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Response of elephant foot yam to different INM sources and its effect on economics and soil health

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Abstract
The effect of different integrated nutrient sources and bio-fertilizers on growth, yield and quality parameters of elephant foot yam (250 g ± 50 g seed corm size) and also its impact on soil fertility status after harvesting the crop was evaluated at RHRS farm, N. A. U., Navsari, Gujarat. The experiment was arranged over 8 treatment combinations comprising 4 levels of integrated nutrient sources and two levels of bio-fertilizers, laid out in a Randomized Block Design (Factorial concept) with three replications. Application of 50 % RDN through inorganic fertilizers + 50 % RDN through vermicompost along with RDF of P and K (T_2) showed significant impact on most of the parameters studied at 120 and 150 DAP. Plant height (73.02 cm and 78.87 cm), petiole length (49.33 cm and 56.75 cm), canopy spread E-W (90.27 cm at 150 DAP only) and N-S (88.87 cm and 89.82), culm girth (15.06 cm and 15.74 cm) and number of leaflets per plant (362.07 and 318.90) were recorded maximum. These values were statistically remained at par with T_3 treatment, except canopy spread in N-S direction which was significantly superior than all other treatments. Application of bio-fertilizres (B_1) [combination of *Azospirillum*, Phosphate solubilizing bacteria (PSB) and Potash Mobilizing Bacteria (KMB) each at 5 liters ha^{-1}.] also showed significant impact over the treatment without bio-fertilizers, on the parameters discuss above at 120 and 150 DAP. Plant height (70.12 cm and 76.68 cm), petiole length (47.94 cm and 53.50 cm), canopy spread E-W (87.09 cm at 150 DAP only) and N-S (83.84 cm and 86.88 cm), culm girth (14.37 cm and 14.82 cm) and number of leaflets per plant (343.63 and 302.98) were recorded maximum at 120 and 150 DAP, respectively. The interaction effect between INM sources and bio-fertilizers was found significant at 150 DAP in two parameters only i.e. plant height and petiole length. Treatment combination of T_2B_1 recorded maximum plant height (79.15 cm) and petiole length (57.30 cm) at 150 DAP. Yield and its attributes *viz.*, harvest index (51.77 %), corm circumference (48.36 cm), fresh corm weight (1.267 kg) and yield per hectare (26.37 t) were recorded highest in treatment T_2 and all these parameters were statistically remained at par with T_3 treatment. These parameters were found significantly superior with harvest index of 48.51 %, corm circumference of 46.99 cm, fresh corm weight of 1.186 kg and yield of 24.84 t/hectare over the treatment without application of bio-fertilizers. Among corm quality parameters, starch content was highest (16.57 %) in T_3 treatment whereas, different INM sources did not show any significant effect on β-carotene and calcium oxalate content. Among different parameters studied for soil fertility status after harvest only organic carbon content showed significant difference with maximum value of 0.597 % in T_2 treatment but remained at par with T_3 and T_4 treatments. The application of bio-fertilizers could not show any significant differences on corm as well as soil quality parameters except organic carbon content which was found significantly superior with 0.588 per cent over no bio-fertilizers application. The treatment combination of T_3B_1 realized highest B:C ratio.

Keywords: Integrated nutrient sources, bio-fertilizers, Elephant foot yam

Introduction

Elephant foot yam (*Amorphophallus paeoniifolius* Dennst. Nicolson), is belonging to the family Araceae. It is the most popular and widely cultivated member of the edible aroids. It is believed to be a native of South East Asia and is indigenous to tropical Asia and Africa with a diploid chromosome number of 28. It is considered as a famine food in the pacific Islands. It is a robust herbaceous plant, with an erect solitary pseudostem bearing a tripartite leaf at the top and large, globuse underground corm. It is a remunerative crop which has high dry matter production capability per unit area than most of the other vegetables. It is gaining popularity as a cash crop among the farming community of our country due to its high production potential, higher biological efficiency, acceptable culinary properties, medicinal utility and therapeutic values. India has an area of 10,000 ha with the production of 266 thousand tonnes having productivity of 26.6 tonnes (http://nhb.gov.in/area-pro/horst_galance _2016.pdf, 2016). In Gujarat it is mainly cultivated in southern and middle region of the state.

Elephant foot yam grows well with adequate amount of organic matter as they prefer well-aerated and well drained soils.

Fertilizer is the other most important inputs for increasing the productivity of crops (Anon.,

1997) [2]. It has been repeatedly confirmed that continuous, sole and imbalanced use of chemical fertilizers deteriorates soil health and ecological balance which leads to decrease in nutrient uptake efficiency (Saravaiya *et al*., 2010) [22]. Soils that receive plant nutrients only through chemical fertilizers are showing declining productivity and deficiency in secondary and micronutrients. The physical condition of the soil is deteriorated with the use of excess chemical fertilizers. Excess use of nitrogenous fertilizers is also responsible for ground water contamination and environmental pollution apart from destroying the ozone layer through N_2O production. On the other hand, the organic matter content of most of the soils is very low which have made it necessary to rethink alternatives.

Crop production potential also relates to soil physical and chemical properties and revolve around the dynamics of organic matter decomposition by soil micro-organisms. Use of bio-fertilizers helps to increase soil micro-flora and fauna, which ultimately increases the decomposition rate, productivity and sustainability of the soils. They provide organic acids that help to dissolve soil nutrients and make them available for the plants.

Organic manures like farm yard manure, bio-compost, poultry manure, neem cake, vermicompost *etc.* were regarded as important, but it was obvious that they were not available in sufficient quantity to drastically increase food production. Therefore, maximizing the usage of organic waste combining it with chemical and bio-fertilizers in the form of integrated manner found to be the best alternative. Bio-fertilizers are not alternatives to chemical fertilizers but can play a supplementary role.

An integrated nutrient management strategy recognizes that soils are the storehouse of most of the plant nutrients essential for plant growth and the way in which nutrients have managed will have a major impact on plant growth, soil fertility and sustainability (Janssen, 1993) [9]. Thus, the use of inorganic fertilizers in conjunction with organic manures is essential for getting sustainable and profitable yield of elephant foot yam.

Materials and methods

The experiment was arranged over 8 treatment combinations comprising 4 levels of integrated nutrient sources and two levels of bio-fertilizers, laid out in a Randomized Block Design (Factorial concept) with three replications.

Levels of integrated nutrient sources

T_1: RDF- 100: 50: 150 NPK kg ha^{-1} + 25 t FYM ha^{-1}

T_2: 50 % RDN + 50 % N from vermi-compost along with RDF of P & K

T_3: 50 % RDN + 50 % N from FYM along with RDF of P & K

T_4: 50 % RDN + 50 % N from bio-compost along with RDF of P & K)

Levels of bio-fertilizers

B_0: without bio-fertilizers

B_1: with bio-fertilizers i.e. combination of *Azospirillum*, Phosphate solubilizing bacteria (PSB) and Potash Mobilizing Bacteria (KMB) each at 5 liters ha^{-1}.

The initial soil samples of the experimental plot was taken and analyzed before planting the corms. Corms of 250 g (± 50 g) weight were planted on 14th March, 2016 and required intercultural operations were carried out time to time. With respect to fertilizer application, nitrogen was substituted on the basis of N content of different organics. FYM was incorporated at the time of soil preparation in T_1 treatment. 50% of N in the form of organics was applied at the time of planting. 100% P_2O_5 and 50% K_2O was applied at 10 DAP in all the treatment combinations. 50% of N for T_1 treatment in the form of chemical fertilizers was applied at 10 DAP. 25% of N and K_2O (in form of CF) was applied at 30 DAP in all treatment combinations. Remaining 25% of N and K_2O (in form of CF) was applied 60 DAP in all the treatment combinations. Each bio-fertilizers (PSB, *AZ* and KMB) were applied at the rate of 5 kg per hectare.

Starch and calcium oxalate content was analyzed with the procedure given by Padmaja *et al.* (2005) [17] while β-carotene content was analyzed with the procedure given by Biswas *et al.* (2011) [7]. Soil samples were analyzed with the procedure given by Jackson, (1979) [8]. The economic parameters with respect to each treatment combinations were worked out on the bases of prevailing market prices of 2017.

Result and Discussion

Growth parameters like plant height, petiole length, canopy spread (E-W and N-S), culm girth and number of leaflets per plant were significantly influenced by application of organics, inorganics and bio-fertilizers. Data presented in Table 1 revealed significant differences in plant height at different growth stages i.e. 120 and 150 days after planting. At 120 and 150 DAP maximum plant height (73.02 cm and 78.87 cm, respectively) was recorded in treatment T_2 (50 % RDN + 50 % N from vermi-compost along with RDF of P & K) and was statistically remained at par with T_3 (50 % RDN + 50 % N from FYM along with RDF of P & K), recorded 67.93 cm and 74.23 cm plant height, respectively. Annepu, 2011 [1] and Venkatesan *et al.*, 2013 [25] are also in conformity with the given results. Similar trend was observed in petiole length also which was found highest in T_2 treatment (49.33 cm at 120 DAP and 56.75 cm at 150 DAP) and remained at par with T_3 treatment.

The interaction effect of integrated nutrient sources and bio-fertilizers resulted in maximum plant height and petiole length at 150 DAP & 3). The maximum plant height (79.15 cm) was recorded in T_2B_1 (50 % RDN + 50 % N from vermi-compost along with RDF of P & K + application of bio-fertilizers) treatment combination but statically remained at par with all other combinations except T_4B_0 (Table 2). Maximum petiole length (57.30 cm) was also recorded in same treatment combination which was statistically remained at par with all other combinations except T_1B_0 and T_4B_0 combinations (Table 3). This may be attributed to the fact that rapid availability of nutrients, especially nitrogen through inorganics and production of growth promoting hormones through bio-fertilizers. Increased petiole length and plant height by enhanced cell division and cell elongation with higher availability of N was also reported by Pande and Sinha (1972) [18]. The results obtained in the present study are in conformity with Murthy *et al*. (2011) [14] in EFY cv. Gajendra and Neerja (1998) [16] and Jayathilake (2002) [10] in onion.

At 120 days of age the canopy spread in east-west (E-W) direction was found non-significant while at the age of 150 days, it was found maximum (90.27 cm) in T_2 treatment but remained at par with T_3 treatment having canopy spread of 83.43 cm. Canopy spread at 120 DAP in north-south (N-S) direction was measured 88.87 cm and the difference with all other treatments was found significant, while at 150 DAP it was measured 89.82 cm in same T_2 treatment but statistically remained at par with T_3 treatment having 84.87 cm canopy spread. Same results were obtained by Murthy *et al.* (2011) [14] and Bairagi and Singh, (2013) [6]. Similarly, treatment T_2 recorded highest culm girth (15.06 cm and 15.74 cm at 120 and 150 DAP, respectively) but statistically remained at par with T_3 treatment, recorded 13.93 cm and 14.10 cm culm girth at 120 and 150 DAP, respectively.

Significant difference in number of leaflets per plant was also observed and found maximum in T_2 treatment which recorded 362.07 and 318.90 leaflets per plant at 120 and 150 DAP, respectively but statistically remained at par with T_3 treatment which recorded 344.27 and 295.70 leaflets at 120 and 150 DAP, respectively. The findings are similar with the research findings of Anonymous 2014 [3], Anonymous 2015 [4] and Anonymous 2016 [5].

Application of bio-fertilizers also showed significant influences on growth of elephant foot yam at 120 and 150 DAP. Maximum plant height of 70.12 cm and 76.68 cm, petiole length of 47.94 cm and 53.50 cm, E-W canopy spread of (at 150 DAP only) 87.09 cm, N-S canopy spread of 83.84 cm and 86.88 cm, culm girth of 14.37 cm and 14.82 cm and number of leaflets of 343.63 and 302.98 per plant were recorded at 120 DAP and 150 DAP, respectively with application of bio-fertilizers over the streatment without bio-fertilizers. The results obtained in the present study are in conformity with Murthy *et al*. (2011) [14] in EFY cv. Gajendra. At 90 DAP none of the growth parameters show any significant difference but it increased rapidly at 120 DAP where the grand growth period involving high physiological activity synchronized with maximum nutrient uptake may have aided to increase the plant height and thereafter at 150 DAP the increase was marginal**.** The reduced rate of increase in plant height may be attributed to the rapid increase in corm growth and also because of diversion of more photosynthates from source (leaves) to sink (corm) which is most common phenomenon in almost all root and tuber crops (Ravindrababu, 1999) [20]. This may be attributed to the fact that rapid availability of nutrients, especially nitrogen through inorganics and production of growth promoting hormones through *Azospirillum* (Tien *et al*., 1979) [24]. The nitrogen fixing capacity of the *Azospirillum*, increased mobility of phosphorous and potassium by PSB and KMB might also have helped in increasing the growth by exerting its synergistic effect with inorganic and organic manures.

Application of organics, inorganics and bio-fertilizers recorded significant differences on yield and yield attributing characters like harvest index, corm circumference, fresh corm weight and yield per hectare (Table 4). Treatment T_2 that received - 50 % RDN + 50 % N from vermi-compost along with RDF of P & K recorded maximum harvest index of 51.77 % which was remained at par with T_3 treatment having 45.87 % harvest index. The maximum corm circumference (48.36 cm) was also recorded in T_2 treatment but remained at par with the circumference of 45.67 cm obtained in T_3 treatment. Maximum fresh corm weight of 1.267 kg was produced in treatment T_2 and was statistically remained at par with treatment T_3 which produced corm of 1.107 kg. As influenced by fresh corm weight the highest corm yield of 26.37 t ha^{-1} was obtained in treatment T_2 which was statistically remained at par with T_3 treatment, which produced 24.28 t ha^{-1} corms. Krishnakumar *et al*. (2013) [11], Sahoo *et al.* (2014) [21] and Saravaiya *et al.* (2010) [22] are in conformity with the above results.

Application of bio-fertilizers also produced the highest harvest index (48.51 %), maximum corm circumference (46.99 cm), fresh corm weight (1.186 kg) and final yield per hectare (24.84 t ha^{-1}) over treatment of without bio-fertilizer application. These findings are in conformity with Murthy *et al*. (2011) [14] and Venkatesan *et al*. (2013) [25]. Application of vermi-compost and FYM favored the activity of soil micro flora and physical conditions, besides supplementing the nutrients might be the probable reason of the result obtained (Saravaiya *et al*. 2010) [22]. By applying 50 % N with inorganic fertilizers had met the plant nutrient requirement at initial stages of growth leading to increased vegetative growth and remaining 50 % N replaced through different organic sources had slowly satisfied the nutrient requirement of the plant at later stages of the growth mainly during corm development (Pillai *et al*., 1987) [19] which ultimately increases the yield. Thus, supplement of nutrients through both inorganic and organic sources had conjointly helped the plants to produce higher yields (Saravaiya *et al*., 2010 and Bairagi and Singh, 2013) [22, 6].

Quality parameters like starch, β-carotene and calcium oxalate content, in the corm obtained due to different treatments are also given in Table 4. The maximum starch content of 16.57 % was found in T_3 (50 % RDN + 50 % N from FYM along with RDF of P & K) treatment and was at par with both T_2 and T_4 treatments with 16.54 and 16.43 per cent starch content, respectively. The increase in starch content of corms with the application of organic sources, seems due to higher levels of potassium added through organic sources which helped the formation and transfer of starch from the leaves to the tubers (Mukhopadhyay and Sen, 1986) [13]. The other probable reason may be that the main constituent of starch is glucose which is the composition of carbon molecules, the organic manures added contains carbon which in turn may had increased the starch content of the corms. While the β-carotene and calcium oxalate content of the corm did not show any significant influence on application of different INM sources. However, the lowest calcium oxalate content (0.213%) was found in T_2 treatment. Application of bio-fertilizers did not show any significant influence on all these quality parameters of corm but it helps to increase β-carotene content by 12.843 $\mu g\ g^{-1}$ and in lowering calcium oxalate content by 0.005 per cent. Annepu, 2011 [1] and Kumar *et al*. 2015 got similar type of results.

Among the soil parameters analyzed, the INM showed significant effect only on soil organic carbon content after harvest (Table 4). The soil organic carbon content was highest with respect to replacement of 50 % of N with vermicompost (T_2) which recorded 0.597 % organic carbon content and was at par with T_3 (50 % of N replaced with FYM) and T_4 (50 % of N replaced with biocompost) treatments which recorded 0.595 % and 0.540 % organic carbon content, respectively. Replacing 50 % N by various organic nutrient sources added larger amount of organic carbon to the soil, thus the obtained result is significant with respect to the soil organic carbon content. Nedunchezhiyan *et al*. (2010) [15] also found increased in the soil microbial bio-mass and carbon content with the application of manures. The enzymes present in the organic manures may also directly increase the soil enzymatic activities. The effect of bio-fertilizers application was found significant and the maximum organic carbon content of 0.588 % was found in the treatment with bio-fertilizers application which may be due to well decomposition of organic manures by microbes applied which may ultimately increase soil organic carbon content (Suja *et al*., 2012) [23]. Other properties of soil *viz.* bulk density, available N, P and K showed non significant results. Even though these parameters showed non significant results the available N, P and K were slightly higher in the treatments in which 50 % N was replaced by organic sources than RDF. Similar results were also obtained by Suja *et al.*, 2012 [23] in same crop.

As compared with the initial soil status (bulk density-1.18 g/cm^3; organic carbon-0.46 %; available N_2 - 261 kg ha^{-1}; available P_2O_5-24.1 kg ha^{-1} and K_2O – 296 kg ha^{-1}) the amount of available N, P and K contents are approximately equal or slightly higher than the initial soil status. From this results it can be concluded that elephant foot yam had efficiently utilized the added nitrogen for the vegetative growth whereas phosphorous and potassium for better quality and corm yield.

The data presented in Table 5 revealed that the highest B:C ratio (2.22) was obtained in the treatment combination of T_3B_1 which was closely followed by the B:C ratio of 2.03, obtained in the treatment combination of T_2B_1. The main reason behind this result is the cost difference of Rs. 4,930/t between the cost of vermicompost and farm yard manure.

Conclusion

The results of the study inferred that individual effect of integrated nutrient sources and bio-fertilizers had influenced highly on vegetative, yield and quality parameters. The investigation clearly laid emphasis on the main effect of integrated nutrient sources and bio-fertilizers for characters like number of days for first sprouting and 50 % sprouting, periodical increase in plant height, canopy spread in both directions, culm girth, petiole length and number of leaflets per plant. Yield characters like harvest index, corm circumference, yield per net plot, yield per hectare and quality characters like starch content, vitamin-A (β-carotene) content and calcium oxalate content. However, integrated nutrient sources and bio-fertilizers in combination had positive and desirable effect only on plant height and petiole length thereby influencing the growth of plants greatly, which in turn may have realized good yields. The replacement of 50 % RDN with vermicompost along with recommended dose of fertilizers (T_2) and application of bio-fertilizers were very effective for improving vegetative, quality and yield characteristics. It has also been observed that integrated nutrient sources (mainly vermicompost and FYM) and bio-fertilizers were effective in improving the soil fertility status which was reflected in better plant growth, higher corm weight and ultimately the highest yield.

From the above enumeration, inference can be drawn that integrated nutrient management by replacing 50 % RDN with vermicompost along with bio-fertilizers largely improves various parameters of growth, yield, corm quality and soil status in cultivation of elephant foot yam. The highest B:C ratio (2.22) was obtained in treatment combination of T_3B_1 (Table 3) (RDF in which 50 % nitrogen was replaced with FYM and application of bio-fertilizers) which was closely followed by treatment combination of T_2B_1 having 2.03 B:C ratio.

Table 1: Impact of organic sources, bio-fertilizers and their interaction on growth of elephant foot yam.

Treatments	Plant height			Petiole length			Canopy spread						Culm girth			No. of leaflets/plant		
	90 DAP	120 DAP	150 DAP	90 DAP	120 DAP	150 DAP	90 DAP		120 DAP		150 DAP		90 DAP	120 DAP	150 DAP	90 DAP	120 DAP	150 DAP
							E-W	N-S	E-W	N-S	E-W	N-S						
T_1	55.88	63.52	72.28	35.13	42.52	48.35	76.41	78.83	74.13	78.80	81.39	80.75	12.65	13.45	13.62	449.6	311.78	272.00
T_2	56.80	73.02	78.87	37.57	49.33	56.75	79.10	81.00	88.17	88.87	90.27	89.82	13.31	15.06	15.74	491.7	362.07	318.90
T_3	56.46	67.93	74.23	35.20	48.23	53.14	77.53	80.37	76.77	79.12	83.43	84.87	13.16	13.93	14.10	466.1	344.27	295.74
T_4	54.78	60.13	69.44	33.10	41.29	45.62	72.47	72.77	76.35	75.48	78.45	78.37	12.53	12.78	13.09	409.5	288.29	250.75
SEm ±	2.02	2.68	2.10	1.34	1.81	2.11	2.68	3.05	3.43	2.69	2.66	2.71	0.42	0.48	0.58	22.22	14.98	13.18
C. D. (@ 5 %)	NS	8.12	6.35	NS	5.48	6.41	NS	NS	NS	8.14	8.07	8.21	NS	1.43	1.76	NS	45.43	39.97
B_0	55.22	62.19	70.71	33.95	42.75	48.44	74.34	76.17	73.80	77.29	79.68	80.03	12.57	13.24	13.45	433.3	309.57	265.76
B_1	56.75	70.12	76.68	36.55	47.94	53.50	78.42	80.32	83.91	83.84	87.09	86.88	13.25	14.37	14.82	475.2	343.63	302.98
SEm ±	1.43	1.89	1.48	0.95	1.28	1.49	1.89	2.15	2.42	1.89	1.88	1.91	0.30	0.33	0.41	15.72	10.59	9.32
C. D. (@ 5 %)	NS	5.74	4.49	NS	3.88	4.53	NS	NS	NS	5.76	5.71	5.80	NS	1.01	1.24	NS	32.12	28.26
T×B	NS	NS	S	NS	NS	S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SEm ±	2.85	3.79	2.96	1.89	2.56	2.99	3.79	4.31	4.85	3.80	3.76	3.83	0.59	0.67	0.82	31.43	21.18	18.64
C. D. (@ 5 %)	NS	NS	8.99	NS	NS	9.06	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V (%)	8.82	9.91	6.96	9.29	9.77	10.15	8.59	9.54	10.65	8.16	7.82	7.94	7.93	8.35	10.04	11.99	11.23	11.35

Table 2: Impact of organic sources, bio-fertilizers and their interaction on yield, quality and soil status of elephant foot yam.

Treat-ments		Yield parameters			Quality parameters			Soil parameters				
	Harvest index (%)	Corm circum-ference (cm)	Fresh corm weight (kg)	Yield per ha (t)	Starch content (%)	β-carotene (Vit-A) content (µg g^{-1})	Calcium oxalate content (%)	Soil O. C (%)	Bulk density (dsm^{-1})	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
T_1	43.43	44.457	1.033	21.77	15.49	677.492	0.233	0.483	1.44	259	26.2	303
T_2	51.77	48.369	1.267	26.37	16.54	679.663	0.213	0.597	1.42	262	27.1	304
T_3	45.87	45.679	1.107	24.28	16.57	684.153	0.217	0.595	1.43	264	27.2	307
T_4	42.55	42.743	0.971	21.48	16.43	674.277	0.220	0.540	1.42	262	27.1	305
SEm ±	2.166	1.286	0.064	1.175	0.273	11.504	0.005	0.023	0.032	5.678	0.771	8.181
C. D. (@ 5 %)	6.570	3.902	0.193	3.564	0.828	NS	NS	0.070	NS	NS	NS	NS
B_0	43.30	43.631	1.003	22.11	16.02	672.565	0.223	0.520	1.45	259	26.1	303
B_1	48.51	46.993	1.186	24.84	16.51	685.408	0.218	0.588	1.41	265	27.6	306
SEm ±	1.532	0.910	0.045	0.831	0.193	8.135	0.004	0.016	0.022	4.015	0.545	5.785
C. D. (@ 5 %)	4.646	2.759	0.137	2.520	NS	NS	NS	0.050	NS	NS	NS	NS
T×B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SEm ±	3.063	1.819	0.090	1.662	0.386	16.270	0.007	0.033	0.045	8.030	1.091	11.569
C. D. (@ 5 %)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. (%)	11.56	6.96	14.25	12.26	4.11	4.15	5.68	10.27	5.41	5.31	7.06	6.58

Table 3: Effect of integrated nutrient sources and bio-fertilizers on economics.

Sr. No.	Treatments	Fixed cost (Rs.)	Variable cost (Rs.)	Total cost (Rs.)	Yield (t ha^{-1})	Gross income (Rs.)	Net income (Rs.)	B: C ratio
1.	T_1B_0	2,02,311	00	2,02,311	20.29	5,07,250	3,04,939	1.51
2.	T_1B_1	2,00,951	3,160	2,04,111	23.24	5,81,000	3,76,889	1.85
3.	T_2B_0	2,00,951	23,560	2,24,511	25.31	6,32,750	4,08,239	1.82
4.	T_2B_1	2,00,951	25,360	2,26,311	27.42	6,85,500	4,59,189	2.03
5.	T_3B_0	2,00,951	4,243	2,05,194	21.87	5,46,750	3,41,556	1.66
6.	T_3B_1	2,00,951	6,043	2,06,994	26.69	6,67,250	4,60,256	2.22
7.	T_4B_0	2,00,951	3,800	2,04,751	20.96	5,24,000	3,19,249	1.56
8.	T_4B_1	2,00,951	5,600	2,06,551	22.00	5,50,000	3,43,449	1.66

Urea-313/50 kg	FYM- Rs.570/t	Irrigation charges- Rs.30/hr
SSP-390/50 kg	Vermi-compost- Rs.5500/t	Labour cost- 178/day (8 hours)
MOP-575/50 kg	Biocompost-400/t	Seed cost – Rs. 20/kg
Chlorpyrifos - Rs.400/500g	Redomil- Rs. 235.5/500ml	Bio-fertilizers – Rs 120 / litre each

References

1. Annepu SK. Effect of integrated nutrient management on growth, yield and quality of elephant foot yam [Amorphophallus paeoniifolius (Dennst.) var. Gajendra]. Thesis M.Sc., submitted to Acharya N. G. Ranga Agricultural Univeristy, Hyderabad, 2011.
2. Anonymous. Fertilizer Recommendation Guide. Bangladesh Agriculture Research Council. Farmgate, New Airport Road, Dhaka. 1997; 1215:22.
3. Anonymous. Horticulture and Agroforestry Research Report, N. A. U., Navsari, 2014, 70-71.
4. Anonymous. Horticulture and Agroforestry Research Report, N. A. U., Navsari, 2015, 102-103.
5. Anonymous. Horticulture and Agroforestry Research Report, N. A. U., Navsari, 2016, 122-123.
6. Bairagi SK, Singh PK. Effect of different integrated nutrient management practices on elephant foot yam (*Amorphophallus paeoniifolius* Dennst.) under eastern Uttar Pradesh conditions. The Asian J. Hort. 2013; 8(2):565-567.
7. Biswas AK, Sahoo J, Chatli MK. A simple UV-Vis spectrophotometric method for determination of β-carotene content in raw carrot, sweet potato and supplemented chicken meat nuggets. Food Sci. & Tech. 2011; 44(8):1809-1813. http://nhb.gov.in/areapro/horst_galance_2016.pdf, (16 Mar, 2017):18.
8. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Pvt., New Delhi, 1979.
9. Janssen BH. Integrated nutrient management with the use of organic and mineral fertilizers. In: The role of Plant Nutrients for Sustainable Food Crop Production in Sub-Saharan Africa. Van Reuler, H. and Prins, W. H. (Eds.). Leidschendam, Dutch Association of Fertilizer Producers. 1993, 89-105.
10. Jayathilake. Integrated nutrient management of *Rabi* onion (*Allium cepa* L.). Thesis M.Sc., submitted to Acharaya N. G. Ranga Agricultural University,

Hyderabad, 2002.
11. Krishnakumar V, Dhanapal R, George Thomas V. Integrated nutrient management for elephant foot yam. J. Root Crops. 2013; 39(2):263-264.
12. Kumar SA, Bhagavan BVK, Sudha Rani V, Ramanjaneya Reddy A, Nagalakshmi R. Effect of integrated nutrient management on yield and quality of elephant foot yam [*Amorphophallus paeoniifolius* (Dennst. Nicolson)] var. Gajendra. J. Envt. & Eco. 2015; 33(2):645-648.
13. Mukhopadhyay SK, Sen H. Effect of nitrogen and potassium on yield and quality of elephant foot yam (*Amorphophallus campanulatus* Blume). J. Root Crops, 1986; 12(2):103-106.
14. Murthy GN, Padma E, Bhagavan BVK, Naga Lakshmi R. Effect of integrated nutrient management on growth and yield of *Amorphophallus paeoniifolius* (Dennst.) Nicolson cv. Gajendra. Proceedings - IX annual group meeting, AICRP on Tuber Crops, 2011, 294-297.
15. Nedunchezhiyan M, Byju G, Dash SN. Effects of organic production of orange fleshed sweet potato (*Ipomoea batatas* L.) on root yield, quality and soil biological health. Int. Res. J. Plant Sci. 2010; 1(6):136-143.
16. Neerja G. Effect of irrigation and nitrogen levels on growth, plant water relations, nutrient uptake and quality of onion. *Thesis Ph.D.*, submitted to Acharya N. G. Ranga Agricultural University, Hyderabad, 1998.
17. Padmaja G, Moorthy SN, Bala N, Lila Babu, Sundaresan S, Sanjeev MS *et al*. Analytical methodologies for tropical tuber crops, CTCRI, Trivandrum. 2005; 9-12:26-27.
18. Pande SN, Sinha BK. *Plant Physiology*. 6th Ed., Vikas Publishing House Pvt. Ltd., New Delhi. 1972, 117.
19. Pillai NG, Mohankumar B, Nair PG, Kabeerathummaand, Mohankumar CR. Effect of continuous application of manures and fertilizers on the yield and quality of cassava in laterite soil. In: Proc. Nat. Symp. on production and utilization of tropical tuber crops, CTCRI, Trivandrum, India. 1987, 109-114.
20. Ravindrababu M. Studies on integrated nutrient management with vermicompost and inorganic fertilizer in carrot. *Thesis M.Sc.*, submitted to Acharya N. G. Ranga Agricultural Univeristy, Hyderabad, 1999.
21. Sahoo B, Nedunchezhiyan M, Pinaki Acharyya. Effects of organic and inorganic fertilizers on yield of elephant foot yam and soil enzymes activity. J. Root Crops. 2014; 40(2):33-39.
22. Saravaiya SN, Chaudhary PP, Patel DA, Patel NB, Aahir MP, Patel VI. Influence of integrated nutrient management (INM) on growth and yield parameters of elephant foot yam under south Gujarat condition. The Asian J. Hort. 2010; 5(1):58-60.
23. Suja G, Sundaresan S, Susan Jhon K, Sreekumar J, Mishra R. Higher yield, profit and soil quality from organic farming of elephant foot yam. Agron. Sustain. Dev. 2012; 32:755-764.
24. Tien TM, Gastins MGH, Hubbell DH. Plant growth substances produced by *Azospirillum brasilense* and their effect on the growth of pearl millet (*Pennisetum americanum* L.). Applied environ. Microbiol. 1979; 37(5):1016-1024.
25. Venkatesan K, Saraswathi T, Jansirani P, Kamalkumar R, Sujatha R. Integrated nutrient management improves yield and quality in elephant foot yam. J. Root Crops. 2013; 39(2):257-259.