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Full Length Research Paper

Enhancing off-season yam production in Nigeria

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Yam cultivation in dry season was tested in the farmer's field at inland valley in Niger state, Nigeria. Water yam (*Dioscorea alata*) variety TDa 95/00328 had the greater response to the gibberellin inhibitor prohexadione-calcium (PC). The sprouting period of PC treated tuber was 21 – 27 days at December. After tuber sprouting, the plants grew in the field during January to September. Shorter sprouting period was not observed in the harvested tuber. Demand of ware yam production during off-season for yam cultivation is high in West Africa. Although yield through this cultivation was smaller than rainy season yam cultivation. The dry season yam cultivation using the gibberellin inhibitors could be new option of intensive yam cultivation technique.

Key words: *Dioscorea alata,* dormancy, gibberellin inhibitors, off-season production, yams.

INTRODUCTION

Cultivation of yams (*Dioscorea* spp.) has been expanding in West Africa but the traditional production systems are under increasing pressure to adapt to short fallow periods owing to limited availability of new lands to support shift-ing cultivation (Manyong et al., 1996). To meet increasing demand for food yams due to increasing population, more intensive production systems are now necessary.

Yam tuber has dormancy; it is an important mechanism for ecological adaptation of yams. Life cycles, the lengths of growth and dormancy of yams are closely adjusted to seasonal changes (Craufurd et al., 2001) . On the other hand, the yam tuber dormancy has limited planting period of yam seed tubers and year round production.

Endogenous gibberellins (GAs) have been implicated in the tuber of dormancy mechanism in water yam (*D. alata*) (Park et al., 2003a; 2003b). The duration of tuber dor-mancy period of *D. alata* has been prolonged by GA_3 and shortened by gibberellin inhibitors (Nnodu and Alozie, 1992; Girardin et al., 1998; Onjo et al., 2001). Gibberellin inhibitors, uniconazole-P [(E)-(S)-1-(4-chlorophenyl)-4, 4-dimethyl-2-(1H-1, 2, 4-triazol-1-yl) pent-1-en-3-ol] and varieties of *D. alata* (Shiwachi et al., 2003a; 2003b).

The objective of this study was to study the feasibility of producing yams in dry season in Nigeria using *D. alata* varieties and Prohexadione Calcium.

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MATERIALS AND METHODS

Three experiments were carried out at the IITA, Ibadan and Niger state, Nigeria from April 2002 to September 2004 using two varie-ties of *D. alata*, TDa 95/00328 and TDa 99/00049 obtained from the Institute's germplasm collection.

In experiment 1, the yam tubers of TDa 95/00328 and TDa 99/00049 were cut into mini -sett (small seed yam) sizes of between 25 to 30 g and the seeds dusted with wood ash, and left in the shade for one day to dry the cut surfaces. Mini-setts of two yam varieties were planted in the field of Ibadan at a population of 4×10^4 ha $^{-1}$ (0.25 x 1 m spacing) on April 2002. Fallow land was used for this experiment. Air temperature during the experiments was about the same level as an average year for the site (between 24 and 31°C) . The rainfall during the dry season was recorded from December 2002 to March 2003 (Table 1).

After plants had senesced, tubers were harvested and soaked in 10 mg l^{-1} of PC for 24 h on 18 December 2002. The PC solution was prepared from bibiful Furoabul (Prohexadione-calcium content of 10 g kg^{-1} , Kumiai Chemical Co., Japan). The concentration of PC was based on those of Shiwachi et al. (2003a). Fifty whole tubers weighing 200 - 300 g of each variety were washed, air-dried for 24 h, and buried in shredded coir (coco-peat) in a growth chamber at 30°C, 24 h dark. Tubers from the same varieties were soaked in water at the same time as for PC and kept in 24 h dark on shelves in a yam tuber storage barn (yam barn) at ambient air temperature and under natural light to serve as controls. The relative humidity in growth chamber was higher than 85%. The mean monthly air temperatures in the yam barn from November 2002 to April 2003 were 26.2, 25.3, 25.8, 27.2, 28.4 and 26.5°C, respectively. Water was supplied every 7 days to prevent drying of the coco-peat. Tuber sprouting was observed every day. Sprouting was said to have occurred if a tuber had a bud 3 mm long. The period of sprout-ing was taken as the time from harvest to when the sprouting rate

Table 1. Temperature and rainfall in dry season during experiment at the IITA Ibadan.

	2002		2003			
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Temperature (°C)						
Max.	31.8	33.0	33.1	34.2	34.8	32.0
Min.	22.5	19.7	20.7	23.6	24.0	22.5
Ave.	27.2	26.3	26.9	28.9	29.4	27.2
Rainfall (mm)	34	0	22	77	15	125

Table 2. Period (days) from harvest to tuber sprouting of tuber soaked in PC and stored under different conditions on TDa 99/00049 and TDa 95/00328.

Variety	Treatment	
Accession code	Yam barn (control)	Soaking* + 30 °C†
TDa 99/00049	84.0 ± 7.0	42.0 ± 0
TDa 95/00328	77.0 ± 7.0	21.0 ± 0
Mean	73.5	31.5

*: Soaking; tubers were soaked in PC (prohexadione-calcium).
†: 30 °C; Constant temperature in growth chamber.
Yam barn: yam tuber storage barn (ambient air temperature).

reached up to 80% (Shiwachi et al., 2003a).

The sprouted 40 tubers of each variety were planted in the field of IITA on 30 January 2003, 0.5 m apart in ridges and 1 m between rows. The yams planted plots were supplied with NPK 15-15- 15 fer-tilizer at 7.5 kg per 100 m^2 placed along a drilled base of the ridges and covered with soil. Weeding and watering was done as necessary. Samples of five plants from each variety were harvested at one month intervals. At each sampling, the roots were washed with water and each plant was divided into leaves (petioles included), vines, roots, and tubers. Each portion was weighed and dried at 80°C for four days.

In experiment 2, mini-setts of the TDa 95/00328 variety were planted on April 2002 and 2003 in the same field as experiment 1. After plants had senesced, tubers were harvested on 18 December 2002 and 15 December 2003, and soaked in PC solution as experiment 1. Seventy five whole tubers weighing 200 - 300 g were selected in each year. The treated tubers were buried in coco-peat boxes and kept, and sprouting was determined as in experiment 1. The sprouted tubers were planted in the field of Bida, Niger state, Nigeria (at Guinea savanna zone, average rainfall 1000 – 1200 mm / year, dry season in November to April) on 20 January 2003 by three farmers and 22 January 2004 by four farmers, 1 m apart in ridges and 1 m between rows. The yam cultivated land in inland valley had available water from stream or groundwater that was the flood plain of small rivers, rice farming (September to December) in the rainy season using rainfalls or irrigation canal. Chemical fertilizer was not applied, it was traditional cultivation method. Weeding and watering was done as necessary. Harvesting was done, and fresh tuber weight was recorded on September 2003 and 2004.

In experiment 3, harvested tubers of the TDa 95/00328 variety from farmer's field at Bida on September 2004 were used in this experiment. Tubers were cut into mini-setts (50 to 75 g) were made 235 seed tubers. These were planted on January 2005 in the same field of three farmers as experiment 2. Chemical fertilizer was not applied. Weeding and watering was done as necessary. Harvesting was done on September 2005 as experiment 2.

RESULTS AND DISCUSSION

In experiment 1, the period from harvest to tuber sprouting (sprouting period) of soaked tuber from TDa 99/00049 and TDa 95/00328 were shorter than untreated tubers (control) (Table 2) . Traditionally, yam tubers are stored in yam burn or cool places such as live shade under the tree. The period of tuber dormancy was shortened by storage at 30^{O}C constant temperature in most of yam varieties (Shiwachi et al., 2003a, 2003b, 2005). Therefore, possibility of shortest period of tuber dormancy in tuber was tested in this experiment using PC at 30^{O}C constant temperature. The mean sprouting period of soaked tubers in two varieties was 31.5 days, and 73.5 days in the control. But the response to tuber sprouting by PC was different between varieties. The sprouting period of soaked tuber of TDa 95/00328 was shorter than tuber of TDa 99/00049. The mean sprouting period of TDa 95/00328 and TDa 99/00049 were 21 and 42 days respectively. The variable responses of varieties of *D. alata* to PC are in line with the results of Shiwachi et al. (2003a). TDa 95/00328 had the greater response.

Sprouted plants of the both varieties were grown in dry season. The rate of growth of top (shoot and leaves) and tuber was slow till March (Figure 1 and 2). But from April, top was rapidly grown up; maximum top weight was observed at July in the both varieties. On the other hand, the tuber growth changed from June, the tuber weight had biggest at harvesting on August in the both varieties. Mean fresh weight of tuber at harvest in TDa 99/00049 and TDa 95/00328 were about 3.7 and 1.7 kg respect-

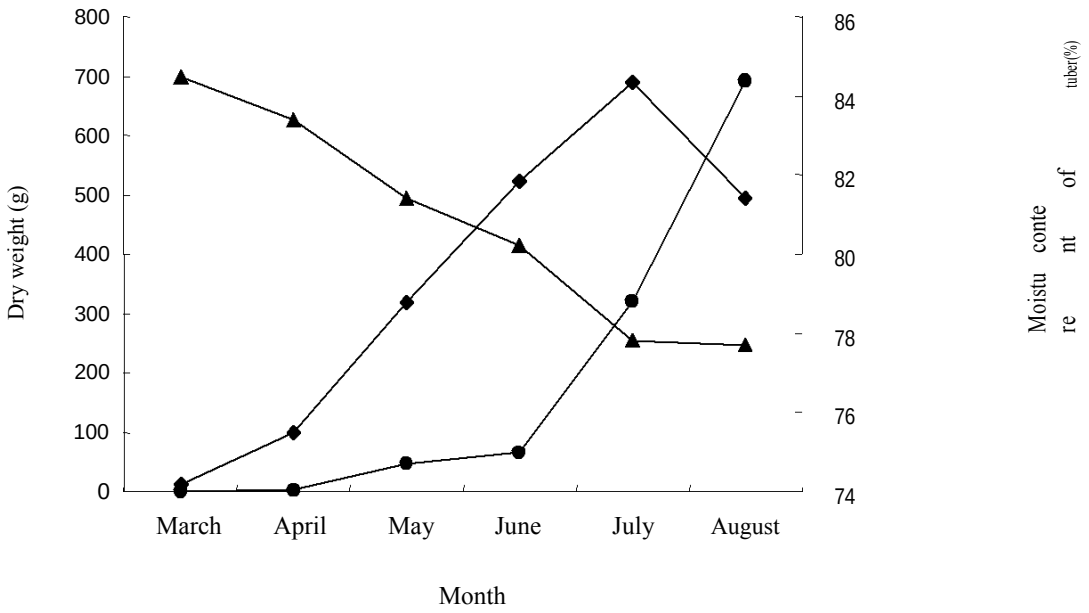

Figure 1. Changes in growth and moisture content of tubers of TDa 99/00049.

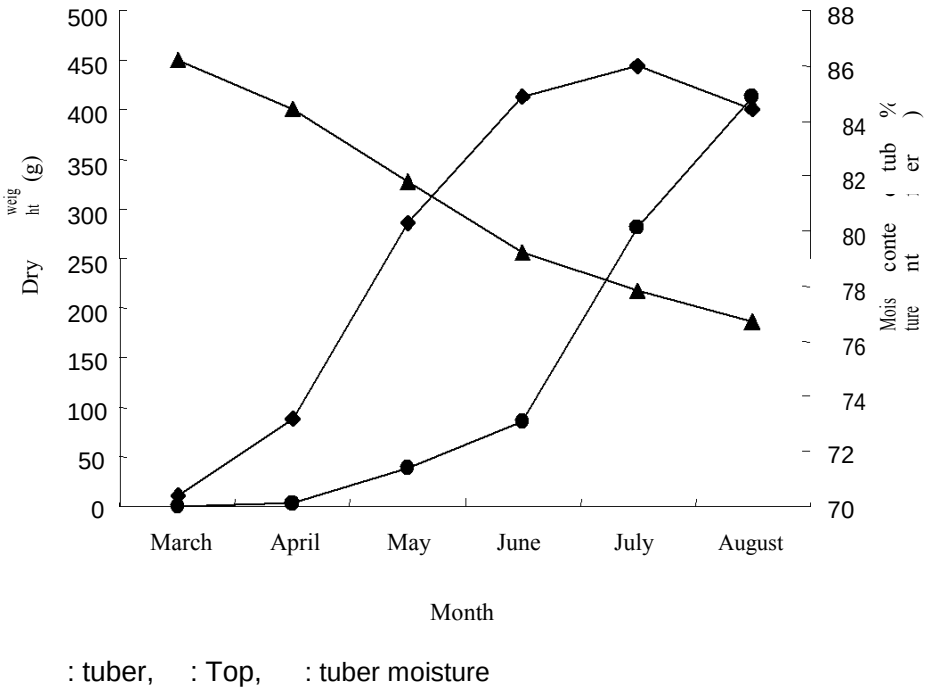

Figure 2. Changes in growth and moisture content of tubers of TDa 95/00328.

Moisture content of tubers in TDa 99/00049 and TDa 95/00328 at the harvest time was 76.7 and 77.7% respectively. Harvested tubers could be use as ware yam for the market.

In experiment 2, TDa 95/00328 variety was used, because of this variety had the greatest response to PC. The sprouting period of tubers in TDa 95/00328 treated with PC as experiment 1 was 21 days in 2002, and 27

Table 3. Yield of TDa 95/00328 on dry season yam production in 2003 and 2004.

Farmer	No. of seed tuber provided	No. of plant survived	Plant survived (%)	Total yield (kg)	Fresh tuber weight (kg) /plant
2003					
A	20	18	90.0	15.9	0.9
B	40	37	92.5	41.8	1.1
C	15	15	100.0	51.9	3.5
Total or average yield	75	70	94.2 ± 5.2	109.6	1.8 ± 1.4
2004					
D	7	7	100.0	5.1	0.7
E	19	19	100.0	13.0	0.7
F	22	22	100.0	44.0	2.0
G	27	27	100.0	76.4	2.8
Total or average yield	75	75	100.0	138.5	1.6 ± 1.0

Table 4. Yield of TDa 95/00328 on dry season yam production in 2005.

Farmer	No. of seed tuber provided	No. of plant survived	Plant survived (%)	Total yield (kg)	Yield (kg) /plant
H	40	39	97.5	35.3	0.9
I	165	159	96.4	126.9	0.8
J	30	27	90.0	30.5	1.1
Total or average yield	235	225	94.6 ± 4.1	192.7	0.9 ± 0.2

days in 2003. The sprouted tubers were planted, and the plants were successfully grown in the field of Bida, 94.2 and 100% of total plants were harvested on September in 2003 and 2004 respectively (Table 3). Total tuber yield from 75 seed tubers in 2003 and 2004 were 109.6 and 138.5 kg respectively. Fresh tuber weight per plant was varied 0.9 to 3.5 kg in 2003 and 0.7 to 2.8 kg in 2004 at farmer. It was not clear that tuber yield was varied among farmers in this experiment. However, farmer's skill, location, cultivated condition for yam production may have effect on yam tuber yield.

In experiment 3, TDa95/00328 variety plants harvested on September 2004, and harvested tubers began to sprout in December 2004. Sprouting period of this variety was similar with control tuber as experiment 1. Continuously the sprouted tubers were planted in the field of Bida on January 2005. The plants 94.6% of total were harvested on September in 2005 (Table 4) . From this cul-tivation, total yield was recorded 192.7 kg by 225 plants. Fresh tuber weight per plant varied from 0.9 to 1.1 kg at farmer. Produced tubers were smaller than one of the experiment 2, this may be due to the smaller sett sizes used in Experiment 3. Enough size for seed tuber was developed on this system.

Yam cultivation in dry season is not well established, especially using tuber dormancy control technique. This is first trial using gibberellin inhibitor in cultivation which is new intensive production systems in yam. The demand of ware yam production is high in off-season yam production. Although milking technique that tubers are twice harvested during and end of cultivation has been very common in Ghana. The off-season yam cultivation using the gibberellin inhibitors could be next option. The variety TDa 95/00328 used showed scarce yield, the protocol for off-season yam cultivation should be developed and the varieties might be select with high response to the gibberellin inhibitors and high yield.

REFERENCES

Craufurd PQ, Summerfield RJ, Asiedu R, Vara Prasad PV (2001). Dormancy in yams. Exp. Agric. 37: 75-109.

Girardin O, Nindjin C, Farah Z, Escher F, Stamp P, Otokoré D (1998). Use of gibberellic acid to prolong dormancy and reduce losses during traditional storage of yam. J. Sci. Food and Agric. 77: 172-178.

Manyong VM, Smith J, Weber G, Jagtap SS, Oyewole B (1996). Macro -characterization of agricultural systems in West Africa. An overview. Resource and Crop Management Monograph No 21, IITA, Ibadan, Nigeria.

Nnodu EC, Alozie SO (1992). Using gibberellic acid to control sprouting of yam tubers. Trop. Agric. 69: 329-332.

Onjo M, Hayashi M (2001). Effects of gibberellins, abscisic acid and uni-

conazole-P on growth of water yam (*Dioscorea alata L*.). Japanese J. of Trop. Agric. 45: 133-141.
Park B, Onjo M, Tominaga S, Shiwachi H, Hayashi M (2003a). Relationship between the dormancy and its release and external factors in tubers of water yam (*Dioscorea alata* L.). Japanese J. of Trop. Agric. 47: 42-50.
Park B, Onjo M, Tominaga S, Shiwachi H, Hayashi M (2003b). Relationship between the release of dormancy and the activity of endogenous gibberellins in the tubers of water yam (*Dioscorea alata* L.). Japanese J. of Trop. Agric. 47: 51-57.
Shiwachi H, Ayankanmi T, Asiedu R, Onjo M (2003a). Induction of sprouting in dormant yam (*Dioscorea* spp.) tubers with inhibitors of gibberellins. Exp. Agric. 39: 209-217.
Shiwachi H, Ayankanmi T, Asiedu R, Onjo M (2003b). lnfluence of exogenous gibberellin inhibitors on tuber sprouting in yam (*Dioscorea* spp.). Tropical Sci. 43: 147-151.
Shiwachi H, Kikuno H, Asiedu R, Onjo M, Toyohara H (2005). Effect of Ethephone and storage temperature on tuber sprouting in yams (*Dioscorea* spp.). J. ISSAAS. 11: 36-43.