Int.J.Curr.Microbiol.App.Sci (2022) *11*(07): 199-205

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 11 Number 07 (2022)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2022.1107.024

Assessment of Biological Properties of Potting Medium under Different Minisett Corm Sizes and Integrated Nutrient Management Practices in Elephant Foot Yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson]

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Keywords

Elephant foot yam, Integrated nutrient management, PGPR mix-I, AMF, Bacteria

Article Info

Received:
09 June 2022
Accepted:
24 June 2022
Available Online:
10 July 2022

A B S T R A C T

Pot culture experiment was conducted to evaluate the effect of different minisett corm sizes and integrated nutrient management practices on biological properties of potting medium in elephant foot yam at Instructional Farm, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala during April 2018-November 2018. The treatments consisted of three minisett corm sizes (s_1-200 g, s_2-300 g and s_3-400 g) and five integrated nutrient management practices (i_1-100 % NPK, i_2-75 % NPK with 50 % N substitution through coir pith compost, i_3-75 % NPK with 50 % N substitution through coir pith compost + PGPR mix-I + AMF, i_4-50 % NPK with 50 % N substitution through coir pith compost, i_5-50 % NPK with 50 % N substitution through coir pith compost + PGPR mix-I + AMF) and a control (1 kg). Higher microbial population was observed in the application of 75 % NPK with 50 % N substitution through coir pith compost + PGPR mix-I + AMF both at 5 MAP and at harvest. Dehydrogenase activity was also observed higher in the same treatment both at 5 MAP and at harvest. Lower microbial population and lower dehydrogenase activity were observed in application of 100 per cent NPK as chemical fertilizers, compared to INM practices.

Introduction

Elephant foot yam *Amorphophallus paeoniifolius* (Dennst.) Nicolson belongs to the family Araceae and is an important tropical tuber crop grown for its edible corms. It is raised as a cash crop due to its higher yield potential, biological efficiency, culinary properties, medicinal uses and therapeutic values, with good acceptance throughout the world. The tuber is useful in the treatment of piles, dysentery, asthma, swelling of lungs, abdominal tumors, asthma, abdominal pain, elephantiasis in addition to use as blood purifier. Size of planting material has been found to be a growth determining factor for

tuber crops as it decides the amount of stored food for the next crop. Continuous and imbalanced use of chemical fertilizers reported to deteriorate soil health and ecological balance, resulting in conjunction to decrease in nutrient uptake efficiency of applied nutrients (Saravaiya *et al.,* 2010). Elephant foot yam requires fairly high amount of nutrients. Adding organic manures to soil increases soil enzymatic activity by altering the soil structure to encourage microbial growth, and beneficial effects of added minerals from organic manure into the soil (Goyal *et al.,* 1993). Coir pith compost is a good soil ameliorant which improve all soil properties. The microbial community plays an important role in ecosystem functioning, both in interactions with plants and in nutrient and organic matter cycling (Adak and Sachan, 2009). Application of bio-fertilizers boosts soil micro-flora and fauna, resulting in faster decomposition, higher productivity and sustainability of soils. As reported by Zahir *et al.,* (2004) microbial inoculants contribute significantly to the soil surface ecosystem by the organic acid secretions, nutrient chelation, fixation and hormonal action. They decomposes and converts organic substances, maintains aggregation stability, and controls carbon, nitrogen, sulfur, and phosphorus cycles and, help to dissolve soil nutrients and make them available for the plants.

The present investigation was taken up to study the effect of minisett corm sizes and integrated use of chemical fertilizers, organic manures along with biofertilizers on the microbial activities in potting medium of elephant foot yam grown under pot culture method.

Materials and Methods

The investigation was carried out at Instructional Farm, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala during April 2018-November 2018. The experiment was a two factorial arrangement laid out in CRD with 15 treatment combinations and a control. The treatments included three corm sizes viz., s_1: 200 g, s_2: 300 g and s_3: 400 g and five integrated nutrient management practices (i_1-100 % NPK, i_2-75 % NPK with 50 % N substitution through coir pith compost, i_3-75 % NPK with 50 % N substitution through coir pith compost + PGPR mix-I + AMF, i_4-50 % NPK with 50 % N substitution through coir pith compost and i_5-50 % NPK with 50 % N substitution through coir pith compost + PGPR mix-I + AMF). Minisett corms and control corms (1 kg) of elephant foot yam var. Gajendra were planted in plastic sacks of uniform size as per the treatments. Potting mixture for filling the sacks were prepared by mixing soil with farm yard manure and sand in 1:1:1 ratio by volume. Recommended dose of N, P and K for elephant foot yam is 100:50:150 kg NPK ha^{-1} and this was modified based on soil test data. Coir pith compost was used as the organic source in the study and was substituted on N equivalent basis as per the treatments, and P and K were given through chemical sources. Full dose of P and half the dose of N and K were applied 45 days after planting. Coir pith compost was applied in full quantity at 45 days after planting. The second dose of N and K was applied one month after first application. Corm treatment with 5 per cent suspension of PGPR mix-I (consortium of *Azospirillum lipoferum*, *Azotobacter chroococcum*, *Bacillus megaterium* and *Bacillus sporothermodurans*), followed by soil application of PGPR enriched cow dung @ 10 g per pit (mixture of dry cow dung and PGPR mix-I in 50:1 proportion) was done at planting and 2 months after planting in treatments i_3 and i_5. AMF was applied @ 10 g per pit at the time of planting in i_3 and i_5. The biofertilizers PGPR mix-I and AMF, supplied from the Department of Agricultural Microbiology, College of Agriculture, Vellayani, were used as per the treatments.

Microbial analysis of potting media was done at the beginning of the experiment, at 5 MAP and at harvest. Population count of microbes in the potting media was estimated using serial dilution and plate count technique with appropriate medium (Agarwal and Hasija, 1986). The media used were nutrient agar for bacteria, Martin's Rose Bengal agar for fungi, Kenknight and Munaier's agar for actinomycetes. The dehydrogenase activity of the

samples was analyzed by following the procedure outlined by Casida *et al.,* (1964). The initial biological properties of the potting medium used for the study are given in Table 1.

Results and Discussion

Count of bacteria, fungi and Actinomycetes

Count of bacteria, fungi and actinomycetes in initial potting medium, during grand growth period (5 MAP) and at harvest revealed that higher count was observed at harvest and there was a general increase in count from initial to harvest. Count of bacteria, fungi and actinomycetes in potting medium at 5 MAP and at harvest influenced by size of minisett corm, integrated nutrient management practices and their interactions are furnished in Tables 2a and 2b.

Count of bacteria

The size of minisett corm could not exert significant effect on the count of bacteria at 5 MAP and at harvest. Bacterial count of potting medium was significantly affected by different INM practices at 5 MAP and at harvest. The count was significantly higher (6.78 log cfu g^{-1}) in i_3 (75 per cent NPK with 50 per cent N substitution through coir pith compost + PGPR mix-I+ AMF) at 5 MAP, and was on par with i_5 (50 per cent NPK with 50 per cent N substitution through coir pith compost + PGPR mix-I + AMF) with a bacterial count of 6.72 log cfu g^{-1}. Lower bacterial count of 6.58 log cfu g^{-1} was found in i_1 (100 per cent NPK as chemical fertilizers). At harvest, the INM treatments, i_3 (75 per cent NPK with 50 per cent N substitution through coir pith compost + PGPR mix-I+ AMF), i_5 (50 per cent NPK with 50 per cent N substitution through coir pith compost + PGPR mix-I + AMF) and i_4 (50 per cent NPK with 50 per cent N substitution through coir pith compost) recorded on par results with a count of 6.87 log cfu g^{-1}, 6.87 log cfu g^{-1} and 6.83 log cfu g^{-1} respectively. The treatment i_1 (100 per cent NPK as chemical fertilizers) however recorded the lowest bacterial count (6.68 log cfu g^{-1}) compared to INM practices. The S x I interactions did not show any significant effect on bacterial count at 5 MAP and at harvest and the treatments *vs*. control effect was also non significant.

Count of fungi

On perusal of data, it was observed that, size of minisett corm, integrated nutrient management practices and their interactions had no significant effect on the fungal count of potting medium at 5 MAP and at harvest. On comparing the treatments with control, no significant variation was observed between treatments and control with respect to count of fungi.

Count of actinomycetes

Count of actinomycetes in potting medium was not significantly influenced by the size of minisett corm at 5 MAP and at harvest. The results showed that count of actinomycetes differed significantly with different INM practices at 5 MAP and at harvest. The treatment i_3 (75 per cent NPK with 50 per cent N substitution through coir pith compost + PGPR mix-I + AMF) recorded significantly higher (2.40 log cfu g^{-1}) count of actinomycetes in potting medium at 5 MAP and was on par with i_5 (50 per cent NPK with 50 per cent N substitution through coir pith compost + PGPR mix-I + AMF) with a count of 2.32 log cfu g^{-1}. A near similar trend was observed at harvest and significantly the highest actinomycetes count in potting medium was recorded in i_3 (2.55 log cfu g^{-1}) followed by i_5 (2.44 cfu g^{-1}). Significantly the lowest actinomycetes count was noted in i_1 (100 per cent NPK as chemical fertilizers) with a count of 2.08 log cfu g^{-1} and 2.20 log cfu g^{-1} at 5 MAP and at harvest respectively. The S x I interactions could not significantly influence the actinomycetes count at 5 MAP and at harvest and treatments *vs*. control effect was also non significant.

The higher microbial population in INM treatments may be due to higher decomposition of organic matter by the addition of organic manures. PGPR mix-I is a consortium of *Azospirillum lipoferum*,

Azotobacter chroococcum, Bacillus megaterium and Bacillus sporothermodurans for supplementing all the major nutrients to the crop (Gopi *et al.,* 2020). The mineral status of the crop rhizosphere is modified by the PGPR application through the secretion of amino acids, organic acids and other compounds which are also having a stimulatory effect on soil microbial activity. Lower population of microbes was observed in i_1 (100 per cent NPK) compared to INM practices.

As reported by Nakhro and Dkhar (2010) the use of inorganic fertilizers resulted in low microbial counts and biomass carbon of the soil. Fertilizer sources had a suppressing effect on microbial population as suggested by Staley *et al.,* (2018) who reported decreased microbial diversity in agricultural soils with urea amendment.

Dehydrogenase activity

The results on the effect of treatments and their interactions on dehydrogenase activity of potting medium at 5 MAP and at harvest are given in Tables 2a and 2b. Dehydrogenase activity of potting medium did not vary significantly with size of minisett corm at 5 MAP and at harvest. Different INM practices showed significant effect on dehydrogenase activity both at 5 MAP and at harvest.

The INM treatment, i_3 (75 per cent NPK with 50 per cent N substitution through coir pith compost + PGPR mix-I+ AMF) recorded significantly the highest dehydrogenase activity of 24.93 µ TPF g^{-1} soil 24 h^{-1} at 5 MAP which was followed by i_5 (24.24 µ TPF g^{-1} soil 24 h^{-1}) on par with i_2 (23.84 µ TPF g^{-1} soil 24 h^{-1}) which in turn was statistically comparable with i_4 (23.36 µ TPF g^{-1} soil 24 h^{-1}). Significantly lower dehydrogenase activity (23.14 µ TPF g^{-1} soil 24 h^{-1}) was noted in i_1 (100 per cent NPK as chemical fertilizers) which was on par with i_4. At harvest, significantly the highest dehydrogenase activity was recorded for i_3 (29.37 µ TPF g^{-1} soil 24 h^{-1}) followed by i_5 (28.18 µ TPF g^{-1} soil 24 h^{-1}) and i_2 (26.62 µ TPF g^{-1} soil 24 h^{-1}) on par with i_4 (26.39 µ TPF g^{-1} soil 24 h^{-1}). However i_2 and i_4 were on par with i_1 (26.65 µ TPF g^{-1} soil 24 h^{-1}). Different S x I interactions significantly influenced the dehydrogenase activity of potting medium at 5 MAP and at harvest.

Among different treatment combinations, s_3i_3 (400 g + 75 per cent NPK with 50 per cent N substitution through coir pith compost + PGPR mix-I + AMF) recorded significantly the highest dehydrogenase activity (25.99 µ TPF g^{-1} soil 24 h^{-1}) at 5 MAP. At harvest, s_3i_3 recorded significantly higher dehydrogenase activity (29.56 µ TPF g^{-1} soil 24 h^{-1}) and was on par with s_2i_3 (29.47 µ TPF g^{-1} soil 24 h^{-1}), s_2i_5 (29.27 µ TPF g^{-1} soil 24 h^{-1}), s_1i_3 (29.08 µ TPF g^{-1} soil 24 h^{-1}) and s_3i_2 (28.31 µ TPF g^{-1} soil 24 h^{-1}).

Comparing the treatments with control, no significant variation was observed in case of dehydrogenase activity of potting medium at 5 MAP and at harvest. In comparison with the initial value, there was an improvement in the dehydrogenase activity of potting medium at 5 MAP and at harvest.

Dehydrogenase catalyzes oxidation-reduction reactions required for the respiration of organic compounds and are intracellular enzymes. Dehydrogenase activity is considered a measure of microbial activity as it is inactive when outside the cell (Maier and Gentry, 2015). Higher dehydrogenase activity with application of organic sources might be linked to more substrate availability and this reflects the greater biological activity in the soil. Manjaiah and Singh (2001) reported increase in dehydrogenase activity and microbial biomass in proportion to the addition of number and amount of nutrients. Lower dehydrogenase activity was found in i_1 (100 per cent NPK), applied as chemical fertilizers, at 5 MAP. Fertilizer application could affect the soil microbial population and consequently soil enzymatic activities. It is often assumed, that inorganic fertilizers had relatively less effect on soil enzymes activity than organic fertilizers (Chu *et al.,* 2007; Xie *et al.,* 2009; Romero *et al.,* 2010).

Table.1 Biological properties of potting medium (initial)

Biological properties	Count
Count of Bacteria (log cfu g^{-1})	6.52
Count of Fungi (log cfu g^{-1})	3.41
Count of Actinomycetes (log cfu g^{-1})	2.09
Dehydrogenase activity (µg TPF g^{-1} soil $24h^{-1}$)	22.65

Table.2a Effect of size of minisett corm and integrated nutrient management on biological properties of potting medium

Treatments	Bacteria (log cfu g^{-1})		Fungi (log cfu g^{-1})		Actinomycetes (log cfu g^{-1})		Dehydrogenase activity (µ TPF g^{-1} soil 24 h^{-1})	
	5MAP	At harvest	5MAP	At harvest	5MAP	At harvest	5MAP	At harvest
Size of minisett corm (S)								
s_1-200g	6.66	6.79	3.55	3.66	2.21	2.39	23.96	27.50
s_2-300g	6.68	6.80	3.58	3.63	2.30	2.43	23.69	27.29
s_3-400g	6.68	6.80	3.60	3.64	2.29	2.34	24.05	27.52
SEm(±)	0.017	0.011	0.036	0.026	0.026	0.026	0.123	0.202
CD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Integrated Nutrient Management (I)								
i_1- 100 % NPK	6.58	6.68	3.50	3.59	2.08	2.20	23.14	26.65
i_2- 75 % NPK with 50 % N substitution through coir pith compost	6.69	6.73	3.59	3.65	2.27	2.35	23.84	26.62
i_3- 75% NPK with 50% N substitution through coir pith compost + PGPR mix-I+ AMF	6.78	6.87	3.65	3.71	2.40	2.55	24.93	29.37
i_4- 50 % NPK with 50 % N substitution through coir pith compost	6.59	6.83	3.56	3.61	2.28	2.41	23.36	26.39
i_5- 50 % NPK with 50% N substitution through coir pith compost + PGPR mix-I + AMF	6.72	6.87	3.59	3.65	2.32	2.44	24.26	28.18
SEm(±)	0.022	0.015	0.046	0.033	0.033	0.033	0.159	0.261
CD(0.05)	0.067	0.044	NS	NS	0.100	0.101	0.479	0.786

Table.2b Interaction effect of size of minisett corm and integrated nutrient management on biological properties of potting medium

Treatments	Bacteria (log cfu g^{-1})		Fungi (log cfu g^{-1})		Actinomycetes (log cfu g^{-1})		Dehydrogenase activity (µ TPF g^{-1} soil 24 h^{-1})	
	5MAP	At harvest	5MAP	At harvest	5MAP	At harvest	5MAP	At harvest
S x I interaction								
s_1i_1	6.58	6.64	3.47	3.60	2.10	2.15	23.06	26.97
s_1i_2	6.69	6.72	3.53	3.70	2.22	2.34	23.57	26.30
s_1i_3	6.72	6.86	3.65	3.71	2.35	2.56	24.60	29.08
s_1i_4	6.58	6.84	3.53	3.63	2.13	2.48	23.83	27.07
s_1i_5	6.72	6.88	3.59	3.68	2.26	2.45	24.75	28.12
s_2i_1	6.62	6.68	3.50	3.58	2.09	2.26	23.41	26.20
s_2i_2	6.66	6.75	3.61	3.64	2.29	2.42	23.37	25.24
s_2i_3	6.83	6.88	3.64	3.72	2.41	2.60	24.19	29.47
s_2i_4	6.58	6.81	3.59	3.61	2.34	2.39	23.44	26.30
s_2i_5	6.69	6.86	3.58	3.61	2.39	2.48	24.06	29.27
s_3i_1	6.54	6.72	3.53	3.61	2.04	2.18	22.96	26.78
s_3i_2	6.71	6.73	3.62	3.61	2.30	2.30	24.57	28.31
s_3i_3	6.80	6.86	3.67	3.71	2.43	2.50	25.99	29.56
s_3i_4	6.62	6.84	3.57	3.60	2.36	2.35	22.81	25.82
s_3i_5	6.75	6.86	3.61	3.65	2.30	2.38	23.91	27.16
SEm(±)	0.038	0.025	0.079	0.058	0.057	0.058	0.275	0.451
CD(0.05)	NS	NS	NS	NS	NS	NS	0.829	1.361
Treatment mean	6.67	6.79	3.58	3.64	2.27	2.39	23.90	27.44
Control (1 kg corm + 100 per cent NPK)	6.62	6.75	3.50	3.61	2.34	2.44	23.02	26.39
Treatment *vs* Control	NS	NS	NS	NS	NS	NS	NS	NS

The study revealed that the biological properties of potting medium were significantly influenced by the application of chemical fertilizers, organic manures and biofertilizers in elephant foot yam.

Application of 75 per cent NPK with 50 per cent N substitution through coir pith compost + PGPR mix-I [at the rate of 10 g per plant (dry cow dung: PGPR mix-I in 50:1 proportion) - at planting and 2 MAP] + AMF (at the rate of 10 g per pit - at the time of planting) recorded higher microbial count and dehydrogenase activity.

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How to cite this article:

Dhanalakshmi, V. N., G. Rajasree and Chitra, N. 2022. Assessment of Biological Properties of Potting Medium under Different Minisett Corm Sizes and Integrated Nutrient Management Practices in Elephant Foot Yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson]. *Int.J.Curr.Microbiol.App.Sci.* 11(07): 199-205. doi: https://doi.org/10.20546/ijcmas.2022.1107.024