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Productivity and Profitability of Elephant Foot Yam Grown under Multilayer Vegetable Growing System

Elephant foot yam (*Amorphophallus paeoniifolius*) is an important crop cultivated for its edible corms rich in vitamins, Ca, P and other minerals and can be profitably raised as an intercrop in different horticultural crops. They can supplement the food requirement of the family besides providing additional employment (Jata et al., 2009). To increase the production of both vegetables and tuber crops from the same piece of land without hampering the main crop yield, the most efficient practice would be to grow these crops in an intercropping system. Elephant foot yam being a long duration and widely spaced crop, takes about 50 – 60 days or more to spread into a full ground cover. Therefore, adequate sunlight and space are available in the early stages of crop growth. Moreover, as the crop removes appreciable quantities of nutrients from the soil, large amounts of organic matter are required to maintain the soil health and quality. Short duration vegetables when grown and turned under can build up the soil organic matter and N in the soil (Chattopadhyay et al., 2008). Several earlier workers have reported that short duration vegetables can be profitably intercropped in elephant foot yam (Sen et al., 1993; Kannan et al., 2001; Chattopadhyay et al., 2008). The farmers of Godda district of Jharkhand state grow low yielding desi variety of elephant foot yam in the backyard of their houses in scattered. But, if cultivated as per scientific recommendations, there is a great possibility for utilizing the interspaces of elephant foot yam grown areas during the early growth stage by intercropping short duration cucurbitaceous vegetable crops like bitter gourd, ridge gourd, bottle gourd, thereby increasing the return per unit area land. The present experiment was thus taken up to find out the suitability of cucurbits as an intercrop with elephant foot yam to get additional income without affecting the main crop yield in the Godda district of Jharkhand state.

The field experiments were carried out during two years (2010-2012) in five villages viz. Nipania, Sundermore, Belbathan (Godda block), Mohanpur (Sunderpahadi block) and Boha (Poraiyahaat block) of Godda district by GraminVikas Trust, Krishi Vigyan Kendra, Godda, Jharkhand under National Agricultural Innovation Project to assess yield and economics of elephant foot yam (cv. Gajendra) with cucurbits viz. bottle gourd (*Lagenaria siceraria*), (cv. Hybrid) ridge gourd (*Luffa acutangula*) (cv. Local) and bitter gourd (*Momordica charantia*) (cv. Hybrid US6214) under multilayer vegetable cropping system. The soil of the experimental site was sandy loam in texture with organic C 0.56 per cent, available N 302 Kg/ha, P_2O_5 21.06 Kg/ha, K_2O 114.46 Kg/ha and pH 6.83. The annual rainfall ranged between 1000 – 1300 mm with majority of rainfall occurring during the monsoon season (July to September). The average maximum and minimum temperature varied between 12^{0}C to 41^{0}C (Table 1). The experiment was laid out in randomized block design with the following four treatments and ten replications: (1) sole crop of elephant foot yam, (ii) Elephant foot yam + Bitter gourd, (iii) Elephant foot yam + Ridge gourd and (iv) Elephant foot yam + Bottle gourd.

Table1 . Weather parameters during the crop growth period (mean of 2010-2011 and 2011-2012)

Month	Temperature (^{0}C)		Rain fall (mm)
	Maximum	Minimum	
April	40.38	14.83	18.60
May	37.58	13.61	64.80
June	37.21	14.15	186.90
July	35.20	14.00	251.50
August	35.09	22.00	253.80
September	35.08	25.02	189.80
October	33.82	24.80	73.20
November	31.82	24.50	8.90
December	29.93	20.85	2.60
January	20.42	12.77	12.00
February	26.37	12.98	18.90
March	32.42	14.80	14.50

Elephant foot yam (EFY) variety Gajendra was planted during the second fortnight of June in plots of size 1000m^2. Pits of 3.375 ft^3 size were prepared at 75cm x 75cm spacing and filled to three-fourth of pit with 2 kg well decomposed farmyard manure (FYM). The tubers were cut in to pieces of 500 g and treated with cow dung slurry (one kg of fresh cow dung in one litre of water one day before planting) were planted and covered with soil so as to form a small mound on the top of the pit. The seeds (hybrid) of cucurbits, bitter gourd, ridge gourd, and bottle gourd were sown in between two rows of main crop i.e. elephant foot yam at the recommended spacing.

Elephant foot yam crop was fertilized with 150 kg N, 100 kg P_2O_5 and 150 kg K_2O ha^{-1}. Half dose of N and K and full dose of P were applied at the time of planting of main crop in pits and rest half of N and K applied after harvesting the companion crops i.e. at 95 days after planting (DAP). Recommended dose of fertilizers were also given to the companion crops as per recommendations. Other cultural practices were done as per recommendations for the cultivation of main crop as well as companion crops. A *machan* like structure was erected with the help of bamboo, wire and threads over 2.03 metre height from the ground level over the main crop i.e. elephant foot yam to trail the vines of bottle gourd, ridge gourd and bitter gourd. Harvesting of bottle gourd, ridge gourd and bitter gourd fruits were done at an appropriate intervals of 4 – 7 days after attaining the marketable size, which continued up to 95 days after sowing. Bitter gourd was harvested 9 times and ridge gourd and bottle gourd were harvested 8 times. Harvesting of main crop was done at 210 DAP. The corm yields and yields of companion crops were recorded in each treatment and the data were statistically analysed by following the method of Panse and Sukhatme (1967). The economics of the vegetable cropping systems was computed based on the mean yields and existing market price.

The data presented in Table 2 depicted that there was no significant difference between sole crop yield of elephant foot yam (37.61 t ha^{-1}) and that under intercropping with bitter gourd (37.43 t ha^{-1}). However these treatments were significantly greater than yields of intercropping with bottle gourd and ridge gourd. It is interpreted that less competition for resources and better scope of intercultural operations at early growth stages were the favourable points, which might have triggered the process of partitioning photosynthates from source to sink resulting in higher yield of main crop. Das and Maharana (1995) reported that elephant foot yam does not compete for light because it tolerated shade. It was also observed that the inclusion of any of the companion crops reduced the yield of main crop. However, the superiority of cowpea and cassava as intercrops with elephant foot yam was reported by earlier workers (Kannan et al., 2001; Chattopadhyay et al., 2008). Among the companion crops, the highest elephant foot yam yield equivalent (91.66) were obtained from bitter gourd where as the lowest value (50.50) was computed from bottle gourd (Table 2).

Table 2.Yield of elephant foot yam and companion crops under multilayer vegetable cropping system

Treatments	Yield(t ha^{-1})						
	Main Crop			Companion crop			EFY yield equivalent
	2010-11	2011-12	Mean	2010-11	2011-12	Mean	
Sole elephant foot yam	37.36	37.86	37.67	——	——		
Elephant foot yam + Bitter gourd	37.20	37.65	37.43	13.88	13.75	13.82	91.66
Elephant foot yam + Ridge gourd	36.20	36.27	36.23	14.73	14.79	14.76	59.26
Elephant foot yam + Bottle gourd	32.74	33.31	33.03	25.16	24.79	24.98	50.50
CD (0.05)	0.839	0.55	0.694	0.847	0.927	0.425	

Considering market price (per kg) of bitter gourd = Rs. 10/-: ridge gourd = Rs. 6/- ; bottle gourd Rs. 3/- ; Elephant foot yam =Rs. 15/- and man days = Rs.150/-

Table3. Economic analysis of elephant foot yam and companion crops under multilayer vegetable cropping system

Treatments	Gross return (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Income per rupee investment (Rs.)
Sole elephant foot yam	564105	289369	274736	1.95
Elephant foot yam + Bitter gourd	699525	321852	377673	2.17
Elephant foot yam + Ridge gourd	640140	322564	317576	1.98
Elephant foot yam + Bottle gourd	566475	345678	220797	1.64

The economic analysis was done on the basis of mean yield of main crop and companion crops of two years and existing market price. The maximum net return (Rs. 377673ha^{-1}) and the income per rupee investment (2.17) were obtained from elephant foot yam + bitter gourd followed by elephant foot yam+ ridge gourd (Rs. 317576 ha^{-1} and 1.98), sole crop of elephant foot yam (Rs. 274736 ha^{-1} and 1.95) and the lowest return (Rs. 220797 ha^{-1}and 1.64) was recorded in the elephant foot yam+ bottle gourd (Table 3).

Kannan et al. (2001) and Chattopadhyay et al. (2008) obtained the highest economic return from elephant foot yam + cow pea intercropping system as compare to sole elephant foot yam, elephant foot yam + okra, elephant foot yam + cucumber and elephant foot yam + amranthus. Ravindran et al. (2006) also advocated the intercropping of tuber crops for better remuneration.

From the present study it can be inferred that bitter gourd can be profitably grown with elephant foot yam under multilayer vegetable cropping system in the Godda district of Jharkhand state

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