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Influence of drip fertigation on leaf characteristics and crop duration of tissue culture Nendran Banana

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Abstract
A field experiment was conducted during 2018 -2019 at eastern block farm, Tamil Nadu Agricultural University, Coimbatore, to study the effect of drip fertigation on leaf characteristics and crop duration of tissue culture Nendran Banana grown in sandy clay loam soils. The experiment was laid out in strip plot design with three levels of drip irrigation (80%, 100% and 120% PE) and four levels of fertilizer management practices *viz.*, 75%, 100% and 125% RDF through fertigation and 100% RDF through soil application. The results of the study indicated that different irrigation levels and fertigation levels had a positive influence on leaf characteristics and crop duration of tissue culture Nendran Banana. Drip fertigation at 120% PE + 125% RDF through fertigation recorded higher leaf area (13.32 m2), LAI (3.020), number of leaves (9.3) respectively at shooting stage, leaf area duration (153.9 days) at 7 months after planting (MAP) to shooting stage, and minimum Phyllochron days (9.17 days) at 7 MAP. The same treatment recorded a minimum total crop duration of 382 days.

Keywords: Drip fertigation, Nendran Banana, leaf characteristics, crop duration

Introduction
Banana (*Musa spp.*) is the oldest fruit of tropical countries, grown in almost all parts of the world and regarded as a fruit of heaven. In the world of fruits, banana contains all the necessary nutrients and provides instant energy. On account of these properties combined with delicious taste and aroma, it is in great demand in fresh as well as processed across the globe and gained commercial popularity in the international fruit trade (Vanilarasu *et al.*, 2018) [14]. Nendran is the most popular variety among banana with multiple benefits like wide adaptability, year-round availability, affordability, yield stability, high nutritive and medicinal value. There has been an increase in the area, production and productivity of banana to the tune of 80, 87 and 34.6 percent respectively in 2015-2016 compared to 2001-2002 (NHB, 2017) [4]. This tremendous increase shows the wide preference and acceptability of the crop among farmers and consumers. Drip fertigation is the best alternative for conventional irrigation practices in terms of growth parameters, productivity and profitability. In recent years, water soluble fertilizers are used as a strong alternative to solid fertilizers. The major advantage of liquid fertilizers is that they are completely soluble in water and can be applied through a drip system with ease, without any losses of fertilizers (Patel and Tandel, 2013) [9]. Fertigation can save 20% - 50% fertilizers while improving the yield and quality as compared with the common methods of fertilizer application (Kavino *et al.*, 2004) [5]. It could be visualized that a properly designed and well managed drip irrigation system and fertigation irrigation schedule for banana will ensure optimal supply matching with crop need thus maximizing the use efficiency of water and fertilizer. Hence, an experiment was designed to evolve a standard drip fertigation technology for enhancing the productivity of tissue culture Nendran Banana.

Materials and Methods
A field experiment was carried out in the Eastern Block farm, Tamil Nadu Agricultural University, Coimbatore. The farm is geographically situated in the Western agro-climatic zone of Tamil Nadu at 11º North latitude and 77º East longitude at an altitude of 427 meters above mean sea level (MSL). Mean maximum and minimum temperatures prevailed during the cropping seasons were 31.6 °C and 22.1 °C respectively.

Total rainfall during the cropping period was 692 mm in 50 rainy days. The soil was sandy clay loam. It was low in available nitrogen (205 kg/ha), medium in available phosphorus (16 kg/ha) and high in available potassium (393 kg/ha). The treatments consisted of three drip irrigation levels at 80 (I1), 100 (I2) and 120 (I3) per cent of pan evaporation (PE) and four fertigation levels at 75 (F1), 100 (F2), 125 (F3) percent of recommended dose of fertilizers (RDF) through fertigation and conventional soil fertilization at 100 per cent RDF (F4). The experiment was laid out in strip plot design and replicated thrice with fifteen plants under each treatment. Irrigation was scheduled daily basis and the water requirement of banana was computed based on past twenty years pan evaporation data of Coimbatore, pan factor, crop coefficient, canopy area factor and wetted area factor. The recommended dose of fertilizer (RDF) *viz*., 250:150:500 g NPK per plant was given through fertigation and soil application using water soluble fertilizers *i.e.*, urea (N - 46%), MAP (N-12% and P - 61%) and SOP (K - 50%). Fertigation was scheduled based on different growth stages of crop and given at once in four days and soil application was given at once in a month. Pits were formed with a size of 45 cm x 45 cm x 45 cm. Tissue culture Nendran banana was taken as a test variety with a spacing of 2.1 m x 2.1 m. Laterals had emitting point spaced at 40 cm apart and spacing between the lateral was 2.1 m with a discharge rate of 4 lph at 1 kg/cm2. All the agronomic management practices and plant protection measures were carried out at the appropriate time as per the recommendation. Leaf characteristics and duration of the crop were recorded as per the standard methodology. To evaluate the effect of different drip fertigation levels on leaf characteristics and crop duration, the data were statistically analyzed. The critical difference at 5% level of significance was calculated to find out the significance of different treatments over each other (Gomez and Gomez, 1984) [3].

Results and Discussion

Leaf characteristics

Number of leaves (Nos.)

The data pertaining on the total number of leaves per plant as influenced by irrigation levels and fertigation are presented in Table 1. During the shooting stage, among irrigation levels, the highest number of leaves (15.60) was retained in 120% PE, which was statistically on par with100% PE (14.74) and lower number of leaves present in 80% PE (13.87). There were significant differences among different treatments of fertigation and the highest number of leaves (16.48) was recorded in 120% PE, which was on par with 100% RDF through fertigation (15.65) and lowest number of leaves (12.47) was recorded in 100% RDF through soil application. The interaction between irrigation levels and fertigation did not differ significantly. The increased number leaves production by better uptake of plant nutrients and excellent maintenance of soil, water and air continuum with higher oxygen concentration in the root zone (Raina *et al.*, 2011) [11]. Also, nitrogen enhances the rate of vegetative growth, which resulted in earlier and maximum leaves. Similar findings were reported by Mustaffa (1983) [7] and concluded that there was an increase in the number of leaves with the application of a higher level of nitrogen.

Phyllochron (days)

Among different irrigation levels and fertigation levels the Phyllochron at 7th MAP significantly different among treatments, while the interaction effect of irrigation levels and fertigation levels did not differ significantly among treatments. At 7 MAP, irrigation levels influenced the Phyllochron days (Table 1). The least number of days (10.21) for successive leaf production was recorded in 120% PE treatment and the maximum days was noted in 80% PE (11.35 days). Among fertigation levels, the minimum days for successive leaf emergence (9.76 days) were recorded in 125% RDF through fertigation and maximum days were noted in 100% RDF through soil application (11.60 days). The interaction effects did not differ significantly. The shortening of time interval between the successive leaves was due to an adequate supply of fertilizer and optimum moisture content in soil at appropriate growth stages and the findings are in corroboration with the results of Sindhupriya *et al.* (2018) [12].

Leaf area (m2)

The leaf area of tissue culture Nendran banana was progressively increased with increasing water and fertilizer levels (Table. 1). At shooting stage, the maximum leaf area of tissue culture Nendran banana was recorded with drip fertigation at 120% PE + 125% RDF through fertigation (13.32 m2). However, this was statistically on par with drip fertigation at 100% PE + 125% RDF and 120% PE + 100% RDF through fertigation at shooting stage. Shorter plant was recorded under Drip irrigation at 80% PE + 100% RDF through soil application (8.42 m2) at shooting stage. Significantly higher leaf area observed under drip fertigation might be due to continuous availability of required moisture near the crop root zone which might have resulted in higher nutrient uptake resulting in greater cell division and elongation and also the positive effect of nitrogen on many important plant structures, genetic and metabolic compounds in plant cells. Similar results were also reported by Don (2001) [1].

Leaf area index

LAI determines the total assimilating area available to the plant and quantum of source that would ultimately be available for translocation to the sink. The importance of leaf area index (LAI) on crop is well recognized in better utilization of solar energy. The variation in LAI is an important biophysical parameter that eventually determines crop productivity because it influences the light interception and transpiration by the crop canopy (Fageria *et al*., 2006) [2]. LAI was influenced by different levels of irrigation and fertigation (Table 1). Drip fertigation at 120% PE + 125% RDF registered higher LAI of 3.02, which was comparable with drip fertigation at 100% PE + 125% RDF (2.95) and 120% PE + 100% RDF (2.85). The lowest LAI was registered under 80% PE with soil application of 100% RDF (1.91) at shooting stage. In this experiment, the LAI was enhanced with an increase of water and constant availability of nutrients which resulted in better translocation of photosynthates and more carbohydrate synthesis contributing to favorable plant water balance. This was perhaps due to the higher production of number of leaves with increased leaf area which was confirmed with the findings of Kumar *et al*. (2009) [6].

Leaf area duration

Leaf area duration is the ability of the plant to maintain the green leaves per unit area of the land over a period of time and reflects the vitality of leaves and an opportunity for assimilation. It also measures the persistence of the assimilating surface. The effect of different irrigation levels and fertigation on leaf area at 7 MAP to shooting stages were

presented in Table 3. Higher LAD (132.4 days) was recorded in 120% PE treatment, which was on par with 100% PE (124.3 days) and the maximum days were observed in 80% PE (115.5 days). About fertigation levels, the higher LAD (144.3 days) was recorded in 125% RDF through fertigation and maximum days were noted in 100% RDF through soil application (101.3 days) at 7 MAP to shooting stage. The interaction effects did not differ significantly. In the present study, the LAD was enhanced with nutrient supply through irrigation water increased solubility and availability of nutrients, decrease the rate of leaf senescence thereby increase the life of green leaves which leads to increased LAD. Maximum LAD due to fertigation has also been reported by Pradesh and Aladakatti (2018) [10].

Crop duration (days)

The data on total duration as influenced by irrigation levels and fertigation are presented in Table 3.There were significant differences in leaf area due to different irrigation levels and fertigation levels at shooting stage. The results revealed that among the irrigation treatments, The least number of days (428 days) for harvest was recorded in 120% PE treatment and the maximum days was noted in 80% PE (475 days). Among fertigation levels, the minimum days for harvest (408 days) were recorded in 125% RDF through fertigation and maximum days were noted in 100% RDF through soil application (489 days). The interactions between irrigation regimes and fertigation levels were found non-significant. This was mainly due to higher irrigation regimes provided require amount of water to the crop in small amounts delivered at frequent intervals as needed by the plant, and water losses to evaporation are less than with surface irrigation and also water is delivered at or below ground level, so that wetting of the foliage is not a problem and timely nutrient application which leads to effectively utilized the accurate placement of fertilizers in solution form at the active root zone area resulting in early flowering and early bunch development. Similar results were also reported by Pandey *et al.* (2001) [8]. Also, the promotive effect of N and K in the rapid production of leaves with better photosynthetic activity resulting in a higher C: N ratio for early shooting and faster bunch development (Turner and Barkus, 1982) [13].

Table 1: Effect of drip fertigation on number of days and phyllochron of tissue culture nendran banana

Treatments	Number of days at shooting stage (m^2)						Phyllochron at 7 MAP (days)				
	F_1	F_2	F_3	F_4	Mean		F_1	F_2	F_3	F_4	Mean
I_1	13.33	14.79	15.49	11.87	13.87	I_1	11.41	11.34	10.86	11.77	11.35
I_2	14.32	15.44	16.77	12.44	14.74	I_2	11.38	10.89	9.25	11.55	10.77
I_3	15.41	16.72	17.16	13.11	15.60	I_3	10.92	9.29	9.17	11.46	10.21
Mean	14.35	15.65	16.48	12.47		Mean	11.24	10.51	9.76	11.60	11.24
	I	F	I at F	F at I			I	F	I at F	F at I	
SEd	0.41	0.56	0.88	0.92		SEd	0.28	0.45	0.64	0.71	
C.D	1.13	1.37	NS	NS		C.D	0.77	1.11	NS	NS	

Table 2: Effect of drip fertigation on leaf area (m2) and LAI of tissue culture nendran banana

Treatments	Leaf area at shooting stage (m^2)						LAI at shooting stage				
	F_1	F_2	F_3	F_4	Mean		F_1	F_2	F_3	F_4	Mean
I_1	9.38	10.23	10.91	8.42	9.73	I_1	2.13	2.32	2.47	1.91	2.21
I_2	9.99	10.58	12.99	8.47	10.51	I_2	2.27	2.40	2.95	1.92	2.38
I_3	10.50	12.57	13.32	8.57	11.24	I_3	2.38	2.85	3.02	1.94	2.55
Mean	9.95	11.13	12.41	8.49		Mean	2.26	2.52	2.81	1.92	
	I	F	I at F	F at I			I	F	I at F	F at I	
SEd	0.30	0.40	0.56	0.59		SEd	0.09	0.09	0.14	0.14	
C.D	0.83	0.97	1.41	1.45		C.D	0.24	0.23	0.35	0.34	

Table 3: Effect of drip fertigation on leaf area duration and total duration of tissue culture nendran banana

Treatments	Leaf area duration at 7 MAP - shooting (days)						Total duration (days)				
	F_1	F_2	F_3	F_4	Mean		F_1	F_2	F_3	F_4	Mean
I_1	112.1	119.8	129.0	101.3	115.5	I_1	481	474	451	494	475
I_2	117.5	126.3	150.1	103.3	124.3	I_2	477	454	390	489	453
I_3	124.9	144.7	153.9	106.2	132.4	I_3	458	388	382	485	428
Mean	118.2	130.2	144.3	103.6		Mean	472	439	408	489	
	I	F	I at F	F at I			I	F	I at F	F at I	
SEd	4.4	4.2	7.9	7.5		SEd	13	16	27	28	
C.D	12.3	10.4	NS	NS		C.D	35	40	NS	NS	

I_1 - 80% PE, I_2 - 100% PE I_3 - 120% PE

F_1 - 75% RDF through fertigation, F_2 - 100% RDF through fertigation, F_3 - 125% RDF through fertigation, F_4 - 100% RDF through soil application.

Conclusion

The results of the experiment revealed that the leaf characteristics and duration *viz.*, leaf area, leaf area index, number of leaves, Phyllochron, leaf area duration and total duration were influenced positively by the drip fertigation levels and leaf area and leaf area index were obtained with drip fertigation at 120% PE + 125% RDF through fertigation which was on a par with drip irrigation at 100% PE + 125% RDF and drip fertigation at 120% PE + 100% RDF in tissue culture Nendran banana.

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