Research Note

EFFECT OF GIBBERELLIC ACID ON PHYLLOTAXY OF BUD GRAFTED CACAO (THEOBROMA CACAO L.)[1]

Almost all the world's cacao production comes from sexually propagated trees. These trees present very complex problems to the grower, such an undesirable growth habit, self incompatibility and segregation of desired traits for pod and seed size and precociousness of flowering and fruiting, among others[2]. Cloning plantations by vegetative propagation presents other inconveniences; the most important is the cost of grafting and training of young plants to obtain a desirable tree shape[3]. In various plant species, modification of the growth habit has been achieved by the application of gibberellins[4]. In the present study, an attempt is made to develop a method of modifying the orthtropic growth of the main stem of bud-grafted cacao plants to obtain the advantages of tree growth characteristics of sexually propagated plants along with the advantages of cloned plants.

The experiment was carried out at the University of Puerto Rico Research farm in Mayagüez, P.R., between June and December 1989. The stock plants (open pollinated Amelonado) were grown for 12 weeks in plastic bags filled with greenhouse soil to about 15 mm stem diameter, then bud grafted under the cotyledonary line with a patch carrying a single bud of clone Pound-7. The graft was fixed with a rubber band and covered with parafilm. Budwood material came from branches at I-2 stage as described by Greathouse et al.[5] Sixteen days after budding, the surviving scions were arranged in a randomized block design with three replications and two plants per treatment. Gibberellic acid was dissolved in 95% ethanol and blended with lanolin according to the technique of Williams and Billingsley[6] so as to provide gibberellic acid treatment of 0, 1, 10, 100, 200, and 4,000 p/m. Each treatment was covered once with a coat of lanolin paste applied with a brush. Each experimental block consisted of 12 plants, with a total of 36 plants in the whole experiment. Every 15 days until 90 days after treatment, length, diameter, distance between leaves, vertical angle and phyllotaxy were measured and leaves were counted.

Table 1 presents average values obtained for the control treatment since no significant differences among treatments were found for any of the characteristics included in the table. For the leaf count and foliar area measurements, the value indicated represents the sum of plants included in the treatment. Such behavior does not coincide with that reported by Hackett[4], who points out that phase changes can al-

[1]Manuscript submitted to Editorial Board 5 November 1990.

[2]Larson, R. E., 1986. Cocoa raw product production and problems, *in* Proc. of Cocoa Biotechnology Symposium. Penn State Univ. Press, State College, PA, pp. 3-13.

[3]Dheesman, E. E., 1944. The vegetative propagation of cacao. *Trop. Agric. (Trinidad)* 12(9): 240-46.

[4]Hackett, W. P., 1985. Juvenility, maturation and rejuvenation in woody plants. *Horti. Rev.* 7: 109-55.

[5]Greathouse, D. C., W. M. Laetsch and B. O. Phinney, 1971. The shoot growth rhythm of a tropical tree, *Theobroma cacao*. *Am. J. Bot.* 58: 281-86.

[6]Williams, M. W. and H. D. Billingsley, 1970. Increasing the number of crotch angles of primary branches of apple trees with cytokinins and gibberellic acid. *J. Am. Soc. Hort. Sci.* 95 (5): 649-51.

TABLE 1.—*Effect of gibberellic acid on some growth characteristics of bud grafted cacao*

Evaluation (DAT)[1]	Number of leaves	Distance between leaves (mm)	Diameter of shoot (MM)	Length of shoot (MM)	Vertical angle (degrees)	Foliar area (cm^2)
30	31[2]	89	12	458	108	1726
45	27	12	508	186	2615	
60	30	44	13	518	194	2501
75	38	34	15	533	151	4077
90	44	36	19	736	132	5123

[1]DAT: days after treatment.

[2]Table indicates average values for control treatment only since no significance difference at the 0.05 level was found for any of the treatments.

TABLE 2.—*Phyllotaxy[1] of clon Pound-7 budded on Amelonado stock with GA_3 applied as lanolin paste*

Level of GA_3 (ug/ml)	At 30 days	From 45 days on		
	All blocks	Block 1	Block 2	Block 3
0	1/2	1/2	1/2	1/2
1	1/2	1/2	3/8	1/2
10	1/2	1/2	3/8	1/2
100	1/2	1/2	2/5	3/8
200	1/2	1/2	3/8	3/8
4000	1/2	1/2	3/8	3/8

[1]1/2 = plagiotropic; 2/5 and 3/8 = orthotropic.

ways be related to other changes in botanical characteristics such as those included in table 1. For instance, a significant difference in vertical angle could be expected because it is evident from tissue culture experiments that orthotropic shoots tend to be upright while plagiotropic ones (fan branches) tend to grow with some bending[7]. Table 2 presents phyllotaxy of treatments at different times of evaluation. Control plants and all treatments had 1/2 phyllotaxy after 30 days, whereas after 45 days all treatments receiving GA_3 started exhibiting orthotropic (3/8) phyllotaxy. It is evident, on the other hand, that in block 1 all plants in all treatments always had plagiotropic phyllotaxy. In this block, all buds had already sprounted at the moment when GA_3 was applied. Results obtained demonstrate that gibberellic acid could be successfully used in modifying the growth pattern of bud grafted cocoa trees. Further studies on this subject should be encouraged.

Milton Martínez
Former Graduate Student
Department of Horticulture
Arturo Cedeño-Maldonado
Professor and Plant Physiologist
Department of Horticulture
Francisco Vásquez
Agronomist
USDA-TARS, Mayaguez, P.R.

[7]Hall, T. R. H. and H. A. Collin, 1975. Initiation and growth of tissue culture of *Theobroma cacao*. *Ann. Bot.* (Annals of Botany) 39: 555-70.