A comparison of banana cultivars Dwarf Cavendish, Grande Naine and Williams, for the Canary Islands

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Received: September 1994
Accepted: March 1996

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ABSTRACT
Comparison was made between three banana cultivars, Dwarf Cavendish (DC), Grande Naine (GN) and Williams (W), during five cycles, at two densities (1,667 and 2,000 plants/ha), under the subtropical conditions of the north of the island of Tenerife. The evaluation was made considering four main aspects: morphological, phenological, production and other characteristics. It was highlighted that DC has the better adaptation to subtropical conditions from the phenological point of view; it is followed by GN. Both regarding quantitative and qualitative characteristics, GN has the higher production. This fact justifies the change presently being recommended to cultivate GN as a substitute for DC in the intensive cultivation systems of the Canary Islands.

Comparaison de trois cultivars de bananier, Dwarf Cavendish, Grande Naine et Williams, cultivés aux îles Canaries.

RÉSUMÉ
Le comportement de trois cultivars de bananier, Dwarf Cavendish (DC), Grande Naine (GN) et Williams (W), a été étudié dans les conditions subtropicales du nord de l'île de Ténérife, sur cinq cycles de production, à deux densités de plantation différents (1 667 et 2 000 plantes/ha). Les évaluations ont été effectuées à partir de l'étude de caractères classés en quatre groupes: morphologiques, phénologiques, de production et divers. D'un point de vue phénologique, les cultivars DC surtout, puis, dans une moindre mesure, GN, se sont révélés présenter la meilleure adaptation aux conditions climatiques de type subtropical ; par ailleurs, les caractères de types quantitatifs et qualitatifs ont montré que le cultivar GN donnait la meilleure production. Ces résultats justifient que la plantation de bananiers GN soit maintenant recommandée pour remplacer le cultivar DC dans le cadre de systèmes de cultures intensives, mis en place dans les îles Canaries.

Comparación de los cultivares de platanera Pequeña Enana, Gran Enana y Williams, bajo las condiciones de cultivo de las islas Canarias.

RESUMEN
Se efectuó una comparación entre tres cultivares de platanera, Pequeña Enana, Gran Enana y Williams, durante cinco ciclos a dos densidades (1.667 plantas/ha y 2.000 plantas/ha) bajo las condiciones subtropicales del norte de la isla de Tenerife. La evaluación se realizó en cuatro aspectos principales : características morfológicas, fenológicas, productivas y otras características. La conclusión más interesante que puede extraerse del trabajo es la mejor adaptación de Pequeña Enana, secundada por Gran Enana, a las condiciones subtropicales desde el punto de vista fenológico, que es claramente superado por la mayor producción de Gran Enana tanto en cantidad como en calidad comercial, lo que justifica el cambio que actualmente se recomienda para cultivar Gran Enana como substituto de Pequeña Enana bajo las condiciones de cultivo intensivo de Canarias.

Fruits, 1995, vol 50, p 255-266

KEYWORDS
Canary Islands, *Musa* (bananas), variety trials, agronomic characters.

MOTS CLÉS
Canaries (îles), *Musa* (bananes), essai de variété, caractère agronomique.

PALABRAS CLAVES
Canarias, *Musa* (bananos), ensayo de variedades, caracteristícas agronómicas.

introduction

Although recent years have witnessed a decrease in its planting area, the banana (*Musa acuminata* Colla AAA) is still the main crop of the Canary Islands. According to CREP (Regional Committee for Banana Export) data for 1992, 10,648 ha are under cultivation with a total production of 468,188 t. For several reasons, chief among which are its theoretical better adaptation to subtropical climates (KUHNE, 1975) and its historical presence due to early introduction (GALÁN SAÚCO, 1982), cv Dwarf Cavendish was until recently the only cultivar used in the Canary Islands.

In 1981, trials were begun to compare cvs Dwarf Cavendish and Williams, the latter introduced in 1978 from South Africa, with a view towards improving commercial quality and increasing production. The trials were prematurely ended due to a severe outbreak of Panama wilt disease, which made it impossible to record data for cycles more representative than the first one. Preliminary results regarding only the first cycle (GALÁN SAÚCO *et al*, 1983) showed no differences between these two cultivars for most phenological and productive parameters, although Williams proved to be qualitatively superior both in finger length and width. In 1984, a new trial was set up in another plot, for five cycles, including in this case the cultivar Grande Naine introduced in 1983 from the French West Indies (source: IRFA[1] at Guadeloupe).

Williams and Grande Naine have substituted Dwarf Cavendish with better yields both in quantity and in quality under subtropical conditions (ROBINSON, 1981; SOTO, 1985; ROBINSON and ANDERSON, 1991c; SOTO, 1985; GALÁN SAÚCO, 1992). Although a preliminary evaluation of the performance of these cultivars covering the parent crop and the first two ratoons has been reported (GALÁN SAÚCO *et al*, 1991), this paper summarizes the final evaluation of the trial after five cycles.

materials and methods

The experiment started in July of 1984 at the CITA's experimental station at Pajalillos (100 m above sea level, northern slope of the island of Tenerife), using traditional cultural techniques and drip irrigation. The trials were set up in a randomized block design, with four replications, three treatments – cvs Dwarf Cavendish (DC), Williams (W) and Grande Naine (GN) – and an experimental unit of 32 plants (12 useful plants) in separate trials at two planting distances (2 × 3 m or 1,667 plants/ha, and 2 × 2.5 m or 2,000 plants/ha).

Sucker selection was made as it traditionally is in the area: the best of those which had produced 13+1 leaves by 1 August for the second cycle, and those which had 16+1 leaves for the third cycle.

The principal parameters measured were:

i) Preemergence phase:
– monthly leaf emission rate for the ratoon crops;
– length and width of the following leaves:
. third leaf after the first adult leaf[2] (DUMAS, 1958),
. sixth leaf after the first adult leaf,
. longest leaf,
. third leaf before the bracteal.

ii) Postemergence phase (one month after emergence):
– number of hands per bunch (if number of fingers/hand [f/h] was 12, the value was 1; if 8 f/h < 12, the value was 0.5; if f/h < 8, the value was 0);
– bunch length (first to last hand with eight or more fingers);
– pseudostem height from ground level to "V" formed by the visible bases of the last two true leaves (not counting the bracteal leaf);
– pseudostem circumference at 1 m above ground level.

iii) Postharvest phase:
– total bunch weight (weighed in the field station);
– length and caliber of characteristic fruits (*ie* center finger of the internal and externals rows of the second superior and inferior hands, measured along the internal side).

Emergence and harvest dates were also recorded. Harvesting was done at the stage called "3/4 full" in banana literature. Emergence was defined as the stage at which the first hand of an immature bunch becomes visible after folding back of the bract.

[1] *IRFA: now called CIRAD-FLHOR, french fruit and horticultural crops department of CIRAD (Centre de coopération internationale agronomique pour le développement), France.*

[2] *Also called orthogonal or LO leaf.*

results

morphological characteristics

pseudostem parameters

There were consistent differences in height — Dwarf Cavendish (DC) was smaller than Grande Naine (GN) and GN was smaller than Williams (W) — and these differences were in all cases significant for DC and also in some cycles for GN *vs* W (table I). Although a comparison between densities is not statistically valid, it is important to note that height for GN and DC does not differ too much at both spacings; differences however exist for W, which is consistently taller, except for the first cycle, at 2,000 plants/ha.

Although no differences were found between cultivars in relation to pseudostem circumference, the relationship height/circumference at bunch emergence showed significant differences (DC < GN < W) between cultivars in all cycles at 2,000 plants/ha, and there was a similar tendency at 1,667 plants/ha with differences also always significant between DC and the other two cultivars and in several cycles for GN and W.

leaf characteristics

Regarding leaf characteristics (table II), there was a clear gradation DC < GN < W in relation to length/width ratio at both densities for all the leaves measured. Differences between DC and the other two cultivars were always significant, but those between GN and W only appeared as such in a few cases. It can also be observed from the same table that these differences were due more to variation in length than in width.

phenological characteristics

Regarding cycle leaf number, *ie* total leaves produced per cycle, no statistical differences were encountered between the three cultivars at either density (table III). Although not statistically analysed, detectable differences may perhaps exist among cycles.

Table I
Comparison of pseudostem parameters between Dwarf Cavendish, Williams and Grande Naine banana plants for plant crop (P) and four ratoons (R1, R2, R3, R4) at two planting densities (AVG: mean of the five cycles).

Density	*Cycle*	*Dwarf Cavendish*			*Williams*			*Grande Naine*		
		Height (m)	*Circum (m)*	*H/C*	*Height (m)*	*Circum (m)*	*H/C*	*Height (m)*	*Circum (m)*	*H/C*
2,000	P	1.91 b			2.55 a			2.40 b		
plants/ha	R1	2.26 b	0.75 a	3.0 c	3.26 a	0.76 a	4.3 a	3.09 a	0.77 a	4.0 b
	R2	2.27 c	0.74 a	2.9 c	3.11 a	0.77 a	4.2 a	2.94 b	0.79 a	3.7 b
	R3	2.47 c	0.81 a	3.0 c	3.40 a	0.82 a	4.2 a	3.28 b	0.84 a	3.9 b
	R4	2.50 b	0.80 a	3.1 c	3.38 a	0.83 a	4.1 a	3.20 a	0.83 a	3.9 b
	AVG	2.28	0.78	3.0	3.14	0.79	4.2	2.98	0.81	3.9
1,667	P	1.89 c			2.56 a			2.40 b		
plants/ha	R1	2.22 c	0.74 a	3.0 b	3.09 a	0.76 a	4.1 a	2.93 b	0.74 a	4.0 a
	R2	2.24 c	0.78 a	2.9 c	3.01 a	0.75 a	4.0 a	2.92 b	0.78 a	3.7 b
	R3	2.36 b	0.81 a	2.9 c	3.18 a	0.79 a	4.1 a	3.19 a	0.85 a	3.8 b
	R4	2.43 b	0.79 a	3.1 b	3.28 a	0.82 a	4.0 a	3.20 a	0.84 a	3.8 a
	AVG	2.23	0.78	3.0	3.02	0.78	4.1	2.93	0.80	3.8

H/C = height/circumference; a, b, c: figures differ significantly ($P \leq 0.05$) when followed by different letters; comparisons between cultivars to be made only within the same cycle and with the same density.

Table II
Comparison of leaf dimensions between Dwarf Cavendish, Williams and Grande Naine banana plants for plant crop (P) and four ratoons (R1, R2, R3, R4) at two planting densities (AVG: mean of the five cycles).

Density	*Cultivar*	*Cycle*	*L0+3*			*L0+6*			*LL*			*L III*		
			Length (m)	*Width (m)*	*L/W index*	*Length (m)*	*Width (m)*	*L/W index*	*Length (m)*	*Width (m)*	*L/W index*	*Length (m)*	*Width (m)*	*L/W index*
2,000 plants/ha	Dwarf Cavendish	P												
		R1	1.30 b	0.60 b	2.19 c	1.42 b	0.68 a	2.10 b	1.73 b	0.72 b	2.42 b	1.65 b	0.71 a	2.35 b
		R2	1.37 b	0.79 b	2.24 b	1.76 b	0.69 b	2.19 b	1.80 b	0.78 b	2.33 b	1.50 c	0.61 b	2.23 b
		R3	1.28 b	0.57 a	2.27 b	1.45 b	0.63 b	2.34 b	1.88 b	0.83 b	2.26 b	1.82 b	0.82 b	2.24 b
		R4	1.38 b	0.63 b	2.22 b	1.53 b	0.65 b	2.36 b						
		AVG	1.33	0.65	2.23	1.54	0.66	2.25	1.80	0.78	2.34	1.66	0.71	2.27
	Williams	P												
		R1	1.76 a	0.63 ab	2.83 a	1.93 a	0.68 a	2.88 a	2.41 a	0.79 a	3.08 a	2.31 a	0.78 a	2.98 a
		R2	1.90 a	0.87 a	2.76 a	2.32 a	0.79 a	2.69 a	2.36 a	0.82 ab	2.85 a	2.12 a	0.70 a	2.73 a
		R3	1.81 a	0.63 a	2.92 a	2.00 a	0.71 a	2.87 a	2.49 a	0.86 ab	2.90 a	2.44 a	0.86 a	2.83 a
		R4	1.93 a	0.72 a	2.69 a	2.12 a	0.78 a	2.75 a						
		AVG	1.85	0.71	2.80	2.09	0.74	2.80	2.42	0.82	2.94	2.29	0.78	2.85
	Grande	P												
	Naine	R1	1.67 a	0.65 a	2.59 b	1.88 a	0.69 a	2.73 a	2.35 a	0.78 ab	3.02 a	2.25 a	0.77 a	2.93 a
		R2	1.86 a	0.86 a	2.67 a	2.24 a	0.77 a	2.57 a	2.34 a	0.85 a	2.75 a	1.99 b	0.70 a	2.60 a
		R3	1.78 a	0.64 a	2.92 a	1.99 a	0.72 a	2.78 a	2.44 a	0.88 a	2.79 a	2.36 a	0.87 a	2.74 a
		R4	1.94 a	0.71 a	2.73 a	2.09 a	0.80 a	2.64 a						
		AVG	1.81	0.72	2.73	2.05	0.75	2.68	2.38	0.84	2.85	2.20	0.78	2.76

1,667 plants/ha	Dwarf Cavendish	P												
		R1	1.27 c	0.59 b	2.18 c	1.39 c	0.65 a	2.15 c	1.74 b	0.75 b	2.35 b	1.67 b	0.74 b	2.29 b
		R2	1.43 b	0.63 b	2.28 b	1.51 b	0.68 b	2.23 b	1.79 b	0.76 b	2.39 b	1.72 b	0.76 b	2.29 b
		R3	1.41 b	0.60 a	2.34 b	1.49 b	0.63 b	2.42 b	1.84 b	0.82 a	2.26 b	1.78 b	0.79 b	2.28 b
		R4	1.43 c	0.63 b	2.30 c	1.55 b	0.67 b	2.33 b	1.92 b	0.86 a		1.78 a	0.83 a	
		AVG	1.39	0.61	2.28	1.49	0.66	2.28	1.82	0.80	2.33	1.73	0.78	2.29
	Williams	P												
		R1	1.72 a	0.61 a	2.83 a	1.92 a	0.68 a	2.86 a	2.39 a	0.80 a	2.97 a	2.30 a	0.79 a	2.94 a
		R2	1.87 a	0.69 a	2.71 a	2.07 a	0.77 a	2.70 a	2.36 a	0.83 a	2.84 a	2.29 a	0.82 a	2.79 a
		R3	1.85 a	0.67 a	2.77 a	2.06 a	0.74 a	2.79 a	2.39 a	0.87 a	2.76 a	2.32 a	0.84 a	2.77 a
		R4	1.96 a	0.71 a	2.78 a	2.09 a	0.80 a	2.62 a	2.41 a	0.89 a		2.30 a	0.89 a	
		AVG	1.85	0.67	2.77	2.04	0.75	2.74	2.39	0.85	2.86	2.30	0.83	2.83
	Grande	P												
	Naine	R1	1.57 a	0.61 a	2.62 b	1.76 b	0.67 a	2.65 b	2.34 a	0.79 a	2.96 a	2.26 a	0.77 a	2.93 a
		R2	1.78 a	0.68 a	2.64 a	2.01 a	0.78 a	2.60 a	2.34 a	0.86 a	2.74 a	2.25 a	0.85 a	2.66 a
		R3	1.77 a	0.67 a	2.69 a	2.00 a	0.70 a	2.86 a	2.40 a	0.88 a	2.73 a	2.36 a	0.87 a	2.74 a
		R4	1.87 b	0.71 a	2.66 b	2.01 a	0.78 a	2.58 ab	1.82 a	0.68 a		1.74 a	0.69 a	
		AVG	1.75	0.67	2.65	1.95	0.73	2.67	2.23	0.80	2.81	2.15	0.80	2.78

L0+3 = third leaf after first adult leaf; L0+6 = sixth leaf after first adult leaf; LL = longest leaf; L III = third leaf before bracteal; L/W index = length/width index; abc figures differ significantly ($P \leq 0.05$) when followed by different letters; comparisons between cultivars to be made only within the same cycle and with the same density.

DC exhibited a higher year leaf number (number of leaves produced per year) for all densities, but differences were only significant in the first two cycles, and, even then, not between GN and DC at the 2,000 plants/ha density. At this density, differences also appear in favour of GN *vs* W, but these were only significant at the first ratoon.

The harvest-to-harvest interval differences between cultivars in the R2 and R3 cycles can be explained by the fact that the normal method of de-suckering in the Canaries tends to select a more developed sucker if the mother plant is relatively less developed and vice versa to regulate the interval between harvests.

production characteristics

Differences in favour of GN in relation to DC and W existed in practically all cycles and densities for both total yield and bunch mass, with a tendency to increase in the last two cycles, at which time they became significant, at least between DC and GN in the last cycle (table IV).

Williams also out-yielded DC in the first two cycles with significant differences for the plant crop at 1,667 plants/ha. In the third cycle, the results were reversed — except at R4 at the higher density — with no significant differences being produced thereafter (table IV). It is particularly important to note that, in all cases, total yield/ha was larger at 2,000 plants/ha, and in the case of GN this was obtained without a reduction in bunch weight in some cycles. Regarding dimensions of characteristic fingers (table V), the same trend GN > W > DC occurred for length and weight, although differences, which are not always significant, were more clearly seen for length than for weight. Differences were also larger at the second inferior hand than at the second superior hand. No differences in caliber between cultivars were found in any case.

Table III
Comparison of phenological characteristics between Dwarf Cavendish, Williams and Grande Naine banana plants for plant crop (P) and four ratoons (R1, R2, R3, R4) at two planting densities (Avg: mean of the five cycles).

Density	Cycle	*Dwarf Cavendish*			*Williams*			*Grande Naine*		
		YLN	*CLN*	*Hv-Hv*	*YLN*	*CLN*	*Hv-Hv*	*YLN*	*CLN*	*Hv-Hv*
2,000 plants/ha	P			531 a			531 a			522 a
	R1	26.8 a	39.8 a	404 b	24.8 b	41.5 a	471 a	26.5 a	41.5 a	439 ab
	R2	25.3 a	43.7 a	378 a	21.0 b	43.9 a	375 a	22.3 ab	43.1 a	399 a
	R3	26.5 a	47.4 a	399 a	24.5 a	46.3 a	395 a	25.3 a	46.4 a	375 a
	R4	25.8 a	42.7 a	371 a	24.0 a	43.1 a	357 a	26.0 a	42.7 a	378 a
	AVG	26.1	43.4	417	23.6	43.7	426	25.0	43.4	422.6
1,667 plants/ha	P			521 a			521 a			538 a
	R1	26.5 a	41.0 a	391 b	24.3 b	41.4 a	437 a	24.0 b	39.8 a	428 a
	R2	25.5 a	43.6 a	343 a	23.3 b	43.2 a	352 a	22.3 b	43.3 a	373 a
	R3	27.3 a	47.4 a	395 a	27.3 a	46.3 a	376 b	27.0 a	47.3 a	358 c
	R4	25.5 a	44.4 a	386 a	24.8 a	43.1 a	380 ab	25.3 a	43.3 a	354 b
	AVG	26.2	44.1	407	24.9	43.5	413	24.65	43.4	410.2

YLN = year leaf number; CLN = cycle leaf number; Hv-Hv = harvest-to-harvest interval; abc: figures differ significantly ($P \leq 0.05$) when followed by different letters; comparisons between cultivars to be made only within the same cycle and with the same density.

Table IV
Comparison of yield and bunch characteristics between Dwarf Cavendish, Williams and Grande Naine banana plants for plant crop (P) and four ratoons (R1, R2, R3, R4) at two planting densities (AVG: mean of the five cycles).

		Dwarf Cavendish						*Williams*						*Grande Naine*					
Density	*Cycle*	*Yield (T/ha)*	*Bunch characteristics*					*Yield (T/ha)*	*Bunch characteristics*					*Yield (T/ha)*	*Bunch characteristics*				
			Weight (kg)	*Length (cm)*	*N° hands*	*Bl/N*	*Bw/H*		*Weight (kg)*	*Length (cm)*	*N° hands*	*Bl/N*	*Bw/H*		*Weight (kg)*	*Length (cm)*	*N° hands*	*Bl/N*	*Bw/H*
2,000 plants/ha	P	45.6 a	33.1 a				17.3 a	52.0 a	37.8 a				14.6 b	49.8 a	35.2 a				14.8 a
	R1	66.2 a	34.8 a	59.9 b	11.5 a	5.2 b	15.4 a	59.0 a	36.8 a	77.6 a	12.1 a	6.4 a	11.2 b	66.8 a	39.7 a	76.4 a	12.2 a	6.2 a	12.5 b
	R2	71.9 a	37.3 ab	64.7 c	12.0 a	5.4 b	16.2 a	67.0 a	34.8 a	71.9 b	11.2 b	6.4 a	11.4 c	73.0 a	38.9 a	77.3 a	11.9 a	6.5 a	13.1 b
	R3	72.8 a	40.2 a	68.7 c	12.6 a	5.5 b	16.0 a	73.5 a	39.6 a	78.4 b	12.2 a	6.4 a	12.0 b	85.2 a	43.6 a	83.5 a	12.8 a	6.6 a	13.0 b
	R4	79.4 b	40.2 b	76.2 b	12.4 a	6.2 b	16.3 a	86.6 a	42.2 ab	84.1 a	12.4 a	6.8 a	12.7 c	88.6 a	45.8 a	85.3 a	12.8 a	6.7 ab	14.2 b
	AVG	67.2	37.1	67.4	12.1	5.6	16.2	67.6	38.2	78.0	12.0	6.5	12.4	72.7	40.6	80.6	12.4	6.5	13.5
1,667 plants/ha	P	36.6 b	33.5 b				17.3 a	44.2 a	39.4 a				15.3 b	41.2 a	38.0 a				15.4 b
	R1	54.6 a	35.8 a	59.9 b	11.7 a	5.1 b	16.3 a	50.1 a	37.3 a	72.9 a	11.7 a	6.2 a	12.1 b	51.5 a	37.6 a	74.3 a	11.7 a	6.2 a	12.8 b
	R2	66.7 a	39.1 a	62.7 c	12.2 a	5.2 b	17.2 a	58.7 a	35.5 b	71.5 b	12.2 a	6.5 a	11.8 c	60.8 a	39.4 a	77.5 a	12.2 a	6.6 a	13.4 b
	R3	57.9 b	39.1 a	68.2 b	12.3 a	5.5 b	17.0 a	64.3 b	41.3 a	77.0 ab	12.3 a	6.3 a	13.0 b	73.0 a	44.7 a	81.4 a	12.3 a	6.3 a	14.0 b
	R4	59.6 b	39.3 b	68.3 b	11.8 ab	5.8 b	16.3 a	60.4 b	39.2 b	80.0 a	11.8 ab	7.0 a	12.3 c	73.1 a	44.3 a	82.3 a	11.8 ab	6.8 a	14.0 b
	AVG	55.1	37.4	64.8	12.0	5.4	16.8	55.6	38.5	75.4	12.0	6.5	12.9	59.9	40.8	78.9	12.0	6.5	13.9

Bunch weight data always refer to total bunch weight including stem; Bl/N = bunch length/number of hands; Bw/H = bunch weight/pseudostem height; abc: figures differ significantly ($P \leq 0.05$) when followed by different letters; comparisons between cultivars to be made only within the same cycle and with the same density.

other characteristics

There were other significant differences in favour of both GN and W *vs* DC in all cases for bunch length (Bl) and bunch length/number of hands ratio (Bl/N), but not for number of hands (N) (table IV). Significant differences between GN and W were detected in the second and third cycles for Bl and in the fourth cycle at 1,667 plants/ha for N, with GN exhibiting higher figures, but these differences did not occur for Bl/N.

The relation bunch weight/pseudostem height was always higher for DC, with GN and W following; these levels were always significant for DC *vs* the other two cultivars, and in several cycles for GN *vs* W, particularly at 1,667 plants/ha.

discussion

morphological characteristics

The values encountered here (table I) coincide, broadly speaking, with those reported by different authors for the same characteristics in the subtropics (GALÁN SAÚCO, 1992), with clear differences between DC and the two cultivars in both pseudostem and leaf parameters and, as reported elsewhere for closely related cultivars (TURNER and HUNT, 1984; STOVER and SIMMONDS, 1987; STOVER, 1988; DANIELLS, 1990; ROBINSON and NELL, 1985), exhibit continuous variation within certain limits.

Under the trial conditions, the parameter pseudostem height/width at flowering seems to be the most sensitive indicator that can be used to discriminate between these cultivars, particularly at 2,000 plants/ha. As these differences are related to pseudostem height — and no differences in width seem to occur — this may indicate a possible problem of overcrowding for W at the higher density, as mentioned in the preliminary report preceding this paper (GALÁN SAÚCO *et al*, 1991). It may be worthwhile to mention here that this relationship height/circumference may be an indicator of wind resistance, *ie* the higher the ratio, the more prone to wind-caused uprooting; if this is the case, DC showed the best adaptation, followed by GN and, finally, by Williams.

phenological characteristics

Confirming what was reported earlier (GALÁN SAÚCO *et al*, 1991), DC with a lighter year leaf number — a consequence of a higher leaf emission rate — seems to be better adapted to the subtropical conditions, although differences are much smaller at R3 and R4 (table III). Grande Naine seems to be better adapted to the 2,000 plants/ha density than W, producing more leaves per year. However, it is of particular interest to note the practically nonexistent differences between cultivars in relation to harvest-to-harvest interval, with perhaps only some advantages for GN at R3 and R4; this is a more critical factor for the subtropics than year leaf number. From the differences between densities, it is, however, clear that some overcrowding occurred for W and GN at 2,000 plants/ha, as these intervals were higher than at 1,667 plants/ha. In any case, this should not be a problem for warmer locations of the Islands or for cultivation of bananas under plastic, a common practice today in the Canary Islands where higher temperatures during winter increase the leaf emission rate and, consequently, the year leaf number (GALÁN SAÚCO *et al*, 1991) which are highly dependent on temperature (GREEN and KUHNE, 1970; AUBERT, 1971), as total cycle length or harvest-to-harvest interval are.

Results regarding cycle leaf number were in line with previous reports for cultivars of the Cavendish group (ZIV, 1970; KUHNE, 1979; GALÁN SAÚCO *et al*, 1984; ROBINSON and NEL, 1985) and indicate that 43-47 leaves can be considered a valid reference for Dwarf and Demi-dwarf Cavendish cultivars.

production characteristics

The differences encountered in this trial in favour of GN regarding both total yield (t/ha) and bunch weight (table IV) validate the change being made worldwide to cultivate GN as the major Cavendish cultivar (GALÁN SAÚCO, 1992). This difference will probably be larger under warmer conditions where, as discussed previously, the leaf emission rate as well as the interval between successive harvests should be smaller. It should also be noted that the decrease in yield observed for W in the third cycle and commented on in the preliminary report (GALÁN SAÚCO *et al*, 1991) did not occur in successive cycles.

The differences in fruit length and weight (table V) in favour of both W and, particularly, GN — both of which are important characteristics in allocating fruit as grade 1 in the market — are especially important for the Canary Islands which, as in other European Economic Community (EEC) countries, from 1993 onwards must compete in the EEC with bananas from other nations, moving away from its mainland Spain protected market to a new common market organization system (GALÁN SAÚCO, 1992). Although planting density has been reported to play an important role in these parameters (STOVER and SIMMONDS, 1987; ISRAELY and NAMERI, 1988) no clear-cut differences were obvious in this trial, although there was an obvious tendency towards fruit weight generally being smaller at the higher density. It should be noted that Grande Naine bunch weight seemed to show less differences for both hands considered here, which may again illustrate some problems of overcrowding at this density for W and even for DC, again indicating that Grande Naine may be cultivated at higher densities than the other cultivars.

The absence of differences in caliber between the three cultivars indicates that harvesting was in fact done when fingers experienced a similar degree of filling, thus not affecting the results.

The longer bunch length, as well as the bunch length/number of hands ratio recorded for both W and GN, should also be considered an advantage as it minimizes damage to individual fingers by the surrounding fruits.

other characteristics

When considering the bunch mass, the values for W were similar to those found in Australia (TURNER and HUNT, 1984), whereas those for the other two cultivars were higher under the conditions of our trial, perhaps due to a better response to more intensive cultivation. In fact, Israel has reported differences in behaviour of these cultivars which indicate that Williams needs better growing conditions than Dwarf Cavendish and, in turn, Grande Naine needs better conditions than Williams (LAHAV, 1985). More work should be done in the future to test these differences, as differences in responses to environmental conditions may affect the extent to which Cavendish cultivars can display resistance to diseases with a greater environmental component (PEGG and LANGDON, 1987), such as fusarial wilt (particularly that caused by race 4), which threaten the future of bananas in the subtropics.

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