African Journal of Plant Science Vol. 5(10), pp. 591-598, 27 September, 2011
Available online at http://www.academicjournals.org/AJPS
ISSN 1996-0824 ©2011 Academic Journals

Full Length Research Paper

Split crown technique for mass propagation of smooth Cayenne pineapple in South-South Nigeria

Agogbua Josephine U. and Osuji Julian O.*

Department of Plant Science and Biotechnology, University of Port Harcourt, P.M.B. 5323. Port Harcourt, Rivers State, Nigeria.

Accepted 15 June, 2011

A study was conducted to investigate the effect of apical meristem destruction on axillary bud growth of smooth cayenne pineapple in South-South Nigeria. Split crown technique (SCT) was used for the study in a randomized complete block design with four replicates and four treatments. The number of days to sucker emergence from the axillary buds were significantly different among the treatments ranging from 36.6 days to 48.8 days. The results indicated high apical dominance in the control with intact meristem (no sucker produced) while the crowns with destroyed meristem varied in their rate of sucker production. Crowns that were split into four had the highest number of suckers (543) than crowns split into two (375) during the period of study. Crowns with meristem destroyed without splitting produced the lowest number of suckers (166). It was also observed that sucker orientation during emergence differed among treatments. The study showed variable response of pineapple crowns to sucker production through macro-propagation. Splitting of crowns into four which gave the best result could be easily adopted by local farmers in Nigeria for plantlet multiplication and expansion of pineapple plantations.

Key words: *Ananas comosus,* split crown, propagation, apical meristem and axillary buds.

INTRODUCTION

The pineapple (*Ananas comosus* L. Merr.) belongs to the Bromeliaceae family which comprises about 2000 species (Purseglove, 1975). Pineapples have diverse uses to millions of Nigerians and are vegetative-propagated from crowns, or axillary shoots arising from either the base of the fruit (slips) or the base of the plant (suckers). In recent times, there has been increasing tendency towards large scale (that is, commercial) production of pineapple in the south-southern and south-eastern Nigeria by some state governments and private farmers.

A major problem to large scale commercial production of pineapple and/or expansion of few existing farms is the difficulty in obtaining uniform planting materials in large quantity due to low rate of multiplication by conventional methods and lack of high quality propagules. However, there are several types of planting materials for pineapple propagation which include:

(i) The use of slips arising from the stock beneath the fruit;
(ii) Suckers originating from leaf axils;
(iii) Crowns of the fruits;
(iv) Ratoons that come out of the underground part of the stems.

These conventional propagation materials are usually in short supply and inadequate to meet large scale production. The need for large number of planting materials such as those for commercial or industrial use is difficult to be achieved by conventional techniques, particularly when uniform planting material is needed.

*Corresponding author. E-mail: julian.osuji@uniport.edu.ng.

Thus, studies about alternative technologies for production of uniform planting material are of fundamental importance. One of the technologies that can be used for this purpose is the *in vitro* technique. The use of this technique has two advantages. It can be used to produce large number and uniform pineapple propagules in a relatively short period of time (Firoozabady et al., 2003), and can also be used to improve plant performances. Sripaoraya et al. (2003) reported that since cultivar improvement requires at least five years by sexual hybridization and selection, tissue culture-based technologies provide a crucial adjunction not only to conventional breeding but also for the propagation and genetic improvement. Plant tissue culture is a technique that has been used for rapid mass production of propagules of various plant species such as *Boerhaavia diffusa* (Biswas et al., 2009), *A. comosus* (Rahman et al., 2001; Firoozabady et al., 2003; Abul-Soad et al., 2006), *Scutellaria baicalensis* (Gao et al., 2002) and *Musa* species (Vuylsteke, 1998). Plants multiplied from tissue culture are healthy, vigorous and free from pest and diseases (Swennen, 1990), however, because it is a sophisticated method requires skilled labour force (Vuylsteke, 1998). Tissue culture as a method of generating planting materials is also capital intensive and is not a technology well developed in Nigeria. There is therefore need for the utilization of cost effective and simple techniques such as macropropagation (Lopez, 1994) to multiply crop plants. The use of macropropagation method for increasing sucker multiplication of plantains and bananas at farm level has been advanced in Nigeria (Baiyeri and Aba, 2005). A major advantage of the macropropagation technique is that it is not highly technical and does not require specialised skills. It is also very cost effective and can be used to produce large scale uniform material in a relatively short period of time (Adelaja, 2000). Therefore, this study aimed to evaluate the efficacy of apical meristem destruction on sucker production of smooth cayenne pineapple using a split crown technique (SCT).

MATERIALS AND METHODS

Experimental area

The experiment was conducted in a home garden located in Port Harcourt, between the months of April and October, 2009.

Plant material

Fresh crowns of smooth Cayenne pineapple cultivars which are normally detached and discarded after purchase of fruits were obtained from the fruit market in Diobu, located one mile from Port Harcourt and transported to the experimental area for preparation and planting.

Crown preparation and planting

A total of 240 crowns of the same weight were used for the experiment. All the crowns were subjected to four treatments (Figure 1) which included:

1) Control: Shoot apex intact;
2) Treatment 1(T1): Shoot apex destroyed without splitting crowns;
3) Treatment 2(T2): Shoot apex destroyed and crown split into two;
4) Treatment 3 (T3): Shoot apex destroyed and crown split into four.

Sixty crowns were used for each treatment and established in a randomized complete block design with four replications spaced at 20 × 20 cm. The crowns were planted on the 30th of April, 2009.

Selection of plantlets

The selection process consists in separating emerging suckers or plantlets from the mother plant or crown commenced two months after planting in the month of June. This step was performed by hand, through slight twist, followed by removal of the plantlet (Figure 2).

Transplanting of plantlets selected

Selected plantlets were potted in polybags with topsoil and left under a local nursery shade for further growth before field establishment (Figure 3).

Data collection and analysis

Data was collected on the weight of each crown prior to splitting and planting, number of days to the emergence of the first plantlets, presence or absence of roots, number of plantlets produced at the different periods of selection. It was also observed the emergence sucker orientation (either erect/clasping or divergent). The data was subjected to analysis of variance (ANOVA) to test for the significance of effects of treatment on the parameters measured. Differences between treatment means were compared using the least significant difference (LSD) test.

RESULTS

Crown weight

All the crowns used for the study had uniform weight of 300 g. There was no variation in the crown weight per treatment.

Number of days to sucker emergence

The number of days from planting to sucker emergence varied among the control treatments. The crowns that were split into four (T3) emerged in 36.625 days while crowns split into two emerged in 40.437 days. The crowns with meristem destroyed but without splitting (T1) emerged in 48.812 days while the control had no suckers

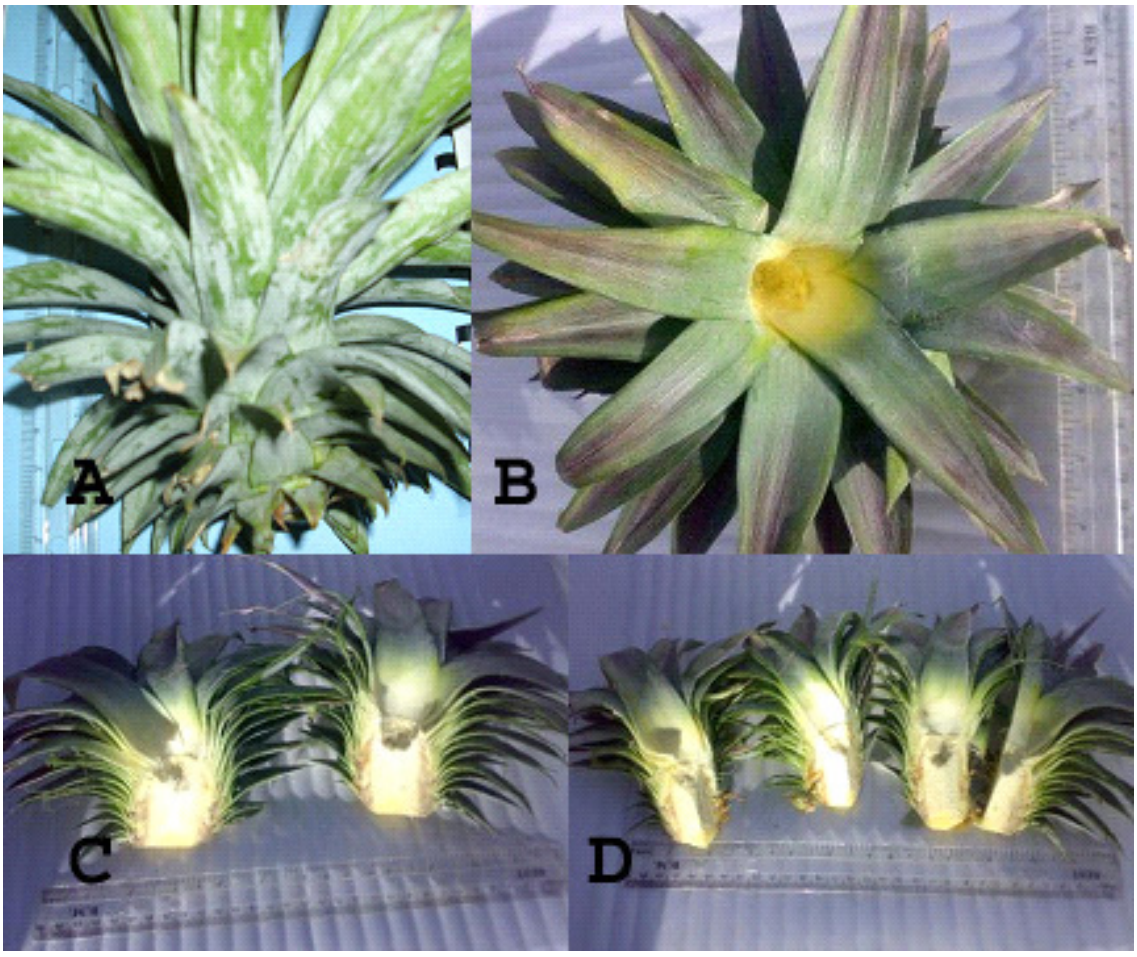

Figure 1. Crowns subjected to four treatments: A) meristem intact (Control); B) meristem destroyed without splitting (T1); C) meristem destroyed by splitting into two (T2); D) meristem destroyed by splitting into four (T3).

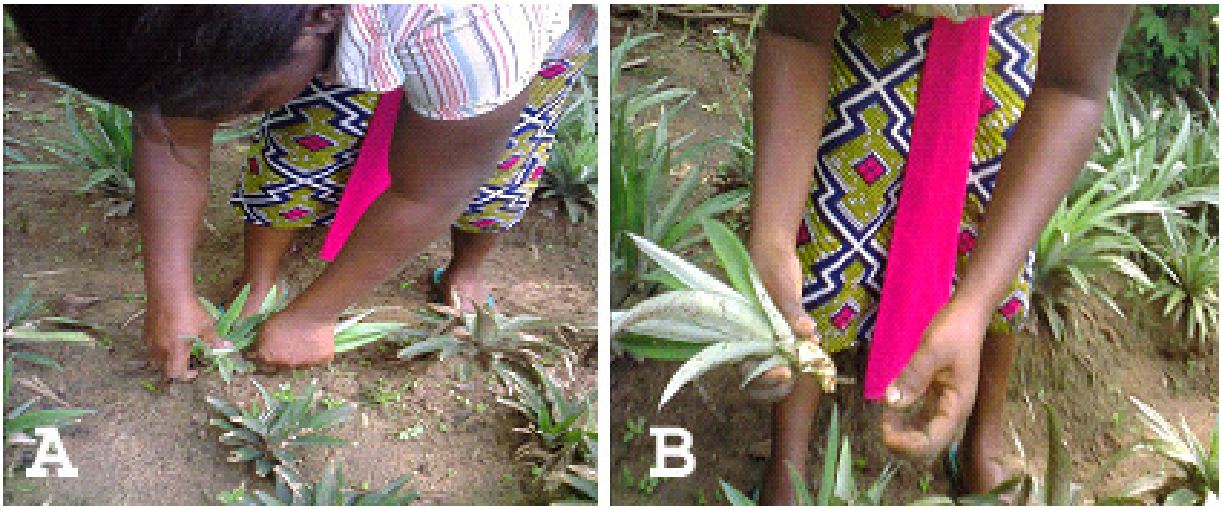

Figure 2. Selection of smooth Cayenne pineapple suckers: A) selection procedure, slight twisting and gentle detaching of the plantlet; B) selected plantlet ready for nursery transplant.

Figure 3. Selected plantlets potted in polybags containing topsoil in a nursery.

(Table 1). There was significant difference at the 1% level among the four treatments (Table 2). All the crowns with meristem destroyed emerged faster than the control. Mean difference between the control and T3 was significant at 0.1% level ($LSD_{0.001}$). Difference between T3 and T1 was significant at $LSD_{0.05}$ (5% level of significance) while the difference between T3 and T2 was not significant (Table 3).

Sucker orientation

The orientation of emerging suckers was erect and clasping to the mother plant in crowns with meristem destroyed but were not split (Figure 4) while the split crowns had divergent suckers as they emerged.

Root formation

It was observed from the study that selected plantlets were either rootless or with roots. This occurred irrespective of the plantlet size and the treatment. Thus plantlets with height of about 8 cm could have 9 roots and those of 16 cm could be rootless or with about one root (Figure 5).

Number of suckers produced

The number of suckers milked was recorded at 2, 4 and 6 months after planting (Table 4). The crowns split into 4 had the highest number of suckers (543) six months after planting followed by crowns split into 2 (375) and the least was the un-split crowns with excised meristem (166) (Table 5). It was also verified that the treatments differed significantly at the 1% level (Table 6). All the crowns with destroyed meristem produced more suckers than the control. Difference between treatment mean of T3 and other treatment means was highly significant at $LSD_{0.001}$ (Table 7).

Transplanting of selected suckers

A total of 1,084 suckers were obtained from all the treatments over the period of six months (Table 5). All these suckers which were potted in nursery bags at various periods of selecting survived irrespective of the plant height and number of roots.

Table 1. Mean number of days to sucker emergence in crowns with four treatments.

Treatment	Number of days				Treatment total	Treatment mean
	Replicate I	Replicate II	Replicate III	Replicate IV		
Control	0	0	0	0	0	0
T1	48.5	36.5	49.25	61.0	195.25	48.812
T2	39.5	48.5	37.25	36.5	161.75	40.437
T3	34.5	38.5	36.25	37.25	146.5	36.625
Rep total (R)	122.5	123.5	122.75	134.75		
Grand total (G)					502.5	
Grand mean						31.468

Table 2. Analysis of variance of number of days to sucker emergence.

Source of variation	Degree of freedom	Sum of squares	Mean square	Computed F	Tabulated F	
					5%	1%
Replication	3	89.266	29.75			
Treatment	3	5,655.34	1,885.11	54.50**	3.86	6.99
Error	9	311.264	34.58			
Total	15	6,055.87				

** = significant at 1% level.

Table 3. Comparison between mean number of days to sucker emergence between the treatments.

Treatment	Mean No. of days to emergence[a]	Difference from T3[b]
Control	0	36.625***
T1	48.812	12.18*
T2	40.437	3.812ns
T3	36.625	-

$LSD_{0.001}$ = 19.88; $LSD_{0.01}$ = 13.51; $LSD_{0.05}$ = 9.41. [a] = Average of four replications. b *** = significant at 0.1% level; ** = significant at 1% level; * = significant at 5% level,ns = not significant.

DISCUSSION

A common limiting factor to large scale production of pineapple and/or expansion of existing plantation is the difficulty in obtaining planting materials due to poor ability to suckering. The inhibition of suckering is due to the suppression of lateral bud growth as a result of a hormone (auxin) secreted by the shoot apex, a phenomenon known as apical dominance. The split crown propagation method in this study utilized pineapple crowns that would otherwise have been left to waste at dumpsites after purchase and/or utilization of edible part of the fruits. The results obtained in this study indicated high level of apical dominance in crowns with intact shoot-tip (meristem) because no sucker was produced from such crowns in the six months of study. It can therefore be stated that any propagation method that destroys the shoot apex enhances axillary bud growth. The results also indicated that the method of shoot apex destruction affects the number of days to sucker emergence and the rate of sucker production. Meristem excision without splitting the crown gave the least number of suckers while split crowns produced more suckers during the period of the study. The more the crowns were split, the higher the number of suckers produced in a relatively short time. This could be due to the fact that splitting the crowns reduced the apical dominance per split and allowed more buds to sprout which would otherwise have been suppressed from sprouting by an emerging sucker in the un-split crowns. The orientation of emerging suckers also varied between the un-split and split crowns. Suckers from split crowns were divergent from the crown while those emerging from un-split crowns were erect and clasping to the crown. The

Figure 4. Erect emerging sucker with developing axillary buds.

Figure 5. Variation in plant height and root formation of selected plantlets.

Table 4. Number of suckers selected at 2, 4 and 6 months after planting (MAP).

Treatment	2 MAP	4 MAP	6 MAP	Total No. of suckers
Control	0	0	0	0
T1	60	58	48	166
T2	160	145	70	375
T3	240	209	94	543

Table 5. Number of suckers produced six months after planting (MAP).

Treatment	Replicate I	Replicate II	Replicate III	Replicate IV	Total	Mean
Control	0	0	0	0	0	0
T1	41	42	42	41	166	41.5
T2	94	92	94	95	375	93.75
T3	136	136	135	136	543	135.75
Rep total (R)	271	270	271	272		
Grand total (G)					1.084	
Grand mean						67.75

Table 6. Analysis of variance of number of suckers produced.

Source of variation	Degree of freedom	Sum of squares	Mean square	Computed F[a]	Tabular F	
					5%	1%
Replication	3	0.5	0.166			
Treatment	3	42.3165	14.1055	21.3719**	3.86	6.99
Error	9	6	0.66			
Total	15	42.323				

[a] ** = significant at 1% level.

Table 7. Comparison between mean number of suckers produced between the treatments.

Treatment	Mean No. of suckers[a]	Difference from T3[b]
Control	0	135.75***
T1	41.5	94.25***
T2	93.75	42***
T3	135.75	-

$LSD_{.001}$ = 2.7464; $LSD_{.01}$ = 1.8669; $LSD_{.05}$ = 1.299. [a] = Average of four replications. [b] *** = significant at 0.1% level.

divergent suckers from the split crowns broke off easily during selection while those from un-split crowns were firmer and not easily separated with the same operation. Based on the results obtained from this study, it can be concluded that:

1) Crowns which are normally cut off and discarded after purchase of pineapple fruits are potential sources of sucker generation.
2) The inhibition of suckering in Smooth Cayenne pineapples grown in Nigeria can be overcome by using a split crown (SCT) macropropagation technique which is relatively cheaper than *in vitro* shoot-tip culture. Macropropagation technique which utilizes the corm of *Musa* species is already well established for plantain and banana multiplication in Nigeria (Adelaja, 2000; Rasheed, 2003; Bayern and Aba, 2005). Beneath every leaf axil of a pineapple crown is a dormant axillary bud which can be induced to sprout. A crown has about 15 to 25 buds, and for each crown that is discarded, those number of buds which are potential plantlets are lost. Pineapple farmers and plant propagators in Nigeria may therefore consider using this technique for plantlet multiplication and expansion of pineapple plantations. The recommended technique from this study is splitting the crown into four (SCT3) which produced the highest number of divergently oriented suckers. The divergent orientation made through selecting suckers is easy.

ACKNOWLEDGEMENT

The authors wish to acknowledge Mrs Grace Amah for her assistance in data collection.

REFERENCES

Abul-Soad AA, Boshra ES, Ali HS (2006). An improved protocol for the micropropagation of pineapple (*Ananas comosus* (L.) Merrill). Assiut J. Agric. Sci., 37(3): 13-30.

Adelaja BA (2000). Rapid On-Farm Propagation Techniques for Plantain and Banana. In Proceedings of 1st International Symposium on Banana and Plantains for Africa. Eds Craenen K, Ortiz R, Karamura E, Vuylsteke D. Acta Hortic., 540: 279-283.

Baiyeri KP, Aba SC (2005). Response of *Musa* species to macro-propagation. I: Genetic and initiation media effects on number, quality and survival of plantlets at pre-nursery and early nursery stages Afr. J. Biotechnol., 4(3): 223-228.

Biswas A, Bari MA, Roy M, Bhadra SK (2009). Clonal Propagation Through Nodal Explant Culture of *Boerhaavia diffusa* L. A Rare Medicinal Plant. Plant Tiss. Cult. Biotechnol., 19(1): 53-59.

Firoozabady E, Heckert M, Gutterson N (2003). Transformation and regeneration of pineapple. In Firoozabady E (ed) Plant Cell, Tiss. Organ Cult., 84: 1.

Gao SL, Chen BJ, Zhu DN (2002). *In vitro* production and identification of autotetraploids of *Scutellaria baicalensis*. Plant Cell Tiss. Organ Cult., 70: 289-293.

Lopez FG (1994). Rapid technique for plantain multiplication in Columbia. INFOMUSA, 3(2): 7.

Purseglove JW (1975). Bromeliaceae. In 'Tropical crops. Monocotyledons' (Longmans, Green and Co Ltd. London), pp. 75-90.

Rahman KW, Amin MN, Azad MAK (2001). *In vitro* rapid propagation of pineapple clones [*Ananas comosus* (L.) Merr.]. Plant Tiss. Cult., 11(1): 47-53.

Rasheed A (2003). Plantain Production as a business. HORT- Mag., 1(1): 11-12.

Sripaoraya S, Marchant R, Power JB, Davey MR (2003). Plant regeneration by somatic embryogenesis and organogenesis in commercial pineapple (*Ananas comosus* L.). *In* vitro cellular and developmental biology. Plant, 39(5): 450-454.

Swennen R (1990). Plantain cultivation under West African Conditions: A reference Manual. Int. Inst. Trop. Agric., Ibadan, Nigeria, P. 24.

Vuylsteke D (1998). Postflask management of micropropagated bananas and plantain plants. A reference Manual, IITA, Ibadan, Nigeria, P. 15.