seed source: A. Aronson, N. Somalia, 1982.

Species seed characteristics: almond shaped seed, 10x5x3 mm

Sample characteristics: clean seed, but only 19 in number

87-01-27: 1 x 10 seeds sown in 1 liter cartons; the seeds were treated with 100 ml of boiling water poured on top of them and were left to cool at room temperature

1 x 9 seeds sown in 1 litre cartons, the seed first treated with concentrated sulphuric acid (H_2SO_4) for one hour, then diluted with excess water and neutralized with caustic potash (KOH)

87-02-08 to 87-06-20: no sign of germination; the seed are still sound

Cyrtocarpa edulis

Seed source: A. Aronson. Ident. No. 884358

Sample characteristics: 190 seeds only

87-01-24: 1 x 190 seeds sown in 1 litre cartons, using 80% coarse river sand and 20% sterilized compost

87-01-31: approx. 40% germination

87-02-27: 87 seedlings to date; no losses

87-03-01: seedlings infested with aphid and to a lesser extent with red spider mite; sprayed with monocrotophos at 1 ml per liter water.

87-03-25: seedlings now mostly 20 cm high

87-06-20: seedlings all healthy and in full leaf

Harpephyllum caffrum

Seed source: Department of Water Affairs, Forestry and Environment, RSA
Seed Number 36899. Date harvested 1986? unselected seed
Species seed characteristics: variably sized seed: 15-25 mm long x 0-15 mm across. 9.5 g per 100 seeds
Sample seed characteristics: clean, no insect damage

87-02-06: 1 x 100 seed sown in 1-liter cartons. Seed treated with hot water at 85°C (100 ml) and left to cool for thirty minutes

87-02-20: 20 seeds sown, treated with conc. sulphuric acid for 20 minutes
20 seeds sown,treated with conc. sulphuric acid for 30 minutes
20 seeds sown, with conc. sulphuric acid for 40 minutes
20 seeds, sown, treated with conc. sulphuric acid for 60 minutes

87-04-02: Hot water treatment applied to 5 seedlings
- 60 minute acid treatment applied to 9 seedlings
- no germination in other treatment groups

87-06-20: 17 seedlings germinated in all

Sclerocarya caffra

Source: collected by A. Aronson, Y. Mizrahi and F. Horenburg March 1986

87-01-30: All seed treated by removing as much of the flesh as possible and then prising off the operculi
1 x 59 of "No 1" sown
Sow 1 x 17 of "No 33" sown in cartons

87-02-08: First signs of germination; seedlings pushing up the soil

87-02-27: "No 1", 24 pots, with germination, including many doubles
- "No 33", 15 cartons, with germination, including many doubles
Growth up to 20 cm, very healthy

87-03-25: "No 1", 35 seedlings in total, approx 35 cm high, plus one sub-standard seedling. 1-4 seedlings per carton
"No 33", 32 seedlings in total, approx 30 cm high

87-04-02: more seed sown: "No 33" x 30, "No 14" x 41, "No 1" x 14

87-06-20: of 87-01-30 sowing; all seedlings alive as of 87-03-25

- of 87-04-02 sowing "No 33" - 2 seedlings
"No 1" - zero seedlings

Ricinodendron rautenenii
Seed source: Botswana seed collections 1986, 1987
Seed not yet sown due to lack of "Ethrel" until March 1987
Seed will be sown in August 1987

Cordeauxia edulis
Seed source: A. Aronson from Somalia, 1985, no ident. number
Seed sample characteristics: seed old with little endosperm remaining (seeds hollow). Seeds infested with insects.

87-01-24: 1 x 166 seeds sown in 1-liter cartons
87-01-31: germination evident in approx. 10% of the cartons
87-02-08: seedlings are sturdy, fleshy, pinnate-leaved, with bright green upper surface and very visible lenticels on the undersurface, giving red-brown speckles
87-02-27: 32 seedlings, no new germination. Seedlings look healthy but don't appear to be growing; 5 cm high
87-06-20: no growth; 32 seedlings

Strychnos cocculoides
Seed source: a single tree approx. 2 km from the Thusego site; seed collected November 1986

87-01-25: 1 x 300 seed sown in cartons, seed cleaned from pulp but otherwise untreated
87-02-27: No sign of germination above ground, but a carton taken at random had a seed beginning to germinate.
87-03-25: Very slow emergence from soil
87-06-20: 210 seedlings, 10-15 cm high

Dovyalis caffra

Seed source: RSA, Dept. Forestry 1986? seed, seed number 337781 (unselected)

Species seed characteristics: irregular pyriform shape. Size varies, approx 10x5x2 mm. Dark brown, covered with light brown hairs. 100 seeds weigh 12 g

Sample seed characteristics: clean sample

87-02-06: 1 x 250 seeds sown in cartons; seed untreated

87-02-27: approx. 100 seed germinated so far

87-03-25: seedlings approx. 5 cm high

87-06-20: 140 seedlings, 5-20 cm high

Vangueria infausta

Seed source: from unspecified trees near Thusego site, Nov 1986.

87-04-20: 1 x 200 seeds sown in cartons, seeds removed from endocarp

87-06-20: 70 seedlings germinated, 2-5 cm high

Note: for all 10 species, the cartons were treated with 1 g/liter water "Chemicult" fertilizer on 87-04-22 and 87-06-12

H. Plot establishment

Trials

The fruit tree introduction trials are about to begin. Land has been allocated for this purpose, and seed collection work is being planned. The layout of the introduction trials is given in Fig. 4.

Fig. 4. Layout of the Fruit Tree Introduction Trials

NON-IRRIGATED						IRRIGATED					
9	17	18	14	8	20	17	20	7	9	14	16
10	11	15	7	13	19	8	10	11	13	12	18
16	12	8	11	10	15	19	15	7	14	16	13
7	19	14	20	18	9	20	19	8	12	10	17
12	13	16	4	3	6	2	1	5	9	11	15
17	14	20	5	4	2	3	6	1	16	20	12
12	15	9	1	6	4	5	3	2	11	9	14
11	7	19	2	4	6	3	5	1	16	15	13
8	10	16	1	5	2	4	3	6	8	17	7
17	18	13	3	4	1	5	6	2	10	18	19 x
1	2	3	4	5	6	7	8	9	10	11	12

NORTH

Remarks

1. Each replication of a species consists of 5 x 2 trees = 10 trees. Therefore, for each species there are 30 trees in the irrigated plots, and thirty trees in the non-irrigated plots.
2. The cactus species, allocated numbers 1 to 6, are planted separately since they have different growth characteristics.
3. The trees are spaced at 2 meters in the row, 4 meters between rows and may be thinned later, as decided upon.
4. There is room for 20 species at present.

5. The species are numbered as follows:
   2) *Pachycereus pringlei*
   3) *Stenocereus gummosus*
   4) *Stenocereus thurberi*
   6) *Opuntia ficus-indica* cvs.
   7) *Mimusops angel*
   8) *Zizyphus mauritiana*
   9) *Cyrtocarpa edulis*
   10) *Psidium guajava*
   11) *Harpephyllum caffrum*
   12) *Sclerocarya caffra*
   13) *Ricinodendron rautanenii*
   14) *Cordeauxia edulis*
   15) *Strychnos coculoides*
   16) *Dovyalis caffra*
   17) *Vangueria infausta*

Field Preparation

Land was cleared of mature tree growth by hand, all large roots being removed. All vegetation was removed, and not burnt *in situ*. Irregularities in the level were smoothed (a history of rain-wash channels across the area has given rise to uneveness in the grades of the soil particles, although the chemical analysis may not vary much).

There are trees up to 15 metres high on three sides of the plot, so a windbreak has only been planted on the fourth side. *Leucaena leucocephala* has been planted in a single line, with 2 meter spacing. This species is untried for long term planting in Botswana, but has a potential for rapid growth. It is being fertilized and irrigated to promote growth. None of the trees providing windbreak are within 12 meters of the trial plot.

The trees in the trial will be planted in holes already prepared. These holes were dug 1 meter deep and 80 cm in diameter, then partially refilled with the same soil mixed with 6 shovelfuls (approx. 12 kg) of poultry manure (deep litter broiler chickens, giving a mixture of wood shavings and poultry manure from chickens fed on commercial poultry feed), and 1 kg of dolomitic limestone. The holes refilled so as to give a slight depression to catch rainfall and reduce run-off in cases of heavy rain, with ridges mid-way between the trees.