



Strategies to Improve date palm production and hence Dates Quality in the Sultanate of Oman.

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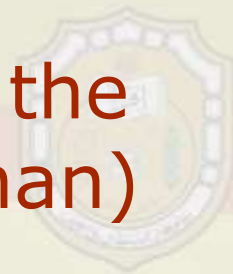




Worldwide Distribution & Production of Dates



In producing countries, date palm is the most widely cultivated crop (e.g. Oman)



Country	Date Production (tons)
Egypt	1,373,570.00
Saudi Arabia	1,122,822.00
Iran	1,016,608.00
Algeria	724,894.00
Iraq	619,182.00
Pakistan	557,279.00
Sudan (N & S)	432,100.00
Oman	268,011.00
UAE	239,164.00
Tunisia	180,000.00

- 50% Agr. Area
- 80% Fruit Crops
- 8 Million Palms
- > 260,000 ton
- 75% from 10 Var.
- 2-3% Exported
- 25% Surplus

Top 10 date producing countries of the world
Source: (FAOSTAT, 2013)

Fruit Quality



- Fruit quality is a measure of the degree of excellence of fresh fruits and their products. It is a combination of attributes, properties or characteristics that give each commodity value as human food

Quality of commodities depend on many components including:



1. **Intended use** (fresh, dried, processed): dates ripening stage
2. **Consumers** (needs, preference, economic, social): appearance/freshness, size, firmness, (later: taste/flavor (eating quality), nutrition)
3. **Producers** (climate, economic, resources, access): yield, no-defects
4. **Processors** (including all postharvest stages needs & resources): long term storage & shipping, shelf-life

Date fruit quality





Un-roasted and Roasted Date Pits



Coconut Coated Date Chocolate



Free Flowing Date Powder



Date Flakes

Date fruit quality



- Many of the date growers are not familiar with the export standards thus many processors face issues receiving dates with lower quality standards.
- In Oman, 25% of all dates produced (approximately 70,000 or production of 1.750 million trees) is wasted every year.
- Thus, preharvest factors are essential for the success of any date export initiative.
- The link between growers and processors can help.

Standards of date quality (various) for export include:



1. Grades (sorting & grading)
2. Hardness/Sugar: Popular varieties: Firm/Semi-dry (Deglet Noor, Zahidi, Fardh), Soft (Halawy, Khadrawy, Khalas; Medjoul)
3. Packaging, pitted unpitted, with/without additives
4. Seasonal availability (Rutab vs Tamar): Depending on producing country
5. Appearance: well colored, moist
6. Defects: discoloration, molding, crystallization (sugar film), other physical defects

Most of the dates quality standards have direct implications to preharvest factors

UN Standards for export-2010:



1. intact; dates affected by mashing, tearing, breaking of the skin, leaving the pit visible so that the appearance of the fruit is noticeably affected is excluded
2. sound; produce affected by rotting or deterioration such as to make it unfit for human consumption is excluded
3. clean, practically free of any visible foreign matter; excluding coating ingredients
4. free from living pests whatever their stage of development
5. free from pest damage visible to the naked eye, including the presence of dead insects and/or mites, their debris or excreta

UN Standards for export-2010:



- 6. free from mold filaments visible to the naked eye
- 7. free of fermentation
- 8. free of unripe fruit, i. e. fruit light in weight, stunted or distinctly rubbery in texture
- 9. free of unpollinated fruit; i. e. fruit not pollinated, as indicated by stunted growth,
- 10. immature characteristics and absence of pit

Date fruit postharvest processing



- Unlike many fruits, dates have little postharvest processing, thus Preharvest Best Management Practices (BMPs) will ensure that the quality standards for export are met.



Tree and orchard Best Management Practices



1) Site selection

is the most critical of all (climate & soil)

(a) Climate: Temperature

- **Temperature: Affects tree growth, yield and quality of dates**

- Date palm is subtropical, can tolerate short frost periods in winter & well adapted to heat in the summer (frond distribution, sunken stomata, fiber isolation)
- Date palm grows in areas with hot summers and mild winters
- Temperature broadly affects all aspects of date production: cultivar selection, growth, flowering, fruit set, yield, fruit quality, etc. (e.g. Oman's North vs South)
- Heat units (Thermal constant, time to harvest in temperature units) accumulated over the growing season (bloom-harvest): dry dates (> 6000 HU; semi-dry dates 5000-6000; soft dates: 3000-4000)

1) Site selection

is the most critical of all (climate & soil)

(a) Climate: Temperature

- **Temperature: Affects tree growth, yield and quality of dates**

- Can tolerate up to 50 °C under irrigation and as low 0 °C.
- Growth ceases below 7 °C and above 40 °C & optimum is 32 °C.
- Temperature affects the quality of dates (& other fruits): maturity, Ripening, color, TSS: TA, flavor (e.g. tannin break down).
- Dates are climacteric but not affected by ethylene, odors absorbent



1) Site selection

is the most critical of all (climate & soil)

(a) Climate: Sunlight & Wind

- Tree growth
- Pollination
- Fruit number (drops)
- Fruit quality (scratch)
- + Aeration
- + Color development
- + Ripening



1) Site selection

is the most critical of all (climate & soil)

(b) Land & Soil Characteristics:

1. Cost of land preparation
2. Topography
3. Texture, structure, fertility, pH, salinity









1) Site selection

(c) Availability of markets:

1. Nearness to population centers
2. Transport availability
3. People preference (taste, color, shape)
4. Storage facilities
5. Competition / supply & demand



1) Site selection

(d) Labor availability & Infrastructure:

- Labor: tree operations (e.g. pollinating, harvesting), cultural practices (e.g. plowing, spraying, fertilizing) can be expensive
- Power supply to operate machinery, irrigation systems, storage facilities, etc.
- Nearness to distribution centers, roads, storage facilities, airports, etc.



2) Plant

(1) Cultivar selection:

- Cultivar selection based on climatic requirements, tolerance to prevailing pests and disease, consumer preference, target market, etc.





2) Plant

(2) Planting and orchard design:

1. Spacing is 7-8 m in dry areas with poor soils and 8-9 m in deep fertile soils
2. Intercropping with citrus and bananas, palms are planted at 12 m
3. Deep holes (1x1x1 m) in heavy soils for root establishment.
4. Shoot tip must not be flooded with irrigation water







2) Plant

(2) Planting and orchard design:

- To ensure high yield & early returns => plants must fill allocated planting space (6-10m)
- Yield & quality related to canopy size, spacing & light exposure
- Also consider: pollinizer placement (male), row orientation, tree density
(Calculated based on spacing: number of trees per hectare)



2) Plant

(2) Planting and orchard design:

- Three systems that fit date palm: Square (easy, common but wasted land), Diagonal system (earlier return, high efficiency but shading & competition), and Hexagonal (Triangular) system (Equal spacing, better land use, 15% more trees, but difficult layout)

3) Irrigation quantity and duration influenced by:



1. Plant species, Root system & distribution
2. Plant canopy & ground cover
3. Growth stage of the plant – young, mature, flowering and fruiting.
4. Irrigation affects flowering (induction or shedding).
5. Peak water during fruit development and seed formation

3) Irrigation quantity and duration influenced by:



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4. Irrigation affects flowering (induction or shedding).
5. Peak water during fruit development and
6. Irrigation essential during fruit development (March to June) and during ripening (to avoid fruit shriveling and shrinking) in August
7. Requirements of date palm is about 200 to 300 L per day on average

3) Irrigation quantity and duration influenced by:



- Climate:
 - Consider climatic factors (temp., RH, rain, wind, & light intensity & duration) for irrigation scheduling via ET
 - Irrigation frequency vary depending on amount and frequency of rainfall
 - Seasonal changes (hot summer → more water)
- Soil type:
 - Heavy soils (high % of clay) → more water but longer durations than light soils (high % of sand)
- Quality of water:
 - Saline water → avoid salt accumulation in root zone (by leaching/flooding)

3) Irrigation quantity and duration influenced by:



- Method: Flood irrigation (e.g. traditional system of basin irrigation of date palm)
 1. Low efficiency, more water loss via runoff, deep percolation, & evaporation
 2. Low cost
 3. Affected by land topography (e.g. not for slopes)
- Method: Modern irrigation system
 1. More efficient
 2. High capital
 3. Can be utilized on wide range of land topography
 4. E.g. sprinkler, drip, bubbler



Results: irrigation experiments

- (a) traditional irrigation system methods need to be changed, and
- (b) application of organic matter alone is not enough to support good yield and quality dates.
- A bubbler irrigation system at 200 L/day supported by mulching with date palm fiber was found to be ideal.



4) Fertilizer requirements:

- A small portion of the plant dry matter is composed of mineral elements from the soil.
(~ 90% water, ~ 9% C,H,O)
 - There are 16 essential elements:
 - 3 are non mineral nutrients (**C, H, O**) taken from the air via photosynthesis (C, O) and soil water (H, O)
 - 13 are mineral nutrients: (in the soil & adsorbed by the plant)
 - Macronutrients (needed in large quantities)
 - Primary nutrients (used in large amounts-lacking): **N, P, K,**
 - Secondary nutrients (usually enough): **Ca, Mg, S**
 - Micronutrients (needed in small quantities)
 - **Fe, B, Mn, Zn, Cu, Mo, Cl,**
 - *Minor importance in some soils: Al, Si*
- *Application Form: Broadcast, Fertigation*
- *Fertilizer type: Organic, inorganic, manure*
- *Application time & dosage: soil & plant dependent*





Results: Fertilizer application

- Chemical fertilizer especially **NPK** was found to **increase yield and improve quality** of Khalas and Khasab dates.
- Preferably in **4 doses** to be applied in **March, May, July and October**.
- The recommend amount for 7-8 years old palm are **1000 g urea, 500 g triple super phosphate and 800 g potassium sulfate** to be supplemented with micronutrients.



5) Other BMPs

(1) Mulching & Cover Crops:

- Cover crop:
 - Growing herbaceous plants (sod grass or legumes) to cover the area between trees, for part or throughout the year
- mulch:
 - applying organic and inorganic insulating materials spread on the soil surface beneath the trees



5) Other BMPs

(1) Mulching & Cover Crops:

- Advantages:

- Regulates soil temperature through insulation, heat absorption and shading. Increases water & nutrients availability & improves root growth
- Conserves soil moisture → reduced temperature & evaporation
- Reduces soil erosion
- Weed control
- If organic → source of organic matter and nutrients
- Early/off-season income from cover crops like alfalfa



5) Other BMPs

(1) Mulching & Cover Crops:

● Disadvantages:

- May harbor pests, pathogens, rodents & other harmful animals
- Roots may grow in the mulch if excessive → easily damaged by chemicals
- Compete for nutrients and water



Cover Crop



Mulch



Results: Mulching

- The importance of mulch is not only for its effect on improving dates yield and quality, but also for its cooling effect which enhances root activity, saving considerable amount of water by reducing evaporation and weed control.



5) Other BMPs

(2) Weed Control:

- May harbor pests, pathogens, rodents & other harmful animals
- Roots may grow in the mulch if excessive → easily damaged by chemicals
- Compete for nutrients and water



5) Other BMPs

(3) Pests and disease management:

- Major pests are Dubas bug and red palm weevil
- Minor pests include red spider mites, scale insects, desert locusts and termites
- No major diseases affect date palm in Oman, Black Scorch is observed
- Bayoud (*Fusarium* spp.) is a common fungal disease in North Africa
- Integrated pest and disease management is the best approach
- Biological, cultural, chemical, quarantine, IPM & IDM



Results: Pest Control

- Dubas bug poses the most serious challenge to date palm production in the Sultanate of Oman.
- Aerial spraying to control should be re-evaluated. Biological and cultural control methods such as introduction of natural predators and timely pruning need to be evaluated.
- The second important pest is red palm weevil.
- Strengthening and adoption of the recommendations established by a previous project undertaken in collaboration between the Sultanate and the United Arab Emirates.





5) Other BMPs

(4) Pruning:

(dead or old fronds, old fruit bunches, offshoots, thrones)





6) Flower & Fruit management

(1) Pollination:

- Dioecious. Naturally by wind → uneconomical, needs many male palms
Two common pollination methods:

- Traditional:

- Place 3-10 male strands or dusting pollen on female spadix

- Mechanical:

- Hand pollinators
- Motorized pollinators
- Aerial dusting





6) Flower & Fruit management

(1) Pollination:

- Advantages of mechanical pollination:
 1. Synchronization between stigma receptivity & pollen availability
 2. Increased palm productivity
 3. Reduced pollen use
 4. Reduced cost
 5. Reduced pollination time
 6. Reduced hazards associated with climbing & pollinating trees

6) Flower & Fruit management

(1) Pollination:

- Selection of Pollen:

1. Healthy male palms:
2. Large number of spadixes
3. High pollen germination
4. Flowering with female trees
5. Compatibility with female cultivars (pollen do not abort, pollen tube germinates)



6) Flower & Fruit management

(1) Pollination:

- Selection of Pollen:

1. Good **metaxenic** effects:
2. Metaxenia: effect of pollen on size, color, & maturity of fruits (i.e. yield & quality)
3. Pollen can be stored for a year with low RH & Temp (< 4 oC)
4. Spadix collected upon opening in the morning or just prior to opening
5. Pollen applied when female spadix just opened or just prior to opening





Results: Pollination

- No critically significant differences between the effect of hand pollination and hand pollen duster (mechanical) on yield, physical and chemical characteristics of Khalas and Khasab fruits.
- Mechanical pollination was preferred than hand pollination.

6) Flower & Fruit management

(2) Bunch/Strand thinning:



- Importance of thinning:
 - Increased fruit size
 - Improves quality (color)
 - Enhance maturity
 - Improves light & air penetration
 - Minimize alternate bearing
- Thinning of the bunch:
 - Retain adequate, well-spaced bunches (ideally 10 at maturity)
- Strand Thinning: suggested to remove 1/3 of the strands (total/length)
 - Use of chemicals (e.g. NAA)



6) Flower & Fruit management

(3) Bunch/Strand lowering or hanging:

- Provide support, aeration, and protection of new fruits & Facilitates harvesting



6) Flower & Fruit management

(3) Bagging :

- *Bagging* of bunches to reduce insect infestation, bird feeding, damage from external factors (e.g. hail)



6) Flower & Fruit management

(3) Harvest:

- Stages of harvest (various ripening indicators: color, moisture content, TSS):
 - Khalal
 - Rutab
 - Tamar
- Manual harvesting, low cost but risky
- Mechanized harvesting , best but high capital investment
- Harvesting considering moisture content standard requirements (26% soft, 30% semi dry)l; size (4.0g);

Fruit developmental stages



Kimri

11-16 WAP



Khalal

17-18 WAP



Rutab

19-23 WAP



Tamar

24 WAP

WAP = Weeks After Pollination



Water content of a date fruit during its maturation from Khalal to Tamar stage

Stage	Water content (%)
Kimri and Early Khalal	85
Late Khalal	50
Early Rutab (tip browning)	45
50% Rutab	40
100% Rutab	30
Tamar	24 and less

Results: Harvest operations



- The problem of **fruit drop** can be tackled by one of two ways;
 - bagging with netted bags after Bisir stage or
 - artificial ripening.
- Date fruits in the **Bisir stage** can be **stored frozen** for **7-8 months** or less as desired and **ripened to Rutab** or **Tamr stage** by **thawing, heating and drying**.
- Tamr stage can be improved by **immersing fruits in sugar solution** to minimize shrinking and wrinkling.

6) Flower & Fruit management

(3) Harvest:



Summary of pre-harvest factors that improve fruit quality:



- Planting the right cultivar in the right location (consider climate & soil)
- Preparedness and management of environmental water stress: drought, salinity, excessive heat, cyclones
- Following BMPs: planting, irrigation, fertilizer, pest control pruning, thinning, harvest
- Development of proper irrigation regimes per region, fruit development (TSS, affects moisture content – a major standard requirement)

Summary of pre-harvest factors that improve fruit quality:



- More attention towards fertilizer requirements (grower-processor linkage)
- Pest & disease control (IDM, biocontrol vs chemical)
- Bunch thinning, affects size directly (major standard requirement)
- Harvest at the right stage, moisture & sugar content level
- Postharvest handling, storage and processing



Managing Quality: Final Thoughts

- **Ameliorate salinity & drought stress through irrigation, fertilization and mulching.**
- **Improve dates yield and quality through palm canopy operations including: pollination, thinning of fruits, bunch bending and covering.**
- **Manage pests and diseases in date fields and stores, such as red palm weevil, dubas bug, grater date moth, fig moth, oryzaephillis, Dplodia and balck scorch disease.**
- **Enhance date quality through improved harvest and post harvest techniques.**
- **Maximize returns by developing date by-products of commercial value.**





Recommendations & Further Studies

- Comprehensive, multi-lateral, & long-term date palm improvement strategy
- 1^o Objective to lower production & processing costs while maintaining high yield and date quality
 - through research & adoption of modern techniques in date cultivation
 - (i.e. modern irrigation, mechanical pollination, bunch netting, post-harvest handling & storage)



Recommendations & Further Studies

- Region-specific palm water requirements
- Proper palm and orchard management practices (e.g. planting, tree density, cultivar selection/area, pruning, thinning)
- Long-term fertilizer effects on tree & environment
- Mechanization of date palm operations
- Management of biotic and abiotic stress factors (i.e. salinity, drought)



Recommendations & Further Studies

- Trading and marketing policy for dates and date products (Egypt, GCC experience)
- Explore new international markets & capitalize on trade agreements for broader distribution in less competitive markets (Malaysian model)
- Assistance to local exporters for market penetration

Recommendations & Further Studies



- Emphasis on varieties and packaging of dates to meet foreign demand
- Date palm by-product assessment and commercialization (e.g. livestock feed)
- Economic assessment of current practices
- Accessible, centralized information database
- Capacity building in date production & processing



Thank you!

Rashid Al-Yahyai