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Developing Drip Irrigation and its Nitrogen Fertigation, Using Sub Recommended Levels for Commercial Production of Clay Loam Soil Cultivated Banana Plants

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ABSTRACT

Two field experiments were conducted at Badaway district, Dakahlia Governorate during 2017 and 2018 seasons. This study aimed to investigate the effect of drip irrigation levels of 120, 100% and deficit drip irrigation at 80 % of crop evapotranspiration, drip fertigated nitrogen rates of 100 % (N_1) recommended, 80 % (N_2) and 60 % (N_3) sub recommended rates and their interaction on growth attributes, fruit yield and its components and water use efficiency of clay loam soil cultivated banana plants var. Grand Nain banana. Also to detect levels and rates that save water and nitrogen fertilizer, maximize WUE. The results revealed that, drip irrigation at 80 % ETc level (deficit drip I) save 20 % water, maximize WUE and gave potential effect and high values of growth attributes and significantly high fruit yield and its components similar to / or more than that obtaining by drip irrigation 100 % of ETc recommended level of clay soil cultivated banana plants. 80 % sub recommended drip fertigated nitrogen rate save 20 % nitrogen fertilizer and gave the same effects on banana growth and productivity as drip irrigation level of 80 % ETc. The most potent concluded was 80 % ETc deficit drip irrigation level x 80 % sub recommended drip fertigated nitrogen, which save 20 % irrigation water and 20 % N fertilizer, maximize WUE and gave potential growth attributes, high yield and its components equal significantly to that of 100 % ETc X 100 N (recommended drip irrigation and its fertigated N levels) of clay loam soil cultivated banana plants.

Keywords: *banana, drip irrigation, fertigated N levels, WUE, ETc, fruit yield.*

INTRODUCTION

Banana fruit crop known as most important crop worldwide due to its high nutritional value. Also, it was known as a crop with high water and fertilizer requirements.

Many world contraries depend mainly on drip irrigation and fertigation in banana farms. This case is true and the same in Egyptian new land sandy soil. Where drip irrigation and fertigation are followed according to the right obvious agricultural ministry instructions. In Egypt old lands of mostly clay heavy soil followed surface irrigation and the classic methods of fertilization causing high losing of irrigation water and fertilizers.

With low water and fertilizers use efficiency, recently drip irrigation and fertigation were followed in clay soil cultivated banana in some areas and in narrow scale with no official recommendation. Therein, drip irrigation and its fertigation of old clay soil cultivated banana plants used mostly in random way with no development and right managements. This mainly causes great water and fertilizer losses. So, drip irrigation and drip fertigation of clay soil cultivated banana plants in old soil still be need to develop and detecting the right accurate levels for saving water and fertilizers with less or no losses and at the same time obtaining high fruit yield. Many investigator study the effect of different levels of drip irrigation and nitrogen fertigation on banana plants and other crops cultivated in different soils (Priyanka *et al.*, 2015; Taia and Weel, 2015; Sanjit and Sammay, 2016; Sanjit *et al.*, 2016 and Oliver *et al.*, 2019), dealing with impact of drip irrigation of fruits yield and its components of banana and other crops. (Navaneetha *et al.*, 2013; Patel and Tandel, 2013; Sanjit *et al.*, 2016 and Senthile *et al.*, 2017) regarding the impact of nitrogen fertigation rates on fruit yield and its components, (Ahmed *et al.*, 2010; Sanjit *et al.*, 2016; Senthile *et al.*, 2017) with respect to the interaction effects on fruit yield and its components of banana and some other crops.

On the other hand, it was reviewed the impact of drip irrigation levels on banana plants growth attributes (Pereira *et al.*, 2002; Fereres and Soriano, 2007; Amer, 2011; Jeelan *et al.*, 2017; Ahmed *et al.*, 2019; Sanjit and Sammay, 2016 and Oliver *et al.*, 2019). Sriniva (1977); Singh and Suryanaryana (1999); Srinivas *et al.*, (2001); Muygan (2003); Patel and Tandel (2013); Navaneeth *et al.*, (2013) regarding effect of N rates on banana growth attributes. Kumar *et al.*, (2005); Ahmed *et al.*, (2010); Sanjit and Sammay, (2016) and Senthile *et al.*, (2017) with respect to interaction effect on banana growth attributes.

The present study aimed to investigate the influence of different drip irrigation regimes, drip fertigation nitrogen rates and their interaction on growth attributes, fruit yield and its components of clay soil cultivated banana plants. Drip irrigation and nitrogen under clay soil condition for banana cultivation still be need scientific and accurate adjustment of their levels with no random non beneficial over applications. Reaching and detecting accurate levels to save more water and nitrogen and at the same time obtaining high fruit yield using deficit drip irrigation and sub recommended rate of drip applied nitrogen. This open, the road for achieving an initial new potential approach of drip irrigation and drip nitrogen

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fertigation to be applied as most effective, cost effective and safe procedure for banana production in clay soils.

MATERIALS AND METHODS

Drip irrigation levels and drip fertigated nitrogen rates:

Drip irrigation in clay soil at levels 100 % of ETc was calculated according to equation of Penman–Monteith formulae (2006) and used as a reference recommended level, drip nitrogen fertigation levels at 100 % rate take from the commonly used in all banana farms in the experiment district as a reference recommended rate, all for clay soil cultivated banana plants. The other studied levels were calculated as a ratio from 100 %.

Physical and chemical properties of the soil are illustrated in Table 1, the field capacity, the permanent wilting point percentage, the available water and bulk density were determined as soil content show in Table 2, while, Table 3, shows the meteorological data in the district, during the two seasons of the study.

Table 1. Physical and chemical properties of the soil.

Parameter	Value	Parameter	Value
Particle size distribution (%):		EC (dS/m, soil paste extract)	1.1
Clay %	39.3	Saturation percent	67.5
Silt %	31.5	Cations and anions in soil paste extract (mmolc/L):	
Fine sand %	28.1		
Coarse sand %	1.1	Na^+	4.1
Texture class	Clay loam	K^+	0.41
$CaCO_3$ g / kg soil	35.9	Ca^{++}	3.07
Organic matter g / kg soil	17	Mg++	2.63
Total N (%)	0.14	$CO_3^=$	0
* Available K mg / kg soil	191.9	HCO_3^-	3.85
* Available P mg / kg soil	11.5	Cl^-	3.7
pH (1: 2.5 w/v soil water suspension)	7.7	$SO_4^=$	2.66

*** Extracts of NH_4 – acetate (for K), and sodium bicarbonate (for P).**

Table 2. Field capacity, wilting point, available water and bulk density of soil at various depths.

Depths	Field capacity (FC)		Wilting point (WP)		Available water (AW)		Bulk density
	% by weight	(cm)	by weight %	(cm)	by weight %	(cm)	(BD) g/cm^3
0-15	38.8	6.81	18.7	3.28	20.1	3.53	1.17
15-30	37.7	6.84	17.8	3.23	19.9	3.61	1.21
30-45	35.9	6.68	17.9	3.33	18	3.35	1.24
45-60	32.3	6.10	17.2	3.25	15.1	2.85	1.26
Total		26.43		13.09		13.34	

FC: moisture at 33 kPa moisture tension. WP: moisture at 1.5 MPa moisture tension. AW = FC – WP.

Soil moisture was determined grave metrically on oven dry basis of soil samples taken from depths of 15 cm. up to 60 cm.

Table 3. Meteorological data in 2017/18 and 2018/19 seasons.

Month	T max	T min.	W S	R H	S S	R F
			2017/2018			
February	21.3	12.1	2.7	67.0	8.2	41.6
March	22.6	12.5	3.5	60.8	8.5	0.4
April	25.9	14.2	3.5	57.7	9.3	30.6
May	30.9	18.4	3.5	50.8	10.5	14.7
June	33.7	21.5	3.4	51.7	11.8	0.0
July	35.9	24.0	3.4	53.8	12.0	0.0
August	34.9	24.4	3.2	56.4	11.9	0.0
September	32.9	22.3	3.3	57.4	11.0	0.0
October	28.3	19.3	3.3	62.4	10.2	0.0
November	23.9	15.9	2.9	64.4	9.1	20.5
December	21.3	14.0	3.2	68.9	8.6	6.3
January	18.9	11.3	3.9	68.9	8.1	33.6
			2018/2019			
February	19.7	10.0	3.4	63.6	8.3	12.3
March	26.1	13.7	3.1	53.3	8.4	2.2
April	27.9	15.6	3.3	53.9	9.5	5.6
May	32.1	20.0	3.7	52.5	10.4	3.4
June	33.8	22.3	3.5	50.5	11.2	0.0
July	35.1	23.8	3.6	55.3	12.4	0.0
August	34.4	24.3	3.4	58.2	11.8	0.0
September	33.4	23.4	3.2	57.7	11.1	0.0
October	29.6	21.0	3.3	59.3	10.3	0.0
November	25.3	17.5	2.9	62.1	9.3	22.6
December	20.2	13.3	3.7	66.9	8.5	23.6
January	18.2	8.8	4.0	60.2	8.2	13.9

Where: Tmax., Tmin.= maximum and minimum temperatures °C; WS = wind speed (m/sec); RH= relative humidity (%); SS = actual sun shine (hour) and RF = rainfall (mm / month). [Data were obtained from the agrometeorological Unit at SWERI, ARC].

Table 4. Penman- Monteith formulae in 2017/2018 and 2018/2019 seasons.

Season		Penman- Monteith (ETo)			
		2017/2018		2018/2019	
Month	Kc	mm/day	mm/month	mm/day	mm/month
February	0.75	3.60	100.8	3.24	90.7
March	0.80	4.12	127.7	4.70	145.7
April	0.81	5.19	155.7	5.64	169.2
May	0.81	6.86	212.7	7.07	219.2
June	1.03	7.61	228.3	7.69	230.7
July	1.18	8.66	268.5	8.00	248.0
August	1.17	7.41	229.7	7.30	226.3
September	0.93	6.44	193.2	6.43	192.9
October	0.96	4.77	147.9	5.12	158.7
November	0.92	3.30	99.0	3.59	107.7
December	0.87	2.63	81.5	2.82	87.4
January	0.76	3.13	97.0	2.81	87.1
Seasonal (mm)			1942		1964

Experimental design and treatments:-

Split plot design with three replicates was adopted.

Irrigation treatments (main plots):

Three amounts of applied irrigation water based by Penman- Monteith equation were tested in this experiment. The irrigation treatments were as follow:

I_1: Irrigation with amount of water equals 120 % of potential evapotranspiration crop (ETc) (9406 and 9610 m^3/fed. at first and second seasons respectively).

I_2: Irrigation with amount of water equals 100% of ETc (7838 and 8008m^3/fed. at first and second seasons respectively).

I_3: Irrigation with amount of water equals 80 % of ETc (6270 and 6406 m^3/fed. at first and second seasons , respectively).

Drip fertigated nitrogen (DFN) treatment (sub-plots):-

N_1 = 100 % N (200g / plant / year.

N_2 = 80 % N (160g / plant / year.

N_3 = 60 % N (120g / plant / year.

- Ammonium sulphat 21 % N used as N source.

Crop-soil-water relations:

Calculation of crop coefficient and evapotranspiration:

The actual evapotranspiration (ETa) or water consumption is a key parameter in the water balance, describing the processes within the soil–water–atmosphere–plan environment and is an important parameter for irrigation scheduling. The methods available for the calculation of the ETa vary from very simple, more empirically based approaches to complex, more physically based approaches. A first approach is based on the calculation of a reference evapotranspiration (ETo) and subsequent calculation of the crop evapotranspiration (ETc) by multiplying ETo with a crop factor kc. For the calculation of ETo, several methods are available, going from more simple to more complex.

Reference crop evapotranspiration (ETo):

ETo values were calculated based on local meteorological data of the experimental site Table 3. and according to the Penman-Monteith equation (FAO, 1998). Calculations were performed using the CROPWAT model (FAO, 1992).

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34 u_2)}$$

Where:
ETo: reference evapotranspiration (mm day-1),
Rn: net radiation at the crop surface (MJ m^{-2} day^{-1}),
G: soil heat flux density (MJ m^{-2} day^{-1}),
T: mean daily air temperature at 2 m height (°C),
u2:wind speed at 2 m height (m s-1),
es: saturation vapor pressure (kPa),
ea: actual vapor pressure (kP)
es-ea: vapor pressure deficit (kPa),
Δ: slope of the vapor pressure-temperature curve (kPa °C-1),
γ: psychrometric constant (kPa °C-1).

Crop evapotranspiration (ETc)

The ETc values were calculated according to the following equation given by FAO (1977):

$$ETc = ETo \ X \ Kc$$

Where:
ETc : crop evapotranspiration (mm day^{-1})
ETo : reference crop evapotranspiration (mm day^{-1})
Kc : crop coefficient

Soil water relations:

1- Amount of applied irrigation water (AIW):

The amount of applied water was measured by a flow meter and was calculated according to the following equation (FAO, 1985):

$$AIW = \frac{Sp \ X \ S_l \ X \ ETo \ X \ Kc \ X \ Kr \ X \ I_{interval}}{Ea} + LR$$

Where:
AIW= applied irrigation water depth (liters/day).
Sp= distance between plants in the same line (m).
S_l= distance between lines (m).
ET_o= potential evapotranspiration (mm/day) values obtained by Penman- Monteith equation.
K_c = crop coefficient.
K_r= reduction factor that depends on ground cover. It equals 0.7 for mature trees (FAO, 1979).
E_a= irrigation system efficiency 0.90
Where: $I_{interval}$ = irrigation intervals (days) = 1 day for the experimental site.
LR= leaching requirements (FAO, 1977).

$$LR = \frac{EC_w}{2 MaxEC_e}$$

Where: EC_w = electrical conductivity of the irrigation water (1.2 dS/m), Max EC_e = maximum tolerable electrical conductivity of the soil saturation extract for banana crop (5 dS/m).

Water utilization efficiency (WUE):

Applied irrigation water is used to describe the relationship between production and the amount of water applied. It was determined according to the following equation (Jensen 1983):

$$WUE = \frac{\text{Total fruit yield (Ton / feddan)}}{\text{Seasonal AIW (m}^3\text{ water applied/feddan)}}$$

Soil analysis:

Particle size distribution was conducted using the pipette method and bulk density according to Klute, (1986). Soil pH, electric conductivity (EC) and cationic and anionic compositions of the saturation extract of the soil were determined according to the standard methods described by Page *et al.,* (1982). Soil moisture constant was determined using the pressure membrane apparatus, considering the saturation percent (SP) at KPa tension. Field capacity (FC) and wilting point (WP) at 0.33 and 15 bar, respectively. Available water is the difference between FC and WP (Stackman, 1966).

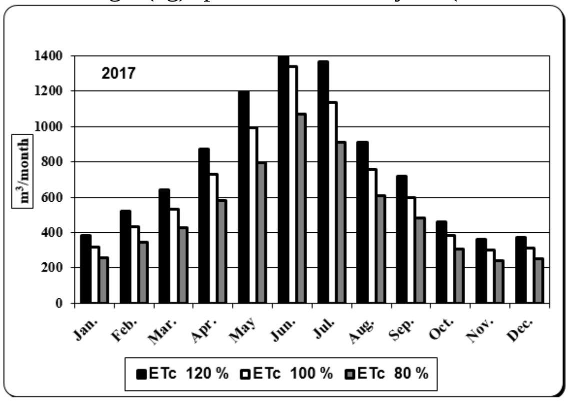
Botanical parameters:-

At mid-season, two banana plants per plot were used to record growth attributes expressed as

- Pseudo stem height (cm).
- Pseudo stem diameter (cm).
- Number of active leaves / plant.

At harvesting, fruit yield and its components were determined, those were as follows:

- Hand number / bunch. - Finger number / hand.
- Hand weight (kg). - Finger weight (g).
- Finger length and width (cm). - Bunch length (cm).
- Bunch weight (kg) / plant. - Fruit yield (ton / feddan).



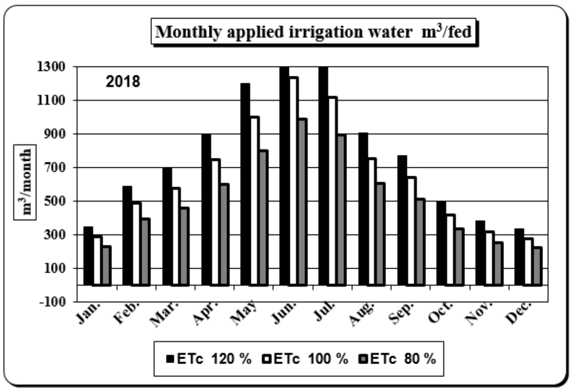


Fig. 1. Monthly applied irrigation water (m^3/month) for banana plants at different irrigation treatments during 2017/2018 and 2018/2019 seasons.

RESULTS AND DISCUSSION

1.Vegetative growth attributes:

Effect of drip irrigation regimes:

Data presented in Table (5) show effect of drip irrigation regimes (DI. Over drip irrigation at 120 % of ETc, D2 normal drip irrigation at 100 % of ETc and D3 deficit drip irrigation at 80 % of ETc) on clay soil cultivation banana crop vegetative growth attributes (pseudo stem height, pseudo stem width and number of active leaves / plant) in two successive seasons of 2017 and 2018). The same data revealed that, D2 had the highest pseudo stem height followed by DI3 and by DI1 with significant differences between them in both seasons. While, there were insignificant differences in pseudo stem diameter and number of active leaves / plant as affected by the applied three drip irrigation /regimes (DI_1, DI_2 and DI_3) in the two seasons, the unique exception was of pseudo- stem diameter which increased significantly by DI_2 compared with DI_1 treatment in the first season only.

Table 5. The Effect of drip-irrigation levels on (pseudo - stem length – pseudo - stem diameter - No. of active leave/plant) during seasons 2017-2018.

Drip irrigation levels	Pseudo - stem length (cm)		Pseudo - stem diameter (cm)		No. of active leaves / plant	
	2017	2018	2017	2018	2017	2018
120%ETc	222.77 c	218.36 c	70.77 b	73.7 a	11.55 a	12.03 a
100%ETc	256.11 a	265.17 a	75.77 a	78.45 a	11.11 a	11.51 a
80%ETc	246.22 b	254.18 b	73 ab	75.37 a	11.55 a	11.93 a

The same data indicated that deficit drip irrigation 80 % of ETc (DI_3) considered as better treatment due to its significant effect on banana growth attributes as the recommended drip irrigation, (ID_2 treatment 100 % of ETc), at the same time save irrigation water by 20 % while DI, (over drip irrigation regime 120 % of ETc) save no water but losses 20 % of it compared to the recommended drip irrigation regime DI_2, 100 % of ETc and 40 % compare to deficit drip irrigation 80 % ETc which supply its plants with no excess water, in turn provide suitable soil condition of proper oxygen and moisture content conducive to root growth and respiration and the whole plant growth and reproductive performance the reverse was true for over drip irrigation regime 120 % of ETc since it gave extra water reduced O_2 content of the soil space which filling with water like. This may be impaired the root respiration and growth and the subsequent reproductive performance. Generally, drip irrigation used as an efficient irrigation methods to improve growth and increase yield of different crops as well as to save water consumption (Kumar *et al.*, 2005; Jeelani *et al.*, 2017 and Ahmed *et al.*, 2019). But it still be need more development and well scientific non- random management for saving more irrigation water and raising crops productivity. Present results proved that, deficit drip irrigation regime considered a new efficient strategy to save more irrigation water and at the same time improve crop growth measurements (Pereira *et al.*, 2002, Fereres and Soriano 2007; Amer 2011). It can be supply the plant accurately and timely with water, which it need for growth and development with no over watering or losses. Deficit drip irrigation slowed that supply the plants with reduce amount of water which directly go to root zone, plants uptake and utilize with all the supplied water with no losses to give the same significant growth and yield (Kirda *et al.*, 2004; Costa *et al.* 2007, Patane *et al.*, 2011; Owusu-Sekyere *et al.*, 2012).

Among this finding, Sanjit and Sammay (2016) investigate the effect of drip irrigation regimes at 50, 60 and 70 % of CPE compared with 100 % CPE on banana growth attributes, they found that 60 % of CPE drip irrigation regime gave the highest growth attributes, highest WUE and save irrigation water by 40 %. Oliver *et al.*, (2019) found that, among the applied drip irrigation regimes 100, 90 and 80 % of ETc to banana plants; 90 % of ETc (deficit drip irrigation regime) gave similar significant effect as treatment of 100 % ETc, gave higher growth parameters without any adverse effects or growth reductions and saving irrigation water by 10 %.

Effect of drip fertigated N rates:

Among the nutrients N is the most essential element has important influence on plant growth, flowering and productivity in (Mostafa and Kumar, 2017). This is due to its participation in the synthesis of chlorophyll, amino acids, proteins, enzymes, phytohormones (IAA and Cytokinins) and the nucleic acids (DNA and RNA). Data in Table (6) showed the effect of three fertigated nitrogen rates N_1 (RFN 100 %), N_2 80 % of the recommended (RFN) and N_3 (60 % of the RFN) on banana growth attributes during 2017 and 2018 seasons. This data cleared that growth attributes were increased along with increasing rates of the fertigated N with less significant differences between the applied N treatments in the two seasons. N_3 rate had the highest significant values of number of active leaves compared with N_1 and N_2 rates with no significant differences among them at both seasons. Similar results were obtained by Hedge and Srinivas (1990); Srinivas, (1997); Singh and Suryanaryana (1999); Srinivas *et al.*, (2001); Murugan, (2003); Gamapathy *et al.*, (2011); Navaneetha *et al.*, (2013); Patel and Tandel (2013) and Sanjit and Sammay (2016).

Table 6. The effect of fertigation nitrogen levels on (pseudo stem length – pseudo stem diameter - No. of active leave/ plant) during seasons 2017-2018.

Fertigation nitrogen levels	Pseudo - stem length(cm)		Pseudo - stem diameter (cm)		No. of active leaves / plant	
	2017	2018	2017	2018	2017	2018
60% N(N_3)	243.55 a	252.21 a	73.44 a	76.07 a	11.88 a	12.32 a
80% N(N_2)	242.88 a	251.87 a	74.33 a	77.1 a	11.22 b	11.64 b
100% N(N_1)	238.66 a	247.23 a	71.7 a	74.35 a	11.11 b	11.51 b

Among this findings, Navaneeth *et al.*,(2013) found that, among the applied fertigated nitrogen (N) rates (50, 100, 200, 250, 300 g / plant, 200 g rate gave the highest banana growth attributes i.e., stem length, stem diameter and number of active leaves and the highest fruit yield and its components.

Patel and Tandel (2013) showed that the fertigated N levels (100, 150, 250 g / plant), 200 g N / plant as soil application (broadcast), 150 g fertigated N gave the highest growth attributes and the highest fruit yield and its components of banana plants. Sanjit and Sammay (2016) found that provided banana plants with 80 % of the recommended N gave the highest growth attributes, save fertilization either via fertigation or via traditional soil fertilization, also, it gave the highest banana fruit yield and its components.

Effect of interaction:

Data in Table (7) showed that the interaction significantly banana growth attributes in both seasons, where the highest significant value of number of active leaves / plant were affected of 120 % ETc X 60 % DFN followed by 80 % ETc X 80 % DFN, respectively with insignificant differences between them in both seasons. Regarding pseudo - stem width the highest value was of 100 ETc X 60 % DFN followed by 80 % ETc X 80 % DFN and 100 % ETc X 80 % DFN without significant differences between them in both seasons. Also, data revealed that, the highest values of pseudo - stem length were of 100 % ETc X 60 % DFN followed by 100 % ETc X 60 % DFN without significant differences among tem in two seasons. Also, 80 % ETc X 60 % DFN followed by 80 % ETc X 80 % DFN were considerable beneficial effect with insignificant differences among them in the two seasons. From these results and based on the reported importance of the number of active leaves and pseudo - stem width of banana growth parameters (Mahendran *et al.*, 2013) drip irrigation at 80 % ETc X DFN at 80% N rates was of the best effect on growth, saved 20 % irrigation water and 20 % N fertilizer. So, could be considered interaction treatment of 80 % ETc X 80 % DFN as the best treatment conducive for growth of banana plants. Our results were in agreement with those obtained by (Kumar et *al.*, (2005); Ahmed *et al.*, (2010); Sanjit and Sammay (2016) and Senthile *et al.*, (2017).

Table 7. The effect of interaction treatments (drip-irrigation / fertigation-nitrogen) levels on (pseudo stem length – pseudo stem diameter - No. of active leave/plant) during seasons 2017-2018.

interaction treatments		Pseudo - stem length (cm)		Pseudo - stem diameter (cm)		No. of active leaves/plant	
		2017	2018	2017	2018	2017	2018
120%ETc	60% N(N_3)	210 f	218.36 f	68.66 c	71.43 d	13 a	13.53 a
	80% N(N_2)	220.66 ef	230.16 ef	72.66 abc	75.8 abcd	10.66 c	11.13 b
	80% N(N_1)	237.66 d	247.33 d	71 bc	73.86 bcd	11 bc	11.43 b
100%ETc	60% N(N_3)	265 a	274.26 a	77.66 a	80.36 a	11.33 bc	11.73 b
	80% N(N_2)	260 ab	269.43 ab	75 ab	77.73 ab	11 bc	11.4 b
	80% N(N_1)	243.33 cd	251.83 cd	74.66 ab	77.26 abc	11 bc	11.4 b
80%ETc	60% N(N_3)	255.66 abc	264 abc	74 abc	76.43 abcd	11.33 bc	11.7 b
	80% N(N_2)	248 bcd	256.03 bcd	75.33 ab	77.76 ab	12 ab	12.4 ab
	80% N(N_1)	235 de	242.53 de	69.66 bc	71.93 cd	11.33 bc	11.7 b

2.Fruit yield and its components:

Effect of drip irrigation levels:

The effect of drip irrigation levels on banana fruit yield and its components were presented in Tables (8, 11, 14 and 17). Table 8 showed that the effect of drip irrigation levels on bunch length, number of hands / bunch and number of finger / hand, such data revealed that irrigation at 100 % and 80 % of ETc gave similar effect and approximately the same highest values of number of hands / bunch and number the fingers / hand with insignificant differences, while 120 % of ETc level had lowest significant decrease in both seasons. 80 % level of ETc gave the highest significant value of bunch length; while the lowest values obtained from 100 % and 120 % ETc without significant differences among them in two seasons of the study. The data in Table (11) indicated that drip irrigation levels at 100 % and 80 % of ETc gave the highest values of finger height and width with insignificant differences among them in the two seasons; whereas the lowest significantly values were of irrigation at 120 % of ETc at both seasons.

Table 8. The effect of drip-irrigation levels on (bunch height- No. of hands per bunch - No. of fingers per hand) during seasons 2017-2018.

Drip irrigation levels	Bunch height (cm)		No. hands per bunch		No. fingers per hand	
	2017	2018	2017	2018	2017	2018
120%ETc	94.55 b	98.44 b	9.55 b	9.66 b	22.33 b	23.11 b
100%ETc	95.88 b	99.28 b	10.55 a	10.88 a	25 a	25.77 a
80%ETc	101.44 a	104.71 a	10.33 a	10.66 ab	24.44 a	25.22 a

The data presented in Table (14) revealed that drip irrigation at 100 and 80 % of ETc gave the highest values of hand and finger weight with insignificant differences, while the lowest values were of 120 % of ETc with significant differences relative to the prior two levels.

Table (17) illustrated bunch weight / plant and yield of banana fruits (ton) / fed as affected by drip irrigation levels. The data cleared that the highest values were of 100 % of ETc followed by 80 % of ETc with slight significant differences and at least 120 % of ETc drip irrigation levels with significant differences between it and the previous two levels in the two seasons. Under present work conditions deficit drip irrigation at 80 % of ETc level could be considered as the best irrigation treatment, since it save irrigation water by 20 %, maximize water use efficiency Table (20), at the same time gave higher potential effects and values of banana fruit yield and its components significantly and approximately similar to 100 % of ETc level, also it affected growth attributes (Table 4) specially stem diameter and active leaves number that positively linked with fruit yield and its components in similar way. These results were in accordance with those obtained by Priyanka *et al.*, (2015); Taia and Weel (2015); Sanjit and Sammay (2016); Sanjit *et al.*, (2016) and Olivere *et al.*, (2019).

Effect of drip fertigated nitrogen rates:

Among the nutrients N is the most essential element has important influence on plant growth, flowering and productivity in banana (Mostafa and Kumar, 2012). This is due to its participation in the synthesis of chlorophyll, amino acids, proteins, enzymes, phytohormones, IAA and cytokinins and the nucleic acids (DNA and RNA). The data presented in Tables (9, 12, 15 and 18) showed that the effect of the drip fertigated with nitrogen rates on banana fruit yield and its components in the two experiment seasons. Table 9 cleared that, the highest values of number of hands / bunch and number of finger / hand were of 100 % nitrogen rate recommended and 80 % of the recommended rate with insignificant differences among them, while insignificantly low values were of 60 % nitrogen. The same data showed that, the highest values of bunch length were obtained from 80 and 60 % nitrogen without significantly differences among them in the two seasons. The lowest significant values were of 100 % nitrogen in the two seasons.

Table 9.The effect of fertigation nitrogen levels on (bunch length- No. of hands per bunch - No. of fingers per hand) during seasons 2017-2018.

Fertigation nitrogen levels	Bunch length (cm)		No. hands per bunch		No. fingers per hand	
	2017	2018	2017	2018	2017	2018
60% N(N_3)	102.11a	105.77a	9.33b	9.55b	22.88b	23.55b
80% N(N_2)	100.88a	104.58a	10.44a	10.66a	24.33a	25.11a
100% N(N_1)	88.88b	92.07b	10.66a	11a	24.55a	25.44a

The data of Table (12) revealed that the highest values of finger length came from 80 % nitrogen followed by 100 % with insignificant differences and the significantly lowest ones were of 60 % nitrogen in both seasons. Also, the same data indicated that, nitrogen rate of 80 % followed by 100 % gave the highest finger width values with insignificant differences among them; the lowest finger width was of 60 % nitrogen in both seasons. Table (15) showed that, the highest hand weight was of 100 % nitrogen followed by 80 rates with insignificant differences among them in both seasons, the lowest significant values were of 60 % nitrogen in the two seasons.

The same data revealed that nitrogen rate of (80 %), gave the highest finger weight followed by 100 % with insignificant differences among them only in the first season, while the lowest significant values were of 60 % nitrogen in the first season only. In the second season the highest values were of 60 and 80 % nitrogen without significantly differed, while the lowest significantly values were of 100 %. Values of total fruit yield and bunch weight / plant were presented in Table (18) they were affected by different nitrogen rates obviously 80 % nitrogen was the most superior one followed by 100 % nitrogen rate and 60 % nitrogen rate; the differences between them were significant in both seasons. Mostly rates of nitrogen at 80 % and 100 % were of the best effect on banana fruit yield and its components with significant differences among them. The significant lowest values were of 60% rate at both seasons. Nitrogen treatment rate at 80 % save 20 % of the fertigated nitrogen and gave best effect on banana fruit yield and yield components similar to or more than (100 %) of the recommended rate. Therefore, it could be considered as the best nitrogen rate. Similar results were obtained from Hegde and Srinivas (1990); Srinivas, (1997); Singh and Suryanaryana (1999); Srinivas *et al.,* (2001); Murugan, (2003); Canapathy *et al.,* (2011); Navaneetha *et al.,* (2013); Patel and Tandel (2013) and Sanjit and Sammay (2016).

Effect of the interaction:

The presented data in Table (10) illustrated the effect of interaction of drip irrigation levels at 80, 100 and 120 % of ETc with the drip fertigated nitrogen rates at 60 %, 80% and 100 % on bunch length, number of hands / bunch and number of finger / hand of clay soil cultivated banana plants in both seasons of the present study. The same data cleared that the interaction was significantly affected all presented banana yield components in both seasons.

Table 10. The effect of interaction treatments (drip-irrigation / fertigation-nitrogen) levels on (bunch length - No. of hands per bunch - No. of fingers per hand) during seasons 2017-2018.

interaction treatments		Bunch length (cm)		No. hands per bunch		No .fingers per hand	
		2017	2018	2017	2018	2017	2018
120%ETc	60% N(N_3)	98.66 cd	102.63 cd	**9** c	9 B	21.66 e	22.33 f
	80% N(N_2)	95 de	99.03 de	9.66 c	9.66 B	22.33 de	23 ef
	80% N(N_1)	90 f	93.66 f	10 bc	10.33 b	23 cde	24 de
100%ETc	60% N(N_3)	102.33 bc	105.93 abc	9.66 c	10 B	23.66 bcde	24.33 cde
	80% N(N_2)	100.33 c	103.96 bcd	10 bc	10.33 B	25 abc	25.66 bc
	80% N(N_1)	85 g	87.96 g	12 a	12.33 a	26.33 a	27.33 a
80%ETc	60% N(N_3)	105.33 ab	108.76 ab	9.33 c	9.66 B	23.33 bcde	24 de
	80% N(N_2)	107.33 a	110.76 a	11.66 ab	12 a	25.66 ab	26.66 ab
	80% N(N_1)	91.66 ef	94.6 ef	10 bc	10.33 b	24.33 abcd	25 cd

Table 11. The effect of drip-irrigation levels on (finger length– finger width) during seasons 2017-2018.

Drip irrigation levels	Finger length (cm)		Finger width (cm)	
	2017	2018	2017	2018
120%ETc	19.44 b	20.1 b	3.64 b	3.69 b
100%ETc	22.33 a	23.07 a	4.10 a	4.20 a
80%ETc	21.88 a	22.52 a	4.00 ab	4.06 ab

Table 12. The effect of fertigation nitrogen levels on (finger length – finger width) during seasons 2017-2018.

Fertigation nitrogen levels	Finger length(cm)		Finger width (cm)	
	2017	2018	2017	2018
60% N(N_3)	20.22 b	20.83 b	3.73 a	3.78 a
80% N(N_2)	21.77 a	22.51 a	4.01 a	4.10 a
100% N(N_1)	21.66 a	22.35 a	4.00 a	4.07a

It was obvious from this data that the highest values of number of hands / bunch and number of finger / hands were of 100 % of ETc drip irrigation X 100 % nitrogen fertigation interaction followed by 80 % of ETc drip irrigation X 80 % nitrogen fertigation interaction with insignificant differences among them, while the lowest significantly values resulted from drip irrigation at 120 % of ETc X 60 % nitrogen. All results were in the same trend in the two seasons.

In similar the data in Table (13) revealed that, the highest banana finger length and width were obtained from plants of (drip irrigation at 100 % of ETc level X 100 % of fertigated nitrogen rate) followed by (drip irrigation at 80 % of ETc X 80 % fertigated nitrogen) interaction with insignificant differences among them in both seasons, while the significantly lowest values were of (drip irrigation at 120 % of ETc X 60 % nitrogen) interaction in both seasons. The data presented in Table (16) showed that, the highest values of finger and hand weights were of treatments of (irrigation at 100 % of ETc level X 100 % nitrogen) followed by (irrigation at 80 % of ETc level X 80 % nitrogen) with no significant differences among them in both seasons. The lowest values were of (irrigation at 120 % of ETc X 60 % nitrogen) at both seasons.

Regarding, bunch weight / plant and total fruit (ton) / fed the data presented in Table 19 cleared that; the interaction was significantly affected banana fruit yield and bunch weight at the two seasons. Such data also showed that, interaction treatment of (irrigation at 100 % of ETc level X 100 % nitrogen) and of (irrigation at 80 % of ETc X 80 % nitrogen) were of the highest values with insignificant differences among them in the two seasons, while the significantly lowest values was of (irrigation at 120 % of ETc X 60 % nitrogen) at both seasons. Mostly the interaction treatments affected banana fruit yield and its components in similar fashion to their effects on growth attributes and mostly number of active leaves and pseudo stem diameter Table (7). Similar enhancable effect of the superior interactions could be extended to the subsequent reproductive phase and fruit yield case of banana plants. It was found that banana plants number of active leaves and pseudo stem diameter are positively linked with banana plants fruit yield and its components due to increase in synthesis, translocation and accumulation of photometabolites within fruits (Nyombi, 2000; Mahendran *et al.,* 2013; Hidoto, 2018). Also, it was known that banana flower and the small bunch are originated, initiated and grown from banana underground corm through pseudo stem and inside it until emergence from its terminal parts, so, stem diameter of banana plants considered as a good indicator parameter for prediction of its fruit yield (Mahendran *et al.,* 2013; Nyombi, 2010). Moreover sub recommended levels of the applied drip irrigation water and drip fertigated nitrogen (N) gave banana fruit yield approximately and significantly the same fruit yield as the obtained by the recommended rates, saving water and nitrogen and reduced their known losses. This lead to increasing WUE and NUE (Table 22)(Sanjit *et al.,* 2016 and Senthile *et al.,* 2017) on banana plants, increasing the efficiency of utilization of the applied water and N in the whole physiological and metabolically processes which reflected on plant growth and yield (Sanjit *et al.,* 2016 and Senthile *et al.,* 2017 on banana plants).

At least, the presented data in Tables (7, 10,13, 16 and 19) proved that interaction treatment of 80 % ETc X 80 % DFN from the recommended rates (100 %) was the best treatment which gave the highest banana fruit yield and its components, saved irrigation water by 20 % and nitrogen fertilization by 20 % and maximize WUE Table (22).

Table 13. The effect of interaction treatments (drip-irrigation / fertigation-nitrogen) levels on (finger length– finger width) during seasons 2017-2018.

interaction treatments		Finger length (cm)		Finger width (cm)	
		2017	2018	2017	2018
120%ETc	60% N(N_3)	18.33e	18.93e	3.55 b	3.60 c
	80% N(N_2)	20.33cde	21.03cd	3.65 ab	3.71 bc
	80% N(N_1)	19.66de	20.33de	3.71 ab	3.75 bc
100%ETc	60% N(N_3)	21.33bcd	22.03bcd	3.88 ab	3.93 abc
	80% N(N_2)	22abc	22.76abc	4.13 ab	4.29 ab
	80% N(N_1)	23.66a	24.43a	4.29 a	4.39 a
80%ETc	60% N(N_3)	21bcd	21.53cd	3.76 ab	3.81 abc
	80% N(N_2)	23ab	23.73ab	4.26 a	4.31 ab
	80% N(N_1)	21.66abcd	22.3bc	4.97 ab	4.07 abc

Table 14. The effect of drip-irrigation levels on (hand weight - finger weight) during seasons 2017-2018.

Drip irrigation levels	Hand weight (kg)		Finger weight (g)	
	2017	2018	2017	2018
120%ETc	2.04b	2.15b	83.35b	82.23b
100%ETc	2.4a	2.5 a	97.55a	98.48a
80%ETc	2.33a	2.43a	97.2a	97.67a

Table 15. The effect of fertigation nitrogen levels on (hand weight – finger weight) during seasons 2017-2018.

Fertigation nitrogen levels	Hand weight (kg)		Finger weight (g)	
	2017	2018	2017	2018
60% N(N_3)	2.16 b	2.25b	88.56b	95.57a
80% N(N_2)	2.28a	2.4a	94.97a	4.889 a
100% N(N_1)	2.32 a	2.43a	94.56a	87.93b

Table 16. The effect of interaction treatments (drip-irrigation / fertigation-nitrogen) levels on (hand weight - finger weight) during seasons 2017-2018.

interaction treatments		Hand weight (kg)		Finger weight (g)	
		2017	2018	2017	2018
120%ETc	60% N(N_3)	2 d	2.06 d	81.16f	79.2g
	80% N(N_2)	2.06cd	2.2 cd	83.86e	82.6f
	80% N(N_1)	2.06cd	2.2 cd	85.03e	84.9e
100%ETc	60% N(N_3)	2.3b	2.4b	91.33d	92.6d
	80% N(N_2)	2.3b	2.4b	100a	100.06bc
	80% N(N_1)	2.6a	2.7a	101.33a	102.8 a
80%ETc	60% N(N_3)	2.2 bc	2.4bs	93.2c	92 d
	80% N(N_2)	2.5a	2.6a	101.06a	102ab
	80% N(N_1)	2.3b	2.3 bc	97.33b	99.03c

Table 17. The effect of drip-irrigation levels on (bunch weight / plant - yield (ton/fed.)) during seasons 2017-2018.

Drip irrigation levels	Bunch weight / plant (kg)		Yield (ton / fed.)	
	2017	2018	2017	2018
120%ETc	18.61 c	18.88 c	14.9 c	15.1 c
100%ETc	24.38 a	25.15 a	19.5 a	20.11 a
80%ETc	23.84 b	24.48 b	19.06 b	9.581 b

Table 18. The effect of fertigation nitrogen levels on (bunch weight / plant - yield (ton/fed.)) during seasons 2017-2018.

Fertigation nitrogen levels	Bunch weight / plant (kg)		Yield (ton/fed.)	
	2017	2018	2017	2018
60% N(N_3)	18.61 c	18.88 c	14.9 c	15.1 c
80% N(N_2)	24.38 a	25.15 a	19.5 a	20.11 a
100% N(N_1)	23.84 b	24.48 b	19.06 b	9.581 b

3. Water use efficiency (WUE):

Effect of drip irrigation levels:

The data presented in Table (20) showed the effect of drip irrigation levels on water use efficiency of clay soil cultivated banana plants during the two experiment seasons. It was obvious from this data irrigation that at 80 % of ETc maximize WUE followed by at 100 of ETc and at least 120 % of ETc levels with significant differences between them in the two seasons. The data proved also that, deficit drip irrigation of clay soil cultivated banana plants at 80 % of ETc level significantly was maximized WUE, Saved 20 % of irrigation water and at the same time gave an noticeable effect on growth attributes, fruit yield and its components (previous tables of the present work). Harby, (2014) found that normal drip irrigation of clay soil cultivated banana lose 10 % or more of the applied water via evaporation. Meanwhile, it was reported that deficit drip irrigation and fertigation provide judicious amount of water and nutrients directly to root rizosphere, thereby enhance WUE and NUE of plants by allowing timely and reduced fertilization in root zone matching only with the plants need. Thus, the plants consumed and efficiently utilized with all the applied water and fertilizer in its growth and production and reduce deep percolation losses (Sanjit *et al.,* 2016 and Senthile *et al.,* 2017 on banana).Stimulating physiological and metabolical processes which reflected on plant growth and yield (Sanjit *et al.,* 2016 and Senthile *et al.,* 2017 on banana).

Table 19. The effect of interaction treatments (drip-irrigation / fertigation-nitrogen) levels on (bunch weight / plant- yield (ton/fed.)) during seasons 2017-2018.

interaction treatments		Bunch weight / plant (kg)		Yield (ton/fed.)	
		2017	2018	2017	2018
120%ETc	60% N(N_3)	16.7 f	17.03 h	13.4 f	13.6 h
	80% N(N_2)	18.73 e	18.86 g	15 e	15.1 g
	80% N(N_1)	20.4 d	20.76 f	16.3 d	16.6 f
100%ETc	60% N(N_3)	21.63 c	22.43 d	17.3 c	17.93 d
	80% N(N_2)	25.03 b	25.63 b	20 b	20.5 b
	80% N(N_1)	26.5 a	27.4 a	21.2 a	21.9 a
80%ETc	60% N.(N_3)	20.63 d	21.33 e	16.5 d	17.06 e
	80% N(N_2)	26.13 a	27.13 a	20.9 a	21.7 a
	80% N(N_1)	24.76 b	25 c	19.8 b	20 c

Table 20. The effect of drip-irrigation levels on (WUE) during seasons 2017-2018.

Drip irrigation levels	WUE(kg / m^3)	
	2017	2018
120%ETc	1.58c	1.59c
100%ETc	2.07b	2.12b
80%ETc	3.04a	3.1a

At least, the presented data in Tables (10,13, 16 and 19) proved that the interaction treatment of 80 % ETc , DI X 80 % DFN from the recommended rates (100 %) was the best treatment which gave the highest banana fruit yield and its components saved irrigation water by 20 % and nitrogen fertilization by 20 % as well as maximize plant WUE. Similar results and interpretation confirmed by the obtainable results of Ahmed *et al.,* (2010); Sanjit and Sammay (2016); Sanjit *et al.,* (2016) and Senthile *et al.,* (2017).

Effect of drip fertigated nitrogen rates:

The data presented in Table (21) cleared that; nitrogen rate of 100 % gave the highest water use efficiency value followed by 80 % rate and at least 60 % with significant differences between them in first season. While in the second one rates of 100% and 80 %, respectively, gave the highest WUE, they significantly not differed, 60 % N rate gave significantly the lowest value. Accordingly, due to the present effect of drip fertigated rates of N (100 % and 80 %) and due to their previous potential effect on growth attributes, fruit yield and yield components (previous data of this work). Therefore it could be considered that, 80% N rate was the best applied N rate; it also save 20 % of the applied N to clay soil cultivated and drip fertigated banana plants. Similar results were of Hedge and Srinivas (1991); Sanjit *et al.,* (2016) and Senthile *et al.,* (2017).

Table 21. The effect of fertigation nitrogen levels on (WUE) during seasons 2017-2018.

Fertigation nitrogen levels	WUE kg / m³	
	2017	2018
60% N(N3)	1.96c	2.01b
80% N(N2)	2.35b	2.39a
100% N(N1)	2.37a	2.40a

Effect of the interaction:

It was obvious from the data of Table (22) that the interaction treatments were significantly affected banana plants water use efficiency (WUE) during the two seasons. Absolutely the highest significant values were of (drip irrigation 80 % of ETc X 80 % N rate) treatment and the significantly lowest values were of 120 % of ETc X 60 % N levels) treatment at both seasons. The mentioned superiors of the interaction treatments effects, could be expected under the present work conditions, since the same interactions gave similar effect on banana plants growth attributes Table (11) and fruit yield (T/F), Table (19). The different treatments and values were agreed by findings of Fayrouz, (2020).

Table 22. The effect of interaction treatments (drip-irrigation / fertigation-nitrogen) levels on (WUE) during seasons 2017-2018.

interaction treatments		WUE kg / m³	
		2017	2018
120%ETc	60% N(N3)	1.42i	1.43i
	80% N(N2)	1.59h	1.59h
	80% N(N1)	1.73g	1.75g
100%ETc	60% N(N3)	1.84f	1.89f
	80% N(N2)	2.13e	2.16e
	80% N(N1)	2.25d	2.31d
80%ETc	60% N(N3)	2.63c	2.70c
	80% N(N2)	3.33a	3.43a
	80% N(N1)	3.15b	3.16b

Moreover, sub recommended levels of the applied drip irrigation water and drip fertigated nitrogen (80 % of ETc X 80 % N) gave significant effect of banana fruit yield like as the obtained by the recommended rates, saving water and nitrogen and reducing their known losses. This lead to increasing WUE, increasing the efficiency of utilization of the applied water and nitrogen. Under present work conditions it could be considered that deficit drip irrigation at 80 % of ETc with drip fertigated N at 80 % sub recommended rate as the potential best application new approach to maximize WUE, save 20 % irrigation water and 20 % of drip fertigated nitrogen (N) fertilizer and at the same time gave vigorous plants with approximately and significantly the same fruit yield as obtaining by the recommended levels. The results were in conformity with those obtained by Patal and Rajput (2004); Rainna *et al.,* (2011); Sanjit *et al.,* (2016) and Senthile *et al.,* (2017).

Generally, the obtained results of using deficit drip irrigation and sub recommended drip N fertigation rates under clay soil, limited water resources and scarcity conditions must be assessed on other fruit crops and in other areas to be used on large scale as a new approach to maximize water use efficiency (WUE), save water and fertilizers and obtain potential fruit yield with no considerable reduction.

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تطوير الرى بالتنقيط والتسميد النيتروجينى من خلال إستخدام مستويات أقل من الموصى بها للإنتاج الإقتصادى لنبات الموز فى التربة الطينية الطميية

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نفذت تجربتان حقليتان بمنطقة بدواى- محافظة الدقهلية والمتميزة بأرضها الطينية الطميية فى موسمى 2017 و 2018 لدراسة تأثير مستويات مختلفة من الرى بالتنقيط (100 % من النتح التبخرى ETc المستوى الموصى به و 80 % و 100 % ETc لمستويات أقل وأعلى من الموصى بها) ومعدلات التسميد النيتروجينى مع الرى بالتنقيط (100 % نيتروجين الموصى به و 80 % و 60 % كمستويات أقل من الموصى به) والتفاعل بينهما على صفات النمو الخضرى ومحصول الثمار ومكوناته وكفاءة استخدام المياه (WUE) لنباتات الموز المزروعة صنف جراند نان. وكذلك للتوصل الى مستويات توفر فى مياة الري والأسمدة النيتروجينية وتعظيم كفاءة استخدام المياه وفى نفس الوقت تعطى نمو خضرى جيد وإنتاجية عالية وإقتصادية للموز المزروع بالأراضى الطينية الطميية ولا تقل عن إستخدام المستويات والمعدلات الموسى بها. وكانت أهم النتائج كما يلى :1- أدى استخدام مستوى الري بالتنقيط (80 % من النتح التبخرى) أقل من الموصي به الى توفير 20 % من ماء الري وتعظيم كفاءة استخدام المياه وفى نفس الوقت زيادة قياسات النمو الخضري ومحصول الثمار ومكوناته بدرجة معنوية مشابهة ومساوية تقريباً للمستوى الموصي به 100 % من النتح التبخرى لنباتات الموز المنزرعة.2- بطريقة مشابهة أدى استخدام النيتروجين بمستوى أقل من الموصى به (80 %) الى توفير 20 % من السماد النيتروجينى وأعطى أفضل قياسات للنمو الخضرى وأعلى محصول ثمار ومكوناته لنبات الموز وكان فى الغالب معنوياً مساوى لمستوى التسميد النيتروجينى الموصى به (100 % نيتروجين).3- كانت أفضل المعاملات وبالمستويات فائقة التأثير والتي يوصى باستخدامها في نفس ظروف التجربة معاملة التفاعل (80 % ETC ري بالتنقيط أقل من المستوى الموصي به مع التسميد النيتروجيني بالري بالتنقيط بمستوى 80 % أقل من الموصي به) حيث وفرت 20 % مياه ري و 20 % سماد أزوتي وعظمت كفاءة استخدام المياه وأعطت في نفس الوقت وبدرجة معنوية أفضل نمو وأعلى محصول ثمار ومكوناته ومشابه للمستوى الموصي به في ري وتسميد الموز بالتنقيط في الأراضي الطينية الطميية (100 % ETC ري 100X % نيتروجين) دون حدوث أي نقص ملموس. بذلك توصى الدراسة باستخدام مستوى ري بالتنقيط (80 % ETc) مع تسميد نيتروجينى بمستوى 80 % من الموصى به لتوفير المياة والتسميد النيتروجينى وتعظيم كفاءة إستخدام المياة والحصول على أفضل نمو وأعلى محصول إقتصادى للموز المزروع بالأراضى الطينية الطميية.