e-planet **13** (2): 60-65 (July 2015)

Production potential of elephant foot yam under different levels of drip fertigation

S. K. JATA[1*], M. NEDUNCHEZHIYAN[1], S. K. MAITY[2] AND MALLIKARJUN M[2]

[1]ICAR-Regional Centre of Central Tuber Crops Research Institute, Dumuduma HBC, Bhubaneswar-751 019, Odisha, India.
[2]Institute of Agriculture, Visva-Bharati, Sriniketan, Birbhum-731 236, West Bengal, India

**skjata@gmail.com*

ABSTRACT

Elephant foot yam, *Amorphophallus paeoniifolius* (Dennst.) Nicolson (Araceae), is gaining popularity as a commercial tuber crop. Effects of different levels of drip fertigation on elephant foot yam was experimented in relation to growth and yield parameters during the year 2013-14 at ICAR-Regional Centre of Central Tuber Crops Research Institute, Bhubaneswar, Odisha. The results showed that early sprouting (47 days) and higher plant height (71.8 cm) at 120 days after planting (DAP), lower leaf orientation to pseudo stem (138.1^0), higher canopy spread (89.8 cm) at 120 DAP and higher corm yield (36.5 t ha^{-1}) was observed with the fertigation level of 140:140 kg N and K_2O ha^{-1} but fertigation levels 120:120 and 100:100 kg N K_20 ha^{-1} were at par with the maximum values. Higher pseudo stem girth (21.7 cm) with at fertigation level of 120:120 kg N and K_2O ha^{-1}. Fertigation with 100:100 kg N and K_2O ha^{-1} had recorded higher corm bulking efficiency (247.2%). Fertigation with 60:60 kg N and K_2O ha^{-1} had recorded higher number of leaflets at 120 DAP (231), higher pseudo stem dry matter production at 120 DAP (30.6 g $plant^{-1}$), higher corm dry matter production at 120 Dap (165.2g $plant^{-1}$) and higher corm bulking rate (8.6 g day^{-1}). Hence, the fertigation treatment 100:100 kg N and K_2O ha^{-1} was better than higher levels of fertigation or soil application of recommended dose of fertilizer in case of elephant foot yam crop.

Kew words: Elephant foot yam, drip fertigation, DAP, yield, corm

INTRODUCTION

Application of fertilizers directly to soil under conventional surface methods of irrigation are not effectively utilized by the crops (Cassel *et al.,* 2001; Hebbar *et al.,* 2004 and Singh *et al.,* 2013a). The elephant foot yam is a tuber crop with high production potential among major tropical tuber crops with wide range of uses including food and medicinal values (Misra *et al*., 2011). As the crop is planted widely spaced (90 cm x 90 cm), conventional surface irrigation results wastage of water. Drip irrigation is advantageous for elephant foot yam with 40 per cent yield increase over surface irrigation (Nedunchezhiyan *et al*., 2008). The Fertigation has been found to be effective in saving labour and energy. Fertigation increases both water and nutrient use efficiency. It supplies nutrients directly to the root zone in available forms and it regulates the nutrient balance and prevents loss of nutrients (Abdul Hakkim, 2014). Oxygenation of irrigation water, particularly in soil

with high clay contents, can help ameliorate the effects of this wetted zone in drip irrigated crops, allowing drip irrigation systems to achieve their full benefit (Bhattarai *et al.,* 2006, Bhattarai *et al.,* 2008). It also provides a simple and precise method of fertilisation and insect management, through fertigation of soluble nutrients and application of systemic insecticides (Collins, 2004). Due to this reason the fertigation has become the state of art in plant nutrition particularly in arid environments as the nutrients can be applied with the correct dosage and appropriate for each specific growth stage of the crop. However, lack of scientific studies on drip fertigation hinders its further expansion in the nontraditional and water scarce areas and proficient use of fertilizer and irrigation. Reasonable and optimal use of time, water and fertilizers are prerequisites to maximize the productivity and returns. Hence, the field experiments was carried out to evaluate the levels drip fertigation in elephant foot yam in terms of growth and productivity.

MATERIALS AND METHODS

Experimental site

A field experiment was conducted at ICAR-Regional Centre of Central Tuber Crops Research Institute, Bhubaneswar, Odisha, India during April to December during 2013 and 2014 to study the effect of different levels of drip fertigation on elephant foot yam (Gajendra). The experimental soil is sandy clay loam. The initial properties of the soil collected at the beginning of the field experiment were 92.5 kg ha^{-1} available N (Kjeldahl), 12.5 kg ha^{-1}available P (Bray-1), 88 kg ha^{-1} available K (1N NH_4 acetate), and 6.9 pH (1:2.5 soil: water). The climate is classified as sub-humid subtropical, characterized by hot summer, hot-humid rainy and mild winter. The weather condition of the experimental area varied considerably between the two crop seasons. Normally the experimental area receives 1273.9 mm rainfall and maximum precipitation generally occurs during June to September as long term average (LTA) rainfall of the area. The temperature and relative humidity during the crop growing period of both the years did not deviate much from their long term averages. The maximum temperature ranged from 29.4 to 38.0^{o}C; while, the minimum temperature varied from 15.4 to 26.6^{o}C during the cropping season (April to December). The average relative humidity during the cropping season varied from 30.2% to 97.6%.

Experimental design and treatments

The experiment was laid out in randomized complete block design with six treatments with four replications. The treatments were [T_1= Drip irrigation with soil application of recommended dose of fertilizer,T_2= Drip fertigation with 60:60 kg N and K_2O ha^{-1}, T_3= Drip fertigation with 80:80 kg N and K_2O ha^{-1}, T_4= Drip fertigation with 100:100 kg N and K_2O ha^{-1},T_5= Drip fertigation with 120:120 kg N and K_2O ha^{-1} and T_6= Drip fertigation with 140:140 kg N and K_2O ha^{-1}] replicated four times in 9 m x 5.4 m plots. Recommended dose of fertilizer followed is 100:80:100 kg of N: P_20_5: K_2O ha^{-1}. The phosphorous (P_20_5) dose was applied @80 kg ha^{-1} as SSP (single super phosphate) and micronutrient zinc sulphate and borax @10kg ha^{-1} at the time of final land preparation in all the treatments. The fertilizer material for N was urea only whereas K was supplied as murriet of potash for T_1 and as sulphate of potash for rest of the treatments with drip fertigation due to its solubility. The experiment was conducted for two successive years in the same lay out.

Crop management practices

The crop variety was “Gajendra” having 50-60 t ha^{-1} yield potential (Nedunchezhiyan *et al.,* 2008). The main field was prepared by two crosswise ploughing by tractor. The manures and fertilizers were applied in the form of farm yard manure, urea, and single super phosphate, muriate of potash and sulphate of potash as per treatments. After proper corm treatment with fresh cow dung slurry, the treated corms were planted on the ridges apart from 90 cm X 90 cm plant to plant and row to row distance. The corms were harvested at eight month after planting. The greengram seeds were sown on same ridges where elephant foot yam

corms were planted. After picking of pods of greengram at 60 and 75 days after sowing, the greengram plants were left on the ridges after trampling by feet to act as mulch. There was no additional supply of water and nutrient to greengram crop. The experimental plots received irrigation through drip irrigation scheduled at IW/CPE=0.08. The treatment (T_1) drip irrigation with soil application of recommended dose of fertilizer (N and K_2O) was applied at three equal split at 45, 75 and 105 days after planting (DAP) whereas drip fertigation treatments received N and K with five splits at 15, 45, 75, 105 and 120 DAP.

Observations recorded

The observations recorded with regards to growth attributes are sprouting period and plant height, pseudo stem girth, number of leaf, leaf orientation, canopy spread at 120 DAP. The observations recorded with relation to yield attributes are corm bulking rate, corm bulking efficiency, pseudo stem dry matter production and corm dry matter production at 120 DAP and final yield after harvest. The data were statistically analyzed by standard analysis of variance technique for randomized complete block design as suggested by Gomez and Gomez and the treatments means were compared based on the least significant difference (LSD) at 0.05 level of probability.

RESULTS AND DISCUSSION

Growth attributes

Elephant foot yam with different levels of fertigation showed significant effect on days to sprouting, pseudo stem girth, and number of leaves per plant and leaf orientation. The days to sprouting of elephant foot yam was decreased with increased levels of fertigation ranged from 52 to 49 days. Soil application of fertilizer took more days for sprouting compared with fertigation due to the direct contact of fertilizer to the seed corms. The treatments with higher dose of fertilizer T_4, T_5 and T_6: Drip fertigation with 100:100, 120:120 and 140:140 kg N and K_2O ha^{-1}) had taken less time for sprouting (47 to 48 days). Sahoo *et al*., 2015 and Singh *et al.,* 2013 reported that the time required for 100 % sprouting in elephant foot yam ranged from 54 to 58 days in different fertility level. The higher dose of fertilizer 100:60:100 of kg N: P_2O_5: K_2O ha^{-1} along with 15 t FYM ha^{-1} in soil application took less time than lower dose. The different levels of fertigation on plant height of elephant foot yam were not statistically significant though the highest plant height attained with T_6 i. e., drip fertigation with 140:140 kg N and K_2O ha^{-1}. Soil application of N at higher doses was reported to increase plant height of elephant foot yam, but not by the application of higher doses of K (Mukhopadhyay and Sen, 1986 and Geetha, 2001). However, Geetha (2001) found no significant increase in plant height even with higher dose of N application to soil. The girth of the pseudo stem increased progressively with increased levels of fertigation. The number of leaf lets and leaf orientation was significantly influenced by the different levels of fertigation. Number of leaf lets was higher at the T_3 FG (80:80 NK) and leaf orientation (in degree) least at the higher level of fertigation T_6 FG (140:140 NK). The canopy spread has not much influenced by levels of drip fertigation.

Yield components

Elephant foot yam with different levels of fertigation showed significant effect on yield components. The corm bulking rate (g day^{-1}) increased with increase in the age of the crop. The corm bulking rate was higher at the treatment T_2 (8.7) and lower at T_6 (6.6). The corm bulking efficiency (%) was from 3-5 month at treatment T_4: FG (100:100 NK). Corm and plant dry matter productions at 120 DAP was significantly influenced by the fertigation levels. Fertigation treatment T_2 i.e. 60:60 kg N: K_2O ha^{-1} recorded significantly higher plant dry matter over soil application of recommended dose of fertilizers (T_1). Plant dry matter at T_2 remained statistically at par with that of T_3 and T_4, but thereafter a gradual significant decrease was observed with T_5 and T_6. In case corms dry matter, it was only T_3 which registered significantly higher (4.5%) dry matter production over T_1, whereas all other fertigation treatments recorded significantly lower dry matter

than T_1 with significant and gradual decrease with the increase in fertigation levels. The result similar to Das *et al.,* 1997 which reported that biomass production of shoot (leaf and pseudo stem/ petiole) increased up to 120 days after planting (DAP) and 150 DAP respectively and declined thereafter whereas the corm dry weight and total dry matter production (TDMP) showed a steady increase up to the maturity.

Crop productivity

The corm yield of elephant foot yam was significantly influenced by the levels of fertigation treatment. Data in the table 2 showed that the corm yield ranged between 29.5 to 36.5 t ha^{-1} in different treatments combination. The highest corm yield 36.5 t ha^{-1} was obtained with higher dose of fertigation which was at par up to the lower dose of fertigation T_3: FG 80:80 kg N and K_2O ha^{-1}. It was also observed drip fertigation with 60:60 kg N and K_2O ha^{-1} yield was higher yield than that of drip irrigation with soil application of recommended dose of fertilizer (100:100 NK) increased by 1.1 % in elephant foot yam. Venkatesan *et al.,* (2014) reported that application of 100 % RDF along with irrigation at 100 % cumulative pan evaporation (CPE) resulted in higher corm yield and promoted plant height, pseudo stem girth and canopy spread in elephant foot yam.

CONCLUSION

Fertilizer use efficiency under fertigation of elephant foot yam crop is effective as compared to manual fertilizer application. Usually farmers follow the flood method of irrigation with manual and labour-intensive use of fertilizer to cope up with the deficiency of rains and unavailability of fertilizers. Water and fertilizer is a scare resource which needs to be preserved and the ultimate goal should be to ensure more crop per drop of water (Patel and Rajput, 2000; Chawla and Narda, 2002). The excess use of fertilizer more than required hampers the soil health. However, lack of scientific studies hinders further expansion of crops in water scarce area. Hence it is imperative to require more studies on the effect of fertigation on crop growth and yield of elephant foot yam. T_4: drip fertigation with 100:100 kg N and K_2O ha^{-1} resulted in significantly at par with the higher level of drip fertigation up to 140:140 kg N & K_2O ha^{-1} in elephant foot yam.

Table 1. Effect of drip fertigation on growth attributes of elephant foot yam (pooled data of two year)

Treatments	Sprouting Period	Plant height (cm) at 120 DAP	Pseudo stem girth (cm) at 120 DAP	No of leaf let at 120 DAP	Leaf orientation (0)	Canopy spread (cm) at 120 DAP
T_1: Drip (RDF soil)	51	68.9	18.0	226.8	142.1	86.0
T_2: FG (60:60 NK)	51	61.3	19.9	227.3	140.9	79.5
T_3: FG (80:80 NK)	49	66.9	19.3	230.5	140.8	86.8
T_4: FG (100:100 NK)	48	68.8	20.6	188.5	143.3	88.1
T_5: FG (120:120 NK)	48	62.9	21.7	224.3	140.6	82.5
T_6: FG (140:140 NK)	47	71.8	20.4	194.9	138.1	89.8
Mean	49	66.8	20.0	215.4	141.0	85.4
SEm (±)	0.6	3.5	0.7	14.5	0.8	3.7
$LSD_{0.05}$	1.7	NS	2.1	42.0	2.3	NS

T_1: Drip (RDF soil): Recommended dose of fertilizer through soil application, T_2: FG (60:60 NK): 60 kg N and 60 kg K_2O through fertigation, T_3: FG (80:80 NK): 80 kg N and 80 kg K_2O through fertigation, T_4: FG (100:100 NK): 100 kg N and 100 kg K_2O through fertigation, T_5: FG (120:120 NK): 120 kg N and 120 kg K_2O thorough fertigation and T_6: FG (140:140 NK): 140 kg N and 140 kg K_2O through fertigation $hectare^{-1}$

Table 2. Effect of drip fertigation on corm bulk rate and yield of elephant foot yam (pooled data of two years)

Treatments	Corm bulk rate g day^{-1}	Corm bulking efficiency (%)	Pseudo stem dry matter production 120 DAP g $plant^{-1}$	Corm dry matter production at 120 DAP g $plant^{-1}$	Corm yield t ha^{-1}
T_1: Drip (RDF soil)	7.9	169.2	28.0	138.6	29.5
T_2: FG (60:60 NK)	8.7	245.0	30.6	165.2	32.5
T_3: FG (80:80 NK)	8.0	238.0	30.5	147.5	34.6
T_4: FG (100:100 NK)	8.6	247.2	27.1	145.0	35.9
T_5: FG (120:120 NK)	7.0	172.3	23.0	135.0	36.0
T_6: FG (140:140 NK)	6.6	129.2	18.8	110.7	36.5
Mean	7.8	183.5	26.3	140.3	34.2
SEm (±)	0.2	3.5	1.2	2.7	0.4
$LSD_{0.05}$	0.4	10.0	3.4	7.9	1.0

T_1: Drip (RDF soil): Recommended dose of fertilizer through soil application, T_2: FG (60:60 NK): 60 kg N and 60 kg K_2O thorugh fertigation, T_3: FG (80:80 NK): 80 kg N and 80 kg K_2O thorugh fertigation, T_4: FG (100:100 NK): 100 kg N and 100 kg K_2O through fertigation, T_5: FG (120:120 NK): 120 kg N and 120 kg K_2O through fertigation and T_6: FG (140:140 NK): 140 kg N and 140 kg K_2O through fertigation $hectare^{-1}$

REFERENCES

Abdul Hakkim, V.M. 2014. Effect of site specific drip fertigation on yield of chilli. *IOSR J. of Eng.* (IOSRJEN), ISSN (e): 2250-3021, ISSN (p): 2278-8719 Vol. 04, Issue **(1)**6: 33-41.

Bhattarai, S.P., Midmore, D.J. and Pendergast, L. 2008. Yield, water-use efficiencies and root distribution of soybean, Patechickpea and pumpkin under different subsurface drip irrigation depths and oxygation treatments in vertisols. *Irrigation Science* **26**(5): 439-450.

Bhattarai, S.P., Pendergast, L. and Midmore, D.J. 2006. Root aeration improves yield and water use efficiency of tomato in heavy clay and saline soils. *Scientia Horticulturae* **108**(3): 278-288.

Cassel, S.F., Sharmasakar, S., Miller, S.D., Vance, G.F. and Zhang, R. 2001. Assessment of drip and flood irrigation on water and fertilizer use efficiencies for sugar beets. *Agric Water Manage* **46:** 241-43.

Chawla, J.K. and Narda, N.K. 2000. Growth parameters of trickle fertigated potato. *Ind. J. Agric. Sci.,* **70**(11): 747-752.

Collins, R. 2004. Alternative irrigation systems: A case study. *In WATER pak: A guide for irrigation management in cotton* (Eds H. Dugdale, G. Harris, J. Neilsen, D. Richards, G. Roth and D. Williams). Narrabri, Australia: Cotton Research and Development Corporation.

Das, P.K., Sen, H., Banerjee, N.C. and Panda, P.K. 1997. Biomass production and growth rate at different phenophases of elephant yam as influenced by chemical treatments. *Indian J. Agric Res*. **31**: 115 – 121.

Geetha, K. 2001. Nutrient management in Amorphophalus grown as inter crop in reclaimed alluvial soils of Kuttanad, Kerala. *J. Root Crops* **27**: 263-266.

Hebbar, S.S., Ramachandroppa, B.K., Nanjappa, H.V. and Prabhakar, M. 2004. Studies on NPK drip fertgation in field grown tomato (*Lycopersicum esculantum* Mill.). *European Journal of Agronomy.* **21**(1): 117-127.

Misra, R.S, Nedunchezhiyan, M., Shivalingaswamy, T.M. and Edison, S. 2002. Mass multiplication techniques for producing quality planting of *Amorphophallus paeniifolius* (Dennst.) Nicolson (Araceae). *Aroideana* **25**: 78-87.

Mukhopadhyay, S.K. and Sen, H. 1986. Effect of nitrogen and potassium on yield and quality of elephant

foot yam (*Amorphophallus campanulatus* Blume). *J. Root Crops*. **12** (2): 103-106.

Nedunchezhiyan, M., James, G., Naskar, S.K., Ravindran, C.S. and Edison, S. 2008. Scope and potential of micro irrigation in *Amorphophallus*. In: *Abstract Book, National Seminar on Amorphophallus: Innovative Technologies*. 19-20 July 2008, Patna, Bihar, India. pp.112-115.

Patel, N. and Rajput, T.B.S. 2000. Effects of fertigation on growth and yield of onion. Proceedings International Conference. *Micro and Sprinkler Irrigation Systems*, 8-10 February 2000, Jalgaon, Maharashtra. 77.

Sahoo, B., Nedunchezhiyan, M. and Acharya, P. 2015. Productivity potential of elephant foot yam in alfisols as influence by fertility level. *The Bioscan.* **10**(1): 1-3.

Singh, A., Gulati, I.J. and Chopra, R. 2013. Effect of various fertigation schedules and organicm manures on tomato (*Lycopersicon esculentum* Mill.) yield under arid condition, *The Bioscan* **8**(4): 1261-1264.

Singh, R., Bhusan, S., Kumar, S. and Sankar, R. 2013. Yield assessment of elephant foot yam growth under multileyar vegetable cropping system. *The Bioscan*. **8**(4): 1237-1239.

Venkatesan, K., Saraswathi, T., Pugalendhi, L. and Jansirani, P. 2014. Impact of irrigation and fertigation levels on the growth and yield of elephant foot yam (*Amorphophallus paeoniifolius* (Dennst.) Nicolson). *Journal of Root Crops*. **40** (1): 1-4.

Verma, P.K., Sen, H., Roychoudhury, N. and Panda, P. K. 1995. Growth, corm development and uptake of N and K as influenced by doses and methods of NK application in elephant foot yam (*Amorphophallus campanulatus* Blume). *J. Potato. Res*., **11**: 68-74.