Research Application Summary

Effect of different drip irrigation regimes on growth, yield and yield components of banana cv. Grand Nain under Gizera condition, Sudan

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Abstract

This study was conducted to investigate the effect of different water regimes applied by drip irrigation on growth and yield of banana cv. Grand Nain in Gizera State. Five different irrigation regimes were applied. These were 40%, 60%, 80%, 100% and 120% of crop evapotranspiration (ET_c) at a 2-day irrigation interval. The experimental design was a randomised complete block (RCBD) with 4 plants per plot. Banana growth parameters increased with the increase in quantity of water applied up to 100% of ET_c. Bunch weight, total yield, number of hands per bunch and numbers of fingers per bunch were linearly related to the amount of water applied in the plant crop and first ratoon. There were no significant differences in bunch weight between 100% and 120% of ET_c of mother plant and first ratoon.

Key words: Banana, crop evapo-transpiration, drip irrigation system, Grand Nain, irrigation water use efficiency partial factor productivity, reference evapotranspiration

Résumé

Cette étude a été menée pour étudier l’effet des différents régimes d’eau, appliqués à l’irrigation par gouttes sur la croissance et le rendement de la banane cv. Grand Nain dans l’Etat de Gizera. Cinq différents régimes d’irrigation ont été appliqués. Il s’agissait de 40%, 60%, 80%, 100% et 120% de l’évapotranspiration des cultures (ETC) à un intervalle d’irrigation de 2 jours. Le dispositif expérimental était un bloc aléatoire complet (RCBD) avec 4 plantes par parcelle. Les paramètres de croissance des bananes ont augmenté avec l’augmentation de la quantité d’eau appliquée jusqu’à 100% d’ETC. Le poids des régimes, le rendement total, le nombre de mains par régime et les nombres de doigts par régime ont été en relation linéaire avec la quantité d'eau appliquée dans la culture des plantes et le premier rejet. Il n'y avait pas de différences significatives dans le poids du régime entre 100% et 120% d'ETC de la plante mère et du premier rejet.

Mots clés: Banane, l'évapo-transpiration des cultures, système d'irrigation par gouttes, Grand Nain, efficacité d'utilisation de l'eau d'irrigation facteur partiel de productivité, évapotranspiration de référence

Background

Bananas and plantains are important staple food in Sub-Saharan Africa, where the fruit is consumed both cooked and as dessert. Bananas need a lot of water for optimum yield; estimated at 25 mm per week in the tropics as its roots are sensitive to water logging, desiccation and over-compacted soil (David, 2007). Therefore, it has become necessary to irrigate banana in periods of water scarcity. Due to water scarcity in such areas, irrigation management (i.e., practices that result in reduction in irrigation requirements, water saving, and conservation, and an increase in crop yield and income per unit of water used) (Capra *et al*., 2008) is necessary. One of the irrigation management practices is deficit irrigation, a strategy that allows a crop to sustain some degree of water deficit in order to reduce irrigation costs and potentially increase income. In this study we determined the effect of different drip irrigation regimes on growth and yield of banana.

Literature Summary

Deficit irrigation is a common practice that involves the use of precision irrigation. Thus, adoption of deficit irrigation requires knowledge of crop evapotranspiration, crop response to water deficit, the use of highly efficient irrigation systems (e.g. micro irrigation) that favor water saving and the prediction of the cost function and crop price (Capra *et al*., 2008). In many countries, water for irrigation is becoming scarce (FAO, 1960) due to the pressure exerted on natural resources by the rapidly expanding human population. It is predicted that by the year 2025 about 35% of the world population may face water shortages (Hinrichsen *et al*., 1980).

Study Description

This study was undertaken to determine the yield response of banana towards a range of water amounts applied by drip irrigation for banana based on agronomic evaluations. The experiment was established in the Horticultural Research Centre Farm of the Agricultural Research Corporation (ARC), Wad Medani, Sudan (latitude 14° 23´ N, longitude 33° 29´ E, altitude

405 masl).The study area is dry and characterised by a hot summer. The soils are silty clay loam, moderately alkaline, nonsaline, non-sodic, has medium available phosphorous and low organic carbon. The experimental area was ploughed and then harrowed after introducing 0.5 m depth silty clay loam on top of the heavy clay soils.

Six months old tissue culture raised bananas were transplanted to the field and excess suckers removed leaving only two, resulting into a plant population of 2222 plants/ha.The standard management practices for banana were carried out, with fertilisers applied by fertigation.

The daily metrological data were used to compute reference evapotranspiration (ET_o). Five different quantities of irrigation water were applied at 2 day-intervals. These were 40%, 60%, 80%, 100% and 120% of crop evapotranspiration (ET_c) under drip irrigation. The treatments were replicated 4 times in randomised complete block design (RCBD) and each plot had 4 plants

Data were collected for Growth plant height, plant girth, number of green leaves (at shooting) and leaf area. Other data collected were days to flowering, flowering-harvesting interval and fruit yield.

Irrigation water use efficiency (IWUE) was calculated as the ratio of the crop yield to seasonal irrigation water applied. Nutrient use efficiency (NUE) was also determined and calculated as the partial factor productivity (PFP, kg crop yield per kg nutrient applied) using the formula:

$$PFP (\%) = \frac{\text{Grain yield (kg ha}^{-1})}{\text{Total nutrient applied (kg ha}^{-1})}$$

CropStat statistical program was used for data analysis and the least significant difference test used for mean separation at the probability level of 0.05.

Research Application

After calibration, the hydraulic characteristic of the drip irrigation system gave 7.92 l/h for average emitters discharge, 90.9% field emission uniformity, 86.8% absolute emission uniformity, 91.9% design emission uniformity and 81.9% irrigation efficiency. The differences among quantities of water applied were highly significant for plant height, plant girth and leaf area; asnd non-significant for number of green leaves of the mother plant crop. Some of these data is given in Table 1.

The same trend was true for the first ratoon crop. Growth parameters increased with quantity of water applied (Table 1). These results are in agreement with those of Goenagea and Irizarry (2000) who reported that irrigation according to increasing pan factors increases the number of functional leaves at flowering. Olanrewaju *et al*. (2009) found that the height and stem diameter of cassava was highest under full water application. Karam *et al*. (2002) reported that water stress caused by the deficit irrigations significantly reduced leaf number, leaf area index and dry matter accumulation of lettuce.

Table 1. Effect of quantities of water applied under drip irrigation on growth parameters of the mother plant and the first ratoon crop of banana cv. Grand Nain at flowering.

Water applied (% of ET_c)	Plant height (cm)		Plant girth (cm)		No. of green leaves	
	MP	FR	MP	FR	MP	FR
40	155 c	206 d	47 c	60 c	12	14
60	158 c	210 cd	51 bc	61 c	12	14
80	174 b	215 bc	57 ab	64 b	13	15
100	180 ab	222 b	53 b	66 b	13	15
120	192 a	231a	61 a	70 a	14	15
SE±	4.4	3.0	2.1	0.97	1.2	0.24
CV%	5.2	2.7	7.8	3.0	6.4	3.9
Significance level	***	***	**	***	NS	NS

MR = Mother plant. FR = First ratoon crop; **, *** and NS: indicate significance at $P \leq 0.01$, $P \leq 0.001$ and not significant, respectively. Means within each Colum followed by the same letters are not significantly different according to Least Significant Difference Range Test.

There were no significant treatment effects for days to flowering and flowering - harvesting interval of the mother plant crop (Table 2). However, significant treatment effects for these parameters were observed for the first ratoon crop. Goenaga *et al*. (1995) reported that increase in the pan factor treatment reduces the number of days to flowering (bunch shooting).

Bunch weight, number of hands per bunch and number of fingers per bunch were linearly and significantly related to the amount of water applied in the plant crop and first ratoon (data not presented). The highest yield and bunch weight were obtained at 100% of ET_c. Goenagea and Irizarry (1998) found that using class A pan factors ranging from 0.0 to 1.0 significantly improved yield and yield components for the plant crop and ratoon crops.

Table 2. Effect of quantities of water applied under drip irrigation on days from planting to flowering (shooting) and from shooting to harvesting of the mother plant and the first ratoon crop of banana cv. Grand Nain.

Water applied (% of ET_c)	Days from planting to flowering		Days from flowering to harvest	
	MP	FR	MP	FR
40	395	409 b	120	533 c
60	390	374 a	113	523 bc
80	298	358 a	106	492 a
100	298	368 a	105	485 a
120	301	387 ab	103	473 a
SE±	5.3	9.7	4.2	12.7
CV%	3.6	3.8	7.6	5.1
Significance level	NS	*	NS	*

MR= Mother plant. FR= First ratoon crop.
*, and NS: indicate significance at Pd" 0.05, and not significant, respectively. Means within each Colum followed by the same letters are not significantly different according to Least Significant Difference Range Test.

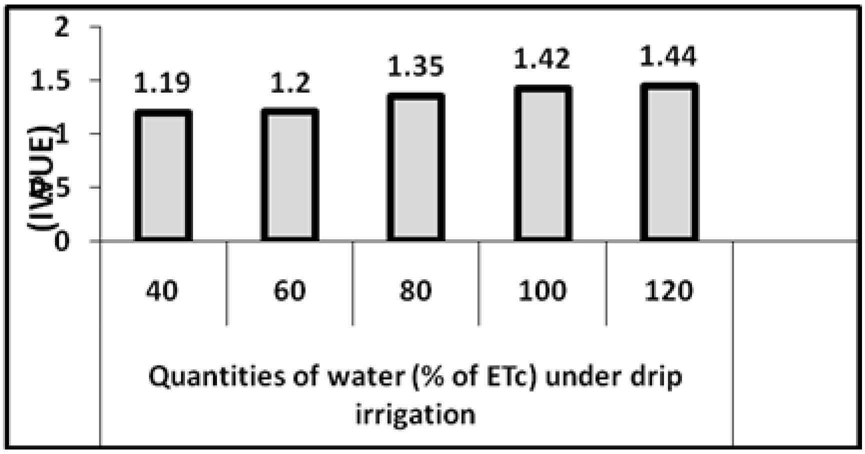

Figure 1. Irrigation water use efficiency (IWUE).

The highest irrigation water use efficiency (1.44 and 1.42 kg/m^3) was obtained with 120% and 100% of ET_c (Fig. 1). These results are inconsistent with Dagdelen *et al.* (2009) who reported that in cotton the highest irrigation water use efficiency was observed at 25% soil water depletion under drip (1.46 kg/m^3), and the least at 100% . Their results also demonstrated that irrigation of cotton to 75% soil water depletion had significant benefits in terms of saved water and large water use efficiency indicating an advantage of deficit irrigation under limited water supply conditions. Zeng *et al.* (2009) found that the lower the amount of irrigation water applied, the higher the irrigation water use efficiency obtained.

The partial factor productivity was higher with 100% and 120% of (ET_c) compared to other treatments (Fig. 2). These results agree with those of Bashour and Nimah (2004) that a proper fertilisation program increased water use efficiency and improve productivity.

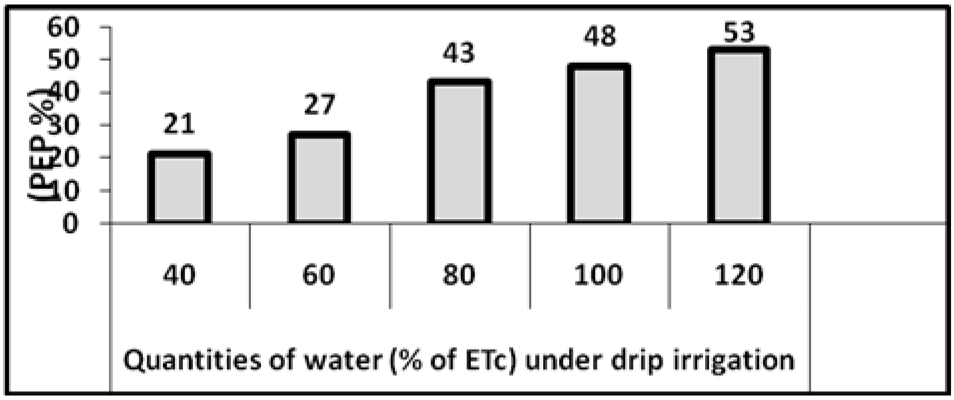

Figure 2. The partial factor productivity (PEP).

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