INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2006/08–1–73–75
http://www.fspublishers.org

Induction of Multiple Tuberization in Yam (*Dioscorea* spp.) using Ethephon

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ABSTRACT

A study was conducted to assess the potential of ethephon to induce multiple tuber formation in yams. The head, middle and tail portions of freshly harvested yam (*Dioscorea rotundata*) were treated with ethephon (2-chloroethylphosphonic acid) solution at 0.5, 1 and 2% concentrations and air dried. The yam samples were sprouted in the nursery and planted in the field. Yam sets treated with ethephon had increased number of sprouts on all portions but reduced vine length. The number of leaves/vine was reduced by higher concentrations of ethephon. Sets from the middle section of the tuber produced the highest number of tubers when treated with the plant growth regulator. Ethephon concentration of 0.5% was the most effective at inducing multiple tuber formation.

Key Words: *Dioscorea rotundata*; Ethephon; Miniset; Multiple tuberization; Yam.

INTRODUCTION

Yams (*Dioscorea* Spp) are important in the farming systems as well as in the traditional cultures of several countries. All the major species of yam are indigenous to Africa, particularly West and Central Africa, which produces over 80% of the world's production (NARP, 1993). Yam production has been on the decline despite the increasing demand for local consumption and for export. Some of the constraints to yam production is the unavailability of planting material, poor handling and storability (Tetteh & Saakwa, 2004). Tubers of yam are bulky, may weigh from 5 to 25 kg, expensive and relatively unaffordable. Retailers of yam therefore cut the tuber into pieces to make it affordable to different categories of consumers. However, cut tubers have a short shelf-life. The marketing system is a linkage between scattered farms in producing areas through a hierarchy of local markets to more distant urban centers (Gray, 1996). Each individual tuber passes through cycles of stacking, loading and transportation, unloading and grading by series of transporters and traders. The size of tubers becomes very critical in the process with bigger tubers being more prone to destruction. Furthermore, consumers prefer small to medium size yams over larger size tubers.

The yam mini set approach is pragmatic in solving the problem of scarcity of planting material as well as producing yams of sizes that are easily handled by producers and consumers (Kalu, 1989). However, sometimes the failure of sets to sprout uniformly or delay in sprouting due to dormancy of tubers hampers the effective use of this technology. Ethylene is a plant growth regulator involved in the modulation of a number of processes throughout the life cycle of plants from seedling development to flowering and senescence (Abeles *et al*., 1992; Reid, 1995). Ethephon (2-chloroethylphosphonic acid), an ethylene releasing agent, has been used to induce sprouting in potato (Sisler & Serek, 1996). Ethephon treatment increased the number of tubers produced per plant although mean tuber weight was reduced. The objective of the study was to examine the potential of using ethephon to induce sprouting and multiple tuber formation in yam.

MATERIALS AND METHODS

Yam stored for three months at room temperature were cut into sets (50 g each) from the head, middle and tail portions of harvested tubers of white Guinea yam (Dioscorea rotundata). The cut surfaces of the sets were initially treated with a wood ash mixture, containing an insecticide (Cymethoate @ 2 mL L^{-1}), fungicide (Dithane M45 @ 5 g L^{-1}) and wood ash at 5 g L^{-1} water and air-dried for 24 hours. To induce sprouting 50 sets each were dipped in ethephon solutions of different concentrations (0.5 %, 1% and 2%), for one hour. As a control, another 50 sets were dipped in water. The air-dried sets were nursed in separate baskets containing moist heat-sterilized sawdust in the green house.

Sprouted sets were planted at a spacing of 50 cm on ridges (mulched with straw) spaced at 1m apart. The experimental layout was a randomized complete block design with four replications. Watering and hand weed control were done as and when necessary. Wooden poles about 2 m high were provided as vine support and Actellic 25 EC was sprayed to control insect defoliators at a rate of 2 mL L^{-1} of water. Data recorded from both the nursery and field experiments included: number of sprouts, number of roots, length of vines at 8 weeks, number of leaves/vine and number of tubers harvested. Analysis of variance (ANOVA) was carried out on the data and means separated by Least Significant Difference (LSD) procedure.

RESULTS AND DISCUSSION

Plant growth and development is controlled by endogenous plant hormones. In general, the application of lower concentration of ethephon hastened sprouting. Sets from the middle portion of the tuber treated with 0.5% ethephon sprouted earlier than those with 2% ethephon (data not presented). Minisets from different sections of a yam tuber show varying rates of sprouting (IITA, 1992). The color of leaves on plants treated with 2% ethephon both in nursery and field was pale till about three weeks after treatment. This may be due to enhanced chlorophyll degradation by ethephon. Ethylene is known to break down chlorophyll by stimulating chlorophyllase activity (Trebitsh, 1993). An increase rate of ethylene production with increasing senescence has been reported for oat leaves cotton leaves (Morgan *et al*., 1992).

Ethephon increased the number of sprouts on sets from all portions (head, middle and tail) of yam sets. However, there were no significant differences in the number of sprouts among sets dipped in different concentrations of ethephon (Table I). Ndzana *et al.* (1992) reported that the middle section of yam sprouted uniformly and had the highest number of sprouts. In the current study, it was observed that mini sets from different portions of the yam responded differently to ethephon. Those from the middle portion and treated with 0.5% ethephon had more sprouts that the other portions. These could be due to unequal concentration of endogenous hormones in the various portions of the yam tuber (Ndzana *et al*., 1992). Higher concentrations of ethephon reduced sprouting of yam sets. The suppression of sprouting on yam sets by 2% ethephon in this experiment could be due to the suppression of the sub-apical meristematic activity (De Wilde, 1971).

Ethephon promoted the early emergence and increased the number of roots on yam sets (Table I). Treating sets with higher concentration of ethephon was more effective at stimulating root formation. Ethylene treatment is reported to play a regulatory role in the initiation of adventitious roots (Visser *et al*., 1996; Zaid *et al*., 2003). This suggests that the growth regulator might be acting directly on the tuber meristem to stimulate cell division and root initiation associated with normal root development Wickham *et al.* (1984 a, b). Length of the vines on ethephon treated sets (Table I) was relatively reduced. The length of vines decreased with increased concentration of ethephon in both the nursery and field. The application of growth regulators has been reported to reduce vine length (Kabir *et al*., 1989).The effect was concentration dependent and the magnitude of reduction was independent of the portion of set.

Table I. Effect of ethephon on growth in the nursery at 8 weeks after planting and yield

Ethephon (%)	Section of yam		
	Head	**Middle**	**Tail**
		Mean number of sprouts/set	
0.0	1.3	1.1	1.2
0.5	2.4	2.6	2.3
1.0	1.8	1.8	2.0
2.0	1.7	1.6	1.6
LSD (5%)	NS	NS	NS
		Number of roots/set	
0.0	4.0	5.0	3.3
0.5	8.0	10.3	7.1
1.0	6.0	8.5	6.4
2.0	6.2	6.2	5.5
LSD (5%)	2.1	4.4	3.8
		Mean length of vine /set	
0.0	27	37	29
0.5	25	36	32
1.0	22	24	26
2.0	18	22	25
LSD (5%)	6.1	8.5	6.9
		Mean number of leaves/vine	
0.0	7.0	8.0	7.0
0.5	9.0	10.0	8.0
1.0	8.0	9.0	7.0
2.0	6.0	7.0	6.0
LSD (5%)	NS	NS	NS
		Mean number of tubers/set	
0.0	1.0	1.0	1.0
0.5	2.4	3.3	2.0
1.0	2.0	2.3	1.8
2.0	1.8	1.7	1.0
LSD (5%)	NS	0.5	NS

There were no significant differences in the number of leaves among the various portions of sets treated with ethephon though sets treated with 0.5% ethephon had more leaves (Table I). The observed effect of ethephon on the number of leaves on vine may be attributed to the growth regulator suppressing sub-apical meristematic activity at high concentration, thus, inhibiting terminal vine growth (De Wilde, 1971). The mean number of tubers produced /set was significantly increased by treating sets with 0.5% ethephon (Table I). Treated sets, especially those from the middle section of the tuber, produced more tubers with lower ethephon concentration than at higher concentrations (Table I).

The higher number of leaves on vines of sets treated with lower concentration of ethephon might have produced more photosynthates to support tuber development. As stated earlier, the leaves on vines of sets treated with 2% ethephon were pale and possibly did not produce enough photoassimilate to support tuber development thereby reducing the number of tubers. In conclusion, ethephon, at 0.5% level promoted multiple sprouting on all portions (head, middle and tail) of freshly harvested tubers and could be used to induce multiple tuber formation in yams.

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(Received 11 October 2005; Accepted 20 December 2005)