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ORIGINAL ARTICLE

Effects of Genotype, Root – Promoting Substances and Planting Media on Yam (*Dioscorea Rotundata*, Poir) Vine Cuttings for Mini Tuber Production.

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ABSTRACT

This study was designed to evaluate the effects of planting media and other root – promoting substances on rooting and mini tuber formation in vine cuttings obtained from white yam (*D. rotundata).* Five months old vine cuttings obtained from three yam genotypes (TDr 98/01230, TDr 97/00940 and TDr 335) were treated with root – promoting substances (wood ash, 1%IBA, coconut water and pyroligneous acid) and planted in three planting media (sterilized top soil, non sterilized top soil and carbonized rice husk). The vine cuttings were sampled for rooting percentage, number of roots, root length and mini tuber initiation 21 days after treatment (DAT), and for number and weight (g) of mini tubers three months after planting. There were no significant differences in the number and weight of tubers produced on vine cuttings of TDr 98/01230, TDr 97/00940 and TDr 335. The number of tubers and weight obtained from vine cuttings planted in carbonized rice husk were significantly different ($P< 0.05$) from other planting media. The number and weight of tubers obtained from IBA and wood ash treated vines were not significantly different.

Key words:

Introduction

Yams belong to the family *Dioscoreaceae* and are members of the genus *Dioscorea*, which produce tubers and bulbils that are economically important [3]. The genus *Dioscorea* is by far the largest genus of the family and is very important throughout coastal West Africa where approximately 60 million people obtain more huge calories of energy of about 800 KJ day^{-1} from it[17]. Food yams are are predominantly cultivated in the humid forest, forest/savanna transition and the southern guinea savanna (SGS) zones of West Africa. Large percentages of current production are in the SGS [21]. The contribution of yams to the dietary needs of man and economic gains accrue from its cultivation cannot be over emphasized[13]. Carbohydrate is derived from yams and it is a good source of energy needed for the day activities of most Nigerians and contributes about 20% of the daily calorie in- take in the diet (Iwueke, 1989). Yams are usually made into various food items, recipes and confectionary according to individuals' preference or needs[20].

Nigeria produces most of the world's annual output of over 27 million tones of yams (FAO, 2004). The edible part of yam is the underground starchy stem called 'tuber' which also serves as the conventional propagules of the crop. Thus, in most parts of Nigeria, up to 30% (3-5t/ha) of the previous harvest may be used to plant a new crop. Yams may be propagated vegetatively or sexually through seed. Up until recently, the traditional and most widely practiced method of growing yams is through the use of tuber or bulbil[19]. Traditionally, whole tubers or large pieces of 200g or more of yams

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(*Dioscorea* spp.) are usually employed for propagation by planting[18]. This means that some marketable tubers must be reserved for planting. The cost of planting material is over 33% of the total outlay for yam production, so there is a need to improve the rate of yam multiplication[18].

Because of difficulties in propagation, the yam is under threat in many traditional areas of production[12]. In view of the large quantities of tubers/bulbils committed to producing new plants, which otherwise would have been available for human consumption, other methods of yam propagation using vine cuttings have been sought after[16]. Propagation from vine cuttings was first reported in non-food yams (Correll *et al*., 1955) and in recent times, it has been extensively reported in food yams[24]. It was demonstrated that cuttings of the vine excluding a node never rooted, even after being treated with rooting substances. A cutting usually involves a node, made in such a way that about 2.5cm of vine tissue is left attached below and above the node with the leaf intact[19].

Cutting of several yam species have been rooted in sand media without hormones[10], however, hormone treatment may accelerate root, shoot and tuber formation[5]. Akoroda and Okonmah[2] obtained that small tubercles, whose size and quantity were not specified from rooted vine cuttings of yam. Acha *et al*.[1], studied the effect of auxin on root development in *D. rotundata* vines and observed the formation of mini tubers. The authors reported that further that treatment of vine cuttings with indolebutryic acid (IBA) significantly increased the number of roots produced by vine cuttings of ten *Dioscorea rotundata* cultivars. Shiwachi *et al*.,[22] reported that mini tubers were produced from two varieties of *Dioscorea rotundata* using vine cuttings planted in carbonized rice husk or coco-peat in a screen house. The cuttings established better and produced more mini tubers in carbonized rice husk than in coco-peat 100 days after planting. Vine cuttings of *D. rotundata* can be used to produce mini tubers within 100-120 days that could be used in germplasm exchange and for production of seed yams.

Carbonized rice husk is useful media for seed or seedling propagation in the nursery[15]. The result of the study conducted on influence of growth – promoting substances on sprouting of white yam (*Dioscorea rotundata*) setts showed that treatment with 2% thiourea induced early sprouting and longer sprouts that led to a vigorous crop[23]. Potassium nitrate had no pronounced effect. The farmers' practice of dipping the setts in cow dung slurry or smearing with wood ash resulted in poor, slow and staggered sprouting. Indole acetic acid had the least effect on sprouting.

IITA[12] annual report showed coconut water (10%) as one of the important compositions of basal medium supplements used in tissue culture for obtaining rooting and plantlet formation from immature yam seeds. Ichikawa *et al*.,[11] in the experiment conducted on the effect of pyroligneous acid on the growth of rice seedlings, reported that seedlings growth was promoted by the soil treatment with pyroligneous acid and that the rooting activity of rice seedlings was accelerated by the treatment with pyroligneous acid prior to transplanting. Treating vine cuttings of responsive clones with different hormone concentrations before planting in a suitable rooting medium could be valuable in determining the optimum hormone concentrations required for effective rooting. The objectives of this study were to: identify locally sourced substances as alternatives to synthetic rooting hormones (chemical auxin), and compare the response of some yam clones vines to the applied rooting - promoting substances.

Materials and Methods

The study was conducted at the International Institute of Tropical Agriculture (IITA), Ibadan (7^{o} 26'N, 3^{o}54'E), a rainforest – savanna transition zone. Three genotypes of yam, *Dioscorea rotundata* Poir ((TDr 98/01230, TDr 97/00940 and TDr 335), obtained from the Germplasm Collection Unit of IITA were used ot evaluate the response of some yam clones vines to the applied rooting - promoting substances. The first experiment was a 3 x 3 x 2 factorial experiment, which involved three yam genotypes (TDr 97/00940, TDr 335 and TDr 98/01230); 3 planting media (non – sterilized top soil, carbonized rice husk and sterilized top soil) and 2 hormone treatments (wood ash and 1% IBA). The sterilized soil was obtained by cooking the topsoil in the drum with firewood. Carbonized rice husks are product of incomplete combustion of organic material. It is prepared by setting fire under half - cut drum containing rice husk. During burning, a stick is usually used to intermittently mix it in order to achieve uniform carbonization. The carbonized rice husks are then cooled with water to prevent it from turning into ashes. Carbonized rice husk is a useful medium for planting seeds and seedlings[15].

The second experiment consisted of application 1% IBA, wood ash (vine cuttings were dusted with IBA and wood ash), coconut water and pyroligneous acid. The nodal points of the cuttings were wounded with a clean razor blade and dusted with 1% IBA or dipped in solutions of coconut water and pyroligneous acid[1]. The wounded nodal points formed callus from where roots would be formed. The control experiment had incisions but no treatment. The plants were excised into vine of 3 - node cuttings after 10 weeks of growth. The cuttings were then dipped in the treatments prepared and left for 24 hours before planting in cups containing the various planting media. Five vine cuttings in three replicate were planted per genotypes and the cups were arranged in the screenhouse using completely randomized block design (CRBD). The experiment was left for 21 days after which the data on percentage rooting, number of roots, root length and number and weight of initiated mini tubers were collected.

Yam setts weighing 50 - 100g were planted in the field as multiplication plot on the ridges of 1m x 0.25m spacing in 2004. The plants were not staked and chemical fertilizer was not applied. Healthy-looking vines were excised from the plants 160 DAP between 8.30 and 9.30am and kept in a moist, polythene bag for transfer to the screen house. The vines from middle portion of the lateral branch were prepared into 3-node cutting sizes with six leaves. The base of the cuttings were slantingly cut for more surface area and the two opposite leaves at the point of insertion into the planting medium were removed with a clean scissors. The prepared cuttings were then powdered at the point of cuts with each of the hormone treatments. The treated vine cuttings were then planted in perforated black nylon bags of size 10x 11 x 25cm already filled with different planting media. Five cuttings were planted vertically in a bag. A treatment had three bags (replications). The planted cuttings were watered sparingly. They were left to root, initiate and develop tubers. Formations of the mini tubers were observed 3 months after treatment when the leaves had senesced. The mini tubers were counted and weighed. Data collected on percentage rooting, number of roots, root length and number and weight of initiated mini tubers were subjected to analysis of variance (ANOVA) and treatments means were separated using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Effects of root – promoting substances, genotypes and planting media on yam vine cuttings mini tuber production:

The mean number of mini tubers obtained from TDr 98/01230, TDr 335 and TDr 97/00940 were not significantly different (Table 1). TDr 335 produced lowest mini tubers number of 0.6 and weighed 1.30g compared with genotype TDr 97/00940 and TDr 98/01230 which produced 0.7 (Fig. 1) as the same numbers of tuber and weighed 1.44g and 2.53g respectively. The use of root – promoting substances (IBA and wood ash) on yam vine cuttings of some genotypes did not significantly affect the number of tubers obtained at harvest. However, tubers obtained from vine cuttings treated with IBA had greater weight of 0.82g compared with wood ash treated vines weighing 0.52g (Fig. 2). Among the three media (sterilized soil, non sterilized soil and carbonized rice husk) used in this experiment, significant difference were obtained on the tuber weight (Fig 3). The mean numbers of tuber of 0.6 weighing 0.78g were obtained from Sterilized soil, 0.5 tubers weighing 1.21g from non – sterilized soil and 1.0 numbers of tubers weighing 3.29g from carbonized rice husk substrate (Table 1). The result of this experiment did not show any interaction among the three factors involved. The mean numbers of tuber from the 3 genotypes was 0.7 with 1.76g as weight. The mean numbers of tuber from root – promoting substance was 0.8 weighing 1.76g while that obtained in the planting media was 0.7 tubers weighing 1.76g.

Effects of IBA, coconut water and pyroligneous acid on rooting and mini tuber initiation in yam vine cuttings;

Root formation was observed on vine cuttings from TDr 335 and TDr 93-49 treated with IBA, coconut water and pyroligneous acid and control treatments three weeks after planting (WAP). In 1% IBA treatment, the mean rooting percentage, number of roots, root length (cm) and the number of initiated tubers obtained from TDr 93-49 were 37.62%, 2.8, 1.85cm and 0.1 respectively. TDr 335 vines gave 33.17% mean rooting percentage, 3.2 as number of roots, root length (cm) of 2.40 and the number of initiated tubers on vines was 0.4. This result indicated similarity in the response of the two genotypes to IBA and control treatments. There were significant differences ($P<0.01$) between the two clones in response to vine cuttings soaked in coconut water for 24 hours before planting in carbonized rice husk (Table 2). The mean rooting percentage were respectively 63.43% and 28.50% from TDr 93-49 and TDr 335. The mean number of roots, length of roots (cm), and number of initiated mini tuber from TDr 93-49 were 3.5, 3.10cm and 0.9 respectively. Treatment of vine cuttings of two yam genotypes with pyroligenous acid show significant difference ($P\leq 0.05$) in their response to treatment. TDr 93-49 was found better than TDr 335 in all the parameters observed. The mean rooting percentage, mean number of roots, mean root length and mean number of mini tuber from TDr 93-49 were 56.7%, 2.6, 2.13cm and 0.6 respectively. TDr 335 had a mean rooting percentage of 29.21%, mean number of roots of 1.5, mean root length of 0.67cm and mean number of mini tuber of 0.01 (Table 2).

Discussion:

It was observed in this study that vine cuttings from some *D. rotundata* clones, treated with various planting media and root – promoting substances rooted and formed tubers. The mean number of mini-tubers obtained from TDr 335, TDr 97/00940, and TDr 98/01230, were 0.6, 0.7 and 0.7 and weighed 1.30g, 1.44g and 2.53g respectively. The above result was less than what was reported by Kikuno (2006) where vine cuttings produced approximately 30g mini tuber under open field condition, although variations in tuber sizes range from 2.7 - 97.7g. Shiwachi [22] also stated that when vine cuttings of seven cultivars were planted in the carbonized rice husk in the nursery, the developed mini tuber had mean weight of 3.0g ± 2.7 g and 1.7 ± 0.8 tubers per vine cuttings. Perhaps, the lowered number of mini tubers obtained in this study was due to the age of vine cuttings (above five months) and the prevailing temperature (average - 27^0c) during the vine propagation. Significant differences were obtained on the tuber weight from planting media treatments in this study. The mean numbers of tuber of 0.6 weighing 0.78g were obtained from sterilized soil, 0.5 tubers weighing 1.21g from non – sterilized soil and 1.0 numbers of tubers weighing 3.29g from carbonized rice husk substrate. This result was in agreement with Shiwachi's [22] report stating the production of mini tubers from two varieties of *Dioscorea rotundata* using vine cuttings planted in carbonized rice husk or coco peat in a screen house. The cuttings established better and produced more mini tubers in carbonized rice husk than in coco peat 100 days after planting. This could be as a result of some properties in carbonized rice husk that always inhibit the activities of pathogens. The use of carbonized rice husk as nursery medium enhanced number of roots, length of new shoots and number of new leaves on new shoots, hence it is a good nursery medium[14].

The use of root – promoting substances on yam vine cuttings of yam genotypes did not significantly affect the number of tubers and weight obtained at harvest. However, tubers obtained from vine cuttings treated with IBA had greater number of tubers 0.8 weighing 2.14g compared with wood ash treated vines having 0.5 tubers weighing 1.38g. This was in agreement with Acha[1] statement that with and without hormone treatment, clonal variations for mean percentage rooting of vines were not significant $P < 0.05$. IITA in her annual report [12], showed coconut water (10%) as one of the important compositions of basal medium supplements used in tissue culture for obtaining rooting and plantlet formation from immature yam seeds. The response of rooting of clone TDr 335 and TDr 93-49 vine cuttings were found to be significantly different ($P \leq 0.05$) when treated with coconut water. Rooting activity and growth of rice seedling was promoted by the soil treatment with pyroligneous acid prior to transplanting[11]. The results suggested that pyroligneous acid effectively enhanced activation of auxins. However, in this study, rooting, number of roots, root length and mini tuber production under control (water) treatment was not significantly different from pyroligneous treatment.

Conclusion

The use of yam vine cuttings as propagative material in view of their potentialities as excellent physiological research material e.g. for clonal propagation, replication and uniformity of starting material. Besides, the technique offers hopes of alternative planting material to the tuber otherwise needed as energy food source for animals and man.

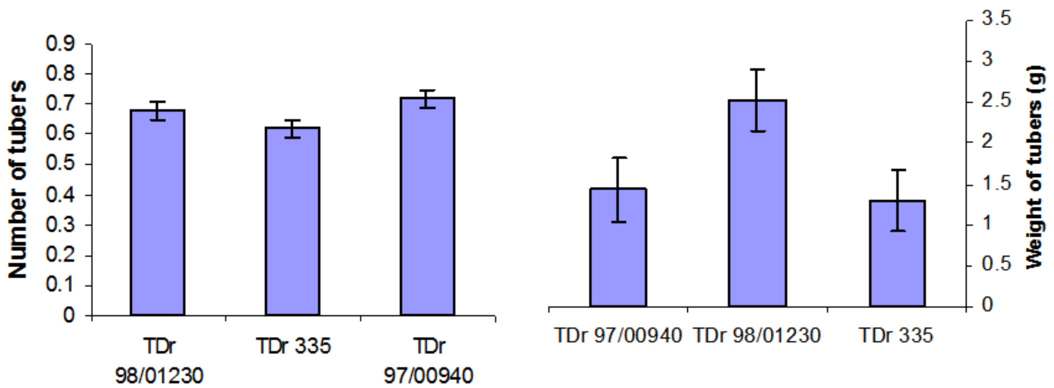

Fig. 1: Effects of genotypes on (A) number of tubers and (B) weight of mini tubers in yam vine cuttings.

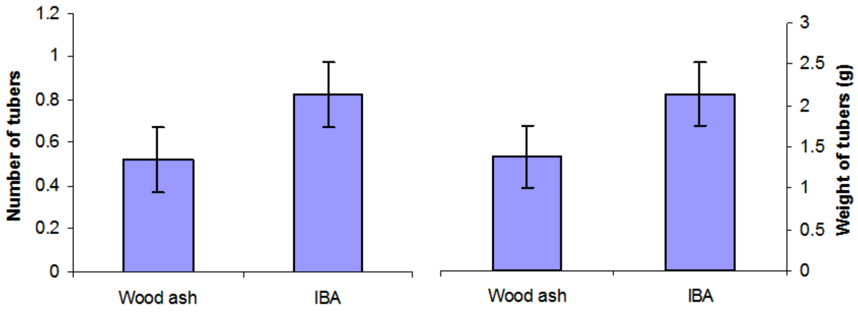

Fig. 2: Effects of rooting substances on (A) number of tubers produced and (B) weight (g) of mini tubers of yam vine cuttings

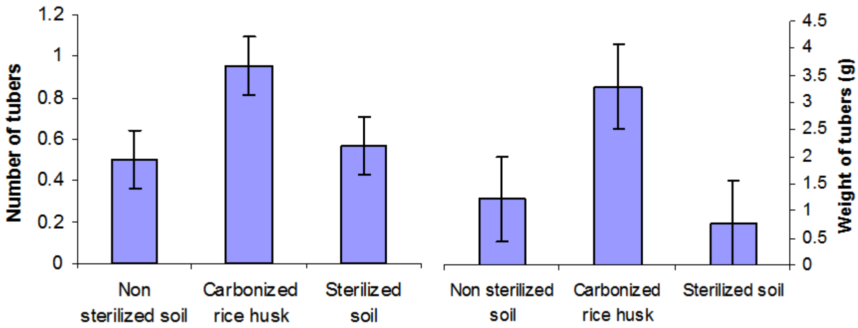

Fig. 2: Effects of rooting media on (A) number of tubers produced and (B) weight of tubers of yam vine cuttings. *Bars represented S.E. values at P<0.05*

Table 1a: Effects of genotypes, root – promoting substances and planting media on yam vine cuttings.

Genotypes	Rooting substances	Planting media / Substrate	Number of tubers	Mini tuber weight (g)
TDr 335	IBA	Carbonized Rice husk	1.0a	2.48ab
		Sterilized rice husk	0.7a	0.26c
		Non sterilized rice husk	0.7a	3.69ab
	Mean	-	0.8	2.14
	Wood ash	Carbonized Rice husk	1.3a	1.38ab
		Sterilized rice husk	0.0	0.0
		Non sterilized rice husk	0.0	0.0
	Mean	-	0.4	0.46
Mean	-	-	0.6	1.30
TDr 97/00940	IBA	Carbonized Rice husk	1.0a	1.71b
		Sterilized rice husk	0.0	0.0
		Non sterilized rice husk	1.3a	2.49ab
	Mean	-	0.8	1.4
	Wood ash	Carbonized Rice husk	1.0a	2.13ab
		Sterilized rice husk	0.7a	1.87b
		Non sterilized rice husk	0.3a	0.43c
	Mean	-	0.7	1.48
Mean	-	-	0.7	1.44
TDr 98/01230	IBA	Carbonized Rice husk	0.7a	6.65a
		Sterilized rice husk	1.3a	1.33b
		Non sterilized rice husk	0.7a	0.63c
	Mean		0.9	2.87
	Wood ash	Carbonized Rice husk	0.7a	5.37a
		Sterilized rice husk	0.7a	1.20b
		Non sterilized rice husk	0.0	0.0
	Mean	-	0.5	2.19
Mean	-	-	0.7	2.53
Grand mean			0.7	1.76
S.E			0.9	2.65

Means with the same letter (s) are not significantly different by Duncan's Multiple Range Test (DMRT).

Table 1b: Interaction effects of factors on the number and weight of tubers produced from yam vine cuttings.

Treatments/factors	Numbers of tuber	Weight of tubers (g)
TDr 335	0.6ns	1.30ns
TDr 97/00940	0.7ns	1.44ns
TDr 98/01230	0.7ns	2.53ns
Mean	0.7	1.76
IBA	0.8ns	2.14ns
Wood ash	0.5ns	1.38ns
Mean	0.7	1.76
Carbonized rice husk	1.0ns	3.29**
Non sterilized soil	0.5ns	1.21ns
Sterilized soil	0.5ns	0.78ns
Mean	0.7	1.76

NS = Non – significant. ** = significant at P<0.05

Table 2: Effects of other root promoting substances on rooting and mini tuber initiation of yam vine cuttings.

Genotypes	Hormone	Rooting (%)	Number of roots	Length of roots (cm)	Number of Initiated mini tuber
TDr 335	IBA	33.17	3.2	2.40	0.4
	Coconut water	28.50	0.8	0.90	0.2
	Pyroligenous acid	29.21	1.5	0.67	0.01
	Control	19.87	3.2	1.22	0.3
TDr 93-49	IBA	37.62	2.8	1.85	0.01
	Coconut water	63.43	3.5	3.10	0.9
	Pyroligenous acid	56.7	2.6	2.13	0.6
	Control	17.07	0.4	0.9	0.0
	S.E	22.38	2.9	2.12	0.3

References

1. Acha, I.A., H. Shiwachi, R. Asiedu and M.O. Akoroda, 2004. Effect of auxins on root development in yam (*Dioscorea rotundata*) vine. Tropical Science, 44: 80-84.
2. Akoroda, M.O. and L.U. Okonmah, 1982. Sett production and Germplasm maintenance through vine cuttings in yams. Tropical Agriculture (Trinidad), 59(4): 311-314.
3. Ayensu, E.S. and D.G. Coursey, 1972. Guinea yams: The botany, ethnology, use and possible future of yam in West Africa: Economic Botany, 26: 301-318.
4. Ayensu, E.S., 1972: Anatomy of the monocotyledons VI *Dioscoreales*, Oxford University Press.
5. Cabanillas, E. and F.W. Martin, 1978: The propagation of edible yams from cuttings, J. Agric. University of Puerto Rico., 62(3): 249-254.
6. Correl, D.S., B.G. Schubert, H.S. Gentry and Hawley, W. D. 1955: The search for plant precursors of cortisone, Econ. Bot., 9: 307-375.
7. Eka O.U., 1998: Roots and tubers. In: Nutritional quality of plant foods (A.U. Osagie and O.U. Eka, editors). Post Harvest Research Unit, Department of Biochemistry, University of Benin, Benin City, Nigeria, pp: 1-31.
8. Eka, O.U., 1985: The chemical composition of yam tubers. In: Advances in yam research: The biochemistry and technology of yam tubers (I.G. O. Osuji, editor): Published by the Biochemical Society of Nigeria in collaboration with Anambra State University of Technology, Enugu, Nigeria, pp: 51-75.
9. Ezeh, N.O.A., 1991. Economics of seed yam production from minisetts in Umudike, Southeastern Nigeria: Implications for commercial growers. In: Proceedings, ninth Symposium of International Society of Tropical Root Crops, Accra, Ghana 20-26 October, 1991. F. Ofori and S.K. Hahn, editors, pp: 378-381.
10. Fergusion, T.U. and F.A. Gumbs, 1976. Effect of soil compaction on leaf number and area and tuber yield of white Lisbon yam. In: Proceedings Fourth Symposium of International Society Of Tropical Root Crops. J. Cock, R. MacIntyre and M. Graham, editors. CIAT, Cali, Colombia IDRC-080e, pp: 89-93.
11. Ichikawa, Tadashi and Ota, Yasuo, 1982. Effect of Pyroligneous acid on the growth of rice seedlings. Japan Journal Crop Sci., 51(1): 14-17.
12. IITA, Annual report, 2000: Ibadan, Nigeria.
13. Iwueke C.C., 1989. "Adoption Behaviour of Farmers toward Yam Minisett Technique in Imo state, Nigeria". Paper presented at the 25th Annual Conference of Agricultural Society of Nigeria, Federal University of Technology, Owerri, September., pp: 5-6.
14. Kikuno, H., Muamba Kabeya., Shiwachi, H., Micho Onjo and Asiedu, R. March, 2006. Mini tuber production of white yam (*D. rotundata*) using vines: Japanese Journal of Tropical Agriculture 50 extra issue., 1: 1-3.
15. Komaki, Y., A. Nakano, H. Katoh and Y. Uehara, 2002. Utilization of chaff charcoal for medium of flower bed seedlings and its effect on growth and quality of Madagascar periwinkle (*Catharanthus roseus* G. Don) seedlings. Japanese Journal of Soil Science and Plant Nutrition., 73: 49-52.

16. Njoku, E., 1963: The propagation of Yams (*Dioscorea* spp.) by vine cutting, J. West Afr. Sci. Assoc., 8(1): 29-32.
17. Nweke, F.I., E.C. Okorji, J.E. Njoku and D.J. Kling, 1994. Expenditure elasticity of demand for major food items in Southeast Nigeria. Tropical Agriculture (Trinidad), 71(3): 229-234.
18. Okoli, O.O. and M.O. Akoroda, 1995. Providing seed tubers for the production of food yams. African Journal of Root and Tuber Crops, 1: 1-6.
19. Okonkwo, S.N.C., 1985. The botany of the yam plant and its exploitation in enhanced productivity of the crop. In: Advances in Yam Research: The biochemistry and technology of the yam tuber. G. Osuji, ed. Biochemical Society of Nigeria and Anambra State University of Technology, pp: 3-29.
20. Orkwor, G.C. and I.J. Ekanayake, 1998. Growth and development. In: food yams: Advances in Research (eds. G.C. Orkwor, R. Asiedu, and I.J. Ekanayake) IITA/NRCRI, Ibadan, Nigeria, pp: 249.
21. Scott, G.J., R. Best, M. Rosegrant and M. Bokanga, 2000. Roots and tubers in the global food systems: A vision statement to the year 2020 (including annex): A co-publication of the International Potato Center (CIP), Centro International de Agricultural Tropical (CIAT), international Food Policy Research Institute (IFPRI), International Institute of Tropical Agriculture (IITA), and International Plant Genetic Resources Institute (IPGRI): Printed in Lima, Peru: International Potato Center, pp: 111.
22. Shiwachi, H., H. Kikuno, R. Asiedu, 2005. Micro tuber production using yam (D. rotundata) vines: Tropical Science, 45(4): 163-169.
23. Suja, G., V.M. Nair, P. Saraswathy, Geetha, V.L, Kumari, 2003. Influence of growth – promoting substances on sprouting of white yam (*Dioscorea rotundata*) setts. Tropical Science, 43(4): 170-173.
24. Vander Zaag, P. and R.L. Fox, 1981. Field production of yams (*Dioscorea alata)* from stem cuttings. Tropical Agriculture, 58: 143-145.