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# NEW SUBTROPICAL FRUIT AND NUT CROPS FOR ARID LANDS

Progress Report
September 1987- February 1988

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## ISRAEL

*Activity during the period surveyed (September 1987-February1988) was devoted to:*

*a. intensified research on the propagation of yehib (Cordeauxia edulis) and ber (Ziziphus mauritiana);*

*b. maintainance of experimental areas;*

*c. investigation of phenological and physiological aspects capable of affecting the cultivation of these plants.*

### PROPAGATION

*Yehib* - In order to improve the development of yehib seedlings (see report BGUN-ARI-51-87), the effect of various potting mixtures on the development of seedlings was examined. Immediately after germination in vermiculite small seedlings were transferred to 10 *l* pots with different potting mixtures. The different mixtures together with data on plant height and leaf numbers after six months in the nursery are listed in Table 1.

Table 1. The effect of potting mixture on the development of yehib seedlings as observed after six months

| Potting mixture | Plant height ± SE | No. of leaves per plant ±SE |
|---|---|---|
| Sand | 8.3±2.2 | 12.3±5.5 |
| Sand:peat 1:1 | 8.1±1.8 | 9.8±0.5 |
| Tuff | 13.3±7.9 | 15.8±6.8 |
| Peat:perlite:vermiculite 1:1:1 | 13.0±2.0 | 11.0±1.8 |

*Note: Each treatment included four plants.*

As judged by plant height, sandy mixtures were inferior to the tuff and peat-perlite- vermiculite mixtures as a medium. Judging by both height and number of

leaves, tuff appeared to be the best medium. In view of the small scale of the experiments no final conclusions can be drawn at the present time. The experiment will be extended when a new batch of seeds is supplied.

Since yehib plant material is scarce, we decided to initiate experiments with vegetative propagation *in vitro*. We attempted to root one-bud shoot cuttings of six-month-old plants in agar medium supplemented with indole-3-acetic acid (IAA). This system is currently under investigation.

*Ber* - We continued our efforts to propagate ber. Earlier experiments with airlayering and cuttings which yielded poor results are outlined in our previous report (BGUN-ARI-51-87). The present report covers propagation trials with seeds and grafting.

Seeds - seed collected from the two plants growing in the Institute were planted in autumn in vermiculite under greenhouse conditions. Germination was poor and slow; after 60 days 23% of the seeds had germinated out of 36 seeds.

Grafting - this method was found to be a promising one for vegetative propagation. In the late summer of 1986, seedlings of *Z. mucronata*, *Z. mauritiana* and *Z. spina-cristi* were tested as rootstocks for one of the ber varieties ("big fruit"). Of each rootstock, 6 plants were grafted (cleft grafting method). In the case of *Z. spina-cristi* 50% of the grafts were successful, while in the other species all the grafts died. In the spring of 1988 the experiment will be repeated.

MAINTENANCE AND DEVELOPMENT OF THE EXPERIMENTAL AREAS

Irrigation and fertilization were in accordance with the program. Soil analysis data are given in Table 2, including data on the N, P, K, Na, Cl contents, electroconductivity (EC) and pH of the soil solution. The soil solution was extracted and analyzed after saturation of the samples. The marked variations in the elemental contents are due in the case of N, P and K to differences in the type and amount of fertilizer applied, and in the case of Na and Cl at least in part to

differences in irrigation regime. Instructions with regard to future application of fertilizer and irrigation have been modified accordingly.

Table 2. Soil solution analysis

| Plot | N | P | K (ppm) | Na | Cl | EC (dS/m) | pH |
|---|---|---|---|---|---|---|---|
| Yotvata | 185 | ~1 | 56 | 783 | 1490 | 3.5 | 8.0 |
| Qetura | 202 | ~1 | 82 | 519 | 1050 | 4.8 | 7.5 |
| Neot Hakikar | 28 | 14 | 42 | 371 | 906 | 4.2 | 7.2 |
| Besor | 180 | ~1 | 12 | 135 | 170 | 2.0 | 7.1 |

*Note - The plots were sampled two to three times in the course of the year; each plot was sampled at 3-4 sites at a depth of 30 cm.*

INVESTIGATION OF PHENOLOGICAL AND PHYSIOLOGICAL ASPECTS

In addition to ordinary phenological determinations, it was decided to study the dates of onset of bud dormancy, leaf shedding and breaking of dormancy in two deciduous species, marula (*Sclerocarya caffra* ) and mongongo (*Ricinodendron rautanenii*). Shoots were tagged in plants growing in the various plots. The parameters which will be studied include the dates of leaf shedding and bud dormancy breaking, as well as the rate of elongation of the shoot and its laterals throughout the year.

In addition we will also study the response of prickly pear (*Opuntia ficus-indica*) to salinity. Rooted cuttings were planted in Hoagland solution with different concentrations of NaCl. This experiment is still under way, and results will be presented in a forthcoming report.

**BOTSWANA**

*This is the third report on activity in Botswana. Work centered on establishment of experimental plots, irrigated and non-irrigated; propagation; observation of plant development; and collection of climatic data.*

The cold season passed without any air frost being recorded at the Thusego site of Thusano Lefatsheng. Although there were probably about twelve ground frosts in the open area of the fruit tree trials, no damage was done to the seedlings in the shade house and the quarantine house, which are amongst tall trees. Seedlings were planted out in September, and more at the beginning of December. Some of the seedlings, notably the cacti, were still very small, and have frequently been covered by sand during the numerous sandstorms. It might have been better not to have planted in basins, but there would have probably still have been losses from sandblow damage.

Botswana in general is experiencing good rains so far this season, although the rainfall at Thusego is rather disappointing (rainfall is calculated from 1st July each year). A summary of climatic data is given at the end of this chapter.

The seedlings on the drip-irrigated plots each have one dripper, with an output of two litres per hour for the cacti, and four litres per hour for the other species. Irrigation from the time of planting to the end of November was twice per week, half an hour per irrigation, but from December this has been increased to three times per week. It will be necessary to add additional drippers for the most rapidly-growing species, as they now have a biomass many times greater than the slower species.

On the plots without drip irrigation, the rule is to irrigate "heavily" (approximately 20 litres per seedling) by hand watering, at the end of any month during the nine hottest months when less than 20 mm of rainfall has occurred. In practice some of the seedlings have needed to be watered more often than this, as they were showing

severe signs of drought, and even then survival and growth have been very disappointing.

A complete nutrient fertilizer ("chemicult", the analysis of which was given in the last report) is given at the rate of 5g per seedling. It is measured out for each plant and placed about 20 cm from the stem, or under the dripper on the irrigated plots. This is both because it is not very readily soluble, and also because with the short irrigation times, it might not be evenly distributed amongst the plants if put in the irrigation water. As with the irrigation, the amount of fertilizer will have to be adjusted to allow for the increasing differences between the sizes of plants, and for the species that have not grown well yet; the fertilizer will only be used every second month, during the hottest nine months of the year.

Pest damage has been quite specific: weevils on the opuntia and the guava, and spider mite on the ciruelo.

Continual weeding has been requird, of some deep-rooted perennial weeds which were not previously eradicated, various herb species that have germinated after rain, and a number of tree species, including morula, which evidently would establish themselves quite successfully on the site if we did not remove them.

The drip-irrigated section of the trial should give useful and rapid results on the growth, habit and fruiting characteristics of the species under test. We are still short of seed of some species, and as it was convenient to lay out the plots for a total of twenty species, we have room for three more species to add to the seventeen of the trial. Water useage may seem low, but the plants still only cover a small fraction of the total land surface.

For the non-drip-irrigated plots, the original plan of watering at planting time and then growing as a dryland crop has not worked out. Some species, notably kei apple and morula, appear to be succeeding, but others, notably guava, have needed water as often as once a week. The ability of tree seedlings to establish themselves within

the area of the trial as "weeds" without watering indicates that with some manipulation and a lot of patience we could establish an area with the four species or so that are already found there, but since we both wish to include other species not indigenous to the site, and also to grow a certain number of trees at a certain spacing and of the same age, we shall have to apply more intensive management. In view of the poor results, it has therefore been decided to modify the "dryland" section of the trials, by growing only those species which we think will have a good chance of survival, and by giving the larger species a wider spacing to reduce the competition for water. Single lines one hundred metres long will be grown for each species, planted as seedlings or sown direct. Drip irrigation will be used for the first two to three months, and then removed. By watering at increasingly long intervals, but with correspondingly increased amounts of water, it is hoped to encourage deep rooting.

NOTES ON INDIVIDUAL SPECIES, AS OF 23RD DECEMBER 1987

1) *Pachycereus pectin-aboriginum*

It is understood that this has now been dropped from the trial. It remains in the plots at Thusego in the absence of any alternative species.

Dryland trial: 50% mortality, average height of the remaining seedlings, 2 cm.

Irrigated trial (2 plots: 6% mortality, average height 5 cm. Average height of the 5 cuttings, 20 cm.

2) *Pachycereus pringlei*

Dryland trial: 37% mortality, average height of remainders, 2 cm.

Irrigated trial: 6% mortality, average height 5 cm; average height of the four cuttings, 19 cm.

3) *Stenocereus gummosus*

Dryland trial: 80% mortality, average height of remainders, 2 cm.

Irrigated trial: only the cuttings were planted; 5 cuttings, average height 17 cm.

4) *Stenocereus thurberi*
(Shortage of seed prevents us from finishing the planting)
Dryland trial: 80% mortality, average height of remainders 2 cm.
Irrigated trial: no cuttings or seedlings planted.

5) *Hylocereus* and *Opuntia ficus-indica* (irrigated plots only)
The *Hylocereus* sp is from cuttings from BGU. Two plants have been planted to date. As it grows as a creeper it is more appropriate to measure its length: average height 80 cm. Of the opuntia cvs, these have only recently been taken from the parent plants which remain at the village plot at Kumakwane.

6) *Opuntia* spp (irrigated plots only)
These cultivars were taken as cuttings from BGU, and were all cuttings from the collections originally made by "C.R." Stem cuttings are being taken from them as they grow to fill the remaining spaces in the plots. The plants are being attacked by weevils, but are growing well none the less. Mortality 0%; average height of first planting, 64 cm.

7) *Mimusops angel*
We are still awaiting seed.

8) *Zizyphus mauritiana*
We understand that we shall be able to obtain cuttings of selected material. In the meantime one of us (Abraham Nkhumane) obtained seed from BGU which has now been planted on the irrigated plots, and seed has also been obtained from Sudan, the seedlings of which are due to go into the dryland trial.
Irrigated trial (2 plots), average height 23 cm.

9) *Cyrtocarpa edulis*
Dryland trial: 0% mortality, average height 17 cm.
Irrigated trial: 0% mortality, average height 42 cm.

This species tends to die off at the top, and produce new growth from near the base of the plant to give a bush form. It is susceptible to red spider mite, *Tetranychus cinnarbarinus*.

10) *Psidium guajava*
Dryland trial, mortality 23%, (4 seedlings replaced), average height 21 cm.
Irrigated trial, nil mortality, average height 42 cm.
The seedlings have suffered from leaf scorch and beetle (weevil) damage, the latter being partially controlled by the use of carbaryl dust (50 g/kg).

11) *Harpephyllum caffrum*
Dryland trial: not planted due to lack of seedlings (more have been sown).
Irrigated trial: 16 seedlings planted so far, 0% mortality, average height 33 cm.
There has been some leaf scorch.

12) *Sclerocarya caffra*
Dryland trial: 8% mortality, average height 17 cm.
Irrigated trial: 0% mortality, average height 51 cm.
The plants have side shoots competing with the main shoot, but with generally vigorous growth.

13) *Ricinodendron rautanenii*
The "Ethrel" (ethephon) needed to break seed dormancy was not available locally, and was brought from Israel, unfortunately before the cold season so it was considered a risk to treat the seed and sow before the spring. There were two treatments given, viz. either to completely remove the seed from the woody endocarp, or to simply crack the endocarp carefully in a vice, but leave the seed within (a much quicker operation). The former method gave 30% germination, the latter only 5%. A 1% solution of Ethrel was used for 24 hours as has been recommended.
Irrigated trial: 10 seedlings sown at the beginning of December.
0% mortality, average height 45 cm (10 more seedlings have just been planted).

Not planted on the dryland trial yet.
Of the seedlings just planted there has been some loss due to the plants being cut off at ground level, presumably by cutworm.

15) *Strychnos cocculoides*
This species has done poorly to date, on all plots, and there has been no growth since shortly after germination, when the seedlings were still in cartons. At times it has seemed that there was going to be a resumption of growth, but this has not occurred. There has been slightly over 50% mortality, the majority of deaths on the dryland plots. It is assumed that this species is very sensitive to transplant shock as any seedlings examined have had only a taproot, and no visible sideroots. In future it will be grown by direct sowing, and the plants at present on the plots will probably be removed.

14) *Cordeauxia edulis*
Shortage of seed prevents us from planting the full number of plots. This species has performed very poorly after transplanting, after a promising start in the nursery, with very little new growth. It has only been planted on the irrigated plots.
Irrigated trial: (26 plants) 42% mortality, average height 6 cm.

16) *Dovyalis caffra*
Irrigated trial: 0% mortality, average height 38 cm.
Dryland trial: 10% mortality, average height 25 cm.
The plants have an upright habit of growth with strong apical dominance.

17) *Vangueria infausta*
The seedlings were too small to plant out until December so it is inappropriate to give heights at this stage.
Irrigated trial: 0% mortality.
Dryland trial: 17% mortality.
Numbers 18,19 and 20 have not yet been allocated.

CLIMATIC DATA

1) *Rainfall*

As of 9th October 1986, a rain guage has been used at Thusego, and rainfall figures are given in comparison with Kumakwane, some 10 km away, where records have been taken over a longer period.

| | | Kumakwane | Thusego |
|---|---|---|---|
| 1986 | July | | |
| | August | 14.4 | |
| | September | 13.2 | |
| | October | 147.81 | (9th onwards) 54.4 |
| | November | 79.5 | 78.0 |
| | December | 81.0 | 48.1 |
| 1987 | January | 73.8 | 63.4 |
| | February | 15.5 | 25.6 |
| | March | 89.7 | 61.8 |
| | April | 12.9 | 7.3 |
| | May | - | - |
| | June | - Year total: 527.8 | -part year total: 338.6mm |
| | July | - | - |
| | August | - | - |
| | September | 21.9 | 27.9 |
| | October | 19.3 | 21.4 |
| | November | 35.2 | 44.2 |
| | December | 64.3 (140.7) | 74.7 (168.2) |

2) Temperature, pan evaporation, and relative humidity
The table below gives average monthly figures for daily maximum and minimum temperatures, evaporation from a Class A pan (net of rainfall, unlike the previous report),and relative humidity measured with a wet and dry bulb thermometer

| | Min. temp | Max. temp | Evaporation (mm) | Relative Humidity 08.00 | 12.00 | 16.00 hr |
|---|---|---|---|---|---|---|
| 1986 October | | | 11.4 | | | |
| November | 18 | 29 | 9.4 | 65 | 49 | 43 |
| December | 20 | 32 | 8.2 | 69 | 50 | 42 |
| 1987 January | 20.6 | 33.3 | 9.3 | 66 | 47 | 34 |
| February | 21.9 | 34.1 | 8.8 | 58 | 44 | 37 |
| March | 19.2 | 30.9 | 6.6 | 68.9 | 47.2 | 41.0 |
| April | 17.0 | 30.9 | 6.3 | 64 | 39.9 | 34.9 |
| May | 11.9 | 27.9 | 5.4 | 50.2 | 35.2 | 30.1 |
| June | 7.0 | 21.9 | 5.9 | 59.1 | 36.1 | 30.1 |
| July | 6.1 | 21.6 | 4.4 | 58.1 | 37.7 | 30.5 |
| August | 9.7 | 24.0 | 6.6 | 56.2 | 36.5 | 26.9 |
| September | 14.2 | 27.5 | 7.3 | 58.1 | 41.1 | 33.7 |
| October | 17.3 | 30.6 | 9.4 | 48.5 | 36.6 | 27.1 |
| November | 20.6 | 32.2 | 10.1 | 59.5 | 42.2 | 36.9 |
| December | 20.7 | 31.0 | | 70.5 | 55.5 | 44.2 |