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An Introduction to Irrigation of Horticultural Crops

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Horticulture in the NT relies heavily on irrigation for its sustainable development and viability.

Irrigation is one facet of the inputs which need to be carefully managed so that profits are maximised. The NT experiences a dry tropical environment in the Top End, where little or no rain falls for eight months of the year, with conditions becoming drier as one moves down to Central Australia. If there is no water there is no growth. Just take a look around you, next time you pass down the Stuart Highway during the dry season. Small pockets of green persist in low lying areas or where permanent water is available. Water is an essential ingredient for growth. Any commercial agricultural enterprise requires water if grown during our long dry season. This includes both annual vegetable and melon crops as well as perennial fruit trees.

Despite the importance of water to production, there has been minimal care taken to maximise the efficiency of irrigation, and hence, crop yield and quality. Maximising efficiency need not be simply maximising yield for every litre of water applied. The timing, frequency and quantity of application can all have a marked effect on crop yield quality and time of harvest. Minimal use of water for maximum returns is also a sensible aim, due to the cost of extracting water (bore installation costs and energy costs to pump the water to where it is required) and to the limited resources of readily available bore and river water which exist in the Top End.

Irrigation practices can be improved if a range of important factors are taken into account. These are: crop type, crop water requirements, climatic conditions, soil type, water quality, method of irrigation.

CROP TYPE

The type of crop grown influences irrigation practice. Annual vegetable and melon crops are high users of water and irrigation management is extremely critical to their productivity during their relatively short life span (10-20 weeks). Perennial tree crops, tend to require less water and management, although critical, is not generally as critical as for annual crops. Some tree crops (mango and cashew) require little or no water for their survival during non-flowering and non-fruiting growth periods, whereas, fruit trees (e.g. carambola, mangosteen, jackfruit and banana) from wetter tropical environments require continuous irrigation throughout the year. Crop type influences rooting depth which determines how much available soil water the plant is able to tap into. Effective root depths vary from 15-30 cm for vegetable crops to 80-100 cm for many tree crops (e.g. mango, citrus).

CROP WATER REQUIREMENTS

The crop water requirement can be calculated using indirect evaporation based models, or directly measured using soil moisture monitoring devices.

In theory both methods should be used, the former method allows the grower and irrigation designer to know how much water is likely to be required during the cropping season and how best to deliver the water so that the crop peak demand for water can be met. The latter method allows the grower to monitor water use during crop growth and to make any small adjustments which are required.

The simplest and most commonly used evaporation based model uses open pan evaporation data to calculate water requirements. This can be done on a daily basis, or by using long term average data for your particular area (Table 1.), generally collected and stored by the weather bureau. This method is useful because the driving forces, (solar radiation, wind, temperature and humidity) which cause evaporation of water from an open surface of water are also responsible for driving water loss (evapo-transpiration) from the plant and its immediate soil surrounds. Plant water requirements are generally less than open pan evaporation and are expressed as crop factors (ratio of plant water use to evaporation loss). For example, a crop with a crop factor of 0.6 will require 6.0 mm of water when the daily loss of water from an open pan evaporimeter is 10.0 mm. Crop factors for a large range of crops, mainly sub-tropical and temperate, have been measured by agricultural scientists using direct soil measurement techniques. As a rough rule of thumb, most vegetable crops would have a crop factor somewhere between 0.8 to 1.0, whereas tree crops can have crop factors which range from less than 0.5 and 1.0 depending on the time of year and the particular growth stage (flowering, fruiting or vegetative) the crop is in. Tropical lawn grasses, generally grow well if irrigation is based on a crop factor of 0.6. More precise crop factors can be obtained from the DBIRD, however, crop factors for many of our more exotic crops are yet to be determined.

Table 1. Mean daily evaporation (mm/day) data for Darwin, Katherine and Alice Springs

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Darwin	6.7	6.1	6.2	7.1	7.3	7.2	7.4	7.7	8.4	8.7	8.2	7.2
Katherine	6.3	5.6	5.6	6.2	5.8	5.6	5.9	6.8	7.8	9.4	9.2	7.8
Alice Springs	12.4	11.4	9.4	6.8	4.6	3.6	3.8	5.3	7.2	9.7	11.1	11.9

Direct soil measurement techniques, allow the grower to monitor the moisture levels in the root zone of the plants. These techniques measure either: (a) soil tension i.e. the tension with which water is held in the soil or the corollary; the pressure required to push water out of the soil matrix, or (b) the soil moisture levels.

Soil tension monitors are commonly used by growers in the form of tensiometers. These water filled tubes have a ceramic tip at the end which is inserted to the required depth in the soil. As the soil dries out water is drawn through the ceramic tip, thereby creating a vacuum in the instrument. The vacuum is measured with a gauge and is an indicator of how difficult it is for the plants to extract water from the soil. Other soil tension devices include, ceramic blocks and gypsum blocks. These devices are good as long as they are well managed and the information is carefully recorded along with information on irrigation times and duration. Further information on tensiometers and their use can be found in Agnote D19 ‘ Tensiometers’.

Direct soil moisture measuring techniques tend to range in complexity and accuracy. The cheapest technique involves auguring a hole and feeling the soil for its moisture content. This technique is a good indicator of watering depth, however it is not accurate when determining the amount of water in the soil. More complex instruments are needed such as the Neutron Moisture Probe which uses a radioactive source to measure the amount of water in soil. However, trained personnel are required to operate and interpret the data. Newer technology which uses electronics to measure the soil electrical capacitance is easier to use and should prove to be a useful management tool. There are a number of cheap conductance based devices, sold mainly to home gardeners, which are of little use.

The advantage of these direct measuring techniques (tension and moisture) is that they can give the grower feedback on the amount of water in the soil at any specific time thereby allowing irrigation to be managed according to crop water use.

SOIL TYPE

Soil type influences irrigation management due to the ability of soils to store varying quantities of water, depending on their texture. Sandy soils hold the least and clays hold the most. Most soil profiles are made up of various texture classes, hence the water storage capacity depends on the cumulative storage capacities of the various layers within the profile. The terms describing soil water holding capacity have been loosely used and as such deserve some clarification.

- Water Holding Capacity: (WHC) Amount of water held between field capacity (point at which soil becomes saturated) and completely dry (oven dried).
- Available Water Holding Capacity: (AWHC) Amount of water held between field capacity and permanent wilting point (when a plant will permanently wilt, soil suction of -15 bars).
- Readily Available Water Holding Capacity: Amount of water held between field capacity and when a plant will begin to show mild signs of stress. This figure is species specific, however it can be approximately 50% of the AWHC.

Most soils in the Top End, used for the production of horticultural crops, would have an available water holding capacity of somewhere between 80 and 120 mm/metre. This means that the readily available capacity is between 40 and 60 mm/metre.

If the above is somewhat confusing it may help to think of your soil profile in terms of a sponge. A sponge pulled from a bucket of water drains freely because it is saturated with water and the pores are unable to hold water against the pull of gravity. The same is true of a saturated soil following drenching rainfall or extended irrigation. Following the period of free drainage the sponge is able to hold water against the pull of gravity, which is similar to the field capacity concept in soil. If one applies pressure to the sponge, water will again begin to drain, equivalent to the active uptake of water by plant roots in soil. A continuing firm pressure must be applied to extract water. The permanent wilting point in soils can be compared to the situation when water can no longer be extracted from the sponge despite giving it a firm squeeze. More water can be extracted from the sponge by allowing it to dry in the sun, similar to the oven dry state in soil water terminology.

WATER QUALITY

The quality of irrigation water in the Top End is generally good. In areas where water is being extracted from limestone aquifers the lime (bicarbonate) levels may present some management difficulties, particularly if using overhead irrigation where the leaves are wetted. Most serious water quality related problems are as a result of high salt (sodium chloride) levels in the water. Fortunately this is not a problem in Top End horticultural areas but can be a serious constraint around Ti-Tree and Alice Springs. Where quality is a problem additional water, above that required by the crop, has to be applied to leach salts out of the root zone. Further advice should be sought from your local extension officer.

IRRIGATION METHOD

Method of application of irrigation is an important part of the management process. The three broad categories, over-head (high pressure), micro-sprinkler (medium pressure) and drip (low pressure) systems all have to be managed in their own specific way. Technically, drip irrigation systems are the most efficient, in terms of units of water delivered per units of water pumped. Micro- sprinklers are again more efficient than over-head spray irrigation.

The type of system utilised will depend on: water availability, crop type, soil type and the managers preferred option. It is of vital importance that the system is hydraulically correct: i.e. it is able to deliver the same amount of water at the required emitter operating pressure to all areas of the crop or orchard. Time spent with a reputable irrigation designer is money well spent. The system must also be designed to deliver sufficient water for the crop peak requirements, as under- watering can be an extremely costly exercise.

TIMING OF IRRIGATION

The timing of irrigation can be a crucial part of managing an orchard. Some tree species, e.g. mango, respond to a dry period by flowering earlier and more profusely than would otherwise occur if they were continually irrigated. The flowering response is also probably influenced by temperature and the effect of irrigation management may not be as evident in a year when we experience a cool dry season. Other species which may respond positively to a dry period are: cashew, rambutan and durian but the response and the length of dry period required will depend on the species.

In summary, efficient irrigation management requires knowledge of your crop, irrigation system, soil and water quality as well as methods of monitoring your soil water status. The Department of Primary Industry, Fisheries and Mines is currently investigating the response of tree and annual crops to irrigation management. For further advice on any of the issues raised in this Agnote contact your local horticulturist or extension officer.

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