Research Article

Vermicompost Application to Improve Corm Quality of *Amorphophallus* Intercropped in Indian Goose Berry Orchard

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ABSTRACT

The investigation carried on the quality analysis of *Amorphophallus* corm grown under shade of Indian goose berry orchard. Integrated nutrient management of *Amorphophallus* intercropped with Indian goose berry can effectively improve corm quality in respect to calcium oxylate, starch and dry matter content. The least amount of calcium oxalate (0.84% and 0.71%), the maximum starch content (17.20% and 17.70%) and dry matter content (22.45% and 22.75%) was reported in T_8 (Aonla + Suran + 25% N_2 from Mustard cake + 25% N_2 from Vermicompost + 50% N_2 from Urea) followed by 0.85% and 0.712% of calcium oxalate, 17.12% and 17.20% of starch; and 22.35% and 22.40% of dry matter in T_3 (Aonla + Suran + 50% N_2 from Vermicompost + 50% N_2 from Urea) during 2007-08 and 2008-09, respectively. The chemical analysis of corms of suran under various treatments has not shown significant variation, however, the maximum amount of calcium oxalate was observed in T_{11} (0.91 per cent) followed by T_9 and T_{10} (0.90 per cent) during 2007-08 while during 2008-09 both T_{11} (*Amorphophallus* sole crop with only inorganic source of nutrients) and T_1 (Intercropping *Amorphophallus* with only inorganic source of nutrients) leads to high value of calcium oxalate which was 0.87% and 0.86%, respectively.

Keywords: *Amorphophallus*; Calcium Oxalate; Corms; Indian Goose Berry; Intercropping; Vermicompost.

INTRODUCTION

Elephant Foot Yam (*Amorphophallus companulatus* L.), commonly known as suran or jimikand, is shade loving tuber crop having great potential to withstand and grow under canopy of fruit plants. It is one of the most common tuber crop grown in tropics and subtropics of the world with greater productivity (50-80 t ha^{-1}) and culinary properties.[1,2] Higher biological efficiency as food producers enable a very high rate of dry matter production per unit area per day among all crops by efficient solar energy transfer (ESET). Among various tuber crops suran performs better in terms of growth and yield parameters.

Amorphophallus is a perennial plant which bears underground hemispherical depressed dark brown corm of approximately 20-25 cm in diameter.[3,4] Leaves are solitary and 30-90 cm broad. Inflorescence consists of a foliar organ, the spathe, which usually envelops a stalk–like organ, the spadix. Flowers are tiny, monoecious and strongly reduced and are found at the base of the spadix. Raphides isolated from corms are pointed at one end and square at other end, cross section is 'X'-shaped at pointed end and they are asymmetrical.[5]

Amorphophallus is cultivated as a mixed crop or as intercrop in the fields of banana, guava, aonla, ginger, groundnuts. Suitability of *Amorphophallus* has been reported under dense foliage of Indian goose berry, litchi and guava. Intercropping is an approach to grow short durational crops in the available interspace of fruit orchard to obtain additional income during non-bearing phase of fruit trees. Proper exploitation of the genetic potential of the different intercrops and proper utilization of interspaces available under the canopy of fruit plants are the basic principles of intercropping. *Amorphophallus* is shade loving plant and can be economically grown in aonla and guava orchards.[6,7]

Plants can be vegetative propagated through corms which can be planted in the pits of size 40cm x 40 cm x 40 cm containing decomposed cow dung compost and sandy loam soil.[2]

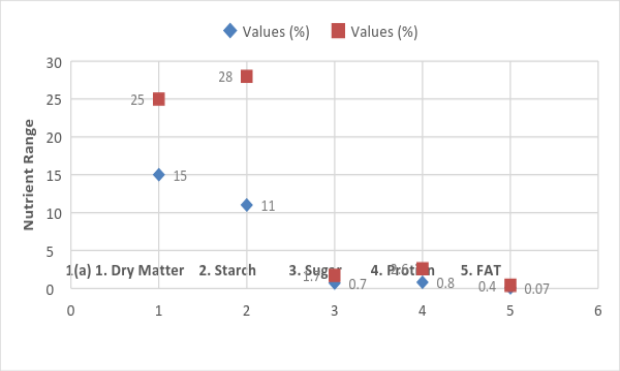
The corms are used to make delicious food products and is good source of minerals, energy, monosaccharides like sugar, polysaccharides like starch and proteins. Average nutritional profile of corms has been propagated through Figure 1.[8,9,10]

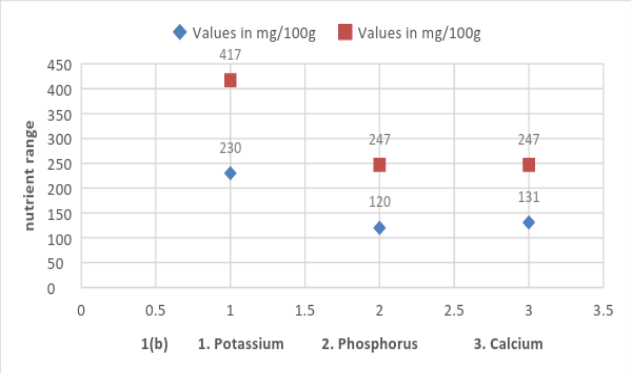
Science Classification	
Kingdom	: Plantae
Division	: Angiospermae
Class	: Monocotyledonae
Order	: Alismatales
Family	: Araceae
Genus	: *Amorphophallus*
Species	: *Paeoniifolius*
Synonyms	: *A. campanulatus*

The oxalates present in corms accumulates in body after consumption and increase the urinary oxalates which leads to kidney stone.

The average value of soluble oxalates in corm is 13.53 mg/100 g which is in safe range from health point.[11] The high nutritive value and energy value (236-566.70 KJ/100g) is the key factor behind its acceptability as vegetable. It can also be used to develop some value-added products like pickles, dried cubes, chips, thickening agent etc.

Fresh corm can be used to prepare osmo-dehydrated slices while corm flour is used to prepare bread which is good source of carbohydrate and protein.[12]





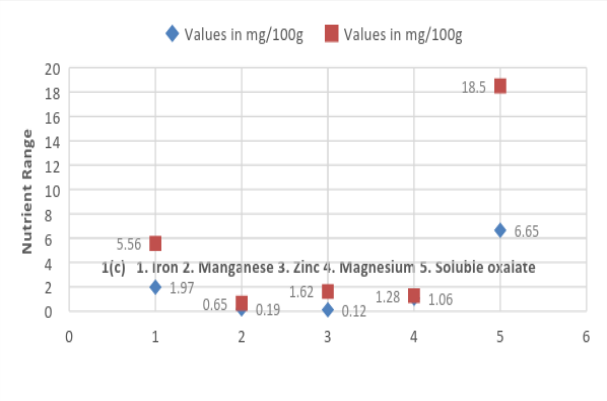


Figure 1(a, b, c): Average nutritional value of *Amorphophalus* corms

MATERIALS AND METHODS

The investigation has been under taken at farmer's field near Narendra Dev University of Agriculture and Technology, Narendra Nagar, Kumarganj, Faizabad (U.P.) during the years 2007-08 and 2008-09 to evaluate the effect of shade of Indian Goose Berry plantation and Integrated Nutrient Supply on starch and calcium oxalate of corms of Elephant Foot Yam. The materials and methodology used in present investigation are discussed below:

Experimental Layout Plan

Total experimental area was 2112 m^2 with 33 plots, gross area of each plot 56.24 m^2 and net area covered by intercrop in each plot was 53.10 m^2. Aonla trees were at spacing of 8m X 8 m and each plot had one centrally located plant. There were eleven treatments with three replications. The treatments are mentioned in Table 1.

Table 1: Treatments or Cropping Systems

S. No.	Treatments or Cropping Systems	Treatment
1.	Aonla + Suran + 100% N_2 from Urea	T_1
2.	Aonla + Suran + 25% N_2 from Vermicompost + 75% N_2 from Urea	T_2
3.	Aonla + Suran + 50% N_2 from Vermicompost + 50% N_2 from Urea	T_3
4.	Aonla + Suran + 75% N_2 from Vermicompost + 25% N_2 from Urea	T_4
5.	Aonla + Suran + 25% N_2 from Mustard cake + 75% N_2 from Urea	T_5
6.	Aonla + Suran + 50% N_2 from Mustard cake + 50% N_2 from Urea	T_6
7.	Aonla +Suran +75% N_2 from Mustard cake +25% N_2 from Urea	T_7
8.	Aonla + Suran + 25% N_2 from Mustard cake + 25% N_2 from Vermicompost + 50% N_2 from Urea	T_8
9.	Aonla + Suran + 100% N_2 from Vermicompost	T_9
10.	Aonla + Suran + 100% N_2 from Mustard cake	T_{10}
11.	Suran alone as sole crop	T_{11}

Table 2: Fresh and Marketable Weight Corms of Elephant Foot Yam Intercropped in Indian Goose Berry Orchard

Treatments	Fresh weight per plant (gm)		Marketable weight per plant (gm)	
	2007-08	2008-09	2007-08	2008-09
T_1	849.70	1125.30	785.95	817.38
T_2	1050.00	1323.50	971.25	1042.26
T_3	1070.00	1340.20	989.75	1075.51
T_4	1039.85	1325.00	962.00	1031.51
T_5	1030.00	1320.00	952.75	1019.70
T_6	999.72	1275.00	924.75	955.87
T_7	969.95	1245.70	897.25	916.25
T_8	1100.00	1394.30	1017.50	1150.30
T_9	899.95	1150.00	832.50	875.68
T_{10}	889.50	1129.00	814.00	852.40
T_{11}	1109.80	1453.50	1026.55	1210.04
Mean	**1001.00**	**1280.00**	**924.90**	**995.20**
CDat 5%	**120.98**	**103.40**	**131.20**	**107.00**

Observation Recorded

The observations on various physical and chemical parameters of corms of elephant foot yam were recorded after harvesting. The fresh weight of mother and daughter corms was recorded in gram for 10 randomly selected plants of suran from each plot. The average dry weight of both mother and daughter corms was recorded after 10 days of harvest of produce of each sampled fresh weight corms. Dry matter content was determined from harvested corms by cutting the corms into pieces and placing them in a hot air oven at 70°C for drying till it obtains constant weight. After preparing samples, starch content was determined from harvested corms by iodine test on dry weight basis. Starch content in corms was estimated in hot water extracts by using spectronic 20 colorimeter.[13]

Calcium oxalate content of corms was estimated by titrating the sample against N/20 $KMnO_4$ and Methyl red as indicator.[14,15] The total calcium oxalate was expressed as anhydrous oxalic acid using the following formula.

1 ml of N/20 $KMnO_4$ = 0.00225 g of anhydrous oxalic acid.

RESULTS AND DISCUSSION

Fresh and Marketable Weight of Corms

The data recorded on average weight of corms per plant has been represented in Table 2 which reveals that the fresh and marketable weight per plant was recorded highest in T_{11} (1109.80g and 1026.55g, respectively in 2007-08; and 14535.50g and 1210.04g, respectively in 2008-09) followed by T_8 (1100.00 g and 1017.50 g, respectively in 2007-08; and 1394.30g and 1150.30g, respectively in 2008-09) and T_3 (1070.00 g and 989.75 g, respectively in 2007-08; and 1340.20g and 1075.51g, respectively in 2008-09).

The significant reduction in yield of *Amorphophallus* in T_1, T_7, T_9 and T_{10} was primarily due to competition and sharing of soil moisture and nutrient between intercrop and fruit trees while secondarily due to lower availability of Photo-synthetically Active Radiation (PAR) under shade of Indian goose berry in comparison to sole crop.[16-18] Thus, light might be primary limiting factor which leads to yield reduction in intercrops followed by relative lower availability of soil moisture to the intercrops grown under shade of orchard.[19]

The treatments like T_8, T_3, T_2, T_4 and T_5 didn't significantly reduced either fresh weight or marketable weight of suran even under shade of aonla orchard which may be due to sustainable availability of nutrients from vermicompost and/or mustard cake and increase in moisture holding capacity.[20]

Significant yield improvement in elephant foot yam with 25-50 % substitution of inorganic fertilisers with organic sources has also been reported.[21,22] Similar results have been reported during intercropping of *Colocassia*, *Amorphophallus* and turmeric in bearing guava orchard and during *Amorphophallus* in bearing Indian goose berry orchard.[23,24]

Corm Quality Analysis

The observations pertaining to chemical composition of corms of suran revealed that there was non-significant impact of shade and different nitrogen sources on starch and dry matter content of corms in both years of experimentation while calcium oxalate content was significantly reduced in second year due to application of mustard cake and/or vermicompost in combination with inorganic nutrient sources (Figure 2, Figure 3).

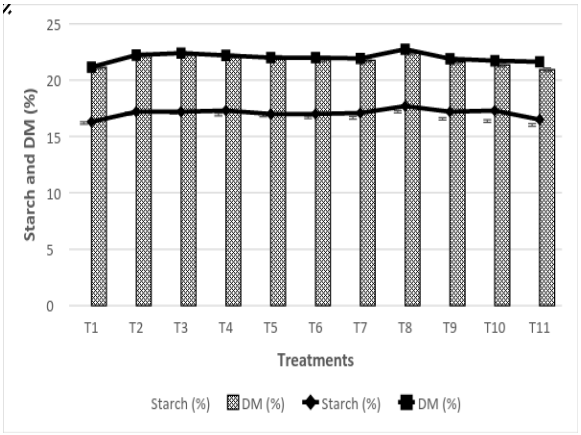


Figure 2: Starch and dry matter content of corms of *Amorphophallus*

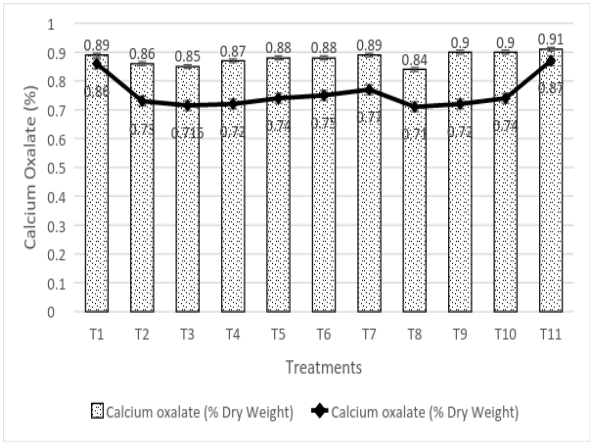


Figure 3: Calcium Oxalate Content of Corms of *Amorphophallus*

Though the least amount of calcium oxalate (0.84% and 0.71%), the maximum starch content (17.20% and 17.70%) and dry matter content (22.45% and 22.75%) was reported in T_8 (Aonla + Suran + 25% N_2 from Mustard cake + 25% N_2 from Vermicompost + 50% N_2 from Urea) followed by 0.85% and 0.712% of calcium oxalate, 17.12% and 17.20% of starch; and 22.35% and 22.40% of dry matter in T_3 (Aonla + Suran + 50% N_2 from Vermicompost + 50% N_2 from Urea) during 2007-08 and 2008-09, respectively.

The maximum amount of calcium oxalate was observed in T_{11} (0.91 per cent) followed by T_9 and T_{10} (0.90 per cent) during 2007-08 while during 2008-09 both T_{11} (*Amorphophallus* sole crop with only inorganic source of nutrients) and T_1 (Intercropping *Amorphophallus* with only inorganic source of nutrients) leads to high value of calcium oxalate which was 0.87% and 0.86%, respectively.

Thus, significant effect of organic sources on oxalate content of corms was reported while shade has no such effect. This reduction in oxalate due to application of vermicompost and/or mustard cake might be due to increased availability of micronutrients influencing metabolism of oxalates in different biochemical products. The present findings could not be confirmed by other workers because it is the first kind of research approach initiated on aonla and suran based cropping systems with integrated nutrient management practice. However, lower oxalate, high crop yield, high starch and high crude protein has been reported when organic sources of nutrients like vermicompost was supplemented with fertilizers in comparison to conventional fertilizers application in aroids.[25] Improvement in corm quality due to lowering of oxalate content in *Amorphophallus* intercropped in Indian goose berry orchard with integrated nutrient management has also been reported.[26]

SUMMARY AND CONCLUSION

Highest economic yield of *Amorphophallus* has been reported when it was grown as sole crop (T_{11}) followed by T_8 and T_3 in which vermicompost was applied with fertilizers for *Amorphophallus* intercropped in Indian goose berry orchard. This might be due to greater availability of sunlight in absence of shade. Oxalate content was reported to be minimum in due to application of combined application of vermicompost, mustard cake and inorganic sources of nutrients (T_8) followed by T_3 while soli crop *Amorphophallus* (T_{11}) has highest oxalate content. Thus, intercropping has not only produced quality yield of corms but also improved maximum benefit to farmers.

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