Original Research Article

Effect of corm and soil treatments with organic liquid formulations on performance of elephant foot yam in Jharkhand, India

Abstract

A field experiment was carried out at the farm of Divyayan Krishi Vigyan Kendra, Ramakrishna Mission Ashrama, Morabadi, Ranchi during kharif season of 2022 with 10 treatments (T_1: control or no treatment, T_2: Corm treatment with Beej Sanjeevani, T_3: Corm treatment with Beejamrit, T_4: Soil application of Jiwamrit, T_5: Soil application of Panchagavya, T_6: Soil application of Jiwamrit + Panchagavya, T_7: Corm treatment with Beej Sanjeevani + soil application of Jiwamrit, T_8: Corm treatment with Beej Sanjeevani + soil application of Panchagavya, T_9: Corm treatment with Beejamrit + soil application of Jiwamrit, T_{10}: Corm treatment with Beejamrit + soil application of Panchagavya) placed in three times replicated randomized block design to study the response of elephant foot yam to organic corm and soil treatments. Results revealed that corm treatment with Beejamrit + soil application of Jiwamrit resulted higher growth attributes, corm length (23.3 cm), dimeter (26.9 cm) and yield (32.8 t/ha). This corm + soil treatment also recorded the highest gross return (₹2,62,400/ha), net return (₹1,69,189/ha) and B:C (2.82). It also increased soil microbial population dynamics especially total bacteria.

Keywords: Beej Sanjeevani, Bijamrit, Jiwamrit, Economics, Elephant foot yam, Panchagavya, Yield

Introduction

Long term exploitation of natural resources under intensive agriculture not only deteriorates agricultural productivity but also hampers the environment safety. Use of chemicals in crop production results in deterioration soil health and overall environment due

to toxic residues. Continuous and pointless application of chemical fertilizers causes impairments of soil physical, chemical and biological properties, loss of soil productivity and environmental pollution, health issues etc. Use of chemicals is beneficial for short term basis and harmful for long term sustainable agricultural production (Biswas *et al*., 2019). Khambalkar *et al.* (2012) stated that the harmful impacts of chemical fertilizers in intensive agriculture such as depletion of reserve pool of carbon, secondary and micro-nutrients, resulting in degradation of soil productivity and fertility. Further, increase of market price of chemicals is another issue under energy crisis scenario. In India, land degradation is a common issue which is contributed to a major extent through faulty agricultural practices (Bhattacharyya et al., 2015). To ensure environment safety without loss of crop productivity eco-friendly alternatives of chemical farming like organic farming, natural farming, integrated nutrient management, biodynamic farming etc. show great prospects in current agriculture scenario (Liao et al., 2019). Addition of organic formulations or proper utilization of natural resources can boost up the growth and productivity by reviving soil productivity (Santhi and Selvakumari, 2000).

The concept of natural farming is receiving spotlight in recent days, which encourages use of liquid formulations for corm and treatment, mulching (Acchadana), and soil moisture conservation (Whapasa) (Liao et al., 2019; Duddigan et al., 2022). Various liquid organic formulations like Panchagavya, Sasyagavya, Kunapajala, and Jiwamrit as soil/foliar use and Beejamrit and Beej Sanjeevani as seed treatment are showing good potential for improvement of microbial activity and population, soil physical and fertility elevation, which finally reflect on crop growth, yield and quality. They contain various beneficial micro-organisms, macro and micro-nutrients, plant growth promoters, antioxidant and plant protection properties etc (Anandan *et al*., 2016). These liquid manures are prepared from on-farm/local raw materials or products like cow dung, cow urine, cow ghee, cow milk, cow curd, crop

field and livestock wastes and some other low-cost materials through fermentation and/or decomposition. Application of these organic formulations leads to healthy plant-microbe interactions (Patel et al., 2020; Sharma et al., 2020) and thus can reduce or omit the use of chemicals (Palekar, 2006).

Elephant foot yam (EFY), [*Amorphophallus paeoniifolius* (Dennst.) Nicolson] is one of the major tropic ariods grown in India since long specially in Andhra Pradesh, Tamil Nadu, West Bengal and Kerala with productivity potential of 30-100 t/ha (Ravi et al., 2011). The tubers, leaves and tender pseudo stem are used as vegetables. The tuber is cheap source of starch, calcium, phosphorus and vitamin A, protein etc and can substitute potato to a great extent specially in economically poor areas. The growth and yield of EFY largely dependent on nutrient management and water availability. Proper corm and soil treatments using different organic liquid formulations can play important role in booting the growth and yield of EFY. With this view, the present experiment was placed at the farm of Divyayan Krishi Vigyan Kendra, Ramakrishna Mission Ashrama, Morabadi, Ranchi during kharif season of 2022 to identify the most suitable corm and soil treatments for growth and productivity of EFY.

Materials and methods

The field experiment was conducted at the farm of Divyayan Krishi Vigyan Kendra, Ramakrishna Mission Ashrama, Morabadi, Ranchi during *kharif* season of 2022 to evaluate the response of elephant foot yam to corm + soil treatments with various organic liquid formulations under 13 years old organic field. The experimental soil was clay loam textured, red and lateritic in nature having 6.70 of pH, 1.23% organic carbon, 396.14 kg/ha of available N, 147.2 kg/ha of available P_2O_5 and 245.71 kg/ha available K_2O. The experiment was placed in randomized block design with 10 treatments (T_1: control or no treatment, T_2: Corm treatment with Beej Sanjeevani, T_3: Corm treatment with Beejamrit, T_4: Soil application of

Jiwamrit, T_5: Soil application of Panchagavya, T_6: Soil application of Jiwamrit + Panchagavya, T_7: Corm treatment with Beej Sanjeevani + soil application of Jiwamrit, T_8: Corm treatment with Beej Sanjeevani + soil application of Panchagavya, T_9: Corm treatment with Beejamrit + soil application of Jiwamrit, T_{10}: Corm treatment with Beejamrit + soil application of Panchagavya), replicated three times. The preparation and application of different organic liquid formulations was shown in Table 1. The EFY variety 'Gajendra' was planted on individual plot size was 4 m×3 m using (≥500 g weight whole/cut corm having bud) on 2nd May, 2022 at a spacing of 75 cm × 75 cm and harvested on Nov 09, 2022.

Prior to planting, 20 t/ha FYM was applied during land preparation. Corm (corm) treatments with two organic liquid formulations were made for 30 minutes before planting. Soil application of organic liquid formulations were made at 15 days interval up to 5 months after planting (MAP). Weeding was periodically done up to 3 MAP. Irrigation (4 cm depth) was given for 4 times during initial 3 months at an interval of 20 days along with leaf and paddy straw mulching to conserve and provide moisture for crop growth during pre-monsoon period. During rainy season, the crop utilized rainwater for its growth. Other agronomic and plant protection measures were taken as per the standard organic farming practices recommended for this region.

Observations on plant population (per plot) was taken at harvest. Different growth attributes like plant height (cm), canopy width (cm) and pseudo stem girth at collar region (cm) were taken using measuring tape/scale at 3 MAP and at harvest. Corm diameter and length as well as corm yield were recorded at harvest. Production economics of EFY consisted of cost of cultivation, gross return, net return and benefit: cost (B:C) which were computed based on following formulae:

- Cost of cultivation (₹/ha) = Cost involved in purchase of inputs as well as practices
- Gross return (₹ /ha) = Yield (kg/ha) × Market price (₹/kg)
- Net return (₹ /ha) = Gross return (₹/ha) - Cost of cultivation (₹/ha)
- B:C = Gross return (₹/ha) / Cost of cultivation (₹/ha)

Soil microbial population (total bacteria and fungi) dynamics during initial (before experiment) and after harvest of crop were estimated at the laboratory of Ramakrishna Mission Vivekananda Educational and Research Institute, Morabadi, Ranchi, Jharkhand. The population of soil rhizospheric micro-organisms (bacteria and fungi) were analysed through counting on agar plates as number of viable cells per gram of soil using Thronton's agar medium and Martin-Rose Bengal Streptomycin agar medium respectively using serial dilution and pour plate process (Pramer and Schmidt, 1965) followed by incubation at 28±1°C. The populations were counted at 5^{th} day of incubation. The data were subjected to statistical analysis using ANOVA method (Panse and Sukhatme, 1985) and treatment means were compared using critical difference at 5% level of significance.

Results and discussion

Plant population and growth attributes

Experimental results (Table 2) expressed that there existed non-significant variations in plant population of EFY at harvest among different organic corm + soil treatments and control with highest plant population observed from corm treatment with Beejamrit + soil application of Jiwamrit (T_9) (21.3/plot) and the lowest was from control (T_1) (18.6/plot). However, different growth attributes of EFY at 3 MAP and at harvest showed significant variations among different organic corm + soil treatments and control. Elephant foot yam showed variation in growth attributes as per the microbial and nutritional properties of the organic formulations used. Corm treatment with Beejamrit ensured high plant population

which might be due to its high nutrients, growth promoters, and beneficial microorganisms possibly resulting in enhancement of metabolic activities like water intrusion to planting material and breakdown of storage materials of corms through enzymes like lipase, proteinase, phosphatase, and hydrolase (Bewley and Black, 1985). Improved metabolic activity led to better emergence of plants. Further, presence of micro-organisms in organic formulations especially Beejamrit and Jiwamrit can protect crops against diseases during the early growth period (Lim et al., 2013). Corm treatment with Beejamrit + soil application of Jiwamrit (T_9) recorded the maximum plant height, canopy width and pseudo stem girth at collar region, being closely followed by corm treatment with Beejamrit + soil application of Panchagavya (T_{10}) which remained statistically similar to corm treatment with Beej Sanjeevani + soil application of Panchagavya (T_8), corm treatment with Beej Sanjeevani + soil application of Jiwamrit (T_7), soil application of Jiwamrit + Panchagavya (T_6) and soil application of Jiwamrit (T_4) in terms of plant height and canopy width at 3 MAP and at harvest. Lowest plant height, canopy width and pseudo stem girth at collar region were noted from control (T_1). The presence of growth-regulating hormones and enzymes in Jiwamrit possibly facilitated the uptake of nutrients and moisture by plants leading to meristematic cell division and elongation, which was finally reflected to plant height (Chakraborty and Sarkar, 2019). Corm treatment with Beejamrit + soil application of Jiwamrit (T_9) outperformed others as both the formulations were possibly rich in macro- and micro-nutrients, vitamins, amino acids, growth regulators and served as storage media for the beneficial microorganisms (Gore and Sreenivasa, 2011; Tao et al., 2015). In soil, they perhaps positively influenced soil microbial activity for sustainable supply of nutrients to EFY (Lian et al., 2017). Greater N availability and uptake might trigger the leaf chlorophyll synthesis for capturing more sunlight and CO_2 resulting in high photosynthesis, dry matter production and good vegetative growth (Biswas et al., 2020).

Yield attributes and yield

Yield attributes such as corm length and diameter and corm yield were taken at harvest and they showed significant variations among different corm + soil treatments (Table 3). It was found that different soil and corm treatments alone or in combination outperformed control in attaining yield attributes and yield of EFY. Among different organic formulations, Corm treatment with Beejamrit + soil application of Jiwamrit (T_9) recorded the highest corm length (23.3 cm) and diameter (26.9 cm), closely followed by corm treatment with Beejamrit + soil application of Panchagavya (T_{10}) (corm length: 21.7 cm and diameter: 25.4 cm). Control showed lowest of those (corm length: 16.8 cm and diameter: 18.3 cm). Corm yield also followed similar trend where T_9 registered the maximum yield (32.8 t/ha) which was 73.5% higher than the control (18.9 t/ha). It closely followed by T_{10} (31.1 t/ha). The sequence of treatments for expressing different yield attributes and yield was T_9> T_{10}>T_7>T_8>T_4>T_6>T_5>T_3>T_2>T_1. T_4, T_6, T_7 and T_8 remained statistically indifferent to each other. Yield attributes and yield were the direct reflection of crop growth. In the present study, corm treatment with Beejamrit might help in initial crop establishment, while soil application of Jiwamrit as in case of T_9 further helped in survivals, multiplications and activities of N-fixing, P-solubilising, cellulose decomposing and other beneficial microbes, which positively changed soil physical properties and chemical properties (Mallick, 2016; Liao et al., 2019). Soil application of Jiwamrit additionally might increase water-holding capacity of soil which helped the crop to utilize water during pre- and post-monsoon periods (Duddigan et al., 2022). Along with these organic formulations, FYM was applied additionally at basal which might help in the early decomposition and quick release of nutrients at initial growth of the plants (Kumar et al., 2009; Mishra, 2014). The adequate supply of nutrients over a longer period of time might not only facilitate the photosynthesis of

the crop but also the translocation of photo-assimilates to economic parts i.e. corm (Kumar et al., 2018; Dutta et al., 2022).

Production economics

Production economics of EFY (Table 4) indicated that use of organic liquid formulations either individually for corm and soil treatments or in combination incurred higher cost of cultivation of over control (₹79,349/ha) because of the requirement of various raw materials for their preparations as well as applications. Among the treatments, corm treatment with Beejamrit + soil application of Panchagavya (T_{10}) incurred maximum cost of cultivation (₹96,487/ha) of EFY. It was perhaps due to the cost of various cow-based products used for preparation of Panchagavya. However, corm treatment with Beejamrit + soil application of Jiwamrit (T_9) recorded maximum gross return (₹2,62,400/ha), net return (₹1,69,189/ha) and B:C (2.82). The result was due to its positive and maximum influence on the growth and yield of EFY (Bhadu et al., 2021) and its efficacy for producing a greater return from corm yield than the expenses required (Gopal and Gurusiddappa, 2014; Yogananda et al., 2019). The above treatment combination was closely followed by corm treatment with Beejamrit + soil application of Panchagavya (T_{10}) (gross return: ₹2,48,800/ha, net return: 1,52,313/ha and B:C of 2.58). Control (T_1), on the other hand, recorded lowest gross return (₹1,51,200/ha), net return (₹71,851/ha) and B:C (1.91) because of poor growth and yield of EFY.

Microbial population dynamics

The changes in total soil bacteria and fungi population before and after EFY cultivation were shown in Table 5. It was observed that except control, population of these microorganisms enhanced at harvest as compared to initial (pre-experiment) status under uses of various organic liquid formulations as corm and soil treatments alone or in combination. In case of control, those declined after crop harvest. Among different organic liquid

formulations, maximum increase of total bacteria (20.59%) and fungi (13.89%) over control (total bacteria: 57.8 CFU × 10^6/g of soil; total fungi: 21.6 CFU × 10^4/g of soil) were obtained from corm treatment with Beejamrit + soil application of Jiwamrit (T_9) (total bacteria: 69.7 CFU × 10^6/g of soil; total fungi: 24.9 CFU × 10^4/g of soil). It was closely followed by corm treatment with Beejamrit + soil application of Panchagavya (T_{10}) (total bacteria: 67.5 CFU × 10^6/g of soil; total fungi: 24.1 CFU × 10^4/g of soil). It might be due to positive influence of organic formulations on soil microbial growth. These formulations perhaps showed synergies with soil micro-organisms due to presence of high nutrients, beneficial micro-organisms, growth regulators like indole acetic acid, gibberellic acid, cytokinin, etc., which was earlier confirmed by many researchers (Palekar, 2006; Sreenivasa et al., 2010; Dhanoji et al., 2018).

Conclusion

In the above study, organic liquid formulations as corm and soil treatments either alone or in combination proved their efficacies in influencing growth, yield, economics and soil residual microbial population of elephant foot yam cultivation. Based on the result, it is concluded that elephant foot yam can be cultivated treating corm with Beejamrit prior to planting and applying Jiwamrit @ 10% to soil at 15 days interval up to 5 months after planting for realizing best growth, corm yield, economic profitability and soil biological property.

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Table 1: Preparation of various organic liquid formulations

Organic liquid formulation	Preparation	Application
Beej Sanjeevani	200 g cow dung, 200 ml cow urine and 800 ml water are mixed together and stirred twice a day (morning and evening), clockwise and anti-clockwise for 7 days.	It was used as corm treatment @ 5% by diluting the mother solution with water.
Beejamrit	200 g cow dung, 200 ml cow urine, 100 g lime, one pinch of live soil and 800 ml water are mixed together. It was followed by stirring twice a day (morning and evening), clockwise and anti-clockwise for 7 days.	It was used as corm treatment @ 5% by diluting the mother solution with water.
Jiwamrit	10 kg fresh cow dung, 10 litres of cow urine, 2 kg jaggery, 2 kg pulse flour, a fist of organically cultivated soil and 200 litres of water are taken	It was applied to soil @ 10% by diluting the mother solution with

	and mixed thoroughly in a container. This mixture is kept in shade for fermentation for 48 hours with regular stirring twice a day (morning and evening), clockwise and anti-clockwise.	water.
Panchagavya	Five cow-based ingredients *i.e*. cow dung, cow urine, milk, curd and ghee were added in a plastic container @ 5:3:2:2:1 ratio and incubated for 7-9 days. The mixture was stirred with a stick every day two times during morning and evening, clockwise and anti-clockwise.	It was applied to soil @ 10% by diluting the mother solution with water.

Table 2: Effect of corm and soil treatments with organic liquid formulations on growth of elephant foot yam

Treatments	Plant population (/plot)	Plant height (cm)		Canopy width (cm)		Pseudo stem girth at collar region (cm)	
		3 MAP	At harvest	3 MAP	At harvest	3 MAP	At harvest
Control (T_1)	18.6	54.3	89.6	49.5	87.3	11.8	17.2
Corm treatment with Beej Sanjeevani (T_2)	20.3	62.1	98.9	59.3	102.1	13.1	19.8
Corm treatment with Beejamrit (T_3)	20.9	64.6	106.2	63.4	108.9	13.4	20.2
Soil application of Jiwamrit (T_4)	19.6	72.5	112.9	72.1	114.2	14.6	21.3
Soil application of Panchagavya (T_5)	19.3	69.1	108.7	69.1	110.5	13.8	20.5
Soil application of Jiwamrit + Panchagavya (T_6)	20.3	71.8	110.9	70.4	111.2	14.2	20.9
Corm treatment with Beej Sanjeevani + soil application of Jiwamrit (T_7)	20.9	74.3	116.8	72.8	118.3	15.8	22.7
Corm treatment with Beej Sanjeevani + soil application of Panchagavya (T_8)	21.0	73.3	114.3	72.6	115.7	15.1	22.3
Corm treatment with Beejamrit + soil application of Jiwamrit (T_9)	21.3	82.4	128.9	77.9	131.4	17.9	24.7
Corm treatment with Beejamrit + soil application of Panchagavya (T_{10})	21.0	74.6	119.3	73.2	121.2	16.3	23.5
S.Em ±	1.2	2.23	2.73	1.30	3.20	0.27	0.37
C.D. (*p= 0.05*)	NS	6.7	8.2	3.9	9.6	0.8	1.1

Table 3: Effect of corm and soil treatments with organic liquid formulations on yield attributes and yield of elephant foot yam

Treatments	Corm length (cm)	Corm diameter (cm)	Corm yield (t/ha)
Control (T_1)	16.8	18.3	18.9
Corm treatment with Beej Sanjeevani (T_2)	18.2	20.4	23.1
Corm treatment with Beejamrit (T_3)	18.9	20.9	24.6
Soil application of Jiwamrit (T_4)	20.4	23.3	26.8
Soil application of Panchagavya (T_5)	19.3	21.8	25.7
Soil application of Jiwamrit + Panchagavya (T_6)	20.1	23.2	26.3
Corm treatment with Beej Sanjeevani + soil application of Jiwamrit (T_7)	21.4	24.9	29.5
Corm treatment with Beej Sanjeevani + soil application of Panchagavya (T_8)	20.6	23.5	27.1
Corm treatment with Beejamrit + soil application of Jiwamrit (T_9)	23.3	26.9	32.8
Corm treatment with Beejamrit + soil application of Panchagavya (T_{10})	21.7	25.4	31.1
S.Em ±	0.43	0.57	1.23
C.D. (*p= 0.05*)	1.3	1.7	3.8

Table 4: Effect of corm and soil treatments with organic liquid formulations on production economics of elephant foot yam

Treatments	Cost of cultivation (₹/ha)	Gross return* (₹/ha)	Net return (₹/ha)	B:C
Control (T_1)	79,349	1,51,200	71,851	1.91
Corm treatment with Beej Sanjeevani (T_2)	84,456	1,84,800	1,00,344	2.19
Corm treatment with Beejamrit (T_3)	84,762	1,96,800	1,12,038	2.32
Soil application of Jiwamrit (T_4)	87,890	2,14,400	1,26,510	2.44
Soil application of Panchagavya (T_5)	91,346	2,05,600	1,14,254	2.25
Soil application of Jiwamrit + Panchagavya (T_6)	90,234	2,10,400	1,20,166	2.33
Corm treatment with Beej Sanjeevani + soil application of Jiwamrit (T_7)	92,345	2,36,000	1,43,655	2.56
Corm treatment with Beej Sanjeevani + soil application of Panchagavya (T_8)	95,327	2,16,800	1,21,473	2.27
Corm treatment with Beejamrit + soil application of Jiwamrit (T_9)	93,211	2,62,400	1,69,189	2.82
Corm treatment with Beejamrit + soil application of Panchagavya (T_{10})	96,487	2,48,800	1,52,313	2.58

*Market price of EFY: ₹ 8.0/kg

Table 5: Effect of corm and soil treatments with organic liquid formulations on soil microbial population dynamics of elephant foot yam field

Treatments	Total bacteria (CFU × 10^6/g of soil)		Total fungi (CFU × 10^4/g of soil)	
	Initial	Harvest	Initial	Harvest
Control (T_1)	57.8	53.4	21.6	19.1
Corm treatment with Beej Sanjeevani (T_2)	57.8	64.7	21.6	22.1
Corm treatment with Beejamrit (T_3)	57.8	65.2	21.6	22.5
Soil application of Jiwamrit (T_4)	57.8	66.3	21.6	23.2
Soil application of Panchagavya (T_5)	57.8		21.6	22.6
Soil application of Jiwamrit + Panchagavya (T_6)	57.8	66.2	21.6	22.8
Corm treatment with Beej Sanjeevani + soil application of Jiwamrit (T_7)	57.8	67.1	21.6	23.9
Corm treatment with Beej Sanjeevani + soil application of Panchagavya (T_8)	57.8	67.0	21.6	23.6
Corm treatment with Beejamrit + soil application of Jiwamrit (T_9)	57.8	69.7	21.6	24.9
Corm treatment with Beejamrit + soil application of Panchagavya (T_{10})	57.8	67.5	21.6	24.1
S.Em ±	-	0.57	-	0.23
C.D. (*p= 0.05*)	-	1.7	-	0.7