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THE DATE PALM JOURNAL

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EDITORIAL

One of the objectives of the Regional Project for Palm & Dates Research Centre is to disseminate the results of continuous research on the date plam. The fact that there is not even a single journal devoted exclusively to the date palm – the Date Growers' Institute (Coachella Valley, California) ceased publishing its Annual Report in 1979 – was a primary factor in convincing us of the importance of publishing a date palm journal so that new research and knowledge in the field would be readily available to specialists. However, in starting this new journal the Regional Project has not acted hastily, but has devoted a long period of time to studying the relevant questions in this regard: first, whether there is a demand for such a journal; and, second, if so, what kind of journal, with what contents, language, periodicity and the like.

The Project subsequently proposed the journal's publication to its Technical Coordinating Board at its first meeting in Tripoli in June 1979. The Board unanimously supported the proposal to issue the journal. One of the many points raised in drawing up the journal's guidelines was one which deserved special attention: the language of the journal. The Board agreed that for the benefit of the Project's participating countries the journal should be bilingual in nature, viz. if an article were in English, it should have an Arabic summary and vice versa. It was also decided to issue the journal semi-annually and that it should contain research papers and review articles (written by persons working in the industry and associated fields), short communications, news and views, new records of insect pests, abstracts of current findings in the field appearing in other publications, book reviews and advertisements related to the date palm industry.

We sincerely hope that the *Date Palm Journal* would not only have a successful career, but will also prove of practical assistance in bringing up-to-date research findings and information to the attention of all specialists in the field .The Editorial Board welcomes any views or suggestions from readers to assist us in improving the journal so that it remains a meaningful and valuable tool to specialists.

T.J. Al Bandar
Chairman, Editorial Board

NOTES FOR AUTHORS

The Date Palm Journal is published twice a year by the FAO Regional Project for Palm & Dates Research Centre (NENADATES), Baghdad, Iraq. Contributions to the Journal may be (a) papers of original research in any branch of date palms, (b) review articles, (c) short communications, and (d) news and views. The research papers submitted for publication in the Journal should not have been previously published or scheduled for publication in any other journal.

Manuscripts

Papers may either be in Arabic or in English with summaries in both. The manuscript should be typewritten (double spaced, with ample margins) on one side of the paper only. Two copies of the manuscript should be submitted, the original typed copy along with a carbon copy. Authors should organize their papers according to the following scheme as closely as possible: (a) title of paper, (b) author's name (and affiliation written at the bottom of the first page), (c) abstract, (d) introduction, (e) materials and methods, (f) results, (g) discussion, (h) conclusion, (i) acknowledgement (s), (j) literature cited (arranged alphabetically), using the following illustrated format:

Andlaw, R.J. (1977): Diet and dental caries – a review. J. Human Nutrition 31:45.

Francis, D.E.M. (1974): Diet for sick children, 3rd Ed. Oxford: Blackwell. 405 pp.

Lepesme, P. (1947): Les insects des palmiers. Paris: Lechevalier. 247-48.

Tahara, A.; T. Nakata & Y. Ohtsuka (1971): New type of compound with strong sweetness. Nature 233:619.

However, in case of short papers and communications, results and discussion could be combined in one section.

Tables

Tables should be reduced to the simplest form and should not be used where text or illustrations give the same information. They should be typed on separate sheets at the end of the text and must in no case be of a size or

form that will not conveniently fit onto the Journal page size. Units of measurement should always be clearly stated in the column headings; any dates relevant to the tabulated information should be stated in the table title or in the appropriate column heading.

Illustrations

Line drawings and graphs must be in jet black ink, preferably on bristol board or tracing paper .Photographs should be on glossy paper, negatives being supplied where possible. Figures including both line drawings and photographs, should be numbered consecutively in the order in which they are cited in the text. The approximate position of tables and figures should be indicated in the manuscript.

Units

Units should follow the metric system. Yield or rate is expressed in metric tons/hectare or kg/hectare. Any reference to currency should be expressed in U.S. dollars or the equivalent to a local currency stated in a footnote.

Offprints

Unbound, free copies of offprints are allowed as follows: one author, 20 copies: two or more authors, 30 copies. Additional copies may be obtained on payment at cost and if more than the gratis number is required, this should be specified when the paper is submitted.

Correspondence

Contributions and correspondence should be addressed to the Chairman, Editorial Board, Date Palm Journal, c/o Regional Project for Palm & Dates Research Centre in the Near East & North Africa, FAO, P.O. Box 163, Baghdad, Iraq.

DIRECTORY OF RESEARCHERS

The Project is planning to publish a directory of date palm researchers and projects and would solicit cooperation of the readers of the *Date Palm Journal* to provide information along the following lines and forward it to the Chairman, Editorial Board of the journal.

1. _____
Name (Family name & first name)

2. _____
Title & business address

3. _____
Date of birth (Day-month-year) 4. Nationality

5. _____
Highest degree (B.Sc., M.Sc., Ph.D. or other) 6 Year awarded

7. _____
Name of university 8. Major subject

9. _____
Present field of specialization

10. _____
Total number of years experience

11. Field of work (Please tick applicable field (s) from those listed):

_____Botany, taxonomy & varieties	_____Insects & mites
_____Breeding & genetics	_____Diseases
_____Plant physiology	_____Plant protection
_____Soils	_____Harvesting, fruit handling, packing
_____Nutrition & fertilizers	_____Fruit chemistry & processing
_____Propagation	_____Economy & trade
_____Other cultural practices & techniques	_____Food & nutritional value
_____Other activities (specify) _____	

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BAYOUD DISEASE IN NORTH AFRICA: HISTORY, DISTRIBUTION, DIAGNOSIS AND CONTROL

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ABSTRACT

Fusarium wilt or Bayoud, caused by a soil – borne fungus (*Fusarium oxysporum* f. sp. *albedinis*), is the most important disease of date plams in the world. Beginning from the Draa Valley sometime before 1870, Bayoud has invaded all Moroccan palm orchards as well as those in the south western part of Algeria and has destroyed more than 10 million trees in Morocco. At the present time, Bayoud constitutes a particular threat to eastern Algeria where the very susceptible variety Deglet Noor is grown, as well as to all date-growing areas in the world.

The external and internal symptoms as well as the characteristics of the pathogen are reviewed. Survival of the pathogen in the form of chlamydospores, its development in the trees, from the roots to the terminal bud through vascular system and the spread of Bayoud by root contact or by diseased offshoots or infected date tissues are described.

Different means of control are reviewed, (chemical control, prophylactic measures, eradication of active foci of Bayoud, etc.); however, the most interesting approach lies in research into resistant varieties. An intensive programme has been undertaken by the author in collaboration with the Saharan Agronomic Centre of Marrakesh, Morocco, aimed at control of Bayoud disease through the selection of resistant, high quality varieties from the natural population of date palms and also through a breeding programme.

محمد الجربي

خبير امراض النبات
المشروع الاقليمي لبحوث النخيل والتمور
في الشرق الأدنى وشمال افريقيا

مرض البيوض في شمال افريقيا: تاريخه، انتشاره، تشخيصه ومكافحته

الخلاصة

يعتبر مرض البيوض من أخطر الامراض التي تصيب نخيل التمر في العالم ويسببه الفطر *Fusarium oxysporum F. sp albedinis* .

وكانت بدايته في وادي درعا في المغرب قبل عام 1870 وبعدها اجتاح كل بساتين النخيل في كل من المغرب والجنوب الغربي من الجزائر حيث قضى على اكثر من 10 مليون نخلة في القطر المغربي. يهدد مرض البيوض في الوقت الحاضر شرق الجزائر حيث يكثر الصنف التجاري دجلة نور الحساس لهذا المرض وبقية مناطق زراعة النخيل في العالم.

أدرجت جميع اعراض المرض الخارجية والداخلية وصفات الفطر المسبب له.

يعيش الفطر في دور السبورات الكلاميدية وينتقل من الجذور الى البراعم الطرفية (القمم النامية) خلال النظام الوعائي. ويكون انتشار مرض البيوض عن طريق تلامس الجذور أو الفسائل المريضة او انسجة النخيل المصابة.

تم ذكر الطرق المختلفة لمكافحة هذا المرض وركز بصورة خاصة على استنباط وايجاد اصناف من النخيل المقاومة للمرض كما وأجرى الباحث بالتعاون مع مركز البحوث الصحراوي الزراعي في مراكش ـ المغرب برنامجا مكثفا بهدف مكافحة هذا المرض من خلال انتخاب اصناف ذات مقاومة عالية من المجاميع الطبيعية لنخيل التمر وبرامج التربية.

INTRODUCTION

Bayoud is incontestably the most serious cryptogamic disease of the date palm (*Phoenix dactylifera L.).* It constitutes a veritable plague in the date-growing areas of parts of North Africa and a threat to those countries which are still unharmed by it. Bayoud is an epiphytotic disease for which there is no known cure at the present time.

Bayoud most probably has its origin in the Draa Valley of Morocco. However, it has advanced both eastward and westward and has now affected most of Morocco's palm groves (44, 55). To the east, the disease has advanced in the direction of the Algerian oases, destroying a part of the palm groves in its path.

The disease continues to advance relentlessly eastward despite prophylactic measures and regular attempts at eradication undertaken in Algeria (5, 20).

HISTORY OF RESEARCH ON BAYOUD DISEASE

The first scientific studies on Bayoud done at Figuig, Morocco, by Foex and Vayssiere in 1919 (18) recognized the disease's vascularity. In 1921, Sergent and Beguet (48) asserted that Bayoud is an infectious and epidemic disease that progresses from the roots upwards. They isolated a microscopic fungus that Maire compares to the *Neocosmospora vasinfecta* Smith.

Nevertheless, in 1925 Pinoy (45) was able to isolate this fungus from affected trees. Not having succeeded in infecting the trees by natural means, he abandoned the notion of a cryptogamic disease. Instead, he returned to a physiological theory implicating asphyxia of the roots as the cause of withering.

During the course of an expedition in southern Algeria in 1926, Balachowsky (3) found Bayoud in the Saoura and considered it a parasitic and infectious disease.

In 1930, Killian and Maire (22) called it *Cylindrophora albedinis* N. sp. (Kill. and Maire). In 1934, Malençon (30 – 32) having undertaken more detailed studies in Morocco, observed intra-vascular microconidia, which

led him to assert that Bayoud is a tracheomycotic disease. Then, in 1934, he noted the presence of microconidia, macroconidia and chlamydospores in culture. He thus identified the fungus as a *Fusarium albedinis* (Kill. and Maire) Malençon, and subsequently linked it to *Fusarium oxysporum*, classing it in the *elegans* section of Wollenweber.

The observations of Pereau – Leroy (44) and Bulit *et al* (11) confirmed this decision and the denomination of this fungus became, according to the present nomenclature of Snyder and Hansen (47 – 48) *Fusarium oxyspo-rum* forma specialis *albedinis* (Malençon) Snyd. & Hansen.

The identification of this fungus as well as its mode of infection of the palm trees incited controversy. Certain authors (22, 30 – 32) thought that infection took place through wounds in the palm trees. Nevertheless, experiments done by Malençon (34, 36 – 37) failed to infect palm trees through their wounds. Malençon also points out that the fungus can infect through female inflorescences; but having obtained the same result with a strain of *Fusarium* beet, he concludes that floral infection is not specifically an agent of Bayoud. Finally, in 1949, Malençon (36, 37) asserts that the fungus is soil – borne and that other modes of infection by the pathogen are only accidental.

The role that this fungus plays in damaging palm trees has been contested on several occasions. Pinoy (45) refers to an asphyxia of the roots. Balachowsky (2 – 3) envisions a viral or bacterial origin of this disease.

Research directed by Pereau – Leroy in Morocco from 1950 to 1957 (43 – 44) specifies information about the casual organism and its progression and geographic distribution in North Africa. This author also reports the indications that there are resistant varieties and classifies the principal Moroccan varieties according to their resistance or their susceptibility to the fusariose in their locality.

After a period of interruption, research was again begun in 1963 as a collaboration project between the Centre for Agronomic Research (Morocco) and the Centre for Research on Pathogenic Flora in the Soil (Dijon, France). In Algeria as well, a team has undertaken short, medium and longterm research projects in order to find means to check the

spread of this disease.

Research during the course of the last decade has led, first of all to a precise description of the symptoms of the disease and characteristics of the pathogen (11, 24 – 29, 58). It has also led to studies on the spread of the disease (11, 17, 57) as well as on the performance of the principal Moroccan, Algerian and Tunisian date varieties with regard to this fungus (47, 56, 58). In addition, it has revealed several directions to be taken to control this disease (21, 26, 47, 51).

3. ORIGIN AND DISTRIBUTION

The history of the spread of Bayoud in North Africa is similar to that of numerous epiphytotic diseases. Originating from a few foci recognized sometime before 1870 in the Draa Valley, the disease in one century has affected approximately all Moroccan palm groves, as well as those of the western and central Algerian Sahara (Fig. 1).

Furthermore, while the spread of the disease in Morocco can be easily explained by its advance from oasis to oasis along the river valleys (Draa, Ziz, Gheris, etc.), the central and western Algerian oases present the ideal conditions for fighting epidemics . Indeed, the date growing zones in these regions are discontinuous and separated by large distances of uncultivated desert that reach hundreds of kilometers at times. In addition, harsh climatic conditions in conjunction with rudimentary road systems have reduced communication between these zones. For these reasons the spread of Bayoud has not taken on the spectacular and epidemic proportions of other epiphytes.

Following is an outline of the stages in the spread of the disease:

As regards the origin of the disease, it is very difficult to establish the exact date, place and conditions under which Bayoud first appeared. But based on the work of several authors (30 – 32, 43 – 44, 54 – 55), the disease can fairly conclusively be considered to have first appeared during the last century in the Draa valley of Morocco, north of Zagora. The disease then advanced westward and especially eastward, following the string of palm groves that are more or less continuous along the valleys.

Bayoud's westward march seems to have been rather slow; indeed, the majority of Moroccan palm groves of the Bani were affected between 1900 and 1920 (Foum, Zguid, Agadir, Tissint, Tata, Tarjicht). The last groves contaminated were at Icht and Foum et Hassane in 1954 and 1960 respectively (54 – 55).

The spread of Bayoud in the east has been much more spectacular. In the Draa Valley, Bayoud reached the Tafilalet (1870) by following the palm groves of Tazzarine, Ait Saidane and Alnif in the Saghro region. Starting from the Tafilalet area, Bayoud spread in three different directions:

- The disease first slowly advanced into the Ziz Valley and destroyed a major part of the fine commercial varieties (Medjool and Bou Feggous).
- Simultaneously, Bayoud advanced into the valley of the western Gheris and covered 25 km in 30 years, reaching Goulmima in approximately 1900, Tagighoust in 1910, Timesguit in 1930 and finally, Amsed in 1930.
- At the same time, advancing in a third direction, Bayoud appeared at the Algerian border in tne palm groves of Boudenib and Figuig in 1890 and 1898 respectively.

Further east the spread of Bayoud is better known because it is more recent and especially because it is found in regions of well-established administrative organizations, notably in Algeria.

The disease entered Algeria and affected Beni Ounif in 1898 and Colomb Bachar in 1900. The palm groves in the vicinity of these centers were in turn affected (Beni Abbes, 1908; Tabalbala, 1912; Taghit, 1923). While the contamination of these oases seems normal given the fact that they neighbour Moroccan palm groves affected by Bayoud, it is nonetheless surprising that the disease appeared at the same time (1902) at Foggaret es Zoua (Tidikelt) in the heart of the Central Sahara, a thousand kilometers from Bechar.

The inhabitants of this oasis belong, historically, to the brotherhood of the Zoua, whose centre is found in the Boudenib region. There were thus

privileged relations between the two villages which explains the enormous leap by the disease.

The contamination of palm groves sometimes separated by distances of hundreds of kilometers can only be explained by travellers transporting the fungus in infected wood or offshoots. Furthermore, Pereau-Leroy's work shows that the disease followed the major highways used by caravan merchants. Between 1920 and 1940 the map of Bayoud foci expanded modestly. Two contaminations are particularly important: in the Adrar and In Salah regions, affected in 1930 and 1941 respectively.

Thus, contrary to Morocco where the disease spread by degrees, in Algeria the disease advanced in disordered leaps and bounds originating from various foci.

The last 30 years have been particularly favourable to the propagation of Bayoud. Indeed, due to the disorganized nature of services during World War II and the Algerian War for Independence, research activities as well as elementary protective measures to check the spread of the disease were lacking in continuity (5, 9 – 10, 15). Many foci thus appeared: Igli, Aoulef, Reggane, etc.

The last stage that Bayoud reached is represented by the barrier of the Great Western Erg and the Tadmait plateau. Indeed, from Ain Salah it reached Metlili in 1950, thus crossing a distance of 700 km in a single bound: the Ghardaia palm grove was in its turn affected more recently (1965).

This summary of the continued spread of Bayoud disease highlights the dangerous problem that weighs upon the important plantations of Deglet Noor in Oued Rhir, Algeria and even in Tunisia (19-20, 26). Bayoud constitutes a potential danger for the majority of the date-growing regions of the world as well; especially since the fungus responsible for the disease can be transported and preserved for a long period of time in soil, in offshoots and in date palm fragments used in the production of craft items. Furthermore, better facilities for the transportation of merchandise

and people could, in the long run, lead to an entry of Bayoud into the large date growing zones of the Middle East. Indeed, the spread and expansion of Bayoud may be likened to the fusiarose of the banana tree, which has become widespread throughout the world.

ECONOMIC IMPORTANCE

Bayoud has caused considerable damage which sometimes takes on spectacular proportions when the disease presents its violent epidemic aspect. Despite the absence of statistics before 1930 and evaluations that are only approximations at the present time, Pereau-Leroy (44) has estimated that Bayoud will have destroyed more than two thirds of the Moroccan palm groves, or, ten million trees, in one century. This reduction in the number of trees, does not reflect the only important effect of the damage. Indeed, Bayoud has destroyed the best world-renowned varieties and especially those that are best cared for and the most productive.

The remaining 4.5 million trees in Morocco were produced predominantly from seedlings (Khalts = Sairs = Deguels) and varieties characterized by low production and are only of local interest compared to the fine Medjool variety. Medjool dates have been an important commercial item on European markets, especially in London, since the 17th centrury, but are presently disappearing. In Algeria, the disease has already destroyed the western and central palm groves and continues to spread from Metlili des Ghambas and Ghardaia .In the latter, practically the whole palm grove was contaminated, despite an information dissemination campaign (20).

The deterioration of a palm grove due to Bayoud disease is catastrophic. It not only causes the loss of the best varieties, but also accentuates and accelerates the phenomenon of desertification. Indeed, Bayoud has greatly contributed to the first stage of degradation of surrounding steppes, stemming from an excessive use of firewood no longer supplied by the palm groves, as well as from overgrazing by animals that no longer find sufficient fodder in the deteriorated oasis. The result is an influx of farmers resettling in large urban centres who have abandoned their land. This phenomenon is

even more frequent when water becomes rare or is lacking. Thus the desert is progressively reaching the steppe, and certain oases destroyed by Bayoud have been abandoned by their owners. Thus, using the Draa Valley as an example, more than 2500 families have emigrated to the north of the country or abroad and more than 7600 workers have temporarily left the Draa palm groves in order to find seasonal work.

Furthermore, Bayoud results in a loss of not only a staple food for the Sharan population (date is known as the bread of the Saharans) but also in the loss of a principal currency exchange for other indispensable products that are imported. Since the commercial variety Deglet Noor (which is very profitable due to its world-wide reputation for high quality) is susceptible, Bayoud is a particular threat to the principal date-growing areas of Algeria and Tunisia.

It is evident therefore, that Bayoud constitutes a plague to Saharan agriculture and at its present expansion rate it will certainly pose serious problems of a human, social and economic nature in other date-producing areas of the world.

SYMPTOMS

The description of the symptoms of Bayoud disease has been the object of numerous publications (11, 22, 26, 28, 30-32, 39, 43-44). This disease appears in mature and young palm trees as well as in the offshoots at their bases.

External Symptoms

The first sign of the disease noticeable to experienced observers appears on a palm frond of the middle crown. This frond takes on a leaden hue (ash-grey) and then withers in a very characteristic manner: some pinnae or spines situated on one side of the palm wither progressively from the base upward to the apex and approaching the leafstalk (rachis). After one side of the frond has been affected, the withering begins on the other, progressing this time in the opposite direction, from the top of the frond to the base, until the whole leaf is destroyed.

During the whitening and dying process of the pinnae, a brown stain

appears lengthwise on the dorsal side of the rachis and advances from the base to the tip of the leaf, corresponding to the passage of mycelium in the vascular bundles of the rachis. Afterwards, the leaf exhibits a characteristic arch looking like a wet feather and hangs down along the trunk. This process may take a few days to several weeks.

The same succession of symptoms then begins to appear on adjacent fronds. As in the previous case, these symptoms may appear unilaterally or just in one sector of the frond; they may appear simultaneously on each leaf and the whole tree. In all cases, the disease advances progressively until the terminal bud is affected when the death of the tree occurs (Figs. 2 and 3). Finally, the offshoots at the base of the palm tree are also attacked. Here, too, the symptoms appear unilaterally.

The death of the tree takes place from several weeks to several months after the appearance of the first symptoms. Indeed, the rather rapid progression of the symptoms depends largely on the planting conditions and on the variety. Toutain (57) demonstrated, on an active focus of Bayoud in Zagora, that 83% of affected date palms die in less than two years after the appearance of symptoms; and no tree lives for more than five years after the appearance of symptoms (Fig. 4 and Table 1).

In certain cases, the external symptoms do not develop unilaterally, as previously (11, 30-32, 44). Indeed, the disease sometimes manifests its first symptoms by the appearance of a brown stain in the middle of the rachis and not on the edge of the palm frond.

The browning process continues up the rachis until the rachis becomes so narrow that all tissues are affected and the whole tip of the leaf whitens and dies. Then, the symptoms advance progressively from the tip of the palm leaf towards its base, affecting both sides simultaneously.

Sometimes, certain palm leaves of a tree that is still healthy undergo a general yellowing several weeks before the appearance of typical symptoms. When the base of the rachis is split at this time, reddish spots of diseased tissue may be found. These atypical symptoms may be mainly attributed to the complicated arrangement of vascular elements in certain varieties.

Table 1

Percentage of trees dying at different times from the appearance of the first symptoms of Bayoud disease

Period from Appearnace of First Symptoms of Bayoud till their death (Yrs)	Percentage of trees dying
0.5 (6 months)	32
1	46
1.5	69
2	83
2.5	93
3	98
5	100

Internal Symptoms

The development of internal symptoms is followed by making transversal and lengthwise cuts in different organs of the palm tree, thus permitting the path of the fungus to be traced in diseased trees from the roots through the trunk to the leaves and terminal bud.

When an affected tree is uprooted, only a reduced number of diseased roots, reddish in colour, are revealed. This number is not in proportion to the extent of damaged tissues observed on the tree. It is this fact which, un-noticed by the first observers, finally led to the conclusion that infection by the fungus does not take place through the roots. These diseased roots correspond to several groups of vascular bundles found on the trunk, which, with the scelerenchyma and the parenchyma which surround them, have taken on a reddish brown colour.

Towards the base of the trunk, the spots are large and numerous. As they advance toward the upper parts the coloured conducting strands separate and one can follow their complicated path inside the healthy tissues (Figs. 5 and 6).

This hypothesis of the progressive advancement of the disease from the roots to the palm crown has been confirmed (11, 35, 44).

Palm leaves manifesting external symptoms exhibit a reddish brown colour when cut, with vascular bundles that are highly coloured (Fig. 3). There is, therefore, a continuity of vascular symptoms that extends from the roots to the tips of the palm leaves.

PATHOGEN

The first precise descriptions of the fungus were done by Malençon (38, 39), Pereau-Leroy (44) and more recently completed by the works of Bulit et al. (11) and Louvet et al. (24).

The causal organism responsible for Bayoud is a microscopic fungus which belongs to the mycroflora of the soil. It belongs to the group Fungi Imperfecti, the Order Moniliales, the Family Tuberculariacae and, at the present time, is named *Fusarium oxysporum* forma specialis *albedinis* (Malencon) Snyd. and Hans.

Macroscopic Characteristics

The isolation, the characterisation, and the maintenance of the *Fusarium oxysporum* f. sp. *albedinis* culture has been the subject of numerous studies (51). Although it is easy to obtain *F. oxysporum* f. sp. *albedinis* cultures from rachis fragments of palm leaves which exhibit vascular symptoms, it is very difficult to preserve the original type of colony (which is still called the wild type). Indeed, the wild form shows greatly unstable cultural characteristics under normal conditions and rapidly produces mutants.

In culture *Fusarium oxysporum* f. sp. *albedinis* forms a fine, clear and curly mycelium in which small orange-pink sporodochia are produced (Fig. 7). Blue to black sclerotia sometimes are born in the medium. They are either dispersed in the mycelium or sometimes form groups.

Microscopic Characteristics

Fusarium oxysporum f. sp. *albedinis* occurs as a septate hyaline mycelium. It is fine and uniform in young cultures, exhibiting, however, in older cultures hypertrophic cells that occur in chains; they are round, greatly resembling chlamydospores, but without thickening of the wall.

Asexual multiplication occurs by microphalides swollen at the base and pointed at the tip, arising perpendicularily from the mycelium. At the apical tip of these phialides, microconidia (microphialospores) form continuously and endogenetically, each one being pushed by the next and they adhere together in the form of small moist heads (Fig. 8).

Great numbers of hyaline microconidia, varying in form and dimensions, can be found in the same culture (3-15 × 3-5 μ). In young cultures they are globulous, while in the older cultures they are more elongated. Microconidia are often unicellular, sometimes bicellular but rarely have two septa. Macrophialides, larger than microphialides, group together to form sporodochia and more rarely *pionnotes* (Fig. 8).

In culture, *Fusarium oxysporum* f. sp. *albedinis* also produces a few macroconidia with pediform base and short, pointed tips; most have three septa, though some have four or five and measure 20-30 × 3-5 μ (Fig. 8).

In older cultures, or in an agar medium covered over with earth, *Fusarium oxysporum* f.sp. *albedinis* forms chlamydospores that are uniform and globulous, with a smooth thick wall varying from 6 to 20 μ. They may be either intercalary or terminal and are isolated or grouped in two or four in short chains. They are formed either on the mycelium or from macroconidia (Fig. 8).

Sclerotia are dark blue-black, measure about 1 mm in diameter and occur rarely.

Physiologic Characteristics

The physiology of *Fusarium oxysporum* f. sp. *albedinis* has been little studied. Malencon (25) determined the optimum temperature range for growth .Growth begins at 7°C, remains slow until 12°C, becomes more rapid between 21°C and 27.5°C and stops at 37°C.

Louvet and Bulit (28) reported the capacity of the fungus to use complex carbon sources and to develop in the presence of high concentrations of carbonic gas or pentachloronitrobenzene.

Bounaga (7) found that the best mycelium growth occurs at 28°C. The

marked preference of *Fusarium oxysporum* f. sp. *albedinis* for pectin, mannose, xylose and cellulose was also noted and in addition to that organic nitrogenous sources are better metabolised than mineral nitrogen. The influence of sodium chloride was also studied and it was observed that there is no lessening of growth up to a concentration of 40 g/1. This observation is similar to Toutain's (59) who found that Bayoud advances normally in salty fields.

Dubost, Kechacha and Rether (16) also studied the pectinolytic and celluloytic enzymes of the fungus. These authors showed the important difference between the enzymatic activities of different isolates of *Fusarium oxysporum* f. sp. *albedinis*, but they did not establish a correlation between this activity and the pathogenic power of the fungus.

Pathogenic Power

On vascular tissues manifesting the brown colour that is characteristic of the disease, isolation often produces a pure culture of *Fusarium oxysporum* f.sp. *albedinis*. (Fig 7). The special form *albedinis* is recognised by the artificial innoculation of date palm seedlings. This study of several isolates of *Fusarium oxysporum*, originating from samples taken from different levels of the palm tree, has shown that the pathogenic power of the isolates depends on the part ofthe tree from which they have been taken (Table 2) (11).

Thus, the more pathogenic an isolate is, the more likely it is to be found at a high level on the plam tree. This is comparable to results that Beckman et al. (4) obtained on the fusariose of the banana tree.

Although no research has been done on the parasitic specialisation of the fungus, the appearance of Bayoud in specific places (Draa Valley) and its geographic expansion into different date-growing zones of North Africa suggests that *Fusarium oxysporum* f. sp. *albedinis* is a unique isolate that is transported by human beings from one palm grove to another. This parasite, therefore, manifests the characteristics of a special monotopic form (29).

Table 2

Pathogenic power of different strains of *Fusarium oxysporum* isolated at different levels of diseased palm — trees.

	Pathogenic Power		
Level	High	Weak	Non-existent
Tips of rachis	X		
Base of rachis	X	X	
Stipe (trunk)	X	X	X
Roots	X	X	X

BIOLOGY AND EPIDEMIOLOGY

Survival, Infection and Disease Cycle

Like all vascular oganisms of telluric origin, *Fusarium oxysporum* f. sp. *albedinis* is preserved in the form of chlamydospores in the dead tissues of infected palm trees, especially in the roots of trees killed by it. With subsequent disintigration of such tissues, the chlamydospores may be released into the soil where they remain in a dormant state. The fungus is found at a depth varying from 5 to 30 cm, and sometimes deeper; it can be preserved for a long period of time, even when the palm trees have long since died (eight years or more).

If nutrients reach the chlamydospores in sufficient quantity, the spore germinates and invades a root, entering the vascular tissues as a parasite. Once the pathogen is inside the vascular element, it grows rapidly and the mycelium advances up the root and into the stem. The mycelium produces microconidia in the vessels and these are carried upwards by the water stream. When their flow up the vessel is impeded by a cross wall, the microconidia germinate, the germ tubes penetrate the wall and then microconidia formation is resumed on the other side of the wall. These new microconidia are in turn carried along to the next transverse wall in the same manner as that of the fusariose in the banana (4). This process thus continues upward, internally through the tree to its terminal bud, leading to

the death of the date palm.

During the course of its upward progression, *Fusarium oxysporum* f. sp. *albedinis* breaks out of the xylem and colonizes the surrounding parenchyma tissues of the tree by an inter-and intra-cellular mycelium which gives the tree the reddish brown colour that is characteristic of Bayoud.

After the death of the date palm, the mycelium continues to develop in the parenchyma of the tree and forms numerous chlamydospores in the sclerenchyma cells. These constitute very favourable conditions for the survival of the fungus in the soil (27).

Spread of Bayoud in Palm Groves.

Little research has been done on the speed of Bayoud's advancement in a plantation. The best information comes from the experimental palm grove of Nebch at Zagora, Morocco (11, 57) and from the palm grove of In Salah in Algeria (9-10, 20, 23).

Starting from a few affected trees (primary centres) Bayoud expands many foci; this is particularily visible in homogeneous plantations. Indeed, the contamination occurs regularily from tree to tree and more rapidly as the intensity of irrigation increases. In this case, the disease takes on an epidemic aspect; the number of affected trees increases rapidly and the life span of the diseased tree decreases.

Thus, at Zagora, on a plot of land containing 125 palm trees of the susceptible Bou Feggous variety, the progression of Bayoud occurred in the manner shown in table 3. (60).

This primary infection, began in 1956, has destroyed the whole plantation over a period of 14 years at the average rate of 6% per year. The intensive cultivation of palm groves, therefore, fosters the expansion of Bayoud.

A high salt content of both soils and water (5 g/l) does not prevent or slow down the spread of Bayoud (59).

Periods of drought, accompanied by lack of water, result in a regression

Table 3

Evolution of Bayoud in Zagora Station (Morocco)

Year	Affected palm trees (No).	Percentage
1955	0	0
1962	35	28
1963	43	34
1964	60	48
1965	68	54
1966	77	61
1967	83	66
1968	102	81
1969	111	88
1970	122	97

of the disease which then becomes dormant. On the other hand, as soon as irrigation becomes significant and frequent, the disease reappears more violently and becomes gravely epidemic, particularily when there is a predominance of susceptible varieties. It thus seems that alternating dry and wet periods are favourable to an explosive expansion of the disease. This phenomenon has also been observed for other *Fusarium* diseases (12).

Furthermore, according to Pereau-Leroy (44), certain intercrops such as lucerne, alfalfa *Medicago sativa,* henna *(Lawsonia inermis* L.) vegetables, etc foster strong attacks of Bayoud. The author thinks that this effect is due to the influence of copious irrigation, indispensable to these crops during the hot season. A study by Laville and Lassois (23) shows that the direction of the advancement of the disease inthe Ain Salah palm grove is related to the dominant winds, irrigation and the salinity gradient. On the other hand, to date no work has been done to demonstrate the possible influence of nematodes on the spread of Bayoud.

The appearance of foci that are rather far from the original focus is essentially related to the transport of infected offshoots or palm tree fragments

harbouring the fungus. The consequences of the spread of Bayoud are particularily visible in Morocco. After the disappearance of a great number of the best varieties, presently in the Moroccan palm groves more than 50% of the trees are of seedling origin – called Khalts, Sairs or Deguels. These Sairs are often of bad quality, meaning of low commercial value.

Host Plants

Many plants are often grown among date palms in the groves, notably alfalfa, henna, etc. To date, *Fusarium oxysporum* f. sp. *albedinis* has only been isolated from henna *(Lawsonia inermia)*; indeed, the plant harbours the Bayoud organism without manifesting any symptoms (symptomless carrier ; 11, 26). More recently in France, Mercier and Louvet (40) also isolated the causal organism of Bayoud on *Phoenix canariensis,* another species of palm trees, which manifests the same symptoms as the vascular fusariose of the date palm trees.

CONTROL, ORIENTATION & ORGANIZATION

Due to Bayoud's epidemic, infectious and vascular nature, successful methods used to control oil palm fusariose and banana wilt can be used as a model in the control of Bayoud (52). Following is a review of the different methods advocated.

Chemical Control

A vascular disease is often thought to be controlled with the use of systemic fungicides. Unfortunately, repeated applications of these products lead to the creation of resistant strains of the parasite. There are various other reasons why soil treatments of this type are destined *a priori* to fail: the distribution of the chlamydospores of the fungus occurs at great depths and over vast areas; the cost of the operation is very high; and, finally, protection of palm trees roots during the course of their life span is impossible. It would, consequently, be unwise to pursue this type of research, especially in oases that are ecologically fragile.

Chemical control can, however, be feasible in the event of the discovery of primary sources of infection in a healthy area. In this case, large scale methods may be used for eradication: indeed,after demarcation with a large

enough security margin for the Bayoud focus, the trees are then uprooted and incinerated on the spot. The soil is then treated with chloropicrin and the closed off area prohibited for replanting until considered safe. Nevertheless, this method of eradication poses many problems:.

- An early diagnosis of the disease before the appearance of symptoms is necessary.
- Uprooting, incineration and soil treatment are expensive and difficult.
- Finally, the laws concerning this operation are not clear, notably concerning the modes of compensation for farmers.

These obstacles have prevented an uprooting campaign at Ghardaia (Algeria). This lack of action has resulted in the contamination of the entire bank of this town (20).

Cultural Control

Certain cultural techniques which place pathogenic organisms in unfavourable conditions sometimes reduce the damage caused by this disease. Unfortunately, the factors that favour a high yield in palm trees (irrigation, fertilizers etc.) are the very same as those that favour the growth of the parasite (24, 26, 44).

A significant reduction in the amount of irrigation can retard the advance of infection; thus Pereau-Leroy (44) has tried to determine an irrigation schedule that would allow for the planting of susceptible varieties in an active Bayoud focus. He concluded that stopping irrigation between the months of May and October (i.e. during the hot season) would allow for the extensive cultivation of susceptible varieties. Nevertheless, at the present time, this method of control does not seem to be too promising, because in such conditions the date yield is also very low.

An interesting result was obtained in Morocco concerning the control of the spread of Bayoud. Disease-free trees were isolated by digging a trench more than 2 meters deep around them. Water was provided by a trough to the land plot. Under these conditions, Bayoud advanced on all sides, but stopped at the outer edge of the trench. It thus killed all the trees on the plot except those enclosed by the trench. This experiment carried out in Zagora

indicates that contamination occurs mainly by root contact among diseased and healthy palms or else by planting of offshoots produced by infected palm trees. It also suggests that irrigation waters passing through an infested field do not seem to favour infection of other trees. Further studies of this phenomenon may assist in arresting the spread of Bayoud and in prolonging the productivity of palm plantings.

If a Bayoud focus is detected in its early stages, this technique can be used to isolate the healthy palms and then sanitation measures may be put into effect in the infested area.

Prophylactic Measures

Some prophylactic measures are applicable to areas or countries which have not yet been infected by Bayoud. They have, however, no value for date – growing regions that are already infected by Bayoud, as is the case in Morocco. Considering the constant spread of Bayoud and the threat that the disease poses to the beautiful Oued Rhir palm groves, the cradle of the Deglet Noor variety, and to Tunisia, these areas should be seriously and constantly surveyed.

The essential task is to prevent the movement of contaminated plant material from an infected palm grove to a healthy one. The material, as has been previously mentioned, consists mainly of offshoots, palm tree fragments, manure and infested soil and artifacts made from these materials. Legislation preventing the conveyance of contaminated vegetative material from one country to another has been effected by various countries. The USA, Tunisia, Mauritania and Iraq have adopted these quarantine measures and have been followed by other date – growing countries (Egypt, Libya, etc.). Algeria enacted quarantine legislation successively in 1942, 1945, 1949 and 1969.

However, the problem is not in promulgating legislation, but rather in enforcing it. The establishment of phytosanitary inspection agents at the entraces and exits of palm groves, especially in Algeria, would certainly prevent massive transportation of contaminated material. A minimal control system should also be set up in the airports of the principal date –

growing countries. But unfortunately, these measures would necessitate a large number of qualified personnel, which are not yet available in areas threatened by Bayoud.

Although Algerian officials have already taken strict prophylactic measures, Bayoud was not prevented from infecting Ghardaia. In any case, although prophylactic measures, accompanied by periodic eradication efforts of primary Bayoud foci, can lessen the spread of the disease, they cannot definitively stop it.

Extention Work and Information

Information dissemination is necessary to the success of all other actions taken in the control of Bayoud. In order to be effective, means for stopping the spread of the disease must be accompanied by efficient information campaigns.

Thus, in Algeria, a film on Bayoud is expected to be released in the near future. In addition, a technical booklet on this subject will be distributed in schools.

In Tunisia, colour pictures of Bayoud, produced jointly by the National Institute of Agronomic Research in France and in Tunisia, were distributed in all departments of the Ministry of Agriculture and in the Saharan area.

The Regional Project for Palm and Dates Research will put together a slide collection on Bayoud, as well as a book on this subject in Arabic, French and English, which will be distributed to all the member countries of the Project. In addition a film on Bayoud is scheduled to be released in 1980. It will focus on date palms and will include the Bayoud problem as well as the biological control of *Parlatoria* date scale.

Genetic Control

Introduction:

A review of other methods of control indicates that the only productive means of controlling Bayoud lies in continued research into resistant varieties. This path is very promising, although it can be difficult and rather slow. Furthermore, if precautions are not taken, there is the possibility of producing new strains of *Fusarium oxysporum* f. sp. *albedinis* which would

be capable of infecting varieties selected precisely for their resistance, as happened in the case of the vascular fusariose of the melon and the tomato. These plants have an annual cycle and sometimes even several cycles each year, which means they are frequently replanted in soil which contains a significant and active population of *Fusarium oxysporum*. Because conditions are completly different for the palm tree, it is likely that there will not be a change in the population of this parasite. Bayoud's appearance in an area of the Draa region and its spread to other date – growing zones of North Africa gives evidence in favour of a unique isolate of *Fusarium oxysporum* f. sp. *albedinis*.

Resistance can be obtained from three sources:

- Selection of Bayoud resistant varieties from those already existing (local and introduced).
- Selection of high quality resistant sairs from the natural population of the date palm.
- Creation of resistant and high quality varieties through a hybridization programme.

Selection for Resistance to Bayoud Among Existing Varieties.

The first search concerning varietal resistance was undertaken by Malencon (30), who was the first to plant offshoots at Ksar Es Souk (Morocco). During the course of a more detailed study, Pereau-Leroy (43-44) was able to classify the principal Moroccan varieties into four categories according to their resistance to vascular fusariose in their original area.

From 1963 to 1976, a systematic survey of Moroccan palm groves led to a knowledge of the distribution of female varieties resistant to Bayoud (58). At the same time, experiments confirming resistance to Bayoud in naturally infested fields were performed at Zagora. The results of these experiments were published successively by Louvet *et al*, 1970; Louvet and Toutain, 1973; and Saaidi, 1979. This work is illustrated in Table 4, which shows the geographic distribution of the principal Moroccan varieties and their degree of resistance to *Fusarium oxysporum* f. sp. *albedinis*: six varieties are completely resistant (Black Bou Sthammi, Iklane, Tadment, Sair Layalet,

★ Note: Sairs = Khalts = Deguels = date palms propagated from seeds.

Bou Feggous ou Moussa, and White Bou Sthammi), while nine varieties are partially resistant. The same authors mention that the susceptibility of a variety can be ascertained in three years, while resistance requires at least five years.

In Tidikelt (Algeria), Toutain and Louvet (58) planted offshoots of the principal Algerian varieties reputed to be resistant. From these experiments, they were able to confirm the resistance of the Takerbouch variety. The resistance of the different varieties of M'zab (Algeria) with regard to Bayoud was studied by Kada and Dubost (20). Unfortunately, among these Moroccan and Algerian varieties, only Takerboucht and Bou Ijjou were of acceptable quality although certainly not equal to Deglet Nour or Medjool.

Within the framework of the Regional Project for Palm and Dates Research, the principal high quality varieties of various date-growing regions of the world (USA, Iraq, Tunisia, etc.) will be introduced into Morocco and Algeria. The Project's aim is to study their performance with regard to *Fusarium oxysporum* f. sp. *albedinis* (13). The offshoots of these different varieties will be placed in nurseries; their resistance to susceptibility will then be confirmed by experimental inoculations.

Selection of High-quality & Resistant Sairs Among the Natural Populations of Date Palms.

In the course of work dealing with the epidemiological study of the disease and the search for resistant varieties, very high quality sairs were often found in active Bayoud foci. Subsequent surveys (1) indicated that sairs constitute more than 50% of the Moroccan palm groves i.e. more than 2 million trees (Table 5).

The prominence of these sairs in Morocco is explained by the fact that when Bayoud has destroyed the best date varieties farmers have allowed date palm seeds to grow in places where henna*(*Lawsonia inermis)* and alfalfa are growing. Henna and alfalfa, which are copiously irrigated during the whole year often occupy the soil for four to six years. These factors

★ a tinctorial plant that grows in abundance in the date growing regions of North Africa and the Middle East.

have allowed the development of palm trees of seedling origin or sairs.

In 1979-81, advantage of this genetic potential was taken by systematic surveys in the principal Moroccan Palm groves (14). During the maturation period of dates (limited to the months of September, October and Novemeber during which the quality of dates on the tree is at its peak), two groups of ten teams conducted surveys in the Draa Valley and the Tafilalet region. Each team was composed of a technician, a guide, a driver and a Land rover. Because of the considerable demands of this campaign, close collaboration was established between the Saharan Agronomic Research Center (Morocco) and the Development Offices of the South (Ouarzazate and Errachidia) in order that the operation would be successful.

The criteria for the selection of sairs are based mainly on the quality of the dates and their location in relation to the Bayoud focus. Each date sample was judged for quality by comparing it to a variety of similar quality. The judging was done on a scale of one to five, with the reference variety rated three.

The criteria used to judge date quality were the following: shape of the fruit, the weight of 100 fruits, colour, aspect of skin, consistency of date, texture, flavour, etc. Other information was also marked on each sair card, such as the characteristics of the palm tree (age, production, etc)., the number and size of available offshoots, as well as a precise map showing the location of the sairs.

Thus, during the campaigns in the Draa Valley and the Tafilalet region, about 7000 good quality sairs were discovered. In the second step of the experiment (Feb. — March 1980-81) 4000 high quality offshoots were separated and planted in nurseries in infested fields at Zagora and Errachidia. The offshoots are undergoing semi-artificial inoculation since 1981 in order to confirm their resistance to Bayoud

The search in palm groves for resistant and good-quality sairs seems to be the quickest way to resolve the Bayoud problem. This program, begun in 1979, will almost certainly by 1984-1985 yield resistant and high quality

Table 4

Geographic Distribution & Resistance of the Principal Moroccan Varieties to *Fusarium oxysporum* f. sp. *albedinis*

Areas	Highly resistant	Moderately resistant	Moderately susceptible	Highly susceptible
Zousfana		Taabdount	Assian Aziza Tiberghaimt	Bou Feggous*
Guir			Bou-Ijjou	Bou Feggous*
Tafilalet	Bou-Sthammi	Bou-Slikene* Bel-Azit* Race-Lahmar* Bou-Cerdoun	Azigzao* Jaji	Bou-Feggous* Medjool* Bouskri
Gheris		Bou-Cerdoun	Azizao Bou-Zeggar*	Bou-Feggous*
Ferkla			Azigzao* Bou-Zeggar*	Bou-Feggous*
Todra			Outoukdim	Bou-Feggous*
Saghro-Est	Black Bou-Sthammi* Iklane	Bou-Slikene Bou-Cerdoun Race-Lahmar	Azigzao	Jihel* Bou-Feggous Bouskri
Saghro-	Black-Bou-	Bou-Slikhene	Azigzao	Jihel*

Ouest	Sthammi*			Bou-Feggous
	Iklane			Bouskri
	Tadment			Bou-Slikhene
Draa	Black-Bou-	Briki	Mydodane	Bou-Feggous*
	Sthammi*	Bou-Khani	Bou-Zaggar*	Ahardane*
	Iklane*	Aissa-youb	Oum-N'hale	Bou Rhar
	Tadment	Mah-El-Baib		Bouskri
		Race-Lahmar		
Bani-	Sairs-Layalet*	Race-Lahmar	Bou-Ittob	Jihel*
Ouest	Black-Bou-		Mydodane	Bou-Feggous*
	Sthammi			Bouskri
	White-Bou-			
	Sthammi			
	Bou-Feggous			
	ou-Moussa			
Bani-Est	Iklane*		Bou-Ittob*	Jihel*
				Bou-Feggous*
				Bouskri
Anti-Atlas	Iklane		Bou-Ittob	Jihel*
	Bou-Sthammi Bl.			Bou-Feggous*
	Bou-Sthammi Wh.			Bouskri*
	Tadment			

★ Main varieties in the area.
Source: Louvet et al (1970), Louvet & Toutain (1973), Saaidi (1979).

Table 5

Distribution of Date Palms in the Main Date-growing Areas of Morocco

	Varieties		Sairs	
Date Palm Areas	Number	Percent of Total	Number	Percent of Total
Draa	891,999	55.43	717,082	44.57
Saghro	32,022	15.28	177,521	84.72
Tafilalet	485,312	59.16	334,924	40.84
Between Haut-Atlas & Saghro	83,756	17.28	400,883	82.72
Anti-Atlas	134,666	40.77	195,635	59.23
Bani	399,899	29.11	973,609	70.89
Oriental	102,588	57.40	76,112	42.60
Total	2,130,242	42.55	2,875,766	57.45

Source: Aouad (1975)

clones that can be vegetatively reproduced in order to restore the Bayoud-infested palm groves of Morocco and Algeria, as well as create new date-growing areas.

Creation of Resistant & High Quality Varieties.

Contrary to the preceding approach, the creation of new, high quality varieties that are resistant to Bayoud is a delicate operation. Indeed, the dioecious nature and the great heterozygosity of the date palm, as well as the lack of information available on the genetics of this tree leave this method of research largely open to chance.

Nevertheless, the abundance of good quality sairs in the regions where the best varieties have predominated and the frequency of these sairs in active Bayoud foci suggest that quality and resistance are not only transmissable, but can also be combined in an individual tree. Furthermore Nixon and Furr (41) studied the inheritability of some characteristics of progenies of Old World varieties and found a significant resemblance to female parents in vegetative and fruit characteristics. This approach has been applied in Algeria and in Morocco (26); it has been further developed in Morocco in 1979 with the establishment of a phytoculture chamber in Marrakesh in order to test *Fusarium oxysporum* f. sp. *albedinis* seedling progenies.

The Center for Saharan Agronomy of Marrakesh, aware of the slowness of this method, in 1972 began different types of crosses using female parents belonging to varieties selected either for their resistance to Bayoud or for their high quality dates. The male parents used were chosen from a group of individual trees selected for their resistance or from backcrossed "varietal" male palms (USA origin). More than 300 crosses were effected which produced nearly one-half million hybrid seeds. This large number of crosses will bring to light new information on the genetics of the date palms, particularily on the transmission of Bayoud resistance and date-fruit quality.

The seedling progenies are inoculated at the appearance of one to two leaves. This stage is particularly important to the success of artificial infection, Indeed, many authors, (4, 17, 47) have shown that the passage of

the *Fusarium oxysporum* f. sp. *albedinis* microconidia into the vessels of the seedling progeny is closely linked to the disappearance of the transversal wall. Vascular ontogenesis in the date palm (Nlendi, 1975) demonstrates that the ligneous vessels lose their transversal septa 48 days after the seedling date: this corresponds to the one or two leaf stage of the seedlings and explains the success of the inoculations during this period.

Progenies of crosses are produced in series of 5000 at a time and include the four combinations previously mentioned. The inoculum is obtained through a shaken culture. The experimental inoculations are carried out in the following manner. The surrounding earth is removed from the collar and adventitious roots of plants having reached the one-and-a-half leaf stage. After being rinsed in tap water, they are treated with 2 ml. spore solution of approximately 10^6 spores/ml concentration. The first symptoms appear after 45 days and the maximal mortality is reached only after the fourth month.

In 1979, approximately 17,000 seedling progenies of the four types previously mentioned were inoculated. This allowed the selection of more than 9,000 resistant plants with an average percentage of attack on the order of 42%. Five thousand of these Bayoud resistant date progenies were placed in a nursery in naturally infested ground. The planting of date progenies in nurseries will take place at the rate of 10,000 resistant plants per year.

During 1980, however, concentration will be on the breeding programme, essentially with the aim of linking resistant characteristics with the highest fruit quality and yield:

- High quality[3], susceptible female X Bayoud resistant male.
- Bayoud-resistant female X advanced backcrossed "varietal" males from Indio (USA).

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3. By high quality female varieties, is meant the Algerio-Tunisian variety Deglet Nour; Menakher (Tunisia); Thoory and Tadala (Algeria); Medjool and Bou-Feggous (Morocco); Saidy (Egypt); Makhtoom, Khastawy, Khadrawy, Halawy, Dayri and Barhee (Iraq).

In addition to these main categories of crosses, other combinations will be made in small numbers in order to complete the cross-breeding programme and to allow a precise study of the Bayoud-resistance mechanism in the date palm. Similar work will be pursued in Algeria.

CONCLUSION & FUTURE PROSPECTS FOR THE CONTROL OF BAYOUD.

The palm tree plays an important role in the ecology, economy and sociology of the Saharan environment; this tree is, in fact, irreplaceable in irrigable desert lands. Because of the considerable damage that Bayoud has caused in Moroccan, and Algerian palm groves and the threat that it constitutes to other countries, the disease has become the greatest enemy to date-growing regions of the world.

As previously mentioned, the biological characteristics of *Fusarium oxysporum* f. sp. *albedinis*, and of its host make any type of successful chemical control unlikely. Furthermore, the projected prophylactic measures will never control Bayoud; they will only temporarily retard the spread of this disease. Genetic control remains the only solution to this problem. Table 6 summarizes the different approaches undertaken as solutions:

The first solution, leading to short-term (within 5 years) results, consists of studying the date palm population existing in contaminated zones in order to select resistant varieties of good quality. This genetic potential will be complemented by the introduction of the world's best varieties which will then be tested for Bayoud resistance. Following the afore – mentioned steps, this course of action will reach completion in 1984-85, with very promising results.

The second approach, giving medium to long-term results (within 5-12 years) consists of creating resistant and superior cultivars through a hybridization programme. It is expected that this research work carried out according to the phases mentioned in Table 6 may yield good results between the years 1984 and 1988.

There remains, however, the problem of propagation of selected cul-

tivars. Indeed, the release of a resistant cultivar and its planting on a mass scale demands in turn the availability of large numbers of offshoots. It is obvious that the natural production of offshoots by palm trees is very slow and insufficient to fulfil the demand for offshoots in all areas damaged by Bayoud disease.

The improvement of the technique of rooting light-weight offshoots in greenhouses equipped with "mist systems" will help to accelerate, at least slightly, the technique of vegetative propagation 47. Nevertheless, this course of action does not solve the need for large number of offshoots.

The solution to the problem lies in the perfection of a method of date palm tissue culture. Several laboratories throughout the world are working on this subject and they have obtained encouraging results. Those of the laboratories of Indio (USA) and (Angers) France are particularily interesting (46, 53). Indeed, these authors have succeeded in obtaining young date palms from inflorescences or from meristematic tissues (Figs. 10,11 and 12). Once this method is perfected, infinite numbers of high-quality, Bayoud-resistant date palms will be obtained from these clones.

Thus, not only will it be possible to rehabilitate the Moroccan and Algerian palm groves that have been destroyed by Bayoud, but it will also be possible to reconstitute the palm groves presently threatened by Bayoud, as well as to create new date-growing areas with the help of high-quality, resistant varieties.

Figs 10-12, by courtesy of Mr. A. Rhiss.

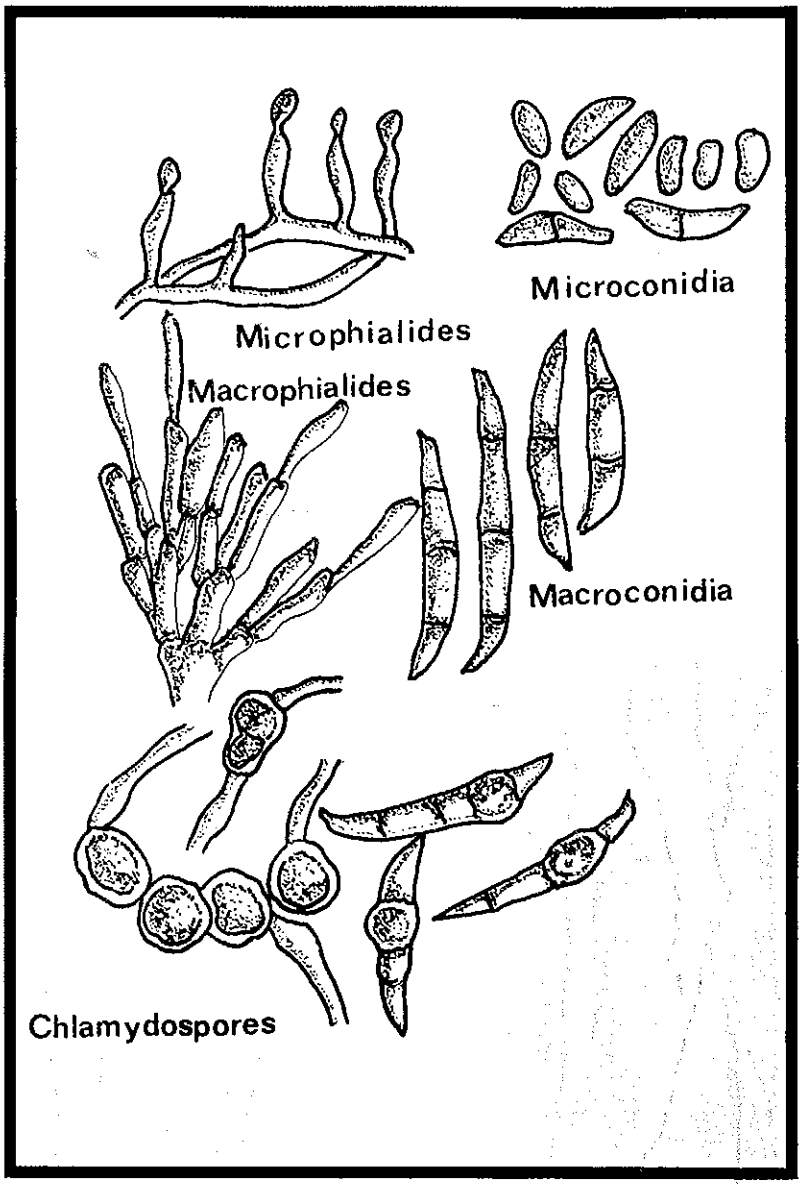


Figure 8: Micro and macroconidia produced by micro and macrophialides and chlamydospores of *Fusarium oxysporum* f. sp. *albedinis*.

Figure 9: Spread of Bayoud in homogenous plantation of Bou Feggous variety (Morocco).

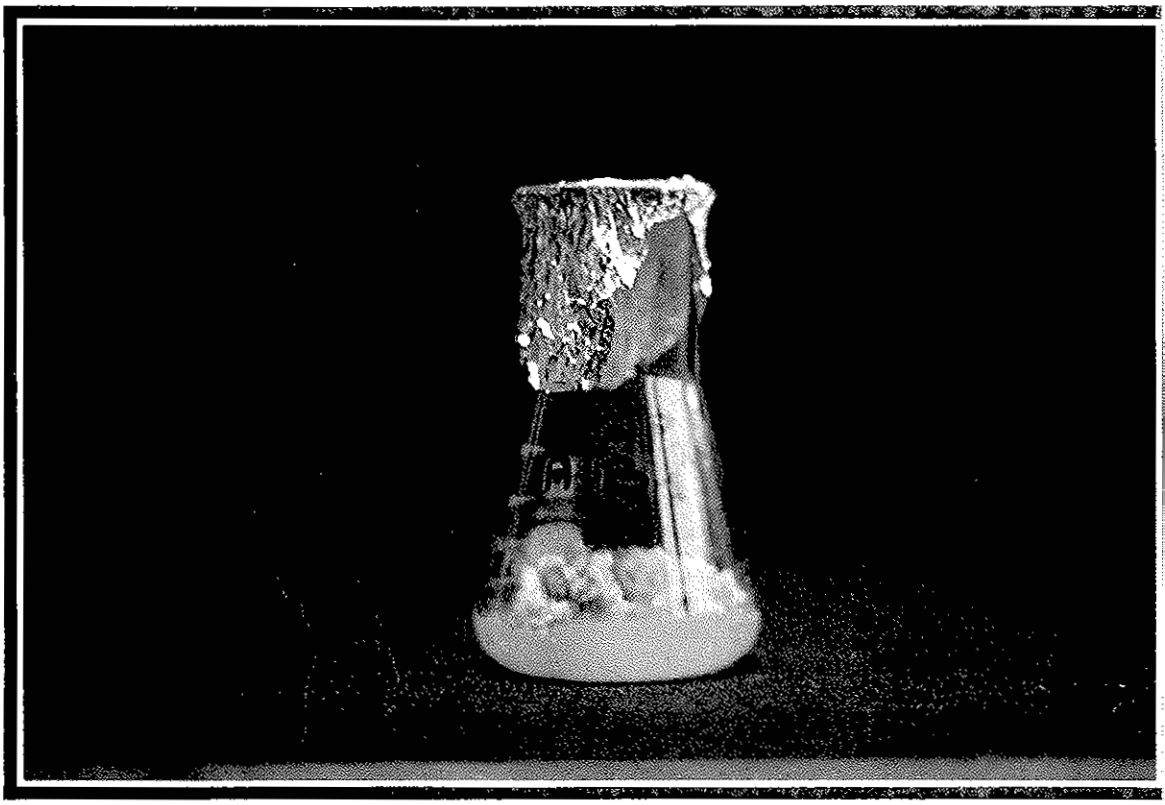


Figure 10: Proliferation of buds from meristematic tissues of date-palm offshoot.

Figure 11: Young date palm with developed leaves and roots.

Figure 12: Successful transplantation of young date palm from tissue culture into pot.

LITERATURE CITED

1. Aouad, L. (1975): Campagne de prospection, 1974-75. Rapport Annuel d'Activités, Sta. Cent. d'Agr. Saharienne, Dir. Rech. Agrono. Min. Agric. Ref. Agraire, Marrakech, Morocco.
2. Balachowsky, A. (1925): La maladie du Dattier dans le Sud-Oranais. Rev. agric. Afr. N. 23: 117-123
3. Balachowsky, A. (1926): La maladie du Dattier dite Bayoud. Rev. agric. Afr. N. 24: 549-554.
4. Beckman, C.H.; M.E.Mace; S.Halmos & M.W. McGahan (1961): Physical barriers associated with resistance in *Fusarium* wilt of bananas. Phytopathology 51 (8): 507-515.
5. Benzaza, H.B.; P.Brochard; D.Dubost & P.Hethener (1970): Progression du Bayoud en Algérie et résultats des prospections entreprises, Travaux sur le Bayoud, 1969-1970. MARA-PV-Congres maghrébin d'agronomie saharienne, 14 p.
6. Bouhot, D. & J.M. Billotte (1964): Recherches sur l'écologie des champignons parasites dans le sol. II. Choix d'un milieu nutritif pour l'isolement sélectif des *Fusarium oxysporum* et *Fusarium solani* du sol. Ann. Epiphyties 15 (1): 57-72.
7. Bounaga, N. (1970): Quelques aspects de la physiologie d'une souche de *Fusarium oxysporum* f. sp. *albedinis*, agent de la maladie du Bayoud. Mémoire D.E.S. Faculté des Sciences, Université d'Alger, 66 p.
8. Bounaga, D. & N.Bounaga (1973): Le Palmier dattier et sa Fusariose vasculaire. I – Les vaisseaux. Bull. Soc. Hist. nat. Afr. Nord Alger., 64, fasc. 3 et 4.
9. Brochard, P. & D.Dubost (1970a): Observations sur de nouveaux foyers de bayoud dans le département des Oasis. Travaux sur le Bayoud 1969-1970. MARA-PV, Congrès maghrébin d'agronomie saharienne, 14 p.
10. Brochard, P. & D.Dubost (1970b): Progression du Bayoud dans la palmeraie d'In Salah. Al Awamia 35: 143-153.
11. Bulit,J.; J.Louvet; D. Bouhot & G.Toutain (1967): Travaux sur les Fusarioses. I – Travaux sur le Bayoud, Fusariose vasculaire du palmier dattier en Afrique du Nord. Ann. Epiphyties 18 (2): 213-239.
12. Djerbi, M. (1970): Etude écologique des actions parasitaires des espèces fusariennes à l'égard du Blé. Bull. Inst. Agro. Tunisie No. 26-27: 5-58.

13. Djerbi, M. (1979a): Proposed research programme on diseases and physiologic disorders and propagation of date palm with special emphasis on Bayoud. FAO/Reg. Proj. for Palm and Dates Reseach, Rep., 13 p.

14. Djerbi, M. & L.Aouad (1979b): Reconstitution de la palmeraie marocaine: recherche de sairs de qualité, résistants au Bayoud. Rapport annuel d'activités (1978-1979). Dir. Rech. Agron., Min. Agric. Ref. Agraire, Marrakech, Morocco.

15. Dubost, D. & P. Hethener (1968): La lutte contre le Bayoud, problèmes et méthodes. Service de botanique, Faculté des Sciences, Université d'Alger, 16 p.

16. Dubost, D.; L.Kechacha & B. Rether (1970): Etude des enzymes pectinolytiques et cellulolytiques d'une souche monospore de *Fusarium oxysporum* f. sp. *albedinis*. Al Awamia 35: 195-211.

17. Dubost, D. & A. Kada (1974): Etude expérimentale de l'inoculation de jeunes plantules de palmier dattier par *Fusarium oxysporum*. Bull. Agr. Sahar. 1 (2): 21-37.

18. Foex, B. & P.Vayssiere (1919):Les maladies du dattier au Maroc. J. Agric. Trop. 162: 336-339.

19. Jamoussi, B. (1967): Le Bayoud du Palmier Dattier. Bull. Ec. Nat. Sup. Agric. Tunis No. 14-15: 5-15.

20. Kada, A. & D.Dubost (1975): Le Bayoud à Ghardaia. Bull. Agr. Sahar., Alger, 1 (3): 29-61.

21. Kellou, R. & D. Dubost (1975): Organization de la recherche et de la lutte contre le Bayoud en Algérie. Bull. Agro. Sahar., (1): 5-13.

22. Killian, C. & R.Maire (1930): Le Bayoud, maladie du dattier. Bull. Soc. Hist. nat. Afr. 21: 89-101 (Abstr. Rev. Appl. Mycol. 10: 99-100).

23. Laville, E. & P.Lassois (1963): Méthode de Van der Planck et mode de propagation du Bayoud. Fruits 18 (5): 249 – 253.

24. Louvet, J.; J.Bulit; G. Toutain & P.Rieuf (1970): Le Bayoud, Fusariose vasculaire du Palmier Dattier. Symptômes et nature de la maladie. Moyens de lutte. Al Awamia 35: 161-182.

25. Louvet, J. (1972): Signification de l'étude quantitative des champignons phytopathogènes telluriques. OEPP/EPPO Bull. 7: 5-15.

26. Louvet, J. & G. Toutain (1973): Recherche sur les Fusarioses. VIII – Nouvelles observations sur la Fusariose du Palmier Dattier et précisions concernant la lutte. Ann. Phytopathol 5: 35-52.

27. Louvet, J. (1977): Observations sur la localisation des chlamydospores de *Fusarium oxysporum* dans les tissus des plantes parasitées. Travaux dédiés à G. Viennot – Bourgin, I.N.R.A., Société Française de Phytopathologie: 193-197 (Paris).

28. Louvet, J. & J.Bulit (1978): Some observations about *Fusarium* wilt of Date palms *(Phoenix dactylifera)*. Pathological wilting of Plants, University of Madras, India: 499-506.

29. Louvet, J. & G.Toutain (1979): Bayoud, *Fusarium* wilt of date palm. In Fusarium T.A.Toussoun and P.E.Nelson, Eds. *Fusarium*. Pennsylvania State University Press.

30. Malençon, G. (1934a): La question du Bayoud au Maroc. Annls. Cryptog. Exot. 7: 43-83 (Abstr. Rev. Appl Mycol. 14: 302-303).

31. Malençon, G. (1934b): Nouvelles observations concernant l'étiologie du Bayoud. In C.R. Hebd. Seanc. Acad. Sci. Paris, 196: 1259-1262 (Abstr. Rev. Appl. Mycol. 13: 505).

32. Malençon, G. (1934c): Les palmeraies du Drâa et le Bayoud. Bull. Soc. Hist. Nat. Afr. 25: 112 – 117.

33. Malençon, G. (1936): Les palmeraies du Drâa et le Bayoud. Rev. Mycol. N.S. 1: 191 – 206. (Abstr. Rev. Appl. Mycol. 16: 34-35).

34. Malençon, G. (1946): L'infection florable du dattier par le *Fusarium albedinis* (Kill. & Maire) Mal. C.R. Hebd. Seanc. Acad. Sci. Paris 223: 923-925. (Abstr. Rev. Appl. Mycol. 26: 53-54).

35. Malençon, G. (1947): Mission d'étude dans les oasis du territoire d'Ain-Sefra et l'annexe de Tidikelt concernant une maladie du palmier dattier. Annls Inst. Agric. Alger. 3: 139-158.

36. Malençon, G. (1949a): Une expérience marocaine de lutte contre les maladies fusariennes. C.R. Journées Agric. N. Afr. Serv. Hort. Rabat 2: 13-24.

37. Malençon, G. (1949b): Le Bayoud et la reproduction expérimentale des lésions chez le palmier dattier. Mém. Soc. Hist. Nat. Afri. (hors série) 2: 217-228. (Abstr. Rev. Appl. Mycol. 28: 522-523).

38. Malençon, G. (1950a): La diffusion et l'épidémiologie de la maladie fusarienne du palmier dattier en Afrique du Nord. Revue Mycol. Suppl. Colon. 15: 45-60 (Abstr. Rev. Appl. Mycol. 30: 154-155).

39. Malençon, G. (1950b): Le Bayoud, maladie fusarienne du palmier dattier en Afrique du Nord. Fruits d'Outre-mer 5: 279-289 (Abstr. Rev. Appl Mycol. 30:155).

40. Mercier, S. & J.Louvet (1973): Recherches sur les Fusarioses. X – Une Fusariose vasculaire du Palmier des Canaries. Ann. Phytopathol. 5: 203-211.

41. Nixon, R.W. and J.R.Furr (1965): Problems and Progress in date breeding. Report of the Date Growers' Inst. 42: 2-5.

42. Nlendi, N. (1975): Recherches sur les relations entre l'ontogénèse vasculaire et le déroulement de la maladie chez le Palmier dattier atteint de Fusariose. D.E.A. Faculté des Sciences, Université de Dijon.

43. Pereau-Leroy, P. (1957): Recherche d'un test de sensibilité des variétés de palmier dattier à la fusariose. Fruits d'Outre-mer 12: 53-56. (Abstr. Rev. Appl. Mycol. 36: 586).

44. Pereau-Leroy, P. (1958): Le palmier dattier au Maroc. Royaume du Maroc, Ministère de l'Agriculture, Institut Français de Recherches Fruitières Outre-mer, 142 P. (Abstr, Rev. Appl. Mycol. 40: 236).

45. Pinoy, P.E. (1925): Sur la maladie du Bayoud des palmiers de Figuig. C.R. Séanc. Soc. Biol. 92: 137 – 138. (Abstr. Rev. Appl. Mycol. 4: 347-348).

46. Poulain, C.; A. Rhiss & G. Beauchesne, (1979): Communication personnelle de M. Rhiss.

47. Saaidi, M. (1979): Contribution à la lutte contre le Bayoud, Fusariose vasculaire du Palmier Dattier. Thèse d'Université, Université de Dijon, 140 pp.

48. Sergent, E. & M. Beguet (1921): Sur la nature mycosique d'une nouvelle maladie des dattiers menaçant les oasis marocaines. C.R. Hebd. Séanc. Acad. Sci. Paris 172: 1624-1627. (Abstr. Rev. Appl. Mycol. 1: 18).

49. Snyder, C.W. et H.N.Hansen (1940): The species concept in *fusarium*. American Journal of Botany, 27 (2): 64-67.

50. Snyder, W.C. & H.N.Hansen (1941): The species concept in *fusarium* with reference to section Martiella. American Journal of Botany, 28 (9): 738 – 742.

51. Snyder, W.C. & A. Watson (1972): Rapport préliminaire sur le Bayoud ou fusariose vasculaire du palmier dattier. The Ford Foundation, Tunis 18 p.

52. Stover, R.H. (1962): Fusarial wilt (Panama disease) of Bananas and other *Musa* species. Phytopathol. Pap. CMI 4: 117 p.

53. Tisserat, B. (1979): Personal communication of Dr. Carpenter, U.S. Date and Citrus Station 44-455 Clinton St. Indio, CA 92201.

54. Toutain, G. (1965): Note sur l'épidémiologie du Bayoud en Afrique du Nord. Al Awamia 15: 37-45

55. Toutain, G. (1965): Note sur l'épidémiologie du Bayoud en Afrique du Nord. Al Awamia 15: 37-45. (Abstr.Rev. Appl Mycol. 45: 273).

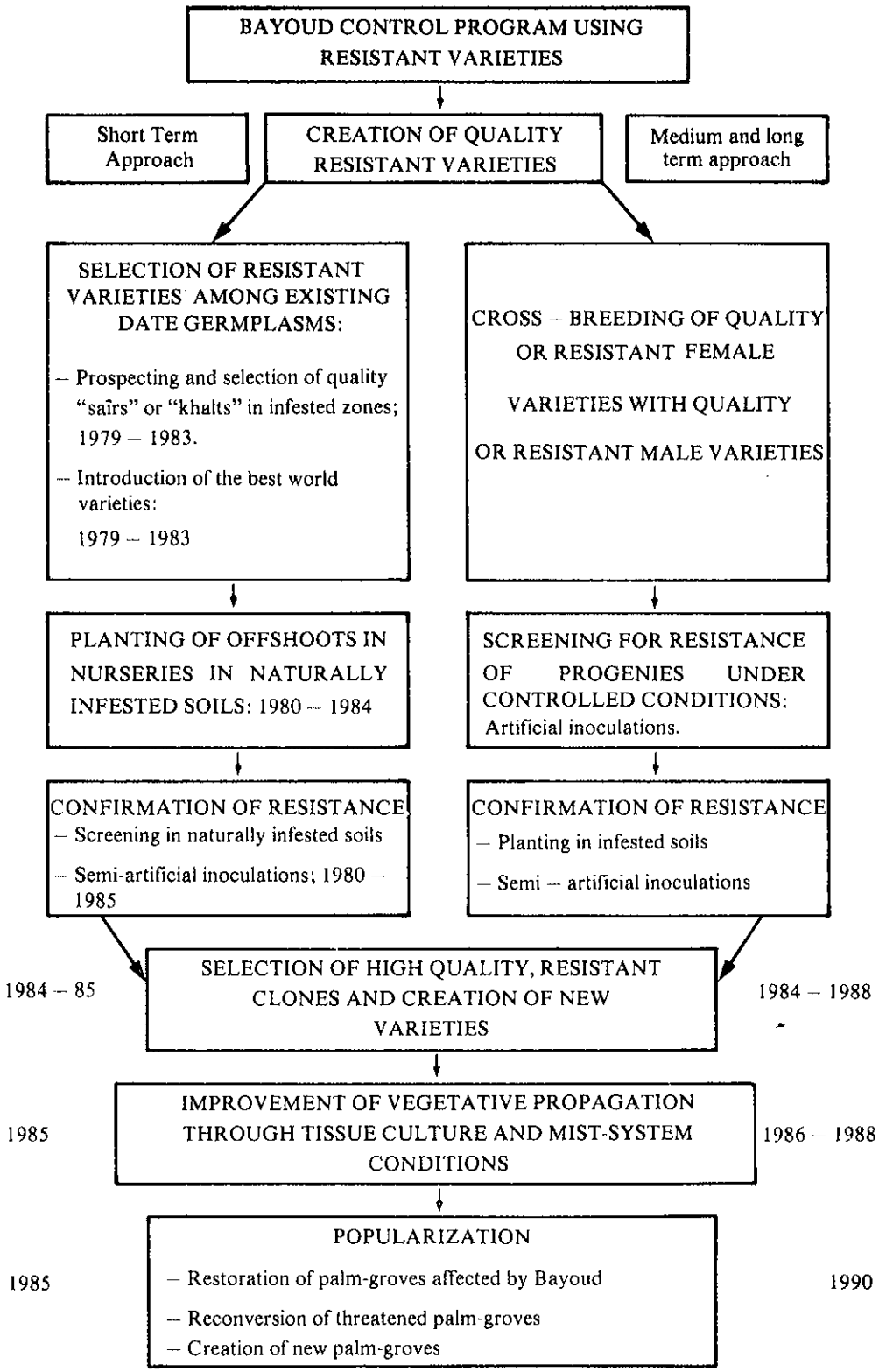
56. Toutain, G. (1968): Essais de comparaison de la résistance au bayoud des variétés de palmier-dattier. Notes sur l'expérimentation en cours concernant les variétés marocaines et tunisiennes. Al Awamia no 27: 75 – 78.

57. Toutain, G. (1970): Observations sur la progression d'un foyer actif de Bayoud ans une plantation régulière de Palmier dattier. Al Awamia 35: 155 – 161.

58. Toutain, G. (1972a): Progression du Bayoud en palmeraies établies sur terrain salés. Al-Awamia No. 42: 65-75.

59. Toutain, G. & J.Louvet (1972b): Résistance to Bayoud in variétiés of date palm. First International Seminar and Workshop on Bayoud, Algiers, Octobre 1972, I.T.A.S., Alger: 208-210.

60. Toutain, G. et J.Louvet, (1974b): Lutte contre le Bayoud IV – Orientations de la lutte au Maroc. Al-Awamia 53: 141 – 160.


BAYOUD CONTROL PROGRAM USING RESISTANT VARIETIES
Short Term Approach
CREATION OF QUALITY RESISTANT VARIETIES
Medium and long term approach
SELECTION OF RESISTANT VARIETIES AMONG EXISTING DATE GERMPLASMS:
– Prospecting and selection of quality "saîrs" or "khalts" in infested zones; 1979 – 1983.
– Introduction of the best world varieties:
1979 – 1983
CROSS – BREEDING OF QUALITY OR RESISTANT FEMALE
VARIETIES WITH QUALITY
OR RESISTANT MALE VARIETIES
PLANTING OF OFFSHOOTS IN NURSERIES IN NATURALLY INFESTED SOILS: 1980 – 1984
SCREENING FOR RESISTANCE OF PROGENIES UNDER CONTROLLED CONDITIONS:
Artificial inoculations.
CONFIRMATION OF RESISTANCE
– Screening in naturally infested soils
– Semi-artificial inoculations; 1980 – 1985
CONFIRMATION OF RESISTANCE
– Planting in infested soils
– Semi – artificial inoculations
1984 – 85
SELECTION OF HIGH QUALITY, RESISTANT CLONES AND CREATION OF NEW VARIETIES
1984 – 1988
1985
IMPROVEMENT OF VEGETATIVE PROPAGATION THROUGH TISSUE CULTURE AND MIST-SYSTEM CONDITIONS
1986 – 1988
1985
POPULARIZATION
– Restoration of palm-groves affected by Bayoud
– Reconversion of threatened palm-groves
– Creation of new palm-groves
1990

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PRELIMINARY RESULTS OF A DATE PALM IRRIGATION EXPERIMENT IN CENTRAL IRAQ

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ABSTRACT

The water use of full-grown date palms and the appropriate irrigation scheduling for Central Iraq was studied. A field with 20 year-old Maktoom, Braim, Barhee and Sayer varieties intercropped with 5-year-old citrus trees and 8 × 8m spacing was selected. Preliminary results obtained in 1980 showed that the total net water use of full-grown date palms in central Iraq was of the order of 18,000m^3/ha/yr. The monthly crop coefficients (Kc) with respect to potential or reference crop evapo-transpiration ranged from 0.75 to 1.00, with a seasonal average of 0.85. The seasonal ratio of date palm water use to Class A pan evaporation was 0.56. For the levee soil of Zafaraniah with a water table depth fluctuating between 3.5 and 4.0m below ground level, the total water used was apportioned as follows: about 12,000m^3/ha from irrigation, 5,000m^3/ha from water table and 1,000m^3/ha from rain. 70 to 74% of date palm feeder roots were located in the top 120 cm of soil. Capillary rise from the water table affected most of the soil profile below 100cm from the surface. The recommended irrigation scheduling is 10 irrigations per year. Two irrigations per month should be given in June, July and August; monthly irrigations are sufficient during May, September and October. Finally, only one irrigation is needed throughout the entire period (November-April). Differential irrigation practised on these four varieties showed that poor irrigation and water stress significantly depressed leaf elongation and reduced fruit size and

weight. In areas planted with date palms, Class A evaporation was reduced to about half the level usual in open fields. This decreased evaporation, produced a favourable micro-climate for young intercropped citrus trees that tolearate extended irrigation intervals.

نتائج أولية عن تجربة ري النخيل في وسط العراق

طوني ابو خالد المشروع الاقليمي لاستعمالات الاراضي والمياه في الشرق الادنى وشمال افريقيا

س. أ. جودري المشروع الاقليمي لبحوث النخيل والتمور في الشرق الادنى وشمال افريقيا

سميه عبد السلام الهيئة العامة للبستنة

الخلاصة

اجريت هذه الدراسة بالتعاون بين المشروع الاقليمي لبحوث النخيل والتمور ومشروع استخدام الاراضي والمياه والهيئة العامة للبستنة والغابات في الزعفرانية / بغداد / خلال عام 1980 . درس احتياج الماء من قبل بساتين نخيل التمر والمواعيد المناسبة للري في المنطقة الوسطى من العراق . تم اختيار بستان نخيل بعمر حوالي 20 سنة مزروعة على مساحة 8×8 م بأصناف المكتوم والبرحي والبريم والساير مع اشجار موالح (حمضيات) كزراعة بينية عمرها خمس سنوات . دلت النتائج الأولية ان استهلاك الماء الكلي للنخيل المثمر في وسط العراق كان بحدود 18000 م^3 / هكتار / لكل سنة .

كانت النسبة الموسمية لاستهلاك الماء لنخيل التمر الى التبخر من حوض (Class A pan) بحدود 0.56 . وبذا يكون المجموع الكلي للماء المستعمل في الترب الرسوبية في الزعفرانية والتي يتراوح فيها مستوى الماء الأرضي ما بين 3,5 – 4,0 متراً موزعة كالآتي :

12000 م3 / هكتار من الري و5000 م3 / هكتار من الماء الأرضي و1000 م3 / هكتار من الأمطار . كان 70 – 74% من الجذور موجوداً في طبقة عمقها 120 سم من سطح التربة . أثرت الخاصية الشعرية من الماء الأرضي على معظم قطاع التربة تحت 100 سم من سطحها وقد أوصي باستعمال 10 ريات في السنة الواحدة بواقع ريتين لأشهر حزيران (يونيه) وتموز (يوليه) وآب (اغسطس) وربة واحدة في كل من شهر أيار (مايو) وأيلول (سبتمبر) وتشرين أول (أكتوبر) وربة واحدة فقط خلال فصل الشتاء من تشرين الثاني (نوفمبر) الى نيسان (ابريل) .

ان الأرض المزروعة تحت اشجار النخيل يقل التبخر فيها الى حوالي نصف المستوى عما هو في الحقول المكشوفة . وان تقليل التبخر هذا يوفر مناخاً أكثر ملاءمة لأشجار الحمضيات المزروعة مع النخيل مما يمكنها من تحمل فترات ري أطول .

INTRODUCTION

The number of date palms in the world is about 93 million. 78% of this total is in the Arab countries with Iraq alone having 37%. Although these figures have changed in the last few years, date palms remain of major importance in the Near East and North African Region.

There is a lack of data on the water use of the date palm in Iraq and in the Near East region. World literature on the subject is also limited.

The purpose of the present experiment is to establish the water use of fully grown date palms and to recommend the appropriate irrigation scheduling for Central Iraq.

The methodology followed allows extrapolation of the results to other regions in Iraq, as well as neighbouring countries. The work is a joint venture between two FAO Regional Projects namely the Date Palm Project (REM 021), the Land and Water Use Project (REM 508) and Zafaraniah Station.

MATERIALS AND METHODS

A field with four varieties of full-grown (20 years old) date palms (Maktoom, Barhee, Braim and Sayer) intercropped with 5 year old citrus trees was selected at Zafaraniah station, 19 km S.E. of Baghdad. Palm spacing is 8×8m. The layout of the experiment is shown in Fig. 1.

Two rows of nine palms for each variety were included in the experiment except for Maktoom where only one row was available. Three irrigation treatments were applied to six trees of each variety (three in the case of Maktoom). All palms received equal amount of a mineral fertilizer (7kg of compound 15,15,15) given in two applications with deep irrigation each time in early March and May, respectively.

The irrigation treatments are based on the concept that date palm water use (ET-Date) can be related to potential or reference crop evapotranspiration (ETO) by the simple equation:

$$ET\ Date = Kc \times ETo \qquad (i)$$

Where, Kc= Monthly crop coefficient as estimated by one of the four methods described in the FAO Irrigation and Drainage Paper (4). The Class A pan method was selected for its simplicity and convenience, thus:

$$ETo = Kp \times Eo \qquad (ii)$$

Where Kp = Monthly pan coefficient, and
Eo = Class A evaporation

Selection of the proper pan coefficient for a given crop and month is to some extent standardized in the paper mentioned. Crop coefficients (Kc) are available for many crops including trees and for ranges of conditions but not for date-palms in Iraq. They have to be established experimentally. Date palm is known to be water-stress and salt tolerant but responsive to good irrigation. Three levels of water use rates were assumed using relation (i) and the following coefficients:

a) Kc_1=0.2 (for strong stress)
b) Kc_2=0.5 (for intermediate stress)
c) Kc_3=0.8 (for non-stress)

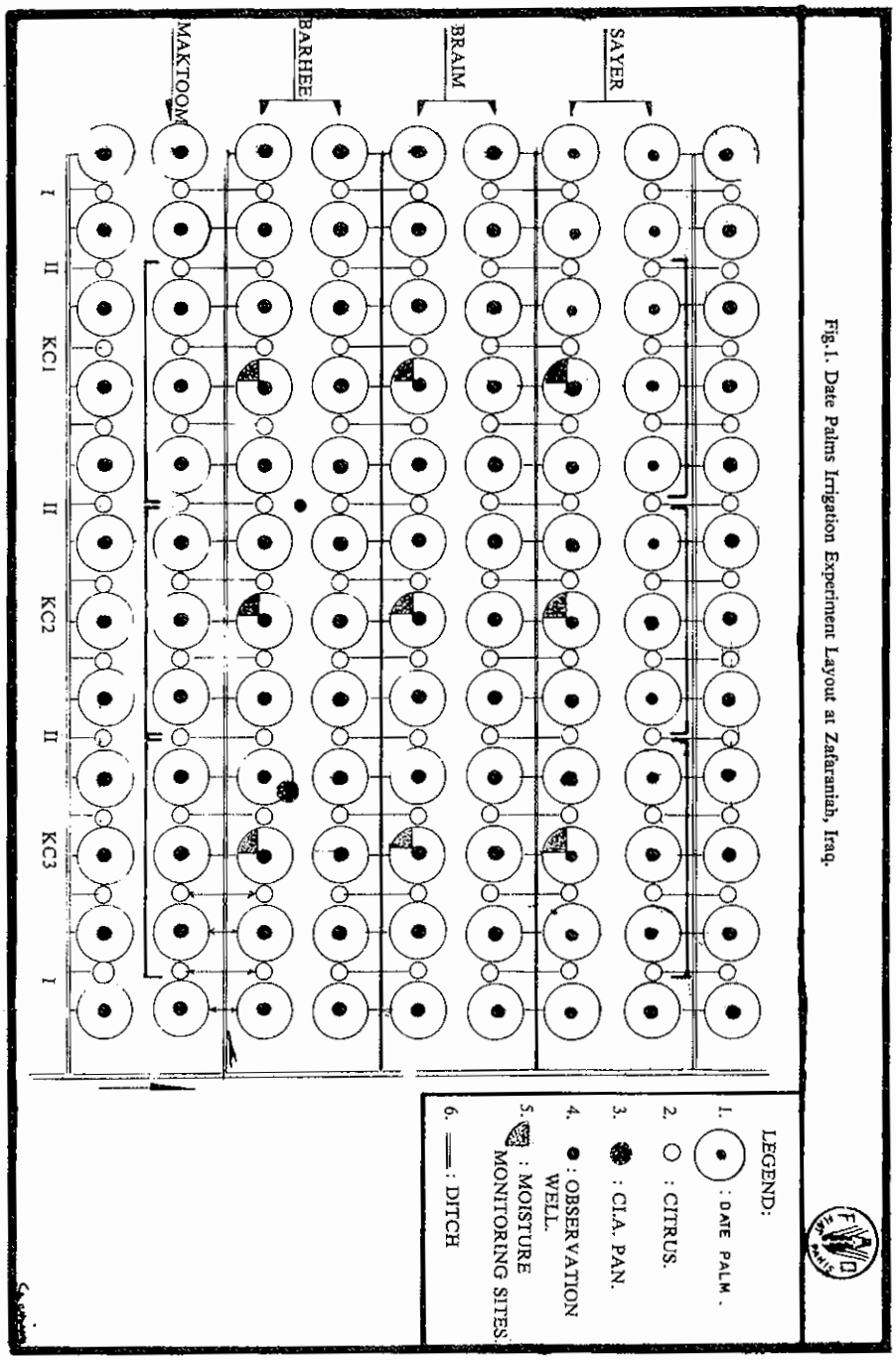


Fig. 1. Date Palms Irrigation Experiment Layout at Zafaraniah, Iraq.

Three irrigation schedulings were calculated on the basis of 75% depletion of available moisture in the top 100cm soil depth. Below the top meter there was evidence of capillary rise from a water table. This meant practically 4 irrigations for the Kc_1 treatment, 7 for the Kc_2 and 9 for the Kc_3 as shown below:

Table 1
Number of irrigations for the three treatments

Treatment	March	May	June	July	Aug	Sept.	Oct.	Total
Kc_1	1	1	-	1	1	-	-	4
Kc_2	1	1	1	1	1	1	1	7
Kc_3	1	1	1	2	2	1	1	9

Water was pumped from the Diala River in most cases. Only on few occasions water was pumped from the Tigris River.

A net water application of 150 mm was given each time to individual trees. Basins 6m in diameter and 30cm ridge height surrounded each tree. An earth ditch between two tree rows supplied water to trees on both sides through 3 or 4 inch PVC segments. Water height in the ditch was controlled by portable check-dams with rectangular opening for overflow. Water depth in the basins had to reach the exact depth as checked by small portable metal indicators. The time required for filling each basin was about 15 minutes.

Soil moisture monitoring was carried out in three basins of each treatment. The set-up is shown in Fig.2.

Gypsum blocks were placed at 40, 80 and 120cm depth and neutron probe access tubes down to 175cm. Tensiometers at 60, 90 and 120 cm depth were placed in wetter treatments (Kc_2 and Kc_3). For the young citrus trees, tensiometers and gypsum blocks were placed at 30 cm depth.

Evaporation data were obtained from Wahda agrometeorological station (SOLR*) 15 km south of the experimental site. In addition, a screened Class A pan was located inside the date orchard to reflect the microclimate affecting evaporation from the soil surface and evapotranspiration from citrus below date trees.

Unfortunately, the neutron probe was received only in early September.

★ State Organization for Land Reclamation.

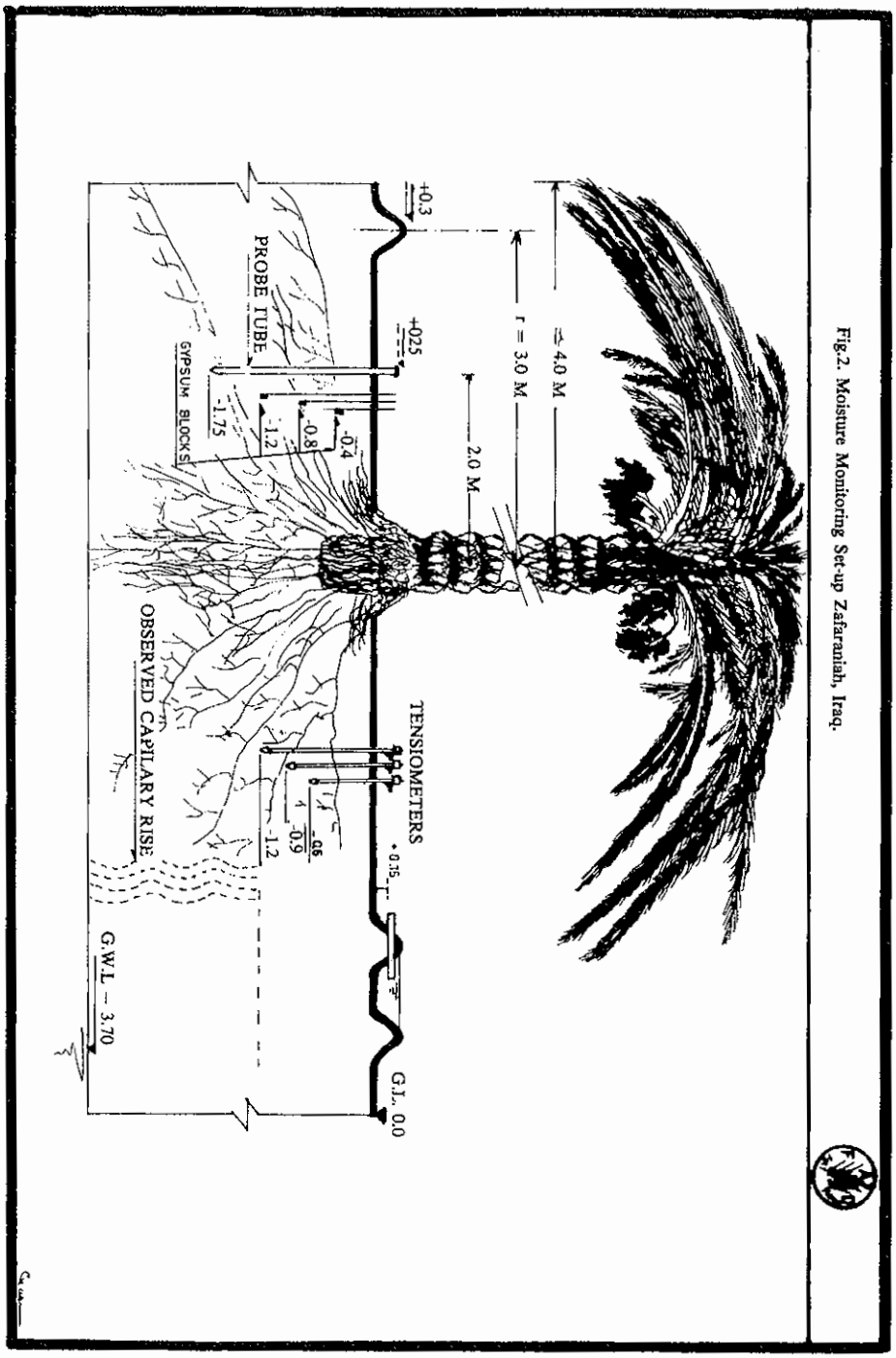


Fig.2. Moisture Monitoring Set-up Zafaraniah, Iraq.

Thus direct measurement of water use by the probe was limited to two irrigation cycles in the medium and non-stress treatments. Most of the C.U. data were derived from gypsum blocks the calibration of which was checked (Fig. 3). Zafaraniah Orchard is on levee soil.

The soil texture and soil moisture retention curves were determined for two sites in the orchard down to 150cm. Observations of the soil profile and root distribution down to 180cm were carried out at 4 meters distance from tree trunks. On the other hand, root density was measured by soil augering down to 2 meters at mid-distance between the trunk and the dripline for three date-palms(★). Details are given in Annex 1.

An observation well installed in September down to 4 meters showed a water table depth at 3.70m.

The following plant parameters were measured: leaf elongation, total yield, fruit size and weight:

- *Leaf elongation* was measured by attatching one end of a long twine to a newly emerging leaf and checking its upward movement at fixed intervals from the comparative position of the lower end of the twine with reference to a fixed nail driven into the palm trunk.
- *Yield* was recorded per palm at the time of harvest at «Rutab» stage.
- *Fruit size* was measured by the use of caliper. Both length and width wise readings were taken.
- *Fruit weight* Average fruit weight in grams for 50 fruits was recorded to determine the influence of water stress.

RESULTS AND DISCUSSIONS

Water Use of Date Palm and Irrigation Scheduling

During the common irrigation period, the water use in late March and in May was on the average 4.0mm/day and the ratio to Class A pan evaporation was 0.35.

(★) The contribution of Dr. Namik Rashid from the Agric. and Water Research Centre is acknowledged.

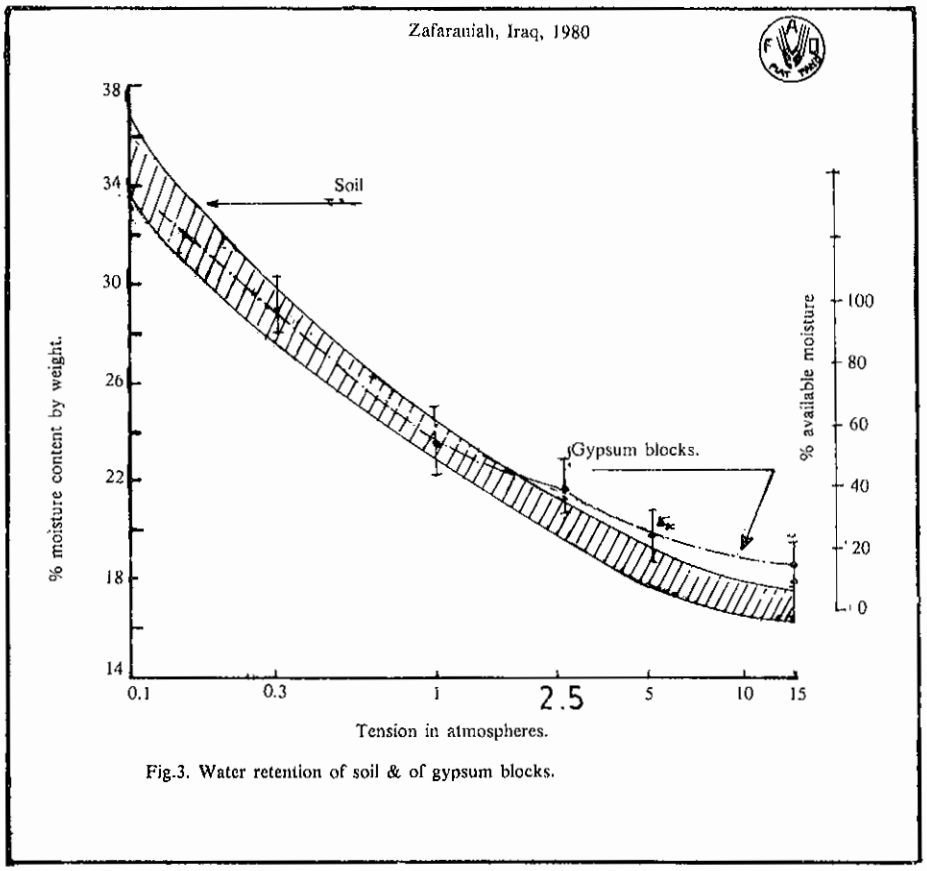


Fig.3. Water retention of soil & of gypsum blocks.

As differential irrigation started in early June, in the stress treatment, the rate of water use from the top soil meter was in the order of 4mm/day during July and part of August. It decreased to about 1.5mm/day in September and less in October. The trees survived by water uptake from the capillary fringe in the deeper layers. Neutron probe data and direct observations in a deep trench showed increasing moisture below 120cm to reach about field capacity at 1.80m depth. The water table, as mentioned before, was at 3.70m from the surface. In June and July Cl.A evaporation reached its maximum of 17mm/day. June rates were exceptionally high in 1980. Some plant control of transpiration might have occurred explaining the relatively

lower ratio of water use to evaporation. Actually, the rate of leaf elongation was markedly reduced in June. An additional irrigation in June would have helped the plant to cope better with the increase in evaporation demand.

In both the intermediate and non-stress treatments, water use increased between June and July to about 5.5mm/day. It increased further between July and August to about 7.0mm/day in the non-stress treatment which had received an additional irrigation on July 18th. In September, and specially October the evaporative demand decreased significantly. As a result, the date palm water use decreased to about 4mm/day.

The ratio of date palm water use from the top soil meter to Class A evaporation for the three irrigation treatments are given below. The average for the period of May to October was 0.34 and 0.40 for the intermediate and non-stress treatments, respectively.

Table 2

Ratios of date palm water use from the top soil meter to Class A evaporation

	Treatments		
Month	Stress	Intermediate	Non-stress
May	0.35	0.35	0.35
June	0.21	0.25	0.25*
July	0.26	0.26	0.34
August	0.26	0.30	0.45
September	0.13	0.39	0.43
October	0.05	0.39	0.43
Average	0.22	0.32	0.38

These figures do not include the uptake from the capillary water prevail-

★ The June ratio of date palm use to Cl.A is considered too low and will be replaced by 0.35 (see section on leaf elongation)

ing below 120cm. This statement is based on the fact that practically little if any change in moisture was detected by the neutron probe from the soil depth below 100cm. Little extraction took place from the layer 95-115cm since on one hand the surface irrigation did not reach this depth and on the other hand the capillary fringe did not supply adequate moisture from the water talbe (located about 470cm below the soil surface). Data from neutron probe, gypsum blocks and tensiometers confirmed the availablity of water at and below 120cm due to capillary rise from a water table.

To find the water use from all the soil profile down to 240cm., ratios of table 2 should be corrected to include the estimated water use from the capillary fringe. The correction is based on considerations of the root distribution of full-grown date trees as reported by Pillsbury (9-10), Armstrong and Furr (2) and as confirmed by some observations and measurements. It has been reported that 50% of the water taken up by the palm is extracted from the top 0-60cm layer, 30% from the 60-120cm layer, 15% from the 120-180 cm layer and finally 5% from the 180-240 cm layer. Thus, about 30% moisture extraction would occur between 100cm and 180cm soil depth. This figure is used in Table 3 to find ET Date/Cl.A for the non-stress irrigation treatment. The ratios to Cl.A of water use from the root zone down to 180 cm are given in the following table.

Table 3

Ratios of date water use from the effective root zone to Class A and crop coefficient (Kc).

Ratios	May	June	July	August	Sept.	Oct.	Average
ET Date/Cl.A	0.50	0.50	0.49	0.64	0.61	0.61	0.558
Kp*	0.68	0.63	0.63	0.63	0.68	0.68	0.655
Kc	0.74	0.79	0.78	0.01	0.90	0.90	0.853

★ – Monthly pan coefficients (Kp) take into account pan environment, monthly wind and relative humidity conditions.

These preliminary results show that Kc ranges from 0.75 to 1.00 and on the average:

ET Date Palm = 0.853 ETo (iii)

or ET Date Palm = 0.558 Class A (iv)

Toutain (13) used Kc values of 0.75 for date palms in the Central Sahara. More complete results are to be expected in 1981 and 1982 as:

1. Neutron measurements will hopefully cover the whole irrigation period,
2. Quantative assessment of root depth down to 240 cm will be completed,
3. Complete records of the water table fluctuations will be made,
4. Yield response data to differential irrigation will be more meaningful, and
5. Agrometeorological data will be generated at Zafaraniah Station itself.

The calculated potential evapotransipiration (ETo) is 2140mm for 1980 at Wahda Station, 15km south of Zafaraniah. Based on relation (iii) date-palm water use is 1825 mm (Fig.4).

This total net water use and its sources would be approximately as follows:

From Irrigation	12000 - 13000m^3/ha
From Rain	750 - 1250
From Water Table:	4500 - 5500
Total	17250 - 19750m^3/ha

The recommended number of irrigations for Zafaraniah would be 10 per year with 130mm as net application each time. The first irrigation should wet the soil profile at least to 120cm depth.

In Coachella Valley (California), the C.U. of Deglet Noor is reported as 6 ft/year or 18300m^3/ha (11). Furr & Armstrong (6) found consumptive use of Khadrawi palms at Indio (California) to be about 5ft/year or 15,200m^3/ha. Application of 6, 10 or 14 feet per year did not cause significant differences in growth and yields(7).

In an arid region where evaporation from a Class A pan is about

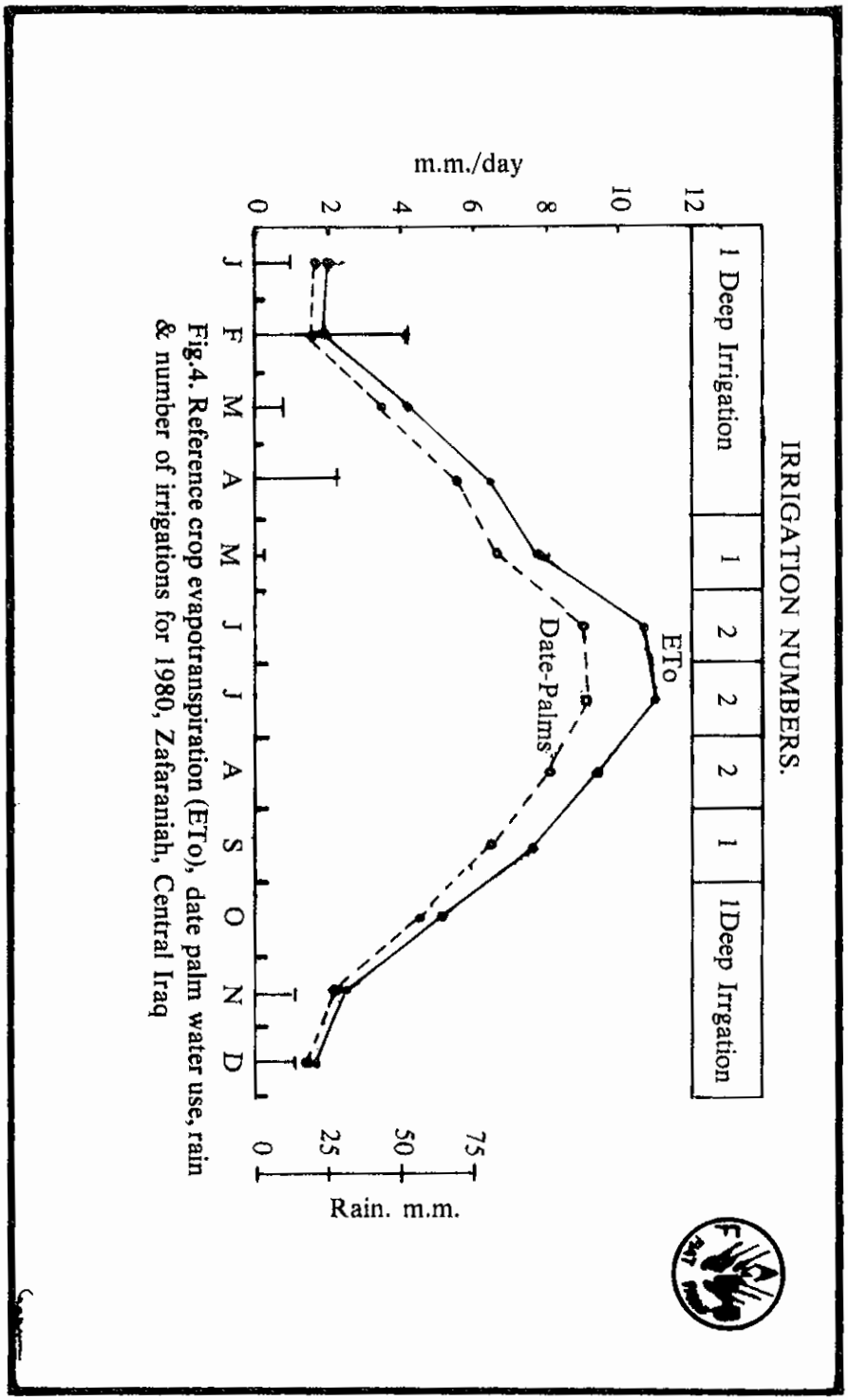


Fig.4. Reference crop evapotranspiration (ETo), date palm water use, rain & number of irrigations for 1980, Zafaraniah, Central Iraq

3500mm/year, Reuveni (12) and others estimated that the water requirement of Deglet Noor palm is between 150 and 200 m^3/tree per year or between 18,525 and 24,700m^3/ha. Our Cl.A evaporation is 3200 mm i.e. about 10% lower.

Furr (5) estimated the annual consumptive use of water by dates in Abadan Island as 24000m^3/ha using Blaney-Criddle formula and a «K» coefficient of 1.2 derived from work in the U.S.A. He also increased his estimate by 20% to 28,800 m^3/ha «because of the possible effect of strong winds of long duration».

In the absence of water table contribution this net water need in central Iraq would be 1700mm or 17,000m^3/ha. The irrigation requirement assuming 70% irrigation efficiency becomes 24300m^3/ha. By achieving good uniformity of water distribution a good deal of salt leaching would take place with the unavoidable deep percolation losses.

With a shallower water table the irrigation requirement will be less and will depend on the magnitude of the capillary rise or fringe and the fraction of the roots benefitting from it. The wetting depth should be limited to the soil not affected by the capillary rise.

This could be assessed by soil moisture monitoring or by visual observations of a soil trench in the orchard. Assessment of the root distribution remains essential to make the necessary adjustments for each case.

Citrus intercropped with date palms

Under date palms, citrus benefit from shading, from reduced wind velocities and from reduced evaporative demand.

For the period April to December, the evaporative demand under the canopy of date-palms was found to be reduced to about half its level in open fields (Fig. 5). Toutain (13) reported 26% to 30% decrease in Colorado pan evaporation (when located inside a date orchard with respect to open field location) under 30% and 50% canopy cover, respectively. In our case the canopy cover was higher ($\geqslant$ 70%) reducing further the evaporation demand below-canopy. The average ratio of full-grown citrus water use to Cl.A pan in the coastal area of Lebanon is 0.67 Cl.A (14). The

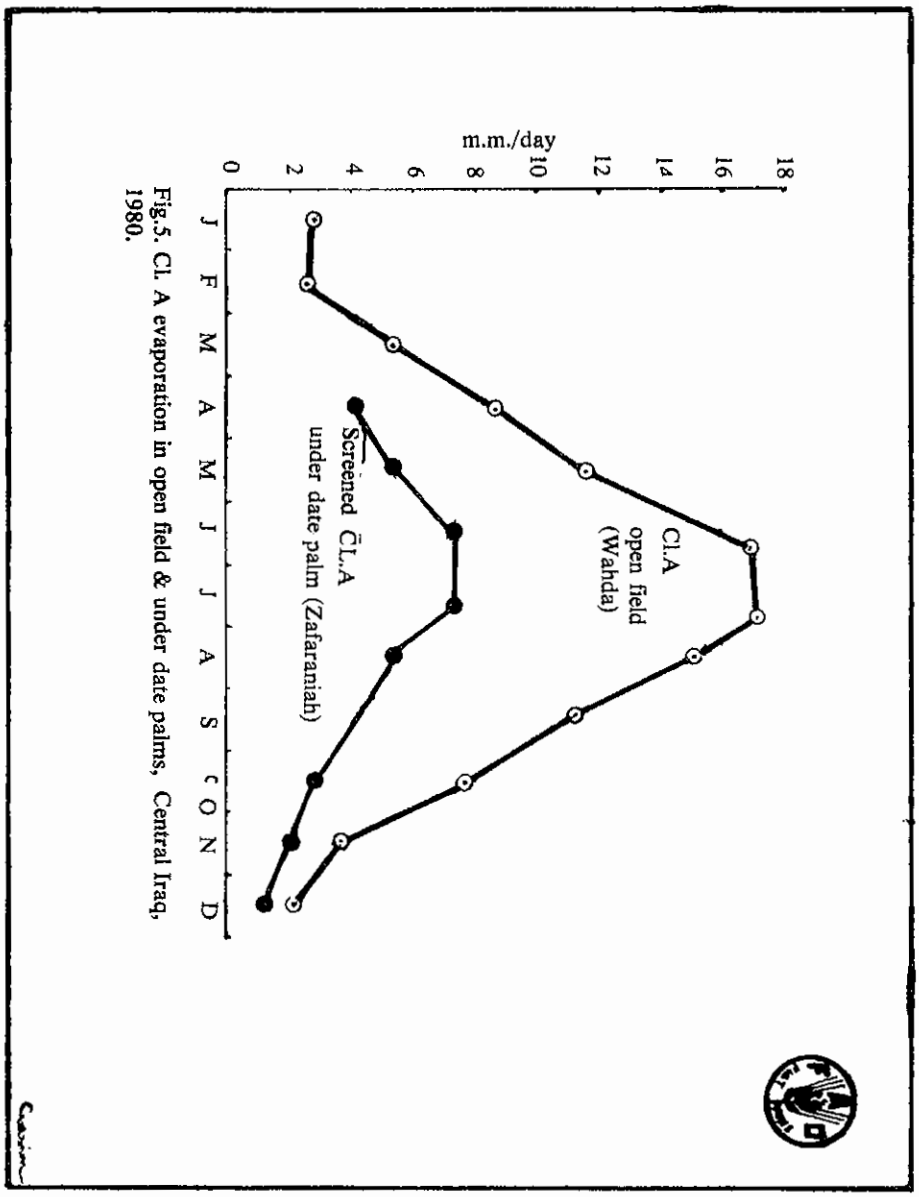


Fig.5. Cl. A evaporation in open field & under date palms, Central Iraq, 1980.

rates of water use for citrus in both open fields and for citrus inside the date palm orchards should be further assessed in Iraq. While citrus trees benefit, without doubt, from the favourable micro-climate created by the date palms, competition for water and nutrient occurs in the top 60cm soil layer. Irrigation scheduling to meet the requirements of both types of trees should be attempted.

At present only some comments could be made:

Citrus roots are much shallower than those of date palms and therefore did not benefit from the capillary fringe of the water table 3.70m deep. It has been reported that some 80% of the total moisture extraction by citrus takes place from the top 60cm of soil.

Depletion of 50% available moisture in this depth represents some 53mm for Zafaraniah soils. The corresponding irrigation intervals during the peak water use (June, July and August) will be from 10 to 14 days. Indeed severe water stress symptoms developed on the young citrus trees under Kc_1 and Kc_2 treatments which had to be irrigated independently at a certain stage to alleviate increasing stress. Tensiometers actually run off scale ($\geqslant$ 85 centibars) for 60 days and 80 days under the Kc_2 and Kc_1 treatments during the period April to September, 1980. Citrus trees were in much better shape under the Kc_3 treatment where soil moisture suction at 30cm remained in general in the tensiometer range during the peak water demand (Fig. 6).

Date palms response to irrigation treatments

(i) Leaf elongation

Leaf elongation was taken as a criterion of vegetative growth. It is a sensitive index of appreciable water deficits.

The average leaf elongation for the various irrigation treatments during the period April to September are given in the following table:

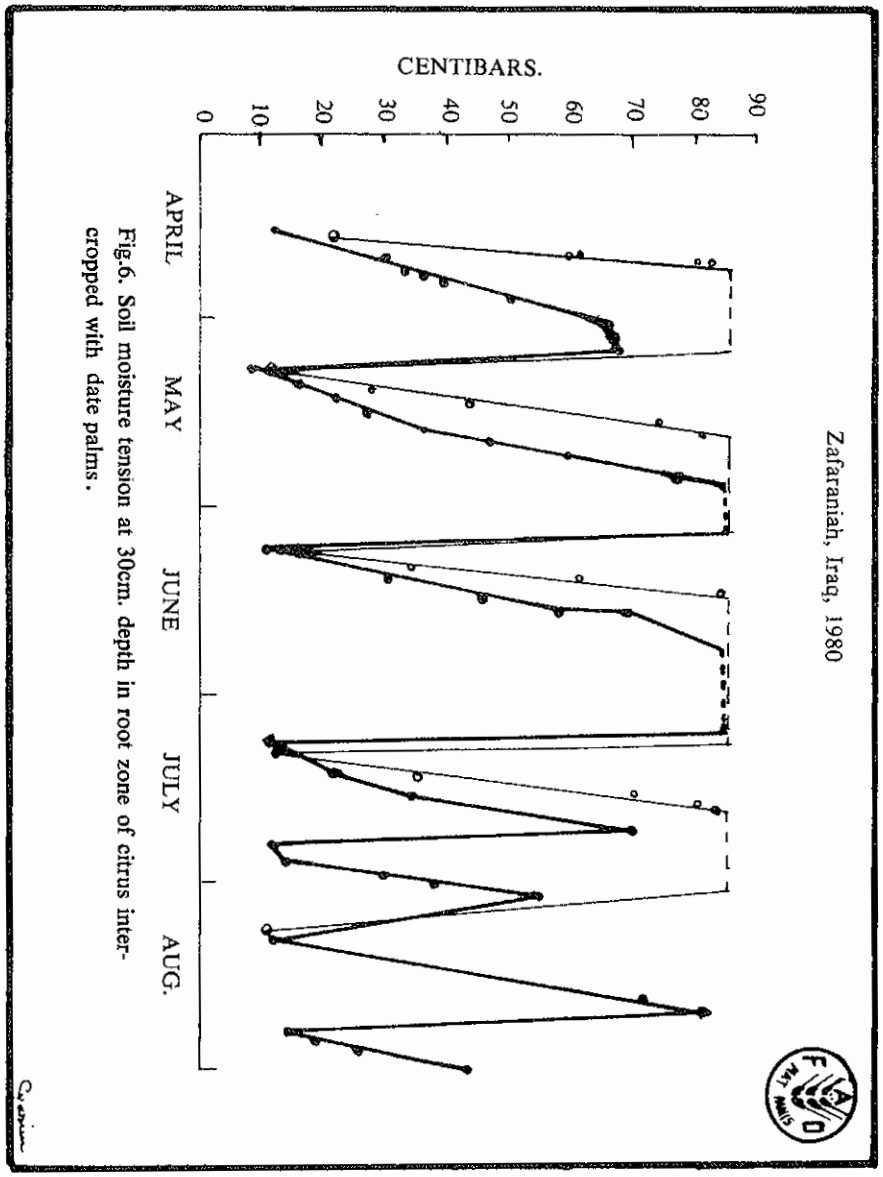


Fig.6. Soil moisture tension at 30cm. depth in root zone of citrus inter-cropped with date palms.

Table 4

Seasonal elongation rates of date palm leaves for different varieties and irrigation treatments

Varieties	Stress (Kc_1)	Intermediate (Kc_2)	Non-Stress (Kc_3)	Kc_3/Kc_1
	cm/day	cm/day	cm/day	
Maktoom	1.80	1.85	2.30	1.28
Barhee	1.66	1.90	2.16	1.30
Braim	1.31	1.31	1.75	1.33
Sayer	1.29	1.38	1.41	1.09

For three varieties out of four the increase in leaf elongation averaged 30% in the non-stress (Kc_3) with respect to the stress treatment (Kc_1). The increase was less (3-14%) in the intermediate treatment (Kc_2). Even under the so-called non-stress treatment (Kc_3) there was depression in leaf elongation in June corresponding to the highest C1.A evaporation rates in 1980 (Fig. 7). Pillsbury (10) showed leaf elongation rate to increase from April to mid-July and to decrease sharply afterwards. Shifting his measurements to new center leaves, high leaf elongation rates were found again for August and September. The rate of elongation of emerging leaves has been used also by Aldrich (1). In our case the same leaves were used throughout the year. A single irrigation in June proved to be inadequate. It should be emphasized that stress and stress relief was limited to a fraction of the root system for two reasons:

(a) The capillary fringe supplying water to the roots below 120cm.

(b) The controlled irrigation wetting about 100cm soil depth over 50% of the surface area available per tree.

In 1981 the diameter of the individual basins will be increased and another water application will be given in June. In the literature leaf elongation rates from 2 to 4 cm/day have been reported for new emerging leaves of Deglet Noor(1).

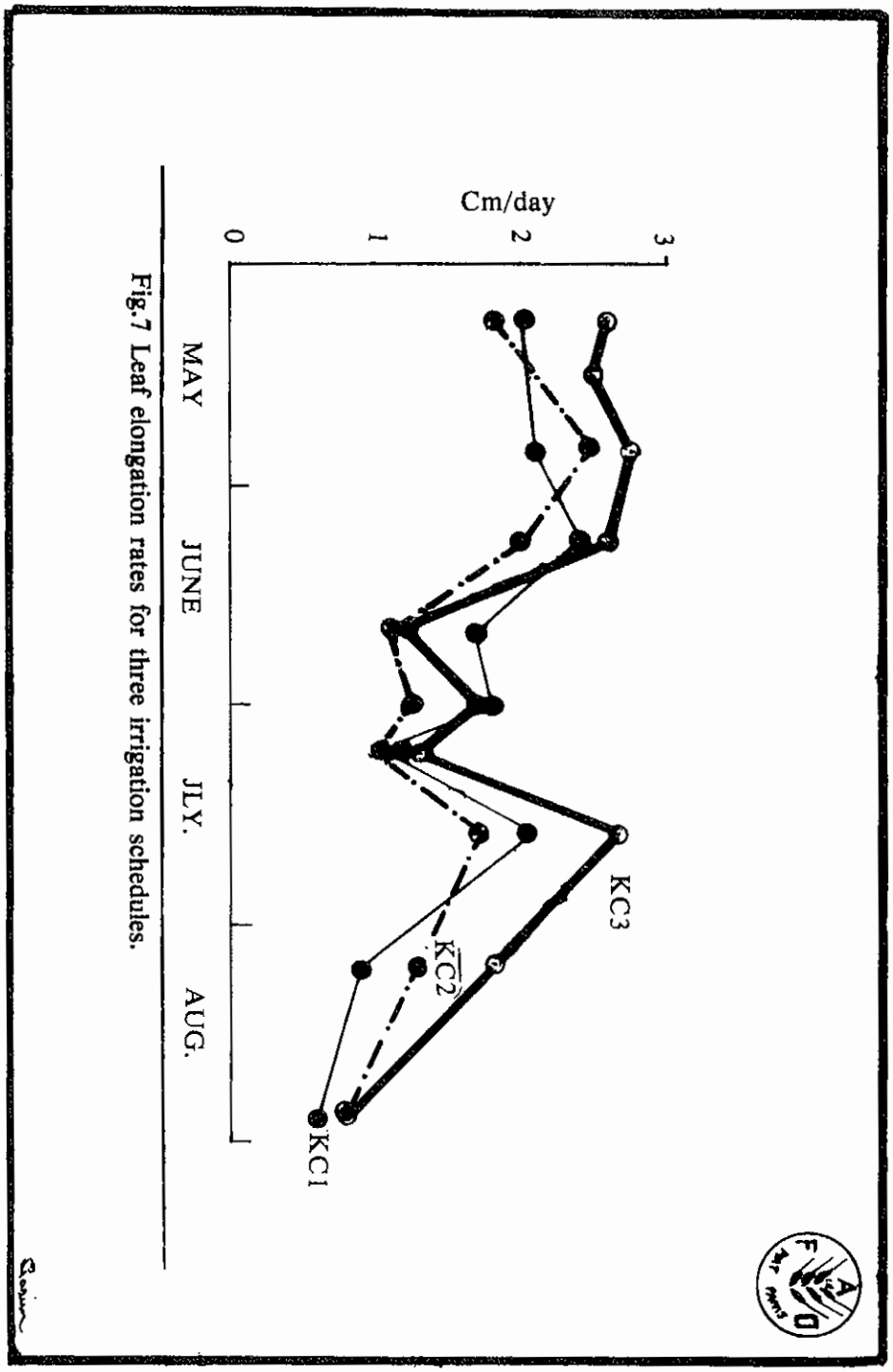


Fig.7 Leaf elongation rates for three irrigation schedules.

In the non-stress treatment (Kc_3), the percent available moisture before irrigation, as measured by gypsum blocks, was down to 30% and 40% at 40cm depth, 65% at 80cm and 95% at 120cm (Fig.8).

In the intermediate treatment (Kc_2), the percent available moisture was down to 10% at 40cm, 50% at 80cm and 90% at 120cm.

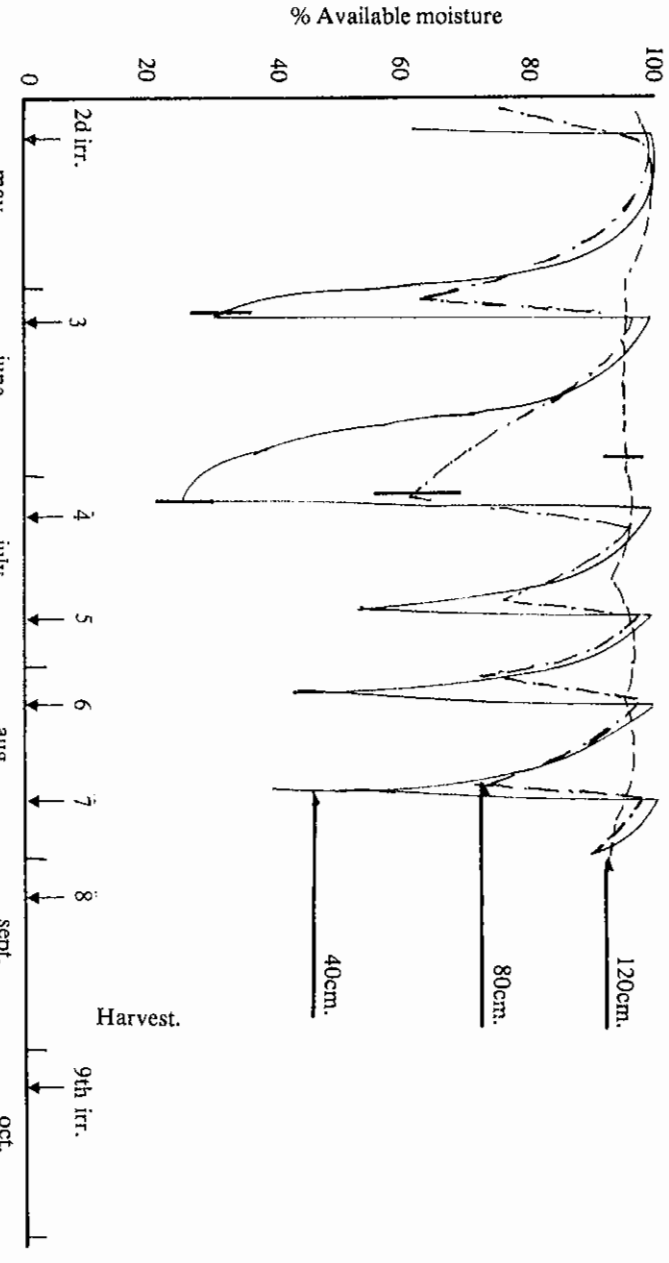
In the stress treatment (Kc_1), the percent available moisture was practically nil at 40cm but still about 90% at 120cm. (Fig. 8a).

Root observations showed the bulk of the root system to be in the top 120cm, with roots extending down to 180cm and more. Moisture from the capillary fringe was visible and increased progressively from the 120cm to the 180cm layers. This also was confirmed by the neutron probe measurements (Fig.9&10).

(ii) Fruit Quality

Fruit weight increased 21% and 47% in the Kc_2 and Kc_3 treatments, respectively i.e. with relief of the severe stress. Similarily, fruit length increased from 5% to 13% and fruit diameter from 8% to 18% Details are shown in Table 5.

Early work by Aldrich (1) showed the effects of soil moisture deficiency upon Deglet Noor fruit. Varietal differences of stress and non-stress irrigation treatments will be assessed further in 1981 and 1982.



Zafaraniah, Iraq, 1980

Fig.8. Available soil moisture at three depths as measured by gypsum blocks in the non-stress date palm treatment (Kc 3).

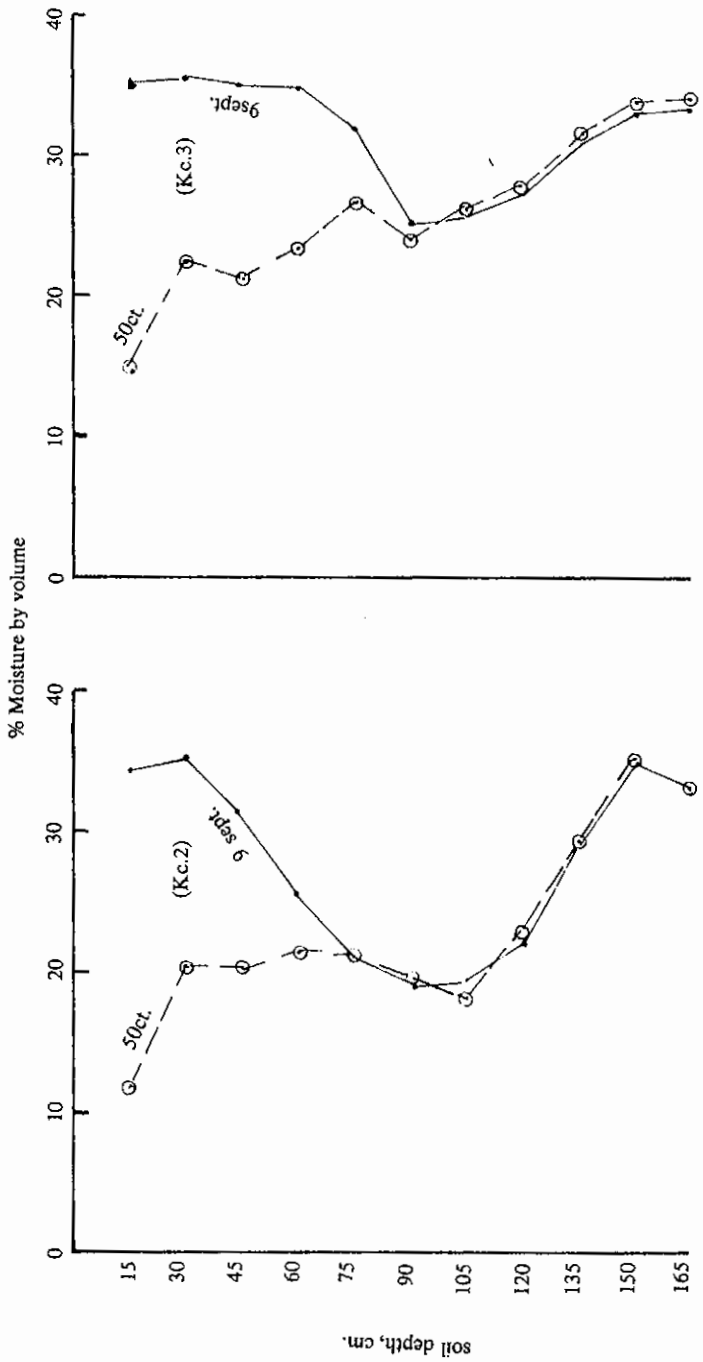


Fig.9. Soil moisture profiles in the medium (Kc.2) & non-stress (Kc.3) treatments of date trees, Zafaraniah, Iraq 1980.

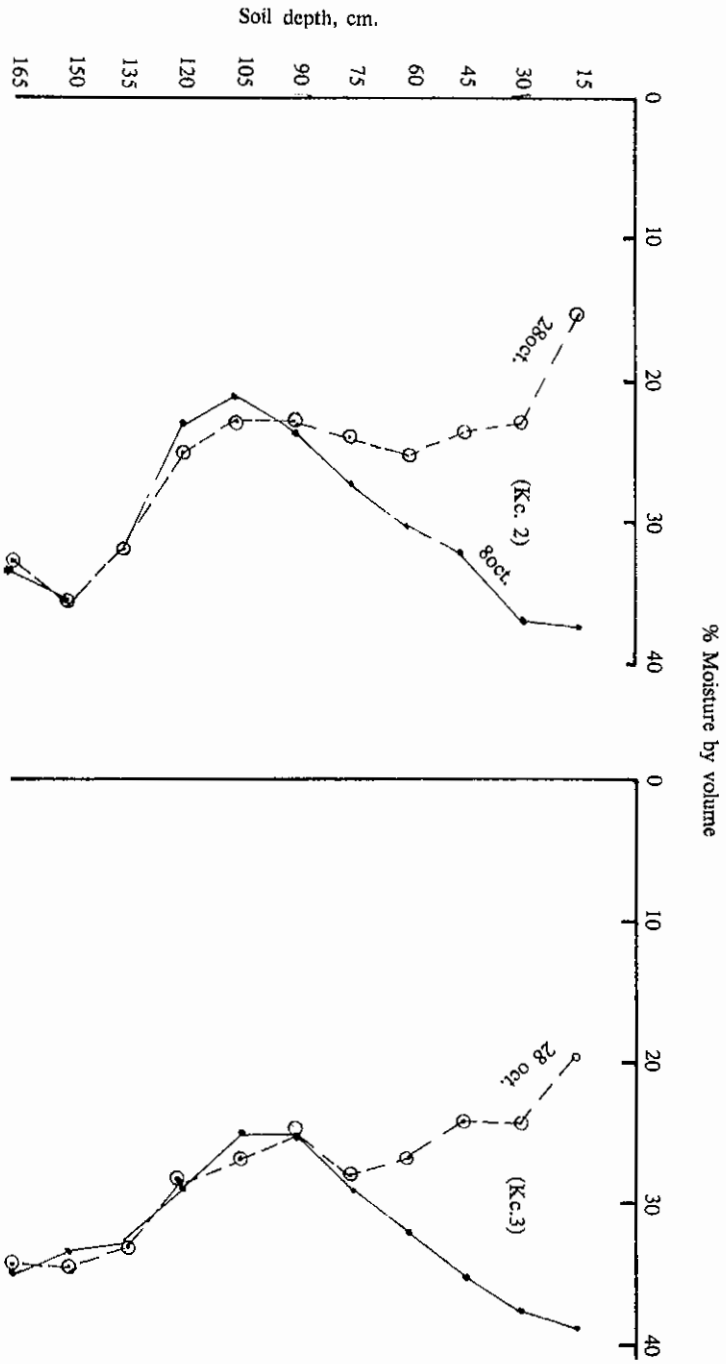


Fig.10. Soil moisture profiles in the medium (Kc.2) & non-stress (Kc.3) treatments of date trees, Zafaraniah, Iraq 1980.

Table 5

Effect of irrigation on average weight and size of date fruits

Variety	Treatment	Average weight/Fruit		Average size of Fruit			
		(gm)	As% of Stress treatment	Length		Diameter	
				cm	As % of Stress treatment	cm	As % of Stress treatment
Barhee	Kc_1=0.2 (stress)	7.00	100	3.16	100	2.34	100
	Kc_2=0.5 (Intermediate)	7.30	104	3.40	107	2.70	115
	Kc_3=0.8 (Non-Stress)	10.60	151	3.50	111	2.80	120
Braim	Kc_1	5.00	100	2.99	100	2.00	100
	Kc_2	7.50	150	3.11	104	1.83	92
	Kc_3	8.08	162	3.46	116	2.00	100
Sayer	Kc_1	6.10	100	2.98	100	1.85	100
	Kc_2	7.05	116	3.15	106	1.95	108
	Kc_3	9.40	154	3.60	121	2.50	135
Maktoom	Kc_1	14.50	100	3.70	100	2.30	100
	Kc_2	16.70	115	3.80	103	2.70	117
	Kc_3	17.50	121	3.87	105	2.75	120

(iii) Total yield

Total date palm yield is conditioned not only by water management in a given year but also by several other management factors as well as by the «previous history» of the tree. The effect of irrigation on reproductive growth (number of fruit bunches) is likely to be more visible in 1981. It is known that water deficit in late August and early September results in fewer inflorescences in the following year.

Alternation in production, fruit dropping, incidence of insects (namely, Parlatoria|date scale and dubas bug) were reflected in the large yield deviations of the date palms under the same irrigation treatment. In the stress treatment (Kc_1) for instance one Braim palm gave an exceptionally high yield (210kg) while in the non-stress treatments two Barhee palms gave low yields (50-60kg/tree).

With these exceptions there was a trend for better yields in the intermediate and non-stress treatments with respect to the severe stress (Kc_1).

The following table gives the yield and the number of fruit bunches.

Table 6

Average Yield in kg/tree and Number of Fruit Bunches.

Treatment	Sayer	No. Palms	Braim	No. Palms	Barhee	No. Palms	Maktoom	No. Palms
Non-stress	58.00	6	138.833	6	79.980*	6	84.250	3
(Kc_3)	(8-13)		(8-14)		(10-13)		(10-11)	
Intermediate	56.500	6	134.200	6	114.260	5	46.800*	3
(Kc_2)	(9-13)		(7-15)		(7-12)		(8-9)	
Stress (Kc_1)	48.500	6	149.300**	6	105.200	5	68.160	3
	(7-15)		(10-16)		(7-11)		(7-11)	

★ = including exceptionally low – yielding trees

★★ = including exceptionally high – yielding trees

( ) = number of fruit bunches

In addition to the effect on the average yield of 3 to 6 trees per variety, the yield response of individual trees to improved water management will have to be assessed in the two coming years.

In Table 7, averages for all varieties of leaf elongation rates, fruit length and diameter are expressed in percent of the stress irrigation treatment.

Table 7

Effects of Irrigation Scheduling on Date Palms Growth and Fruit Size. Zafaraniah, 1980

Treatment	No. of Irrig.	Leaf elongation	Fruit weight	Fruit length	Fruit diameter
Severe stress	4	100%	100%	100%	100%
Medium stress	7	118	123	108	110
Non-stress	9	125	145	114	123

Soil salinity and water quality

It is worth recalling that water stress increases with salt accumulation in the root zone. However, date palm is salt tolerant and can produce 90% of its potential yield with water having an EC of 4.5 mmhos/cm and when the soil saturation extract (EC_e) is 6.8mmhos/cm(3). Although Diala river water is of less good quality than that of the Tigris, its use is not likely to be a constraint for date palm growth on a levee soil.

Toutain (13) estimated as 10% the leaching requirements for irrigation waters containing 2.5 to 3g/1 (2.2 mmhos/cm) i.e. for water of poorer quality than that we used.

CONCLUSION

An irrigation experiment was conducted in 1980 at Zafaraniah Station, 20km south of Baghdad, to determine the water use (ET Date) and crop coefficient (Kc) of fullgrown date palms as well as the response of four known varieties to three irrigation schedulings.

The relation used is: ET Date = Kc ETo is reference crop evapotraspir-

ation, an improved estimate of potential evapotranspiration. ET Date was measured during six months mainly by gypsum blocks supported by some neutron probe, tensiometer and root measurements. ETo was calculated by the Class A method as described by Doorenbos and Pruitt (4) using data of an agrometeorological station 15 km south of the experimental site.

The experiment included sixty one palms divided into three blocks, each one receiving a different irrigation schedule assuming Kc_1=0.20, Kc_2=0.50 and Kc_3=0.80. Controlled irrigation was applied to each tree individually. These schedules were intended to produce severe water stress (Kc_1), non-stress (Kc_3) and intermediate moisture conditions (Kc_2) in the top meter of soil. The date palm orchard is on levee soil having a water table between 3.70 and 3.90 m with a capillary rise affecting the rootzone below 1.0 or 1.20m.

Results obtained in 1980 are summarized as follows:

1. Class A pan evaporation and ETo are 3200 and 2140mm, respectively.
2. Neutron probe, tensiometer and gypsum block readings showed little if any moisture change below one meter depth, yet roots were observed down to 2.0 meters. World literature, our observations and some direct measurements showed about 80% of the active roots to occur in the top 1.20m. Lateral root expansion reached 3.5 to 4.0m from the date-palm trunks.
3. In the so-called «non-stress» (Kc_3) treatment, ratios of date-palm water use, from the top soil meter, to Cl.A pan evaporation ranged from 0.34 to 0.45 with a seasonal average of 0.39 (or a Kc=0.605). These figures do not take into account water uptake from the capillary rise. They however, reflect a yearly water need of 13000m^3/ha for Zafaraniah. Rainfall contribution (130mm in 1980) is about 1000m^3/ha. The remaining 12000m^3/ha have to be provided by irrigation.
4. The peak monthly date palm water use from the top meter of soil was about 7mm/day. It occurred in July and August. In June, water use as

well as leaf elongation rates were depressed as monthly Class A evaporation was exceptionally high (17 mm/day instead of 13mm/day) therefore the pre-set schedule became inadequate.

5. The crop coefficient should account for the date palm water use from the entire effective root zone i.e. should also include the estimated contribution from the water table. Thus monthly Kc would range from 0.75 to 1.00 with a seasonal average of 0.835, i.e. ET Date palm = 0.853 ETo. The total net water use becomes 18250m^3/ha/year divided as follows:

   - 12000 to 13000 m^3/ha from irrigation,
   - 750 to 1250 m^3/ha from rain, and
   - 4500 to 5500 m^3/ha from water table.

6. For Zafaraniah soils (silty to clay loam), the available moisture for the top 1.20m depth is about 185mm. Depletion of two thirds the available moisture would require about two weeks during the peak water use period of June, July and August .The total number of irrigations is ten. The recommended irrigation schedule is the following:

J	F	M	A	M	J	Jly	A	S	O	N	D	Total No of Irrigations
1	0	0	0	1	2	2	2	1	1	0	0	10

   The net application required is 120mm each time except for the autumn and winter period (October to April) where two deeper irrigations, 180mm each, would be preferable.

7. The above irrigation schedule (Kc_3 treatment) gave, as a matter of fact, the best results in 1980 although one irrigation was missed in June.

   — for three varieties out of the four the increase in the leaf elongation averaged 30% in the nonstress (Kc_3) with respect to the stress (Kc_1) treatment with four irrigations per year. In the intermediate treatment (Kc_2) with seven irrigations the increase

was less (3-14%).

- fruit weight increased 21% and 47% in the Kc_2 and Kc_3 treatments, respectively with respect to Kc_1.
- fruit length increased from 5% to 13% and fruit diameter from 8% to 18%.
- varietal differences in response to improved irrigation scheduling were shown as well as trends to increased total yields. Large deviations of yield within treatments were observed as a result of past history of the trees i.e. occurrence of alternation in production, incidence of pests, fruit droppings, etc.. It is recognized that soil water stress or non-stress conditions in 1980 affect the number of inflorescences i.e. of fruit bunches in 1981. Therefore the experiment will continue for another two years to support or improve these preliminary results.

8. For the period April to December, Class A pan evaporation under date-palms was found to be reduced to about half its level in open fields. The full-grown date-palms spaced 8×8m had a canopy cover exceeding 70%. Young citrus trees intercropped with the date-palms benefitted from this favourable microclimate which reduced significantly their water demand .Citrus in the Kc_3 block (9 irrigations per year) experienced stress in May and June 1980 when soil moisture tension at 30 cm depth exceeded 85 centibars (about 50% moisture depletion) for a total period of 3 weeks. One or two additional irrigations were required during this period.

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Annex 1

A – Soil Characteristics

The date-palm orchard of Zafaraniah is on levee soil. Some observations and measurements of the soil characteristics are given below.

1. Profile description

Observations made* at the end of the irrigation season (Nov. 1980) are given below:

0-15 cm:	prismatic structure, silty clay, very dry
15-45 cm:	silty clay, more clay, more compact, very dry
45-75 cm:	silty clay, no structure, higher% of silt
75-150 cm:	silty clay, friable to very friable, little mottling (colors due to water table effect). At 120cm laminar structure, (thin plates) wetter friable soil.
150-160 cm:	more clay, clay lenses, reddish color.
160-180 cm:	heavy silty clay, roots of various sizes still are observed.

2. Mechanical analysis

Soil samples taken at three selected depths gave the following results:

Depth	% Sand	% Silt	% Clay	Texture
50 cm	13.4	40.6	46.0	Silty clay
100 cm	23.9	46.1	30.0	Clay loam
150 cm	16.4	31.6	52.0	Clay

3. Moisture retention

The field capacity (0.3 atmosphere value) for soil samples taken at 35, 50, 100 and 150 cm depth is 28.54% with a standard deviation of 1.27. The permanent wilting point is 17.18 ± 1.26. The bulk density increases with depth from 1.31 to 1.59 from the surface down to 180cm. The available moisture is about 160mm per meter of soil depth.

★ Dr Dhari Al-Hardan

B – Date-palm roots

Soil layer	Dry weight (1)	Moisture (2)	Extraction (3)	Feeder Roots (4)
cm	%	%	%	5 ft* 15ft*
0-60	51.6	52	50	23.2-27.8%
60-120	28.5	34	30	32.8-25.9
120-180	19.9	11	15	27.1-26.5
180-240	--	3	5	5.6-5.0

(1) Namik Rashid, 1980. (Personal communication).
(2) Pillsbury, 1937.
(3) Pillsbury, 1938.
(4) Furr and Armstrong, 1956 (*distance from trunks).

LITERATURE CITED

1. Aldrich, W.W. (1942): Some effects of soil moisture deficiency upon Deglet Noor fruit. Report of the Date Growers' Institute (Coachella Valley, California) 19:7-10.
2. Armstrong, W.W. & J.A. Furr (1959): Root distribution of Khadrawi date-palms in relation to frequency of irrigation. Report of the Annual Date Growers' Institute (Coachella Valley, California) 36: 13-15.
3. Ayers, R.S. & D.W. Westoot (1976): Water quality for agriculture. FAO Irrigation and Drainage Paper No. 29 (Rome).
4. Doorenbos, J. & W.O. Pruitt (1977): Guidelines for predicting crop water requirements. FAO Irrigation and Drainage Paper No. 24: 144p.
5. Furr, J.R. (1975): Water and salinity problems of Abadan Island Date Gardens. Report of the Date Growers' Institute (Coachella Valley, California) 52:14p.
6. Furr, J.R. & W.W. Armstrong (1958): The seasonal use of water by Khadrawy date palms. Report of the Date Growers' Institute (Coachella Valley, California) 33: 5-7.
7. Furr, J.R. & W.W. Armstrong (1958): The influence of heavy irrigation and fertilization on growth, yield and fruit quality of Deglet Noor Dates. Report of the Date Growers' Institute (Coachella Valley, California) 35:22-24.
8. Munier,Pierre (1973): Le palmier-dattier. Collection Techniques Agricoles et Productions Tropicales. Paris: Maisonneuve, G. – P. & Larose.
9. Pillsbury, A.F. (1937): How much water does a date-palm use? Report of the Date Growers' Institute 14:13-16.
10. Pillsbury, A.F. (1938): A further report on water use by Coachella date-palms. Report of the Date Growers' Institute 15:17-19.
11. Pillsbury, A.F. (1941): Observations on the use of irrigations water in Coachella Valley, California. Calif. Agric. Expt. Stat. Bull. No. 649.
12. Reuveni, O. (1975): Drip versus sprinkler irrigation of date-palms. Report of the Date Growers' Institute 51: 3-5.
13. Toutain, G. (1977): Elements d'agronomie saharienne; Cellule des Zones Arides, INRA, France.
14. Vink ,N.; Abou-Khaled & S. Sarraf (1970): Measured and estimated water use by a citrus and an apple orchard. Magon Publ. Institute Rech. Agron. Serie Tech. No. 11:18p.

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STAIN TESTING OF DATE POLLEN VIABILITY

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ABSTRACT

Determined the effectiveness and reliability of five staining agents as indicators of viability of date palm (*Phoenix dactylifera* L.) pollen. Results were correlated with the *in vitro* germination of pollen. Correlation coefficients between pollen staining percentage and germination percentage for Iodine – Potassium iodide, Aniline blue, Nitro blue tetrazolium, and 2,3,5-triphenyl tetrazolium chloride were low and insignificant. However, the coefficient of correlation for 3 (4 – 5 – dimethyl-thiazolyl – 2) 2,5 – diphenyl tetrazolium bromide was positive and significant and it offers a better estimate of viability of date pollen.

التصبيغ كطريقة لقياس فعالية حبوب لقاح نخيل التمر

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الخلاصة

تم تقدير فعالية وكفاءة خمس اصباغ كدلائل لفعالية حبوب لقاح نخيل التمر.

وعند ربط النتائج مع الانبات الخارجي *in vitro* لحبوب اللقاح كان معامل الارتباط بين نسبة اصطباغ حبوب اللقاح ونسبة الانبات للمواد – Iodine – Potassium iodide, Aniline blue, Nitro blue tetrazolium, and 2,35 – triphenyl tetrazolium chloride. واطئة وغير معنوية. في حين كان معامل الارتباط موجباً ومعنوياً للصبغة 3 (4-5 dimethylthiazolyl-2) 2,5 – diphenyl tetrazolium bromide وتعطي احسن تقدير لفعالية حبوب لقاح نخيل التمر.

date palm pollen.

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Table 1

Date Pollen Germination *in vitro*

Pollen Source*	Germination % ± S.E.
I	63.4 ± 0.52
II	75.5 ± 0.72
III	74.2 ± 0.51
IV	85.0 ± 0.96
V	69.1 ± 0.50
VI	71.0 ± 0.73

★ All male plants were of seedling origin. These are not named as cultivars but just called Fahal, an arabic word meaning male.

Table 2

Correlation Coefficients (r) and Coefficients of Determination (r^2) of Pollen Germination with Percentage Viability Using Various Stains for Determination of Viability of Date Pollen.

Staining Agent	Correlation Coefficient (r)	Coefficient of Determination (r^2)
IKI	– 0.12	0.014
AB	– 0.04	0.002
NBT	0.29	0.084
MTT	0.73*	0.533
TPT	0.34	0.116

★ Significant at 5% level.

LITERATURE CITED

1. Asif, M.I. & O.A. Al-Taher (1981): Studies of variations in date pollen material. Submitted to Hort. Science for publication.
2. Cook, S.A. & R.G. Stanley (1960): Tetrazolium chloride as an indicator of pine pollen germinability. Silvae Genet. 9:194-96.
3. Edwardson, J.R. & N.K. Corbett (1961): Asexual transmission of cytoplasmic male sterility. Proc. Nat. Acad. Sci. 47: 390-96.
4. Hauser, E.J.P & J.H. Morrison (1964): The cytochemical reduction of nitro blue tetrazolium as an index of pollen viability. Amer.J.Bot. 51: 784-52.
5. Maneul, W.E. (1936): Lactophenol preparations. Stain Tech. 11:9p.
6. Nixon, R.W. (1927): Further evidence of the direct effect of pollen in the fruit of the date palm. Annual Report of the Date Growers' Institute 24: 7-9.
7. Norton, J.D. (1966): Testing of plum pollen viability with tetrazolium salts. Proc. Amer. Soc. Hort. Sci. 89: 132-34.
8. Oberte, G.D. & R. Watson (1935): The use of 2,3,5 triphenyl tetrazolium chloride in viability tests of fruit pollens. Proc. Amer. Soc. Hort. Sci. 61: 299-303.
9. Sarvella, P. (1964); Vital-stain testing of pollen viability in cotton. J. Hered. 55: 154-58.
10. Werner, D.J. & S. Chang (1981): Stain testing viability in stored peach pollen. Hort. Science 16:522-23.

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ABSTRACT

Bracon hebetor (Say) (*Habrobracon juglandis* Ashmead) has been studied in the laboratory at different simulated field temperatures. Development time from egg to adult was 9.8 & 7.5 days at 25°C and 30°C, respectively. However, a temperature of 25°C seemed to be more favourable in terms of percentage of adult emergence, fecundity, egg hatchability, and longevity. In cold storage (2 – 5°C) females did not lay eggs. At truncated temperatures (2 – 5°C and 30°C) all biological activities seemed to be unaffected. Fecundity and egg hatchability were almost normal. Under such conditions maximum female life-span was prolonged to 68 days.

Three to four days old pupae have been stored for 60 days at 2 – 5°C without severe consequences on the percentage of adult emergence. Low temperature was shown to be detrimental for eggs, larvae, and 1 to 2 day old pupae. It is therefore, evident that *Bracon hebetor* could survive the winter in Iraq as adult and late pupae.

Before embarking on a sterile-insect technique to control the fig moth *Ephestia cautella* (Walker), which is a serious pest of ripe date fruits and other foodstuffs, it might be advisable to rear *B. hebetor* in the laboratory and to increase the density of this wasp by releasing or distributing the more resistant-to-cold stages (adults and 3 to 4-day-old pupae) in certain affected areas.

تأثير درجات الحرارة المختلفة على نشاط طفيلي عثة التين
Bracon hebetor (Say) (Hymenoptera)

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الخلاصة

تمت دراسة طفيلي عثة التين *Bracon hebetor* (Say) في المختبر في درجات حرارة مشابهة للظروف الحقلية. استغرقت فترة النمو من البيضة إلى البالغة 9,8 ± 0,70 و 7,5 ± 0,88 أيام في حالة حفظها في 25° م و 30° م على التوالي. إلا أن درجة حرارة 25° بدت أكثر ملائمة لنشاط الحشرة البالغة من ناحية زيادة النسبة المئوية لظهور البالغات والتفقيس ومعدل عدد البيض للأنثى الواحدة وعمر الأنثى.

ولدى خزن البالغات بدرجات حرارة منخفضة (2 ـ 5° م) لم تلق الاناث بيضاً. وفي حالة حفظها في درجات حرارة متقطعة (2 ـ 5° و 30° م) لم تتأثر النشاطات الحيوية بصورة واضحة. وكان معدل البيض ونسبة التفقيس طبيعيين نوعاً ما. الا أن معدل عمر الأنثى ازداد زيادة ملحوظة (23.0 ± 48,2 يوماً) وبلغ اطول عمر لأنثى واحدة 68 يوماً.

اما العذارى (الشرانق) والتي عمرها يتراوح بين 3 ـ 4 أيام فقد أمكن خزنها لمدة 60 يوماً في 2 ـ 5° م دون أن تتأثر نسبة ظهور البالغات تأثراً كبيراً. في حين أن درجات الحرارة الواطئة هذه أدت الى موت البيض واليرقات والعذارى التي عمرها من يوم الى يومين خلال مدة قصيرة.

لذا يمكن القول بأن طفيلي عثة التين يقضي الشتاء في العراق في طور البالغات او العذارى المتأخرة. لذلك وقبل البدء بمشروع مكافحة عثة التين (وهي حشرة خطرة تالفة للتمر وكثير من المحاصيل الاخرى) بطريقة تعقيم الحشرات بالاشعاعات أو غيرها، فقد يكون من المفيد جداً تربية هذا الطفيلي (*B. hebetor*) في المختبر ومن ثم زيادة كثافته باطلاق او توزيع الاطوار المقاومة للبرودة (البالغات والعذارى التي عمرها 3 ـ 4 أيام) في المناطق المصابة.

INTRODUCTION

Before embarking on a pest control program by sterile insect release the natural population of that insect should be reduced to a minimum (8). The most efficient pest control system is the one for which we can apply at least two different methods (10). It is also clear that the use of insecticides for lowering the density of insect population may cause more problems than it solves (7). Also, the release of an efficient parasite that could destroy a high percentage of the immature stages with the simultaneous release of a sterile insect to compete with the reduced population might prove a more effective and desirable combination than using insecticides (8).

It has previously been concluded that the sterile-insect technique might be effective in controlling the fig moth *Ephestia cautella* (Walker) through radiation induced complete or inherited partial sterility (1,2, 4-6). Ahmed *et al.* (1) reported that the biotic potential of *Bracon hebetor* (Say) *(Habrobracon juglandis* Ashmead) was greater than that of *Ephestia cautella*. In this respect, data of a more recent field survey showed that the adults of *E. cautella* could be found more or less all around the year, but its population density is apparently under continuous check by this parasitic wasp (3). Therefore, it might be possible to use this parasite to decrease the natural population of the fig moth to a minimum so that the control or eradication of this insect could be feasible by a sterile-insect release program. The first step towards achieving this goal is to study the biology of the parasite and to find the best methods of rearing it under various simulated field conditions.

The present study concerns some aspects of the life history and biology of this parasitic wasp reared and stored at different temperatures.

MATERIALS AND METHODS

Bracon hebetor (Say) was continuously reared in the laboratory to provide a sufficient number of insects for the present study. Adults were fed on small pieces of date fruit or provided with a piece of cotton-wool soaked in 10% sucrose solution. The immature (larval) stages were reared on paralysed *Ephestia cautella* last instar larvae. All males used in the present experiments were progeny of virgin mothers to insure they were not sterile

nocular microscope.
by giving them access to one larva of *Ephestia* [illegible].

Emphasis in the current investigation is put on the effect of different temperatures on various developmental stages. Three main topics have been studied: —

1 — The effect of two different temperatures (25°C and 30°C) on the development of *Bracon* wasps from eggs to adults.

2 — The effect of cold storage on pupae (2°C — 5°C), on adult emergence.

3 — Adult emergence, egg hatchability, and longevity of *B.hebetor* adults have been studied at three different temperatures (2-5°C, 25°C, and 30°C) and at truncated temperatures 2-5°C and 30°C (approximately 10-15 days in cold storage followed by 2-5 days at 30°C, and so on).

RESULTS AND DISCUSSION

Temperature influenced the development of immature stages and the biology of *Bracon hebetor* adults in different ways. The development periods from egg to adult were 9.8 ± 0.70 and 7.5 ± 0.88 days at 25°C and 30°C, respectively (Table 1). Thus, the optimum temperature for development is 30°C which is somewhat in agreement with Martin (11). On the other hand, percentage of adult emergence, fecundity, egg hatchability, and longevity of the wasp seemed to be larger at 25°C than at 30°C (Table 2). The number of eggs per female was more at 25°C (average, 81.3) than at 30°C (average, 55.3). The maximum number laid per female was 272 eggs at 25°C, and 117 eggs at 30°C. Females lived somewhat longer than males in both cases.

Adult males stored at 2 — 5°C lived somewhat longer, but females did not lay eggs (Table 2). When wasps, which were held at 2 — 5°C, were transferred to 30°C at certain intervals, all biological activities of the adult *Bracon* appeared to be almost unaffected. Fecundity and egg hatchability were near normal. Life-span of both male and female was apparently longer than that of adults which were held at other temperatures (Table 2). At

these truncated temperatures females lived for an average [illegible] (maximum 68 days) and males for 20.2 days (maximum 33 days).

Data in Table 3 shows that pupae of *Bracon hebetor* can be stored for a long period at 2-5°C when they are 3 to 4 days old. At this age the organism has almost completed the differentiation of various organs so that a complete adult can be seen through the partially transparent cocoon. These pupae could withstand a very long period of storage (2 months) and when they were transferred to 30°C, adults emerged without significant losses (37.5%). However, when pupae were 1 to 2 – days – old, the effect of cold storage was quite detrimental after a short period (10 – 30 days).

Eggs and larvae held at 2 – 5°C for more than 10 days were completely killed.

It is interesting to mention that all the temperatures used in these experiments lie within the range of the fluctuating temperatures in Iraq. The lowest one in this study was shown to be detrimental for eggs, larvae and 1 to 2 day old pupae. However, it proved to be least harmful to late pupae or adults.

It is, therefore, evident from this study that all *Bracon hebetor* immature stages are killed by cold and only adults and late pupae might survive the winter in Iraq. Consequently, the biotic potential (12) could be suppressed and limited during the cold season because of low fecundity of the adult females and natural mortality of early stages of this beneficial parasitic insect.

It might be then advisable to rear this insect in the laboratory and to increase the density of more resistant – to-cold stages (adult and 3 to 4-day-old pupae) by releasing or distributing them in certain affected places with *Ephestia cautella*. Thus, it may be possible to disrupt the existing natural parasite-host (*Bracon – Ephestia)* balance by increasing periodically the population density of this parasitic wasp.

Table 1

The effect of two different temperatures on the development of *Bracon hebetor* eggs to adults

Temperatures °C	No. of eggs observed	Development period from egg to adult in days ± S.D.
25	113	9.8* ± 0.70
30	159	7.5* ± 0.88

*t- value between the two means = 23.97, $P < 0.001$.

Table 2

Adult emergence, fecundity, egg hatchability, and longevity of *Bracon hebetor* held at various temperatures.

Temperature °C	No. of pairs observed	Adult longevity, average no. of days ± S.D.		Total No. of eggs laid	Average no. of eggs/ ± S.D.	% larvae**	% pupae**	% adults**
		Female	Male					
2 – 5	11	19.4 ± 13.9	21.5 ± 11.3*	0	–	–		–
25	21	19.6 ± 12.8	5.8 ± 3.8	1708	81.3 ± 70.9	82.5	72.3	61.4
30	19	14.6 ± 7.1	6.2 ± 4.5	1051	55.3 ± 35.7	77.2	70.9	50.5
[2° – 5° & 30°]	4***	48.2 ± 23.0*	20.2 ± 8.8*	235	58.8 ± 25.2	69.8	59.4	53.6

★ These averages are significantly different from those of the same column by using t – test analysis between them at $P < 0.05$.

★★ Percentages of each column are not significantly different when using Chi – square test at $P < 0.05$.

★★★ These adults were held at 2 – 5°C for 10 – 15 days, then transferred to 30°C for 2 – 5 days, and again to 2 – 5°C , and so on...

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DISINFESTATION OF COMMERCIALLY PACKED DATES, ZAHDI VARIETY, BY IONIZING RADIATION*

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ABSTRACT

Disinfestation of packed dry dates, Zahdi variety in standard cartons, such as are used in the industry was studied by using gamma radiation or methyl bromide fumigation. The dose distribution of radiation from Gammabeam – 650 facility with a ^{60}Co source was calculated and the best feasible uniformity ratio (=1.4) was followed where the average absorbed dose of 15 points was 75.65 ± 8.03 krad.

The results of examination indicated that a complete disinfestation was achieved in both methyl bromide – and radiation – treated boxes when stored for 25 d. The live insects found in the irradiated dates were genetically sterile and developmentally inactive. While on longer periods of storage (55 or 80 d), live, active and fertile insects have been found in the treated as well as untreated (control) boxes indicating reinfestation cases.

On the basis of the present results, the parameters of measuring the induction of full sterility and incapability of immature stages to develop, could easily be utilised as methods for scientifically sound quarantine measures as far as radiation disinfestation of foodstuffs is concerned. Also, insect – proof packages, which are possibly impermeable to chemical fumigation, should be tried in future disinfestation of dates by using gamma radiation.

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تعقيم التمر الزهدي المعباء تجارياً بالاشعة المؤينة

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الخلاصة:

قامت شعبة الحشرات في قسم الزراعة والبايولوجي، مركز البحوث النووية بغداد بالتعاون مع مكبس تمور بغداد، هيئة التمور العامة، بدراسة تتعلق بتعقيم التمر الزهدي المعبأ بعبوة تجارية مهمة، زنة 250 غم، باستخدام اشعة كاما من مصدر الكوبلت ـ 60 في جهاز كامابيم ـ 650 الذي انشيء حديثا في مركز البحوث النووية، مقارنة بطريقة التبخير بمادة بروميد المثيل المتبعة حاليا.

لقد تم تعليب ما يقرب من 70 كيلوغراما من التمر الزهدي من الدرجة الثانية المصابة بالحشرات، وضعت في 280 عبوة وغلفت بالسيلوفين، ثم وزعت بالتساوي على سبعة كارتونات قياسية (ابعادها التقريبية /48,5 × 31 × 19 سم). تم تعيين جرعة التشعيع الملائمة للتعليب في الكارتونات القياسية وهي 75,65 ± 8,03 كيلورادٍ وذلك بعد القيام بعدة محاولات. كانت نسبة أعلى الى اوطأ جرعة في الكارتون القياسي الواحد وفي موضع معين تساوي $\frac{84,45}{61,31} = 1,4$ في حالة استعمال احدى الطاولات الدوارة لجهاز التشعيع وهذه نسبة مقبولة دولياً. لذا فقد استعملت لمعاملة كارتونين قياسيين في التجربة الحالية. وعومل القسم الآخر من التمر المعبأ بالمثيل بروماید حسب ما هو متبع تجارياً، وترك الثالث كمقارنة. خزنت هذه الكارتونات بعناية في غرفة تربية حيث كانت درجة الحرارة حوالي 25 +2° م وتراوحت الرطوبة النسبية بين 40 الى 60% . أخضعت التجربة للفحص بعد فترات الخزن التالية 80,55,25 يوماً على التوالي، وذلك بأخذ عينات

(اربع عبوات او أكثر من كل كارتون قياسي) وفحص التمر وتسجيل نسبة الاصابة بالحشرات الحية التي تعود الى عثة التين *Ephestia cautella* أو خنفساء الحبوب ذات الصدر المنشاري *Oryzaephilus surinamensis* على الاغلب، وسجل وجود زنبور البراكون *Bracon hebetor* ثم تم قياس نمو بعض اطوار الحشرات الحية ودرجة خصوبتها، ان امكن، بطرائق وراثية بسيطة لمعرفة تأثير المعاملة على استحداث العقم ومنع تكاثر الحشرات او ظهور الجيل الاول.

كانت نتيجة الفحص مرضية نسبياً بعد مرور فترة الخزن الاولى (25 يوماً) سواء في التمر المعامل بالتبخير او التشعيع، اذ كانت جميع الحشرات الحية التي عثر عليها في التمر المشعع عقيمة بعد فحص خصوبتها، كما وقد هلكت الاطوار الاخرى دون ان تنمو. اما بعد فترتي الخزن: 55 و80 يوماً، فقد ظهرت حشرات في التمر المعامل (المشعع والمبخر) غير عقيمة، مما يشير الى ان الاصابة بالحشرات جديدة تمت خلال فترتي الخزن الاخيرتين، وقد يعود هذا الى عملية التعليب نفسها التي تكون على الاغلب غير محكمة بقصد اعطاء مجال لنفاذ المثيل بروميد ابان التبخير.

INTRODUCTION

Date production in Iraq is approximately 350,000 tons per year (19). Despite the large numbers of date varieties, there are only four main varieties, viz. Zahdi, Sayer, Hillawi, and Khadhrawi, which account for about 95% of production, and comprise almost 80% of the annual export of dry dates from Iraq (19). Dry dates of all varieties are commonly attacked by more than 12 insect species belonging to the Coleoptera and Lepidoptera (18 – 19). Previous studies indicate that by far the most serious insect species of stored dates in Iraq are the fig moth, *Ephestia cautella*, and the saw-toothed grain beetle, *Oryzaephilus surinamensis* (1, 4, 18, 19). Therefore, the experiments reported here have been concentrated on investigations concerning the effect of different doses of gamma radiation on these two species. They are good representatives of all species related to the two major orders from the point of view of their response to ionizing radiation in general (1, 5).

Based on our results obtained previously (8, 14), and in the light of the recent recommendations of the Joint Expert Committee on Food Irradi-

ation (JECFI) on the acceptability of food (dry date included) preserved by using an overall average dose of 10 kGy (1 Mrad) of gamma radiation from ^{60}Co source as well as from some other sources and electrons of a certain maximum energy level (3, 17, 20), it is, therefore, anticipated that dry date disinfestation by ionizing radiation may, sooner or later, be preferred to conventional chemical methods. Accordingly, we believe that the scale of our experiments should be increased to cover a large quantity of packed dates in order to simulate treatment under commercial conditions. There should also be an emphasis on packaging materials that could prevent reinfestation. In addition, these contemplated pilot – scale experiments should compare the effectiveness of irradiation with chemical fumigation and extending over different periods of storage. Presently such studies are made possible by the availability of a suitable food irradiation facility (Canadian type Gammabeam – 650, with a ^{60}Co source with an initial strength of 16630 curies (September 1978) and provided with 6 turntables), which has been recently installed at the Nuclear Research Centre (13).

Therefore the main objectives of the present investigation are:

(1) To study the dose distribution of gamma radiation in standard commerically important dry date (Zahdi variety) packages.
(2) To compare the effectiveness of disinfestation by an acceptable dose of radiation with that by methyl bromide fumigation of dry date on a pilot – scale, taking into account mainly the two above – mentioned damaging insect species.

MATERIALS AND METHODS

Dosimetry and Treatment of Packed Dates:

Dry date packaging was carried out according to the most advanced methods available and undertaken by Baghdad Packing House (19). Seven Standard Carton Boxes (SCB) (approxiate dimensions of each: 48.5 × 31 × 19 cm) with 70 kg of naturally infested dry date were used. These single walled SCBs meet the construction requirements of the uniform freight classification (NMFC). Each one holds 40 cellophane sealed lunch boxes (window cartons) each one of which is filled with about 250 g of loose dry date, Zahdi variety (Fig. 1).

After completion of packaging processes, usually done shortly before exportation, the seven SCBs were then subjected to the following treatments:

(a) One SCB, with 10 kg packed date in 40 small lunch boxes was used solely for dosimetrical calculations (Fig. 2, 3) at 15 equally distributed points on 3 levels using Fricke dosimetry.

(b) Two SCBs with 80 full lunch boxes were irradiated with appropriate disinfestation dose of gamma radiation (Fig. 4).

(c) Two similar standard boxes were treated with methyl bromide fumigation according to the instructions mentioned in the earlier researches (18, 19), at the rate of approximately 1.5 pounds per 1000 ft^3 and were inadvertantly left for 48 hours instead of the usual 24 hours before removing them out of the fumigation chamber.

(d) Two untreated SCBs full of dates were kept alongside as controls.

All boxes then were placed on stands (Fig. 5) in a room which is used for rearing the insect stocks, and maintained at about 25 ± 2°C and 40 – 60% relative humidity. Date fruits from about 4 or more lunch boxes taken out of each SCB were examined accurately (Fig. 6) every 25,55, and 80 days after treatment, respectively, and live insects at any stage recorded.

Development and Genetic Tests:

Due to the fact that reasonable doses of ionising radiation have a delayed effect on insect killing (8, 16, 21), it was thought advisable to measure the development capability of the immature stages and to assess the fertility of adult insects collected after various periods of storage of both treated and untreated packages of dates. The following three categories of tests have been adopted:

(i) When *Ephestia cautella* adults were found, they were mated to females of 'A' mating type or males of 'B' mating type to avoid the possiblity of any incompatible crosses (10,11). Then fertility, i.e. percentage of egg hatch, was counted. Adults of *Oryzaephilus surinamensis*, were usually left to breed and their progeny or longevity observed.

(ii) Other immature stages of both the species were left to develop on natural food.

(iii) *Bracon hebetor* adults: According to Whiting (22) there are nine alleles of a particular X gene in this wasp. The presence of a single allele in haploid condition produces fertile males when the unfertilized eggs divided asexually. Parthenogenesis phenomena have been utilized to measure the absence or presence of females among the progeny of

wasps found in packed dates by crossing them to individuals of the opposite sex from a laboratory strain in order to know whether the collected wasp was fertile or sterile.

RESULTS AND DISCUSSIONS

Dosimetrical Calculations

Figures 7 - 10 illustrate the dosimetrical calculations using Fricke dosimetry that measures the absorbed dose. Dose rate measurements were done by placing a standard carton box (SCB), containing dry dates packed in 40 lunch boxes, on one of the six turntables available in our Gamma beam – 650. The figures show the dose rate calculations at uniformly distributed points at 3 levels inside the SCB which was placed vertically (Fig. 2 – 4) on a turntable (40.5 cm dia.) of the irradiator.

Two kinds of dose – rate measurements have been carried out:

(a) When the turntable was rotating at a speed of 3 rev/min and the minimum and maximum dose rates registered were 551.36 and 759.49 rad/min, respectively, and the average and its standard deviations were 680 ± 72 rad/min for the 15 – points measured inside the SCB (Fig. 3,7). Consequently the recommended disinfestation dose for such date packages was obtained only after a continuous irradiation for about 111.2 min at the time of measurements. This resulted in a minimum dose of 61.31 krad and a maximum of 84.45 krad. Thus the dose uniformity ratio was equal to 1.4, and the average of 15 points was 75.65 ± 8.03 krad (Fig. 8). Such a dose range lies within the technically recommended ranges of the well studied and the internationally accepted doses for the dry date disinfestation by ionizing radiation (3, 8, 14 – 15, 17, 20).

(b) Irradiation by placing one SCB on a stationary turntable gave the following results (Figs. 9, 10):

$$\text{Average dose} = 638.95 \pm 261.51 \text{ rad/min}$$

or

$$69.64 \pm 28.50 \text{ krad/111.2 min}$$

$$\text{Uniformity ratio} = \frac{116.99}{35.88} = 3.3$$

Such a maximum to minimum ratio is scientifically unacceptable as far as insect control is concerned, especially where lepidopteran species are the pests involved, on account of their peculiar high radio – resistance (6, 7).

Therefore, the irradiation of the packages used in the present experiments was carried out for 111.2 min and according to the specifications described in (a).

Disinfestation of Date Packages:

The results of the examination of treated or untreated date packages are summarized in Table I, where 2479 date fruits in 78 lunch boxes have been carefully examined after the three different periods of storage. When storage duration was 25 d, the occurrence of the various live stages of the insects per 100 dates was 7.7 in the control, 0.0 in methyl bromide fumigated dates, and 9.6 in the radiation treated batch. On testing the adult insects collected from the control or radiated dates for development activities or genetic effects, it was found that a male adult of *Ephestia cautella* from the irradiated batch failed to mate, while adults of the control mated normally and resulted in normal fecundity and fertility, as shown in Table 2. Two live *E. cautella* larvae collected from an irradiated batch died at this very stage, 10 and 31 d post – irradiation, respectively. Also, adults of *O. surinamensis* collected from irradiated dates did not reproduce and died after a short period of time (Table 3), while those of the control reproduced and lived for a much longer period.

The progeny of 6 *Bracon hebetor* males detected in the irradiated dates, when mated with laboratory virgin females were devoid of females and comprised of males only as a result of asexually developed haploid unfertilized eggs (22); on the other hand, the progeny of a laboratory stock contained more than 20% females (Table 4). It is therefore, concluded that after 25 d of storage the irradiated packages contained only sterile adults of inactive (developmental) stages of insects which ended up in a complete mortality within a reasonable period of time after treatment. However, 55 or 80 d of storage resulted in a completely different picture as live insects have been found in the fumigated as well as irradiated and, of course, control batches. It is interesting to mention that all insects, captured after such barely prolonged storage periods, were fertile and active, as shown in Tables 3 – 7, indicating highly probable reinfestation cases. This could be attributed to the type of packaging material which is usually imperfectly hermetically sealed in order to allow for the entry of fumigant during

methyl bromide fumigation. Surprisingly, it was noticed that irradiated batches were somewhat less reinfested in comparison with the fumigated ones (Table 1). Such observations may be worthy of full investigation in the future to determine the role of irradiation in apparently providing partial protection against reinfestation (16). On the other hand, the rate of infestation in the untreated control increased from the initial 7.7 percent, 25 d after treatment, to approximately 9 — and hundredfold when stored for 55 or 80 d, respectively, as shown in Table I. Tables 2-5 show that all the simple genetic and developmental observations conducted on the insects found in control batches throughout the whole three periods of storage showed them to be fully fertile and normally active, i.e. immature stages developed to the next stages and easily passed through metamorphosis.

On the basis of the results achieved in the present study, the parameters of measuring the induction of full sterility and incapability of immature stages to develop, could easily be utilized as identification methods for scientifically sound quarantine measures as far as radiation disinfestation of foodstuffs is concerned (2, 8 — 9, 12). The present results also lead to the conclusion that insect-proof packages, which are mostly impermeable to the methyl bromide fumigation, should be tried in future disinfestation using the highly penetrative gamma radiation from a ^{60}Co source.

ACKNOWLEDGEMENTS

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Table 1

Insect Disinfestation of Packed Naturally Infested Dry Dates (Zahdi Variety) Using Methyl Bromide or Low Dose of Gamma Radiation followed by Different Periods of Storage.

Treatment	Approx. Storage period (in days)	No. of lunch boxes* examined	Total No. of dates	Live insects per 100 dates
T_1				
Untreated (control)	25	8	273	7.7
Methyl bromide	25	8	256	0.0
Radiation	25	8	270	9.6 (sterile)
T_2				
Untreated (control)	55	8	240	65.0
Methyl bromide	55	8	258	7.8
Radation	55	16	510	0.9
T_3				
Untreated (control)	80	2	65	73.38
Methyl bromide	80	8	241	1.6
Radiation	80	12	366	0.8

For each treatment 2 standard carton boxes (dimensions: 48.5 × 31 × 19 cm,) each holding 40 × 250 g lunch boxes, were used. The dimensions meet the construction requirements of NMFC of uniform freight classification.

Table 2

Fertility of *Ephestia cautella* collected as Larvae, Pupae, or Adults from both Gamma Irradiated and Unirradiated Packed Dates (Zahdi Variety)

Treatment	Crosses insect × insect Collected Lab.	No. eggs laid	% hatch	Sperma-tophore	Remarks
Irradiated T_1 (stored for 25 days)	M × A F	12	O	O	M collected as adult*.
Unirradiated T_2 batch (control)	F × B M	168	80.36	1	F as adult.
	F × B M	192	27.60	1	F as pupa.
T_3(stored for 25 days)	M × A F	O	–	1	M as larvae.
	F × B M	229	39.30	1	F = =
	F × B M	22	O	O	= = =

★ Two live *Ephestia cautella* larvae collected from irradiated batch died at this very stage 10 and 31 days postirradiation, respectively.

Table 3

Fertility and Appropriate Survival Periods of Different Developmental Stages of *Oryzaephilus surinamensis* found in Irradiated (Naturally Infested) Dates, Zahdi Variety.

Treatment	Development Stage	No. of insects	Stage or F_1 progeny	Longevity (days)	Discarded after (days)
T_1 Irradiated batch (stored for 25 days)	Adult	8	Nil	8-10	—
	Larva	12	Nil	2-13	—
T_2 Unirradiated batch (25 days)	Adult	6	32 larvae	5 (1 adult)	28
	Larva	1	1 adult	—	34
T_3 Unirradiated (stored for 55 days	Adult	6	70 eggs	—	31
			12 Larvae	—	

Table 4

Fertility of *Bracon hebetor* Males collected from Irradiated Packed (Naturally Infested) Dates (Zahdi Variety), and mated to Normal Unirradiated Females from a Laboratory Stock.

Treatment	Test Crosses Collected × Lab. M O	No.of Pupae (F_1)	No.of Adults (F_1)	% females
T_1 Irradiated batch	1M × F	25	25	O
(stored for 25	1M × F	13	6	O
days)	1M × F	13	13	O
	1M × F	22	21	O
	1M × F	31	30	O
	1M × F	21	18	O
T_2 Unirradiated control	14 (single	—		
(laboratory stock)	pair matings)	—	2835	21.97
T_3 Irradiated batch	1 F × 3 lab M	19	15	60.0
(stored for 80 days)				
T_4 Methyl bromide	F × 1 M*	—	50	40.0
(stored for 80 days)				

★ Both F and M adults were collected from date batches treated with methyl bromide.

Table 5

Fertility of *Ephestia cautella* Collected as Larvae and Pupae from Packed Naturally Infested Dry Dates treated with Radiation or Fumigated with Methyl Bromide and stored for 55 days with their Untreated Control.

Treatment	Crosses Collected Lab. insect	No. of eggs laid	% hatch	Sperma-tophore	Remarks
T_1 Irradiated batch	F × BM	304	72.37	1	O collected as pupa
	M × AF	304	33.88	2	M as larva.
T_2 Fumigated batch	F × BM	48	O	O	F as pupa
	M × AF	50	60.0	—*	O as larva
	F × BM	337	78.54	1	O as pupa
	M × AF	403	85.36	2	O as pupa
	M × AF	157	93.63	—*	O as larva
T_3 Untreated batch (control)	M × AF	153	93.46	1	O as larva
	M × AF	89	84.27	1	= = =
	M × AF	67	59.70	1	= = =
	F × BM	87	O	O	F as larva
	F × BM	162	92.59	1	= = =

★ F was not dissected.

Figure 1: A standard carton box with small cellophane sealed lunch boxes (window cartons).

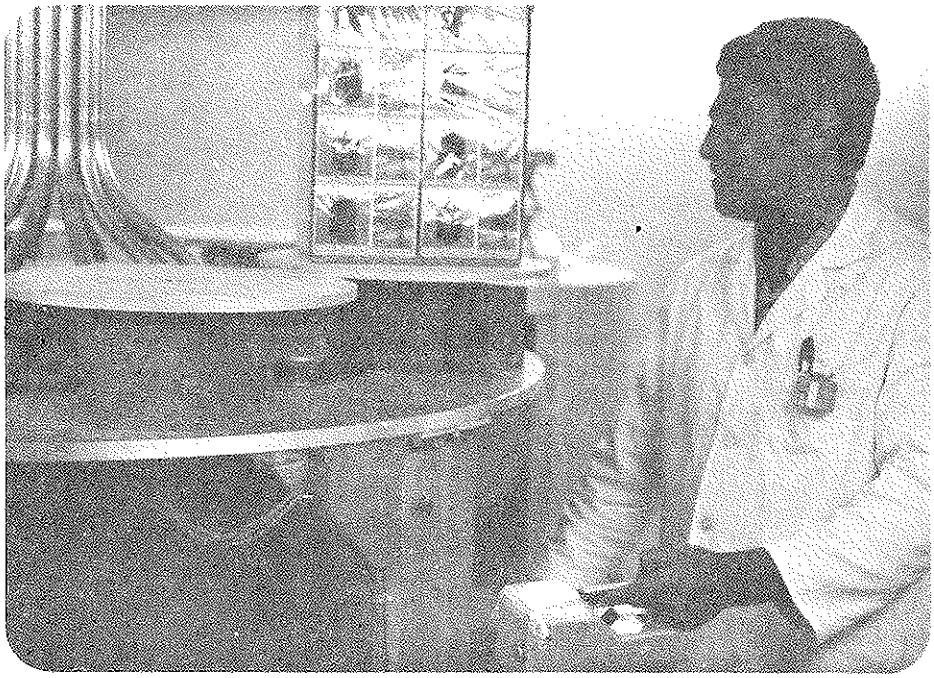

Figure 2: View of irradiation chamber of Gammabeam — 650 irradiator and a standard carton box full of dates.

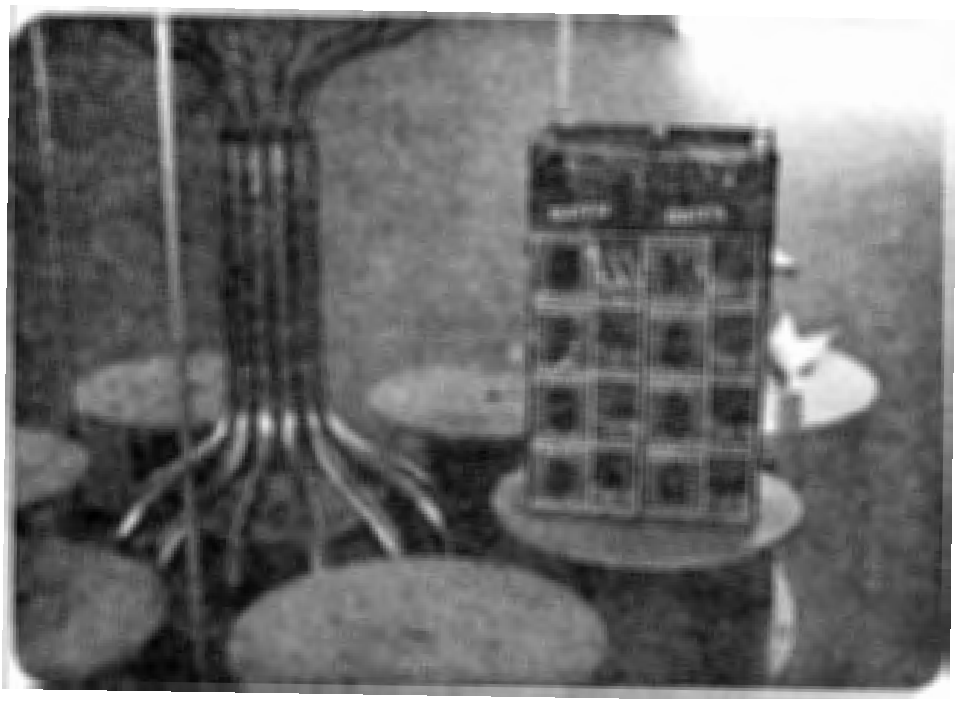

Figure 3: A standard carton box put on one of the 6 turntables of the irradiator for dosimetrical calculations.

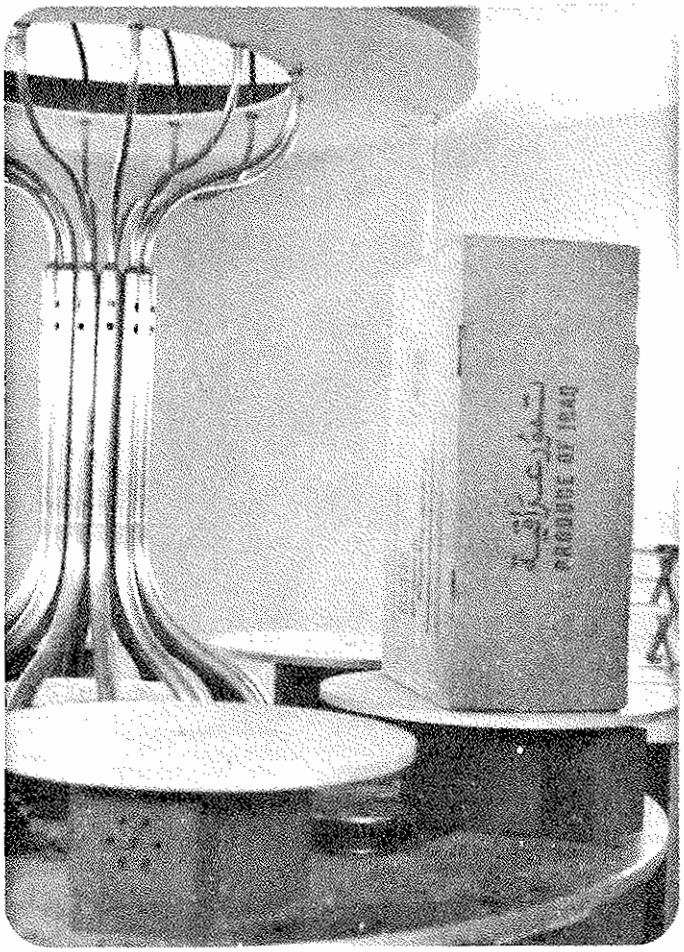

Figure 4: View of a date container to be disinfested by gamma radiation.

Figure 5: Variously treated dates packed in standard carton boxes and stored under controlled conditions.

Figure 6: An infested date fruit.

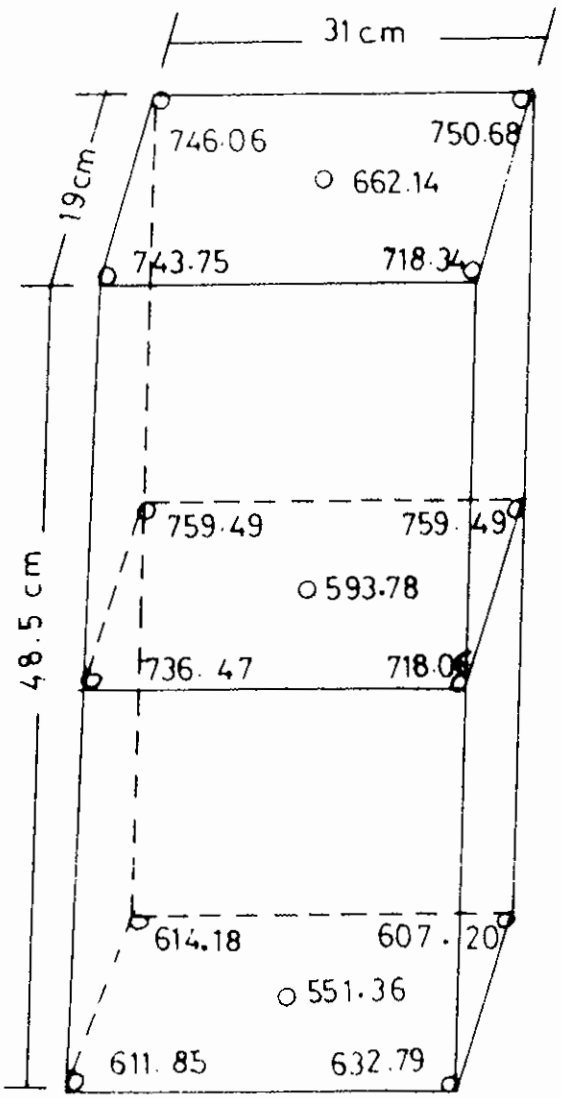

Figure 7: Dosimetrical calculations (rad/min) at 15 points in an NMFC standard carton box used as a date container irradiated on a rotating round turntable (3r/min) of the gammabeam — 650 irradiator.

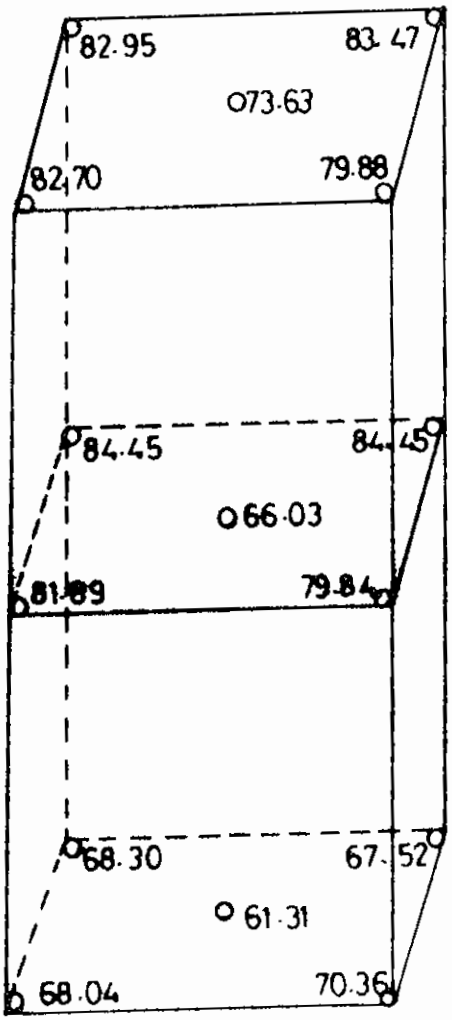

Figure 8: *Dosimetrical calculations (krad/111. 2 min) at 15 points in an NMFC standard* ***carton box*** *as date container irradiated similar to Fig 7.*

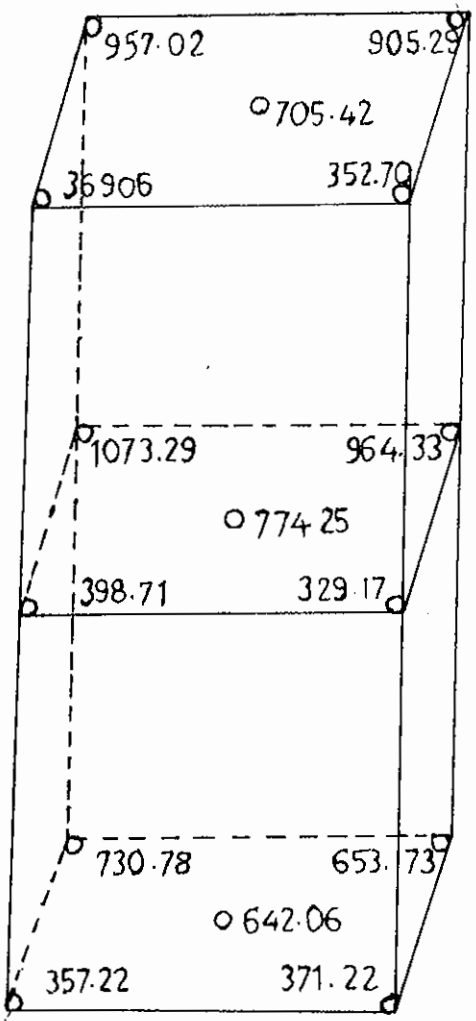

Figure 9: Dosimetrical calculations (rad/min) at 15 points in an NMFC standard carton box as a dry date container irradiated on a stationary round turntable of the gammabeam — 650 irradiator.

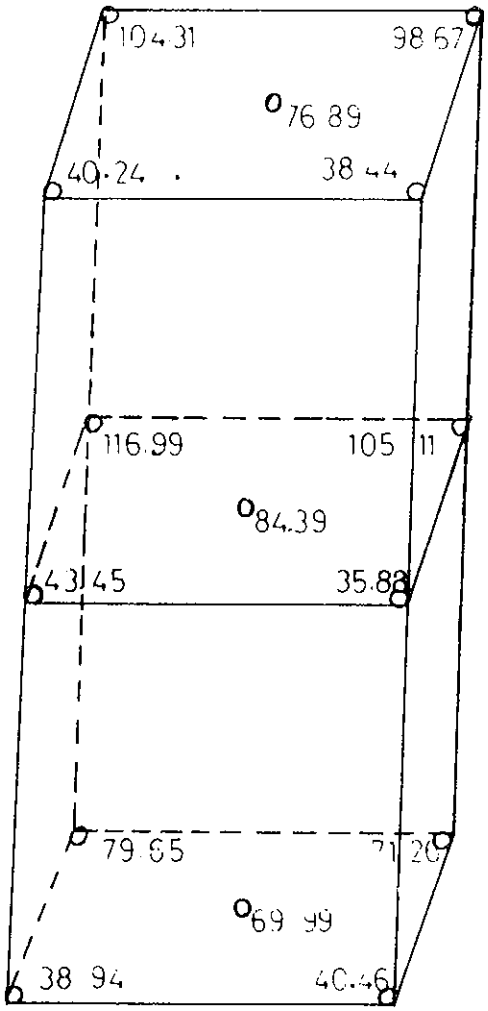

Figure 10: Dosimetrical calculations (krad/111.2 min) at 15 points in an NMFC standard carton box as a date container irradiated similar to Fig 9.

LITERATURE CITED.

1. Ahmed, M.S.H. (1976): Investigations on insect disinfestation of dried dates by using gamma radiation: Presented at the Joint FAO/IAEA Advisory Meeting on Low – Dose Irradiation of Agricultural Products (Rio de Janeiro, Brazil), Oct. 1975; Issued: IAEC, NRI, Tuwaitha, Baghdad, Rep. No. B – 34 (1976) 14p.
2. Ahmed, M.S.H.(1976): Some Studies on Recent Methods in Insect Control. Report to the Agriculture & Biology Department, Nuclear Research Centre, pp. 50, Tuwaitha, Baghdad.
3. Ahmed, M.S.H. (1980): International Symposium on Combination Processes in Food Irradiation, and the Special Committee on Legislative Aspects of Food Irradiation, Sri Lanka, Colombo, 24 – 29 November 1980.
4. Ahmed, M.S.H.; N.A.Ouda; S.B.Lamooza; Z.S.Al-Hakkak & A.M. Al-Saqur (1972): Disinfestation of dry dates by gamma radiation: Proc. 1st Sci. Conf., Scientific Research Foundation, Baghdad, 1972, 264 p.
5. Ahmed, M.S.H., N.A. Ouda; S.B. Lamooza; I.A. Al-Hassany (1974); Effect of gamma radiation on some embryonic stages of two stored – date insect species. Acta Aliment.3 (4): 431.
6. Ahmed, M.S.H.; Z.S.Al-Hakkak & A.M.Al-Saqur (1971): Exploratory studies on the possibility of integrated control of the fig moth *(Ephestia cautella* Walk.). Application of Induced Sterility for Control of Lepidopterous Populations: Proc. Panel Vienna, 1970, pp. 1, IAEA, Vienna.
7. Ahmed, M.S.H.; Z.S.Al-Hakkak & A.M.Al-Saqur (1972): Inherited sterility in the fig moth, *Cadra* (*Ephestia cautella* Walker). Int. Conf. Peaceful Uses Atom. Energy: Proc. Conf. Geneva, 1971, pp. 383, 12 UN, IAEA, Vienna.
8. Ahmed, M.S.H.; Z.S.Al-Hakkak; S.K.Al-Maliky; A.A.Kadhum & S.B.Lamooza (1980): Irradiation disinfestation of dry dates and the possibility of using combination treatments: Extended Synopsis, Intern .Symp. on Combination Processes, Colombo, Sri Lanka, 1980: 27 – 28 p. IEAE – SM – 250.
9. Ahmed, M.S.H.; Z.S.Al-Hakkak; H.Auda : S.K.Al-Maliky; S.R. Ali; L.K. Nasser & A.A. Kadhum (1981): Insect Disinfestation of Dried Dates by using Ionizing Radiation: Final Report to IAEA, Research Agreement No. 1768/CF.
10. Ahmed, M.S.H.; I.A.Al-Hassany; S.B. Lamooza; N.A. Ouda; & A.A. Al-Taweel (1975): Further hybridization experiments with different strains of *Ephestia cautella* (Walker). Peaceful uses of Atomic Energy for Scientific and Economic Development: Proc 1st Sci. Conf. Iraqi Atomic Energy Commission, Baghdad, 1975, pp. 108, Baghdad.
11. Ahmed, M.S.H.; S.B. Lamooza; N.A. Ouda & I.A.Al-Hassany (1975):

Preliminary report on mating studies of three varieties of *Cadra (Ephestia cautella)* (Walker). Sterility Principle for insect Control: Proc. Symp. Innsbruck, 1974, pp. 413, IAEA, Vienna.

12. Annual Report: Disinfestation of Packaged Dates and the Control of Stored – Product Insects, Annual Draft Report (Manuscript) of Research Project No. 1/506/67, (1980) 38 pp. Agriculture and Biology Department, Nuclear Research Centre, Tuwaitha, Baghdad. (In Arabic).
13. Atomic Energy of Canada Limited, Commercial Products (1978): Certificate of Measurement, Gammabeam – 650, No. 16 Canada, Ottawa, Quality Control.
14. Auda, H. (1980): Date irradiation in Iraq. Food Irradiation Information 10:34 P.
15. Auda, H. & L.K. Nasser The effects of combination treatments of gamma irradiation and heat on some chemical constituents of dates. Ibid. 25 – 26.
16. Cornwell, P.B. (1966): Status of irradiation control of insects in grain. Food Irradiation: Proc. Symp. Karlsruhe, 1966, pp. 455. IAEA, Vienna.
17. FAO/IAEA/WHO (1981): Wholesomeness of Irradiated Food, Tech. Rep. Geneva: WHO Series 659: 34 p.
18. Hussain, A.A. (1963): Pests of Date Palms and Dates with Methods of Control in Iraq (Ay). Baghdad: Al – Edara Al – Mahlia Press, 209 p.
19. Hussain, A.A. (1974): Date Palms and Dates with their Pests in Iraq. Iraq: Mosul University Press, 166 p.
20. IAEA (1979): Legal Series No. 11, IAEA, Vienna.
21. Tilton, E.W. & J.H.Brower (1972): Status of US Department of Agriculture Research on irradiation disinfestation of grain. Radiation Preservation of Food: Proc. Symp. Bombay, 1972 pp. 295. IAEA, Vienna.
22. Whiting, P.W. (1939): Multiple alleles in sex – determination of *Habrobracon*. J. Morph. 66: 325 – 355.
M.W. Strickberger, 2nd Ed. Genetics. 1976. New York: Macmillan Pub. Co. 229 p.

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ORGANIC AND INORGANIC CONSTITUENTS OF DATE PALM PIT (SEED)

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ABSTRACT

The organic and inorganic constituents were determined in seeds (pits) of six leading southern Libyan date cultivars: namely Taleese, Adwi, Taghiat, Tasfert, Aspear and Seloulou. The averages of different constituents (on dry weight basis) of all cultivars were as follows: starch 20.64%, reducing sugars 2.4%, non-reducing sugars 1.98%, protein 6.43%, oil 9.2%, ash 1.20%, Ca 0.038%, K 0.244%, P 0.112%, Na 0.0082%, Cl 0.161%, Fe 30.4 ppm, Mn 15.7 ppm, Zn 28.84 ppm, and Cu 8.1 ppm. The chemical characteristics of oil were as follows: Iodine number 54.8, saponification value 207.3 and acid value 1.75. Reducing sugars, starch, total carbohydrates, protein, oil, ash, K, P, Cl, Mn and Zn were significantly different among cultivars, whereas non-reducing sugars, total sugars, Ca, Na, Fe and Cu did not show significant differences due to cultivars.

المكونات العضوية والمعدنية لبذرة نخلة التمر

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كلية الزراعة، جامعة الفاتح، طرابلس، ليبيا.

الخلاصة:

تم تقدير المكونات العضوية والمعدنية في بذور ستة أصناف رئيسية من تمور جنوب ليبيا، هي:
تاليس، اضوي، تاغيات، تاسفرت، اسبير، سلولو.

وقد وجد أن متوسط محتوى بذور الاصناف المذكورة من المكونات التي تم تقديرها كما يلي (على اساس الوزن الجاف):

- النشا 20,64%
- الزنك (الخارصين) 28.84 جزء في المليون
- السكريات غير المختزلة 1,98%
- السكريات المختزلة 2,46%
- الدهون 9,2%
- البروتين 6,43%
- الكالسيوم 0,038%
- الرماد 1,20%
- الفسفور 0,112%
- البوتاسيوم 0,244%
- الكلوربد 0,161%
- الصوديوم 0,0082%
- المنجنيز 15,71 جزء في المليون
- النحاس 8,1 جزء في المليون
- الحديد 30,4 جزء في المليون

أما مواصفات الدهون فقد كانت كما يلي:

الرقم اليودي 54,8 ، رقم التصبن 207,3 ، الرقم الحمضي 1,75 وقد وجدت فروق احصائية بين الأصناف في محتوى بذورها من:

السكريات المختزلة، النشا، الكربوهيدرات الكلية، البروتين، الدهون، الرماد، البوتاسيوم، الفسفور، الكلور، المنجنيز، الزنك، بينما لم توجد فروق احصائية بين الأصناف في حالة كل من السكريات غير المختزلة، السكريات الكلية، الكالسيوم، الصوديوم، الحديد، والنحاس.

INTRODUCTION

Pit of date palm (seed) is a waste product of many industries based on flesh of date fruit such as date syrup (known as Dibis, in Libya as Rub altamar),dry invert sugar,yeast, alcohol, vinegar, citric acid and different sweets (9). Although the pits are about 13% of the total weight of date fruit (4), no serious attempts were made to make good use of these as potential by-products. In some date producing countries, pits are used as fodder for domestic farm animals. Little work has been published earlier on chemical

composition of date palm seed (1, 3, 7-8).

The objective of this study was to determine the sugars, starch, protein, oil and oil characters, and minerals in pits of six leading date cultivars of southern Libya. This might be helpful in producing fodder for ruminants, and other domestic animals, in addition to the use of some of these components for industrial purposes.

MATERIALS AND METHODS

Pits of major date cultivars of southern Libya were used in the present study; namely Taleese, Adwi, Taghiat, Tasfert, Aspear and Seloulou. Fruit samples of about 20 orchards were collected in October, 1978 at tamar stage from three major date growing districts in southern Libya (Sebha, Ubari, and El-Shatie). Fifty fruits from each sample were taken and deseeded. The pits of each cultivar, in each district, were combined to make a composite sample and used as a replicate. The pits were dried in a draft oven at 65°C to a constant weight and ground for chemical analysis.

Minerals:

Two grams of the ground samples were digested with HCl (dry ashing) according to Chapman and Pratt (2). Analysis for K, Ca, and Na was by flame photometer, Zn and Cu by atomic absorption, P, Mn and Fe by spectrophotometer and Cl by titration with silver nitrate (2).

Carbohydrates:

Three grams of the ground material were used for sugar extraction using 80% ethanol. The non-reducing sugars were determined by hydrolysing a part of the sugar extract with 1 N HCL for 10 minutes on a water bath at 67°C (3). Starch was determined in the dried alcohol insoluble residue after hydrolysing with 1 N HCl for 4 hours on a water bath at 90°C (6). The reducing power of reducing and non-reducing sugars and starch after hydrolysis, was determined by Somogyi micro-copper reagent method (11). The non-reducing sugars were taken as the difference between the reducing sugars before and after acid hydrolysis.

Oil:

Ten grams of dried pits were used for oil extraction with petroleum ether in a Soxhlet apparatus for 8 hours. Iodine value, saponification value, and acid value were determined according to Pearson (10) in a composite sample for the three districts.

Protein:

Total nitrogen was determined by the micro-Kjeldahl method. Protein was calculated using the general factor (6.25).

Data are expressed as percent of dry weight except for Fe, Mn, Zn and Cu which are expressed as ppm.

RESULTS AND DISCUSSION

Carbohydrates: Carbohydrate contents of pits represented about 25% of their total dry weight (Table 1). Starch was the dominant form of carbohydrate in the pits. The starch: total sugars ratio was about 5:1. The pits of Taghiat contained the highest percentage of carbohydrates (26.86%), while pits of Aspear contained the lowest percentage (24.24%). Other cultivars were intermediate. Pits of all cultivars contained much lower quantities of sugars (about 4.5%) as compared to their flesh which contained about 69.03% (Table 3). Tasfert pits contained higher amounts of reducing sugars than other cultivars. This was statistically significant. Non-reducing sugars and total sugars were not significantly different. The amount of sugars and starch obtained in the present study were generally similar to those reported for pits of Khalas (8).

Oil and Oil Characteristics: Appreciable amounts of oil were found in the pits (Table 1). Oil content ranged from 8.7% for Taleese to 10.0% for Adwi. Values obtained were generally similar to those cited by Dowson and Aten (3) and Hussein and El-Zeid (8), but higher than those reported by Al-Talikani et al (1). Iodine value ranged from 48.32 for Aspear to 66.28 for Taleese. These values were lower than those for olive oil, almond oil, sesame oil, soya oil and sunflower oil (10). In other words, the degree of saturation of date palm oil was less than that of these oils. The

saponification values ranged from 201.03 for Seloulou to 224.40 for Adwi. These values were within ranges reported for date palm pits (1,3) and olive oil (10). The acid value and free fatty acids obtained for the cultivars studied were slightly higher than those reported earlier (1, 3).

Protein: Date palm pits contained considerable amounts of protein (Table 1). Pits of Seloulou were the highest (7.68%) while pits of Adwi were the lowest (4.46%). These results were in general agreement with those reported by Dowson and Aten (3) and Furr and Cook (7), but higher than those of Hussein and El-Zeid(8).

Inorganic Constituents:

Ash: The percentage of ash in the pits varied with cultivars; it was the highest in Taghiat pits (1.43%) and the lowest in Adwi pits (1.03%) (Table 2). Values obtained were similar to those cited by Dowson and Aten (3), but were much lower than those reported by Hussein and El-Zeid (8).

Minerals: The mineral contents of pits of all cultivars are presented in Table 2. Amounts of K in the pits were found in excess of any other element determined in this study and it was over 29 times of Na. Potassium, P, Cl, Mn and Zn contents were significantly different in cultivars, whereas Ca, Na, Fe and Cu did not show significant differences among cultivars.

Pit/Flesh: In the previous studies (4,5),the different constituents of the flesh of these cultivars were determined. It seems worthwhile to compare organic and inorganic constituents of pits with those of flesh. The pits were found to contain higher percentage contents of oil, protein, P, Fe, Mn and Cu and lower contents of total sugars, ash, Ca, K, Na, Cl and Zn than the flesh (Table 3).

Table 1

Organic Constituents of Pits of Six Leading Date

Cultivars	Carbohydrates				
	Reducing Sugars %	Non-Reducing Sugars%	Total Sugars %	Starch %	Total Carbohydrates %
Taleese	2.25b	1.25a	2.77a	20.38abc	24.48b
Adwi	2.00b	2.27a	4.27a	21.50ab	25.77ab
Taghiat	2.21b	2.57a	4.78a	22.02a	26.86a
Tasfert	3.37a	1.85a	5.20a	20.07bc	25.27ab
Aspear	2.47b	1.81a	4.61a	19.63c	24.24b
Seloulou	2.43b	1.88a	4.35a	20.22bc	24.59b
Mean	2.46	1.98	4.50	20.64	25.14

Means in a column followed by the same letter are not significantly

Cultivars Grown in Southern Libya (On Dry Weight Basis)

Oil and Oil Characters					
Protein (Nx6.25) %	Oil %	Iodine number	Saponi-fication Value	Acid Value mg/KOH/g.oil	Free Fatty Acid Expressed as Oleic Acid
5.96ab	8.70b	66.28	204.0	1.41	2.81
4.46b	10.00a	52.35	224.4	1.53	3.06
6.55ab	9.38ab	50.14	208.2	2.04	4.08
7.33a	9.21ab	61.96	203.4	1.87	2.74
6.33ab	9.21ab	48.32	202.7	1.68	2.36
7.64a	8.7b	49.76	201.1	1.96	2.92
6.43	9.20	54.80	207.3	1.75	3.50

different at P=0.05 according to Duncan's multiple range test.

Table 2

Inorganic Constituents of Pits of Six Leading Date Cultivars

	Concentration				
Cultivars	Ash %	Ca %	K %	P %	Na %
Taleese	1.18ab	0.050a	0.237ab	0.128a	0.0089a
Adwi	1.03b	0.038a	0.221ab	0.0915b	0.0069a
Taghiat	1.43a	0.037a	0.217b	0.112ab	0.0088a
Tasfert	1.15ab	0.042a	0.297a	0.116ab	0.0085
Aspear	1.12ab	0.029a	0.023ab	0.109ab	0.0076a
Seloulou	1.30ab	0.033a	0.268ab	0.114ab	0.0084a
Average	1.203	0.038	0.244	0.112	0.0082

Means in each column followed by the same letter are not significantly

Table 3

The Ratio of Organic and Inorganic Constituents

Constituents*	Reducing Sugars %	Non-Reducing Sugars %	Total Sugars %	Protein %	Oil %	Ash %	Ca %
Pit	2.46	1.98	4.50	6.43	9.2	1.203	0.038
Flesh	66.13	3.00	69.03	1.98	0.067	2.583	0.058
Pit/Flesh	0.037	0.66	0.065	3.25	137.3	0.47	0.66

* Average for all cultivars

Grown in Southern Libya (On dry Weight Basis)

Cl	Fe	Mn	Zn	Cu
%	ppm	ppm	ppm	ppm
0.122c	35.2a	19.4a	26.5ab	7.41a
0.228a	24.4a	18.0a	32.8a	8.51a
0.151abc	34.7a	18.3a	27.2ab	7.94a
0.154abc	35.1a	14.0ab	30.7ab	8.54a
0.130abc	27.1a	9.7b	24.4b	7.41a
0.184a	25.5a	14.8ab	31.4ab	8.52
0.161	30.4	15.7	28.84	8.10

different at P = 0.05 according to Duncan's multiple range test.

Between Pits and Flesh (4,5).

K	P	Na	Cl	Fe	Mn	Zn	Cu
%	%	%	%	ppm	ppm	ppm	ppm
0.244	0.112	0.008	0.161	30.4	15.7	28.8	8.05
0.703	0.059	0.011	0.468	28.4	8.1	57	5.1
0.35	1.9	0.75	0.34	1.07	1.9	0.51	1.5

LITERATURE CITED

1. Al-Talikani, T.E.; M.B.AL-Aswad; M.Ahmed & D.M. Sabir (1975): Chemical investigation of date (Zahdi Iraqi) stones. Fatty acids composition of the oil. Technical Bull. No. 4/75, Palm & Dates Research Center, Baghdad, Iraq.
2. Chapman, D.H. & P.E. Pratt (1961): Methods of analysis for soil, plant and waters. Univ. of Calif. Div. of Agric. Sc.
3. Dowson, V.H.W. & A.Aten (1962): Dates: handling, processing and packing. FAO Agric. Develop. Paper 72 (Rome), 394p.
4. El-Shurafa, M.Y.; H.S. Ahmed & S.E. Abou-Naji (1979): Sugar contents and physical characters of six leading date cultivars of southern Libya. Libyan J. Agr. 8: 153-159.
5. El-Shurafa, M.Y.; H.S. Ahmed & S.E. Abou-Naji (1980): Mineral contents of fruits of six leading date cultivars of southern Libya. Libyan J. Agr. 9: (In press).
6. Friedemann, T.E.; N.F. Witt; B.W. Neighbours & C.W. Webber (1967): Determination of available carbohydrates in plants and animal foods. J. Nutrition 91: 1-37.
7. Furr , J.R. & J.A. Cook (1952): Nitrogen content of pinnae, fruit, and seed of Deglet Noor and Khadrawy date palms as related to nitrogen fertilization. Report of the Date Growers' Institute (Coachella Valley. California) 29: 13-14.
8. Hussein, F. & A.El-Zeid (1975): Chemical composition of 'Khalas' dates grown in Saudi Arabia. Egypt. J. Hort. 2: 209-214.
9. Passat, F.F. (1971): The industrialization of date palm products Baghdad: Al-Adib Press. (in Arabic).
10. Pearson, D. (1972): Laboratory techniques in food analysis. (6th edition). London: Churchill.
11. Wistler, R.L. & M.L. Walform (1962): Methods in carbohydrates chemistry. London & New York: Academic Press.

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CHEMICAL COMPOSITION OF FOUR IRAQI DATE CULTIVARS

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ABSTRACT

The nutritive value of four commercial Iraqi date cultivars: namely, Hallawi, Sayer, Zahdi and Khadrawi, were studied with regard to sugar, protein, fat, ash, fibre, water soluble vitamins, minerals and trace element contents. The analysis revealed that the studied dates have low moisture, protein, fat and non-reducing sugar contents. On the other hand, dates were found to contain relatively large amounts of reducing sugars. The ratio of glucose to fructose was found to be a function of the agroclimatic conditions prevailing in the areas from which the samples were obtained. The data also showed that dates contain moderate amounts of thiamine, riboflavin and folic acid, while biotin and ascorbic acid are present in small quantities. With respect to minerals and trace elements, the results of this study showed that dates could be considered a good source of iron, potassium, copper, sulphur and manganese and a fair source of calcium, chlorine and magnesium.

التركيب الكيمياوي لأربعة اصناف من التمور العراقية

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الخلاصة

أجريت هذه الدراسة للتعرف على القيمة الغذائية لأربعة اصناف من التمور

العراقية التجارية (حلاوي، ساير، زهدي، خضراوي) وذلك بدراسة محتواها من البروتين، الدهن، الألياف، السكريات، الفيتامينات الذائبة في الماء، الأملاح المعدنية والعناصر النادرة.

أظهرت نتائج هذه الدراسة أن الاصناف التي تم تحليلها كانت تحتوي على نسب منخفضة من الرطوبة وعلى كميات قليلة من البروتين والدهن. وأشارت نتائج هذه الدراسة أن التمور تحتوي على كميات كبيرة من السكريات المختزلة وعلى كميات قليلة من السكروز. كما لوحظ أن الظروف البيئية كان لها تأثير كبير على النسبة في محتوى الجلوكوز الى محتوى الفركتوز في التمور التي تمت دراستها.

وفيما يتعلق بمحتوى التمور من الفيتامينات الذائبة في الماء فقد وجد أن التمور تحتوي على كميات جيدة من الثيامين والريبوفلافين وحامض الفوليك وعلى كميات قليلة من البيوتين وحامض الاسكوربيك.

وعند أخذ محتوى التمور من الاملاح المعدنية والعناصر النادرة بعين الاعتبار فقد أشارت نتائج هذه الدراسة الى أن التمور تعتبر مصدراً جيداً لكل من الحديد والبوتاسيوم والنحاس والكبريت والمنغنيز ومصدراً معتدلاً لكل من الكالسيوم والكلورين والمغنيسيوم، بينما تعتبر مصدراً فقيراً لكل من الفسفور والصوديوم والزنك (الخارصين).

وعند اجراء مقارنة بين أصناف التمور التي تمت دراستها من حيث محتواها من الاملاح المعدنية والعناصر النادرة، دلت نتائج هذه الدراسة على أن تمور الزهدي كانت أغنى في كل من البوتاسيوم والحديد والكبريت والكلورين من بقية الاصناف الثلاثة الأخرى الأمر الذي يؤكد القيمة الغذائية المرتفعة لتمور الزهدي عند أخذ محتواها من الاملاح المعدنية والعناصر النادرة بعين الاعتبار.

كما لوحظ أن هناك اختلافات في المحتوى الفيتاميني والمعدني لأصناف التمور التي تمت دراستها وقد يرجع ذلك الى اختلاف الاصناف أو الظروف البيئية السائدة في مناطق الزراعة.

INTRODUCTION

Iraq is considered to be the leading date producing country in the world and its annual production is estimated at about 350,000 tons. Date fruits constitute a substantial part of the diet in Iraq and other Arab States especially for those of the low income group. The provision of vitamins and minerals as well as sugars is the greatest contribution that dates can make to the human diet.

The chemical composition of different date cultivars has been reported by several investigators (8, 10, 11, 17). Recently Salem and Hegazi (12) and Hussein (6) studied the chemical composition of some Egyptian date cultivars.

Literature on the vitamin content of dates is scanty. Smith and Farankop (15) studied the vitamin content of 15 cultivars of Arizona dates. Nixon (10) and Spoon (17) found that dates are a good source of niacin, thiamine and riboflavin, while other vitamins have been reported to be present but in negligible amounts. The mineral composition of American dates has been reported by Zook (19). Waheed Khan and Chungtol (18) also studied the nutritive value of Pakistani dates.

The present study was undertaken to contribute further information on the nutritive value and chemical composition of some commercial Iraqi date cultivars. Attention was focused on the sugar, water soluble vitamins, minerals and trace element contents.

MATERIALS AND METHODS

Ripe fruits of four cultivars of Iraqi dates (*Phoenix dactylifera* L.) were used in this study. Three cultivars, viz. Hallawi, Sayer and Khadrawi, were procured from the southern area, while the fourth cultivar, Zahdi, was obtained from the central area of Iraq. Samples of 5 kg were collected randomly for each cultivar. They were cleaned, placed in polythene bags and stored in a deep freezer until analyzed.

Samples were analyzed for moisture, pH, protein, ash, crude fibre, total thiamine, ascorbic acid, phosphorus, chlorine and fluorine using AOAC

procedures (1). Total soluble and insoluble solids were estimated as described by Sinclair et al.(14). Reducing sugars were determined as glucose by the Luff and Schoorl method (7), recommended by Dowson (4). Total sugars were determined by inversion, while sucrose was estimated by subtracting reducing sugar from total sugar and multiplying by the factor 0.95. Glucose and fructose were determined calorimetrically as described by Snell and Snell (16).

Lactobacillus casei, Lactobacillus rabinosus and Strepeococcus faecalis were used in estimating riboflavin, biotin and folic acid respectively as described by the Association of Vitamin Chemists (9). Zinc, iron, manganese, copper, sulphur and cobalt contents were determined using atomic absorption spectrophotometry (1). The rapid flame photometric method (1) was used in estimating sodium and potassium.

RESULTS AND DISCUSSIONS

The chemical analysis of the date cultivars studied,viz. total soluble and insoluble solids, pH, protein, ash and crude fibre is presented in Table 1. The moisture, total soluble and insoluble solid values are expressed as percentages of the fresh weight of the sample, whereas protein, fat, ash and crude fibre values are given on a dry weight basis.

Results in Table 1 indicate that the date cultivars studied have a low moisture content varying from 7.30 to 9.50%. However, these values are lower than those of 23 to 28% reported earlier for Egyptian soft dates (6).

A close similarity can be seen in the total soluble solids of Sayer, Khadrawi and Zahdi cultivars while the values were higher for Hallawi. Data presented in Table 1 also show that the pH varied from 5.6 for Hallawi to (6,7) for Khadrawi. This indicates that dates are slightly acidic.

Table 1 further reveals the presence of relatively small amounts of protein and fat in all the cultivars studied. These results are in agreement with previous findings (6). In spite of the low protein content of dates, Salem and Hegazi (3) believed that dates can contribute an additional source of protein to the human diet with high qualities of some essential amino acids.

As far as ash is concerned, one can notice a low variability in the ash

content of the analysed dates. On the other hand, a relatively large variability can be observed in the crude fibre content. However, these differences could be explained by variations in cultivars and/or agroclimatic conditions.

The average percentages of total sugars, reducing sugars, sucrose, glucose and frutcose are given in Table 2. The sugar values are given on a dry weight basis.

Table 1

Chemical composition of 4 commercial Iraqi date cultivars

Composition	Date cultivars			
	Hallawi	Sayer	Khadrawi	Zahdi
Moisture %	7.30	7.50	9.50	8.26
Total soluble solids %	84.20	81.30	80.80	82.14
Total insoluble solids %	17.90	10.00	9.52	9.23
Protein %	2.30	2.78	2.43	2.16
Fat %	0.51	0.32	0.47	0.43
Ash %	1.92	1.80	2.12	1.86
Crude Fibre %	1.82	1.72	2.28	2.50
pH	5.60	6.00	6.70	6.10

Note: The first three determinations are expressed on a fresh weight basis while the last four are based on dry weight.

Table 2

Sugar analysis of 4 commercial Iraqi date cultivars

Composition	Date cultivars			
	Hallawi	Sayer	Khadrawi	Zahdi
Total sugars %	87.91	86.10	87.74	86.80
Reducing sugars %	82.72	82.60	81.91	73.40
Sucrose %	4.80	3.50	4.50	12.70
Glucose %	43.69	44.79	44.73	32.77
Fructose %	37.21	38.04	38.48	39.15
Glucose/Fructose ratio	1.17	1.17	1.16	0.83

Table 3

Vitamin content* of 4 commercial Iraqi date cultivars (mcg/100g)

Vitamins	Date cultivars			
	Hallawi	Sayer	Khadrawi	Zahdi
Thiamine (B1)	99	130	94	80
Riboflavin (B2)	173	135	149	167
Biotin (H)	4.63	4.66	4.09	5.74
Folic acid (Folacin)	57	70	43	63
Ascorbic acid (C) (mg/100g)	3.56	17.51	3.20	2.41

★ On dry weight basis

The average percentages of total sugars, reducing sugars, sucrose, glucose and fructose are given in Table 2. The sugar values are given on a dry weight basis.

Results in Table 2 indicate that reducing sugars are the dominant form of sugars found.

This is as expected since the investigated dates are of the "soft" type. On the other hand, the analysed dates contain only small amounts of non-reducing sugars. These results confirm those obtained earlier by Cavell (2) and recently by Hussein (6) who reported that soft dates contain larger quantities of reducing sugars with lesser quantities of sucrose than the "semi-dry" and "dry" date types.

The glucose: fructose ratio was the same in the three date cultivars obtained from Basrah. However, glucose contents of these cultivars were more than fructose by 17%, while the opposite was true in Zahdi dates obtained from the central area of Iraq.

The vitamin content of four Iraqi date cultivars is given in Table 3.

Thiamine content of the studied dates ranged from 80 mcg/100g in case of Zahdi dates to 130 mcg/100g in Sayer dates. These thiamine values are similar to those of Arizona dates (15). The results also indicate that Iraqi dates contain higher amounts of riboflavin than California dates (17). As far as folic acid is concerned, dates appear to contain moderate amounts of this vitamin. On the other hand, dates seem to be a poor source of biotin.

Although fruits and vegetables are usually considered the major dietary source of ascorbic acid, results in Table 3 reveal that dates contain negligible amounts of this vitamin. These findings are in agreement with those reported by Waheed Khan and Chungtal (18) and Spoon (17).

The macro element composition of the four commercial Iraqi date cultivars studied is presented in Table 4.

Results in the Table 4 indicate that potassium is the predominant element found in dates. As far as calcium and chlorine are concerned, the results show that the studied date cultivars also contain relatively high concentrations of these two elements. The cultivar Zahdi showed more calcium and chlorine than the other cultivars studied.

On the other hand, the analyses suggest that dates are a poor source of both phosphorus and sodium.

The data presented in Table 4, indicate that Iraqi dates contain comparatively higher qualities of calcium, potassium, sodium and magnesium and lower concentrations of phophorus than American dates (19).

Considering the daily requirements of macro elements by humans, it can be concluded that approximately 15 dates could furnish more than 80% of magnesium, 70% of sulphur, 25% of potassium and 20% of the calcium needed.

Table 4

The macro element composition* of 4 commercial Iraqi dates (mg/100g)

Minerals	Date cultivars			
	Hallawi	Sayer	Khadrawi	Zhadi
Calcium	184	203	133	207
Phosphorus	16	13	15	14
Potassium	854	833	894	887
Sulphur	10	20	14	21
Sodium	14	10	16	5
Chlorine	260	312	266	342
Magnesium	56	58	60	59

* On dry weight basis

Table 5

The micro element content* of 4 commercial Iraqi date cultivars (mg/100g)

Minerals	Date cultivars			
	Hallawi	Sayer	Khadrawi	Zahdi
Iron	5.26	3.21	4.5	10.37
Manganese	5.86	5.25	5.14	5.16
Copper	2.77	2.89	2.54	2.75
Zinc	1.39	1.82	1.29	0.74
Cobalt	0.76	0.96	0.96	0.95
Fluorine	0.20	0.12	0.14	0.12

* On dry weight basis

The micro element content of the four commercial Iraqi dates cultivars is given in Table 5.

The human daily need for iron has been estimated 10 mg, manganese 4

mg; copper 1 – 2 mg and zinc 15 mg (12). Referring to data presented in Table 5, it can be concluded that Iraqi dates contain relatively high amounts of iron, manganese and copper and small amounts of zinc. On the other hand, the human daily need for cobalt has not so far been established. As far as fluorine is concerned, the results in Table 5 show that dates contain relatively high concentrations of this element, as Clifford (3) reported that most fruits contain less than 0.03 mg fluorine per 100g. Results given in Tables 4 and 5 also indicate that Zahdi dates contain higher values of potassium, iron, sulphur and chlorine than the other three cultivars (Hallawi, Sayer and Khadrawi), which implies that the nutritive value of Zahdi dates with respect to their mineral composition is higher than those of the other cultivars studied.

Furthermore, some differences in the vitamin and mineral composition of the cultivars studied can also be observed which may be due to variations in cultivars and/or agroclimatic conditions. The present findings appear to confirm those obtained by Duckworth (5) who reported that vitamin and mineral contents of fruits in general may show considerable variations not only among species and cultivars but also among different batches of the same cultivar grown under different agroclimatic conditions.

LITERATURE CITED

1. AOAC (1970): Official methods of analysis. IIth. ed., Washington D.C.
2. Cavell, A.J. (1947): Basrah dates: relationship between ripening and sugar content of 12 varieties. J. Soc. Chem. London 66: 195-98.
3. Clifford, P.A. (1945): Report on Fluerine .J. Assoc. Offic. Agr. Chem. 28:277p.
4. Dowson, V.H.W. & A. Atten (1962): Dates: handling, processing and packing, FAO Agric. Develop. Paper 72 (Rome) 394 p.
5. Duckworth, R.B. (1966): Fruit and vegetables. Pergamon Press.
6. Hussein. F. (1972): Kinds and relative amounts of sugar in some Egyptian date cultivars .Beitrag, Trop., Subtrop. Med. 10 (2): 159 – 62.
7. Luff. G. & N. Schoor (1953): Physical and chemical properties of the reducing sugars. *In:* P. Hing, Eds. Principles of Sugar Technology, Vol. I, 75 127 p. London: Elsevier Publication Company.
8. Mair, V.P. & F.H.Schiller (1960): Date research programme at the Pasadena Lab. Rept. of the Date Growers' Inst. 36: 8 – 10.
9. Methods Vitamin Assay (1966): 3rd ed., New York: Inter-science Publisher Inc., N.Y.
10. Nixon, R.W. (1951): The date palm. Economic Botany 5: 274 – 301.
11. Patron, A.; S.Patron & H.Swinzow (1954): The chemical composition of Moroccan dates considered from the view point of their food value. Fruits 9 (10): 44 – 9.
12. Robinson, C.H. (1972): Prodfit Robinson's Normal and Therapeutic Nutrition. 13th. ed. New York: Macmillan Company.
13. Salem, S.A. & S.M.Hegazi (1971): The chemical composition of Egyptian dry dates. J.Sc. Food Agri. 22: 632-33.
14. Sinclair, W.B.; E.T. Bartholemew & D.E.Bliss (1941): Composition of dates as affected by soil fertilizer treatments. Report of the Growers' Inst., 18: 11 – 16.
15. Smith, C. & H.Farrankop (1945): Vitamin contents of 15 varieties of Arizona Dates .Report of the Arizona Agri, Expt. Sta. No. 69.
16. Snell, F.D. & C.T. Snell (1953): Calorimetric Methods of Analysis. Vol. III, 195 – 215 p. New York: Von Nostrand Reinold Company.
17. Spoon, W. (1963): Dates and date syrup. Voeding, 24: 147 – 52.
18. Waheed Khan, A. & I.D.Chungtal (1956): Nutritive value of food stuffs. Pakistan J. of Scientific Res. 8: 73 p.
19. Zook, E.G. (1968): Mineral composition of fruits. J. Amer. Diet. Ass. 53: 588.

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LETHAL YELLOWING: A POTENTIAL DANGER TO DATE PRODUCTION

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ABSTRACT

Lethal yellowing is a fast spreading, destructive disease of coconut palm that is believed to affect a number of other palm species including *Phoenix dactylifera*. This disease is present in Florida, the West Indies and possibly the west coast of Africa. Symptoms include fruit loss and inflorescence necrosis, followed by death of the entire crown within 3 to 6 months. Observation of the phloem of declining palms by electron microscopy reveals the presence of mycoplasma-like organisms. These organisms are presumably transmitted from tree-to-tree by a piercing-sucking insect, probably a leafhopper. However, a vector has not yet been found. Suggested control measures include quarantine of the infected areas, removal of diseased palms, planting of resistant varieties, and treatment with tetracycline antibiotics.

Lethal yellowing (LY) is a devastating disease of coconut palm *(Cocus nucifera* L.), that was first reported on the Caribean island of Jamaica at about the turn of the century (2). LY has decimated coconut production in Jamaica Figure 1 and has spread to Hispaniola, Cuba, Nassau and other islands of the West Indies. The disease was found in Key West, Florida in 1955 where 15,000 coconut palms were killed over a 7 year period. LY appeared in Miami, Florida in 1971 and has killed more than 80% of the 350,000 coconut palms in the greater Miami area in the succeeding 4.5

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years (8).

The Kaincope disease of coconut palm in Togo, West Africa is identical to LY in symptomology and therapeutic response. It is likely that this disease and LY are coidentical (8, 12). If so, the distribution and worldwide significance of LY are greatly extended.

When LY became established on the Florida mainland, a new phenomenon of paramount importance was observed. Several other species of palms were noted to be declining and dying in areas where LY was actively spreading in coconut palms (13, 14). The suspected casual agent of LY was also observed in these declining species. The suspected host list has been expanded (Table 1) and now includes the date palm, *Phoenix dactylifera* L. (Figure 2) as well as *P. canariensis* Hort. ex Chab. (Figure3) and *P. reclinata* Jacq. (10,18).

SYMPTOMOLOGY

The symptoms of LY in coconut, as the name implies, consist of a rapid, generalized chlorosis followed by death of the palm, usually within a 4 month period. Prior to the development of yellowing symptoms, developing fruit drops from the tree and new inflorescences become necrotic, even before the opening of the spathe. Most of the fallen fruit have grey to black, water-soaked discoloration at the stem end. Yellowing begins at the tips of the fronds and moves towards the frond bases. The older fronds within the crown are the first to become yellow. The yellowing extends upwards through the crown from old to young fronds. In the dates and some other species of palms, the fronds do not become yellow, but rather become desiccated and gray-brown,the older fronds again being affected first. Fruit loss and inflorescence necrosis also occur in date palms.

When approximately half of the crown has become yellowed or necrotic, the folded spear or bud leaf will often become necrotic. A soft rot then extends down the spear and into the bud shaft, eventually reducing the meristematic area to a putrid, slimy mass. Death of the rest of the crown follows rapidly. The crown soon topples from the stem, leaving a naked trunk.

ETIOLOGY

A common factor observed in all declining palm species listed in Table 1, along with similar symptom expression, is the presence of mycoplasmalike organisms (MLO) within the sieve tubes of the affected trees. (Figure 4). The MLO, which are present only in the phloem tissues of the diseased palms, are the suspected casual agents. Mycoplasmas are smallest of all known cellular organisms. They are simpler than bacteria, have no cell wall, and have only a delicate membrane surrounding their cytoplasm. Currently, mycoplasmas or mycoplasmalike organisms are known to cause, or to be associated with more than 100 plant diseases. The term mycoplasmalike is used when these organisms have been observed by electronmicroscopy, but have not been isolated and grown in pure culture. Attempts to isolate the LY organism are underway in both Florida and Jamaica.

MODE OF SPREAD

The mechanism of spread of LY has not been determined, although it is the belief of many researchers that the LY pathogen has been transported around the West Indies and Florida by wind-borne arthropod vectors. The only known means of natural transmission of MLO's in other plants has been by leafhoppers and psyllids. This is a plausible method since these insects feed by piercing the phloem cells of plants and sucking out the sieve tube sap. If the plant on which the insects are feeding is infected by MLO, the insects will pick up the organisms and become infected themselves. The MLO's are later transmitted to the sieve tubes of other plants when the insects feed on them.

Extensive transmission experiments have been carried out in Jamaica with white flies, flatid and fulgorid planthoppers, tingid bugs, and gall mites (1,3,5). Other tests with the planthoppers *Haplaxius crudus*(Van Duzee), *Antillixius* spp., two species of *Omolicna, Colpoptera elevans* (Walker), *Psenoflata brevis* (Van Duzee), and *Ceratophis veriabilis* (Hille Ris Lambers) were made in Jamaica (16). No specific transmissions of LY have been reported.

Rotary flight nets within palm plantings and sticky traps within palm crowns have been employed to study the insect fauna present in coconut

palms in South Florida. Emphasis was placed on sampling the homopteran insects belonging to the Suborder Auchenorrhyncha. From this survey, the following planthoppers and leafhoppers have been selected as the primary suspect vectors to be used in transmission attempts: *Haplaxius crudus* (Van Duzee), *Chlorotettix spp.*, *Balclutha* spp., *Graminella* spp., *Empoasca* spp., *Delphacodes* spp., *Agallia constricta* (Van Duzee), *Idioderma virescens* (Van Duzee), *Pintalia* spp., *Bothriocerna* spp., *Protalebrella brasiliensis* (Baker), *Planicephalus flavicosta* (Stal).

CONTROL

Attempts to contain or slow the spread of LY in Florida have been based on an integrated program involving removal of diseased palms in areas where the disease is advancing; protection of healthy palms and therapeutic treatment of diseased palms with the antibiotic, oxytetracycline-HCL; quarantine of all affected countries; and replanting with non-susceptible types of palms (10). Vector control is another possible avenue for LY control; however, no feasible control may be aimed at the vector until the target insect is known.

The removal of diseased palms was the first line of defence against LY in Florida until development of the antibiotic treatment. Some twelve thousand diseased palms were removed early in the epidemic in Florida in an effort to slow the spread of disease by the reduction of inoculum (10). Cutting diseased palms did not stop the spread of LY either in Florida (8) or Jamaica (15). However, although no quantitative measurements were recorded it is certain that the cutting program did retard the spread of LY somewhat.

Treatment of palms with oxytetracycline is a recently approved control measure that is presently available for both coconut and pritchardia palms in Florida (6). This treatment is used both therapeutically in diseased palms prior to the development of extensive symptoms (7), and as a protectant for healthy palms (9). It is a generally established fact that mycoplasmas are sensitive to this type of antibiotic (17). A Florida Department of Agriculture and Consumer Services Program of treating healthy palms surrounding new cases of disease in areas of low LY incidence has effectively depressed disease spread for 16 months in five counties. A test to determine the pro-

tective action of oxytetracycline in the Canary Island date palm is currently underway. No data are available on the efficacy of antibiotic treatment in *Phoenix dactylifera.*

To curb the inadvertent spread of LY by man, the State of Florida has implemented a quarantine on all infested counties to stop the shipment of susceptible palms out of the affected areas. In addition, Texas, Hawaii, California and Louisiana have all enacted quarantines against the shipment of susceptible palm species from Florida into their states. The spread of LY in nature is extremely fast, so particular precautions should be taken to prevent the movement of affected trees to areas free of LY.

The major factor for LY control in coconut is the planting of the resistant 'Malayan Dwarf' cultivar. The Malayan Dwarf coconut palm is highly resistant to LY and is being widely planted in both Jamaica and Florida (4,11). Hybrids between Malayan Dwarf and other coconut cultivars also have a high degree of resistance to LY (4). The degree of susceptibility of resistance of various date cultivars to this disease is unknown.

DISCUSSION

The current state of knowledge about lethal yellowing in coconut palm is very sketchy, and much less is known about lethal declines of date and other palms that are associated with lethal yellowing. In all cases, the disease acts rapidly, killing the affected palm in about 4 months. Tree-to-tree spread is rapid and nearly always affects 100% of the susceptible palms in any infested area. Symptom development is similar in all species and all affected palms have mycoplasmalike organisms present in their sieve tubes. In addition, six species tested have all responded to oxytetracycline treatment. The evidence thus far accumulated indicates that lethal yellowing attacks not only coconut palms, but also the other species listed in Table 1. The causal agent is believed to be a mycoplasma, but this has not been proved. The organism must be isolated in pure culture and then used to reproduce the disease after inoculation in order to prove pathogenicity.

The chances of lethal yellowing spreading from Florida to the South-

western USA have been lessened considerably by instituting a quarantine on Florida palms. The potential danger of LY to date production in Africa is real if the Kaincope disease proves to be coidentical with LY. A priority research effort should be made to determine if Kaincope is identical to LY and whether or not it can attack date palms.

Judging from experience with other diseases of mycoplasmalike etiology, the vector is probably a piercing-sucking insect like the leafhopper. However, the vector of lethal yellowing is,as yet,unknown. Since the vector of LY is probably a flying insect, it would also be important to determine the identity of insects on date palm that could be potential vectors, especially members of the Cicadellidae. If LY were to appear in a date production area, a control program might be instituted against these insects. The infected trees should be removed and the feasibility should be explored of antibiotic treatment of palms in a 100 yard circle around the infection site, as successfully used in Florida.

Another priority area of research would be the screening of various date cultivars for resistance to LY. This would have to be done in an LY infested area, but could be of inestimable value to future date production. LY resistance has been found in the coconut palm and is being fully exploited in both Florida and Jamaica.

Table 1

List of declining palms in South Florida infected with mycoplasmalike organisms and placed under the lethal yellowing quarantine

Scientific Name	Common Name
1. *Cocos nucifera* L.	Coconut-all varieties including Malayan Dwarf
2. *Veitchia merrillii* (Becc.) H.E.Moore	Adonidia or Christmas palm
3. *Pritchardia pacifica* Seem. & H. Wendl.	Fiji fan palm
4. *Pritchardia thurstonii* F. Muell. & Drude	
5. *Arikuryroba schizophylla* (Mart.) Bailey	Arikury palm
6. *Corypha spp.*	Talipot palm
7. *Phoenix reclinata Jacq.*	Senegal date palm
8. *Phoenix canariensis Hort.* ex Chab.	Canary Island date palm
9. *Phoenix dactylifera L.*	Date palm
10. *Trachycarpus fortunei* (Hook). Bailey	Windmill palm
11. *Mascarena verschaffeltii* (Wendl.) Bailey	Spindle palm
12. *Caryota mitis* Lour	Cluster fish-tail palm
13. *Borassus flabellifer L.*	Palmyra palm
14. *Chrysalidocarpus cabadae* H.E. Moore	Cabada palm
15. *Dictyosperma album* (Bory) H.Wendle. & Drude	Hurricane or Princess palm
16. *Latania* spp.	
17. *Aranga engleri* Becc.	

LITERATURE CITED

1. Carter, W.; R.K. Latta & J.R. Suah (1965): The symptoms of lethal yellowing disease of coconut palms. FAO Plant Protect. Bull. 13: 49-55.
2. Fawcett, W. (1891): Report on the coconut disease at Montego Bay. Bull. Bot. Dept. Jamaica 23:2.
3. Grylls, N.E. & P. Hunt (1971): Studies on the etiology of coconut and lethal yellowing in Jamaica, by mechanical and bacterial inoculations and by insect vectors. Oleagineaux 26:543-49.
4. Harries, H.C. (1972): Botany/plant breeding, p. 15-30. *In* 12th Rep. of Res. Dep., Coconut Industry Board, Jamaica. 65p.
5. Heinze, K. (1972): Lethal yellowing disease of coconut. FAO Report TA 3152 to the Government of Jamaica.
6. McCoy, R.E. (1974): How to treat your palm with antibiotic. Univ. Fla. Agric. Exp. Sta. Cir. S-228. 7p.
7. McCoy, R.E. (1975): Effect of oxytetracycline dose and state of disease development on remission of lethal yellowing in coconut palm. Plant Dis. Rep. 59: 717-720.
8. McCoy, R.E. (1976): Comparative epidemiology of the lethal yellowing, Kaincope and cadang-cadang diseases of coconut palm. Plant Dis. Rep. 60:498-502.
9. McCoy, R.E.; V.J. Carroll; C.P. Poucher & G.H. Gwin (1976): Field control of coconut lethal yellowing with oxytetracyclin-hydrochloride. Phytopathology 66: 1148-50.
10. McCoy, R.E.; D.L. Thomas & J.K. Condo (1976): Lethal yellowing - why the quarantine. Fla Nurseryman 21(3): 49-52.
11. Midcap, J.T. & R.E. McCoy (1975): Malayan Dwarf palm, resistant to lethal yellowing, is recommended for planting in Florida. Sunshine State Agric. Res. Rep. 20(3): 8-9.
12. Ollagnier, M. & G. Weststeijn (1961): Coconut diseases on the Islands of the Caribbean: comparison with the Kaincope disease in Togo. Oleagineux 16:729-36.
13. Parthasarthy, M.V. (1973): Mycoplasmalike organisms in the phloem of palms in Florida affected by lethal yellowing. Plant Dis. Rep. 57:861-862.
14. Parthasarthy, M.V. (1974): Mycoplasmalike organisms associated with lethal yellowing disease of palms. Phytopathology 64:667-74.

15. Romney, D.H. (1971): Attempts to control lethal yellowing, p, 85-86.*In.* 11th Rep. Res. Dep., Coconut Industry Board. Jamaica. 90p.

16. Schuiling, M. & C.G. Johnson (1973): Current attempts to find a vector associated with lethal yellowing disease of coconut. Principes 17:151-59.

17. Smith, P.F. (1971): The biology of mycoplasmas. Academic Press, New York. 257p.

18. Thomas, D.L. (1974): Possible link between declining palm species and lethal yellowing of coconut palms. Proc. Fla. State Hort. Soc. 87:502-504.

Figure 1. Coconut plantation destroyed by lethal yellowing in Jamaica.

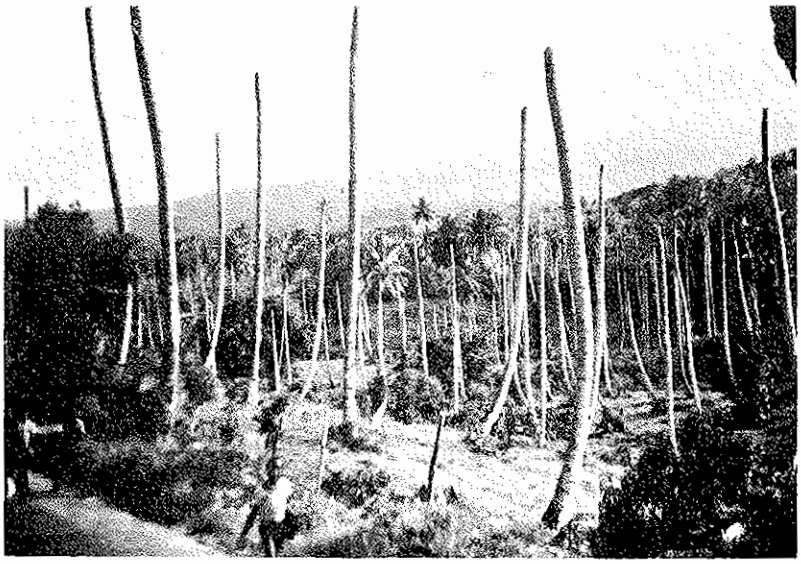

Figure 1. *Coconut plantation destroyed by lethal yellowing in Jamaica.*

Figure 2. *Lethal decline of Phoenix dactylifera in Florida. This disease is believed to be caused by the lethal yellowing pathogen.*

Figure 4. Mycoplasmalike organisms within a phloem sieve tube in a declining Phoenix palm.

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NEW RECORDS

NEW RECORDS OF DATE PALM DISEASES IN THE UNITED ARAB EMIRATES (UAE) AND BAHRAIN

M. DJERBI

Regional Project for Palm & Dates Research Centre in the Near East and North Africa

As a result of recent survey of date palm diseases in UAE & Bahrain, the following diseases have been reported either for the first time or first time in the history of these countries:

(i) Spot blotch – caused by *Helminthosporium* sp. This disease is reported for the first time of date palm, affecting leaves and fronds and causing a serious problem in the UAE.

(ii) Jahla disorder – which is a physiological disorder. This is also a new disease of date palm. Affected trees characteristically bend their central leaves to the south or south-east.

(iii) Inflorescence rot – caused by *Mauginiella scattae*. It is a very serious disease affecting date palm inflorescences mainly in Bahrain. It needs a large scale control programme.

(iv) Diplodia disease – This is reported for the first time in these countries, causing considerable damages. The fungus infects and kills the outside fronds, leaving younger shoots and bud alive for sometime before finally causing their death.

The disease can be controlled by dipping or spraying the offshoots with copper sulphate, bordeaux mixture, benomyl or methylthiophonate, etc.

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NEW RECORDS OF DUBAS BUG (*Ommatissus binotatus lybicus* De Bergevin) ON DATE PALMS IN SUDAN

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During a recent survey of date palm insects in the North province of Sudan, dubas bug was found in an area called "Gaab" on 23rd October 1981. Population was heavy on palms left with a large number of offshoots around them. Honey dew was observed on the leaflets (pinnae) and on the ground as a result of the insect feeding. It is suggested that this pest has two generations in Sudan.

Dubas bug is a serious pest of date palms in various countries. It is reported by various authors from Spain, Southeast U.S.S.R., Iran, Libya,Egypt, Kuwait, Bahrain, UAE, Oman, Saudi Arabia, Algeria and Iraq. It is assumed that this is a first record of this pest in Sudan.

Domestic quarantine measures and pesticides treatment were recommended against this pest.

Date Palm J 1 (2) – 309 – 316
Published 1382

DOCUMENTATION

ABSTRACTS OF RECENT RESEARCH ON THE DATE PALM

General

GIRARD, F. Palm plantations and date palm cultivation in the Aïr massif (Northern Niger). Fruits 1980, 35 (6): 383 – 91 (Fr).

A review of the geography, history, population and date palm cultivation methods of the area. Dates are important in Aïr, both for the fruits and by-products, such as timber. Flowering occurs in February after the cold season and fruiting is completed before the July rains. Some trees flower twice a year, in February and October, the later crop maturing in the following March – April. Soft dates are sold immediately and drier types are packed in sacks for longer storage or transport.

(Abstracts taken from *Horticultural Abstracts* verbatim).

VITTOZ, J. The date palm in Oman. Fruits 1979, 34 (10): 609 – 21 (Fr).

A detailed survey of crop production, covering soils, irrigation, planting methods, pollination, pests and diseases, cultivars, labour requirements, costs and returns.

Botany

BOUGUEDOURA, N. Morphology and ontogenesis of growth from axillary buds of date palms. Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, D 1980, 291 (10): 857 – 60 (Fr with En summ.).

A vegetative or a flower bud may arise from the primordium in the axil of a leaf or at the base of the date palm. A comparative study showed that both types of bud were the result of development from the same primordial structure.

(Abstract taken from *Horticultural Abstract* verbatim)

Morphology

SHABANA, H.R. & ANTOUN, N.S. The determination of leaf area in date palm. Beiträge trop. Landwirtsch. Veterinärmedizin 1980, 18: 345 –

49 (En with En, De, Ru, Fr & Es summs.).

In 12-yr.-old date palms of Zahdi cultivar, the leaf area of the upper, middle and lower regions of the palm crown were measured. Leaflet length gradually increased from the top of the leaf to the proximal end. Basal leaflets were longer but narrower and of smaller area than the wider leaflets in the mid-portion of the leaf. There were no consistent differences in the area of leaves from the various regions of the crown. Total leaf area calculated as leaflet length x maximum leaflet width x 0.84 x number of leaflets/leaf agreed with total leaf area measured with a planimeter.

Breeding

GUPTA, M.P. Resistance of some promising date palm cultivars against rainfall and bird damage. Punjab Horticultural J. 1980, 20 (1 & 2): 74 – 77.

Data were analysed on 5 date cultivars. Medjool was the most resistant to rain damage (with no split fruits); it ripened late and missed the rains. Khadrawi cultivar was the most susceptible with 78.4% split fruits. Medjool cultivar showed the least (0.5%) and Hillawi the most (20%) bird damage.

SAAIDI, M.; TOUTAIN, G.; BANNEROT, H. & LOUVET, J. The selection of date palm *(Phoenix dactylifera)* for resistance to bayoud disease. Fruits 1981, 35 (4): 241 – 49 (Fr with En, De, Es and Ru summs).

Data were collected on the behaviour of 32 date palm cultivars which have been under observation for up to 14 years. Bou Sthammi Noire, Iklane, Tadment, Saîr-Layalet and Bou Feggous ou Moussa are so far completely resistant to bayoud. Selections have been made of individuals resulting from both natural and planned crosses. Encouraging results have been obtained in preliminary work on the micropropagation of promising material.

Physiology

CARPENTER, J.B. Lethal disorders of unknown cause in the date palm. Third Meeting of the International Council on Lethal yellowing. Fort Lauderdale, USA; Agricultural Research Centre 1978, FL – 78 – 2: 33.

The symptoms of rapid decline (rhizosis) of date palms in California,

fayoun in Mauritania and al – wijam in Saudi Arabia are briefly described.

MOHAMMED, S. & SHABANA, H.R. Effects of naphthalene-acetic acid on fruit size, quality, and ripening of 'Zahdi' date palm. Hort Science 1980, 15: 724 – 25.

Pre – harvest application of naphthaleneacetic acid (NAA) at 10,20,40 and 60 ppm to immature fruit 15 – 16 weeks after pollination influenced pomological characters of Zahdi date palm cultivar. The treatments with 40 and 60 ppm NAA increased fruit size, weight, volume, pulp to seed ratio and moisture content and delayed ripening by at least one month compared with untreated fruit. TSS were not significantly altered.

(See also Date Palm J. 1981, 1 (1): 145).

Production

GUPTA, M.R. & THATAI, S.K. Storage of date pollen. Punjab Horticultural J. 1980, 20 (3 & 4): 211 – 14.

Pollen was collected on 18th March in two years; dried in the sun for 6 hours and in the shade for 18 hours, and stored in the corked phials at 9°C or at room temperature forup to 8weeks. Fresh pollen gave a higher fruit set than stored pollen. In one year pollen stored at 9°C gave higher fruit set than pollen stored at room temperature, but in another year fruit set was similar irrespective of pollen storage temperature. At low temperature, pollen viability was 99% at 8 weeks whereas it declined to 95% at room temperature.

HUSSEIN, F.; MOUSTAFA, S. & MAHMOUD, I. The direct effect of pollen (metaxenia) on fruit characteristics of dates grown in Saudi Arabia. Proceedings Saudi Biological Society 1979, No. 3: 69 – 78 (En with En & Ar summ.).

In 2-yr. trials, the dates of Nebut Seif cultivar were pollinated with pollen of 4 different cultivars. Pollen of the Barhee cultivar increased fruit size and yield but did not increase the percentage of top grade fruits. Shalaby pollen gave the best results with regard to fruit quality. Data are tabulated for all variants.

MOUSTAFA, S.; HUSSEIN, F. & ELKAHTANI, M.S. Yield, fruit quality and ripening of "Sukhari" dates irrigated at different intervals. Pro-

ceedings Saudi Biological Society 1978, No. 2: 7 – 16 (En with En & Ar summs.).

In 2-yr. trials with 12-yr.-old date palms growing at 10 × 10m, 400 m^3 water/ha was applied 8, 4 or 2 times/month. Yield per palm was slightly higher under heavy irrigation, but the percentage of first and second grade fruit and fruit quality were appreciably higher in palms receiving the lowest irrigation rates. Heavy irrigation also delayed ripening of fruit.

SAAIDI, M. & TOUTAIN, G. Transplanting young date palms. Fruits 1979, 34 (10): 623 – 24 (Fr.).

Date palms of several cvs. grown for two years in the nursery and well rooted with 2-8 new fronds were transplanted either with a root-ball and cut back to 0.5 or 1 m, or bare – rooted and cut back to 0.2 or 0.4 m. The root – ball of soil was obtained by cutting a trench 30 cm wide around the plant; the ball was then wrapped in hessian and carried to the planting site in a large container or a further hessian wrap to prevent disintegration. Only 6-8 such palms/day could be lifted by one worker, compared with 15-20 bare – rooted palms. Four years after planting the average percentages of successful establishment were 54 and 82 for root – balled palms cut back to 0.5 and 1 m, and only 32 and 23 for bare – rooted palms cut back to 0.2 and 0.4 m, respectively. All rooted – balled palms of the cv Iklane survived.

(Abstract taken from *Horticultural Abstract* verbatim).

Propagation

BEAUCHESNE, G. Interest of *in vitro* culture for vegetative propagation. Comptes Rendus des Séances de l'Académie d'Agriculture de France 1980, 66 (8): 638 – 49.

A discussion, with reference to several ornamental and vegetable spp. Problems caused by *Xanthomonas perlargonii* and *Corynebacterium fascians* in pelargonium *in vitro* culture are outlined. The production of 50,000 – 100,000 date palms in 2 years is foreseen. The interest of the technique for saving rare plants is mentioned.

(Abstract taken from *Horticultural Abstracts* verbatim).

POULAIN, C.; RHISS, A. & BEAUCHESNE, G. Vegetative propagation of the date palm by *in vitro* culture. Comptes Rendus des Séances de

l'Académie d'Agriculture de France 1979, 65 (13). 1151 – 54 (Fr with En summ.).

When tissue taken from the soft parts of adult date palm offshoots (cv. Bou Feggous) was cultured on a Murashige and Skoog medium with the addition of auxins (IAA, IBA and/or naphthoxyacetic acid at 0.5 – 5.0 mg/litre) and cytokinins (6-furfuryl-amino-purine [kinetin] at 0.1 – 1.0 mg/litre), buds were formed after 3 months. When these buds were transplanted to a medium where the cytokinin was reduced to 0.1 mg/litre isopentenyl-adenine and the auxins modified to 1 mg/litre naphthoxyacetic acid, 2 mg/litre IAA and 3 mg/litre IBA, the plants rooted. The plants were later planted out in well-drained compost under grass.

(Abstract taken from *Hoticultural Abstracts* verbatim).

RHISS, A.; POULAIN, C. & BEAUCHESNE, C. *in vitro* culture for the vegetative propagation of date palms. Fruits 1979, 34 (9): 551 – 54 (Fr).

Shoot-tips from cvs. Bou-Feggous and Bou-Sthammi offshoots were propagated on a supplemented Murashige and Skoog medium. Plantlets formed roots, but the roots rotted due to poor substrate drainage when the plants were transplanted with a view to growing them on under glass.

(Abstract taken from *Horticultural Abstracts* verbatim).

SAAIDI, M.; DUVAUCHELLE, G. & TOUTAIN, G. Propagating date palms. Study of some factors affecting rooting of date palm offshoots. Fruits 1979, 34 (9): 556 – 61 (Fr).

Seventy eight percent of cv. Bou Slirène offshoots rooted whereas with cvs. Tadment, Iklane and Bou Sthammi Noir the percentages were 64,53 and 31, respectively. There was little difference in the rooting ability of offshoots weighing 3-5 kg, 5-7 kg or 7-10 kg. Irrigation was an important factor.

(Abstract taken from *Horticultural Abstracts* verbatim).

SHARMA, D.R.; KUMARI, R. & CHOWDHURY, J.B. *In vitro* culture of female date palm *Phoenix dactylifera L.* tissues. Euphytica 1980, 29 (1): 169 – 74.

Roots, leaf petioles, short tips and immature fruits formed the source

material for *in vitro* cultures. Isolated embryo excised from mature seeds were also cultured. Some of the leaf petioles and fruit mesocarp gave rise to calluses in Staritsky's and Eeuwen's media, whereas the isolated embryos produced seedlings in Murashige and Skoog's medium. Although calluses were established from seedling segments, no shoot regeneration could be induced. Browning of the tissues and media was partially overcome by adding charcoal to liquid media and cystein to solid media.

TISSERAT, B. & DEMASON, D.A. A histological study of development of adventive embryos in organ cultures of *Phoenix dactylifera* L. Annals of Botany 1980, 46 (4): 465 – 72.

Callus cultures from axillary buds of 2 – to 4-yr-old offshoots of date palms yielded plantlets adventitiously. Adventive embryos originated from meristematic cytoplasmrich cells located in the epidermal and adjacent sub-epidermal portions of the periphery of callus on a basal medium supplemented with 2, 4-D and isopentenyladenine (IPA). The formation of adventive embryos is described. Morphogenetically component cells proliferated into globular proembryos which differentiated into bipolar structures. Transfer to a medium devoid of hormones enhanced embryo development and promoted plantlet growth. Comparative studies between zygotic and adventive embryos in various stages of development are described. Production of plantlets from callus might offer a more rapid means of cloning superior genotypes.

(Abstract taken from *Horticultural Abstracts* verbatim).

TISSERAT, B.; ULRICH, J.M. & FINKLE, B.J. Cryogenic preservation and regeneration of date palm tissue. Hort-Science 1981, 16 (1): 47 – 48.

Embryogenic callus cultures of date palm were subjected to 0, – 15, – 23, – 30 and – 196°C for up to 3months in the presence of a cryoprotective mixture of 10% polyethylene glycol, 8% glucose, and 10% dimethylsulphoxide. Revived cultures developed callus and plantlets.

Processing & Products

HASEGAWA, S. & MAIER, V.P. Polyphenol oxidase of dates. J. Agri-

cultural & Food chemistry 1980, 28 (5): 891 – 93.

The extraction and activities of polyphenol oxidase from Deglet Noor date cultivar are described. Each fruit contained about 0.39 – 0.43 units of enzyme activity at the early red stage of ripening and about 0.4 units when harvested at the late ripe stage.

HASSAN, H.K. Preservation of high – moisture dates (rutab) by antimicrobial agents. Palm & Dates Research Centre Technical Bulletin 1979, No. 2: 9 pp.

Dates of Khadrawi, Berben and Teberzal cultivars in the rutab stage were washed and dipped for one minute in solutions of Ca – propionate, Na – benzoate, SO_2, K – sorbate or dehydroacetic acid or their mixtures. The rutab dates were then drained, packed in transparent plastic cups and inoculated with the storage pathogens *Aspergillus niger* and *Saccharomyces rouxii* before storage at 18-25 or 2-5°C. Potassium sorbate was the most satisfactory of the single dips. At 2% concentration and low temperature it prevented fermentation for at least 14 weeks except in the case of Berben cultivar. Of the mixtures, Na – benzoate + SO_2 and Na – benzoate + Ca-propionate prolonged storage life at 2-5°C upto 9 months.

JADDOU, H. & AL-HAKIM, M. Gas-liquid chromatography of trimethylsilyl derivatives of sugars from Iraqi dates. J. Agricultural & Food chemistry 1980, 28 (6): 1208 – 12.

Ninety-five percent ethanol was used in the Soxhlet extraction of sugars from semi-dry dates of Zahdi and soft dates of Sayer cultivars. The sugars were converted to trimethylsilyl ether derivatives for gas-liquid chromatography. Fructose, α – glucose, ß – glucose and sucrose were the major sugars and small amounts of sorbitol and sorbose were found.

Protection

RATTAN, S.S. & AL-DBOON, A.H.A. Notes on fungi associated with date-palm 1. Sydowia 1980, 33: 246-64 (En).

Ten pathogens isolated from standing and fallen trees around Basrah are described. Notes on cultural growth characteristics, ability to decay and temperature studies are given.

جدول (١) يبين تأثير بعض المبيدات على حشرة الحميرة على النخيل موسم ١٩٨١ في البحرين

المعاملة	معدل التطبيق لكل 150 لتر ماء	متوسط الاصابة قبل الرش	متوسط الاصابة على أربعة شماريخ خلال أيام الفحص			
			٣ يوم	٧ يوم	١٤ يوم	٢١ يوم
اكتلك 50% سائل	225 سم^3	6,50	4,25أب	1,25 أب	0,75	0,50
مالاثيون 75% سائل	200 سم^3	5,50	2,50 أ	1,50 أب	0,00	1,00
ريبكورد 5% سائل	187,5 سم^3	3,00	2,00 أ	0,25 أ	0,50	0,75
دبتركس 80% مسحوق قابل للذوبان في الماء	300 حجم	2,75	1,25 أ	0,25 أ	0,00	,0,50,0,25 0,50
سوميثيون 50% سائل	225 سم^3	7,52	3,75 أب	2,00 ب	0,75	1,00
مقارنة بدون رش		6,52	5,75 ب	2,50 ب	1,25	

الاعداد التي لها نفس الحرف في كل عمود لا يوجد بينها فرق معنوي عند احتمال 5%

وقد تركت معاملة أخرى بدون رش لغرض المقارنة . استعمل تصميم القطاعات العشوائية الكاملة . كان عدد المعاملات (6) معاملات مكررة (4) مرات وشملت كل معاملة نخلة واحدة كررت اربع مرات . تم اجراء الرش بالمبيدات بعد عقد الثمار وعند مستوى اصابة ما بين 2,75% و 7,25% . ثم أخذ اربعة شماريخ من كل معاملة (نخلة) وحسبت عليها عدد الثمار السليمة والمصابة بعد مرور 3 و 7 و 14 و 21 يوماً بعد الرش ثم حللت النتائج احصائياً باستخدام طريقة دانكن للتفريق ما بين المتوسطات (المعدل) .

النتائج :

يوضح الجدول (1) تأثير المبيدات المستعملة على حشرة الحميرة عام 1981 . كانت الفروقات بين متوسطات كل من المالاثيون والربيكورد والدبتركس والمقارنة معنوية بعد ثلاثة ايام من الرش . وأما بعد سبعة أيام من الرش فقد كان الفرق معنوياً ما بين كل من الربيكورد والبتركس والمقارنة .

ولم تظهر فروقات احصائية معنوية بعد 14 و 21 يوماً من الرش بين جميع المعاملات . ويمكن تفسير ذلك الى كون ان اليرقات قد تحولت الى عذارى خلال هذه الفترة حيث وجد أن فترة الطور اليرقي لحشرة الحميرة هي بحدود اسبوعين ، وبهذا يمكن نجاح استعمال كل من مبيدي الدبتركس والربيكورد في مكافحة حشرة الحميرة في البحرين وللتأكد من هذه النتائج يجب اعادة التجربة .

CONTROL OF THE LESSER DATE MOTH (*Batrachedra amydraula* Meyrick) BY PESTICIDES IN BAHRAIN

ABDUL JABBAR, A., A. ALI, & H.S. EL – HAIDARI

ABSTRACT

The lesser date moth is a major pest of date palms in Bahrain. An experiment was conducted during 1981 to evaluate the effect of five pesticides i.e. Actellic, Malathion, Ribcord, Dipterex and Somithion against this pest. It was found that both Dipterex and Ribcord are promising pesticides for the control of the lesser date moth.

اخبار قصيرة

تجربة مكافحة حشرة الحميرة *Batrachedra amydraula* Meyrick على النخيل بالمبيدات الكيمياوية في البحرين

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حيدر الحيدري ـ المشروع الاقليمي لبحوث النخيل والتمور ـ بغداد

المقدمة

تعتبر حشرة الحميرة من الأفات المهمة التي تصيب النخيل في دولة البحرين حيث تؤدي الى انخفاض في انتاجية النخلة وتختلف هذه الكمية من سنة الى أخرى ولهذا فقد تضمنت خطة عمل المشروع الاقليمي لبحوث النخيل والتمور في الشرق الأدنى وشمال افريقيا دراسة ومكافحة هذه الحشرة حيث قام الدكتور حيدر الحيدري خبير الحشرات في المشروع بوضع برنامج تفصيلي يهدف الى ايجاد مبيدات كيمياوية فعالة وامينة واقتصادية ضد حشرة الحميرة وثم تطبيقه بالتعاون مع ادارة الزراعة في البديع / البحرين.

المواد والطرق المستعملة:

استعملت خمسة مبيدات كيمياوية بالنسبة التالية لكل 150 لتراً من الماء:

أ. اكتلك 50% مستحلب مركز بنسبة 225 سم^3

ب. مالاثيون 50% مستحلب مركز بنسبة 300 سم^3

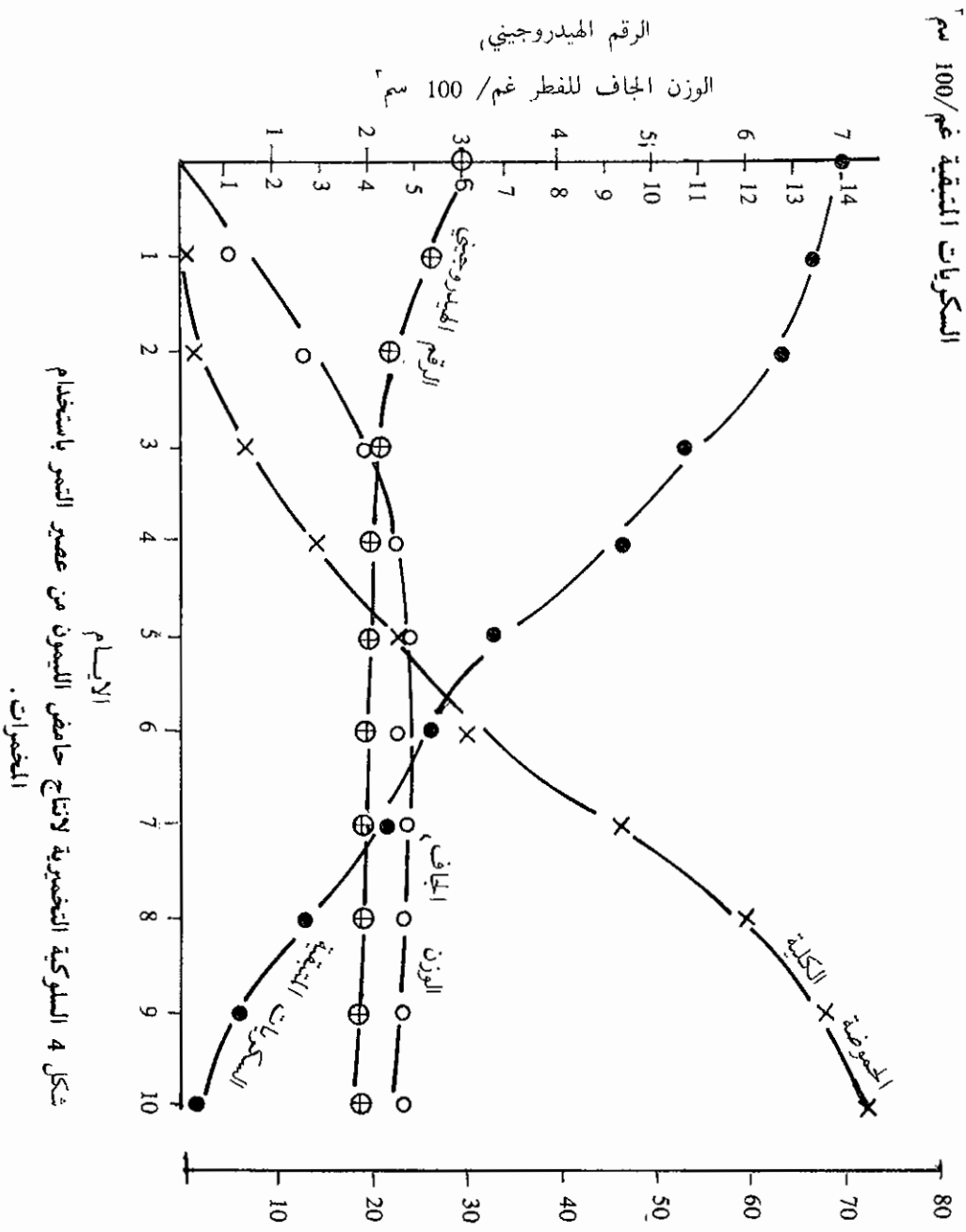
جـ. ريبكورد 5% مستحلب مركز بنسبة 187,5 سم^3

د. دبتركس 80% مسحوق قابل للبلل بنسبة 300 غم

هـ. سوميثيون 50% مستحلب مركز بنسبة 225 سم^3

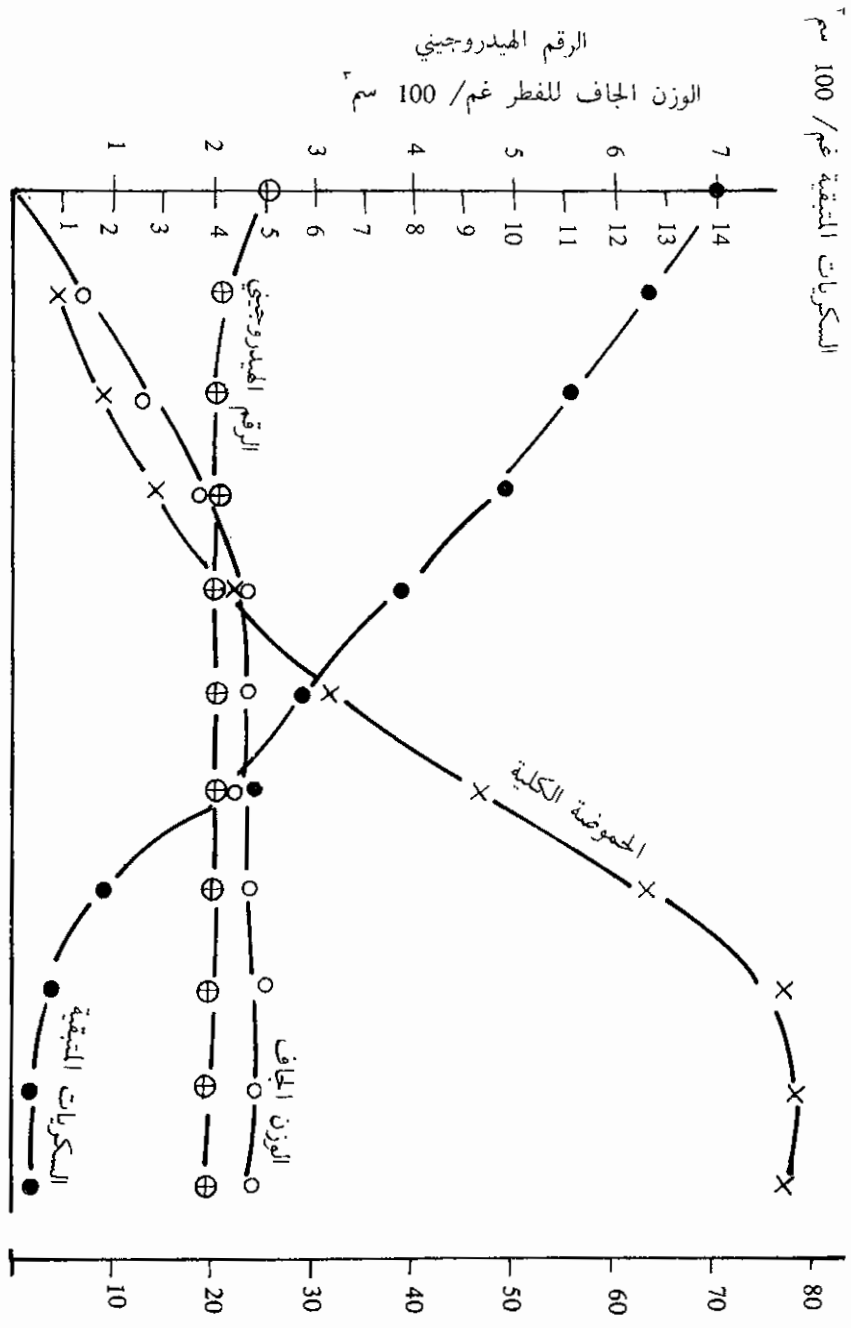
LITERATURE CITED

1. Al-Obaidi, Z.S. & D.R. Berry (1981): Production of citric acid from date syrup. Date Palm J 1 (1): 79-98.
2. Batti, M.A. (1966): Process for citric acid. United States Patent, 3290227.
3. Brierley, N.R. & R. Steel (1959): Agitation-aeration in submerged fermentation. Part II. Effect of disperse phase on oxygen absorption in fermenter. Applied Microbiology 7: 57 – 61.
4. Chain, E.B.; P. Gualandi & G. Morisi (1966): Aeration studies: Part IV Biotechnology and Bioengineering 8: 595 – 613.
5. Clark, D.S. & C.P. Lentz (1961): Submerged citric acid fermentation of sugar beet molasses: effect of pressure and recirculation of oxygen. Canadian Journal of Microbiology 7: 447 – 53.
6. Cocker, R. (1975): The morphological development of *Aspergillus niger* in tower fermentation culture. Ph.D. Thesis, Aston University, Birmingham, U.K.
7. Gold, W. & R.J. Kieter (1968): Process for making citric acid production. United States Patent, 3372094.
8. Millis, N.F.; B.H. Trumpy & B.M. Palmer (1963): The effect of lipids on citric acid production by an *Aspergillus niger* mutant. Journal of General Microbiology 30: 365 – 79.
9. Shu, P. (1953): Oxygen uptake in shake flask fermentation. Journal of Agriculture and Food Chemistry 1: 1119 – 22.
10. Snell, R.L. & L.B. Schweiger (1949): Production of citric acid by fermentation. United States Patent, 2492667.
11. Solomons, G.L. (1969): Materials and Methods in Fermentation. London and New York: Academic Press.
12. Wold, W.SM. & I. Suzuki (1976): The citric acid fermentation by *Aspergillus niger:* regulation by Zinc of growth and acidogenesis. Canadian Journal of Microbiology 22: 1083 – 92.

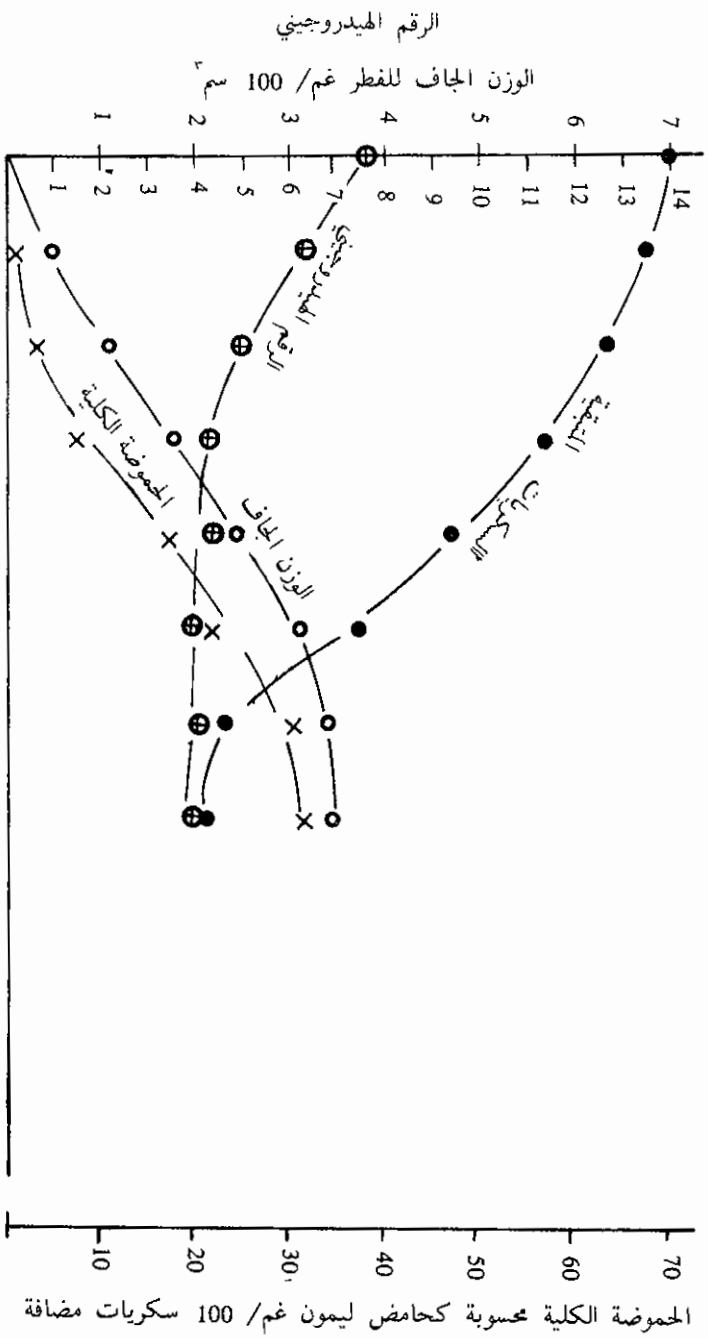


شكل 4 السلوكية التخميرية لانتاج حامض الليمون من عصير التمر باستخدام المخمرات .

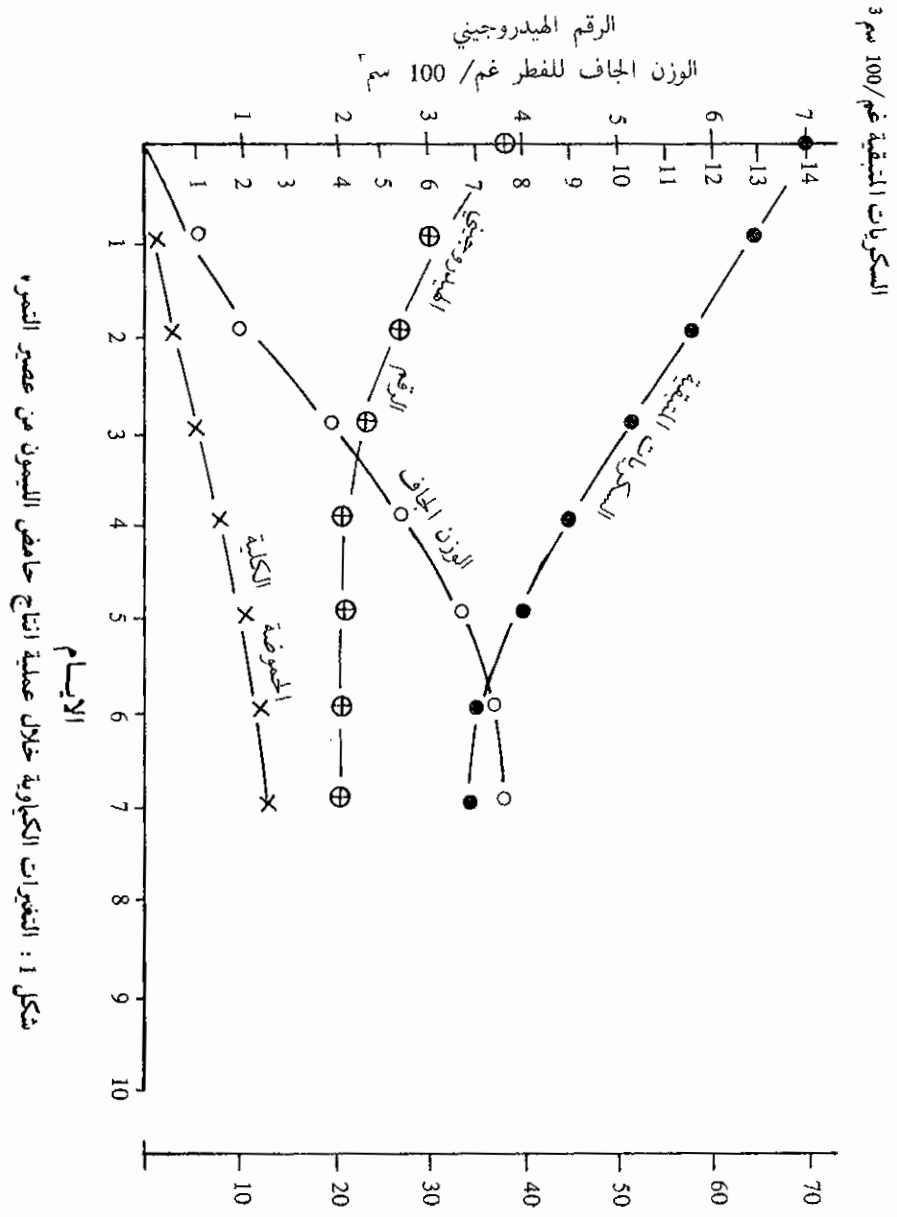
الحموضة الكلية محسوبة كحامض الليمون غم/ 100 سكريات مضافة



شكل 3: السلوكية التخميرية لانتاج حامض الليمون من الوسط الغذائي الحاوي على • السكروز (نموذج المقارنة) في المخمرات.



شكل 2: السلوكية التخميرية لانتاج حامض الليمون من الوسط الغذائي الحاوي على السكروز (نموذج المقارنة في الحاضنات الهزازة)



شكل 1 : التغيرات الكيماوية خلال عملية انتاج حامض الليمون من عصير التمر.

شكر

يشكـــر المؤلفـــان الأستـــاذ الدكتـــور اي . او . مـــورس رئيس قسم المايكروبايولوجي التطبيقي في جامعة ستراثكلايد لتقديم كافة التسهيلات اللازمة لاجراء هذا البحث كما نقدم شكرنا الى الدكتور عدنان شفيق الزبيدي باحث علمي في قسم النخيل والتمور / مجلس البحث العلمي لقراءاته البحث وتقديم الاقتراحات القيمة بخصوص ذلك .

نموذج المقارنة على الرغم من ان التحسن الذي طرأ على نسبة الانتاج باستعمال زيت الذرة بدلا من السليكون كمضاد للرغوة الا أن التهوية والتحريك كانتاردينتين نتيجة ظهور القوام المخاطي للمزرعة التخميرية الذي أعاقهما . ان ظهور الصبغة الصفراء في بداية انتهاء مرحلة النمو قد لوحظت ايضا من (12) .

ظهر تحسن ملحوظ في الصفات التخميرية عند استبدال نترات الأمونيوم بكربونات الأمونيوم مع اضافة تراكيز واطئة من كل من الفوسفات والمغنيسيوم (10) . وأن أحد مظاهر هذا التحسن هو تقصير الفترة التخميرية لمدة يومين مقارنة باستخدام الحاضنات الهزازة التي استغرقت 10 أيام لأكمال عملية التخمير .

ان وجود كل من الحديد والخارصين يعتبر أساسياً في الاوساط التخميرية لانتاج حامض الليمون بطريقة الحاضنات الهزازة، اما باستخدام المخمرات فلم يضف الحديد الى الوسط الغذائي وذلك لاحتمال تعويض الحديد المضاف من الاجزاء الحديدية الموجودة في المخمر في ظروف الرقم الهيدروجيني الواطيء (11) .

ان استعمال عصير التمر المزالة منه الأيونات الضارة والمضاف له المواد الغذائية بتراكيز مناسبة لانتاج وسط غذائي يشابه نموذج المقارنة اعطى نسبة انتاج جيدة (72%) منتجة بمعدل 10.1 غم / لتر / يوم . كان الحد الأقصى لنسبة انتاج الحامض اعلى مما هو عليه في الحاضنات الهزازة وهذا ممكن لأن كفاءتي التهوية والتحريك في المخمرات عالية جداً بالاضافة الى وجود زيت الذرة .

ويمكن القول اخيراً بأنه قد تم الوصول الى أحسن الظروف التخميرية لانتاج حامض الليمون من التمور بعد معاملتها معاملات خاصة غير معقدة . وتبقى الدراسات الاقتصادية ضرورية في مثل هذه الحالة .

بالامكان ملاحظة هبوط قيمة الرقم الهيدروجيني الى 2.1 بعد يومين ثم الى 1.8 عند انتهاء عملية التخمير . كان الوزن الجاف للفطر المستعمل 2.2 غم / 100 سم ^{3} في اليوم الرابع وبقي على هذا الوزن حتى النهاية . بدأ تكون الحامض بعد يومين من عملية التخمير ووصل الى نسبة 72% بعد عشرة أيام . ان اضافة زيت الذرة كمادة مضادة للرغوة قد رفعت نسبة الكربون في الوسط التخميري ، وبعد طرح نسبة الحامض المحتمل انتاجه من الكربون المضاف على شكل زيت الذرة فإن نسبة انتاج الحامض المحتملة تكون 70.3% محسوبة على السكريات المضافة فقط . ان معدل انتاج الحامض كان 10.1 غم / لتر / يوم خلال عملية التخمير . بالامكان أيضاً ملاحظة ان معظم السكريات المضافة قد استهلكت اذ ان السكريات المتبقية كانت 0.3% وان 98.5% من الحموضة الكلية هي نتيجة وجود حامض الليمون عند تحليل نموذج اليوم العاشر .

4 ـ الاستنتاج :

ان طريقة الانتاج المثالية من وجهة النظر الاقتصادية لانتاج حامض الليمون هي الحصول على كتلة حيوية قليلة ونسبة انتاج عالية لحامض الليمون .

ان الوسط الغذائي الحاوي على عصير التمر والذي استعمل بنجاح في الحاضنات لم يعط نتائج مرضية في المخمرات ، وسبب ذلك يعود الى احتمال وجود الكتلة الحيوية بنسبة عالية والقوام المخاطي للمزرعة واللذان أديا الى نقصان في معدل امتصاص الأوكسجين . هذا يتفق مع الاستنتاجات التي توصل اليها كل (3) و (4) . الذين اشاروا الى النقصان في معدل امتصاص الأوكسجين بزيادة الكتلة الحيوية في طرق التخمير المغمور . وهنالك احتمال آخر أدى الى النقصان في الأوكسجين المذاب وهو استعمال السليكون كمضاد للرغوة والذي اشار اليه (6) ولهذا السبب تقرر استبدال السليكون بزيت الذرة . نتيجة لاستعمال مضاد الرغوة الجديد (زيت الذرة) حصل بعض التحسن في نسبة انتاج حامض الليمون وهذا ما توصل اليه كذلك (8) عند استعمالهم الزيوت الطبيعية بنسبة 2% التي أدت الى زيادة في نسبة الانتاج تقدر بـ 20% وبالنسبة لهذه الدراسة فإنه وفي حالة استخدام

السكريات المتبقية بعد ثمانية أيام كانت 0.69%. أما الرقم الهيدروجيني فقد انخفض الى 1.8 عند انتهاء عملية التخمير . كـان الوزن الجاف للفطـر مسـاويـاً الى 2.3 غم/100 سم^3 بعد خمسة أيام من ابتداء التخمير واستمر على ذلك حتى النهاية ، وخلال فترة التخمير لم يظهر القوام المخاطي ولا الصبغة الصفراء .

تطوير وسط غذائي يحتوي على عصير التمر لانتاج حامض الليمون

من النتائج السابقة تبين أن نسبة الانتاج في الحامض كانت عالية عند استعمال السكروز كمصدر كربوني ونتيجة لذلك تقرر اعادة استعمال عصير التمر المزالة منه الأيونات الضارة في محاولة لانتاج نسبة عالية من حامض الليمون بوسط غذائي جديد . آخذين بنظر الاعتبار مستويات كل من النتروجين والفوسفات والمغنيسيوم والخارصين والتي أضيفت مع الأخذ بنظر الاعتبار تراكيزها في عصير التمر المستخدم كمصدر كربوني . ولما لم يحصل أي نمو للفطر المستعمل في حالة الهزازات عندما يكون الرقم الهيدروجيني الابتدائي للوسط الغذائي مساوياً الى 2.5 فتقرر تعديله الى 3 يتكون الوسط الغذائي الجديد من : ـ

أ . عصير التمر المزال منه الايونات الضارة		203.00	غم
ب .	$(NH_4)_2CO_3$	1.90	غم
جـ .	KH_2PO_4	0.12	غم
د .	$MgSO_4.7H_2O$	0.10	غم
هـ .	Zn^{++}	3.90	ملغم
و . ماء		1.00	لتر

أما الظروف التخميرية الأخرى فكانت مشابهة لما سبق .

تظهر النتائج المبينة في شكل (4) الحموضة الكلية والسكريات المتبقية والوزن الجاف للفطر وقيمة الرقـم الهيـدروجيني للمـزرعـة خلال 10 أيـام تخميريـة .

بالامكان مشاهدة النتائج في شكل (2) التي تبين أن هنالك بعض التحسن في نسبة انتاج الحامض عند استعمال الوسط الجديد وكان اخماد الرغوة أطول باستعمال زيت الذرة . اذ لوحظ ان اضافة 2 سم ^{3} من الزيت لكل 5 لتر من الوسط الغذائي في اليوم كاف لمنع تكون الرغوة في الأيام الأربعة الأولى من عملية التخمير . ان النتائج شكل (2) تشير الى ان الرقم الهيدروجيني هبط بسرعة في الأيام الثلاثة الاولى وبقي ثابتاً تقريباً مسجلا 2.1 ان الحد الاقصى لنمو الفطر كان أقل بقليل عما كان عليه في الوسط الغذائي الحاوي على التمر حيث ان الوزن الجاف للفطر كان 3.4 غم / 100 سم ^{3} ، وكانت أقصى نسبة لانتاج الحامض تساوي 31% بعد سبعة أيام من ابتداء عملية التخمير .

ومرة أخرى لوحظ ظهور الصبغة الصفراء والقوام المخاطي للمزرعة الذي أدى الى ضعف كفاءة التهوية والتحريك والذي أدى الى النقصان في نسبة انتاج الحامض .

3 – 3 – تثبيت وسط غذائي حاوي على السكروز (نموذج مقارنة) لاستعماله في المخمرات :

من التجربتين السابقتين ظهر أن الاوساط الغذائية التخميرية التي تم تركيبها بواسطة الحاضنات الهزازة غير مناسبة لانتاج حامض الليمون باستعمال المخمرات ، لذلك تقرر استخدام وسط غذائي تم تخمره تحت ظروف تخميرية مشابهة لظروف هذه الدراسة ، فالوسط الغذائي الذي اختير هو الذي تم دراسته من (10)، كانت الظروف التخميرية الأخرى مشابهة لما هو مذكور سابقاً كما تم استعمال زيت الذرة كمادة مضادة للرغوة (8) .

النتائج في شكل (3) تبين السلوكية التخميرية للوسط الغذائي الجديد حيث أمكن ملاحظة التحسن الكبير في كل من نسبة ومعدل انتاج الحامض اذ ان اقصى نسبة انتاج كانت 76.4% بعد ثمانية أيام وكان معدل الانتاج يساوي 13.4 غم / لتر / يوم . بالامكان ايضا ملاحظة استهلاك السكريات بمعدل عال حيث ان

3 ـ النتائج:

3 – 1 – انتاج حامض الليمون باستعمال الوسط الغذائي الحاوي على عصير التمر:

بالإمكان مشاهدة النتائج في شكل (1) الذي يبين السلوكية التخميرية للوسط الغذائي الحاوي على عصير التمر اذ أن نسبة انتاج الحامض كانت 12.5% بعد سبعة أيام من ابتداء عملية التخمير وأما السكريات المتبقية خلال الفترة نفسها كانت تعادل 6.7% ـ والوزن الجاف للفطر مساوياً الى 3.8 غم/100 سم^3 . لوحظ تكون رغوة كثيفة في اليوم الثاني واستمرت لمدة يومين واستعملت مادة السليكون للسيطرة عليها وثبتت كفاءتها عند اضافتها بكمية لا تزيد على 1 سم^3 من تركيز 5% ، لكن هذا التأثير وقتي ولا يستمر لأكثر من 3–4 ساعات بعد ذلك قلت كثافة الرغوة وتوقفت في اليوم السادس وفي خلال هذه الفترة ظهرت صبغة صفراء اللون في المزرعة التخميرية . علاوة على ذلك فإن قوام المزرعة التخميرية كان مخاطياً مما أدى الى صعوبات في الحصول على كفاءة عالية في عمليتي التحريك والتهوية . وعلى هذا الأساس تقرر ايقاف عملية التخمير في اليوم السابع .

3 – 2 – انتاج حامض الليمون من الوسط الغذائي الحاوي على السكروز (نموذج المقارنة في الحاضنات الهزازة)

ظهر من الدراسة اعلاه ان نسبة انتاج الحامض كانت منخفضة عند استعمال الوسط الغذائي الذي تم تركيبه بالاستناد على النتائج المحصل عليها بطريقة الحاضنات الهزازة بالاضافة الى ذلك كانت السيطرة على الرغوة غير مرضية اذ أن كميات كبيرة من مضادات الرغوة يجب اضافتها وباستمرار ويمكن اعتبار هذه الظاهرة احدى العوامل التي أثرت على نقصان كمية الحامض المنتج . لذلك تقرر تغيير كل من مادة مضاد الرغوة والوسط التخميري . ان الوسط الغذائي الذي تم اختياره في هذه الدراسة هو نموذج المقارنة الذي استعمل بنجاح في الحاضنات الهزازة . أما المادة التي وقع عليها الاختيار لاستعمالها ضد الرغوة فكانت زيت الذرة .

أ . عصير تمر مخفف ومزال منه الأيونات الضارة		203.00	غم
ب .	NH_4NO_3	2.00	غم
جـ .	KH_2PO_4	1.00	غم
د .	$MgSO_4.7H_2O$	0.2	غم
هـ .	Cu^{++}	0.03	ملغ
و .	Fe^{+++}	0.8	ملغ
ز .	Zn^{++}	0.5	ملغ
ح . ماء مقطر		1.0	لتر
ط . الرقم الهيدروجيني (pH value)		الى4	

2 – 1 – 2 – الوسط الغذائي الحاوي على السكروز (نموذج المقارنة):

يتكون الوسط الغذائي الذي استعمل لأجل المقارنة من:

أ . سكروز		140.00	غم
ب .	$(NH_4)_2CO_3$	2.00	غم
جـ .	KH_2PO_4	0.20	غم
د .	$MgSO_4.7H_2O$	0.10	غم
هـ .	Zn^{++}	4.00	ملغم
و . ماء مقطر		1.00	لتر

أما الرقم الهيدروجيني فتم تعديله الى 2.5 باستعمال حامض الهيدروكلوريك قبل وبعد التعقيم (10) .

لتلوث الميكروبي . بعد مرور حوالي 30 ساعة من اضافة اللقاح تظهر عادة رغوة كثيفة وتختفي في اليوم الخامس من الفترة التخميرية . وجد سنيل وشفايكر (10) ان اضافة عالق من كحول الأوكتا أسيل في زيت معدني بكمية من 0.25% الى 0.5% سم3 لتركيز 3% من العالق لكل لتر من الوسط الغذائي لها تأثير فعال في السيطرة على الرغوة . لوحظ مؤخراً أن اضافة الزيوت الطبيعية بنسبة 2% الى الوسط الغذائي التخميري يحسن من نسبة انتاج حامض الليمون بحوالي 20% بدون أي تأثير على الوزن الجاف للفطر المستعمل (8) ، أما كولدوكيتر (7) فقد لاحظا أن ادامة تركيز المواد الدهنية بنسبة 0.1% ترفع من نسبة انتاج الحامض وتثبيط الرغوة .

2 ـ الطرق والمواد:

استعمل الفطر *Aspergillus niger* 72-4 لانتاج حامض الليمون ، وجرت أدامته وحضر منه اللقاح المناسب حسب الطريقة المذكورة في الدراسة السابقة (1) كان حجم اللقاح المستعمل يساوي 1×10^7 سبور / لتر وكان معدل التحريك يتراوح ما بين 400-500 دورة / دقيقة ومعدل تيار الهواء الداخل الى جهاز التخمير ـ بحدود 0.8 حجم / حجم من الوسط الغذائي / دقيقة بعد ترطيبه بالماء وتعقيمه بالمرشحات . كما كان حجم الوسط الغذائي المحضر للتخمير يساوي 5 لتر هذا وقد تم سحب 10 سم3 من الوسط المخمر لنماذج التحليل يومياً .

2 – 1 – الاوساط الغذائية

الوسط الغذائي الحاوي على عصير التمر:

يتكون الوسط الغذائي الذي تم تركيبه بالاستناد على الدراسات السابقة والمذكورة في الجزء الأول والذي يحتوي على التراكيز المثلى باستثناء حجم اللقاح من : –

quired different conditions compared to those used for the shake flask system. Some improvement in the yield of citric acid was achieved as a direct result of the use of corn oil as antifoam agent. The efficient aeration and agitation of the culture increased the yield of citric acid up to 72% i.e. 10% higher than the yield obtained in shake flask system.

1 ـ المقدمة:

أظهرت الدراسة السابقة امكانية الحصول على نسبة انتاج عالية من حامض الليمون باستعمال عصير التمر المزالة منه الأيونات الضارة بواسطة أعمدة التبادل الأيوني عند توفر الظروف التخميرية المناسبة باستعمال الحاضنات الهزازة (1) .

ان الهدف من دراستنا هذه هو تطوير طريقة لانتاج حامض الليمون من عصير التمر وعلى نطاق أكبر مما هو عليه في الحاضنات الهزازة وذلك باستعمال المخمرات .

من المعروف أن انتاج حامض الليمون يتطلب ظروف تهوية عالية خاصة اذا استعملت طريقة التخمير المغمور ، حيث ان الانقطاع في عملية تجهيز الهواء بعد البدء بانتاج الحامض يؤدي الى توقف الانتاج مباشرة . واذا كان الانقطاع لفترة اقل من دقيقة واحدة فليس هنالك تأثير ملحوظ على معدل الانتاج ، لكن انقطاع التهوية لفترة تزيد على الدقيقتين تؤدي الى تأثير سلبي واضح على انتاج حامض الليمون (2) . ان الاوكسجين يحفز تكوين حامض الليمون بواسطة الفطر *Aspergillus niger* (9) حيث أن تثبيط انتاج الحامض قد لوحظ بتقليل مستوى الاوكسجين المذاب في المزارع التخميرية لذا فإن الضرورة تقضي ان تكون نسبة الاوكسجين المذاب بحدود 60% . ويمكن ادامتها بالحفاظ على معدلات ضخ تيار الهواء والتحريك المستمر (4) .

عند استعمال المخمرات يجب اضافة مواد ضد الرغوة لمنع الفقدان لهذه المواد اثناء عملية التخمير التي قد تحصل نتيجة التحريك والتهوية وللتقليل من خطر

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انتاج حامض الليمون من عصير التمر المركز (الدبس)(*)
2 ـ مضاعفة الحجم التخميري باستخدام المخمرات

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مجلس البحث العلمي / قسم النخيل والتمور

الخلاصة :

جرت في هذه الدراسة محاولة ناجحة لمضاعفة الحجم التخميري باستخدام المخمرات وفي سبيل ذلك استعمل مخمر ذو حجم تشغيلي يعادل 5 لترات وظهر أن الظروف التخميرية المناسبة لانتاج حامض الليمون باستخدام الحاضنات الهزازة تختلف عما هي عليه باستخدام المخمرات .

تمت أيضاً دراسة تأثير مضادات الرغوة على نسبة انتاج الحامض وتبين انه بالامكان استعمال زيت الذرة كمضاد للرغوة بدلاً من السليكون .

ان الكفاءة العالية لمعاملي التهوية والتحريك كانت واضحة وذلك بارتفاع نسبة انتاج حامض الليمون الى 72% أي بزيادة لا تقل عن 10% عن تلك التي نحصل عليها باستخدام الهزازات .

SCALING UP OF CITRIC ACID FERMENTATION USING FERMENTERS

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ABSTRACT

A successful attempt on the scaling up of the fermentation process by using 5 lit. fermenter was made. The scaling up process by fermenters re-

(*) جزء من رسالة الدكتوراه .

isolation of plant enzyme. Phytochemistry 5: 423 — 38.

15. Maier, V.P. & F.H. Schiller (1959): Progress of chemical studies of Deglet Noor dates. Report of the Date Growers Inst. 36: 8 — 10.

16. Maier, V.P. & F.H. Schiller (1961): Studies on domestic dates: III Effect of temperature on some chemical changes associated with deterioration. J. Food Sci. 26: 529 — 33.

17. Maier, V.P.; D.M. Metzler & A.F. Ituber (1964): Effects of heat processing on the properties of dates. Report of the Date Growers Inst. 45: 8-9.

18. Maier, V.P. & D.M. Metzer (1965): Quantitive changes in date polyphenols and their relation to browning. J. Food Sci. 30: 8 — 84.

19. Maier, V.P. & D.M. Metzeler (1965): Changes in individual date polyphenols and their relation to browning. J. Food Sci. 30: 747 — 52 .

20. Negal, C.W. & M.E. Palterson (1967): Pectic enzymes and development of the pear (*Pyrus communis*). J. Food Sci. 32 294 — 97.

21. J.K. Palmer (1963): Banana polyphenol oxidase: preperation and properties. Plant Physiol. 38: 508 — 10.

22. Rouse, A.H.; C.P. Atkins & E.L. Moor (1965): Seasonal changes occuring in the pectinestrase activity and pectic constituents of the component parts of citrus fruits. III Silver cluster grape fruit. J. Food Technol. 241 — 44.

23. Smolensky, D.C.; W.R. Raymond & V.P. Maier (1973): Pectic enzymes and their application in the quality improvement of mixed green dates. Report of the Date Growers Inst. 50: 7 — 8.

24. Turrell, F.M.; W.B. Sinclaire & D.E. Bliss (1940): Structural and chemical factors in relation to fungus spoilage of dates. Report of the Date Grower Inst. 17: 5 — 11.

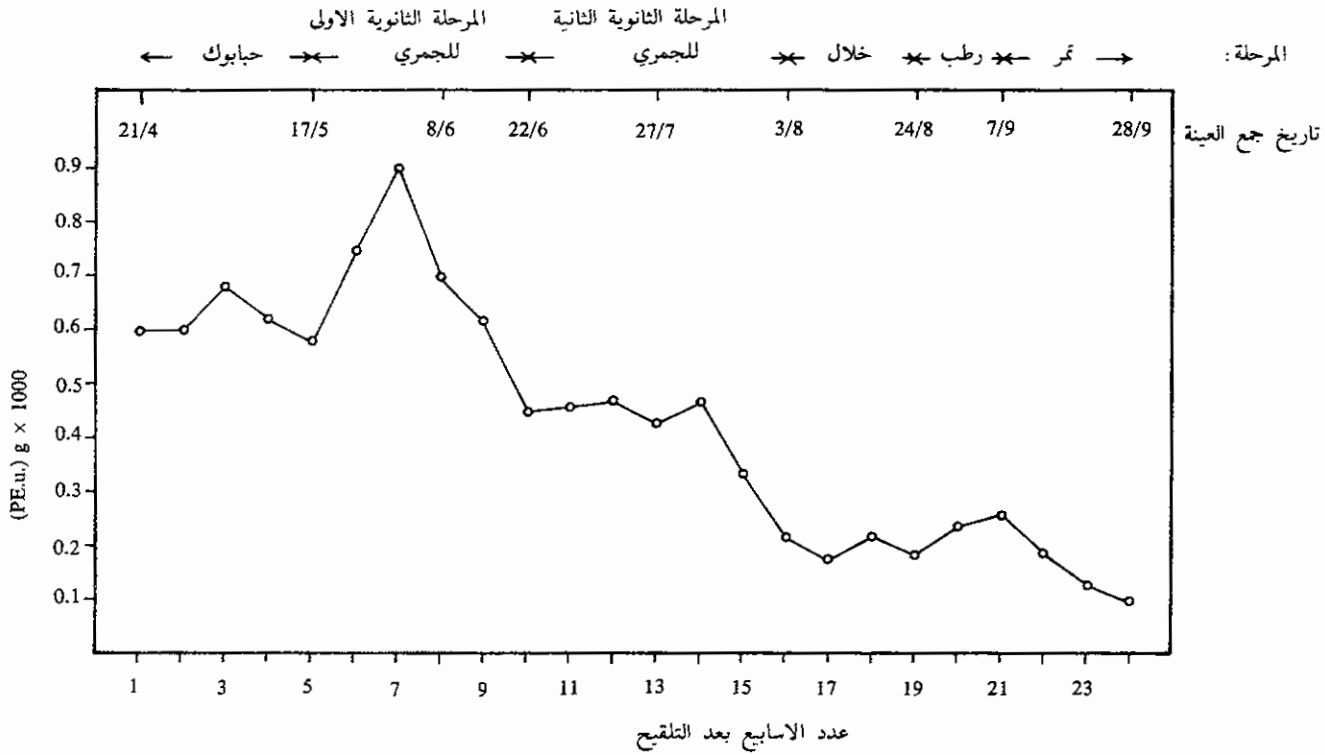
25. Weurman, C. (1954): Pectase in Doyenne Boussoch pears and changes in the quality of the enzyme during development. Acta Botan. Neerl. 3: 100 — 104.

26. الجراح . آمنه والعاني بدري 1981 التغييرات النسيجية في ثمرة نخيل الخضراوي مجلة نخلة التمر، العدد الأول .

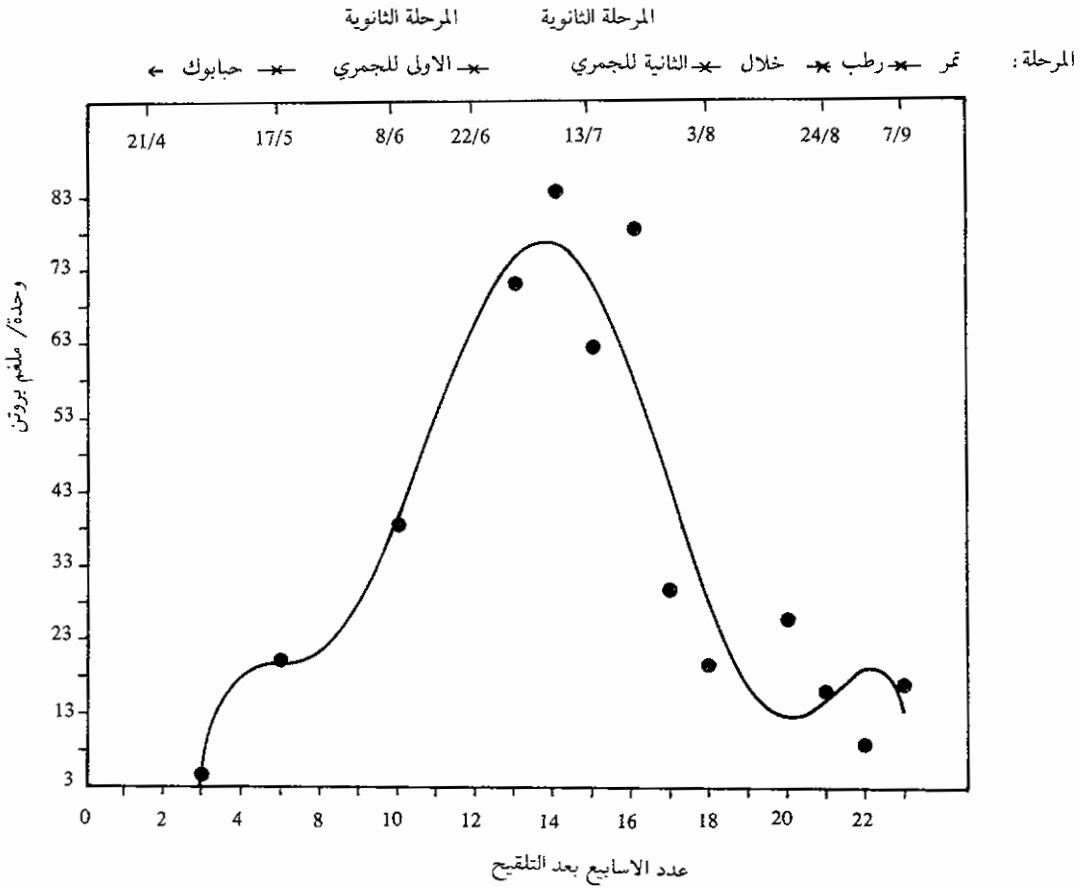
27. عبد الحسين . علي . 1974 النخيل والتمور وآفاتها في العراق الطبعة الرابعة جامعة بغداد، بغداد .

LITERATURE CITED

1. Al-Jasim, H.A. & K.S.Al-Delaimy (1972): Pectin estrase activity of some Iraqi dates at different stages of maturity. J. Sci. Food Agr. 23: 915 – 917.
2. Benjamin, N.D. & M.W. Montgomery (1973): Polyphenol oxidase of Royal Ann cherries: purification and characterization. J. Food Sci. 38: 799 – 806.
3. Benjamin, N.D,C. Tonelli Peres & N.M. Ali (1977): Date polyphenol oxidase: partial purification characterization. Third Conference of Chemical Engineering. Baghdad, Iraq.
4. Coggins, C.W. & J.C.F. Knapp (1971): Growth development, and softening of Deglet Noor date fruit. The Punjab Fruit Journal Nos. 114 – 119: 85 – 90.
5. Collins, J.L. (1965): Determination of pectin-methyl estrase activity in plant tissues. Food Technol Lab. Method Sheet No. 6.
6. Davignon, M.L. (1961): Contribution a letude de l'evolution chimique des substances pectiques au cours de la croissance, de la maturation et de la senescence des fruits. Compt. Rend. Acad. Agr. France 47: 62 – 66. G.Reed & L.A. Underkofler, 1966 Eds., 86 p. Enzymes in Food Processing. New York & London: Academic Press.
7. Eskin, N.A.M.; H.M. Henderson & R.J. Townsend (1971): Browning reactions in foods. *In* Biochemistry of Foods. 69 – 108 p. New York & London: Academic Press.
8. Hasegawa, S.; V.P. Maier; H.P. Kaszycki & J.K. Crawford 1969. Poly galacturonase content of dates & its relation to maturity and softness. J. Food Sci. 34: 527 – 29.
9. Hathway ,D.E. & J.W. Seaking (1958): The influence of tannins on the degradation of pectinase enzyme. Biochem. J. 70 158 – 63
10. Hobson G.E. (1963): Pectinestrase in normal and abnormal tomato fruit. Biochem. J. 86: 358 – 64.
11. Hultin, H.O. & A.S. Levine (1965): Pectin – methyl estrase in the ripening banana. J. Food Sci. 30: 917 – 21.
12. Kalcker, H.M. (1974): Differential spectrophotometry of purine compounds by means of specific enzymes: 3 studies of the enzymes purine metabolism. J. Biol. Chem. 167: 461 – 62.
13. Keresz, Z.T. (1955): Pectic Enzymes, pp. 158 – 66 *In* Methods in Enzymology. New York: Academic Press, Inc.
14. Loomis, W.P. & J. Baltaile (1966): Plant phenolic compounds and the



شكل (2): نشاط الانزيم بكتين ١ تريز (P.E.) خلال المراحل المختلفة لنمو ونضج ثمار الخضرواي



شكل (1): نشاط الأنزيم بولي فينول اوكسديز (P.P.O.) خلال المراحل المختلفة لنمو ونضج ثمار الخضرواي

جدول (2) : معدل نشاط الانزيمين بولي فينول اوكسيديز PPO وبكتين استريز PE خلال المراحل الرئيسية للنمـــو

المرحلة	النشاط النوعي للأنزيم PPO وحدة / ملغم بروتين (100 x)	نشاط الانزيم PE (PE.u.) g x 1000
حبابوك	4.557	0.626
المرحلة الثانوية الأولى للجمري	29.491	0.712
المرحلة الثانوية الثانية للجمري	65.736	0.436
خلال	23.173	0.207
رطب	12.706	0.214
تمر	17.434	0.170

جدول (1) : نشاط الانزيم بولي فينول أوكسيديز (PPO) خلال المراحل المختلفة لنمو ثمار الخضراوي

تاريخ جمع العينة	اسبوع بعد التلقيح	المرحلة	نشاط الانزيم وحدة/مللتر	امتصاص الاشعة 280 nm	امتصاص الاشعة 262 nm	بروتين (ملغم/مللتر)	النشاط النوعي وحدة/مللغم بروتين 10x1 $^{-2}$
5/3	3	منتصف الحبابوك	0.693	25.8	30.0	15.21	4.556
5/17	5	المرحلة الثانوية الأولى للجمري	0.941	8.2	9.8	4.638	20.278
6/8	8	=	1.463	7.2	9.0	3.78	38.704
6/30	11	المرحلة الثانوية الثانية للجمري	1.881	6.2	8.6	2.626	71.631
7/6	12	=	2.228	5.8	7.8	2.638	84.439
7/13	13	=	2.376	7.7	10.0	3.765	63.108
7/20	14	=	3.152	8.1	10.5	3.975	79.283
7/27	15	=	1.394	9.0	11.4	4.614	30.218
8/3	16	خلال	0.682	7.3	9.7	3.407	20.015
8/17	18	=	0.693	6.0	8.2	2.632	26.311
3/24	19	رطب	0.868	10.0	12.4	5.324	16.302
8/31	20	=	0.561	11.8	14.8	6.158	9.110
9/7	21	تمر	0.825	10.0	13.2	4.782	17.434

ان هذه النتيجة توافق سلوك الانزيم في ثمار العرموط (25, 6) غير أنها تخالف ما تم الحصول عليه في ثمار نخيل الزهدي ، والبربن ، والخستاوي والخضراوي (1) وقد يعود السبب في ذلك الى اختلاف الطريقة المتبعة وقلة عدد العينات (6) في تلك الدراسة .

ان سبب تثبيط نشاط الأنزيم قد يعود الى وجود بعض مركبات الفينولات المختلفة (24, 14, 10, 9) حيث يكتمل نمو خلايا التانين الحاوية في مرحلة الجمري وهذا يوافق بدء انخفاض نشاط الانزيم .

ويتضح من الجدول 2 أن معدل نشاط الانزيم بولي فينول أوكسديز قد بلغ أقصاه في المرحلة الثانوية الأولى للجمري .

والتي تمثل عدد المليوحدات المكافئة Milliequivalent من الأستر المتحلل في الدقيقة لكل غرام من المادة المراد تقدير نشاط الأنزيم فيها وفق المعادلة التالية

$$(PE.u.)g = \frac{\text{ml NaoH X Normality}}{\text{Weight of sample (g) x time (min)}}$$

ويضرب الناتج عادة X 1000 تسهيلا للحسابات.

النتائج المناقشة:

(1)انزيم البولي فينول اوكسيديز

بدأ نشاط الانزيم منخفضاً في مرحلة الحبابوك وارتفع تدريجياً خلال مرحلة الجمري حيث بلغ أعلى نشاط له خلال المرحلة الثانوية الثانية منها، وذلك في الاسبوع الثاني عشر بعد التلقيح حيث وصل الى 84 وحدة/ ملغم بروتين (شكل 1 وجدول 1) وتبع ذلك انخفاض تدريجي في النشاط النوعي للأنزيم، حتى منتصف الخلال، حيث حصل ارتفاع بسيط تلاه انخفاض تدريجي حتى نهاية مرحلة التمر.

ان النشاط النوعي للأنزيم في ثمار الخضراوي يشابه تماماً نشاطه في ثمار الزهدي والساير (3).

ويعتقد أن سبب انخفاض الأنزيم بعد المرحلة الثانوية الثانية للجمري ربما يعود الى اشتراك الأنزيم في التفاعلات الكيمياوية داخل الخلايا والتي تؤدي الى ظهور اللون الغامق في الثمار خاصة بعد حصول التكسر في جدران الخلايا في نهاية مرحلة الجمري وبداية الخلال (26, 4)

(2) انزيم البكتين استريز

بدأ نشاط الأنزيم مرتفعاً نسبياً وبلغ أعلى نشاط له في منتصف المرحلة الثانوية - الأولى للجمري (الأسبوع السابع بعد التلقيح) ثم بدأ بالانخفاض التدريجي (شكل 2) مع ارتفاع بسيط في مرحلة الرطب تبعه انخفاض تدريجي حتى نهاية مرحلة النضج.

أما النشاط النوعي للأنزيم Specific Activity فقد حدد بوحدات النشاط الانزيمي في كل ملغم من البروتين ، حيث وحدة النشاط الأنزيمي هي كمية الأنزيم اللازمة لاحداث تغير في الامتصاص مقداره 1 / دقيقة .

(2) نشاط الانزيم بكتين أستريز:

تعتمد طريقة استخلاص الانزيم على قياس المجاميع الكاربوكسيلية المتحررة نتيجة فعل الأنزيم ، وذلك بالتسحيح ضد قاعدة ، ذات عيارية معلومة ، مع تثبيت الرقم الهايدروجيني في مزيج التفاعل ، وغالباً ما يكون 7.5 بالنسبة لأغلب النباتات (13) .

وتتلخص الطريقة المتبعة في استخلاص الأنزيم (5) بهرس 100 غم من الثمار المنتخبة بصورة عشوائية مع 100 ملليتر من الماء المقطر في مولف Blender لمدة دقيقتين . ثم أخذ 50 غم من المهروس في بيكر صغير ، مع اضافة 20 ملليتر من محلول ملح الطعام بتركيز 8.8%و30 ملليتر من الماء المقطر ، ومزجه بالخلاطة المغناطيسية داخل حمام مائي بدرجة 30 مئوية . يثبت الرقم الهايدروجيني للمزيج على 7.5 باستعمال هيدروكسيد الصوديوم بعيارية 0.01 ثم يضاف 50 ملليتر من محلول البكتين بتركيز 2% (Apple Pectin, 250 Grade BDH Chemicals Ltd. Product No. 38052) ويعادل الرقم الهايدروجيني حالاً الى 7.5 أيضاً ، ويبدأ بحساب الوقت حين تصل درجة حرارة المزيج الى 30 مئوية . وتمت المحافظة على الرقم الهايدروجيني لمزيج التفاعل خلال الدقائق العشرة الأولى ، وحسبت الكمية اللازمة منه لهذا الغرض .

وبنفس الطريقة السابقة ، عمل نموذج ضبط ، دون استخدام مهروس الثمار . أن الفرق بين عدد ملليترات هيدروكسيد الصوديوم اللازمة لمعادلة العينة ، وتلك اللازمة لمعادلة محلول الضبط ، تمثل عدد ملليترات هيدروكسيد الصوديوم اللازمة لمعادلة مجموعات الكاربوكسيل المنفردة المتحررة بفعل الأنزيم .

وقدر نشاط الانزيم بدلالة وحدات النشاط الانزيمي التي يرمز لها g(PE.u.)

مغناطيسية، موضوعة داخل الثلاجة لمدة نصف ساعة. ثم رشح المزيج خلال عدة طبقات من قماش الشاش، وفصل الراسب بالطرد المركزي المبرد، بسرعة عشرة آلاف دورة بالدقيقة لمدة عشرة دقائق وبدرجة 4 مئوية وأخذ الراشح في وعاء من الثلج، لتعيين نشاط الانزيم.

2 . قياس نشاط الانزيم

عينت الكثافة الضوئية Optical density بقياس زيادة الامتصاص بطول موجي مقداره 400 نانوميتر وبدرجة 30 مئوية باستخدام جهاز مقياس الطيف الضوئي Perkin Elmer 402 Ultra violet–Visible Recording Spectrophotometer.

وكانت سرعة اللوحة البيانية 2 سم / دقيقة. ووضع في مركن المرجع Reference Cuvette ملليتر واحد من محلول الفوسفات المنظم (Buffer) ذي رقم هايدروجيني 6.2 وملليتر واحد من المادة التي يعمل عليها الانزيم وهي الكاتيكول (0–Dihydrox benzen) بتركيز 0.1 مولار. أما مركن العينة Sample Cuvette فيحوي 1.7 ملليتر من محلول الفوسفات المنظم وملليتر واحد من الكاتيكول و 0.3 ملليتر من الأنزيم المستخلص. يرج كلاهما، ويعين الامتصاص بسرعة.

3 . تقدير البروتين:

تعتمد الطريقة على قياس الاشعة فوق البنفسجية في جهاز مقياس الضوء الطيفي بطول موجي مقداره 260, 280 نانوميتر باستعمال الماء المقطر كمرجع. ثم حساب عدد ملليغرامات البروتين في ملليتر واحد من المستخلص الحاوي على الأنزيم

حسب المعادلة التالية (12)

$$mg/ml\ Protein = 1.45E280 - 0.74\ E260$$

حيث E_{280}، E_{260} تمثل امتصاص الأشعة بطول موجي مقداره 280 و 260 على التوالي.

للسلالات: زهدي، خضراوي، خستاوي، بربن (1) بأخذ ستة قراءات خلال المراحل المختلفة لنمو ونضج الثمار، وقد لوحظ زيادة نشاط الانزيم بتقدم مراحل نمو ونضج الثمار كما لوحظ بعض الاختلاف بين السلالات المختلفة.

المواد والطرق المستعملة:

أخذت النماذج من أشجار السلالة خضراوي في محطة الأبحاث التابعة للهيئة العامة للبستنة في الزعفرانية ـ بغداد. وجمعت العينات أسبوعياً بعد التلقيح، وحتى نهاية مرحلة التمر. وجرى تسمية المراحل المختلفة لنمو ونضج الثمار طبقاً لما يستعمل في منطقة شط العرب في جنوب العراق.

(1) دراسة نشاط الانزيم بولي فينول أوكسديز

تعتمد طريقة استخلاص الانزيم على تقييد المركبات الفينولية باستعمال مواد مثل البولي اثيلين كلايكول PEG أو البولي فينيل بايروليدون PVP (14) غير أنه يفضل استعمال مادة PEG عند استخدام الاسيتون في فصل الانزيم، وذلك لسهولة ذوبانها فيه.

1 . استخلاص الانزيم:

استخدمت طريقة استخلاص الأنزيم في ثمار الكرز (2) مع بعض التحوير، كي تلائم التمور (3). وذلك بتقطيع عشرة غرامات من الثمار، بصورة عشوائية، وسحقها في هاون خزفي، داخل وعاء من الثلج (حفظت كافة المحاليل والأدوات المستعملة في المجمدة قبل يوم من اجراء التجربة) مع ستة ملليترات من PEG (20,000) بتركيز 20% لمدة دقيقتين، ثم اضافة خمسة ملليترات من الأسيتون المبرد. ونقل المزيج الى أنبوب الطرد المركزي، ووضع في جهاز الطرد المركزي المبرد SORVAL-RC2-B لمدة عشر دقائق بسرعة عشرة آلاف دورة بالدقيقة، وبدرجة 4 مئوية. يفصل الراشح ويغسل الراسب مرتين بالأسيتون المبرّد ثم يضاف 25.0 ملليتر من محلول الخلات المنظم Acetate Buffer ذو رقم هايدروجيني 5.2 وينقل الى بيكر صغير محاط بوعاء من الثلج مع التحريك المستمر باستعمال خلاطة

تكون ذائبة في التمور الخضراء، بينما تكون في الثمار الناضجة، بحالة غير ذائبة. أما في الثمار التالفة، فإن التانينات لا تعطي الكشف الخاص بها، مما يدل على أنها عانت تغيرات كيمياوية، حيث يعتقد أن لهذه التغيرات دور في عملية اسمرار اللون في هذه التمور. ويعتقد أن انزيم البولي فينول أوكسديز مسؤولاً في الغالب عن اسمرار اللون الانزيمي في تمور السلالة دكلة نور (16).

ان دراسة التغيرات في كمية المركبات متعددة الفينول في ثمار السلالة دكلة-نور (18) قد أوضحت ان المركبات متعددة الفينول البسيطة تقل خلال المراحل المختلفة من النمو والنضج والخزن، بينما تزداد التانينات الذائبة من مرحلة الجمري الى مرحلة الخلال، وتقل من مرحلة الخلال حتى اكتمال نضج الثمرة، ثم لا يحصل تغير ملحوظ في كميتها اثناء الخزن. أما التانينات غير الذائبة، فتزداد بتقدم مراحل نضج الثمرة، إلا أنها تقل عند الخزن، مما يدل على أن التانينات الذائبة تتحول الى تانينات غير ذائبة خلال نمو الثمرة.

ولكن وجد أنه بالرغم من احتواء الليكوسياندين الذائب على مجموعة أورثوهيد روكسيلية غير أنه لا يتأثر بالانزيم بولي فينول أوكسديز، كما لا يؤثر على التانينات غير الذائبة (19) ويعتقد أن ذلك يعود الى طبيعة التانينات البولمرية. ووجد أن المركبات متعددة الفينول التي يعمل عليها الأنزيم في التمور هي أحماض الداكتيلفريك Monocaffeoly shikimic acids.

إن دراسة الانزيم بكتين استيريز مهمة في تحديد قوام وبنية الثمرة، والتي تؤثر الى حد كبير على نوعية التمور (8) اذ من الممكن تحسين قوام التمور غير الطبيعية والحاوية على بقع خضراء في مراحل متقدمة من النمو بمعاملتها بتحضيرات أنزيمية ذات نسب عالية من الانزيم بكتين استريز (23) حيث أعطت نتائج مرضية في هذا المجال.

ولقد درس نشاط الانزيم بكتين استريز في العديد من ثمار النباتات الراقية، كما أجريت دراسات فيما يتعلق بالتغيرات الحاصلة في نشاطه خلال مراحل مختلفة من النمو والنضج والخزن (25, 22, 20, 11, 10, 6) كما جرت دراسة الانزيم في التمور

development. The activity of polyphenol oxidase was very low during the early stages of development, and increased gradually, reaching its peak during the 12th week after pollination, with a specific activity reaching 84 unit/mg protein. The activity decreased gradually afterwards and increased towards the end of "Khalal" and "Tamar" stages.

The activity of pectin estrase was high during the early stages of fruit development, then increased gradually, reaching its peak, 0.9 (PE.u.) g, at the 7th week after pollination & decreased gradually till the beginning of second "Chemri" stage, & remained almost stable till the last week of this stage, followed by a gradual decrease, till the full ripening of the fruit.

المقدمة :

يحوي نوع نخيل التمر *Phoenix dactylifera* L. سلالات زراعية عديدة ففي العراق ، هنالك أكثر من 455 سلالة ، والتي تشكل 25% من الأصناف العالمية تقريباً (27) . ولا توجد دراسات كافية حتى الآن لتصنيف هذه السلالات على أسس علمية ومن هنا تأتي فكرة اجراء دراسات مستفيضة لتحليل مكونات الثمار للسلالات المختلفة عسى أن يتسنى من خلالها تحديد صفات ثابتة لكل صنف .

لقد اختير انزيم البولي فينول أوكسديز Polyphenol oxidase (PPO) لما له من تأثير في تحديد لون الثمار ، اذ يعمل هذا الأنزيم على أكسدة المركبات متعددة الفينول الى كوينونات Quinones والتي تدخل سلسلة تفاعلات ، مكونة صبغة الميلانين السمراء التي تعطي الثمار لونها المميز (21, 7) .

وهناك ثلاثة أنظمة تؤدي الى اسمرار لون ثمار النخيل وهي : الاسمرار المتسبب عن السكريات ، والاسمرار المتسبب عن أكسدة التانينات ، واسمرار اللون الانزيمي ، بسبب أكسدة المركبات متعددة الفينول ، حيث وجد أن هذه الأخيرة هي المسؤول الرئيس عن اللون الغامق المميز للثمار الناضجة ، وهي تسبب الاسمرار الحاصل خلال معاملات التصنيع والفترة الأولى للخزن . (17)

وقد وجد أن التمور تحوي كميات من الفنيولات المتعددة ، والتي يطلق عليها التانينات (15) . والتي تتكون من مادة الليوكوسيانديـن Leucocyanidin والتي

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دراسة نشاط انزيمي البولي فينول اوكسديز والبكتين استريز خلال مراحل نمو ونضج ثمرة الخضراوي*

آمنة ذا النون جراح ونمرود داود بنيامين مجلس البحث العلمي
مركز البحوث الزراعية والموارد المائية
قسم النخيل والتمور

الخلاصة

درس نشاط انزيمي البولي فينول اوكسديز والبكتين استريز خلال المراحل المختلفة لنمو ونضج ثمار نخيل الخضراوي. وقد بدأ نشاط الأنزيم بولي فينول أوكسديز منخفضاً في المراحل المبكرة للنمو، ثم ارتفع تدريجياً حتى وصل اقصاه في الأسبوع الثاني عشر بعد التلقيح، حيث بلغ نشاطه النوعي 84 وحدة/ ملغم بروتين. ثم انخفض تدريجياً بعد ذلك، وارتفع قليلاً في مرحلتي الخلال والتمر. بينما بدأ نشاط انزيم البكتين استريز مرتفعا في بداية النمو وازداد تدريجيا حتى وصل أقصاه في الاسبوع السابع بعد التلقيح حيث بلغ 0.9 (PE.u.)g ثم انخفض تدريجيا حتى بداية المرحلة الثانوية الثانية للجمري، وبقي ثابتاً تقريباً حتى الاسبوع الأخير منها حيث انخفض نشاطه ثانية، وبصورة تدريجية حتى نهاية نضج الثمرة.

ACTIVITY OF POLYPHENOL OXIDASE AND PECTIN ESTRASE DURING DIFFERENT STAGES OF GROWTH AND DEVELOPMENT

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ABSTRACT

The activity of PPO & PE were studied in date Fruit, *Phoenix dactylifera*, L., CV. "Khadrawi", during different stages of growth &

* - جزء من رسالة ماجستير

المحتويات

اعتذار

نتوجه بالاعتذار الى السيدة آمنة الجراح عن الخطأ الحاصل في ترتيب الصور في بحثها المنشور في العدد الأول من المجلة وندرج الوضع الصحيح :

صورة الشكل	رقم الشكل الصحيح
6	8
7	9
8	6
9	1
9	7

رقم الايداع في المكتبة الوطنية ببغداد
٤٤٠ لسنة ١٩٨١

2

مجلة نخلة التمر

مجلة نصف سنوية تصدر عن مشروع المركز الاقليمي لبحوث النخيل والتمور في الشرق الأدنى وشمال افريقيا .

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