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Impact of Irrigation and Fertigation Levels on the Growth and Yield of Elephant Foot Yam (*Amorphophallus paeoniifolius* (Dennst.) Nicolson)

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Abstract

Elephant foot yam is gaining popularity as a commercial or cash crop in Andhra Pradesh, West Bengal, Uttar Pradesh, Bihar, Jharkhand and Tripura. Its area is expanding in Tamil Nadu, Gujarat and Maharashtra. However, lack of scientific studies on fertigation hinders its further expansion in the nontraditional and water scarce areas. Judicious and optimal use of water and fertilizers are pre-requisites to maximize the productivity and return. Hence, field experiments were carried out at Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during 2010-2013 through AICRP on Tuber Crops to standardize drip with fertigation technology for elephant foot yam. The experiment was laid out in factorial RBD and replicated thrice. For standardizing the fertigation system, five irrigation levels (I_1-25% cumulative pan evaporation (CPE); I_2-50% CPE; I_3-75% CPE ; I_4-100% CPE and I_5-Flood irrigation) and four fertigation levels (F_1 - fertigation with 100% recommended dose of fertilizers (RDF); F_2-fertigation with 75% RDF; F_3-fertigation with 50% RDF and F_4-absolute control) were followed.. The greatest plant height (78.89 cm), pseudostem girth (12.29 cm), canopy spread EW (65.58 cm) and NS (64.47 cm) were observed under application of 100% RDF along with flood irrigation. There was significant difference in yield among fertilizer levels and irrigation levels. The highest corm yield (47.66 t ha^{-1}) was observed under application of 100% RDF along with irrigation at 100% CPE.

Key words: Elephant foot yam, fertigation, drip irrigation, CPE, yield

Introduction

Amorphophallus paeoniifolius (Dennst.) Nicolson is a herbaceous perennial crop belonging to the family Araceae, commonly known as elephant yam, elephant foot yam, Suran, sweet yam (Hetterscheid and Ittenbach, 1996). It is basically a crop of south east Asian origin. It has long been used as a staple food in many countries such as Philippines, Java, Indonesia, Sumatra, Malaysia, Bangladesh, India, China and south eastern countries (Chandra, 1984). Generally, elephant foot yam is considered only as famine food in the Pacific Islands (Thaman, 1984). It is commercially cultivated due to its productivity and popularity as a vegetable in various Indian cuisines. In India, it is cultivated in Andhra Pradesh, West Bengal, Gujarat, Kerala, Tamil Nadu, Uttar Pradesh, Maharashtra and Jharkhand, whereas in north eastern states, wild local cultivars grown are being generally used for making vegetable pickles and medicine

preparations for various ailments. In addition, it is used in pharmaceutical preparations in Ayurvedic medicines (Patel et al., 2011). The tubers are believed to have blood purifying property and are used in medicines for piles, asthma and dysentery.

More than 30-40% reduction in crop yield has been reported due to climate change and water scarcity. Judicious use of inputs and manipulation of microclimate is essential to maximize the corm yield (Das et al., 1995). Drip irrigation is high frequency irrigation method with an efficiency of about 98-99%. Wetting pattern and its subsequent effect on moisture and salt distribution in a soil under drip is mainly governed by the texture of soil, quantity of water applied through drip irrigation and its discharge rate. Quantity of water per plant per day (1 ha^{-1} day^{-1}) depends on crop, plant spacing or spacing between emitter and laterals (m), peak evapo-transpiration of crop (ET) and irrigation efficiency (Eta) of the system (Nalge et al., 2008). Pan evaporation is widely used method to schedule the irrigation due to its easy and inexpensive use (Ertek et al., 2007).

Presently the area under elephant foot yam is expanding in Tamil Nadu, Gujarat and Maharashtra. Corm pieces are normally planted during February-March, before the onset of monsoon. Now a days monsoons are highly erratic and unpredictable. Generally farmers follow flood method of irrigation to cope up with the deficiency of rains. Judicious and optimum use of water and nutrients are prerequisites to enhance the yield, improve the quality and economic return. Water is a scare resource which needs to be preserved and the ultimate goal should be to ensure more crop per drop. The method of fertilizer application is also important in improving the use efficiency of nutrients. Fertigation enables adequate supply of water and nutrients with precise timing and uniform distribution to meet the crop demand so as to get maximum yield (Patel and Rajput, 2000; Chawla and Narda, 2002). However, lack of scientific studies on fertigation hinders further expansion of crops in water scarce area. Hence it is imperative to undertake studies on the effect of fertigation on crop growth and yield of elephant foot yam.

Materials and Methods

A field experiment was carried out at the College Orchard, Horticultural College and Research Institute, Tamil Nadu Agricultural College, Coimbatore during 2010-2013 to study the effect of drip fertigation on the growth and yield of elephant foot yam. The daily temperature during the study period varied widely between 21.9°C-32.07°C and the average annual rainfall was 356 mm. The soil of the experimental field was sandy clay loam with pH of 7.96. The soil had electrical conductivity (EC) of 1.92 dS m^{-1} and available N, P and K contents of 130, 20 and 660 kg ha^{-1} respectively. The experiment was laid out in RBD with combinations of five levels of irrigation (I_1-25% cumulative pan evaporation (CPE); I_2-50% CPE; I_3-75% CPE; I_4-100% CPE and I_5-Flood irrigation) and four levels of nutrient doses (F_1-fertigation with 100% recommended dose of fertilizers (RDF); F_2- fertigation with 75% RDF; F_3-fertigation with 50% RDF and F_4-absolute control) and replicated thrice.

Land was prepared with the help of mould board plough and then harrowed twice to pulverize the soil. Well decomposed FYM @ 10 t ha^{-1} was added prior to second harrowing and then leveled manually. Healthy corms were cut into pieces of about 300-400 g, having a portion of the central bud and treated with Dithane M-45 @ 0.2% and monocrotophos @ 0.2% for 30 min. and dried under shade for 18 h to avoid the incidence of diseases and pests. To impose the treatments water potential levels in the soil were used in order to determine irrigation time, corresponding to I_1-25% CPE; I_2-50% CPE; I_3-75% CPE; I_4-100% CPE and I_5-Flood irrigation. All irrigation treatments were imposed three weeks after planting and drip irrigation method of irrigation was followed. The duration of irrigation intervals was calculated on the basis of pan evaporation records. The experimental site was kept free of weeds by periodic hand weeding. All the necessary cultural practices and plant protection measures were followed uniformly for all the treatments during the entire period of experimentation. Observations on plant height, canopy spread, pseudostem girth and corm yield were recorded. The data were analysed statistically according to Panse and Sukhatme (1967) and pooled analysis was done.

Results and Discussion

The irrigation and fertigation levels profoundly influenced the growth and yield characters of elephant

foot yam. Plant height varied significantly. Averaging over the years (2010-2013), the plant height ranged between 43.70 cm and 78.89 cm, the greatest plant height (78.89 cm) was observed under application of 100% recommended dose of fertilizers along with flood irrigation, which was followed by the application of 100% recommended dose of fertilizers along with drip irrigation at 100% CPE (72.75 cm) (Table 1). Among the imposed treatments, I_5 (flood irrigation) resulted in greater plant height followed by I_4, whereas the least was recorded with I_1 level. It was clear that impact of fertigation levels on plant height was significantly higher than irrigation levels. According to Singh et al. (1997), N is associated with synthesis of amino acid, which would have increased the meristematic activities at faster rate under fertigation and caused better growth.

Considering the average of three years (2010-2013), the pseudostem girth ranged between 7.18 cm to 12.29 cm, the highest pseudostem girth (12.29 cm) was observed under application of 100% recommended dose of fertilizers along with flood irrigation, which was followed by the application of 100 % recommended dose of fertilizers along with irrigation at 100% CPE (11.38 cm) (Table 1). The highest pseudostem girth was noticed with flood irrigation. This result is similar to the findings of earlier workers, Shibhila and Balakrishnan (1990) and Doyle et al. (1994).

Likewise, the highest canopy spread E-W (65.58 cm) was observed due to application of 100% recommended dose of fertilizers along with flood irrigation which was followed by the application of 100 % recommended dose of fertilizers along with irrigation at 100% CPE (59.62 cm) (Table 1). Canopy spread in N-S direction also followed similar trend (64.47 and 61.60 cm respectively). The copious amount of water provided through flood irrigation promoted the profuse growth of plant, resulted in more plant height, pseudostem girth and canopy spread. The increase in the fertigation levels positively increased the plant height, canopy spread and pseudostem girth. This result is similar to the findings of Odubanjo et al. (2011).

The corm yield of elephant foot yam was significantly influenced by the various treatments. The corm yield ranged between 6.83 t ha^{-1} to 47.66 t ha^{-1}. The highest corm yield (47.66 t ha^{-1}) was obtained with the application of 100% recommended dose of fertilizers along with drip irrigation at 100% CPE, which was on par with the application of 100% recommended dose of fertilizers along with flood irrigation (46.26 t ha^{-1}) (Table 5). Results revealed that treatments imparted significant influence on the corm yield, besides the microclimate played a pivotal role in enhancing the yield of crop, irrespective of treatments. The influence of fertilizer application was much more than irrigation on the corm yield. These findings are in accordance with that of Verma et al. (1996). The increased application of major nutrients under fertigation increased the corm yield as reported by Manickasundaram et al. (2002).

Table1. Effect of irrigation and fertigation levels on growth attributes of elephant foot yam (pooled mean of three years)

Fertilizer/	Plant height (cm)						Pseudostem girth (cm)						Canopy spread (EW) (cm)						Canopy spread (NS) (cm)					
Irrigation levels	I_1	I_2	I_3	I_4	I_5	Mean	I_1	I_2	I_3	I_4	I_5	Mean	I_1	I_2	I_3	I_4	I_5	Mean	I_1	I_2	I_3	I_4	I_5	Mean
F_1	51.10	54.60	62.89	72.75	78.89	64.05	9.05	9.38	9.72	11.38	12.29	10.36	52.70	55.34	57.56	59.62	65.58	58.16	49.84	53.81	58.00	61.60	64.47	57.54
F_2	50.40	53.60	64.45	64.82	69.60	60.57	8.17	9.00	9.18	9.74	10.93	9.40	43.67	48.10	50.72	51.81	58.91	50.64	50.39	52.73	54.39	54.53	60.19	54.45
F_3	46.60	50.80	53.34	53.51	59.98	52.85	8.03	8.53	8.61	9.19	10.19	8.91	45.09	46.19	49.19	51.08	56.05	49.52	44.67	47.19	45.18	48.66	52.94	47.73
F_4	44.50	43.70	48.51	51.52	49.67	47.58	7.18	8.09	8.13	8.24	8.96	8.12	42.67	45.33	46.04	47.02	49.64	46.14	38.70	37.62	42.91	43.58	49.01	42.36
Mean	48.15	50.68	57.30	60.65	64.54	56.26	8.11	8.75	8.91	9.64	10.59	9.20	46.03	48.74	50.88	52.38	57.55	51.12	45.90	47.84	50.12	52.09	56.65	50.52
	CD (0.05) for I = 1.09, F = 0.97, IxF = 2.18						CD (0.05) for I = 0.17, F = 0.16, IxF = 0.35						CD (0.05) for I = 1.13, F = 1.01, IxF = 2.64						CD (0.05) for I = 1.08, F = 0.96, IxF = 2.15					

Table 2. Effect of irrigation and fertigation levels on corm yield (t ha^{-1}) of elephant foot yam during 2010-2013

Fertilizer/	2010-2011						2011-2012						2012-2013						Pooled					
Irrigation levels	I_1	I_2	I_3	I_4	I_5	Mean	I_1	I_2	I_3	I_4	I_5	Mean	I_1	I_2	I_3	I_4	I_5	Mean	I_1	I_2	I_3	I_4	I_5	Mean
F_1	26.83	33.84	36.35	48.01	45.73	38.15	28.22	35.28	44.45	54.13	49.99	42.41	28.35	33.10	37.20	44.25	43.50	37.28	28.33	34.04	39.22	47.66	46.26	39.10
F_2	24.34	28.85	32.18	44.84	42.61	34.56	24.75	30.23	41.45	47.17	45.17	37.75	24.10	29.50	30.00	39.80	39.00	32.48	24.50	29.31	33.79	43.45	42.25	34.66
F_3	12.39	15.35	22.36	21.51	26.50	19.62	13.94	16.45	23.35	25.89	27.39	21.40	11.60	14.38	20.15	25.90	23.10	19.02	12.64	15.40	21.89	24.53	25.94	20.08
F_4	6.46	9.36	11.91	11.24	17.84	11.36	8.34	10.74	14.82	16.24	19.89	14.00	5.95	7.15	10.15	16.25	12.25	10.35	6.83	8.79	12.07	14.13	16.82	11.73
Mean	17.50	21.85	25.70	31.40	33.17	—	18.81	23.17	31.01	35.86	35.61	—	17.50	21.03	24.37	31.50	29.46	24.78	18.08	21.89	26.74	32.44	32.82	26.39
	CD (0.05) F=3.15; I=3.52 ; I x F=7.05						CD (0.05) F=3.46; I=3.10 ; I x F=6.93						CD (0.05) F=1.24; I=1.39 ; I x F=2.79						CD (0.05) I=0.48 ; F=0.43; I x F=0.95					

Conclusion

The present study revealed that application of 100 % RDF along with irrigation at 100 % CPE resulted in higher corm yield and promoted plant height, pseudostem girth and canopy spread in elephant foot yam.

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