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Vine cuttings as a versatile means to propagate yams (*Dioscorea* spp.) and save more tubers for food

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Introduction

Yam is an important economic crop in West Africa where more than 96% of world production takes place. It is customarily propagated vegetatively using tubers, which would otherwise be food to millions of people in the region. The average yield of 10 t/ha is low compared to a potential of up to 50 t/ha. The reasons for low productivity are mainly related to the quality of planting material:

1. The use of predominantly farmer-saved seeds (one-third of harvest) that are highly infected with viruses,
2. The traditional tuber-based methods of production have low rates of multiplication (1:3-5), limiting the availability of improved varieties.
3. Seed yam is the most expensive input and could be 60% of production cost.
4. About 30% of the harvest is reserved as seed for the subsequent crop.

Research at the International Institute of Tropical Agriculture (IITA) has developed new methods to rapidly propagate yam using virus-free vines. Some of the techniques and results obtained are presented.

Objectives

1. To improve the multiplication rate of yam and quality of seed tubers.
2. Study the potential of nodal cuttings in seed yam production using different systems.

Materials and Methods

Yam plant meristems were cleaned of virus (YMV) using thermotherapy and meristem culture (Balogun et al., 2017), followed by scale-up propagation in Temporary Immersion Bioreactor System (TIBS). Hardened TIBS plants served as initial planting materials and nodal cuttings were used in different propagation methods as follows:

1. Temporary Immersion Bioreactor System (TIBS) using meristems tissue culture (Balogun et al., 2017).
2. Aeroponics System (AS) using TIBS plantlets or 2-node cuttings (Maroya et al., 2014).
3. Other hydroponics systems using plantlets or 1-node cuttings and different substrates such as sand (sandponics), cocopeat, and rice husk.

Results and Discussion

The results of the series of trials carried out to improve the yam seed system by increasing the multiplication rate is presented mostly as visuals to show the possibilities. After cleaning the plant from virus its potential in multiplication is highly enhanced whether using vines or tubers. It was confirmed that yam multiplication using vines was faster (1:300 in TIBS and AS) than when seed tubers are used as in traditional systems (1:3-5) (Aighewi et al. 2014). More robust plantlets are produced in TIBS than in conventional tissue culture (Fig. 1).

Virus-free plantlets from the TIBS were used to establish plants in the AS in a screenhouse, thus maintaining the quality of plants. With proper nourishment and crop husbandry, the establishment of nodal cuttings was maintained at more than 95% survival in the screenhouse and outdoor on beds (Fig. 2-3).

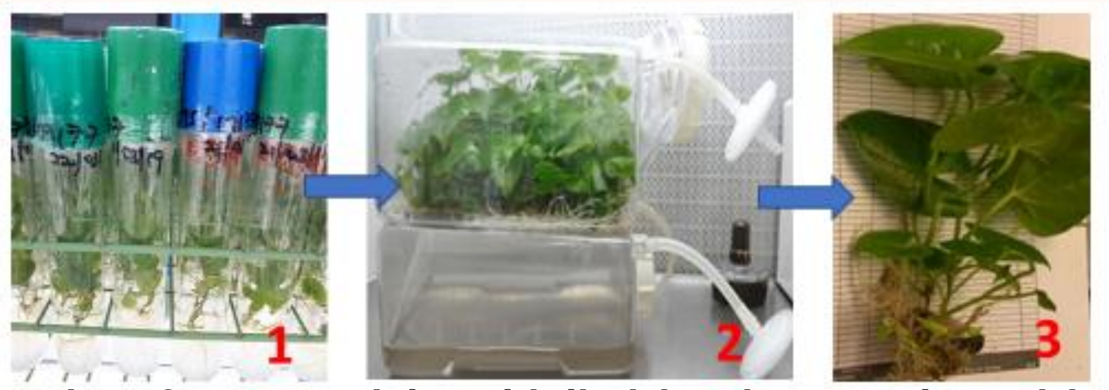

Figure 1: Virus-free material multiplied by tissue culture (1) and in vitro nodal cuttings in Temporary Immersion Bioreactors (2); plantlets produced after 10 weeks (3).

The AS can be fed with plantlets from TIBS (Fig. 1) or 2-node vine cuttings from potted mother plants (Fig 3). In 2018, single-node seedlings from the AS plants were transplanted on 5 ha of research land at IITA, Ibadan with more than 92% establishment. Six months after planting (MAP), over 30% of the tubers harvested weighed > 1 kg, with up to 6 Kg tuber harvested 8 MAP. The yields were 4-18 t/ha (Fig.2).

Figure 2: An Aeroponics System (AS) with foliage ready for cutting (1); rooted nodal cuttings (2), cuttings transplanted to the field (3) and tubers harvested (4)

Plant establishment in different substrates at 12 weeks after planting (WAP) using a nutrient solution was 90.1%, 91.5 and 93% for sand (sandponics), rice husk and cocopeat, respectively. The cocopeat substrate was observed to retain the nutrient solution for a longer period than the other substrates. Plants in cocopeat produced the longest vines (136.5 cm), most leaves (49) and largest tuber (334 g) (Fig. 3).

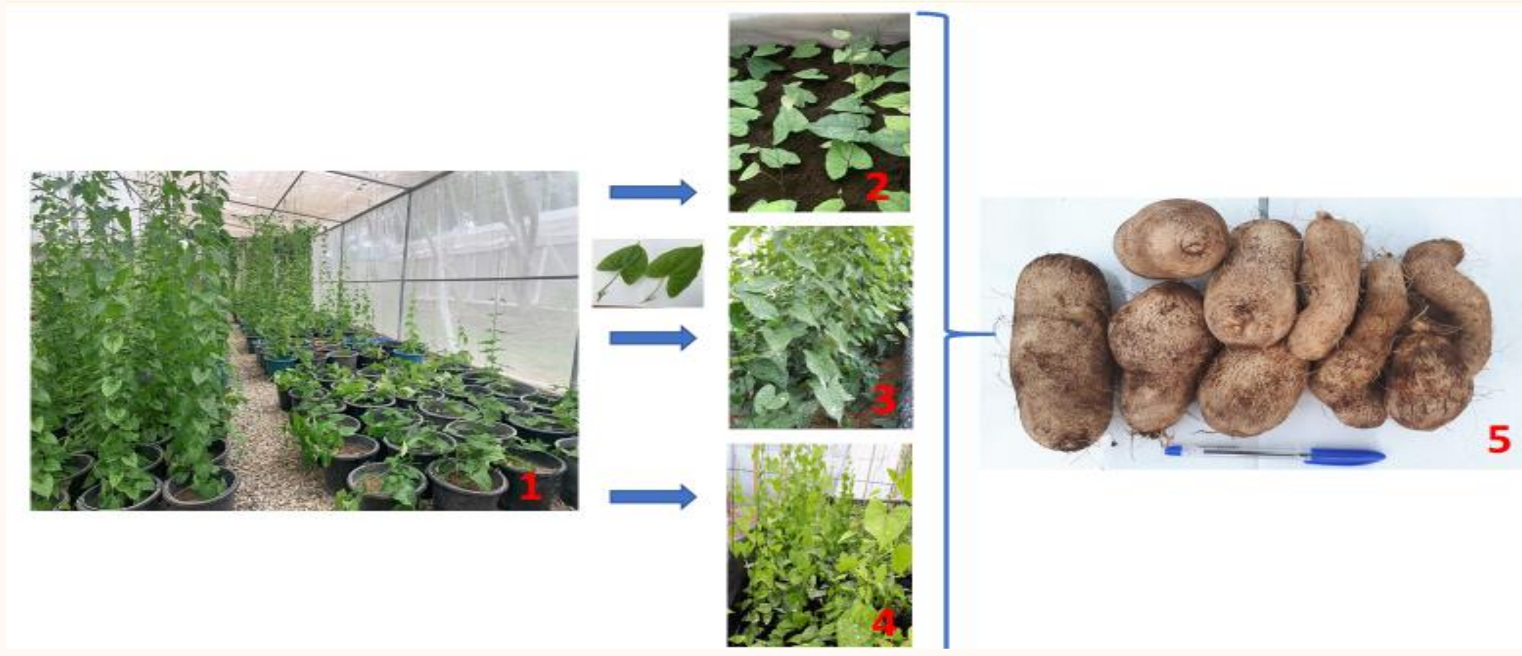

Figure 3: Mother plants to supply vines (1); nodal vine cuttings planted in cocopeat (2), river sand (3) and rice husk (4); tubers harvested at 4 months (5).

Single-node vine cuttings can be planted in different types of containers to get more vines or minitubers. The bigger the receptacle, the bigger the potential size of tuber or foliage (Fig 4).

Figure 4: Single-node cuttings growing in layered slit PVC pipes (1); polystyrene seed trays (2) slit bamboo (3) and rolled polythene sheet (4).

Plants grown to maturity in polystyrene seed trays produced minitubers of 1 – 6 g. Even without the formation of shoots, the single leaf plants produced tubers. The minitubers can be planted in the field, after the break of dormancy, to produce tubers of up to 1 kg (Fig 5).

Figure 5: Plants grown to maturity in polystyrene seed trays (1); minitubers from the seed trays (2) plants from minitubers (3) harvest from minitubers (4).

Nodal cuttings planted directly in beds outdoors and provided with shade until establishment (4 weeks) also had more than 90% establishment (Fig. 6). Four months after planting, tuber yields of 2.8, 1.7 and 1.2 Kg/m2 were recorded for plant spacings of 10x10 cm, 20x10 cm and 30x10 cm, respectively. Mean tuber weights were 26-37 g with up to 200 g recorded.

Figure 6: Newly planted 1-node yam vine cuttings in outdoor beds (1); young shoots three weeks after planting (WAP) (2); full canopy at 12 WAP (3) harvested tubers at 16 WAP (4).

It should be noted that after vines are harvested from mother plants new shoots are produced for another multiplication cycle.

Conclusion

The above results clearly point to the versatility of using yam vine cuttings in yam propagation. Depending on the need and type of structures or inputs available, different sizes of tuber can be produced with a greatly enhanced rate of multiplication. A focus on yam propagation with vine cuttings will release more tubers for food.

References

- Aighewi B. A., R. Asiedu, N. Maroya and M. Balogun. 2015. Improved propagation methods to raise the productivity of yam (*Dioscorea rotundata* Poir.) *Food Security*, DOI 10.1007/s12571-015-0481-6.
- Balogun M, Maroya N, Taiwo J, Ossai C, Ajayi A, Kumar L, Pelemo O, Aighewi B and Asiedu R. (2017b). Clean Breeder Seed Yam Tuber Production using Temporary Immersion Bioreactors. 66 pp. ISBN 978-978-8444-89-3.
- Maroya N, Balogun M, Asiedu R, Aighewi B, Kumar L and Augusto J (2014) Yam propagation using aeroponics technology. Ann. Res & Rev in Biology, 424: 3849-3903.

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