DATE PRODUCTION AND MARKETING IN JORDAN

Prepared for
The Agricultural Marketing Development Project
Amman, Jordan

At the request of
The Agricultural Marketing Organization, Amman, Jordan
and
The Sigma One Corporation, Raleigh Durham, North Carolina

Under Contract to the
US Agency for International Development

Prepared by
Benjamin T. Laflin
Oasis Date Gardens
Laflin & Laflin Date Palm Research and Development Company
P. O. Box 10700, Indio, California 92202, USA

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INTRODUCTION

PURPOSE OF STUDY:

This study was undertaken in support of the AID funded Jordan Agricultural Marketing Development Project. The specific program is the Date Production and Marketing Study in Jordan.

This report seeks to cover the following issues:

Observations on the current status of date growing in Jordan.

Discussion of the constraints to increased production.

Evaluation of existing date processing capability in Jordan, and recommendations for future processing of anticipated production.

Assessment of export market for dates.

Recommended strategies for increased production and export market development.

Preliminary presentation of findings to interested parties in Amman.

PLAN OF STUDY:

The writer was in Jordan from June 29 until July 20, 1995 and was able to visit most of the areas where dates are now being grown or could be grown in Jordan. Visits included the opportunity to talk with local authorities in these various areas, date garden owners, managers and workers. The universally expressed desire was for more information about how to grow, pack and market dates. Therefore a considerable portion of this report is devoted to basic questions about date culture.

Beyond that, the report includes information needed to assess potential date growing areas of Jordan. Local agriculture officials will need to consult temperature records and analyze soil and water conditions in any location being considered for a date planting to see if that area meets the criteria. Jordan is fortunate in having several quite different areas where dates should do well. Each requires its own assessment as to whether dates are the best crop to be grown there. To supplement on-site evaluations by the writer, a selection of current studies and information are being furnished to the Jordan Agricultural Marketing Development office in Amman, Jordan.

ABOUT THE CONSULTANT:

The writer has been growing dates in the Coachella Valley of California, USA, for more than fifty years and is the present owner of the 250 acre Oasis Date Gardens and an additional 20 acre date garden devoted primarily to growing Barhee and Medjool dates. He has served as a date consultant to the Date Improvement Project of India, under the auspices of the United Nations, and to agencies and individuals in Oman, Saudi Arabia, and Bahrain, as well as to countless visitors to the date gardens of Southern California. He has a B.S. degree in Plant Science and a M.S. degree in Plant Pathology, both from the University of California, Berkeley. Most recently he presented a paper on the Marketing of US dates at the International Symposium on Date Palm Cultivation and Oasis Agriculture in Mediterranean Countries in Elche, Spain, April 1995.

ACKNOWLEDGEMENT:

Many people have very graciously helped with this project. Fred Nustas, Project Administrator, and Loret Mansour, Office Manager from the Agricultural Marketing Development Project in Amman were of great assistance.

From the Agricultural Marketing Organization, the writer would particularly like to recognize the help and enthusiasm of Dr. Salem Al-Lozi, Director General, Mr.Jamel Zureigat, Deputy Director General, and Mr. Nasser El Ali, our AMO counterpart who drove us over a large area of Jordan for two weeks and always managed to get us safely back to our hotel.

There were many other very kind and hospitable people who made our trip very enjoyable and we deeply appreciate all they did.

"We" is used advisedly. Mrs. Patricia Laflin, the writer's wife, participated in the visits and is the principal compiler of this report. She, too, has been a date grower for the forty-six years of our marriage and enjoyed also the opportunity to observe date growing in Jordan and to help in preparing a document which hopefully will encourage the growth of Jordan's date industry.

SUMMARY

I. Observations on the current status of Date Growing in Jordan Pgs. 7-11

Dates are being grown successfully in Jordan for domestic consumption. Jordan only produces 1/4 of what it consumes each year and imports the balance. Farmers are eager for more information and help in improving existing plantings. Most of the dates come from trees of local varieties or from seedling trees rather than from known commercial varieties and are mainly suitable for sale as fresh dates on the local market. A shortage of offshoots of principal commercial varieties and a lack of knowledge as to how to accomplish a good survival rate have hampered expansion of a commercially viable industry in the past. There are now several commercial plantings of tissue culture date palms which have not yet come into bearing. There are areas in the Jordan Valley, in Wadi Araba, and near Al Guwaira where date palms should grow and produce well. Azrak has the problem of too little water and possibly a lack of sufficient heat units to mature quality fruit.

II. Origin and Distribution of the Date Palm and Today's Commercial Varieties Pgs. 13-15

The date palm is probably man's oldest cultivated fruit. No other plant has contributed so much toward making the desert habitable, and it is found in a belt stretching from India across the Middle East and North Africa. Where dates are consumed locally, most of the palms are seedlings, but in each of the more important date growing and exporting countries, good varieties have been selected, named and planted in commercial gardens.

III. Basic Requirements of the Date Palm Pgs. 16-21

The date palm needs a long, intensively hot summer, without rain or excessive humidity. It also needs plentiful water, but tolerates saline water in varying degrees better than almost any other fruiting tree. It grows and fruits best within an area 20 to 30 degrees N. Latitude. Jordan is located within this favorable zone.

Altitude affects temperature. The date palm flourishes and fruits within a range of 1,892 meters--from 392 meters below sea level to 1500 meters above sea level. Jordan has possible date growing areas within these limits.

Temperature is a very important factor in determining suitability of an area for a particular date variety. A careful study of temperatures should be made in areas being considered for expanding the date industry in Jordan.

The amount of rain is less important than the conditions under which it occurs. High humidity just before harvest can do more damage than a rain shower. Light does affect the growth of date palms. Most dates are grown in sunny countries where the sky is virtually cloudless during the ripening season.

Wind does not seem to trouble the date palm and date palms can be very useful if planted as a windbreak around a field where other more susceptible crops are grown. This pattern of planting is recommended for Jordanian farmers who wish to continue growing other crops. When the palms begin to bear fruit, their "windbreak" becomes a source of income.

The date palm tolerates saline soil, but thrives and produces best if there is good drainage and the soil is prepared well before planting.

It is important to investigate the availability of sufficient water before planting a commercial date garden. Drip irrigation is the most efficient way of delivering water to the date palms and charts are included to show palm water consumption in the date gardens of California.

IV. Methods of Propagation Pgs. 22-27

There are three methods of propagating date palms. The first, by planting seeds, results in a garden of totally mixed trees. Half will be male trees, which produce no fruit. The female trees will all be different and the fruit is usually inferior to that from which the seeds came.

The second method is to plant offshoots (fasila). This results in a tree identical to the mother palm from which the offshoot was taken, because the offshoot is really a part of that mother palm. Offshoots from female trees will always be female and offshoots from male trees will be male. Great care must be taken in removing the offshoots and in planting and caring for them. A very important step in this process is cutting back the leaves of the offshoot to reduce the amount of leaf surface through which the young offshoot looses moisture and may die before it establishes new roots to take up water from the soil where it is planted. Care should be taken to avoid importing offshoots from areas which have serious palm diseases and pests.

The third method of propagation is by planting tissue culture date palms. This is a fairly new method which holds promise, but very few tissue culture palms have come into bearing and it remains to be seen if genetic change has taken place during the in-vitro process. A nursery in the Jordan Valley is using a technique which seems to avoid genetic change, and if the work there is successful, this could be a good source of plants for Jordan.

V. General Cultural Practices Pgs. 28-37

This section seeks to briefly provide a manual for the basic cultural practices to be carried out if date fruit production is to be successful. Date palms are remarkably hardy and will survive under very adverse conditions, but to be a profitable commercial operation, a date garden must receive proper care. Topics covered are: Irrigation, Fertilizer, Pollination, Thinning and Tie-down, Pest Control and Fruit Protection, When to Pick Dates, Grading and Packing the Dates, and Pruning and Dethorning the Palm.

VI. Evaluation of Production Possibilities and Recommendations Pgs. 38-42

We concur with the vision expressed by the Jordanians we met that there is a profitable future for the date industry in Jordan, for the following reasons:

1. There is an unmet local demand for dates in Jordan. It is presently being filled by imported dates.

2. There are neighboring countries which offer export possibilities such as Lebanon, Syria and Turkey. Farther away, both Morocco and India are among date importers and the European market is open to quality fruit.

3. The Jordan Valley, in particular, has a very long growing season without rain. It does not have any serious pest or disease problems, so is capable of producing early, good quality fruit. Dates are being grown successfully in the West Bank, with virtually identical growing conditions.

4. Jordan has an apparently adequate supply of affordable labor. This gives Jordan a competitive advantage especially on the export market.

There are some problems which can be overcome with a well-planned and executed program:

1. There is not at the present time a trained labor force that is knowledgeable with regard to date production.

2. There is a lack of an adequate supply of date offshoots of good commercial varieties.

3. There is a shortage of low salinity water and much of the soil is quite saline.

4. It will be very important to assess all of the conditions in each area where date palms might be planted and to choose the varieties most suited to temperature and other characteristics of that area.

Specific Recommendations:

1. Recommend to farmers which varieties should be planted.
2. Establish demonstration plots.
3. Assess water quality and availability for farming vs. other needs.
4. Educate people to ecological value of date palms.
5. Help farmers achieve better survival of offshoots now being planted.
6. Encourage farmers to remove excess trees in older dense plantings.
7. Set quality standards and establish marketing groups.
8. Encourage the building of good grading and packing facilities.
9. Establish Date Reference Libraries.
10. Educate as to the dangers of bringing in offshoots from areas which have serious plant diseases and pests.
11. Establish some kind of Date Growers Institute to share information and ideas.
12. Make plant-laboratory facilities available.
13. Establish a nursery of good commercial varieties of dates.
14. Establish contact with the Volcani Center at Bet Dagan, Israel in order to benefit from the experience of date researchers and date growers in the West Bank part of the Jordan Valley.
15. Promote the consumption of dates within Jordan.
16. Consider the feasibility of helping date growers organize themselves into groups which could buy needed supplies in bulk.

The above recommendations should be considered and implemented in whatever order seems appropriate, as funds and interest dictate.

Reference Material Cited and Provided with this Report Pg. 43

A basic reference library consisting of these titles is being furnished to the Agricultural Marketing Development Project in Amman. They include: Growing Dates in the United States by Nixon and Carpenter; The Date Palm, Tree of Life in the Subtropical Deserts, by Nixon; Pests and Diseases of the Date Palm, by Carpenter and Elmer; Soil, Water and Climatic Considerations in Selecting Date Palm Planting Sites in the Coachella Valley, by Aslan et al; Imported Varieties of Dates in the United States, by Nixon; and Information on Length of Leaves to be Left on Offshoots, by Laflin.

Appendices Pg. 44

Appendix A deals with an analysis of the international date situation.
Appendix B gives valuable information on climate requirements of dates.
Appendix C includes charts showing water consumption of dates, grapes and citrus in the Coachella Valley of California

Right--An imported Medjool offshoot, properly trimmed, planted and watered, is beginning to grow at the Prince Abdullah Farm in South Shuna.

Below--Medjool date palm with an excellent crop of dates at Samir Kawar Farm in Mid-Ghor

I. Observations on the current status of date growing in Jordan, based on visits to these areas:

July 1, 1995 Visit to officials at Agricultural Marketing Organization in Amman. Discussed the project with Dr. Salem Al-Lozi, Director General AMO; Jamil Zureigat, Deputy Director General AMO; Nasser El Ali, AMO; and Fred J. Nustas, Agricultural Marketing Development Project, Sigma One Corporation. Mr. Nasser El Ali was the person responsible for setting up the master visitation schedule and for driving us to the various locations.

July 2, 1995 Visit to Prince Abdullah Farm in South Shuna. Met the Manager, Abdulrahim Al Shaikh, and observed the planting of Medjool offshoots sent by Oasis Date Gardens in California in April. The offshoots were beginning to grow and the planting looked very good. Observed also the other varieties grown there, including Barhee and Helwat al Medina, and the method in use for the successful rooting of high offshoots.
Traveled north through the Jordan Valley to Al Baqura Station in the area of North Ghor, North Shuna, where we met Supervising Engineer Mustafa Al Khasim. Saw many varieties of older palms. Most of these varieties were eaten in *khalal* and *rutab* stage. Mr. Al Shaikh, who had worked at this station until recently, assisted us in our tour there.

July 3, 1995 Visit to Deir Alla Station in Mid-Ghor. We met Mustafa Abu Zaid, Director of Deir Alla Station and Ali Hamadneh, Head of Extension Department. While in this area we visited the Diat Field Station and met the supervisor, Faid Hwarat'sis, who was doing a good job growing many varieties from offshoots, some of which were producing very good fruit bunches.
We visited Fahad Abu Kamer Nursery and talked with Dr. Assem Al Kalisy in his tissue culture laboratory. He is using the method called *organogenesis* and is hopeful of producing date plants true to the mother variety. It was an impressive operation and could be a very good source of plants for Jordan in the future.
Visited Ghour Kabed Royal Farm in Mid-Ghor and met the Director, Mohammad S. Al-Labadi. He is growing about 1,000 palms of many varieties, all sent as gifts. He mentioned the need for good packing facilities. We saw no packing houses in the Jordan Valley and were told that most local dates are sold as *khalal* fruit. *Tamar* dates are imported from Iraq, Iran and Saudi Arabia.
Water salinity at the Royal Farm is 2500 ppm and is Authority Water from the Ghor Canal.

July 4, 1995 Visit to South Shuna see the Saleim Al Naber Farm. It is a very efficiently run farm planted entirely to tissue culture date palms. They are just beginning to produce. There are 1250 palms of Barhee, Deglet Noor, Medjool and some local varieties. We were given a tour by Mr. Naber, who mentioned

several problems, including "heavy" soil and high water salinity (I believe he said it was 4300 ppm). Gypsum is available at little cost and he is considering adding it to improve the soil. He discussed what appeared to be a pollination problem, but it might be related to fertilization practices. There is a good room for drying and packing his dates--a commendable operation.

On this day we also visited Mohammed Basha's farm in South Shuna. Here we saw 100 dunnums of young palms, most of which were the Barhee variety, grown from tissue culture plants purchased from the lab in England. The trees were on drip irrigation and looked very good. Salinity of the soil is quite high, but the salinity of the water was said to be quite low. This farm is quite close to the Jordan River. It is an interesting layout, with palms planted on several terraces with a portion interplanted to apples and other fruit trees.

July 5, 1995 Visit to Al Safi area at the south end of the Dead Sea. Visited first at Al Safi Station and met sehveral persons in the office, including Supervising Engineer Ahmed Madadha and Ohud Hourani. We saw palms planted in 1978 as well as others planted later. They had many varieties that were doing well. Their Zaglool and Hayany dates were already quite red. They mentioned the problem of not having male pollen early enough for their first-blooming female palms. They do soil analysis and water analysis for local farmers. The water is from streams and is not classified as saline. They reported production of 250 kgs. of *khalal* dates per tree. Here it was suggested by an Agricultural Credit man that it might be a good idea to give a farmer 40 palm trees of a good variety to make a fence around his farm. Trees can be planted closer together because they get light from both open sides when they are planted as a border.

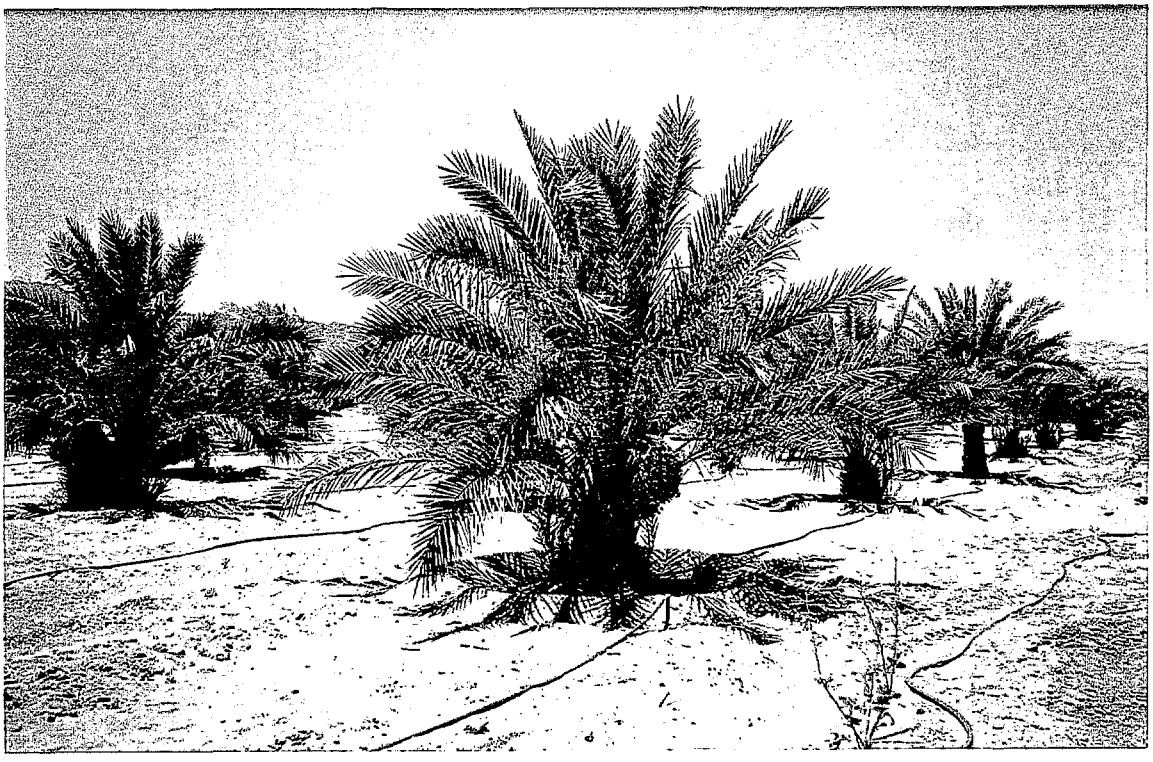
Visited also the Sharif Zaid Ben Shaker Farm of 40 dunnums. Trees there were 8 years old. There were several varieties of dates, including Khadrawy, Zaglool, Khustawy and Red and Yellow Shweity growing successfully. The farm is not far from Al Safi Station, and included citrus, banana and vegetable plantings which were all doing very well.

Conferred with Dr. Salem Al-Lozi at lunch in Al Safi about the date palm possibilities in this area.

In the late afternoon we drove through Aqaba and north to the Saleim Al Naber Farm in Al Guwaira. This is a very modern farm of 900 dunnums. There are 11,000 tissue culture palms on drip irrigation, interplanted with apples, nectarines and almonds. Main varieties are Barhee, Medjool and Deglet Noor. Palms are 3-4 years old and not yet bearing. Altitude is 250 to 300 meters, higher than any other plantings we saw, and it remains to be seen if the high-sugar varieties of dates will get enough heat units at this elevation. It is still within the range which should be ok. The manager, Hamdullah Akram, is from a date growing in Iraq and is doing an excellent job of farming here.

Above--The visit to Queen Alia Foundation Farm near Aqaba. From left, Ben Laflin, Dr. Ibrahim Algharib, Pat Laflin, Hamdullah Akram and Nasser Ali of AMO.

Below--Hayany date palms on drip irrigation at Queen Alia Foundation Farm. They were already showing red color, an indication that they were going into khalal stage.



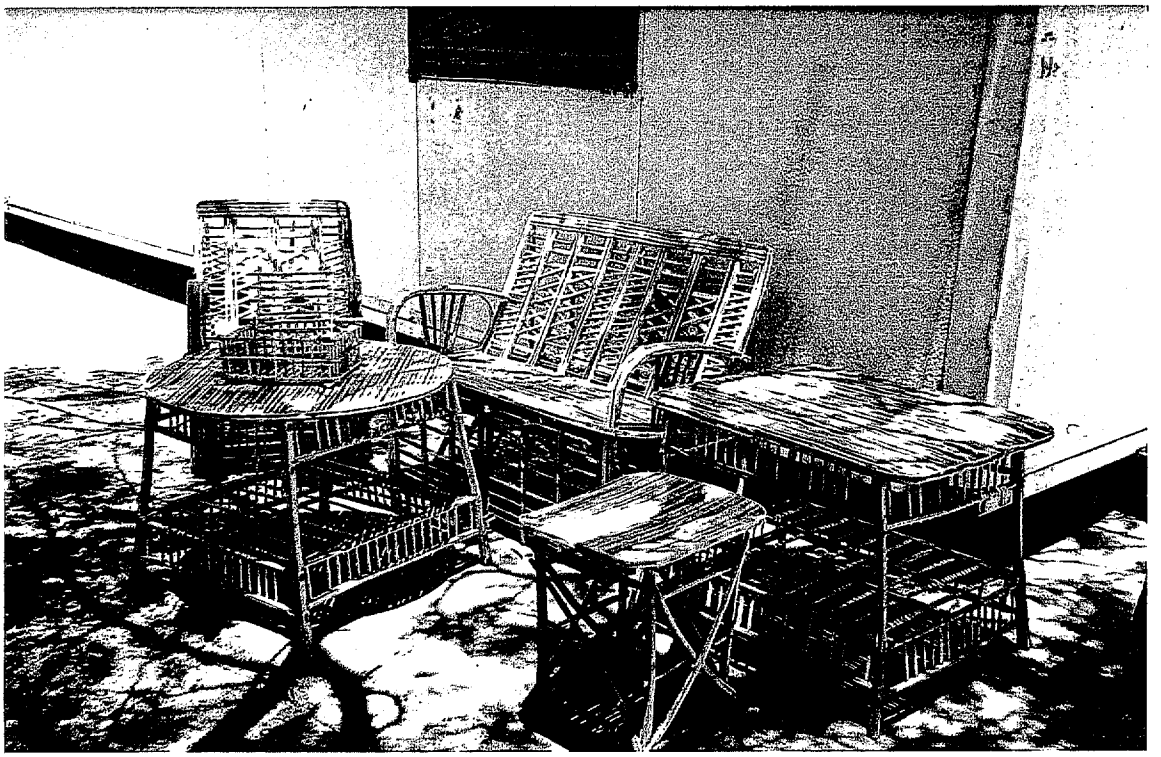
July 7, 1995 Observed palms growing in Aqaba city area, mostly seedlings planted as ornamental palms. We could observe commercial groves of date palms growing near Eilat and in the area directly to the north in Israel. Apparently dates of very good quality and production are grown in Israel in this area south of the Dead Sea, under conditions very similar to Wadi Araba, on the Jordan side of the border. Wadi Araba certainly has the potential to become a date growing area if water is available..

July 8, 1995 Visited the Director of Agriculture in Aqaba County, Omar Abu Karaky, Dr. Ibrahim Algharib and Hamdullah Akram. After a good discussion in the office, we were taken to Queen Alia Foundation Farm. A shortage of water in Wadi Araba has limited date plantations to date, but there is interest among farmers. Dr. Algharib gave us a history of the planting at Queen Alia Foundation Farm. Many of the original plants died and have not been replaced. They have a number of standard varieties and also local varieties. Mr. Akram has completed a map of the entire planting and intends to put together a guide of all varieties grown. The value of a "slip-knot" in tying the flowers as they are pollinated was suggested. They need more official support to get the maximum benefit from the work that has been started here. Hayany variety looked good here--many of the dates were already red.

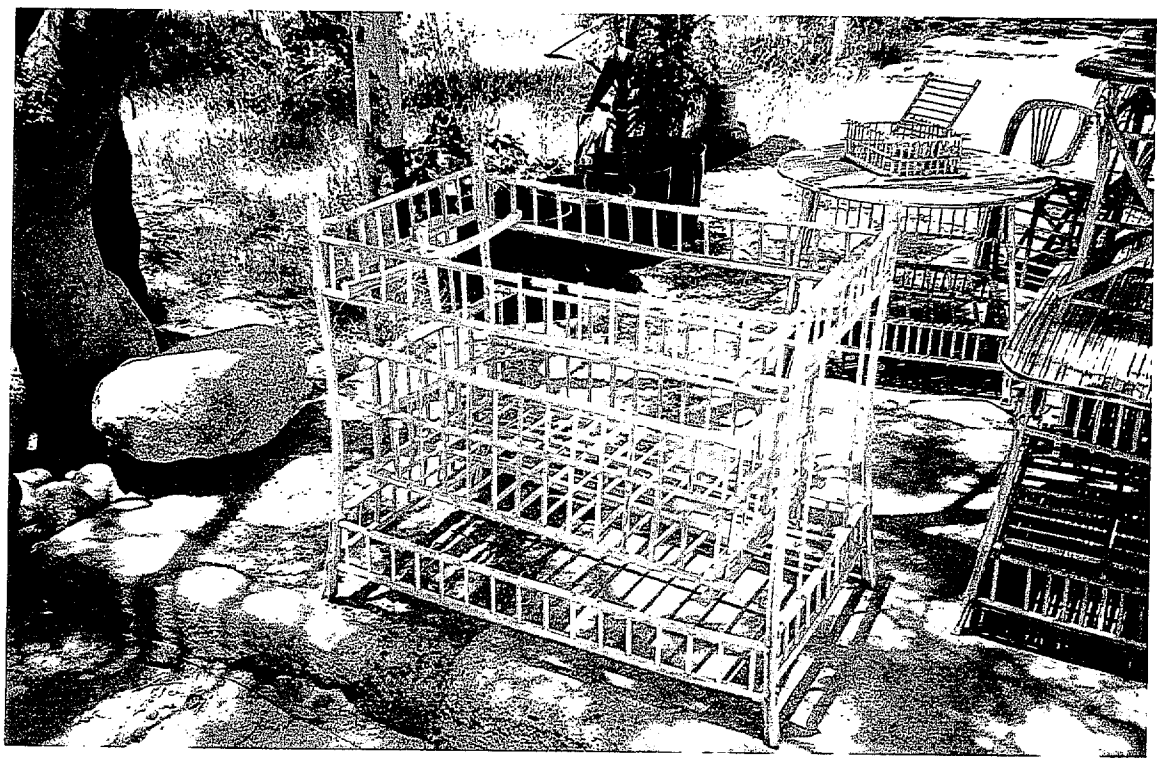
July 9, 1995 Visited the Agricultural Station in Azrak, about 80 kms east of Amman. We talked to Mahmood Al Uwaimer and traveled around the area with Yusif, who is in charge of Integrated Pest Management at the Station. There is a small test garden for date palms. It gets almost no water. Older trees just barely survive. Lack of water is a serious problem in Azrak. Wells are going down partly because of water being taken for the city of Amman. On one farm which we visited the well had gone dry and the seedling palms looked very poor. Another large olive farm had planted date palms along the borders, but they did not look very well. This is a relatively high area which may not have sufficient heat units to mature the more profitable varieties of dates and it is likely that other crops would be a better investment here. I would not recommend this as an area to plant date palms.

July 10, 1995 Dr. Lozi accompanied us on a visit to the Samir Kawar Farm near Deir Alla. At Mr. Kawar's headquarters farm he had 58 Medjool date palms that had grown from offshoots sent from the farm of Don Mitchell, a neighbor of mine in the Coachella Valley of California. They were growing and producing very well in a very well-kept farm. We gave instructions to the farm manager as to how to trim offshoots to make plantings more successful, and also how to treat Black Scorch, a date palm disease.

We visited several other smaller farms in the area on this day.



Furniture made from the mid-ribs of date palm leaves by workers at the Queen Alia Foundation Farm. Above--tables and chairs ; Below--a baby cradle. In many date growing countries, use is made of palm leaves and leaf bases for a variety of household articles.



July 11, 1995 (Election Day) Visited the green houses and tissue culture operation of Munir Sukhtrain Co., Ltd., a large chemical sales company. Met with Basin Al Khawalden, Technical Manager and Waheeb Al Rafati, Agricultural Engineer. The business is located near Amman airport. They were acclimatizing the tissue culture plants in their green houses.

We journeyed from there to a place at the edge of the Dead Sea, down the mountain from Ma'in. Warm spring water flows down the mountainside here. It is extremely rocky but the water was quite good--less than 1,000 ppm salinity. They were considering some commercial use of the property, probably as a possible hotel site. Ornamental use of palms would probably be appropriate here, but not a commercial date garden.

July 12, 1995 Met with Anwar Haddad in Amman Agricultural Credit Bank, Research and Planning Department. He was very knowledgeable and interested in expanding the date industry. He said that local consumption of dates is 4,000 tons annually and that local production is 1,000 tons. This would indicate that Jordan imported 3,000 tons of dates last year. Increasing Jordanian production by 3,000 tons would just take care of the local market and would require about 60,000 more producing palms.

Visit to Israel to review date production there:

July 14, 1995 Went to visit the Volcani Center for Agricultural Research at Bet-Dagan. Met with Dr. Oded Reuveni and Dr. Abraham Meiri of the Center and observed and discussed some of the research being done there. They have spent years in evaluating the effects of saline water, saline soil and temperature on various date varieties. Their commercial groves are located in areas very comparable to those already planted and being considered for planting in Jordan. This can be a great help in deciding on the best way to expand date production in Jordan.

July 15, 1995 We traveled with Dr. Reuveni and discussed his findings with regard to dates and other crops.

July 16, 1995 Traveled with Dr. Reuveni and Dr. Meiri to the Experimental Station for Research and Development in Gilgal in the Jordan Valley, north of Jericho. They were evaluating the effects of different concentrations of saline water on date palms and on the production and quality of dates. The experiment is still in progress. Most of the palms were planted in 1984 and were of the Medjool and Deglet Noor varieties. The information from such experimentation can help farmers regulate irrigation in the most efficient manner.

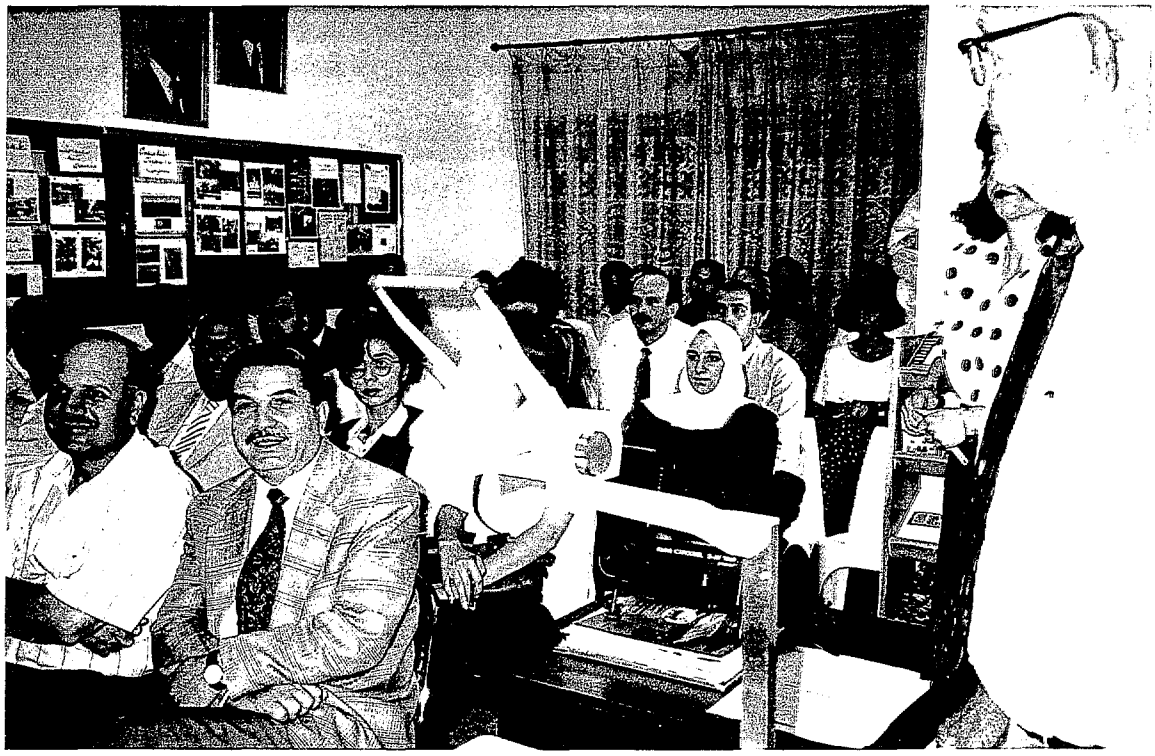
Above--Medjool palms in the foreground and Deglet Noor palms in the background in a planting in the West Bank a short distance south of Jericho, near Qumran. They are 20 to 30 years old and producing very well.

Below--The same date garden, where protective mesh bags are being put on. Some pruning of old leaves is being done at the same time. Picture was taken July 16, 1995. This area is just across the river from the South Shuna area in Jordan, with comparable soil, water and temperature.

We then visited a farm near the Dead Sea at Qumran (approximately due west of South Shuna). The palms we saw there were in top producing condition. Varieties grown were Deglet Noor, Medjool, Halawy, Zahidi and Khadrawy. All had been grown from offshoots. They had also planted some tissue culture Barhee plants secured from a lab in England. These were two years old. All were being irrigated by drip, with just a single hose for each row of palms. The older palms had 5 emiters per palm, emitting 2 gallons of water per hour for a total of 10 gallons per hour or 240 gallons per day and were running continuously during the hottest 3 months of the year. As the weather cools the amount of irrigation time is reduced.

The balance of time in Jordan has been spent in the office of the Agricultural Marketing Development Project in Amman. The officers and staff of this office have been most gracious in providing office space and support for the preparation of this report. I have appreciated the opportunity to visit such a wide area of Jordan and to meet with interested people in all of those areas. The people of Jordan are friendly and helpful. I particularly appreciated the widespread use of English and wish I were as competent in Arabic. If there are inaccuracies in my understanding of what I saw and heard I blame my inability to converse in Arabic, and apologize for the misunderstanding.

July 19, 1995 At 10:00 AM in the conference room of the Agricultural Marketing Organization in Amman, a preliminary presentation of findings was presented to more than fifty persons. The meeting was announced to those visited in the preceeding two weeks and notice was placed in the newspaper. It was obvious that there is real interest in improving the present date industry and in expanding into appropriate areas in the future.



Some of the participants in the presentation by Mr. Laflin on July 19, 1995 in Amman. Dr. Salem Al Lozi, Director General of AMO is in the center, front of picture above.

More participants in the presentation on July 19. Picture above shows Loret Mansour, Office Manager of AMDP, Sigma One, Mr. Laflin and Nasser El Ali of Amo. Pictures courtesy of Fred Nustas, Project Manager of AMDP, Sigma One. Slides and photos of areas visited and a period of questions and answers supplemented Mr. Laflin's talk.

II. ORIGIN AND DISTRIBUTION OF THE DATE PALM

Several thousand years before its cultivation prehistoric man used the fruit from wild palms and carried the seeds over the wide area from India through the Middle East and later to North Africa. The date palm (Phoenix dactylifera L.) was known to ancient peoples as the "Tree of Life" and is probably one of the first fruit trees to be cultivated. Representations of the date palm, dating back to 3,000 BC appear on Sumerian temple walls , in present-day Iraq. In Egyptian hieroglyphics the date palm is used as the symbol for a year and its frond is the symbol for a month. Date palm logs were used to roof royal tombs as early as 2700 BC. The words for "sweet" and "date" are identical in Egyptian, suggesting that by the time writing was invented the date was already known.

The date palm contributed so much to the material needs of early peoples who cultivated it that it became a sacred tree to them. No other plant contributed so much toward making the desert habitable.

Date seeds were probably carried around the Mediterranean Sea by Phoenician traders. Introduction of date culture into the Saharan oases was furthered by the introduction of the camel and the Arab advance across North Africa. Subsequent pilgrimages of faithful Moslems back to their homeland in Arabia promoted exchange of varieties in North Africa.

The first date palms in North America came from seeds planted by Spanish missionaries in the 1500s. The first commercial offshoot importations were made around 1900. The only places in the United States with a climate suitable for the production of dates are the hot desert valleys of Southern California and Arizona, although the trees will grow over a wide area in gardens and parks.

The date palm is mentioned more than 60 times in the Bible and it is highly recommended to the followers of Islam by the Prophet himself. Dates and milk are thought to be an almost perfect diet, and modern-day dieticians agree. For many months of the year desert dwellers for centuries depended upon the date trees of the oases for their food.

Although we think of present day date farming as more scientific and advanced, the following excerpts from JANI AN-NAHLAH FI KAYFIYYAT GHARS AN-NAHHLAH by Amin bin Hasan Hulwani Al-Madani, Teacher in the Haram an-Nabawi (the Prophet's Mosque),and published in Medina in 1886, reveal how very similar our farming is to the original methods.

"The purpose of this article on planting date palms is that they may be of all the palms in the world the strongest and stoutest and heaviest yielding and so firmly fixed in the earth that no storm can uproot them. Know then that date planting in the olden times was known only to the inhabitants of al-Madinah, and that date palms were their dearest possessions, and that it was of them that they used to boast; but, with the passing of years, they forgot how to plant correctly; and they began to plant anyhow in the style of Khaybar and Egypt and Morocco and other places, where care is not taken of palms.

Then, in the year 1260 A.H. (1844-5 A.D.) the people of al-Madinah woke up to this fact, and learned again how planting should be carried out from the people of al-Qasim, that is to say, from the people of Buraydah and 'Unayzah and ar-Rass'

There are seven rules to be observed in the correct cultivation of date palms.

The First Rule: Dig a hole one metre cube...Return two-thirds of the earth to the hole and leave one-third unreturned. Then plant the offshoot. Water the offshoot with a little water, so that the heart is not drowned, daily for sixty days, until it is apparent that the shoot has stuck and put out new roots in the earth surrounding it, and produced small new fronds, whereupon another ten centimeters of earth should be filled into the hole. Do likewise, as new fronds appear and the shoot grows, until you are certain that the shoot has become strong and stuck and produced many fronds. At this stage, watering may be heavy, because there is no further fear that the shoot may be drowned.

The Second Rule: Space palms at least ten metres apart. We have found that closely planted palms do not yield heavily. Supposing an acre (of land) were to be planted with a hundred palms and another acre with fifty, it is certain that the yield of the fifty would be greater than that of the hundred.....Heavy yield results from a large number of roots. The presence of a large number of roots depends on the presence of friable soil. This is the reason for first digging out a hole and then filling it up again when planting offshoots. There is no doubt that roots can penetrate better and more easily in loose earth than in hard ground.

The Third Rule: Choose a shoot for removal from a palm of known variety, which bears heavily of good dates....because the date palm is like the sons of Adam who resemble their parents.

The Fourth Rule: The first year that a palm bears....cut off all the bunches and throw them away, because the removal of the first yield strengthens the heart of the palm. It will be found that, supposing a palm bears two bunches in its first year of yielding, and these are removed, the next year it will bear five in their place."

The Fifth, Sixth and Seventh Rules concern the necessity for removing offshoots to give more vigor to the mother palm, a rule for cutting fronds when they hang downwards of their own accord, and irrigation practices.

It is interesting to note how similar today's accepted cultural practices are to those recorded in 1886.

A. VARIETIES OF DATES

Varieties of dates differ greatly, both in the characteristics of the tree and in the fruit. All commercial date varieties were once chance seedlings which appeared good to their owner and which were then propagated by means of offshoots from the mother palm.

The fruit of the date palm in *tamar* is generally classified as soft, semi-dry or dry. Examples of a soft date are Medjool and Barhi. A semi-dry date is like the Deglet Noor or Zahidi. A dry date is like the Thoory (also called a "bread date", a staple of diet for desert people).

Where dates are all consumed locally, most of the palms are usually seedlings, but in each of the more important date growing and exporting countries, good varieties have been selected, named, and planted in commercial gardens. In Jordan several good local varieties have been recommended by those farmers growing them. If they give good production and good quality, they should by propagated.

Some varieties are best if picked and marketed as *khalal* and or *rutab* fruit. In Jordan the Egyptian varieties Hayany and Zagloul are successfully grown. Zagloul is marketed in the *khalal* or hard-red stage, and Hayany is usually marketed in the *rutab* or very soft stage. Barhi is an excellent Iraqi variety which is delicious in the *khalal* or hard-yellow stage. It is being grown in several large date gardens in Jordan. Several other local varieties and some seedling dates are grown and sold immediately as fresh dates for local consumption.

Tamar dates require more care in handling and storing. For the export market, the Medjool, which originated in Morocco, brings the most money, but it must be handled carefully to produce top quality fruit. The Medjool is especially susceptible to Bayoud disease which has destroyed almost all of the Medjool trees in Morocco. Fortunately 11 offshoots were sent to the United States in 1927. They grew and multiplied there and now the US is the principal supplier of Medjool offshoots and Medjool fruit to the world. The variety has wide acceptance in Europe and Australia, as well as the United States.

Other good commercial varieties include Deglet Noor, Halawy, Khadrawy, Khalas, Zahidi and Barhi, which is an excellent *tamar* date as well as good in *khalal.* It is usually softer than the Medjool and must also be handled carefully. It is probably a good idea to grow several varieties of dates. Some are more tolerant of rain and some ripen earlier or later. You can spread out the period in which you have fresh dates to sell by having several varieties growing in each of the suitable date growing areas of Jordan.

III. BASIC REQUIREMENTS OF THE DATE PALM

A. Distribution by Latitude

The date palm needs a long, intensively hot summer, without rain or excessive humidity for the period from pollination to harvest. It also needs plentiful irrigation. The palms grow best and fruit best within an area 20 to 30 degrees N. Latitude. Trees will grow beyond this zone, but fruiting is not successful. Clearly Jordan is located within this favorable zone.

B. Distribution by Altitude

Altitude affects temperature. A dictionary of geography gives the average lapse rate in the atmosphere at 1 degree C. in about 183 meters, so the temperature 1,830 meters up a mountain would be, other things being equal, 10 degrees C. colder than at its foot. Of course, there are other factors that affect temperature such as slope of the land and the tendency of cold air to collect in the lowest spots, but in general, the distribution of date palms within the above-mentioned latitudes is largely determined by the temperature limits imposed by altitude and the availability of water. It would seem from data collected in all of the date palm growing areas of the world that the palm flourishes and fruits within a range of 1,892 meters--from 392 meters below sea level to 1500 meters above sea level. Jordan has possible date growing areas within these limits.

C. Climatic Factors

Temperature is a very important factor in determining suitability of an area for date culture. This table shows annual average temperatures for various date growing areas.

Table 1.—Average daily and annual maximum air temperatures at five subtropical stations in the United States as compared with those in Basra, Iraq, and Touggourt, Algeria

Station in—	Length of record	Average daily maximum temperatures												Average annual maximum temperature
		January	February	March	April	May	June	July	August	September	October	November	December	
	Years	° *F*	° *F*	° *F*	° *F*	° *F*	° *F*	° *F*	° *F*	° *F*	° *F*	° *F*	° *F*	° *F*
Miami, Fla.....	19	74.3	74.8	76.8	79.7	82.5	86.9	86.9	87.3	86.0	82.8	77.6	75.2	80.8
Carrizo Springs, Tex	8	66.5	73.5	78.7	85.9	91.3	19.1	99.1	99.2	93.4	85.0	74.0	65.5	84.0
Phoenix, Ariz	35	65.0	69.1	74.1	81.8	90.0	100.9	102.7	100.9	96.7	85.9	74.5	65.0	83.9
Yuma, Ariz	53	66.7	72.0	78.1	85.4	92.5	101.9	105.5	104.1	99.6	88.0	76.2	67.2	86.4
Indio, Calif	25	69.6	74.8	79.6	86.2	92.7	102.1	106.5	105.5	100.6	90.7	80.4	70.7	88.3
Basra, Iraq.....	19	60.0	65.2	73.7	84.0	94.3	100.6	104.4	104.9	101.3	90.6	77.0	64.0	84.9
Touggourt, Algeria..	15	62.6	67.1	73.0	82.2	90.1	99.0	106.3	104.2	96.8	84.2	71.2	63.3	83.4

TABLE II

CLIMATIC DATA FOR CRITICAL PERIODS IN COUNTRIES WHERE DATES ARE GROWN*

Station	Latitude N.	Average Daily Air Temperature			Average Rainfall		
		No. yrs. record	Maximum May to Oct. incl.	Minimum Jan.	No. yrs. record	July to Oct. incl.	Annual
Multan, Pakistan	30° 12′	10	102.5	43.3	?	4.75	7.30
Basra, Iraq	30° 34′	19	99.4	43.6	20	0.14	6.42
Muscat, Arabia	23° 37′	18	101.4	60.6	27	0.14	4.17
Alexandria, Egypt	31° 12′	45	83.8	51.1	62	0.28	7.24
Cairo, Egypt	30° 2′	37	92.7	45.7	37	0.08	1.02
Dakla, Egypt	25° 29′	21	99.4	40.6	15	0.00	0.04
Gabes, Tunisia	33° 57′	40	84.7	42.8	10	2.29	7.82
Touggourt, Algeria	33° 9′	15	96.6	38.1	16	0.31	2.27
El Kantara, Algeria	35° 12′	9	88.5	36.5	15	2.28	9.71
Erfoud, Morocco	31° 26′	12	97.5	34.3	12	0.83	2.72
Elche, Spain	38° 16′	6	82.7	44.4	1	7.00	15.9
Indio, Calif.	33° 43′	25	99.7	38.6	53	0.66	3.00
Phoenix, Ariz.	33° 28′	35	96.2	38.7	55	3.07	7.43
Carrizo Springs, Texas	28° 32′	8	94.0	40.4	17	8.93	20.57

*Data from official records of countries named, supplied either direct or through the U. S. Weather Bureau with the exception of that for Multan, Pakistan, which is from Milne and which omits the rainfall for October, probably less than 1 inch and not included in the July-October average.

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No place on earth seems to be too hot for the date palm, but in places where the heat is very intense, the dates may ripen hard and dry rather than soft and sticky. The principal date-growing areas of the world, lying on either side of 30 degrees N. Latitude, are sometimes hotter than many regions within the tropics, probably because of low humidity and long summer days. Total heat units are what is important, and some varieties of dates require more than others. Zahidi variety, the most common variety in northern Iraq, is the least damaged by cold, and varieties like Khalas are the most delicate. It appears that high minimum temperature is more important than high maximum temperature. S. C. Mason was the first to point out the important fact that the woody and fibrous trunk of the date palm provides massive insulation against extremes of air temperature, making the date palm the most resistant of all the palms to extremes of heat and cold.

Studies have shown that the date palm will flower only when the shade temperature rises to 17.8 or 18 degrees C. and will form fruit only above a temperature of 25 degrees C. and that it needs a total of 5 100 degrees C. of heat units reckoning from 0 degrees C. to ripen dates completely. Interesting calculations of heat units are given in FAO Bulletin 35, pages 11-17 (Appendix B of this report) and would be useful in assessing the date producing potential in particular locations in Jordan.

Rain often does good by washing away some of the salt in the soil, but if it occurs during the period a few hours before or after pollination it may reduce the amount of fruit. The chief damage is caused when dates are in the soft *rutab* stage. The dates absorb moisture and swell and splits occur in the skin, resulting in mold, rotting and dropping of the fruit. For this reason, rainfall records should be consulted before planting dates in specific areas of Jordan.

Early ripening varieties such as Medjool are suitable for areas where rains occur early. Since dates are generally not harmed while in the hard green *kimri* stage, early summer rain is not a problem. Apparently most of the potential date areas of Jordan are rainless until late November or December, so rain should not be a problem. Actually, the amount of rain is less important than the conditions under which it occurs. A light shower, followed by a long period of cloudy weather and high humidity can cause more damage than a heavy rain followed by clear weather and drying winds.

Humidity influences the characteristics of the ripe date fruit. Where the humidity is high, the cured, *tamar* dates are soft. Where the humidity is low, but the heat great, the date cures to almost rock-like hardness. High humidity just before harvest can do more damage than a rain shower, especially on the Deglet Noor and other varieties most affected by high humidity.

Light does affect the growth of date palms. When the intensity of the sunlight is reduced by clouds, the violet rays of the spectrum that inhibit growth are of less intensity. Obviously most dates are grown in sunny countries, where the sky is virtually cloudless during the ripening season. The date palm tree grows chiefly at night.

Wind does not seem to trouble the date palm, but when it carries dust and sand the latter may scar the fruit. It is likely that mites are carried from palm to palm by the wind. A strong wind may blow down an old, very tall palm if it is growing alone, or in shallow soil. Another danger comes if a large number of offshoots have been removed all around the base of the tree at one time, depriving the palm of support.

Palm trees can be very useful if planted as a windbreak around a field where other more susceptible crops are grown. This pattern of planting is recommended for Jordanian farmers who wish to continue growing other crops. When the palms begin to bear fruit, their "windbreak" becomes a source of income.

D. Soil Requirements

The date palm will grow in soils containing more alkali or salts than most other plants will tolerate, but palm growth and fruit quality are reduced under very saline soil conditions. Although dates are grown on a wide variety of soils, the maximum water-holding capacity consistent with good drainage is desirable.

Coarse sand requires excessive fertilization and irrigation and permits rapid leaching of minerals unless there is an underlying layer of more retentive soil somewhere in the first 6 feet. Good growth and production can only be expected if the soil takes water readily to a depth of 6 to 8 feet. If at all possible, before offshoots are planted in excessively saline soil, the area to receive the young plants should be leached to reduce salinity in the immediate area of the plants.

E. Water Requirements

When selecting a site for growing date palms it is important to investigate the availability of sufficient water, both for quality and quantity. All plants grow best on sweet water, but the date palm is probably the best fruit tree to be grown on salty soil with salty water. How salty (saline) is the question. Mature palms have been known to tolerate a salinity level of 5,000 ppm without losing much yield. Newly planted offshoots are susceptible to high salinity.

A mature palm tree, during the hottest time of the year will use 700 liters of water per day. Dr. John Carpenter of the USDA Date and Citrus Station in Indio,

California has stated "On a per-tree basis, a full-bearing date palm requires about 185 to 250 cubic meters of water per year, depending on water quality, soil type and drainage. This is based on a spacing of 8 to 9 meters between trees. Date palm trees will survive and even grow on less water, but to achieve the best fruit production possible, these water requirements should be met.

An accompanying chart gives a drip irrigation guide for date palms of various sizes by months of the year. Water consumption is calculated for conditions in the Coachella Valley of California.

Above--Mature date palms at Al Baqura Station in North Ghor. Most ripen in September and are sold as khalal (belah) or rutab fruit.

Irrigation Application Guide for Dates
(assuming 85% effeciency of water use)
(Do not use this guide for newly-planted offshoots)

Drip or Trickle Irrigation
Liters per day per palm

MONTH

Palm canopy diameter in meters	Consumptive Use in liters per palm per day											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
3 meters	23	23	38	42	53	65	84	72	65	49	38	30
6 meters	95	106	148	182	213	247	338	289	250	190	160	118
9 meters	224	236	334	410	475	555	756	657	562	426	357	262

NOTES: 1. Reference:The seasonal use of water by Khadrawy date palms. J.R. Furr and W.W. Armstrong. U.S. Date Field Station, Indio, Ca.
2. Design trickle systems for minimum of 46 liters per hour per palm. Maximum design application time should be limited to 18 hours per day
3. Newly planted offshoots will use much less water than that shown for palms with a 3 meter diameter canopy.
4. Above normal temperatures and below normal humidity will increase water requirements
5. Weedy conditions and high winds may increase water requirements.
6. Do not rely on this chart alone. Periodically check soil moisture to determine adequacy of irrigation.
7. Use this guide only to estimate crop requirements for the Coachella Valley of California

Provided by the USDA Soil Conservation Service, Indio, California.

See Appendix C for original chart, with consumption given in gallons per palm. Also included , for purposes of comparison, are charts showing consumption of water by grapes and citrus plantings in the Coachella Valley of California..

IV. METHODS OF PROPAGATION

The propagation of date palms is obviously extremely important if date production is going to become a viable and profitable industry in Jordan. There are three methods of propagation:

1. Growing date palms from date seeds is the first method. These palms are called seedlings because they come from seeds. They are extremely variable in their characteristics. About one half (1/2) will be males and one half (1/2) will be females. All of the palms will be different and the fruit will show a wide range of characteristics as to size, shape, color, consistency, sugar content, flavor, etc. They will nearly always be less desirable than selected, named varieties, although occasionally there will be an outstanding fruit. Offshoots from the palm producing that fruit should be saved and given a name as a new variety. We should keep in mind that all of our named varieties were once seedlings which were selected for their outstanding characteristics and propagated by means of their offshoots (fasila).

2. Growing date palms from offshoots (fasila) is the second method of propagation. Offshoots grow out from the trunk of the mother palm at, or slightly above ground level. Occasionally the offshoots will be produced higher on the trunk. The offshoots will be identical to the mother palm in every way since they are actually a part of the mother palm which can be cut off and grown in another place. The offshoots are genetically identical to the palm from which they came. The offshoots of male palms will be males with identical characteristics of the palm from which they came and the offshoots of the female palms will produce female with the identical characteristics of the female palms from which the offshoots came. This is the way particular varieties of date palms, such as Barhee, Medjool, Deglet Noor, Halawy, Khalas, Zahidi, Hayany, etc. have been propagated for centuries. This method of propagation remains the best way of getting a new date palm true to the parent variety.

Date palms will usually have some offshoots that are ready to cut from the mother palm by the time they are five (5) years old and will continue toproduce offshoots for about the next ten (10) years. The offshoots are ready to cut from the mother palm after they become twenty (20) centimeters or larger in diameter. Different varieties vary in their production of offshoots. For instance, an average Barhee palm will only produce about six (6) offshoots total while an average Medjool palm will produce about twenty (20) offshoots total.

There are certain things that are very important to remember when propagating by means of offshoots. First, it is important to do a good job of cutting the offshoot from the mother palm. There is a rather small connection which is only a few inches in diameter and only a few inches long between the mother palm

and the offshoot, and that is where the cut should be made to separate the offshoot from the mother palm. In order to do this it is important to clean the dirt away from the base of the offshoot to see what you are doing so as not to cut into the base of the offshoot or very much into the base of the mother palm. The cut should be clean, not ragged, and can be painted with an asphalt emulsion, such as Tree Seal, to help protect from organisms that might possibly cause rot. However, this is not usually done.

Undoubtedly the single most important thing to know about successful propagation of offshoots is the length of the leaves that are left on the offshoots when they are cut and trimmed for planting. A considerable amount of research has been done to try to determine the best length at which to cut back the leaves. The most important point to remember is that when an offshoot is removed from the mother palm, all the roots are cut back, so that they are only a few inches long. Most of what is left of these roots die back, and are not functional. The offshoot is not able to take up much water for several weeks, until new roots develop. Since practically all of the water loss is from the leaves, and the amount of water loss is determined by the amount of leaf surface, it is consequently vital to reduce the leaf area as much as possible during this period when the roots, or what is left of them, are not able to take up water to replace that lost through the leaves.

Several methods are useful in reducing water loss. They are:

1. Pruning the outside leaves off so that only about 8 or 10 of the central leaves remain. This reduces the leaf area.

2. Cutting the remaining leaves quite short, preferably to only 12 to 24 inches (30 to 60 cm), depending on the size of the offshoot, so that most of the actual leaf surface is removed.

3. Tying the leaves tightly together, preferably with twine, which can be easily cut when the central leaves are growing and the bundled leaves become tight, which is usually from 6 months to a year after planting.

4. Sometimes bundled leaves are wrapped with paper or cloth to further protect them from drying. If this is done, the top of the bundle should be left open so that new growth is exposed to sunshine and air, so that photosynthesis can take place. However, if the leaf surface has been sufficiently reduced by cutting the leaves back as recommended, it is usually not considered necessary to wrap the leaves.

5. If more than the recommended amount of leaf surface is left, it would be helpful to spray the leaves with an anti-transpirant like "Wilt Pruf", or a similar product.

I might add, that in going through some of the records regarding the first importations of date offshoots in the United States in the early 1900s, all of the offshoots died until they learned that it was necessary to cut off most of the leaves as I have described on the previous page. After that, most of the imported offshoots lived. My personal experience in planting offshoots on my farm in California has been that only five (5) to ten (10) percent die. We consider this a very good result. We then replant the skips the following Spring.

Often, when cutting offshoots of the proper size for planting in the field, smaller offshoots must be removed to allow access to the larger offshoot. These smaller offshoots can be planted in a nursery row and used for replants. They should not be dug the first year after planting. Give them at least two years to establish a good root system and rebuild the stored energy in their trunk to enable them to survive the transplanting. Small offshoots can also be planted in pots of adequate size to allow them to grow properly. They can be used for replants sooner since their root system will not be appreciably disturbed when they are planted in the field.

3. Growing date trees from tissue culture plants is the third method of propagation. It is also known as in-vitro propagation. This method has been developed quite recently and is, in fact, still in the process of being perfected. It began on a very experimental basis about 30 years ago. There are two distinct methods of tissue culture. The first one is called *somatic embryogenesis* and is used by the commercial tissue culture companies. It uses *meristematic* (undifferentiated) tissue, usually from the growing tip of the bud. Through the use of plant growth hormones it is induced to form *callus* tissue. This can then be induced to form embryos and then plantlets which can be grown in test tubes and gradually adapted to grow in pots and later be acclimated and transferred to a field.

There is a general sense that some genetic change takes place during the *callus* stage and that the plants may not be exactly true to type. I have personally grown about 50 tissue culture date plants on my farm and found that when they fruited, the fruit was not exactly true to the variety. Now, ten years later, the commercial tissue culture people assure me that they have improved their technique to the point that the general public will not notice the difference between the true variety and the dates from tissue culture palms.

At the present time comparatively few tissue culture palms have come into bearing so we are still learning. I think we should continue to propagate by offshoots some of the varieties we wish to grow. We know they will be true to type and can be used as backup and a source of material to produce tissue culture plants.

The other tissue culture method is usually called *organogenesis* and is the method being used for in-vitro propagation in Morocco at the present time. We visited a relatively new plant laboratory in Jordan at the Fahad Abu Kamer Nursery and talked with Dr. Assem Al Kalisy, who is using a technique similar to that used in Morocco. The results still must be field-tested, but the work to date looks very promising and could provide a good source of date palms true to the parent variety in the future. This method involves using the very tiny buds in the leaf axils of the terminal bud to produce little plants which produce more little plants. This method avoids the use of *callus* tissue and is felt by the scientists in Morocco to produce plants exactly like the mother plant. To my knowledge, this method is not used by any of the commercial tissue culture producers in the United States, England and France because it is a slower process. That leaves us with us these commercial companies as the only source at present for in-vitro (tissue culture) plants.

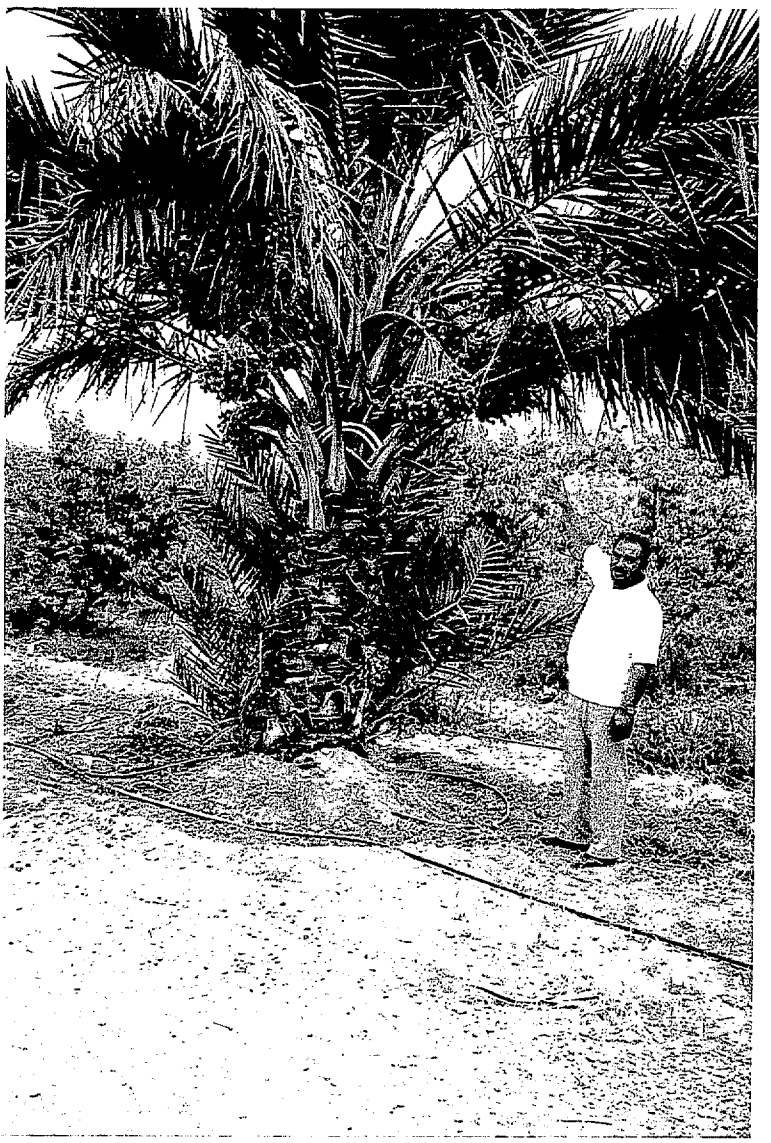
General Information with regard to Propagation of Date Palms

On a smaller scale than the quantities available of tissue culture plants, there are sources where fairly large quantities of offshoots can be obtained. Some are in the United States and possibly in Israel, although I have been told that the farmers there are planting most of their offshoots. I would be careful about importing offshoots from other areas. They are having a problem at present with *Indian Red Weevil* in Saudi Arabia and the UAE and I have heard that the Egyptians imported some offshoots from Saudi Arabia that carried the insect to Egypt. The *Bayoud* disease in Morocco is a very devastating disease of date palms. It has been moving into western Algeria and is to be very carefully avoided. There is no treatment and the tree always dies. *Broken Leaf* is in Tunisia and is another serious disease.

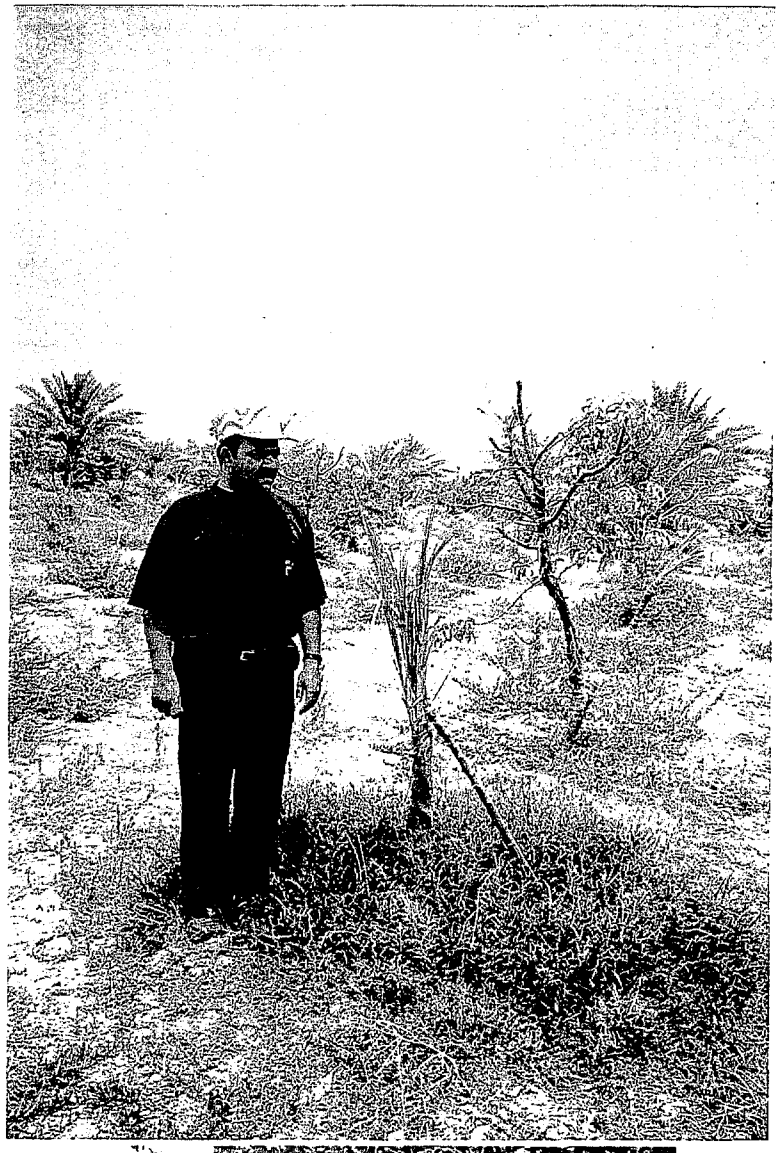
Another thing which should be mentioned with regard to propagation of young palms , whether by offshoots or tissue culture plants, is irrigation. When the plants are young it is important not to over-irrigate them. If a soil is saturated for very long it becomes *anaerobic (*no air is present). Palm roots need some air, especially the roots of young plants, and if the soil becomes *anaerobic* after a time the roots will rot and the young plants will die. It is important that after an irrigation there is a time when the soil is moist but not saturated. The time between irrigations depends on the texture of the soil. A very sandy soil with low water holding capacity needs to be irrigated more often than a soil with more silt or clay in it. Generally speaking, newly planted offshoots should be irrigated twice a week and after a month or two, if the soil has reasonably good water holding capacity, the time between irrigations can be extended to once a week. We usually irrigate our older palms every two weeks although when it is very hot we may irrigate a little more often. Water management is very important.

When we first plant offshoots we usually put 2 to 4 slow-release fertilizer tablets (21 grams each) around the offshoots at a distance 1- to 15 cm away from the trunk. That is all the fertilizer they need at the start. It is not good to put animal manure under or around a new plant that is just getting established since it is easy to burn the new roots. The second (2nd) year is a good time to start fertilizing, but not too heavily. Much more damage is done by over-fertilizing than by giving too little fertilizer.

The fertilizer can be gradually built up until when the plant is 5 or 6 years old it can receive a total during the year of about 2 1/2 kgs. of actual nitrogen per year. Nitrogen is usually the most essential element for good growth of date palms. Occasionally some response may be seen to potassium and/or phosphate. However it is not advisable to apply phosphate year after year because of a possible harmful buildup in the soil which can lead to micro-element deficiencies.



Right--10 year old Medjool date palm grown from an offshoot imported from California. It is on drip irrigation and is carrying a good crop. Offshoots from such a tree can be cut as they reach the right size and used to increase an existing planting, or be sold.



Right--Offshoots planted without cutting back leaves often die due to loss of moisture through the leaf area before new roots have a chance to grow and take up moisture from the soil.

Below--Offshoots properly cut back before planting. Covers may help avoid drying-out, but are usually not necessary.

V. GENERAL CULTURAL PRACTICES

A. Irrigation

Careful attention to irrigation in order to maintain good palm growth and high yields of fruit of the best quality cannot be stressed too much. Frequency of irrigation will depend on soil texture and weather conditions. Producing date gardens in light soils are usually irrigated every 7 to 14 days in midsummer and every 20 to 30 days during the winter, if flood irrigation is used. It is assumed that drip irrigation will be the generally preferred method of irrigation in Jordan. Growers in other date producing areas have had good success running their emiters continuously during the hot summer months. Where drip irrigation is used from an early age, the root distribution of the palms will be within the area of moist soil around the tree. It is very important that the emiters be moved out away from the tree as it grows taller so that a normal spreading root system will develop. It is also very important to let the soil aerate between waterings.

B. Fertilizer

Nitrogen is always needed, at a minimum rate of at least I kg N/tree/year. A rate of 1.5 to 2.5 kgs is much better. If the need exists for phosphorus and/or potassium, then a compound fertilizer should be used such as 20-10-10. With reference to P and K, if local vegetable crops do not show a need for these elements, then they are probably not needed for dates. In fact, excess P can be detrimental to micro-element nutrition.

If manure is used, the desired amount of nitrogen is easily calculated. Good steer manure usually contains about 2% nitrogen. 200 pounds of steer manure will give nearly 2 kgs of nitrogen per palm. Chicken manure usually contains about 3 or 4% nitrogen, but is high in P so it should be mixed about half and half with steer manure to reduce the possible detrimental effect of too much P on micro-element nutrition.

Vegetables or cover crops are often grown between young palms, but older palms planted in a commercial garden will shade out vegetable crops.

C. Pollination

Note: For convenience in this report, the word flower is used for the inflorescence at the time of pollination and the word bunch is used for the pollinated, growing fruits.

One of the very unique and distinctive operations in date culture is artificial pollination. It is a very ancient practice, going back to the time of Hammurabi in

Sumer. Apparently the Sumerians recognized the fact that it was wasteful to water and care for a seedling garden where half of the trees would be male and produce no fruit. One good male palm will produce enough pollen for 50 female trees if the pollen is collected and applied to the female flowers.

The most common method of pollination is to cut the strands of a freshly opened male flower and insert 2 or 3 of them among the strands of the female flower cluster, hopefully during the first few days after it has opened. In the United States, twine is tied around the pollinated cluster, not only to hold the male flowers in place but also to prevent the strands of the female flower cluster from becoming entangled in the leaves during the rapid growth that follows. To provide for expansion of the cluster as the fruit develops, the twine is commonly tied in a slipknot, having the free end long enough to permit later adjustment to the maximum size of the bunch. Sometimes, if the weather is cool or there is a chance of rain, a small paper bag is placed over the pollinated flowers, held in place by a date thorn. The bag will blow off later as the pollinated bunch grows.

In the United States, pollen is also dried and applied either on small pieces of cotton or with dusters. Dry pollen, protected from extreme heat, remains viable for two or three months. If stored in a sealed container and placed in cold storage it may be held until the next season. Actually, this is a good way to have pollen on hand in case you have some very early female flowers the next year, before the male trees bloom. Also, new pollen can be mixed with the older pollen to increase the amount of pollen available. There has been very little research done to study the effects of specific pollen on the time of fruit ripening or size of fruit, or effectiveness with particular female varieties. It is therefore a good idea to mix the pollens from several male trees before applying it to the female flowers, thereby increasing the chances for a good pollination on all varieties. It is a good idea to observe which of your male trees are the best producers of pollen and to plant the offshoots from those trees for future pollen production.

Pollination should be done at 7 to 10 day intervals until at least 10 to 14 flower clusters per bearing tree are pollinated. Many mature trees carry 20 good bunches. Excess or small, late flowers can be removed and discarded.

D. Thinning and Tie-Down

Without fruit-thinning, date palms tend to bear only in alternate years. The easiest way of controlling yield and alternate bearing is to limit the number of bunches per tree. The earliest flowers are usually the largest and most vigorous. Therefore, in studies on retention of various numbers of bunches per tree, it was shown that it is best to use the early, vigorous flowers and to remove later flowers in excess of the number wanted.

It is also important to pay attention to the onset of fruiting in young palms. Although palms may flower in Jordan in the second or third year after planting the offshoot, it would probably be a good practice to remove the flowers until the trees are four or five years old, in order to encourage vegetative growth. In the first bearing year not more than 3 or 4 flowers per tree should be left.

Better quality fruit is generally obtained by reducing the size of all the bunches retained. At pollination, about 1/3 of the upper portion of the flower is cut off. Four to six weeks later, when pollination success can be determined, enough center strands are cut out to leave 1/2 to 2/3 of the total strands intact.

Any method of reducing the number of fruits per bunch will increase the size and up to a certain point, improve the quality. Overthinning increases puffiness and blistering (separation of skin and flesh of the date). Slightly larger fruits are produced on the outer strands. The larger the bunch, the more fruit it can carry satisfactorily. The earlier thinning is done, the more effective it is in increasing size.

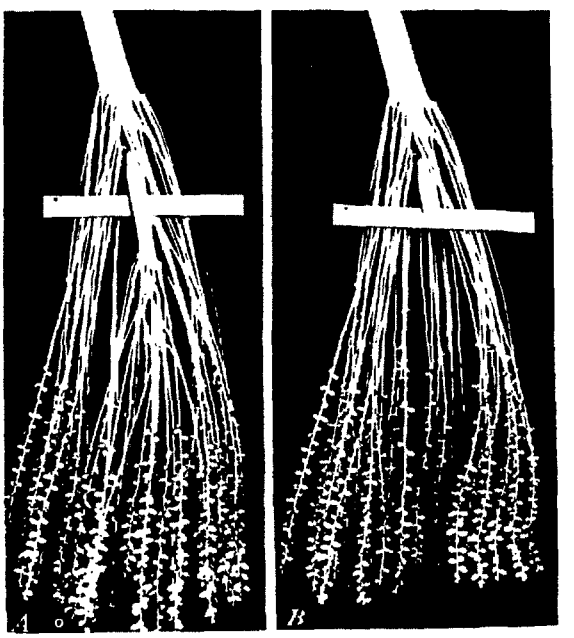
Most commercial growers follow a practice of pulling down and supporting the bunches. This is usually done at the time of the second part of bunch thinning. The fruitstalk is pulled down through the leaves and tied to the midrib of one of the lower leaves. This prevents scarring of the fruit and lessens the later danger of fruitstalk breakage.

Pulling down bunches should be done with great care to avoid breaking fruitstalks. Bunches should not be pulled down until the fruitstalk is long enough to permit some of the curvature to be distributed, so that the base will not take all of the stress. If it is not done until the fruitstalk has entirely ceased elongation, there appears to be more danger of breakage. Broken fruitstalks are an obvious loss, but partial breaks are also a source of shriveled or low-grade fruit. The fruitstalk grows rapidly for the first few weeks after pollination. During this time it is quite pliable and is easily bent at its base.

With young palms, bunches can be held off the ground by attaching the fruit stalk to one end of a wooden stake.

BN-8103-X

Figure 10.—Pollinating date flowers: *A*, Strands of male flowers being placed in the center of the female cluster; *B*, freshly opened spathe ready for pollination; *C*, flower cluster after pollination. Twine is tied around the strands to hold the male flowers in place and to prevent tangling in the leaves. The tips of all strands in the female cluster were cut back at the time of pollinating as the first operation of fruit thinning.



BN-8101-X

Figure 14.—Second step in bunch thinning long-strand varieties of dates (Deglet Noor): *A*, Bunch of dates cut back 6 weeks previously, as shown in figure 11; strands in front of ruler must be entirely removed to prevent undue crowding of fruit; *B*, same bunch after one-third of the strands have been removed by a single cut. (X about 1/16.)

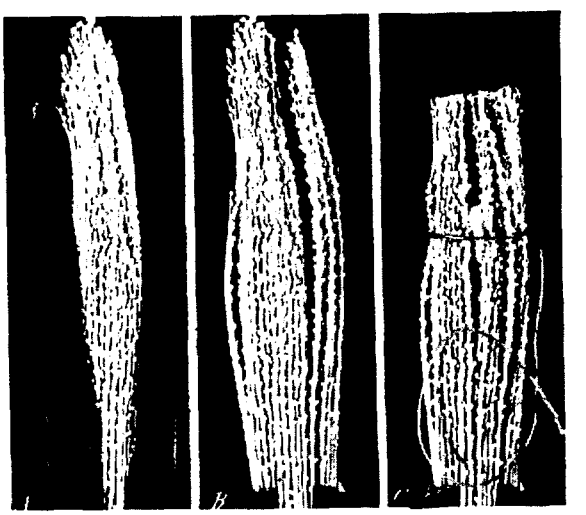


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Figure 15.—First step in bunch thinning short-strand varieties of dates (Halawy) at the time of pollination: *A*, Flower cluster just emerging from spathe; *B*, flower cluster with spathe cut away; *C*, flower cluster with just enough cut from the tips of the strands to remove about 15 percent of the flowers. Under some conditions it may be preferable to omit this and do all thinning by removing entire strands from the center. In *C*, note the cotton used to apply pollen and the twine around the strands to hold the cotton in place. (X about 1/8.)

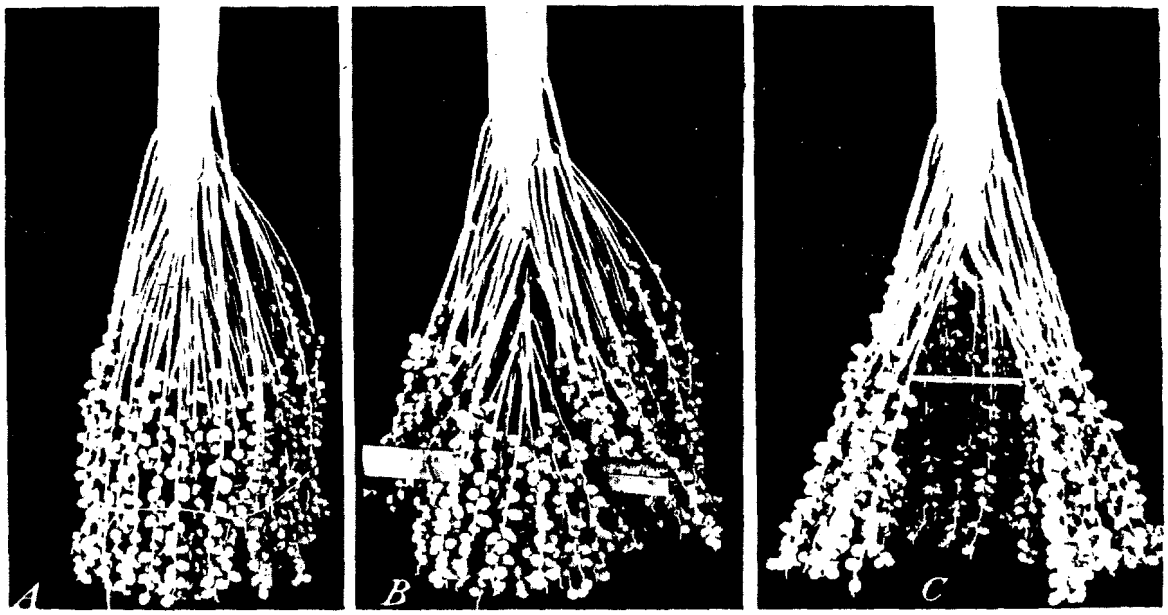

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Figure 16.—Second step in bunch thinning short-strand varieties of dates (Halawy) about 6 weeks after pollination: *A*, Bunch of dates before second step in thinning; *B*, bunch showing strands that should be removed from the center; *C*, bunch with outer strands held apart to show appearance after thinning. Half of the total number of strands were removed. If the tips had not been cut back at the time of pollination, about two-thirds of the strands should have been removed. (X about 1/9.)

BN-8097-X

Figure 17.—Bunches of mature Deglet Noor dates that received different thinning treatments: *A*, No thinning, which resulted in small fruit below commercial size and with a large percentage of shrivel; *B*, moderate thinning, which resulted in fruit of satisfactory commercial size and very little shrivel; *C*, excessive thinning, which resulted in serious reduction in yield, oversized fruit, and a high percentage of checking and blacknose. (X 1/11.)

E. Pest Control and Fruit Protection

This is probably the number one problem in growing good quality dates. There is not much profit in growing fruit for birds and insects.

Net bags or paper covers are effective in protecting the ripening fruit. The paper also serves a rain protection if the date garden is in an area with late summer rains.

Mites, which create a webbing on the fruit and reduce its quality can be controlled with sulfur dust. It should be applied about the last of May or the first of June. In severe infestations, a second application may be necessary a month later. Sulfur applied as a spray is also effective.

5% Malathion dust, applied in the field, controls the Nitidulid and other small dried fruit beetles.

As further protection, in California the dates are fumigated with Methyl Bromide when they are taken to the packing house.

In our visits to several agricultural field stations in Jordan, the following diseases and pests were mentioned, and in some cases, the present method of control was given. The diseases are:

Leaf miners
Oryctes elegans, a trunk borer
*Batrachedra amydroula,*the lesser date moth
Oligonschus, a mite
Parlatoria date scale
Diplodia
Thielaviopsis paradoxa, Black Scorch

Mocar is used as a soil fumigant; Decis is used for *Oryctes*; Sanmite and other miticides are used for *Oligonschus;* Benlate is used for Black Scorch.

The optimum use of pesticides both as to rate and frequency will vary in different sections of the country and depending on the severity of the infestation. Pesticides mentioned here are available in verious formulations that contain varying amounts of active ingredients. For example, 1 pound of active ingredients equals 2 pounds of a 50% formulation. The user is cautioned to read and follow all directions and precautions given on the label of the pesticide being used.

F. When to Pick Dates

Because all the dates on any one bunch do not ripen at the same time, it has been the practice in the United States to make several pickings to harvest the fruit during a season which lasts from 3 to 4 weeks for early maturing varieties and 2 to 3 months for the late ones. Dry dates like Thoory and the semi-dry variety, Zahidi, are left until all the fruit is fully ripe and then the whole bunch is cut down. In the United States, Deglet Noor is usually allowed to ripen completely on the bunch and then the whole bunch is cut down and the drier fruit is softened by hydration. This makes for cheaper handling by the packing house and cheaper harvest cost by the farmer. It definitely reduces the quality of the fruit, however.

For handpicking of softer varieties, the stage of maturity at which the fruit is picked depends on local weather conditions, consumer preference and variety. Where or when the weather is favorable, the fruit of most varieties should be left on the palm until it reaches the stage of maturity at which it is to be consumed or stored.

At the present time, most dates in Jordan are sold as fresh or *khalal* dates. They are ready to pick when the fruit has turned to its characteristic yellow or red and it has lost excessive astringency. Hayany and Zaglool are two good red (almost black) varieties and Barhee is a highly prized yellow variety. Actually this is an excellent way to sell dates. Little is required in the way of packing facilities. The dates are taken almost immediately to market and payment is usually quick. Best of all, the dates weigh almost twice as much as they do when they have lost most of their water and have become *tamar* dates. Not all varieties can be eaten in this fresh state. Many are simply too astringent to be palatable.

Loss of astringency is associated with the loss of *khalal* color. Loss of moisture also begins at about the same time, as the date begins to dry down to become the kind of date which will keep for a relatively long period of time. Many people find that the fruit in this stage called *rutab* is the very best in taste, but it is very difficult to handle when it is moist and soft and it must either be eaten immediately or placed in cold storage or a freezer for keeping. People in Jordan, and most of the Arab world love dates in both *khalal* and *rutab* stage and there should be an excellent domestic market for such dates grown in Jordan. Both the United States and Israel ship *khalal* Barhee dates to Europe. Air freight makes it possible to fly these fresh dates into many of the Gulf States as well.

The most desirable stage of maturity for consumption varies with the variety. Some dry down to almost nothing if left on the tree too long. Many seedling dates have this problem. Some varieties ferment and sour more readily than others. To put fruit on the market in just the right condition is the problem of

both the grower and the packer. With best quality dates, like Medjool, it will be very important to develop grading and packing facilities that do not exist at the present time in Jordan. There is undoubtedly a domestic market for good Medjool dates, but highest prices are dependent on excellent quality and presentation.

G. Grading and Packing the Dates

In Jordan, some individual farmers have rooms on their farms to receive the dates and pack them for market. If the industry is to grow, it will be necessary to arrange for more packing facilities if top quality is to be achieved. Essential steps in preparing the fruit for market are fumigation, cleaning, grading, drying or hydrating to achieve the proper moisture content, packing and storing.

Methyl bromide is the usual gas employed for fumigation. It is very poisonous and should be handled with extreme caution. The fumigation room should be located so that direct outside ventilation can be provided for the removal of toxic gas.

Dates may be cleaned by passing them over damp toweling. Mechanical shakers lined with damp toweling and sloping toward one end permit softer fruit to be gently cleaned. Drier fruit is often cleaned with a compressed air hose, or the fruit may be run over a series of brushes.

Grading is necessary to remove culls and to separate the fruit into lots of uniform ripeness, consistency, size and appearance. In larger packing houses, a moving belt carries the fruit from the cleaner past the people who sort the dates. Small lots of dates may be graded on tables.

If dates are very soft when received at the packing house, they may be placed on shallow, screen-bottom trays and stacked in a well-ventilated room or in some version of a drying tunnel, where a fan draws air through the trays. This usually only takes a day or two in warm, dry weather. If the dates are too dry, the same trays may be used. The dry dates are spread out on the trays, moistened with water, and then the trays are put in a hydrating room, which is tightly closed. Low temperature steam is introduced and the fruit left is left for a period of several hours, depending on its original dryness and the softness desired.

Dates are packed in containers according to market demands. In 1995, the usual bulk pack box used in the United States is a 15 pound cardboard carton. Another standard box is the 10 kg box used by North African and Middle East packers. Fancy dates may be packed in a variety of 1/2 kg, 1 kg and larger packages for the consumer.

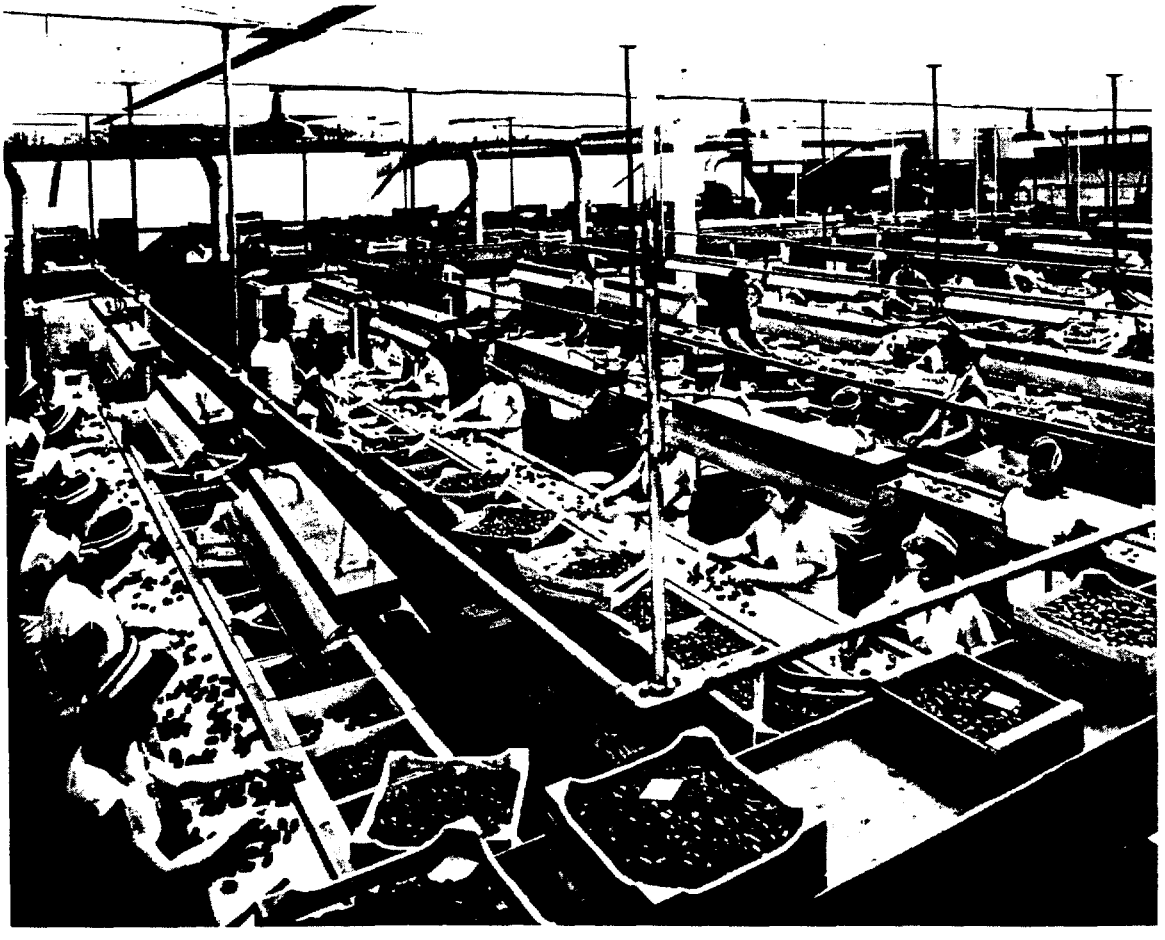

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Figure 21.—Grading dates in a modern date packinghouse. (Photographed by Field Studios.)

Only fruit that has been properly dried can be kept for any length of time without refrigeration. The higher the moisture content of the fruit, the more perishable it is. The lower the storage temperature, the longer the fruit can be held without deterioration. Fruit held at 0 degrees F. keeps for a year or more. Sugar-spotting, which is really the formation of sugar crystals under the skin of the date, can be delayed or prevented entirely by sufficiently low temperatures.

Itis probably very fortunate that Jordan has a culture that knows and appreciates dates, and it is quite likely that for awhile at least, all the dates grown in Jordan can be sold quickly on the domestic market. The acceptance of dates in the *khalal* and *rutab* stages will also be an advantage. This will give time for more adequate packing facilities to be built, or perhaps it will be possible to use packing houses now in existence for other crops to be used for dates in the off-season.

H. Pruning and Dethorning the Palm

During the winter, the spines are removed from all leaves of the previous year's growth to facilitate pollination and subsequent handling of fruit bunches. A sharp pruning knife with a long, curved blade, mounted on a handle 1 foot or more long, is the most frequently used for this work.

Yellow leaves should be removed from the palm. They are no longer working for the palm. The number and size of green leaves are the best indication of the health and vigor of the palm and its fruiting capacity. Differences in this respect explain some of the differences between varieties as regards yields.

There is no agreement among scientists as to the exact number of leaves the palm needs to produce a pound of fruit. Irrigation, fertilization and other factors also affect fruit production. Sixty leaves on a mature palm is a number sometimes given. There may be a reason for removing lower leaves that interfere with handling of the fruit bunches on varieties with short fruit stems. In countries where there is a market for date palm leaves, often leaves are considered a cash crop and more may be cut than is advisable. The fruit crop may be diminished by this over-harvesting of leaves.

BN-8106-X

Figure 9.—Removing spines from date leaves.

VI. EVALUATION OF PRODUCTION POSSIBILITIES AND RECOMMENDATIONS

Advantages:

We have talked to many people who are very much interested in expanding the date industry in Jordan. They are interested because they can see a profitable future for the date industry and we concur with their vision for the following reasons:

1. There is a large local demand for dates in Jordan which is not presently being filled by local production.

1994 consumption of dates in Jordan was 4,000 tons (4,000,000 kgs.)
1994 production of dates in Jordan was 1,000 tons (1,000,000 kgs.)

Jordan imported approximately 3,000 tons (3,000,000 kgs.) in 1994. Using a conservative estimate of production at 50 kgs. per palm of marketable fruit, it would take 60,000 date palms to fill local needs in Jordan. At 10 dunnums per hectare and 10 palms per dunnum, it would take 600 hectares (6,000 dunnums) of date palms, in addition to present production, to fill domestic consumption alone. (When figuring area (hectares) needed to produce a given amount of dates it is always necessary to add in some other factors such as roads, packing facilities, non-producing but very necessary male palms, etc.)

2. The preceeding figure of 600 hectares (6,000 dunnums) of palms needed for local demand does not take into consideration the possibilities for export to surrounding countries that import very considerable quantities of dates to fill the needs of their own people. Examples are Lebanon, Syria, and Turkey. Farther away, both Morocco and India are date importers, and the European market is open to quality fruit.

3. Jordan has some advantages that other producers and exporters do not have. The Jordan Valley is very hot and has a long growing season without rain. It does not appear to have a serious pest or disease problem, so it is capable of producing early, good quality dates for the market. It also has suitable locations in cooler areas which will produce later crops so that the season can be spread out over a long period of time. This is a very important advantage for varieties that are eaten in the *khalal* or "fresh date" stage--varieties like Barhee and Zaglool. *Khalal* dates now being grown in the Jordan Valley on the west bank of the Jordan River are two weeks ahead of those shipped to Europe by Tunisia, which formerly was alone in the early market. It is also an advantage to be early with other varieties since you can get your dates to market sooner than your competitors and thus be able to capture some of the higher early market prices.

4. Another advantage is an apparently adequate supply of labor that is not too expensive. Dates are a fairly labor-intensive crop so a good supply of labor at affordable prices gives you a competitive advantage on the market, especially when exporting to other countries. We were not able to see any actual records of the present cost of producing dates in Jordan.

Problems:

There are some problems to be overcome if date production is to be a profitable industry in Jordan, but they can be overcome if a well-planned and executed program is undertaken.

1. There is not a trained labor force that is knowledgeable with regard to date production--both in growing in the field and in handling in the packing house. There must be cooperation between the farmer and the packing house, or whoever markets the fruit. It must be grown well and handled well for all involved to prosper.

2. Another problem is the lack of an adequate supply of offshoots of good commercial varieties, and there is a lack of knowledge of how to plant and nurture them. Propagation of offshoots is covered in another section of this report. We found farmers, farm managers and agriculture station personnel eager to learn more about this important topic. Choosing the right varieties for particular locations is extremely important. For example, the Deglet Noor variety will be very hard and dry if grown in a excessively hot and dry area, but will be good in a cooler area. However, since it is a high-sugar, rather late-maturing variety, it still requires a lot of heat units. For this reason Deglet Noor has a rather narrow of conditions, including soil type, to which it is well-adapted. Some varieties are adapted to sandy soils and some will tolerate a wide range of soils. Some will tolerate higher salinity than others, etc. World-wide, the Medjool date has brought the highest returns at the highest profits. It is being grown in the Jordan Valley in Jordan on a small scale with very good results and there is a tissue culture Medjool planting at Al Guwaira which has not yet come into bearing. Medjool is the principal export variety of Israel and has been grown there for more than 30 years. It too needs the proper number of heat units, and on the west side of the Jordan River it is marginal when planted north of Mehola in Israel, approximately due west of Ajlun. Hayany variety grows north of that point because it is a lower-sugar date, harvested and sold in *khalal*, but it is a less profitable date, unless you have high local demand.

I prefer propagation by offshoots rather than tissue culture plants, if offshoots are available, principally because I am confident that my new trees will be exactlyl like the mother palm. If offshoots are not available, tissue culture plants

can be used and they, in time, will produce offshoots which the farmer can cut and plant to expand his own planting or to sell.

Do not even consider planting seeds in order to produce commercially marketable fruit. Most female seedling trees produce fruit of very poor quality and poor appearance and half of the seeds planted will produce male trees which bear no fruit at all. If you need some male trees for pollen, planting seeds may be a good option and you can select the males that seem the most vigorous and get rid of the rest. However, if it is possible, get offshoots of good selected males. An offshoot will always be exactly like the parent palm--male offshoots come from male palms and female offshoots come from female palms.

3. Still another problem is the shortage of good quality, low salinity water and the presence of a lot of soil that is saline in varying degrees. The good news is that dates will tolerate more salinity than almost any other cultivated fruit. Mature date palms will tolerate high salinity soils measuring up to 5,000 parts per million of dissolved salts without losing much yield. Newly-planted offshoots are more tender and an effort should be made to use the best water available while the plantings are very new.

In some saline soils, where citrus, apples, grapes and other fruits and vegetables grow poorly, dates will grow and produce quite well. This makes dates a very good crop in more saline areas. It will be important to assess the various potential date areas in Jordan with regard to salinity of water and soil. If there is the possibility of having a limited quantity of fairly sweet water and a larger amount of relatively saline water, studies have shown that fruit quality and quantity is improved if irrigation is done with the better water during the fruit producing time. The poorer water does less harm during the period of the trees' vegetative growth (after harvest).

4. It will be very important to choose varieties appropriate to the particular growing conditions in the various parts of Jordan. It must be remembered that growing good quality dates of high-sugar content requires a lot of heat units. Tables which accompany this report can be consulted for verification of the range. Such varieties as Deglet Noor, Medjool, Barhee, Halawy, Khadrawy and Zahidi do not ripen well and make a good quality date unless you have a long, very hot growing season. There are other low-sugar varieties such as Zaglool and Hayany that are usually eaten in either *khalal* or *rutab* stage that do not require as many heat units and for that reason can be grown in somewhat cooler areas. Probably the best information for your purposes is the experience of the date growers just across the Jordan River where they grow approximately 1600 hectares (16,000 dunnums) of dates, most of which are very good quality. Specific information as to which varieties do best and where they are most successfully grown is available.

If a decision is made to encourage the production of dates in Jordan, the following specific recommendations are made, to be implemented as funds and interest dictate, and not necessarily in the order listed:

1. Recommend to farmers the varieties of dates with the greatest commercial potential. If the considerable financial commitment required to begin growing dates is to be worthwhile, the varieties with the greatest possible success should be planted.

2. Establish new demonstration plots and expand existing demonstration plots in the several areas suitable for date production in order to show farmers all stages of growing and harvesting dates.

3. Assess water quality and availability for farming vs. other needs. The water needs of the City of Amman vs. the needs of farmers in the Azrak area is an example of the decisions that have to be made.

4. Educate people as to the ecological effect of palms. Date palms improve climate, make other agriculture possible in their shade and provide shade for people, animals and birds. Perhaps some joint funding with ecology groups might be available to plant date palms and derive income from the fruit of the trees.

5. Encourage growth of the present date industry by helping farmers achieve better survival of offshoots (fasila) which presently have a very poor success rate--estimated at 10 to 50%. With proper care of fasila there should be a success rate of 85 to 90%.

6. In older plantings, encourage farmers to remove excess trees of poorer varieties in dense plantings. Too many trees close together reduce individual tree yields and use water in quantities that cannot be justified by the fruit produced. There should be at least 7 to 8 meters between trees.

7. Establish marketing group(s) and set quality standards which can be monitored.

8. Encourage the growth of good packing facilities as more quality *tamar* fruit is produced. There will be a need for many more packing and grading facilities as the industry grows.

9. Establish Date Reference Libraries at existing Agriculture Stations such as Al-Baqura , Deir Alla, Al Safi, Aqaba and Azrak.

10. Educate the public as to the dangers of planting offshoots from areas where serious pests and diseases of the date palm exist, especially Morocco. Establish and enforce plant quarantine regulations.

11. Establish some kind of Date Growers' Institute which would meet regularly, (possibly annually) to exchange information and ideas. Persons from the Agricultural Stations, farmers and university researchers could be a part of such a group.

12. Many of those interested in dates in Jordan suggested the need for a good plant lab.

13. Establish a nursery of good commercial varieties of dates.

14. Establish contact with the Volcani Center at Bet Dagan, Israel, through Dr. Oded Reuveni in order to learn what the experience has been in growing dates just across the Jordan River from the possible commercial date areas of Jordan. They have 30 years experience in dealing with very similar soil, water and climate and have expressed a willingness to work with Jordan's date producers. Agricultural Marketing Development Project has the address of Dr. Reuveni.

15. Promote the consumption of dates within Jordan through a publicity campaign emphasizing the excellent nutritional value of dates used whole or in cooking.

16. Consider the feasibility of organizing date growers into groups which could buy fertilizer, pesticides, packaging materials and other supplies in bulk usually at a substantial savings to those participating. Such farmer's groups in a given area could also meet with Agriculture Extension Agents to share questions and information, and particularly to work together on marketing strategies.

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APPENDICES

Appendix A International Date Situation Analysis with accompanying Charts and Graphs

Appendix B Climate Requirements for Producing Dates FAO Bulletin Number 35, 1982

Appendix C Water Consumption Charts showing usage by dates, citrus and grapes in the Coachella Valley of California

Appendix A
Analysis of the International Date Situation

Based on FAO reports and an analysis of the international situation done in the United States in 1991, the following information with regard to date production and date markets for the years 1980 to 1989 is offered, with comments as to the current situation. So far as is known, there are no more recent studies. Pertinent tables and graphs are included.

The World Supply of Dates

World date production increased during this time period by about 25%. Total production was estimated at 3,113, 000 metric tons in 1989. Production is concentrated in Muslim and/or Arabic countries, with Middle East producers and North African countries accounting for 50% and 38% of the world supply. The world's largest producer of dates is Egypt (560,000 metric tons in 1989, which is 18% of the world's production). Other large producers include Saudi Arabia (16%), Iran (14%), Iraq (12%), Pakistan (9%) and Algeria (7%). Clearly the Gulf War in the 1990s was harmful to Iraq's date gardens and may have changed these numbers significantly. The prolonged Iraq-Iran war which preceeded it also had a devastating effect on those important date-growing areas in the Shatt-el-Arab.

Only a Small Percentage of World Production is Traded Internationally

Only about 6 to 7% of total date production (about 210,000 metric tons) was traded during the period 1980 to 1989. Three types of exporters were noted:

1.Producer-Exporters: large producers of dates with surplus to export, or which produce dates specifically for export. Major Producer-Exporters were Iraq, Saudi Arabia, Iran, Tunisia, Algeria, Oman and Sudan.

2. Producer-Traders: producing countries which export, but also import significant quantities of dates. Producer-Traders included Pakistan, Kuwait, the United States, United Arab Emirates and Egypt.

3, Re-Exporters: non-producing nations which re-exported imported dates. Major re-exporters were China, France, Singapore and Hong Kong. In Table II.1.a, Jordan is listed as a Re-Exporter, which probably accounts for the very high imports for Jordan shown on Graph III.3.6.

Iraq, Pakistan, Iran, Tunisia and China were suppliers for the United States and these five countries accounted for 75% of the world exports. Most dates exported were in bulk packages, whole and also with the seeds removed.

Who Imports Dates?

The top five importers accounted for 47% of the trade.

India took 14% of the total for domestic consumption.
China took 13% of the total for domestic consumption and re-export.
United Arab Emirates took 8% for re-export.
France took 7% for domestic consumption and re-export.
United States took 5.5% for domestic consumption.

When considered as one market, Europe was the leading importer of dates, taking 19% of all imports. At least 35 countries world-wide import significant amounts of dates.

World Date Markets

During the period studied the best markets were in non-producing areas such as Europe, Canada, Australia and the Far East. It appears in 1995 that there is also an opportunity in traditional date-consuming countries which do not produce enough dates to supply their domestic markets. Just how profitable such sales will be is uncertain. Many of the countries around the Mediterranean which formerly produced enough dates for their own domestic consumption have seen a flight of agricultural workers to cities, to jobs in the oil industry and to a variety of employment opportunities which offer better pay than farming. The Bayoud disease in Morocco has killed so many of its producing palms that Morocco is now an importing nation.

What will happen to the date market in Jordan when Iraq is again able to export its dates is a big question. Its proximity to Jordan makes it a logical supplier. However, Jordan has the advantage of expanding its present relatively small date industry using the best commercial varieties available--varieties which if properly handled will bring the higher prices associated with top quality, not only in such areas as Europe and Australia, but also in neighboring Arab countries which do not grow dates like the Medjool.

Emerging markets in Eastern Europe and Asia can increase the present demand appreciably, as can an increasing awareness of the nutritional value of dates. Much of the world has never tasted a date and has yet to experience this exceptional fruit.

I.2. Date Production per Region

Date production is centralized in the Middle Eastern and North African countries and in Pakistan where Arab and/or Muslim populations predominate, and the climatic conditions are favorable. Egypt, Saudi Arabia and Iran alone produce 48% of the world's dates (see Table I.2.a. and Graph I.2.a). The United States is the only significant date producer on the American continent. Dates from "Spain" are not grown on the European peninsula but rather on overseas territories. Virtually no dates are grown in the Far East or Asian countries.

Graph I.2.a.

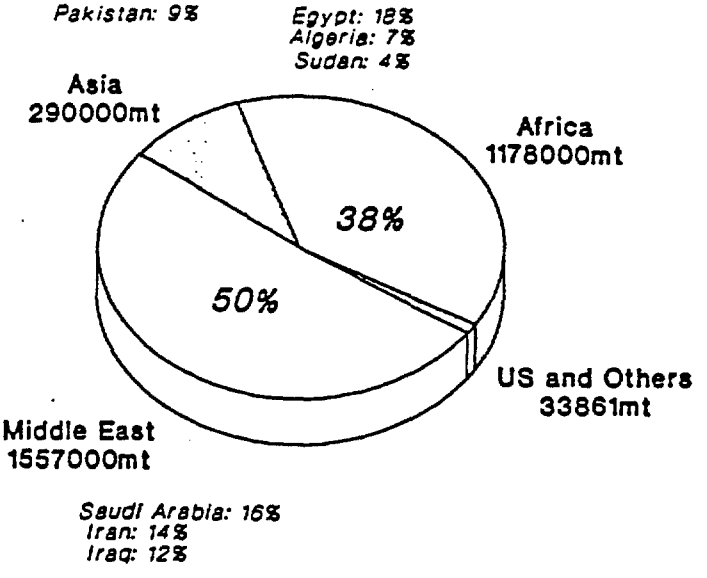


Chart based on 1989 Production Estimates

The Middle East produces 50% of the world date supply. North African countries, which are increasing production, represent 38% of the world supply.

Table I.2.a.

Production of dates per region

(countries producing over 1,000 metric tons)

	1980-89 Average	*1989*	*Total Region 1989*	*% of world production 1989* ▼
Africa				
Egypt	461,410	560,000		18%
Algeria	200,500	210,000		7%
Sudan	120,090	130,000		
Libya	96,600	105,000		
Tunisia	63,490	72,000		
Morocco	62,600	46,000		
Chad	27,800	32,000		
Mauritania	11,777	13,000		
Somalia	n.a.	10,000		
			1,178,000	38%
Middle East				
Saudi Arabia	448,550	500,000		16%
Iran	389,454	440,000		14%
Iraq	339,060	375,000		12%
Oman	82,000	121,000		
UAE	58,800	68,000		
Yemen AR	44,440	16,000		
Yemen Dem.	24,100	12,000		
Israel	6,600	9,000		
Turkey	n.a.	8.000		
Qatar	n.a.	5,000		
Gaza Strip	3.460	2,000		
Kuwait	n.a.	1,000		
			1,557,000	50%
Asia				
Pakistan	244,050	290,000		
			290,000	9%
North America				
United States	22,286	20,861		0.7%
Mexico	n.a.	2,000		
			22,861	0.75%
Other				
Spain	n.a.	11,000	11,000	

▼ World date production is estimated at 3,113,000 metric tons

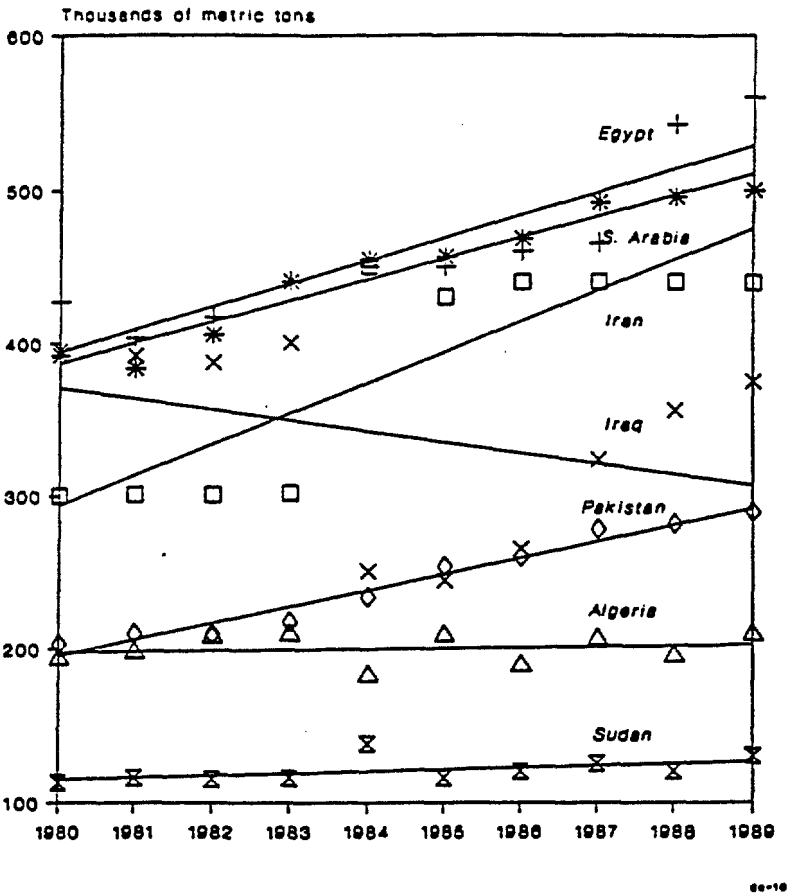
Analysis: The ten largest date producing countries in the world (based on a 10 year average) are: Egypt, Saudi Arabia, Iran, Iraq, Pakistan, Algeria, Sudan, Libya, Oman, and Tunisia. The Middle East represents 50% of the world production. North African countries provide 38% of the world supply.

Graph I.2.b.

Production of Dates: Trends

Major World Producing Countries

(FAO Estimates)



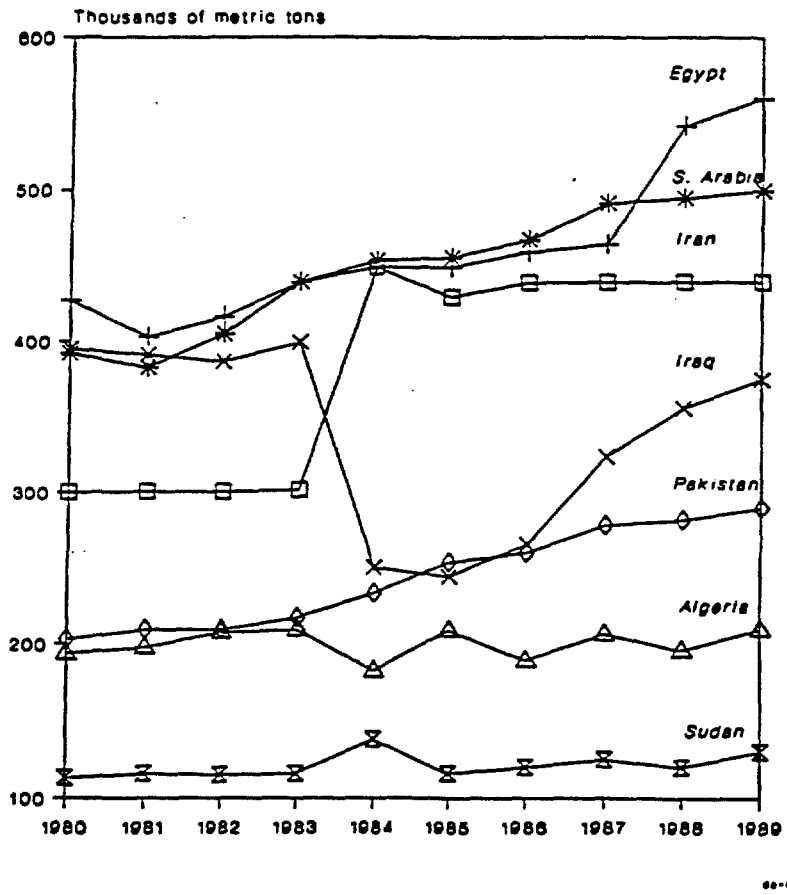
Egypt, Saudi Arabia, Iran and Pakistan are increasing production. Iraq, Algeria and Sudan display stable or decreasing production.

Date Production Trends per Region:

Graphs I.2.b. and I.2.c. present changes in production observed for the seven most important producers. Four countries present a positive trend towards increased production: Egypt, Saudi Arabia (growing at a similar rate), Iran and Pakistan. Date production in Algeria and Sudan is relatively stable. Production projections based on past year figures for Iraq indicated a decline in production of about 25% during the period studied. This decline will probably be accentuated by losses resulting from the Gulf War.

Graph I.2.c.

Production of Dates
Major World Producing Countries
(FAO Estimates)



Major Producing Countries

Dates are produced in over 25 countries worldwide. Table I.2.d. and Graphs I.2.d. present the production data of countries producing over 1,000 metric tons per year.

Table I.2.d.
Production of dates
(countries producing over 1,000 metric tons)

Country	*1980-89 Average*	*1989 Estimate*
Egypt	461,410	560,000
Saudi Arabia	448,550	500,000
Iran	389,454	440,000
Iraq	339,060	375,000
Pakistan	244,050	290,000
Algeria	200,500	210,000
Sudan	120,090	130,000
Libya	96,600	105,000
Oman	82,000	121,000
Tunisia	63,490	72,000
Morocco	62,600	46,000
UAE	58,800	68,000
Yemen AR	44,440	16,000
Chad	27,800	32,000
Yemen Dem.	24,100	12,000
United States	22,286	20,861
Mauritania	11,777	13,000
Spain	n.a.	11,000
Somalia	n.a.	10,000
Israel	6,600	9,000
Turkey	n.a.	8,000
Qatar	n.a.	5,000
Gaza Strip	3,460	2,000
Mexico	n.a.	2,000
Kuwait	n.a.	1,000

Analysis: About 25 countries are significant producers of dates. Other countries may produce small amounts of date, insignificant for the world trade.

Table II.1.a.

Top Exporters of Dates in the 1980-89 Period

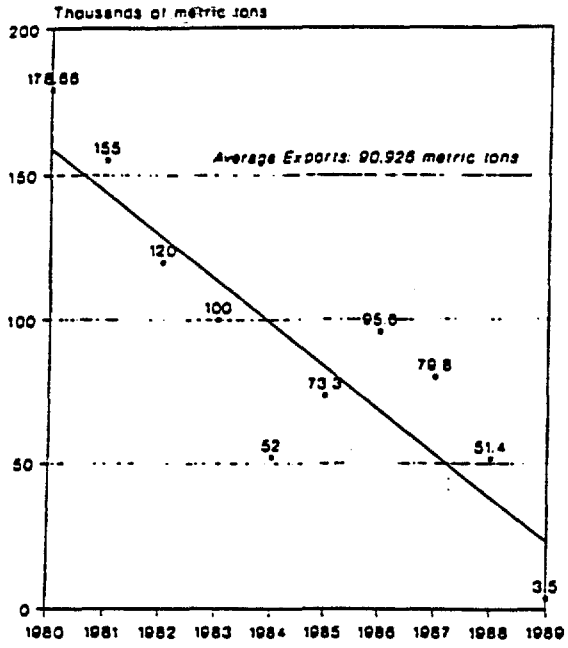
(average exports)

1980-89 Country	Exports	Exports as % of production	Imports	Exports as % of imports	Exporter Type
IRAQ	90,926	27%	--		EXPORTER
S. ARABIA	24,125	5%	2,717		PROD. EXPORTER
PAKISTAN	17,750	7%	7,712		PROD.TRADER
IRAN	14,481	4%	--		PROD. EXPORTER
TUNISIA	13,540	21%	--		PROD. EXPORTER
CHINA	6,550	N.P.	6,550	25%	REEXPORTER
FRANCE	6,026	N.P.	6,026	37%	REEXPORTER
KUWAIT	5,662	500%	6,040	98%	PROD. TRADER
U.S.	4,260	19%	11,846		PROD.TRADER
SINGAPORE	3,943	N.P.		60%	REEXPORTER
HONG KONG	3,818	N.P.		54%	REEXPORTER
ALGERIA	3,468	2%	5		PROD. EXPORTER
OMAN	2,506	3%	--		PROD. EXPORTER
JORDAN	2,212	••		20%	REEXPORTER
U.A.E.	2,030	3%	17,173		PROD.TRADER
SUDAN	1,212	3%	--		PROD.EXPORTER
EGYPT	887	<1%	1,960		PROD.TRADER
U.K.	860	N.P.		9%	REEXPORTER
TURKEY	610	n.a.	1,423	43%	PROD.TRADER
BELGIUM/LUX	427	N.P.		18%	REEXPORTER
SWITZERLAND	382	N.P.		27%	REEXPORTER
CANADA	207	N.P.		4%	REEXPORTER
NETHERLANDS	197	N.P.		20%	REEXPORTER
SPAIN	154	n.a.		10%	PROD.TRADER
MALAYSIA	125	N.P.		2%	REEXPORTER
GERMANY	112	N.P.		5%	REEXPORTER
DENMARK	65	N.P.		6%	REEXPORTER
NEW ZEALAND	51	N.P.		6%	REEXPORTER
YEMEN DEM.	18	<1%	3,459		PROD.TRADER
SRI LANKA	9	N.P.		<1%	REEXPORTER

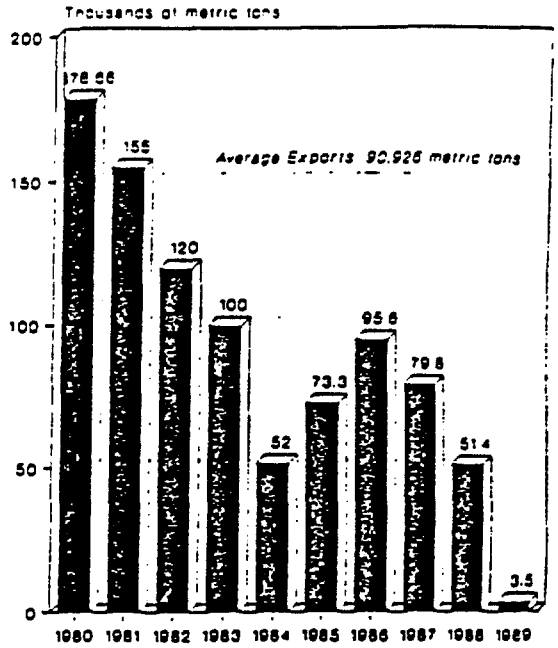
-- IMPORT INFORMATION NOT AVAILABLE
•• PRODUCTION IN THIS COUNTRY IS NEGLIGIBLE
N.P.. NON PRODUCER
n.a NOT APPLICABLE

Graphs II.3.1.

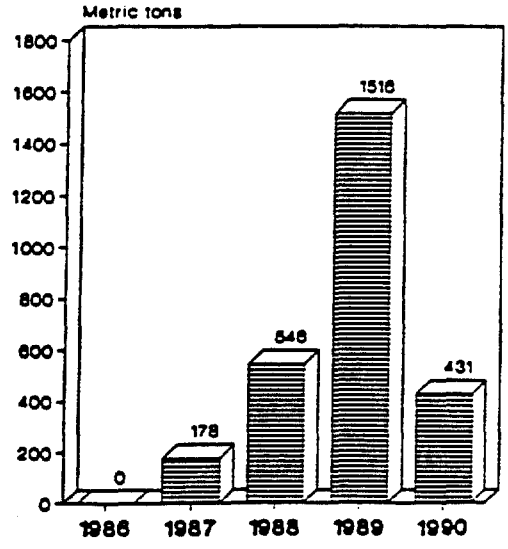
Iraq: Trends of Exports
(FAO Estimates)



Iraq: Exports of Dates
(FAO Estimates)



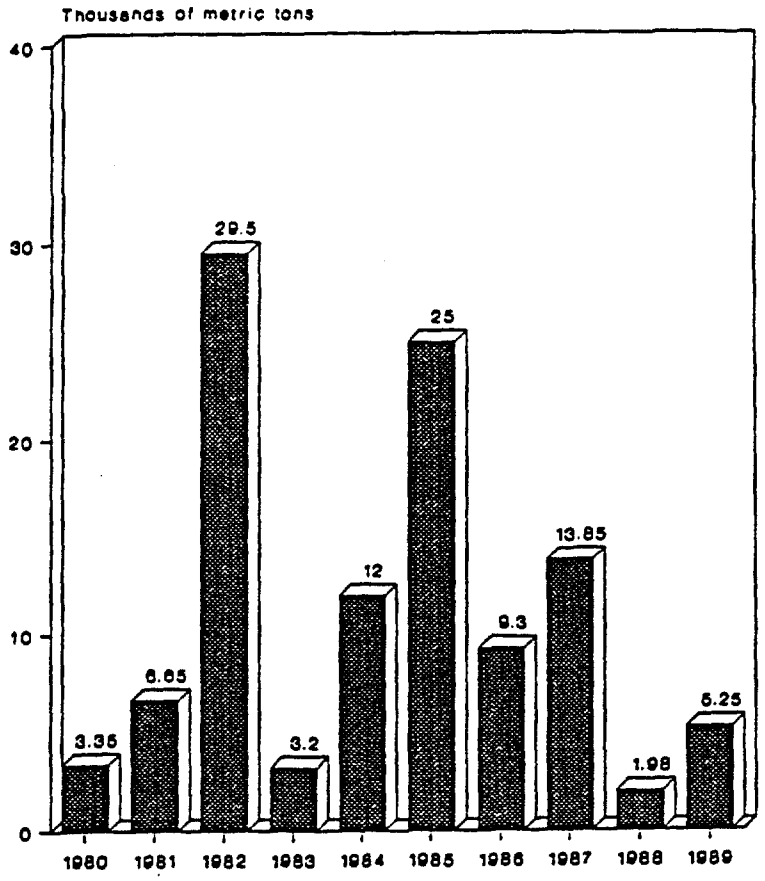
Iraq Exports to the United States, 1986-1990

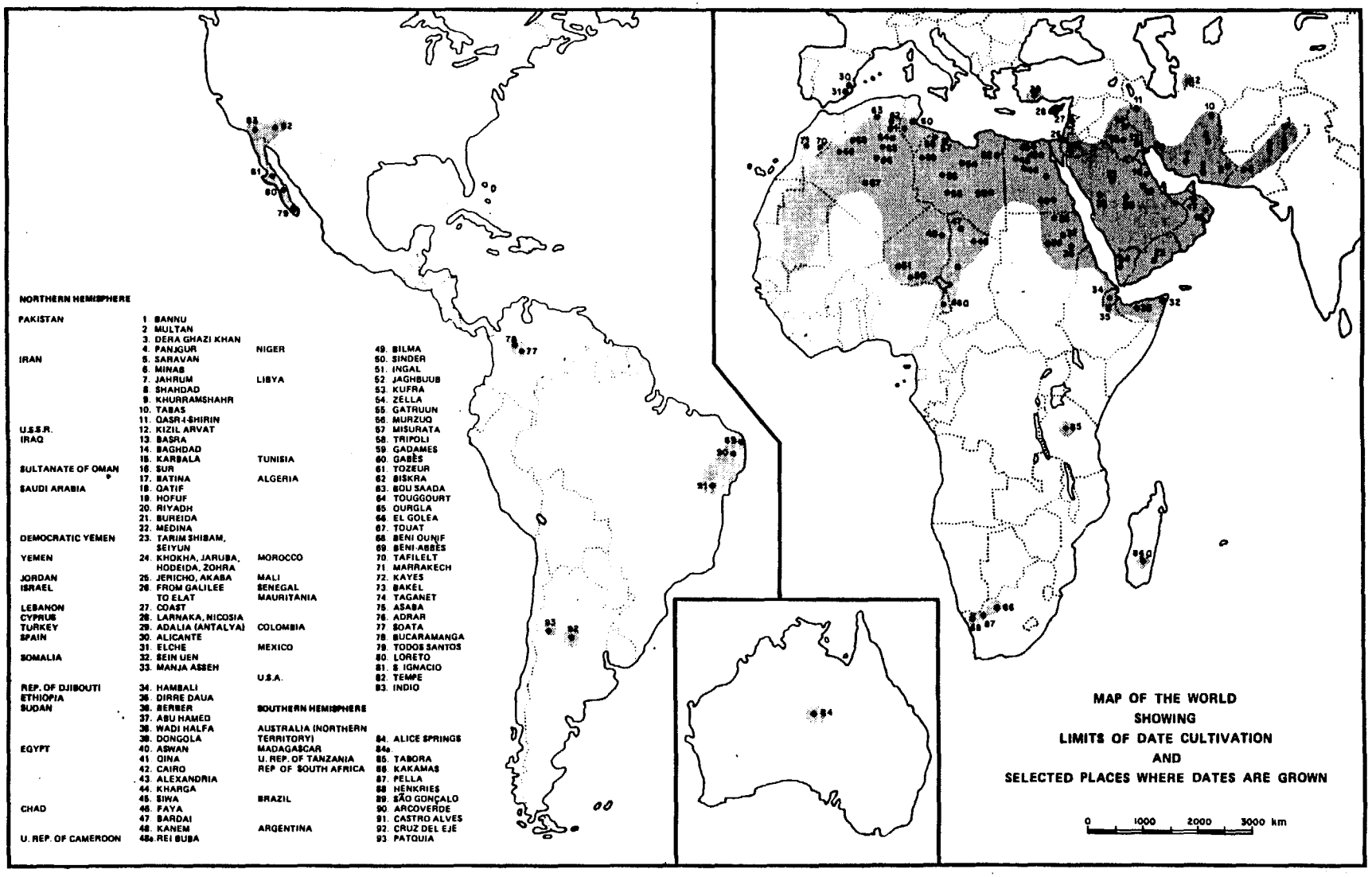


*Based on data collected by the USDA

Graph III.3.6.

Jordan: Imports of Dates
(FAO Estimates)




NORTHERN HEMISPHERE
PAKISTAN
1. BANNU
2. MULTAN
3. DERA GHAZI KHAN
4. PANJGUR
IRAN
5. SARAVAN
6. MINAB
7. JAHRUM
8. SHAHDAD
9. KHURRAMSHAHR
10. TABAS
11. QASR-I-SHIRIN
U.S.S.R.
12. KIZIL ARVAT
IRAQ
13. BASRA
14. BAGHDAD
15. KARBALA
SULTANATE OF OMAN
16. SUR
17. BATINA
SAUDI ARABIA
18. QATIF
19. HOFUF
20. RIYADH
21. BUREIDA
22. MEDINA
DEMOCRATIC YEMEN
23. TARIM SHIBAM, SEIYUN
YEMEN
24. KHOKHA, JARUBA, HODEIDA, ZOHRA
JORDAN
25. JERICHO, AKABA
ISRAEL
26. FROM GALILEE TO ELAT
LEBANON
27. COAST
CYPRUS
28. LARNAKA, NICOSIA
TURKEY
29. ADALIA (ANTALYA)
SPAIN
30. ALICANTE
31. ELCHE
SOMALIA
32. SEIN UEN
33. MANJA ASSEH
REP. OF DJIBOUTI
34. HAMBALI
ETHIOPIA
35. DIRRE DAUA
SUDAN
36. BERBER
37. ABU HAMED
38. WADI HALFA
39. DONGOLA
EGYPT
40. ASWAN
41. OINA
42. CAIRO
43. ALEXANDRIA
44. KHARGA
45. SIWA
CHAD
46. FAYA
47. BARDAI
48. KANEM
U. REP. OF CAMEROON
48a. REI BUBA
NIGER
49. BILMA
50. SINDER
51. INGAL
LIBYA
52. JAGHBUUB
53. KUFRA
54. ZELLA
55. GATRUUN
56. MURZUQ
57. MISURATA
58. TRIPOLI
59. GADAMES
TUNISIA
60. GABÈS
61. TOZEUR
ALGERIA
62. BISKRA
63. BOU SAADA
64. TOUGGOURT
65. OURGLA
66. EL GOLEA
67. TOUAT
68. BENI OUNIF
69. BENI-ABBÈS
MOROCCO
70. TAFILELT
71. MARRAKECH
72. KAYES
MALI
73. BAKEL
SENEGAL
74. TAGANET
MAURITANIA
75. ASABA
76. ADRAR
COLOMBIA
77. BOATA
78. BUCARAMANGA
MEXICO
79. TODOS SANTOS
80. LORETO
81. S IGNACIO
U.S.A.
82. TEMPE
83. INDIO
SOUTHERN HEMISPHERE
AUSTRALIA (NORTHERN TERRITORY)
84. ALICE SPRINGS
MADAGASCAR
84a.
U. REP. OF TANZANIA
85. TABORA
REP OF SOUTH AFRICA
86. KAKAMAS
87. PELLA
88. HENKRIES
BRAZIL
89. SÃO GONÇALO
90. ARCOVERDE
91. CASTRO ALVES
ARGENTINA
92. CRUZ DEL EJE
93. PATQUIA
MAP OF THE WORLD
SHOWING
LIMITS OF DATE CULTIVATION
AND
SELECTED PLACES WHERE DATES ARE GROWN
0 1000 2000 3000 km

APPENDIX B

CHAPTER II

CLIMATIC FACTORS

A. GENERAL

The number of plant species increases towards the equator, and decreases towards the poles. Similarly, as one approaches the sub-tropical deserts, the number of plant species rapidly become less. Of those that remain in the centre of the Old World sub-tropical deserts of the northern hemisphere and which survive their rigorous climate, the most striking is the date palm. This palm, unknown in the wild state, although typical of these deserts and widely spread over them, covers only an extremely small part, and produces satisfactory fruit on an even smaller one.

The date palm is not easy to place in one of the usually accepted classes of plants, grouped according to their normal habitat. Thus, this palm, although frequently found growing in sand, can hardly be classed as arenaceous, nor aquatic, although its root is characterized by air spaces like those of the banana root, and it grows well in situations where the subsoil water is very close to the surface. Nor is it a true halophyte, despite its healthy growth in exceedingly salty places, as it grows better where the soil and water are sweet. Nor is the date a xerophyte, since, although it has a thick, waxy cuticle, leaflets with the two halves of their upper surfaces to the sun, reduced leaf surface, and remarkably efficient insulation of the growing point and of the vascular bundles of the trunk, yet it needs a copious water supply. It has not the tiny, dry head above ground and the immensely long tap-root of a typical xerophyte, such as Caligonum Camosum or Pieris Sahariae. Its roots are adventitious and, though they grow horizontally a long way, the palm suffers when they have to search for water at a depth of more than about two metres.

The five most important climatic factors which determine the suitability of a site for horticultural purposes, are temperature, rain, atmosphere, humidity, light and wind. The effect of these factors on the growth of the date palm will be discussed in the following paragraphs.

B. THE EFFECT OF TEMPERATURE

1. Average Temperatures

The average daily temperature is usually given in climatic tables as the average of the daily maximum and daily minimum. The average of a larger number of records for each day would give a more accurate result, but the average of the two extremes is probably near enough to the true average to make that figure sufficiently useful for comparing the climates of different places with regard to their suitability for date cultivation. The annual average of the daily averages then give a useful filter, as it were, for the separation of those places which might grow dates, from those that are probably unsuitable.

Table 3 gives the annual average temperatures for various date growing regions.

Table 3

AVERAGE ANNUAL TEMPERATURES FOR DATES IN VARIOUS PLACES

Place	Country	Authority*	Temperature °C	Period
Basra	Iraq	1	24.2	1937-1941
Baghdad	Iraq	2	22.5	1937-1946
Tozeur	Tunisia	3	21.3	1901-1950
Touggourt	Algeria	4	21.45	1913-1938
Biskra	Algeria	4	21.8	1913-1938
Niamey	Republic of Niger	5	31.5	?
El Facher	Republic of Mali	5	24.8	?
Kidal	Republic of Mali	5	27.7	?

* 1 - Iraq, Prin. Bur. Stat. (1941)
2 - Iraq, Prin. Bur. Stat. (1946)
3 - Tunis, Service Tun. Stat. (1953 ?)
4 - Seltzer (401)
5 - Munier (299)

2. Minimum Temperatures

Mason (271) states that mature date palms at San Antonio, Texas, survived a temperature of 4°F (-16°C) for a short while, although the foliage was killed, that many hundreds of date palms in the Coachella Valley, California, survived minimum temperatures between 13 and 15°F (-11 and -9°C) on two days in 1913, and that growth was not checked by a short spell at 21°F (-6°). In the Coachella Valley, in 1937, between 3 January and 10 February there were 26 days on which the temperatures fell below freezing, and the total time that the temperature remained below freezing was 14 hours. For 4 hours and 50 minutes the temperature was below 20°F (-7°C), and the lowest temperature recorded was 13.4°F (-11°C). Severe damage was reported to most of the Valley's 146 000 date palms (Nixon, 319). Nixon further stated that he had never observed damage to dates when the minimum temperature was above 20°F (-7°C). He also noted that gardens that were irrigated during the freeze were less damaged than the dry ones.

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The Zahidi variety, which is the most northerly of the common Iraqi varieties, was one of the varieties least damaged, according to the speakers at the date growers meeting in Coachella at which the freeze was discussed, and the Khalasa was mentioned as among the varieties most damaged. The home of the last is much further south than that of the Zahidi, and thus some confirmation is given to the general belief that the distribution of date varieties in the date-growing districts of the Old World corresponds, at least to some extent, to their climatic requirements. See also Nixon (323) where he estimates the intensity of the damage caused by the freezes of January 1949 and January 1959 to 43 varieties growing in the Coachella Valley.

Mason's careful experiments show (271) that the growth of the date palm does not cease if:

(a) the minimum daily temperature does not fall below freezing; and

(b) the maximum daily temperature at the growth centre does not fall below a point between 48°F (9°C), and 50°F (10°C).

For short periods, the air temperature may be below this point, but the time lag between the air falling so low and the temperature of the growing point falling so low may be greater than the period during which the air temperature is so low and, therefore, growth would not stop. As Mason remarks, the sero temperature for growth is rarely reached in date-growing regions, and then only for very short periods.

Official meteorological records for January 1964 for Abadan, close to the head of the Persian Gulf, and for Ahwaz and Kut Abdullah, close together and both about 100 km further away from the Gulf, all date-growing districts are as follows:

Table 4

JANUARY TEMPERATURES, KHUZISTAN, IRAN.

Particulars	Abadan	Kut Abdullah	Ahwaz
latitude N	30°22'	31°13'	31°20'
Longitude E	48°13'	48°40'	48°40'
Elevation, m	3	15	20
Temperature, C, at 135 cm above ground, monthly average	7.8	7.5	-
Temp. C, at 135 cm, above ground, average of daily maxima	14.5	14.1	-
Temp. C, at 135 cm, above ground, highest	20.2	19.3	20.2
Temp. C, at 135 cm, above ground, average of daily minima	-	-0.9	1.1
Temp. C, at 135 cm, above ground, lowest	-4.5	-8.5	-7.0
Temp. C, at 135 cm, above ground, number of days minima less than C	-	16	10
Temp. C, at 2 cm above ground, lowest	-	-8.5	-1.3
Temp. C, at 2 cm above ground, monthly average	-	-2.8	-

In official meteorological records, 1964, it is stated that on 18 and 19 January 1964 an extraordinary weather situation occured. An unusually deep depression passed over Iran from the northwest, after the passage of which very cold air was transported from the inner parts of Asia over the whole country.

Meteorological readings have been taken at Abadan Refinery from 1914 to 1961. The cold spell that occured from the 19th to the end of January 1964 is the longest and most severe that has been recorded since 1914. /Presumably the records from 1961 to 1964 were kept at Abadan, but not in the refinery./

No adult date palms, and only a few shoots, were killed by the cold in the above mentioned places, but the number of fronds killed varied from a few in some (protected) palms, to nearly all in the others (more exposed). Perhaps the average number of fronds killed at Ahwaz and Kut Abdullah was about half the total, and at Abadan between a fifth and a quarter. The yield of dates in the autumn of 1964 was generally considered however to have been somewhat heavier than that of 1963.

3. Maximum Temperatures

Vinson (446) appears to have been the first writer to note that "high minimum temperature seems to be a more important factor in determining the maturity of the (date) fruit than high maximum temperature".

No place on earth seems to be too hot for the date palm; but in places where the heat is intense, the northern Sudan and the southern Fezzan, for example, the dates do not ripen into the usual syrupy and sticky stage, but into a very hard and dry form. It is, however, probably the dryness of the atmosphere rather than the extreme heat that hardens the date. The matter will be mentioned again under humidity.

An annual maximum shade temperature of nearly 120°F (49°C) is usual at Basra (Iraq) close to the river and somewhat higher at Shaiba in the desert. The absolute maximum shade temperature at Basra near the river between 1938 and 1952 was 123°F (50.5°C) in July, and at Shaiba 125°F (51.7°C). At Baghdad, 121°F (49°C) was recorded on 21 June 1943, and at Haditha on the Euphrates 123°F (51°C) was recorded in 1940.

The maximum recorded temperature during the years 1913 to 1938 at Biskra at the northern edge of the Sahara was 49.2°C (120.6°F) in August (Seltzer, 1946); at Touggourt, 200 km further south, in the same months and during the same period, it was 49.8°C (121.6°F).

/The report, quoted in successive issues of Whitaker's Almanack, that a temperature of 136°F (58°C) was recorded at Azizia in Libya on 13 September 1922, is open to grave doubt, because a study of the Italian original records shows much irregularity in the administration of the meteorological office in that hamlet in that year. Whitaker in 1965 (p. 1007) makes no mention of the Libyan so-called record but gives the same temperature for San Louis, Mexico, on 11 August 1933./

N.B.: The temperature of objects exposed to the sun may rise to as much as over 40°C above the ambient air temperature on a clear day in still air, but in a moderate breeze the excess temperature may be no more that 8°C (Iraq, Met. Dept., 1919).

The principle date-growing regions of the world, lying on either side of 30°N latitude are sometimes hotter in the summer than many regions within the tropics; the reason for the heat of the date lands is their low humidity, great insulation, and their long days in summer.

4. Diurnal Range

At Bushire, on the shore of the Persian Gulf, where dates grow well, but are generally eaten fresh, the greatest diurnal range of temperature occurs in November and December, and then amounts to no more than 9°C, whereas, at Baghdad, in Iraq, 500 km from the head of the Persian Gulf, the greatest diurnal range amounts to 17°C, and occurs in the months of August and September. Fischer (168) states that in the Algerian Sahara a daily range of 20°C is almost the rule, while a jump of as much as 40°C has been observed in 24 hours with a change of wind. Seltzer (401) gives the average diurnal temperature amplitude for Touggourt (1913 to 1938) as 14.8°C in July.

Cosson (96) seems to have been the first botanist to conclude that the high degree of thermostasy of the interior of the date palm trunk was due to the influence of the ascending sap stream from the roots, although other investigators (see Mason, 271) had already come to the same conclusion with regard to other trees. Mason was the first to study thoroughly the close correspondence between the temperature in the centre of the date-palm trunk and that of the sub-soil water, and to point out the importance of the massive insulation against extremes of air temperature provided by the woody and fibrous parts of the palm. As Mason rightly remarks, the date is the most resistant of all the palms to extremes of heat and cold.

5. Total Heat

It was De Candolle in 1955 (110) who first discovered that the date palm will flower only when the shade temperature rises to 17.8 or 18°C (64°F), will form fruit only above a temperature of 25°C (77°F), and that it needs a total of 5 100°C of heat units, reckoning from 0°C, to ripen dates completely.

Twenty-four years later, in 1879 (97), Cosson estimated the sum of heat units necessary as 6 000°C, while Fischer (168) calculated that the date palm from flowering to fruiting in Cairo received a total of 6 136°C heat units in the 239 days from 26 February to 22 October, and at Biskra of 6 216°C heat units in the 227 days from 24 March to 5 November. The earlier date in each place is that when the temperature first reaches 18°C in the year, and the later date is that of the last day in the year when the temperature reaches that limit. Fischer adds that Hardy, a former director of the Botanical Garden at Hamma near

Algiers, reckoning the period from the beginning of ripening to the complete ripening of the fruit as 214 days, calculated that the palms received 6 362°C of heat units. Swingle (419) made similar calculations in order to estimate whether various places in the southwest of the USA would be hot enough for dates. He took as his length of fruit growth season the 184 days from the beginning of May to the end of October, and used the daily maximum temperatures minus 18°C, which he considered gave a more reliable guide than the temperature reckoning from 0°C, since the flowering process does not commence below 18°C. His calculations for various places in the Sahara and for Baghdad were as follows:

Table 5

HEAT UNITS AND PRODUCTION - SAHARA AND BAGHDAD

(After Swingle, 1904 [419])

Place		Heat Units (C)
Laghouat Algeria	at 792 m on southern slope of outlier of Atlas Mountains north of Sahara. (30 000 date palms in whole district); Too cold for good date production	2 337 (= 4 243°F)
Biskra Algeria	at 122 m, close to southern slope of outlier of Atlas Mountains. 150 000 palms (800 000 in whole district). Excellent dates, but not quite hot enough for best quality Daglat Nuur.	3 049 (= 5 489°F)
Ayata Algeria	40 km N of Touggourt. Less than 69 m. Swingle says Daglat Nuur matures well if summers are hot but ripens imperfectly during cool years.	3 295 (= 5 932°F)
Touggourt Algeria	69 m, 170 000 date palms, (1 690 000 in whole district). Excellent Daglat Nuur.	3 666 (= 6 599°F)
El Golea Algeria	383 m, 7 000 date palms, (80 000 in whole district). No (or few) Daglat Nuur.	3 990 (= 7 182°F)
Baghdad Iraq	34 m, 2 211 000 date palms in whole district (Hussain, A.A.) Excellent climate for first-class dates.	3 898 (= 7 017°F)

Cook (93) in the Coachella Valley, using 1 December as his starting point and continuing for 242 days, that is, to the beginning of the harvest in the Coachella Valley at the end of September, and using the daily mean temperature in degrees F, and subtracting 50°F from each daily mean when it was above that figure, puts the total heat units at 6 900°F. Cook subtracts 50°F instead of Swingles 64.4°F (18°C), De Candolle's limit below which the palm does not set fruit, because for his daily temperature he uses the mean (instead of Swingles maximum) which, he considers, is on the average of about 14.4°F below the maximum.

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His figures, therefore, are moderately comparable with those of Swingle, if one consideres the heat units in October (which Swingle includes but which Cook does not), to be about as many as those of December to April inclusive (which Swingle does not include but which Cook does).

Munier (299) considers the fruiting period to last for 180 days for the so-called common varieties: Gharas, Daglat Beida, etc., and 200 days for the Daglat Nuur. He gives as the "norme denommée chaleur fructification", at Touggourt, 1 800°C for the "common" varieties and 1 890°C for Daglat Nuur.

Swingle made the total heat units for the dates in that place 3 666°C. These two figures agree pretty well considering that Munier uses the mean daily temperature and had access to a much shorter period of records (Seltzer 401).

For the present purpose, which is to correlate temperature with fruit production, one might expect the mean daily temperature to be better datum than the maximum temperature from which to calculate the amount of heat to which the palm is subjected.

Table 6 has been compiled mostly from Munier (298). It gives his calculations of the heat units received by dates from pollination to harvest at several, widely separated places where dates are grown in Africa north of the Niger.

Table 6

METEOROLOGICAL AND OTHER DATA FOR VARIOUS PLACES WHERE DATES ARE GROWN NORTH OF THE NIGER

Place Country	Touggourt (Algeria)	Atar (Mauritania)	Bilma (Niger)	Kidal (Mali)	Nema (Mauritania)	Kayes (Mali)
N Latitude	33°9'	20°38'	18°50'	18°27'	16°50'	14°26'
Longitude	6°2'E	13°12'W	13°30'E	1°21'E	7°00'W	11°28'W
Elevation m	69	229	305	479	266	below 200
Aridity Index	1.95	1.34	?	?	5.33	25.45
Heat units	1 800-1 890	1 875	1 950	1 960	1 903	1 980
No. of days, pollination to harvest	180-200	150	150	135	135	150
Date of pollination	?	1 March	15 March	1 March	15 Feb.	1 Jan.
Date of harvest	?	31 July	15 August	15 July	30 June	31 May
Date Rains begin (over 10 mm a month)	Nov.	?	?	May	?	?

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C. RAIN

Rain often does good by washing away some of the salt in the soil, which is the chief trouble in much of the date country, but if it occurs during the period, a few hours before, or a few hours after pollination it may seriously reduce the set of the fruit, unless the pollination is repeated when the weather dries up. (See Nixon, 333 Chapter 10). The chief damage caused by rain occurs when either the rain is early or the dates are late in ripening. Rain does not always damage the dates when they are in the hard glossy, green or yellow (and red) stages, although it can sometimes cause severe checking, and cracking in the late green (Kimri), and coloured (Khalal) stages. When the dates are in the soft "rutab" stage however, rain and the associated humidity causes severe damage including rotting, and fall.

In almost all places where dates grow, the winter rains start sometime before the last of the dates are harvested. The extremely late varieties like Khasaab and Hilaali, however are not damaged, because they are still in the hard glossy stage and will be eaten like that. Some early varieties, for example the very early Al Mehtari of Minab, on the southern coast of Iran which, like the dates in Kidal, Mali (see the section "Total Heat"), take only 135 days from pollination to ripening, entirely escape rain damage. In other cases, where the rains are early, much of the crop can be saved by being cut in the hard yellow (or red) stage and boiled. Drying on the ground after boiling takes a week or 10 days. The dates are then sacked and stored under shelter. Alternatively, crops harvested before being properly cured on the palm may be finished off on the roofs or in the yards of the cultivators, being taken inside their huts when rain is imminent, and put back outside when the rain stops.

At Minab and in Makran in Iran, much of the crop of rutab is passed through simple but effective man-power presses to expel the syrup, which is then preserved in earthenware jars, while the now drier dates are stamped into baskets. Both the syrup and the dates can be kept for several months, whereas, if the soft dates were left in that state, there would be much wastage.

Varieties of dates differ in their susceptibility to rain and himidity. The Deiri (Dayri) variety for example, which in Basra is a hard date, in the climate of the Coachella Valley of California is semi-dry, its quality being improved by the higher humidity of its new home. Nixon (325) found it to be one of the least damaged of sixteen varieties by rain and humidity.

The foregoing shows that little can be learned of the suitability of any particular place for date growing by a study merely of annual totals of rainfall. Autumn rains are the important ones for the date grower; spring showers at pollination time can generally be dodged or pollination can be redone.

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Table 7

RAINFALL IN VARIOUS DATE GROWING PLACES

Country	Place	Period	Rainfall mm July	Aug.	Sept.	Oct.	Nov	Authority*	Harvest begins
Pakistan	Multan	?	60	50	8	0	2	3	
Oman	Masqat	1903–1940	0	0	0	2	10	1	
Iran	Bushire	1886–1938	0	0	0	2	40	1	
Bahrein	Bahrein	1917–1938	0	0	0	0	10	1	
Iraq	Basra (Shaiba)	1914–1938	0	0	0	2	22	1	Mid-August
Iraq	Baghdad	1888–1918	0	1	0	2	21	2	Mid-Septembe
A.R.E.	Cairo	?	0	0	0	1	3	2	
Tunisia	Tozeur	1901–1950	1	2	7	9	12	6	
Algeria	El Oued	1913–1938	0	0	3	7	13	5	
Algeria	Touggourt	1913–1938	1	1	2	5	11	5	
Algeria	Biskra	1913–1938	1	2	7	7	12	5	
Niger	Niamey	?	133	226	93	24	0	4	
Mali	Kidal	?	37	68	20	3	0	4	Mid-July
Mali	El Facher	?	114	136	30	5	0	4	

* 1 – Hodgson (202)
2 – Iraq Met. Dep. (214)
3 – Milne (277)
4 – Munier (299)
5 – Seltzer (401)
6 – Tunis Ser. Met. (436)

Table 7 shows that the main date-growing regions are almost rainless until November, with the exception of Multan, where the monsoons break in July, and where the dates are mostly eaten fresh, and with the striking exception of the three places in the Republics of Niger and Mali, where there is heavy rain in July, August and September, and where November is dry. Munier does not state whether the dates cure on the palm in these two Republics, but one would suppose that they are harvested at an early stage.

D. HUMIDITY

The date palm is par excellence the fruit tree of the arid lands of the torrid zone. Air humidity has a considerable influence on the date palm. Where it is high the well-known date palm fungus, Graphiola phoenicis (Moug.) Poit., is common and the well-known pest, the Date Mite, is absent. Where it is low, the fungus is absent and the mite common.

Where the humidity is high, the cured dates are soft, rutab stage, which precedes that of the cured date in a more normal environment. Where the humidity is very low, but the heat great, the date cures into almost stone-like hardness.

The influence of humidity is plainly seen at Basra in Iraq, where the prevailing summer wind is that which blows from the northwest over the dry, bare, scorching deserts of Syria, Jordan, Arabia and Iraq. If this wind blows continuously up to the date harvest, the dates are dry and hard. The Hallaawi variety is especially susceptible to damage by excessive dry wind. The dates shrivel at the apices, the bases remain yellowish, and the flesh is hard. /The name given to these dates is Abu'l Khusheim, "The Father of the Little Nose"; with reference to the yellowish shiny shoulder/ On the other hand, when there are long spells of calm days with a slow drift of almost saturated air up from the Persian Gulf, the dates become soft, sticky, difficult to handle, and are easily damaged. The best results from the point of view of grower, packer, and merchant are obtained in those years, which are in a majority, when the northwest wind, the Shamaal, blows steadily in the early part of the ripening season, followed by a shorter period of the south-westerly drift, the Sharji (Sharqi), and with 10 days or so of Shamaal to finish the curing process.

At places such as Bahrein, and Minab in Iran, where the humidity is very high during the whole of the ripening season, great loss is caused by the falling of the soft dates to the ground. High humidity just before harvest can do more damage than showers of rain followed by bright sunshine and drying winds.

The measure of humidity which would appear to represent numerically most simply the relationship between the texture of the ripe date and the humidity of the atmosphere is the average monthly percentage relative humidity for the months of July to October. Relative humidity may be defined as the ratio of the mass of water vapour per unit volume of the air to the mass of water vapour per unit volume of saturated air at the same temperature (Uvarov and Chapman, (441).

A striking series of old records from the Gulf area is provided by those from Baghdad in the north, where the desert influence is (or was, when the records were taken) strong, from Basra which, although close to the sea, is chiefly influenced by the northwest desert wind, and from Bahrein, a small island in the midst of an extremely hot and steamy sea. The records are given in Table 8.

Table 8

RELATIVE HUMIDITY AT 08.00 HOURS, BAGHDAD, BASRA AND BAHREIN.

Iraq, Meteorological Department, 1919

Place	N Lat	Period of Record	Averages of % Relative Humidity			
			July	Aug.	Sept.	Oct.
Baghdad	33°21'	1838–1918	37	40	42	51
Basra	30°25'	1900–1918	51	51	55	60
Bahrein	26°15'	1905–1919	68	74	74	77

Notes: Baghdad — Chief variety, Zaahidi, rather tough. Excellent Khastaawi, Khadraawi (Baghdad type) etc. Hard varieties (chesib), e.g. Ashrasi, common.

Basra — Excellent dates cured on palm just right for packing direct into cartons or cases without any hydration or dehydration.

Bahrein — Few varieties, e.g. Hallau, cure on palm. Most only reach rutab stage on palm and have to be dried in the sun on the ground.

Table 8 could have been extended to include the Sultanate of Muscat where the average daily relative humidity at 08.00 hours is 81, and which is well known as a date producing country, but to have done so would have been misleading, because the meteorological station is in the town, close to the shore of the bay, and surrounded by mountains. The air of Muscat town in summer, therefore, is rather like that of a minute kitchenette on whose stove a large cauldron of water is boiling vigorously. Where the dates grow, however, is along the 180 km shore to the northwest of Muscat. The gardens are bounded on the west by copen desert, from which come the prevailing winds, more especially of course, the night wind, so that the dates ripen reasonably well on the palms. For the best quality, however, one has to go inland to the mountains of the Fardh country, less influenced by the daily off-sea wind.

The temperature and humidity within a date grove are different from those in the encircling desert and the bigger the grove, the bigger, up to a point, are the differences. Returning in the evening from the still hot, dry desert to the date gardens, one notices their comparative coolness and dampness, especially if much alfalfa is growing below the palms. Meteorological records taken outside the gorves, therefore, even in places only a little way into the desert, for

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example Shaiba aerodrome near Basra, do not exactly represent the conditions within the groves.

E. LIGHT

Mason (272) has shown that light rays at the violet end of the spectrum inhibit the growth of the date palm which, therefore, grows chiefly by night, and that it is the rays at the other end of the spectrum that are most active in promoting photosynthesis.

The intensity of sunlight may be reduced by clouds. On the whole, the sky is un-clouded in the date countries during the ripening period. Lasserre (241) gives the average number of cloudless days from July to October during the years 1916 - 1920, in three of the most famous date districts of the northern Sahara, as Touggourt 38, Biskra 52, and El-Oued 75.

F. WIND

Wind does not seem to trouble the date palm much. In a gale, whereas bananas growing below the palms will have their leaves torn to shred, the date palm shows no damage. It may be, however, that the nearly black, indurated patches sometimes seen on the developing green dates are due to wind beating the tender dates in their earliest stage against the hard fronds, and not merely to rough handling of the female inflorescence at pollination.

Wind as a carrier of dust and sand is objectionable. Such dust is especially noticeable when it lodges in the webs spun on the date bunches by the Date Mite. Sand and dust do not adhere to the date in its glossy, green, and yellow stages, but they can, and do, adhere to the dates in their soft stage, though much less than one might expect. It has been suggested that mites are carried from palm to palm by wind.

A strong wind may occasionally blow down and old palm if it is very tall, has a large crown, and is growing in shallow soil. A palm can also be blown down if a large number of off-shoots have been removed from all round its trunk at one time, thus depriving it suddenly of its support, or if the Bandicoot Rat has gnawed away the roots on one side of the palm.

Wind can reduce the temperature of the parts of the palm exposed to the sun by convection and by increasing evaporation at the stomata.

Strong, hot, dusty summer winds from the desert can dry up vegetation. Young tomatoes and other vegetables can be killed and citrus and other fruit trees damaged. The date palm however, withstands such winds with equanimity, and is particularly useful in the oasis in breaking the force of the wind, and sheltering more susceptible vegetation. (Langronier and Monciero, 240).

Wind creates sand dunes, and causes them to travel and bury date gardens

and the villages dependent upon them. Sometimes the dunes will not entirely cover the palms, whose crowns, once perhaps 10 m above the ground, appear only a short way above the sand. Sometimes the dune may travel on and the trunks of the palms will gradually emerge. If the sand has covered the trunks for a long time, a mass of roots may be found hanging from them from ground level to near the crown.

The chief labour of date cultivators in the Oued Souf, to the east of Touggourt in the northern Sahara, is the daily and continuous carrying up of sand from the great pits in the dunes in which the palms grow and into which it has been blown by the wind, and emptying their baskets and donkey panniers over the crest of the encircling walls of sand.

Appendix C
Water Use of Various Crops and Salinity Tolerance Table

SHOULD YOU PLANT DATE PALMS?

If you will refer to the irrigation guides for dates, citrus and grapes, you will see that dates use substantially more water per given area. (It should be noted that Medjool dates appear to use about 20% less water for a given canopy size than the Deglet Noor variety, and the Medjool will also tolerate a much wider range of soil conditions.(I do not have irrigation guides for other crops.) In an area that is short of water this is a disadvantage. However, dates have a big advantage, where it is necessary to utilize saline soil and water. A look at the chart showing salt tolerance of various crops shows that mature date palms will tolerate salinity rates as high as 5,000 parts per million (4 to 8 millimohs or Decisiemens per meter) and still produce a good crop of dates. Pomegranates, figs and olives will produce well only up to 2500 parts per million of salinity and citrus, apples and grapes only up to 1300 PPM

Since, in Jordan, salinity even more than the quantity of water may be a limiting factor, it is very important to check out all of these factors before deciding what to plant. If the salinity of the soil is very high--perhaps 4,000 PPM, you can probably grow a normal crop of dates but only a very poor crop of citrus, apples, grapes or bananas. If the salinity of the soil and water are low, then it may be better to grow a crop other than dates.

Then, too, you must calculate all other factors such as expected yield, expected price and availability of water (as well as its quality) to make a decision whether to grow dates or some other crop. The bottom line--relative profitability of various options is what counts. The dates Jordan is presently growing and marketing within the country are not a reliable measure of what the returns could be if the principal commercial varieties were grown efficiently, graded and packed as tamar fruit for sales within Jordan and for export. You will have to decide what crop will give you the best returns per dunnum.

WHICH CROPS ARE MOST SALT TOLERANT?

Barley, Sugar Beets, and Cotton

Crops differ very much in salt tolerance. Except for a few of the tolerant crops, yields drop off as salinity increases so that there is no "safe limit". If, however, small decreases in yield are permissible, then approximate salt tolerance limits can be given.

Plants that can tolerate:		
Up to 4-8 millimhos or Decisiemens/meter or 2560 to 5120 PPM	Only up to 2-4 millimhos 1280 to 2560 PPM	No more than 0.5-2.0 millimhos 350 to 1280 PPM
	FIELD CROPS	
Barley, Cotton, Beets	Rye, Wheat, Oats	Field beans, Sweet corn
	FORAGE CROPS	
Bermuda grass, Barley	Tall fescue, Wheat Sudan grass	Alfalfa, Vetch
	VEGETABLE CROPS	
Economically not feasible	Tomato, Asparagus, Broccoli	Spinach, Radish, Celery, Cabbage, Green beans, Lettuce, Sweet corn, Bell peppers, Carrots, Onion, Squash, Peas, Cucumber
	FRUIT CROPS	
Date	Pomegranate, Fig, Olive, Cantaloupe	Pear, Apple, Grape, Citrus, Plum, Apricot, Peach, Watermelon

Within each group, field, forage, vegetable, and fruit, crops are listed in order of decreasing salt tolerance. The values in millimhos at the head of each column give the approximate range of salinity that can be tolerated by the crops in that column.

IRRIGATION APPLICATION GUIDE FOR DATES. 85% EFFICIENCY

(DO NOT USE THIS GUIDE FOR NEWLY PLANTED SHOOTS)

TRICKLE IRRIGATION

(GALLONS PER DAY PER PALM)

KHADRAWY

USDA, Soil Conservation Service
83-180 Requa Ave, Ste.
Indio, CA 92201
Phone: (619) 347-7658

MONTH

	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
CONSUMPTIVE USE, NET INCHES/DAY	0.089	0.094	0.133	0.163	0.190	0.221	0.302	0.262	0.225	0.169	0.142	0.105
PALM CANOPY DIAMETER, FT. 8	4	4	6	8	9	10	14	12.7	10	8	6	5
10	6	6	10	11	14	17	22	19	17	13	10	8
15	15	15	22	27	32	37	50	43	37	28	23	18
20	25	28	39	48	56	65	89	76	66	50	42	31
25	41	43	61	75	87	102	139	119	103	78	65	48
30	59	62	88	108	125	146	199	173	148	112	94	69

NOTES:

1. Reference: The seasonal use of water by Khadrawy date palms. J.R. Furr and W.W. Armstrong U.S. Date Field Station, Indio, CA.
2. Design trickle systems for minimum of 12 gallons per hour per palm. Maximum design application time should be limited to 18 hours/day.
3. Newly planted shoots will use much less water than that shown for palms with an 8 ft. diameter canopy.
4. Above normal temperatures and below normal humidity will increase water requirements.
5. Weedy conditions and high winds may increase water requirements.
6. Do not rely on this chart alone. Periodically check soil moisture to determine adequacy of irrigation.

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IRRIGATION APPLICATION GUIDE FOR CITRUS, 85% EFFICIENCY

March 18, 1986

TRICKLE IRRIGATION

(GALLONS PER TREE PER DAY)

USDA, Soil Conservation Service
83-180 Requa Avenue, Suite 3
Indio, CA 92201
(619) 347-7658

TREE SPACING	TREE DIA. FT.	AVERAGE IRRIGATION WATER REQUIREMENT - GALLONS PER TREE PER DAY											
24' x 24'	4	2	3	4	5	7	9	11	8	7	5	3	2
	6	3	5	7	10	14	17	20	18	14	9	6	4
	8	5	7	10	15	20	26	30	27	21	14	8	6
	10	7	10	14	20	27	35	40	36	29	19	11	8
	12	9	13	18	25	34	44	51	46	36	24	14	10
	14	10	15	21	30	41	53	61	55	43	28	17	12
	MATURE	20	29	41	57	78	100	115	105	82	54	33	22
CONSUMPTIVE WATER USE AC IN/AC		0.047	0.068	0.096	0.134	0.185	0.238	0.273	0.248	0.195	0.127	0.077	0.052
MONTHS		JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NOTES:
1. Maximum design application time should be limited to 18 hours/day.
2. Above normal temperatures and below normal humidity will increase water requirements.
3. Weedy conditions and high winds may increase water requirements.
4. Do not rely on this chart alone. Periodically check soil moisture to determine adequacy of irrigation.
5. Use this guide only to estimate the crop requirements for the Coachella Valley.

IRRIGATION APPLICATION GUIDE FOR CITRUS, 85% EFFICIENCY

March 18, 1986

TRICKLE IRRIGATION

(GALLONS PER TREE PER DAY)

USDA, Soil Conservation Service
83-180 Requa Avenue, Suite 3
Indio, CA 92201
(619) 347-7658

TREE SPACING	TREE DIA. FT.	AVERAGE IRRIGATION WATER REQUIREMENT - GALLONS PER TREE PER DAY											
20' x 20'	4	2	3	4	5	7	9	11	8	7	5	3	2
	6	3	5	7	10	14	17	20	18	14	9	6	4
	8	5	7	10	15	20	26	30	27	21	14	8	6
	10	7	10	14	20	27	35	40	36	29	19	11	8
	12	9	13	18	25	34	44	51	46	36	24	14	10
	14	10	15	21	30	41	53	61	55	43	28	17	12
	MATURE	14	20	28	39	54	70	80	73	57	37	23	15
CONSUMPTIVE WATER USE AC IN/AC		0.047	0.068	0.096	0.134	0.185	0.238	0.273	0.248	0.195	0.127	0.077	0.052
MONTHS		JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NOTES:
1. Maximum design application time should be limited to 18 hours/day.
2. Above normal temperatures and below normal humidity will increase water requirements.
3. Windy conditions and high winds may increase water requirements.
4. Do not rely on this chart alone. Periodically check soil moisture to determine adequacy of irrigation.
5. Use this guide only to estimate the crop requirements for the Coachella Valley.

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IRRIGATION APPLICATION GUIDE FOR CITRUS, 85% EFFICIENCY

March 18, 1986

TRICKLE IRRIGATION

(GALLONS PER TREE PER DAY)

USDA, Soil Conservation Service
83-180 Requa Avenue, Suite 3
Indio, CA 92201
(619) 347-7658

TREE SPACING	TREE DIA. FT.	AVERAGE IRRIGATION WATER REQUIREMENT - GALLONS PER TREE PER DAY											
16' x 16'	4	2	3	4	5	7	9	11	8	7	5	3	2
	6	3	5	7	10	14	17	20	18	14	9	6	4
	8	5	7	10	15	20	26	30	27	21	14	8	6
	10	7	10	14	20	27	35	40	36	29	19	11	8
	MATURE	9	14	18	25	35	45	52	47	37	24	15	10
CONSUMPTIVE WATER USE AC IN/AC		0.047	0.068	0.096	0.134	0.185	0.238	0.273	0.248	0.195	0.127	0.077	0.052
MONTHS		JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NOTES:
1. Maximum design application time should be limited to 18 hours/day.
2. Above normal temperatures and below normal humidity will increase water requirements.
3. Weedy conditions and high winds may increase water requirements.
4. Do not rely on this chart alone. Periodically check soil moisture to determine adequacy of irrigation.
5. Use this guide only to estimate the crop requirements for the Coachella Valley.

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U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
81-711 Hwy. 111
INDIO, CA. 92201

IRRIGATION APPLICATION GUIDE FOR GRAPES; 80% EFFICIENCY

VINE SPACING	VINE AGE YEARS	AVERAGE IRRIGATION WATER REQUIREMENTS, GALLONS PER VINE PER DAY											
7' x 11' spacing 77 SQ. ft.	1	0.1	0.3	0.7	1.8	4.0	6.8	8.9	8.3	5.7	3.4	1.5	0.7
	2	0.6	1.1	2.2	4.7	9.0	13.4	13.9	14.1	9.2	5.2	2.2	1.0
	3	0.9	1.4	2.7	5.7	10.9	15.8	18.3	15.0	10.1	5.5	2.4	1.1
	4	0.9	1.5	2.8	5.9	11.1	16.1	19.5	16.0	10.2	5.6	2.4	1.1
Consummative Daily Water Use AC IN/AC		0.15	.025	.046	.098	.185	.268	.308	.266	.170	.094	.04	.018
Months		JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

Add water for inefficiencies and for leaching. These values are based on long-term average water use. Actual use values may be higher or lower for early or late seasons or for unusually hot periods.