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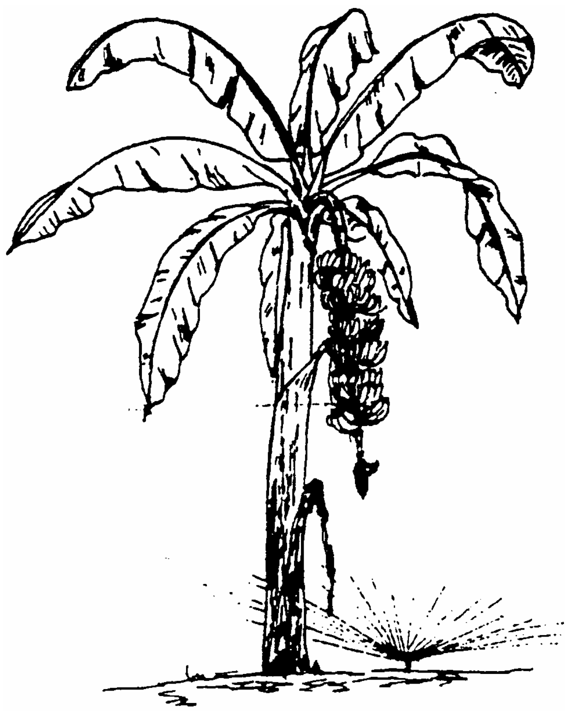
Irrigation Management of Bananas in the Top End

Y. Diczbalis, formerly Horticulture Division, Darwin and B. Toohill, formerly Horticulture Division, Katherine

INTRODUCTION

Banana plants require regular watering, from rainfall or irrigation, all year round. In the Top End climate, April to October are usually dry months and rainfall varies greatly during November to March. Irrigation is therefore critical to maintaining plant health and high yield.



The irrigation system is a major cost of setting up a banana plantation. The cost of the system will depend on a number of factors such as the water requirement for the crop (litres/ha/day), the water source (bore or surface water), water quality, application method (overhead or under tree sprinkler), pumping pressure and flow rate and the number of sprinklers per hectare.

An irrigation system should be designed to apply water evenly over the entire planted area of the plantation. This can only occur if the designer has information on crop water requirements.

Crop water requirements are generally calculated using long term evaporation data for the particular growing area and knowledge of crop water use in relation to evaporation. The term Crop Factor (CF) was coined to describe the relationship between crop water use and evaporation.

$$\text{Crop factor} = \frac{\text{crop water use (mm/day)}}{\text{evaporation (mm/day)}}$$

For example if crop water use is 10 mm/day and evaporation is 10 mm/day then CF equal 1.0; if the crop water use is 6.0 mm/day then CF = 0.6

Literature on banana and its water use suggests that the CF is equal to one. This means the crop uses as much water as is lost from evaporation. Using long term evaporation data for a particular growing area, crop water requirements can be easily calculated and the peak water use period can be identified.

The irrigation system should be designed to supply enough water to replace evaporation. An additional capacity is needed to deal with system inefficiency which requires more water to pass through the system to make up for losses which occur along the way (leakage, frictional loss, direct loss to evaporation). Typical under-tree systems are 85% efficient, whereas, over-head systems are, at best, 70% efficient.

EVAPORATION

Crop water requirements differ between Darwin and Katherine districts (Table 1). Water requirements are expressed in Megalitres/ha/month (ML/ha/mth) and are based on 100 per cent canopy cover and planted area only. Theoretically, the planting arrangement will not alter water requirements as it is assumed canopy cover is 100 per cent and irrigation is uniformly applied to the entire planted area. For the sake of budget calculations, the planting pattern is assumed to be 3.0 m x 2.0 m (1666 plant sites/ha) with 17 rows between roadways. (See Fig 1 and Agnote 556).

Water requirements for younger crops (canopy cover less than 100 per cent) can also be calculated. However, the system must be designed to supply the maximum water requirements.

Once the crop water requirements are known, the design of an appropriate irrigation system is possible. The designer will require the following additional information:

- crop area
- water source and distance from planting site
- water availability (flow rate of bore)
- preferred method of water application; overhead or under tree
- required irrigation frequency (daily, weekly etc.)

The latter three points are discussed below.

WATER AVAILABILITY

The amount of water available for irrigation will determine the area of crop planted. For example, near Darwin maximum pumping requirement at 85% efficiency (3.17 ML/ha/mth) occurs in October (Table 1). This is equal to 102,258 L/day which over a 2.5 hour irrigation period is equal to 9.5 L/sec. Low flow rate bores, 3-4 L/sec, common in the Darwin rural area, would be unable to cope with planted areas of more than 1.0 ha.

METHOD OF APPLICATION

Experience from the Ord River irrigation area, WA and some growers in the Top End, suggests that under tree micro-irrigation is the preferred method in this environment. Design of the system must ensure that full ground cover occurs in the planted area. Irrigation every day or every second day is essential and the application rate should be greater than 3.0 mm/hour.

There are several advantages of under-tree irrigation. Water is applied more uniformly and less water loss occurs due to evaporation or wind. The system is generally cheaper to run due to the lower pressure requirements at the sprinkler head. Generally speaking, under-tree systems are better for maintaining soil moisture levels at field capacity in a harsh environment such as that experienced in the Top End.

Over-head irrigation systems, (high pressure sprinkler on riser tubes above the canopy) are also used in the Top End. However, such systems are less able to keep the soil at or near field capacity. These systems are also more inefficient (Table 1) than under-tree systems and water loss due to evaporation may exceed 40% on hot windy days. Windy weather which contributes to poor spray patterns also limits the rotation schedule of irrigation shifts between blocks due to the requirement to irrigate at night or early morning, thereby complicating irrigation management. Such systems also tend to be more expensive to buy, install and run, due to the high pressure requirements at the sprinkler (250-300 kpa). Over-head systems should be designed to apply at least 130 per cent of maximum irrigation requirement, to adequately fill the soil profile as well as to provide for high evaporative losses.

The main advantage of over-head systems is that they provide evaporative cooling to the crop, thereby reducing evaporative demand on the plant during maximum periods of extreme heat. However, it is not known if such systems produce higher yields. Growers also find over-head systems easier in terms of plantation management as under-tree systems are more prone to damage from various cultural operations, such as harvesting, detrashing, desuckering, spraying, etc.

A major disadvantage of over-head systems is that they encourage the spread of leaf spot disease (yellow sigatoka) particularly during the hot, humid summer months. Over-head systems are also disadvantageous where the water supply is high in calcium, bicarbonates and or chlorine. These will stain or burn the leaves thus resulting in lower photosynthesis (plant productivity).

IRRIGATION MANAGEMENT

The aim of managing irrigation is to ensure that the crop attains maximum yields and quality. Incorrect irrigation management of bananas can lead to reduced bunch size, weight and plant vigour. Because bananas are inefficient users of soil moisture, careful irrigation management is required if maximum yields are to be attained.

Bananas are shallow rooted, with the bulk of the root system in the top 30-40 cm. The crop performs best in well drained soils which are maintained at or near field capacity, that is, after free drainage has stopped, when the soil holds its maximum amount of water. Sandy loams and sandy clay loams are ideal soils for banana production. Sands should be avoided.

Although crop water requirements can be determined from evaporation pan readings, management of irrigation scheduling is best carried out with the aid of tensiometers (a device which measures soil water tension). See Agnote D19 for more details on tensiometers and their use and maintenance.

Research work carried out overseas and in NW Western Australia shows that banana yields are adversely affected when soil moisture tensions are allowed to exceed 25 kPa (cbars) in the root zone. For sandy clay loam soils, typically used in the Top End for banana production, field capacity is equivalent to 10-12 kPa. Therefore soil suctions in the root zone should be kept between 12-25 kPa for optimum irrigation management. The combination of high water requirement, shallow root system, low soil water holding capacity and the inability of the crop to use more than a third of the available water in the root zone before stress occurs, means that high frequency irrigation (minimum daily) is essential. Under very hot, dry conditions, as can occur during the late dry season, two irrigations per day would be advantageous.

Initially irrigation inputs for a mature crop should be in the order suggested in Table 1 for your growing area. Further refinements can be made to irrigation inputs by using tensiometers. Tensiometers should be located in nests, preferably of three, with tensions being monitored daily at 20, 40 and 80 cm depth at approximately 50 to 75 cm from the plant. The selected plant should be away from exposed edges of the plantation and in an area of representative soil. Two to three nests per hectare should be used. The tensiometer data should be recorded graphically in conjunction with records of irrigation inputs and timing. Tensions at the 20 cm depth should not exceed 25 kPa, whereas tensions at the 40 and 80 cm depths should not exceed 30 kPa and 60 kPa respectively. If tensions at the 80 cm depth are regularly below 30 kPa this suggests that water in excess of plant requirements is being applied. Future irrigation inputs should be slowly reduced until the 80 cm deep tensiometer responds appropriately.

Tensiometer and irrigation data recorded faithfully over one to two seasons will give managers a clear understanding of crop water requirements under their local conditions. The correct application of water will enhance crop yield and quality potential, maximise the efficiency of pumping costs and ensure that excess water and nutrients are not needlessly draining past the root zone, thereby contributing to ground water pollution and water wastage.

APPLICATION RATE

Soils display different infiltration rates, that is, the rate at which water can enter the soil. Heavier, clay soils may have lower infiltration rates and sandy loams generally have higher infiltration rates. If water is applied at a rate which exceeds the soil's infiltration rate, the excess amount will run off the surface. This can lead to erosion and certainly to waste of water. However, on occasion, especially if there are dry areas due to shadow effects, this approach can be used to wet the full surface area. Generally, the application rate of irrigation water should not exceed the infiltration rate of the soil on which the crop is growing.

CONCLUSION

Efficient production of bananas can only occur if the irrigation system is able to match the crop's water requirements and water inputs are managed well. It is imperative that new and old irrigation systems are properly designed and managed. Seek professional design advice to ensure that the issues raised in this Agnote are incorporated into your irrigation system.

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Table 1. Crop water requirements and irrigation rates for bananas grown in Darwin and Katherine

Location: Darwin

Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Crop Factor:	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Av. Evaporation (mm/month):	208	171	192	213	226	216	229	240	252	270	246	223
Av. Rainfall (mm/month)	406	349	317	99	20	2	1	7	18	73	141	232
Crop water requirement												
(mm/month):	208	171	192	213	226	216	229	240	252	270	246	223
(mm/day):	6.7	6.1	6.2	7.1	7.3	7.2	7.4	7.7	8.4	8.7	8.2	7.2
Crop Water Req (ML/ha/mth):	2.08	1.71	1.92	2.13	2.26	2.16	2.29	2.39	2.52	2.70	2.46	2.23
*Irrig Appl (85%) (ML/ha/mth):	2.44	2.01	2.26	2.51	2.66	2.54	2.70	2.81	2.96	3.17	2.89	2.63
*Irrig Appl (70%) (ML/ha/mth):	2.97	2.44	2.75	3.04	3.23	3.09	3.28	3.41	3.60	3.85	3.51	3.19
+Irrig Appl (85%) (ML/ha/mth):	0	0	0	1.34	2.43	2.52	2.69	2.73	2.75	2.31	1.24	0
+Irrig Appl (70%) (ML/ha/mth):	0	0	0	1.63	2.95	3.06	3.26	3.31	3.34	2.81	1.50	0

Location: Katherine

Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Crop Factor:	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Av. Evaporation (mm/month):	194	156	173	186	180	169	182	212	235	292	275	242
Av. Rainfall (mm/month)	234	246	195	44	6	3	3	1	7	31	90	152
Crop water requirement												
(mm/month):	194	156	173	186	180	169	182	212	235	292	275	242
(mm/day):	6.3	5.6	5.6	6.2	5.8	5.6	5.9	6.8	7.8	9.4	9.2	7.8
Crop Water Req (ML/ha/mth):	1.94	1.56	1.73	1.86	1.80	1.69	1.82	2.12	2.35	2.92	2.75	2.42
*Irrig Appl (85%) (ML/ha/mth):	2.28	1.84	2.04	2.19	2.12	1.99	2.14	2.49	2.76	3.44	3.24	2.85
*Irrig Appl (70%) (ML/ha/mth):	2.77	2.23	2.47	2.66	2.57	2.41	2.68	3.03	3.36	4.17	3.93	3.46
+Irrig Appl (85%) (ML/ha/mth):	0	0	0	1.67	2.05	1.95	2.11	2.48	2.68	3.07	2.18	1.06
+Irrig Appl (70%) (ML/ha/mth):	0	0	0	2.03	2.49	2.37	2.56	3.01	3.26	3.73	2.64	1.29

LEGEND

Crop Factor	=	crop water use (mm)/evaporation (mm)
Av. Evaporation	=	Darwin - average of 31 years data (1958-1989) Bureau of Meteorology
Av. Rainfall	=	Katherine - CSIRO Res. Station Records 1974-81 (Williams et al. 1985)
Crop Water Requirement	=	Evaporation x Crop Factor
Maximum Water Requirement (ML/ha/mth)	=	(Crop Water Req (mm/month) x 10,000 m^2)/10^6 L (planted area only) does not include roadways.
Irrigation Applications (Irrig. Appl.)		
(ML/ha/mth)	=	Maximum Water Requirement/0.85 Assumes - efficiency of irrigation system is 85% (under-tree system) hence more water needs to be pumped than is actually applied. For overhead systems use data for 70% efficiency.

* = No rainfall
\+ = Average rainfall

Example Farm - (Under-tree sprinklers)

Planted Area = 4.0 ha
Layout - see plan
- 3.0 m x 2.0 m with a double follower

Plant Canopy Cover - 100%

Bore Capacity - 6.5 l/sec
Bore Head - 5.0 m
Pump - 15 H.P. submersible in a 15 cm diameter casing

Sprinklers - Under-tree Wingfield Blue Challenger (120 l/hr) @ 150 kPa
Sprinkler Spacing - between rows 6.0m
- within row 5.0 m

Precipitation rate - 3.5 mm/h, Coefficient of Uniformity (measure of the evenness of precipitation over the irrigated area) - 92% (Wingfield information sheet 55-03-005A)

Irrigation Schedule
- Shift Size 0.5 ha block
- Run Time/Shift - minimum 1.74 hr/day (February)*
  - maximum 2.49 hr/day (October)

- Total Irrigation/Run Time
  - minimum 1.74 hr/day/shift x 8 shifts = 13.92 hr
  - maximum 2.49 hr/day/shift x 8 shifts = 19.92 hr+

\+ Note higher flow rate bores, will allow for higher flow rate sprinklers to be used which results in higher precipitation rates, and hence, shorter pumping times. Values presented are examples only.

* This data assumes that no rain falls during February.

NB The mention of brand names in this Agnote does not constitute recommendation of the product by the DBIRD.

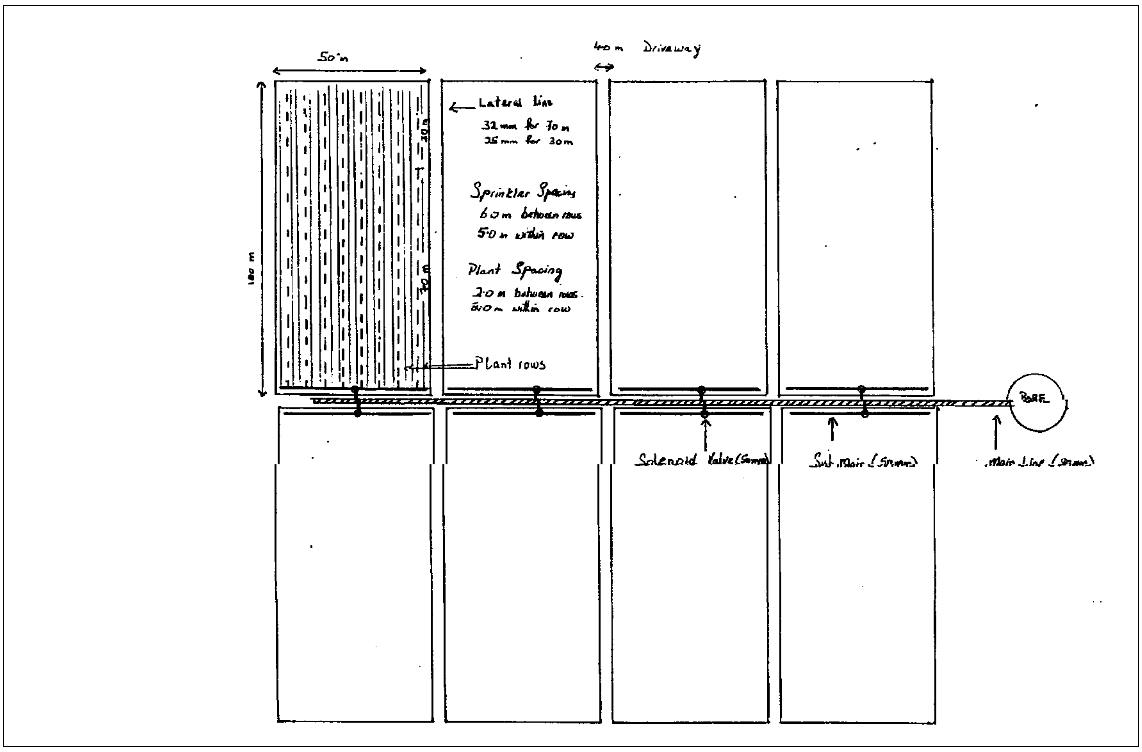

Figure 1. Example of farm layout

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