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Productivity and Profitability of Elephant Foot Yam under Drip and Flood Irrigation

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Abstract

Productivity and profitability of elephant foot yam under drip and flood irrigation was worked out, based on the data collected from field experiments conducted at ICAR-CTCRI, Thiruvananthapuram, during two years, 2013-14 and 2014-15. The experiment consisted of two methods of irrigation (Drip and Flood irrigation methods) applied at three periods of growth (first 12 weeks after planting (WAP), 13-24 WAP, 1-24 WAP) along with a rainfed crop for comparison. Whole corm size of 500 g each of the variety 'Gajendra' was uniformly used as the planting material. Pooled analysis of the data showed superiority of drip irrigation over flood irrigation. Among the six treatments, drip irrigation during 13-24 WAP resulted in the maximum corm yield (40.59 tha^{-1}). However, corm yield was on par with drip or flood irrigation given during the period of 1-24 weeks. Even though the cost of cultivation was more under drip irrigation, it resulted in more gross (` 12,17,700) and net income (` 8,38,900) and B:C ratio (3.21). Maximum productivity per day and profitability per hectare per day were recorded when drip irrigation was provided during 13-24 WAP corms. Relative economic efficiency was 119 to 275% higher under drip irrigation and 109 to 168% higher under flood irrigation relative to rainfed cultivation. Productivity per mm of water consumption was more under drip irrigation, and the values were less under flood irrigation compared to rainfed conditions.

Key words: Elephant foot yam, B:C ratio, drip irrigation, flood irrigation, productivity, profitability

Introduction

Elephant foot yam (*Amorphophallus paeoniifolius* (Dennst.) Nicolson), is one of the major tropical tuber crops, which is gaining popularity as a food security crop and as a cash crop. It is popular as a starchy vegetable having high nutritive and medicinal values. Its cultivation is mainly confined to India, Philippines, Indonesia, Sri Lanka and South East Asia. Traditionally, the crop is cultivated under rainfed conditions, like other tuber crops in areas with annual rainfall varying between 1000 mm and 3000 mm. Presently, its cultivation is attempted in non traditional areas also due to its perennial demand as well as the attractive prices. Commercial growers plant the crop by the end of March or beginning of April with protective irrigation in Odisha and Andhra Pradesh (Nedunchezhiyan et al. 2008). Farmers give more than 20 irrigations apart from rainfall. Generally they follow flood irrigation providing 4-5cm water, thereby lot of water is wasted by runoff and percolation. Recently, commercial farmers use micro irrigation, but without any rationale.

Drip irrigation is capable of applying precise amounts of water in soil around the root zone, with a high degree of uniformity and frequency. These features make it potentially much more efficient than other irrigation methods (El-Hendawy et al. 2008). But the farmers have to incur a reasonable expenditure towards initial installation of the micro irrigation facilities. However over the period of years, it would be profitable in terms of higher yield and income. In this study, an attempt was made to work out the productivity and profitability of elephant foot yam cultivation raised under drip irrigation, in comparison to flood irrigation and rainfed cultivation.

Materials and Methods

The field experiment was carried out in elephant foot yam at ICAR-Central Tuber Crops Research Institute,

Thiruvananthapuram, Kerala, India during 2013- 14 and 2014-15 under drip and flood irrigation applied at different stages of crop growth. The variety 'Gajendra' was used for the study by planting 500 g each of the whole seed corm at a spacing of 90 × 90 cm with a gross plot size of 25 plants, during February in both the years. Data were collected from seven treatments *viz*., drip irrigation @ 100% cumulative pan evaporation (CPE) during first 12 weeks (T_1); drip irrigation @ 100 CPE during 13-24 weeks (T_2); drip irrigation @ 100% CPE during the whole 24 weeks (T_3); flood irrigation during first 12 week (T_4); flood irrigation during 13-24 weeks (T_5); flood irrigation during the whole 24 weeks (T_6); and a rainfed crop (T_7).

Standard nutrient dose of 25 tha^{-1} of FYM and 100-50-150 $kgha^{-1}$ of N, P_2O_5 and K_2O were applied uniformly in all the treatments. Under drip method, drip pipes were laid out and drippers were placed at a distance of 90 cm, coinciding with each plant. Under flood system, channels were laid out to allow free movement of water to each plot. Quantity of irrigation was fixed based on the daily open pan evaporation and the pan factor. Reference crop evapotranspiration (ET0) was estimated from pan evaporation (Ep), pan factor (Kp), and the crop coefficient (Allen et al. 1998). Drip irrigation was given once on alternate days. For flood irrigation, the field was irrigated once in a week. The flow of water in both the irrigation methods was controlled by water meters with control valves. The crop was harvested after 10 months during December and corm yield from the net plot was recorded and corm yield per ha was estimated. A rainfed crop was also raised as control for comparison. Economic indices *viz*., cost of cultivation, gross income, net income, benefit: cost ratio, and profitability per day, were worked out based on various inputs and labour costs at the end of two years. Relative economic efficiency of irrigation treatments was computed as compared to rainfed crop (Urkurkar et al. 2008). Based on the total water used through irrigation and rainfall received during the growing period (862 mm), productivity per mm of water was worked out for various irrigation treatments.

Results and Discussion

Corm yield

During the first year of the experiment, drip irrigation was found significantly superior over flood irrigation and resulted in a corm yield of 31.69 t ha^{-1}. During the second year, corm yield from flood irrigation was on par with drip irrigation. Pooled analysis of the corm yield data showed superiority of drip irrigation over flood irrigation. Rainfed crop had the lowest corm yield during both the years (18.5 t ha^{-1}).

Drip irrigation during 13-24 weeks, (T_2) resulted in the maximum corm yield which was on par with irrigation during 1- 24 weeks (40.59 t ha^{-1}). Flood irrigation during first 12 weeks (T_4) as well as 1-24 WAP (T_6) resulted in corm yield on par with drip irrigation (T_2 and T_3). However, there was 30-35% increase in corm yield under drip irrigation (T_2) than flood irrigation (T_4 and T_6). Drip irrigation is established to be an efficient irrigation method where water is applied exactly in the root zone without any loss through seepage or run off. Fertigation experiment conducted at CTCRI, RC, Bhubaneswar indicated that drip irrigation at 100% PE and 100% fertigation resulted in maximum corm yield (CTCRI, 2011). The results of the present study clearly indicated that water requirement of elephant foot yam is critical during 13-24 weeks after planting, which coincides with tuber development phase. This is in agreement with Ravi *et al.* (2015) and Sunitha *et al*. (2018) . Drip irrigation at 100% PE during this phase is as good as irrigation given throughout the growth cycle. Soil moisture during the initial stages of planting is mainly utilized for sprouting of the planted corms and initial establishment of canopy. Tuber initiation also occurs during 45-60 days after planting along with sprouting. Translocation of starch from vegetative parts to the corm is faster during 3-6 months, which results in more tuber bulking. Once the corm development is over, senescence starts, normally during 6 to 7 months after planting. Corm maturity occurs at this stage (AICRP TC, 2014).

Cost of installation of drip irrigation

The cost of irrigation materials depends mainly on the distance of the field from the water source. The total cost of installation of drip system in one ha is about ` 1.5 lakhs (Table 1) including accessories and installation charges. After considering the life span, depreciation, interest on capital, repair and maintenance cost *etc* during subsequent years, the cost of main pipes, valves and motor is worked to be ` 9,500 /- and that of laterals and drippers is ` 30,700/- per hectare per year. Thus the

Table 1. Cost of installation of drip irrigation in 1 ha (Fixed cost per ha per year)

Particulars	Cost of laterals, drippers etc (`)	Cost of pipes, valve, motor, filters etc(`)
Fixed cost	1,00,000	50,000
Life span	6	20
Depreciation	16,700	2,500
Interest (12%)	12,000	6,000
Repair and maintenance(2%)	2,000	1,000
Total	30,700	9,500
Grand total	40,200	

total fixed cost involved in installation of drip irrigation unit in one hectare area of elephant foot yam is worked out as about ` 40,200/- per year.

Cost of cultivation

The cost of cultivation of elephant foot yam under drip and flood irrigation was worked out based on various inputs and labour costs and it ranged from ` 3,78,800 to ` 3,85,800 ha^{-1} under drip irrigation and ` 3,37,900 to ` 3,40,700 under flood irrigation. The high cost under drip irrigation is mainly due to the cost of irrigation accessories and its installation (Table 2). Under rainfed conditions, the cost of cultivation was only ` 3,31,600 $ha^{-1}$. More than 55% of the total cost of cultivation is the cost of planting material in elephant foot yam (6.25 t @ ` 30). This is followed by the cost of labour for different operations (37%) and various inputs (7%).

Gross income and net income

The gross income ranged from ` 8,05,800 to 9,05,100 $ha^{-1}$- under flood irrigation whereas under drip irrigation at different periods, it ranged from ` 8,68,500 to 12,17,700 ha^{-1}. Net income ranged from ` 4,67,900 to 6,00,500 $ha^{-1}$ under flood irrigation and ` 4,89,700 to 8,38,900 ha^{-1} under drip irrigation during different periods. Gross and net income from rainfed crop was ` 5,55,000 and 2,23,400 ha^{-1} respectively. The maximum net income was obtained under the treatment T_2. The net income was minimum under the treatment T_5. Drip irrigation, especially during the 13-24 weeks, coinciding with tuber development phase of elephant foot yam resulted in more corm yield which consecutively resulted in more gross and net income. Among the treatments, drip irrigation resulted in 2.2 to 3.7 fold and flood irrigation resulted in 2.0 to 2.7 fold net income compared to rainfed control.

B:C Ratio

B:C ratio followed a similar trend as in gross and net income. The ratio ranged from 2.3 to 3.2 under drip irrigation (T_1, T_2, T_3) and 2.4 to 2.8 under flood irrigation (T_4, T_5, T_6), whereas B:C ratio was the lowest (1.67) under rainfed conditions. Similar increase in corm yield, gross and net income and B:C ratio under drip fertigation over flood irrigation due to increased water and nutrient use efficiencies in elephant foot yam, has been reported (Nedunchezhiyan, 2017).

Productivity, profitability and relative economic efficiency

The crop takes 10 months for maturity (300 days) and productivity in terms of corm yield and

Table 2. Corm yield and economics of elephant foot yam cultivation under drip and flood irrigation at different spells

Irrigation treatment	Tuber yield (t ha^{-1})	Cost of cultivation (` ha^{-1})	*Gross income (` ha^{-1})	Net income (` ha^{-1})	B:C Ratio
T_1: Drip irrigation for 1-12 wks	28.95	3,78,800	8,68,500	4,89,700	2.29
T_2: Drip irrigation for 13-24 wks	40.59		3,78,800	12,17,700	8,38,900 3.21
T_3: Drip irrigation for 1-24 wks	39.65	3,85,800	11,89,500	8,03,700	3.08
T_4: Flood irrigation for 1-12 wks	31.28	3,37,900	9,38,400	6,00,500	2.78
T_5: Flood irrigation for 13-24 wks	26.86	3,37,900	8,05,800	4,67,900	2.38
T_6: Flood irrigation for 1-24 wks	30.17	3,40,700	9,05,100	5,64,400	2.66
T_7: Rainfed crop	18.5	3,31,600	5,55,000	2,23,400	1.67
CD	10.56				

***** price of corms @ ` 30000 per tonne

profitability in terms of profit day^{-1} were worked out. The productivity day^{-1} was 1.5 to 2.2 fold and profitability ha^{-1} day^{-1} was 2.2 to 3.7 fold higher under drip irrigation (T_1, T_2, T_3) based on pooled means, compared to rainfed control. Under flood irrigation, productivity day^{-1} was 1.4 to 1.7 fold and profitability ha^{-1} day^{-1} was 2.1 to 2.7 fold higher than that of rainfed control. Relative economic efficiency (which is a measure of increase in net income over control) was worked out to be 119 to 275% higher under drip irrigation (T_1, T_2, T_3) and 109 to 168% higher under flood irrigation (T_4, T_5, T_6) over rainfed cultivation. Maximum productivity day^{-1} and profitability ha^{-1} day^{-1} were recorded under the treatment T_2 (drip irrigation during 13-24 WAP) corms. In this experiment, the crop yielded 1.3 fold and 2.2 fold more under drip irrigation (T_1, T_2, T_3) compared to flood method of irrigation and rainfed conditions respectively, which resulted in more gross and net income and B:C ratio, productivity and profitability under drip irrigation treatments (T_1, T_2, T_3) (Fig.1).

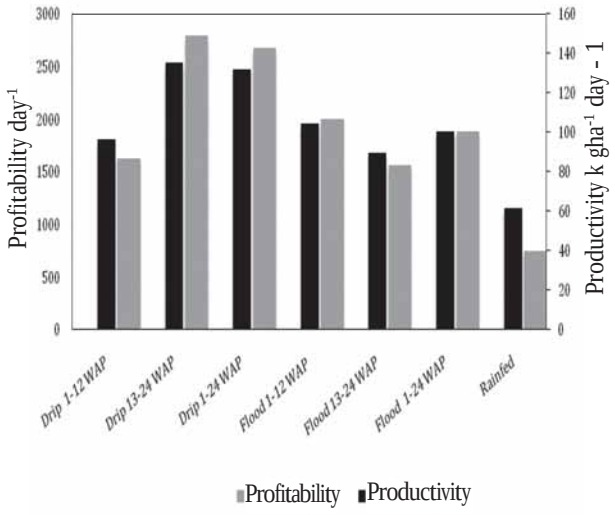

Fig. 1. Productivity and profitability of elephant foot yam ha^{-1}day^{-1} under drip , flood and rainfed conditions

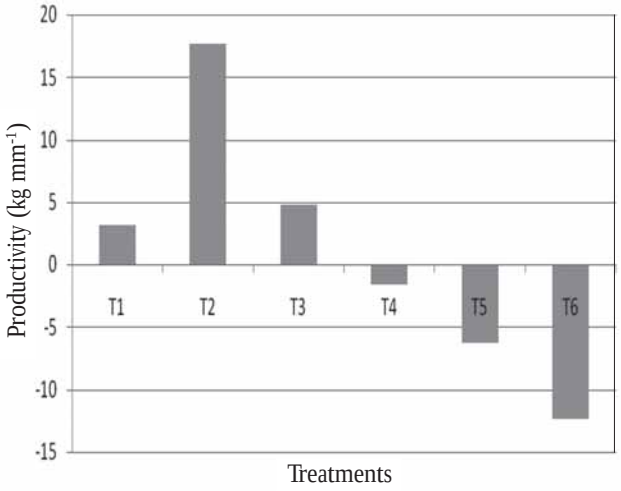

Fig.2. Corm productivity per mm of water consumption under drip and flood irrigation compared to rainfed crop

Corm productivity per mm of water used

Based on the total water consumption by the crop in different treatments either through rain fall or through irrigation and the economic produce obtained, and productivity per mm of water were calculated. Productivity was maximum in T_2, (drip irrigation during 13-24 WAP ,51.8 kg mm^{-1}) where the corm yield was maximum (Table 3). Even though T_3 resulted in corm yield on par with T_2, the total water used was more in the former since irrigation was given throughout the crop period. Flood irrigation (T_4,T_5,T_6) resulted in least productivity and was 0.6 to 1.37 fold lower than T_2. Rainfed crop recorded a productivity of 34.2 kg mm^{-1} (Fig. 2).

Conclusion

It is concluded that elephant foot yam cultivation under drip irrigated is economic compared to flood irrigated or rainfed cultivation. Drip irrigation during the period 13-24 WAP resulted in maximum corm yield, gross and

Table 3. Corm productivity per mm of water used under different treatments

Item	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Irrigation water used (mm)	234.3	241.9	476.2	234.3	241.9	476.2	0
Effective rainfall (mm)	541	541	541	541	541	541	541
Total water consumption (mm)	775.3	782.9	1017.2	775.3	782.9	1017.2	541
Corm yield (t ha^{-1})	28.95	40.59	39.65	31.28	26.86	30.17	18.5
Productivity mm^{-1}	37.3	51.8	39.0	32.5	28.0	21.8	34.2

net income, B:C ratio, productivity per mm of water consumption and profitability per ha per day in elephant foot yam.

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