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Growth and Yield of Container Grown Elephant Foot Yam as Influenced by Growth Medium, Nutrient and Irrigation Schedules

Elephant foot yam *(Amorphophallus paeoniifolius* (Dennst.) Nicolson) is an important tuberous vegetable with good keeping quality. In the present context of shrinking land area available for cultivation especially in urban areas, elephant foot yam can be raised in containers in the available space around houses or on house terraces for which an ideal growth medium is necessary. Usually soil, sand and FYM are taken in 1:1:1 ratio to prepare the growth medium. Due to the present problems of availability and high cost of sand, it can be substituted with coir pith which is abundantly available in Kerala as a byproduct of coir industry. Use of coir pith will reduce the weight of the container. At present, technology for organic production of elephant foot yam in containers is lacking. Hence the present study was undertaken in the Instructional Farm, College of Agriculture, Vellayani to standardize growth medium and nutrient and irrigation schedule for elephant foot yam grown in containers. Vellayani experiences a humid tropical climate. The location received a rainfall of 1220 mm distributed over 70 days during the cropping period.

The experiment was conducted by raising elephant foot yam var. Gajendra in plastic sacks during April to November 2016 with 12 treatment combinations involving three growth media (M_1 - soil : sand : FYM 1:1:1, M_2 - soil : coir pith : FYM 1:1:1 and M_3 - soil : coir pith : FYM 0.75:1.25:1), two nutrient schedule (N_1 – N and K in three splits at bimonthly interval and N_2 – N and K in six splits at monthly interval starting from 1 month after planting - MAP) and two irrigation schedule (I^1 - irrigation once in three days and I^2 - irrigation once in six days) with four replications in factorial completely randomized design. Plastic cement sacks of uniform size (capacity of 50 kg) were used as containers. Different growth media used in the experiment were prepared with soil, sand, FYM and coir pith in different proportions by volume. The growth medium M_1 was prepared by mixing 9 kg soil, 3 kg sand and 3 kg FYM, M_2 with 9 kg soil, 3 kg coir pith and 3kg FYM and M_3 with 7 kg soil, 3.75 kg coir pith and 3 kg FYM. Lime @ 10g and neem cake @ 100g $sack^{-1}$ were applied initially in all growth media. Initially, the moisture content of growth media was brought to field capacity. Composite samples of growth media were analysed for their physico - chemical properties using standard procedures and results are presented in Table 1. Initially, all the growth media were having near neutral pH and electrical conductivity within tolerable limits. The growth medium M_1 had higher dehydrogenase activity and available N status and lower organic carbon and available P and K status. The growth medium M_2 was having higher pH, dehydrogenase activity and available N and P status and lower organic carbon than M_3. The growth media M_2 and M_3 were similar in their electrical conductivity and available K status.

Corm pieces of 250 g, treated with *Trichoderma* – cow dung slurry and shade dried, were planted in each sack on 11- 04-2016. The recommended dose of 100:50:150 kg NPK ha^{-1} for elephant foot yam (KAU, 2011) was

Table 1. Physico- chemical properties of growth media prior to experiment

Growth media	pH	EC (dSm^{-1})	Dehydrogenaseactivity (µg TPF g^{-1} 24 h^{-1})	Organic Carbon (%)	Available N (%)	Available P (%)	Available K (%)
M_1	7.25	0.83	320.15	3.68	0.095	0.034	0.015
M_2	7.12	1.78	263.24	5.65	0.084	0.042	0.017
M_3	6.91	1.78	258.09	5.85	0.077	0.038	0.017

applied to each sack through organic manures like groundnut cake, bone meal and wood ash. The total nutrient contents of the organic manures were determined by following standard procedures (Jackson, 1973). The calculated quantities of groundnut cake (50 g), bone meal (10 g) and wood ash (100 g) based on their nutrient contents (Table 2) were applied in each sack. Uniform dose of bone meal (10 g $sack^{-1}$) was applied as a single basal dose in all sacks prior to planting of corm. The groundnut cake (50 g $sack^{-1}$) and wood ash (100 g $sack^{-1}$) were given in split doses as per the treatments. The groundnut cake was made into 10 per cent slurry with water, fermented for three days and mixed with wood ash and applied. The crop was mulched with dry leaves throughout the growth period. No irrigation was given during rainy days. When irrigation was needed, measured quantity of water, calculated based on evaporation data taken from the Agro Meteorological Observatory in the College, was applied at different intervals as per the treatments either once in three days or once in six days. The crop was harvested on 23-11-2016.

Growth characters were recorded from the observational plants at bimonthly interval from 2 MAP upto harvest. Height of the plant (cm) was measured from the base to the growing tip in their vertical position. Total leaf area (cm^2) of elephant foot yam was determined as suggested by Ravi et al.(2010) and leaf area index (LAI) was worked out using the formula given by Watson (1947). At the time of harvest, weight of corm from the observational plants of each treatment were recorded and average was worked out in g $sack^{-1}$.

Irrespective of treatments, plant height and canopy spread increased with the age of the crop (Table 3). But a faster rate of increase in plant height was registered upto 6 MAP. Leaf area index increased from 2 MAP upto 4 MAP, retained values at 6 MAP and thereafter declined towards harvest which indicated that maximum LAI might have occurred between 4 MAP and 6 MAP. This is in conformity with the findings of Das et al. (1997) who observed maximum LAI between 4 MAP and 5 MAP by using corm pieces weighing 250 g as planting material as in the present study. Considering all growth characters, it can be inferred that maximum vegetative growth might have occurred between 4 MAP and 5 MAP.

Table 2. Nutrient contents of organic manures (%)

Organic manures	N	P	K
Groundnut cake	6.86	0.69	1.24
Bone meal	3.08	19.85	0.10
Wood ash	0.58	0.37	5.16

Growth medium had significant influence on all growth characters at all growth stages except on plant height at 2 MAP. At all stages, taller plants and higher LAI were produced in the growth medium M_2 (Table 3). The growth medium M_2 was similar in composition to the conventional growth medium M_1 (soil: sand: FYM in 1:1:1 proportion) except that the sand was replaced with coir pith. The results indicated that vegetative growth of elephant foot yam was not affected by including coir pith as a component, upto a certain proportion, in the growth media. At all stages, the growth medium M_3 with lesser quantity of soil and more quantity of coir pith than M_2 performed equally well as M1 in producing taller plants. But M_3 was inferior to M_1 in the development of leaf area and higher LAI at all growth stages.

Nutrient schedule could markedly affect plant height and LAI especially during later stages of crop growth. Application of N and K in six splits resulted in taller plants at 6 MAP and harvest and higher LAI from 4 MAP onwards (Table 3) compared to application in three splits. It can be presumed that application of nutrient in more splits is advantageous for container cultivation

Padmanabhan and Swadija (2015) advocated ration irrigation but daily irrigation for vegetables grown in containers on house terraces. However, daily irrigation is not required for a tuber crop like elephant foot yam. Hence, in the present study, two irrigation schedule (once in three days and once in six days) were experimented for container grown elephant foot yam. No marked variation in plant height was recorded due to irrigation schedule either once in three or six days (Table 5). This is an agreement with the findings of Santosa et al. (2004) when elephant foot yam was grown in plastic bags. But irrigation once in three days produced markedly higher LAI than once in six days during later stages of the crop *viz*., at 6 MAP and harvest. Santosa et al. (2004) also reported that frequent irrigation produced larger leaves and extended the life span compared to less frequent irrigation for elephant foot yam. In the present study, the crop received sufficient rainfall during initial stages upto 4 MAP while only few irrigations were given during non- rainy periods. This might have led to significant

Table 3. Effect of growth medium, nutrient schedule and irrigation schedule on plant height, leaf area index and corm yield of container grown elephant foot yam

Treatments	Plant height (cm)				Leaf area index				Corm yield, g sack^{-1}
	2MAP	4MAP	6MAP	Harvest	2MAP	4MAP	6MAP	Harvest	
Growth medium (M)									
M_1 - soil : sand : FYM 1:1:1	42.17	46.83	55.92	57.58	1.32	2.20	2.16	1.94	1629.17
M_2 – soil : coir pith : FYM 1:1:1	45.42	52.33	66.25	68.67	1.45	2.53	2.55	2.34	1760.42
M_3- soil: coir pith : FYM 0.75:1.25 :1	42.42	47.25	55.58	57.17	1.28	1.80	1.81	1.59	1383.33
CD(0.05)	-	3.350	3.760	4.465	0.073	0.128	0.141	0.105	101.810
Nutrient schedule (N)									
N_1 – N and K in 3 splits	43.33	48.00	56.78	58.5	1.36	2.08	2.06	1.83	1531.94
N_2 – N and K in 6 splits	43.33	49.61	61.72	63.78	1.35	2.28	2.29	2.08	1650.00
CD(0.05)	-	-	3.070	3.640	-	0.104	0.115	0.085	83.130
Irrigation schedule (I)									
I_1 - Irrigation once in 3 days	42.95	48.66	58.00	60.11	1.38	2.22	2.30	2.05	1773.61
I_2 - Irrigation once in 6 days	43.72	48.94	60.50	62.17	1.33	2.13	2.04	1.86	1408.33
CD(0.05)	-	-	-	-	-	-	0.115	0.085	83.130

influence of irrigation schedule on LAI during later stages with more frequent irrigation.

Corm yield plant-1 was profoundly influenced by growth medium, nutrient schedule and irrigation schedule (Table 3). The highest yield of 1760.42 g plant^{-1} was obtained in the growth medium M_2 followed by M_1 (1629.17 g plant^{-1}). The superiority of growth medium M_2 in the expression of vegetative characters especially higher LAI might have led to higher production of photosynthates and subsequent translocation to corm which resulted in the highest corm yield plant^{-1} at harvest in M_2. Corm yield was found to be significantly and positively correlated with LAI at 4 MAP (0.783) and 6 MAP (0.87).

The results indicated that sand in the ordinary growth medium can be suitably substituted with coir pith so that the composition of the best growth medium for elephant foot yam is soil: coir pith : FYM in 1:1:1 ratio (M_2). The corm yield was reduced to 1383.33 g plant^{-1} in M_3 when quantity of soil was reduced and that of coir pith was increased (soil: coir pith: FYM in 0.75: 1.25:1 ratio). Mukherjee (2011) reported higher yield of elephant foot yam from soil amended with 50% coir pith than from 100% soil. But the results of the present study revealed that only 33% by volume of the growth medium can be constituted by coir pith (M_2) which might have provided ideal soil compaction for tuber development. Compared to conventional growth medium (M_1- 20 kg), the growth medium M_2 was lighter (15 kg) which is advantageous especially for farming on house terrace.

More frequent irrigation *i.e.*, irrigation once in three days than once in six days during non-rainy periods produced higher corm yield. Santosa (2004) also observed that infrequent irrigation (irrigation once in seven days) reduced corm yield. Application of N and K in six splits and irrigation once in three days have also resulted in higher LAI leading to higher photosynthate production and translocation to corm.

The results of the study revealed that the best growth medium for container cultivation of elephant foot yam is soil, coir pith and FYM in 1:1:1 ratio by volume (9 kg soil + 3 kg coir pith + 3 kg FYM). The recommended dose of 100:50:150 kg NPK ha^{-1} may be supplied to each plant through groundnut cake, bone meal and wood ash. Basal application of P (bone meal @ 10 g sack^{-1}) along with application of N (groundnut cake @ 50 g sack^{-1}) and K (wood ash @ 100 g sack^{-1}) in six splits at monthly interval starting from 1 MAP and irrigation once in three days during non-rainy period resulted in

maximum vegetative characters and higher corm yield sack^{-1} of container grown elephant foot yam.

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