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Lecture-4
Modern Field Preparation and Planting Methods

Land preparation

When establishing a new date plantation, certain actions need to be implemented to ensure the long term success of the plantation. One of these actions involve the initial land preparation which should be done prior to transplanting of the plant material (offshoots or tissue culture-derived plants).

The purpose of land preparation is to provide the necessary soil conditions which will enhance the successful establishment of the young offshoots or the tissue culture plants received from the nursery. Considering the nature of the date palm, one can not "save" on this operation and hope for long term sustainability of the plantation.

The aim is to enable the date grower to plan and structure the implementation process in advance, ensuring the successful establishment of the date plantation. Planning forms part of the initial preparation and will help to limiting unnecessary stoppages during the implementation phase.

Critical factors to consider during this planning exercise are summarized as follows:

Availability and quality of irrigation water;

- Field selection;
- Mechanical actions to be implemented;
- Chemical needs for pre-plant soil improvement;
- Tools and equipment needed for date cultivation;
- Labor needs;
- Irrigation design and installation;
- Leaching schedule;
- Hole preparation;
- Financial requirements and
- Time schedule.

1. Field selection

The area selected for the establishment of the date plantation can infl uence the cost of land preparation to the extent that it may not be viable to proceed with the development at all. The authors' aim is to highlight the critical areas to be considered when selecting the land for the establishment of a new date plantation.

1.1 Availability of water

Although not always realised, the date palm requires a rather large quantity of water for sustainable growth. Critical factors regarding water for irrigation purposes are:

(i) the sustainability of the water source,
(ii) the quantity of water available for irrigation,
(iii) the distance to the fi eld, and
(iv) the quality of the water.

1.2 Soil depth

In time date palms grow very tall and become top heavy especially during the fruit bearing stage. They therefore need sufficient room for proper root development to support the palms. Besides the importance of root development, soil depth also infl uences drainage and leaching possibilities. Any obstructive

layers must be evaluated to determine whether they will infl uence root development and whether they can be corrected.

1.3 Soil quality

Date palms can grow and produce in different types of soil in both hot arid and semi-arid regions. Adaptation could go from a very sandy to a heavy clay soil. The soil quality is related to its drainage capacity mainly when soils are salty or the irrigation water is characterised with a high salt content. Sandy soils are common in most date plantations of the old world. Rare cases of clay soils (i.e. Basra-Iraq) with drainage systems are found allowing the culture of date palms. The optimum soil conditions are found where water can penetrate to at least 2 m deep.

When evaluating the soil quality, attention must be given to:

(i) the soil texture which will infl uence the water retention capacity, and

(ii) the nutrient content to determine the corrective measures necessary for soil improvement.

1.4 Soil salinity or acidity

Plant growth is influenced by either saline or acid soil conditions which, in the end, will result in a loss of potential yield.

Saline and alcaline soils are common in date plantations and are characterised by a high concentration of soluble salts, and exchangeable sodium, respectively. Soluble salts present in these soils belong to cations: sodium, calcium and magnesium and to chloride and sulphate anions.

Saline soils have an electric conductivity (EC) of their saturated extract higher than 4 mmhos/cm at 25°C, with a sodium absorption rate less than 15 and a pH generally less than 8.5. Saline soils can be recognised by the presence of a white layer on the surface of the soil resulting from the high salt concentration which may harm the growth and development of date palm.

Alcaline soils are characterised by an EC of their saturated extract less than 4 mmhos/cm at 25°C with a sodium absorption rate higher than 15, and a pH higher than 8.5. Alcaline soils do contain harmful quantities of alkalis with the hydroxyl group - OH, especially NaOH. These types of soil are usually diffi cult to correct coupled with a low production resulting from low content of calcium and nitrogen. However, it is recommended to eliminate the excess of sodium by the addition of acidifying agents (gypsum, sulphate of iron or sulphur).

Saline and alkaline soils are usually the result of:

(i) an increase of the underground level caused by excessive drought situations (high evaporation);

(ii) the use of high salt content water, and

(iii) very poor drainage system.

Where date palm grows in climates of little rain, but great heat and much evaporation, irrigation or flood water evaporates quickly, and its salts are left on the surface of the soil.

The negative infl uence of saline conditions are:

(i) high concentration of soluble salts;

(ii) high soil pH;

(iii) poor drainage and aeration; and

(iv) the negative effect of sodium on the plant metabolism.

Relationship between crop response and soil salinity

Crop Response	Scale of Conductivity (Millimhos/cm at 25°C)

Salinity effects mostly negligible	0 - 2
Yields of very sensitive crops may be restricted (Radish 4*)	2 - 4
Yield of many crops restricted (Castor 6*)	-
Only tolerant crops yield satisfactorily (Alfalfa 9*) (Tomato 10*) (Garden beet 12*)	8 - 16
Only a few very tolerant crops yield satisfactorily (Barley 16*)	17 +

Source: Richards et al., 1954.

* The electrical conductivity values of the saturation extract in millimhos per cm at 25°C associated with a 50 % decrease in yield.

Compared to other fruit crops, the date palm is considered to have a high tolerance for salts. Table 38 illustrates this high tolerance.

Relative salt tolerance of fruit crops

High salt tolerance ($EC_e \times 10^3 = 18^{(2)}$)	Medium salt tolerance ($EC_e \times 10^3 = 10$)	Low salt tolerance ($EC_e \times 10^3 = 5$)	
Date Palm	Pomegranate	Pear	Almond
	Fig	Apple	Apricot
	Olive	Orange	Peach
	Grape	Grapefruit	Strawberry
	Cantaloupe	Prune	Lemon
		Plum	Avocado

The numbers following $EC_e \times 10^3$ are the electrical conductivity values of the saturation extracts in millimhos per cm at 25°C associated with a 50 % decrease in yield.

2. Physical land preparation

Once a suitable area for establishing the plantation is selected and the planning operation is fi nalised, the actual preparation can be activated. These activities are divided to structure and pace the implementation process in order to be ready for planting at the most suitable time, according to the specifi c regional climatic conditions.

2.1 Mechanical field preparation

The mechanical or initial soil preparation concerns mainly the preparation of a field for further detailed preparation such as irrigation system installation, hole preparation, etc. Actions, if applicable to the area, include:

(i) debushing/bush clearing;
(ii) removal of stones and rocks;
(iii) ripping; and
(iv) leveling of the soil.

2.2 Irrigation system installation

The type of irrigation system to be used will be determined by the availability of water, topographical and soil conditions. When the initial soil preparation is completed, the installation of the required irrigation system will be implemented according to the prescribed design (Figure 55).

2.3 Soil improvement

The scheduling of the soil improvement programme will depend on the date grower, as certain applications could be combined with the initial actions of soil preparation. Due to the long waiting period,

planting to first production, it is a trend to establish date plantations on new soils, with the exception of areas where date palm is used for intercropping.
If new soils are considered, the soil improvement programme will mostly deal with:
(i) the application of organic matter; and/or
(ii) the elimination of soil salinity.

2.3.1 Organic material

In general, most soils are poor in organic matter content and the improvement of this situation plays an important role in soil fertility. Some of the advantages of a higher humus content in the soil are summarised as follows:

- Enhances crumb formation which improves the respiration of the roots;
- Increases the water infi ltration rate;
- Increases the water holding capacity;
- Lowers soil compaction and crust formation; and
- Limits the harmful effects of alkalinity and improves the leaching of salts.

2.3.2 Salinity

In an attempt to reclaim salt affected soil, consideration should be given to:
(i) the type of salinity/alkalinity,
(ii) the drainage possibilities of the soil profi le,
(iii) the origin or the source of salts,
(iv) the quality of irrigation water and
(v) the leaching of salts from the soil.

If the source of salts is identifi ed as drainage water from higher lying areas, a cut-off canal may be suffi cient to eliminate this source of "salt" supply.
Poor drainage normally goes hand in hand with soil salinity problems and therefore the improvement of the drainage potential should be addressed before any leaching programme is implemented. A soil cover (mulching) and the application of organic material will improve the water infiltration resulting in improved drainage (excluding soils with obstructive layers).
In saline soils (soluble salts present as chlorides, sulphates and/or carbonates of calcium, sodium or magnesium), only leaching will be necessary to drain the excess salts. In the case of alkaline and/or saline-alkaline soils, sodium can be replaced through the application of gypsum or acidifying agents like sulphur. Once the sodium has been replaced, a programme should be followed to leach it out.
When the irrigation water is of poor quality, proper drainage and over irrigation, without the development of a water table, is very important.

2.4 Hole preparation

The actual digging of the hole is one of the last actions before planting takes place, but it must be emphasised that this is not the fi nal preparation for the planting operation itself. This is the point where the required inputs such as gypsum and organic materials are worked into the soil and a start is made with the leaching programme. The reason why the leaching is only applied at this stage is because of the relatively small area that is occupied by the date palm. If the total area had to be leached, it would become very costly with little or no benefi t in the long run.

It is recommended that a hole of 1 m³ be prepared and that the soil from the hole be mixed with the organic material and gypsum (Figures 56 and 57). The soil mix is then put back into the hole, whereafter the site is clearly marked for positioning of the small date palm plants.

At this stage, once the hole has been prepared and closed, it is irrigated and a leaching programme implemented. The water supply will then enhance the leaching of excessive salts and contribute to the fermentation process of the organic material. Subsequent irrigation, several times (2 to 3) before planting, will also allow the mixed soil to settle in the hole.

In most soils, the early and rapid growth of the date plant is better when the holes are prepared one to two months before planting. Well-rotted manure can also be used in holes prepared and irrigated shortly before planting, but extreme care must be taken to put the manure (and fertilisers) deep enough to allow a layer of soil at least 15 to 20 cm thick to be placed between the manure and the roots of the date plant.

II. Planting operation

This is probably the most critical phase in the establishment of a new date plantation. Mistakes at this point may lead to a poor survival rate of offshoots or tissue culture-derived plants, regardless of the efforts put in during the preparation phases. The aim is to assist the date grower to execute the planting operation in a way that will ensure a high transplanting survival rate in the newly established plantation. The planting operation is divided into different activities which will be discussed separately.

1. Plant spacing

It is diffi cult to prescribe a defi nite plant spacing but there are specifi c factors infl uencing the spacing such as:

1. to allow for suffi cient sunlight when palms are tall;
2. to allow for suffi cient working space within the plantation; and
3. to provide suffi cient space for root development.

Previously, the general assumption for a commercial date plantation was to use a plant spacing of 10 m × 10 m (100 palms/ha). It has, however, changed over time and a plant spacing of 9 m × 9 m (121 palms/ha; Israel) or 10 m × 8 m (125 palms/ha; Namibia), is used in modern plantations.

As an example of different spacing used with date palm, Table 40 illustrates the distance apart, the square unit to each palm and the number of palms in each spacing.

Comparative table of spacing distances (Palms planted at the corners of squares)

Distance Apart (m)	Square Units to each palm (m)	No of Palms in Each (Hectare)
10.06	101	100
9.14	84	119
8.83	78	129
8.53	73	137
8.23	68	148
7.92	63	159
7.62	58	172
7.32	54	185
7.01	49	204
6.71	45	222
6.40	41	244
6.10	37	270
5.79	34	294

5.49	30	333

he planting density also depends on ecological factors (mainly humidity) and on varieties. In general, commercial plantations use 10 m × 10 m, 9 m × 9 m or 10 m × 8 m, for all varieties except for Khadrawy (dwarf variety with a small canopy) which could be planted at a higher density. The tendency to plant more closely is found when the prevailing wind is dry and extremely hot and strong. The 10 × 10 is desired in areas where humidity during the date ripening period (Coachella valley-USA, Elche-Spain and Coast of Libya (Zliten)) is high (Dowson, 1982); This wider spacing is to allow sun and wind to counteract the humidity's infl uence. According to Nixon (1933), wide spacing is also recommended whenever there is considerable danger of rain damage to dates during the ripening season.

2. Time of planting

The critical factor is to transplant the young tissue culture date palms or offshoots at that time of the year that will ensure a good survival rate and proper establishment before the beginning of a "hard" season.

In most of the date regions in the northern hemisphere, spring and autumn are preferred for the planting out of tissue culture-derived date plants or offshoots. Spring avoids the cold of winter and takes advantage of the warm weather that encourages rapid growth, while autumn gives the young shoot a longer time to establish itself before the heat of summer. Each of the two seasons, however, has its corresponding disadvantage; spring, the early approach of the great heat, and autumn, the early approach of the cold.

In the southern hemisphere the best time of establishment is during autumn (February/March) because of the following reasons:

-Winters are relatively frost free,
- Very high summer temperatures,
- Strong, dry winds during August-January, and
- Sand storms during the summer.

In areas without extreme dry, hot summers and with severe frost during winter it is recommended to plant during August/September or at a time safe from the occurrence of frost.

3. Transplanting stage

Research has shown that the best fi eld survival rate, as well as early plant development, is obtained when the date tissue culture plantlets are transplanted at the four (4) plus pinnae leaf stage. Plants received from a tissue culture laboratory normally only have juvenile leaves or one pinnae leaf at the most. These plants are thus too small to be transplanted into the field. It is therefore necessary to include a hardening-off phase for plant development which also allows some time for plants to adapt to local climatic conditions. This results in the young plants being kept in the farm nursery for a period (approximately 8-12 months), until the suffi cient number of pinnae leaves have developed before transplanting takes place.

In a fi eld test at the Eersbegin project (Namibia), tissue culture plants with 4-6 pinnae leaves were transplanted and the results indicated that the initial plant development, after transplanting, was better when the plants were transplanted at the 4-pinnae leaf stage than at the 5-6 pinnae leaf stage. Regarding offshoots, it is highly recommended to ensure their rooting in the nursery after separation from the plant mother (at least 10 to 12 months). It is not recommended to plant an offshoot directly after its separation.

4. Planting time and depth

Planting should always be initiated early in the morning to limit stress on the date plantlets and also to allow suffi cient time for adaptation (from the plastic bag to the soil). Bags are to be removed with care and the plant, with most of its surrounding substrate, to be planted carefully.

Planting is probably the area where most people make the vital mistake of planting the plant too deep. The planting depth is critical because the "heart" of the plant should never be covered with water. Once the plant is covered with water the growing point rots and the plant dies off. If a date plant is planted too shallow, its roots will desiccate and die.

The golden rule is to ensure that the greater diameter of the bulb of the plant is at the same level as the soil surface after transplanting and to ensure that water does not go over the top of the date plant.

5. Basin preparation

Immediately after transplanting, a basin is prepared around the palm to prevent run-off and to ensure a suffi cient supply of water to the plant. When using a micro irrigation system, it is recommended to have a basin of approximately 3 m in diameter and 20 to 30 cm deep. The basin should have a slight downward slope towards the plant to allow the water to reach the root system of the young plant.

6. Mulching

The benefi ts of organic material were highlighted when land preparation, as part of the plantation development, was discussed. The mulching is done by putting a layer of organic material (e.g. wheat straw) around the base of the palm. Mulching of the basin has the following advantages:

- Limits water loss from the soil through evaporation;
- Prevents crust formation;
- Allows better water penetration into the soil:
- Limits weed growth around the plant; and
- Improves the humus content of the soil.

7. Irrigation

Immediately after transplanting, the palm should be irrigated to limit transplant stress. Once the plantation is established, a frequent irrigation schedule is to be followed to allow suffi cient water supply to the young date palm.

The irrigation frequency, is soil type dependant, but on very sandy soils it requires daily irrigation during the first summer. Heavy soils will require irrigation once a week, while in most soils, irrigation is required every second or third day. During the first six weeks, the date growers should inspect their planted date palms to verify that the surface soil does not dry and shrink away from the plant.

8. Protection

Tissue culture-derived plants and young offshoots should be protected from harsh climatic conditions (sun and wind during the first summer and cold the following winter) and against some animals (rabbits, etc.). The use of a hessian wrapping, a shade net cover, or a tent of date leaves is recommended. The top is to be left open so that new growth may push out.

9. Aftercare

Beside irrigation applications, the annual fertilization schedule, weeding and mulching, the date grower should, for at least the first 10 to 12 months, keep an eye on the plantation in order to detect and consequently correct any adverse situations.