The evaluation of different bunch covers for bananas *(Musa acuminata)* in the Canary Islands

V Galán Saúco
J Cabrera Cabrera
PM Gómez Leal
Dpto Fruticultura Tropical
Instituto Canario de Investigaciones Agrarias
Apdo 60
La Laguna
38200 Tenerife
Spain

Received 9 June 1995
Accepted 22 May 1996

The evaluation of different bunch covers for bananas *(Musa acuminata)* in the Canary Islands.

ABSTRACT
To evaluate the influence of the bunch-cover technique on productivity (both in terms of quantity and quality), a comparison of different bunch covers, currently used in the Canary Islands, was carried out at three different altitudes, during the autumn-winter period for Dwarf Cavendish bananas. Results showed that at low elevations this practice is not justifiable. At higher elevations, however, the use of bunch covers should be recommended as it improves both bunch weight and quality, as well as the degree of filling, leading to the possibility of reducing the length of the emergence to harvest interval. Blue covers perform generally better than the white ones, but some controversial results were obtained when comparing blue opened-bottomed bunch covers that reduced the E-H interval with blue closed-bottomed bunch covers which improved the weight and other bunch characteristics.

KEYWORDS
Canary Islands, bananas, *Musa acuminata*, crop management, cultivation, production, quality.

Comparaison de différents types de protection des régimes de bananes *(Musa acuminata)* aux îles Canaries.

RÉSUMÉ
Pour évaluer l'influence de diverses techniques de protection des régimes de bananes sur la production (qualitative et quantitative), la comparaison de différents types de gaines utilisés aux îles Canaries a été faite sur des bananiers du cv Cavendish nain, à trois altitudes différentes, durant l'automne/hiver. D'après les résultats, aux basses altitudes, cette pratique n'est pas justifiée ; à des hauteurs plus élevées, cependant, la protection des régimes est recommandée, car elle améliore à la fois le poids du régime, la qualité des fruits ainsi que leur remplissage ; cela peut conduire à réduire l'intervalle émergence-récolte. Des gaines de couleur bleu sont, en général, plus performantes que les blanches, mais des résultats contradictoires ont été obtenus lors de la comparaison de gaines bleues ouvertes à leur extrémité basale, qui réduisent l'intervalle E-H, et de gaines bleues fermées, qui améliorent le poids et d'autres caractéristiques du régime.

MOTS CLÉS
Iles Canaries, bananes, *Musa acuminata*, conduite de la culture, pratique culturale, production, qualité.

Evaluación de diferentes tipos de embolsado en platanera *(Musa acuminata)* en las Islas Canarias.

RESUMEN
Para estudiar el efecto en productividad (tanto en cantidad como en calidad) del embolsado se compararon diferentes tipos de bolsas y sistemas de colocación usados en Canarias en platanera 'Pequeña Enana' a tres diferentes altitudes. Los resultados indican que a baja altitud esta práctica no presenta ventajas que la justifiquen. A mayor altitud el uso de la práctica del embolsado es recomendable, ya que aumenta el peso del racimo y la calidad de la fruta, particularmente el grado de llenado, permitiendo reducir el intervalo emergencia - recolección. Las bolsas de color azul se comportan de modo general mejor que las de color blanco, debiendo destacarse sin embargo el contraste observado entre las bolsas azules abiertas que reducen el intervalo emergencia-recolección y las cerradas por su base que mejoran el peso y otras características del racimo.

PALABRAS CLAVES
Islas Canarias, banano, *Musa acuminata*, manejo del cultivo, cultivo, producción, calidad.

Fruits, 1996, vol 51, p 13-24

introduction

Although the bunch-cover technique was firstly thought of as a protection against low temperatures, pest damage or leaf abrasion (SOTO, 1985), its side effects on the reduction of the bunch emergence to harvest interval (E-H) and increase in production (both in quantity and quality) make it even more interesting for the banana industry.

However, reports on E-H interval length are not always in agreement, while most authors (BERRIL, 1956; TURNER and RIPPON, 1973; DANIELLS et al, 1987) indicate a shorter interval for covered versus non-covered bunches, some trials show no differences (ROBINSON and NEL, 1984) or even a bigger interval for the first one (SCOTT et al, 1971). These contradictions can be partially explained by the different concepts used when estimating harvesting criteria, not always considered as a calliper degree, but as a subjective determination. It can also be a consequence of different treatments themselves, such as bunch covers opened or closed at the distal end.

The great majority of authors with the exception of SCOTT et al (1971), the latter using closed bunch covers in winter, report an increase in bunch weight which may reach up to 30% and for individual fingers up to 40% (JOHNS and SCOTT, 1989b). As for the reduction in interval length, there is general agreement that the temperature increase (up to 0.5 °C) occurring inside the bunches due to the effect of the covers may explain these beneficial effects (GANRY, 1975; SAMSON, 1980; ROBINSON and NEL, 1984; JOHNS and SCOTT, 1989a).

Some detrimental effects have also been reported for banana bunch covers, such as the lack of uniform ripening for bunches covered in the summer (ROBINSON, 1982) and an increase in the number of fruits with a persistent perianth (ISRAELI et al, 1980).

As in many other regions of the banana world, bunch covers are currently used in the Canary Islands and have been recommended in the past (ROMERO RODRÍGUEZ et al, 1975; ALVAREZ DE LA PEÑA, 1981), but no trial has ever been realized to compare the different types of bunch covers under the different climatic conditions which occur on the islands.

With the change in production experienced in the Canary Islands after 1993, moving from the completely reserved Spanish Mainland Market to a European Market ruled by a Common Market Organization, it is necessary to be more economically efficient in order to achieve the best profitability and, as a consequence, all cultural techniques must be checked.

This trial was set up to quantitatively evaluate the influence of several commercial bunch covers on the productivity (in terms of quantity and quality) and E-H length in three different producing plots located areas at different altitudes on the island of La Palma.

material and methods

Seven different treatments, three types of polyethylene bunch covers with two variants (closed or opened at the distal end) and the control (no bunch covers) were compared at three different altitudes (table I) in the Valley of Aridane, in the west of the island of La Palma (Canary Islands). The trial was set up separately for each location in a completely randomized design, using 25 plants per treatment. All the plants chosen (cv Dwarf Cavendish) had attained the bunch emergence stage in an interval of 15 days. The treatments are identified as follows:

– BO and BC: account for unperforated blue (B) bunch covers of 80 cm x 150 cm, opened (O) or closed (C) at the distal end;

Table I
Bunch emergence and bunch cover dates for three chosen locations.

Location	*Altitude (m)*	*Bunch emergence*	*Bunch cover date*
1	110	17/08/91	30/09/91
2	200	6/10/91	20/11/91
3	320	10/11/91	26/12/91

– ABO and ABC: refer to unperforated, blue (B) on one side, argent (A) on the other side, the bunch cover also being 80 cm x 150 cm, opened or closed as above;
– WO or WC: refer to a perforated white (W) bunch cover of 80 cm x 152 cm, opened or closed as above;
– T: control without cover.

In all cases the bunch covers were placed as in the commercial practice, approximately 45 days after the main bunch emergence period for the location (table I), which is realized shortly after removal of the remaining of the flower perianths, once the fingers have changed position, turning the tips upwards.

In all cases preventive treatments with dimethoate were given to the bunch in August. Bunch covers were placed in the usual way and in the case of the AB treatments, the argent side was orientated to the south side.

The following parameters were recorded:
– date in which the characteristic fruits (ie, the centre finger of the internal row of the second superior and inferior hand) reached 34 mm caliber (weekly observation), which is the minimum width considered for the extra category; it should be said that not in every hand, particularly in the inferior hands, the characteristic finger will reach this size, ripening beforehand instead;
– commercial harvesting date;
– weight of the bunch and of the second superior (starting from the top of the bunch) and second inferior (starting from the male bud) hand; a hand is only considered as such if it has at least 12 fingers;
– length and caliber of the characteristic fruits (ie, internal centre finger, concave face for the length and external central finger for the caliber of the second superior and inferior hand);
– number of hands per commercial category (at packing house).

With the objective of comparing the technical characteristics of the bunch covers measurements of the net and photosynthetically active radiation, inside each type of bunch, covers were taken at full sunlight (1200 hours) with the sensor in a horizontal position using a pyranometer sensor LI-200SA. Temperature values were also taken on a daily basis for each treatment using two maxima-minima thermometers located on the second superior hand and always orientated towards the north. Five different bunches were measured for each treatment. In all cases the bunch covers selected for each treatment were randomly chosen.

In addition, a study of homogeneity of the initial plants was made by comparing the following morphological characters:
– height and width of pseudostem;
– number of functional leaves present;

Table II
Comparison of the length of the period between bunch emergence and the date on which the characteristic fingers reached 34 mm (second superior hand).

Location	*Parameter*	*Treatments*						
		BO	*BC*	*ABO*	*ABC*	*WO*	*WC*	*T*
1	days	144 ab	159 d	150 bcd	157 cd	138 a	138 a	147 abc
	date	08/01/92	23/01/92	14/01/92	21/01/92	01/01/92	01/01/92	10/01/92
	% bunches	100	100	100	100	100	100	100
2	days	189	206	186	201	199	197	195
	date	09/04/92	28/04/92	08/04/92	24/04/92	22/04/92	20/04/92	17/04/92
	% bunches	86	74	86	83	68	79	12
3	days	212	214	211	221	216	215	234
	date	09/06/92	11/06/92	07/06/92	18/06/92	13/06/92	11/06/92	01/06/92

Figures differ significantly ($P \leq 0.05$) when followed by different letters. No statistical comparisons are made at locations 2 or 3 as % of bunches differs widely.
B: blue, A: argent, W: white, C: closed, O: opened, T: control.

– number of hands/bunch, number of fruits on the second superior and inferior hand, and bunch length.

All statistical comparisons between treatments were made using the Duncan multiple range test and are only valid within each location.

results

length of the interval

length of the emergence-date in which the fingers reached 34 mm

Considering the second superior hand at location 1 (low altitude), there was a significant delay (table II) in the BC treatment in relation to the control. WO and WC exhibited a significantly shorter interval than all the other treatments except BO and the control. Additionally, there were statistically significant differences between BO and BC, the latter exhibiting the longest interval length for all the treatments.

Results for the second inferior hand (table III) exhibited the same trend as for the second superior hand but occurred about 7 days later in all cases than for the second superior hand. Practically all bunches reached 34 mm before commercial harvest.

At location 2 (intermediate altitude) and location 3, all treatments showed a greater degree of filling with a range of 68-89% of the bunches reaching 34 mm at commercial harvesting when compared to the control, with only 12-17% for the second superior hand. These differences were smaller for the second inferior hand (17-33% at location 2 and 4-15% at location 3, versus 4% for the control). In the majority of the sites, the blue closed treatment exhibited a greater interval than the blue opened treatment. At location 3, the interval length for the control was much longer than any other treatment for the second superior hand, being also one of the longest for the second inferior hand.

length of the bunch interval

At the low altitude (location 1), no treatment was significantly better than the control, although the white covers clearly showed a shorter interval length than the rest (table IV and fig 1). It should also be mentioned that in both blue closed covers a significant delay occurred.

A similar trend occurred regarding blue closed covers at location 2, while no difference was seen at the high altitude (location 3).

Table III
Comparison of the length of the period between bunch emergence and the date in which the characteristic fingers reached 34 mm (second inferior hand).

Location	*Parameter*	*Treatments*						
		BO	*BC*	*ABO*	*ABC*	*WO*	*WC*	*T*
1	days	150 ab	164 b	156 ab	165 b	146 a	144 a	154 ab
	date	15/01/92	28/01/92	20/01/92	29/01/92	9/01/92	7/01/92	17/01/92
	% bunches	96	93	93	96	96	100	100
2	days	189	207	188	197	196	188	209
	date	10/04/92	27/04/92	9/04/92	23/04/92	14/04/92	10/04/92	27/04/92
	% bunches	32	33	24	17	20	18	4
3	days	240	221	236	238	231	231	238
	date	6/07/92	18/06/92	3/07/92	6/07/92	29/06/92	29/06/92	6/07/92
	% bunches	14	15	11	4	14	11	4

B: blue, A: argent, W: white, C: closed, O: opened, T: control.
Figures differ significantly ($P \leq 0.05$) when followed by different letters. No statistical comparisons are made at location 2 or 3 as % of bunches differs widely.

Table IV
Comparison of the bunch emergence-harvest interval.

Location	*Parameter*	*Treatments*						
		BO	*BC*	*ABO*	*ABC*	*WO*	*WC*	*T*
1	days	177 a	197 b	184 ab	194 b	172 a	175 a	175 a
	date	10/02/92	1/03/92	17/02/92	27/02/92	4/02/92	4/02/92	7/02/92
2	days	199 a	213 b	199 a	210 b	209 b	205 ab	200 a
	date	22/04/92	6/05/92	22/04/92	3/06/92	2/05/92	29/04/92	23/04/92
3	days	222 a	225 a	221 a	229 a	224 a	228 a	229 a
	date	19/06/92	22/06/92	18/06/92	25/6/92	21/06/92	25/06/92	25/06/92

B: blue, A: argent, W: white, C: closed, O: opened, T: control.
Figures differ significantly ($P \leq 0.05$) when followed by different letters. Comparisons to be made only within each location.

observations on bunch characteristics

weight

At all locations all the covered bunches exhibited higher weights than the control (table V and fig 2). It should be noted, however, that these differences were not significant at the low altitude, and always were at the medium altitude (location 2), while, at location 3, differences were intermediate. It should also be mentioned that, at locations 2 and 3, the blue closed treatments showed higher weights than any other.

Regarding the second superior hand, there were also significant differences at locations 2 and 3 in favour of the covered bunch when compared to the control, and not at location 1. Differences between the treatments were not so clear regarding bunch weight, but there appeared to be a slight trend in favour of blue covers, especially at the intermediate altitude. No significant differences in weight were detected for the second inferior hand.

length and caliber of the characteristic finger

Significant differences in length (table VI) were clearly detected on the second superior hand in favour of all covered bunches (with practically no differences between them) versus the control at all locations. These differences also appeared, although they were not always significant, for the second inferior hand at locations 2 and 3, the only exception being treatment ABC which had lower but not significantly different values than the control. At the low elevations no differences in length were detected.

Clear differences in the caliber of all covered bunches when compared to the control were also detected in the second superior hand, which were always significant at locations 2 and 3. Blue covers exhibited generally greater values than the rest. Differences were also detected for the second inferior hand, except at the low altitude (location 1), in favour of all treatments when compared to the control, although the differences were not always significant.

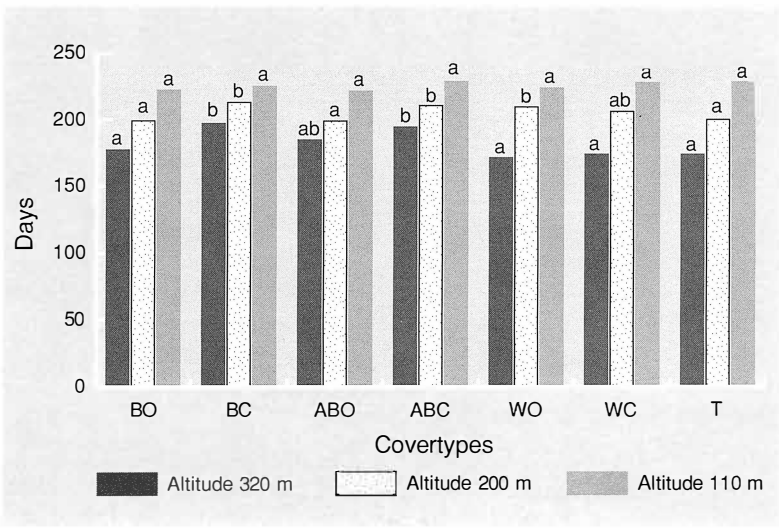

Figure 1
Comparison of different bunch coverings for banana: differences of the bunch emergence-harvest interval at three altitudes cover types: blue (B), white (W), argent (A), opened (O), closed (C), without cover (T). Figures differ significantly (P ≤ 0.05) when followed by different letters.

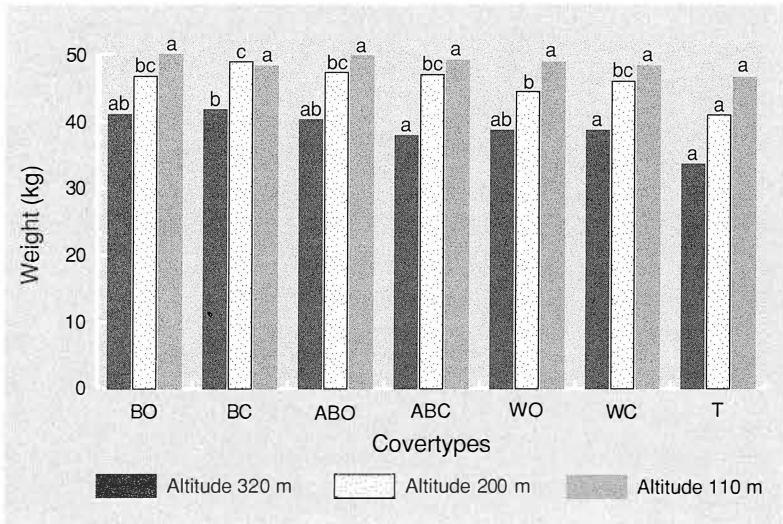

Figure 2
Comparison of different bunch covers for banana: differences of the bunch weights at three altitudes [cover types: blue (B), white (W), argent (A), opened (O), closed (C), without cover (T)]. Figures differ significantly (P ≤ 0.05) when followed by different letters.

number of hands on the extra category (at the packing house)

No differences were detected at the low altitude (table VII and fig 3), but there were significant differences for all the covered bunch treatments when compared with the control at the intermediate altitude. The differences were particularly noteworthy at the highest altitude (location 3). In the case of the caliber others the blue covers generally exhibited greater values than the others at locations 2 and 3.

other observations

radiation

As can be noted in table VIII, the blue cover allowed more penetration of light, followed by the white one, and then the blue-argent cover.

temperature

As can be noted in table IX, the higher the altitude is, the lower the temperatures, with differences between 1.3 and 3.0 °C.

Regarding temperature differences within the treatments (table X), they were practically insignificant at location 1 (low altitude) while at location 3 (high altitude) differences were greater, with the control showing lower temperatures in the winter months. The differences became less important in the spring months except for the blue covers which attained a higher temperature than the others. At the intermediate altitude (location 2), the results were intermediate.

analysis of the original population

No significant differences were detected for any of the parameters studied, which were very similar at each location (tables XI and XII).

number of leaves present at harvesting

As can be seen in table XIII, there were some differences between treatments at locations 1 and 2,

Table V
Comparison of bunch and characteristic hand weight (kg).

Location	*Parameter*	*Treatments*						
		BO	*BC*	*ABO*	*ABC*	*WO*	*WC*	*T*
1	bunch	50.0 a	49.0 a	50.0 a	49.0 a	49.0 a	48.0 a	46.0 a
	2nd sp hand	4.9 a	4.9 a	4.8 a	4.9 a	5.0 a	5.0 a	4.6 a
	2nd if hand	2.5 a	2.5 a	2.5 a	2.5 a	2.5 a	2.6 a	2.5 a
2	bunch	46.7 bc	48.3 c	47.2 bc	46.9 bc	44.3 b	45.8 bc	40.9 a
	2nd sp hand	4.5 bc	4.5 bc	4.3 bc	4.6 c	4.2 b	4.3 bc	3.6 a
	2nd if hand	2.1 a	2.0 a	2.1 a	2.0 a	2.1 a	2.1 a	2.0 a
3	bunch	38.3 ab	41.8 b	37.6 ab	35.4 a	37.4 ab	34.6 a	32.4 a
	2nd sp hand	3.9 bc	4.0 c	4.0 c	3.5 b	3.7 bc	3.7 bc	3.1 a
	2nd if hand	1.7 a	1.8 a	1.8 a	1.7 a	1.8 a	1.8 a	1.7 a

B: blue, A: argent, W: white, C: closed, O: opened, T: control, 2nd sp: second superior, 2nd if: second inferior. Figures differ significantly ($P \leq 0.05$) when followed by different letters. Comparisons to be made only within each location.

and none at location 3. It should be noted that although no statistical comparisons were made, it appeared to be a clear trend to retain fewer functional leaves at the higher altitudes (photos 1 and 2). When comparing with the initial data at the moment of bunch covering (table XI), it is clear that there was a greater reduction in functional leaves at higher elevations, two to three leaves being lost at location 1, versus three to four at location 2 and five to six at location 3. Additionally, it was observed that at location 1 most leaves exhibited the full lamina while, at location 3, most of them were completely shredded, those at location 2 being intermediate.

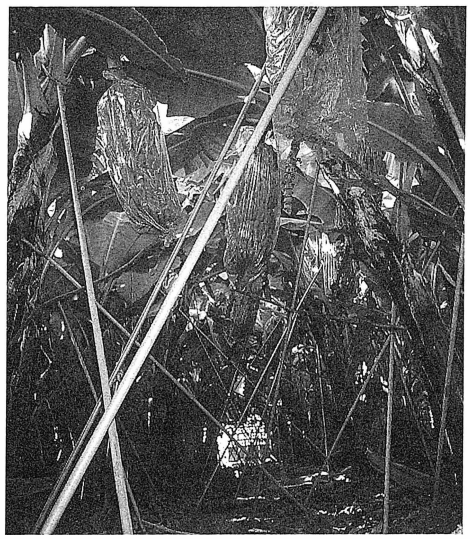

Photo 1
Use of bunch covers at low elevation.

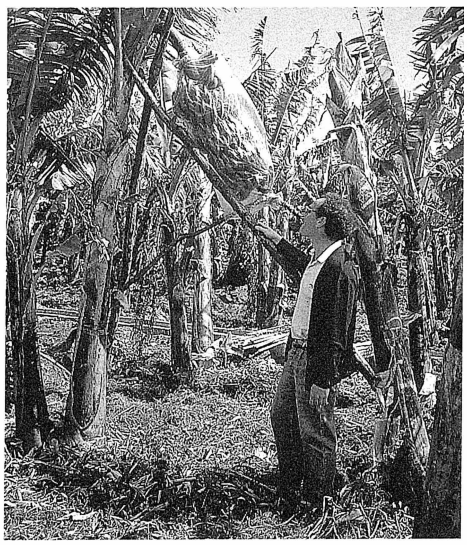

Photo 2
Use of bunch covers at higher elevation: see reduced number of leaves present in relation to low elevation.

discussion

degree of filling of bunches and length of interval

The scarce differences encountered at the low elevation (location 1) between treatments cannot be attributed to differences in temperature, this being very similar in all cases (table IX). A certain effect of light could, however, be responsible for the differences regarding interval length in favour of the control, white and blue covers allowing more light penetration than those blue-argent

Table VI
Comparison of finger dimensions.

Hand number	*Location*	*Parameter*	*Treatments*						
			BO	*BC*	*ABO*	*ABC*	*WO*	*WC*	*T*
	1	L (cm)	18.1 b	18.0 ab	18.4 b	18.2 b	18.2 b	18.3 b	17.3 a
2 nd		c (mm)	37.1 bc	36.1 ab	37.2 c	36.3 abc	36.6 bc	36.6 bc	35.5 a
superior	2	L	18.4 b	18.6 b	18.3 b	18.5 b	18.1 b	18.0 b	17.4 a
hand		c	35.6 b	35.0 b	35.1 b	34.9 b	34.5 b	34.7 b	32.2 a
	3	L	16.9 b	17.1 b	17.2 b	16.9 b	17.0 b	17.0 b	16.0 a
		c	35.4 cd	36.0 d	35.8 d	34.5 bc	34.2 b	34.1 b	31.5 a
	1	L	16.4 a	16.1 a	16.2 a	16.3 a	16.0 a	16.4 a	16.2 a
2 nd		c	35.0 a	35.0 a	35.2 a	35.0 a	35.5 a	35.7 a	35.6 a
inferior	2	L	15.4 abc	15.8 c	15.5 abc	15.7 bc	15.2 ab	15.3 abc	14.9 a
hand		c	32.9 ab	32.3 ab	32.7 ab	32.4 ab	32.5 ab	32.6 ab	31.9 a
	3	L	13.9 abc	14.2 c	14.0 abc	13.4 a	14.0 bc	13.9 abc	13.6 ab
		c	31.5 ab	31.8 b	31.6 ab	30.8 a	31.5 ab	31.2 ab	30.7 a

B: blue, A: argent, W: white, C: closed, O: opened, T: control, c: caliber, L: length.
Figures differ significantly ($P \leq 0.05$) when followed by different letters. Comparisons to be made only within each location.

Table VII
Comparison between the number of hands on the extra category.

Location	*Treatments*						
	BO	*BC*	*ABO*	*ABC*	*WO*	*WC*	*T*
1	10.1 a	10.5 a	10.2 a	10.3 a	10.2 a	10.1 a	10.0 a
2	9.4 bc	9.7 bc	10.2 c	9.2 bc	8.8 b	9.2 bc	5.3 a
3	5.4 bc	6.7 d	6.0 cd	5.1 bc	5.0 bc	4.5 b	1.5 a

B: blue, A: argent, W: white, C: closed, O: opened, T: control.
Figures differ significantly ($P \leq 0.05$) when followed by different letters. Comparisons to be made only within each location.

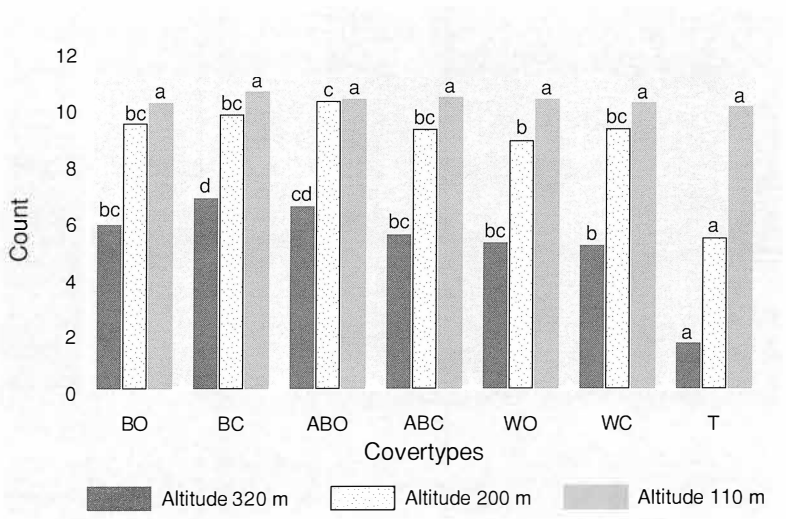

Figure 3
Comparison of different bunch coverings for banana: differences of extra category hand numbers at three altitudes (cover types: blue (B), white (W), argent (A), opened (O), closed (C), without cover (T)). Figures differ significantly (p < 0.05) when followed by different letters.

(table VIII). The fact that the plants keep all their leaves fully intact and with very few losses (tables XI and XIII and photo 1) may, however, be responsible for not clearly detecting this effect. Additionally, the delay observed in most cases for the blue closed covers can be explained by the accumulation of water in the bottom part of the covers (which does not occur in the case of the white perforated bunch covers). This may act indirectly on the temperature, particularly in the warmest portion of the day, keeping it more constant and preventing it from increasing to the range of temperature (20-28°C) reported by several authors (AUBERT, 1971; GANRY, 1973) as being best for the growth and development processes of the banana plants. Although it is clear that at this location no improvement was obtained for the length of the E-H interval, there was an improvement in the degree of filling for the second inferior hands, which may make it worthwhile to use bunch covers, particularly white covers, for those markets where the caliber is one of the determinants of the quality classification.

Table VIII
Comparative radiation measurements for the different bunch covers.

Type of cover	*Net radiation*		*Photosynthetically active radiation*	
	Watts/m²	*% versus control*	*µ E.s⁻¹.m⁻²*	*% versus control*
Blue	619	81.13	990	76.15
White	487	63.66	920	70.77
Blue-argent	363	47.45	580	44.62
Control	765	100.00	1300	100.00

Table IX
Mean temperature (°C) registered during bunch development (data from control bunches).

Location	*16-27 Nov*	*23 Dec-2 Jan*	*3-13 Jan*	*28 Jan-3 Feb*	*13-23 Apr*	*29 May-6 Jun*
1	20.0	17.9	17.1	17.5	19.3	22.2
2	19.3	17.5	16.8	17.1	18.1	21.7
3	18.0	16.6	15.5	15.9	16.3	20.6

Table X
Mean temperature (°C) registered for the different treatments and dates.

Dates	*Location*	*Treatments*						
		BO	*BC*	*ABO*	*ABC*	*WO*	*WC*	*T*
16/27 Nov 91	1	19.9	20.1	20.2	19.8	19.8	20.0	20.0
23 Dec 91 - 2 Jan 92	1	17.4	17.3	17.0	17.1	17.4	17.1	17.9
3-13 Jan 92	2	17.0	16.9	17.2	17.2	16.2	16.5	16.8
28 Jan 92 - 3 Feb 92	3	16.9	16.2	16.6	16.5	15.8	16.3	15.9
13/23 Apr 92	2	19.6	19.6	21.0	20.3	19.2	20.5	18.1
29 May 92 - 6 Jun 92	3	22.0	22.0	20.9	20.8	22.2	20.3	20.6

B: blue, A: argent, W: white, C: closed, T: control.

Table XI
Morphological comparison between treatments for the initial population.

Location	*Parameter*	*Treatments*						
		BO	*BC*	*ABO*	*ABC*	*WO*	*WC*	*T*
1	H	287	283	279	289	287	284	284
	C_p	91	89	89	93	89	92	91
	L	14.3	13.9	13.9	14.5	14.1	14.2	13.8
2	H	274	278	279	273	273	274	273
	C_p	91	93	92	91	90	91	92
	L	14.6	14.8	14.7	14.7	14.6	14.7	14.5
3	H	242	243	242	238	239	237	239
	C_p	83	83	84	81	83	83	83
	L	13.4	13.7	13.8	13.4	13.6	13.6	13.4

B: blue, A: argent, W: white, C: closed, O: opened, T: control.
H: height of pseudostem; Cp: circunference of pseudostem; L: number of functional leaves at the moment of placing the bunch covers.

Table XII
Bunch characteristic comparison between treatments for the initial population.

Location	*Parameter*	*Treatments*						
		BO	*BC*	*ABO*	*ABC*	*WO*	*WC*	*T*
1	HN	12.9	13.0	12.9	12.8	13.0	12.6	12.9
	FSN	25.7	26.1	25.7	25.7	26.3	26.0	27.0
	FIN	17.6	17.5	17.4	17.3	17.5	17.3	17.1
	L	71	73	71	72	69	72	70
2	HN	13.5	14.0	13.8	13.5	13.7	13.7	13.9
	FSN	26.8	26.5	26.8	27	25.9	26.5	26.8
	FIN	18.3	18.1	18.3	18.7	18.2	18.0	18.7
	L	70	72	73	71	70	71	72
3	HN	13.7	13.5	13.3	13.4	13.3	13.7	13.5
	FSN	25.4	25.5	25.1	24.6	24.9	26.0	25.5
	FIN	17.4	18.0	18.0	18.1	18.2	17.9	18.1
	L	56.6	58.3	56.5	56.2	56.9	58.6	56.0

B: blue, A: argent, W: white, C: closed, O: opened, T: control.
HN: number of hands, FSN: number of fingers on the second superior hand, L: length (cm), FIN: number of fingers on the second inferior hand.

Table XIII
Comparison of functional leaves present at harvesting.

	Treatments						
Location	*BO*	*BC*	*ABO*	*ABC*	*WO*	*WC*	*T*
1	11.8 b	11.1 ab	10.7 a	11.0 ab	11.5 ab	11.7 b	11.2 ab
2	9.2 ab	9.1 ab	9.3 ab	9.4 ab	9.2 ab	9.6 b	8.4 a
3	6.1 a	6.2 a	5.9 a	6.3 a	6.0 a	6.4 a	6.1 a

B: blue, A: argent, W: white, C: closed, O: opened, T: control.
Figures differ significantly ($P \leq 0.05$) when followed by different letters. Comparisons to be made only within each location.

At higher elevations (locations 2 and 3), the beneficial effects of the bunch covers are very clear, when regarding the degree of filling (tables II and III). This can be explained by the higher temperatures registered inside the covers, for the period of the E-H interval (table X) which coincides with the period in which banana fingers experiment a uniform growth rhythm in width (LASSOUDIÈRE and MAUBERT, 1971). These differences were not detected for the E-H interval length (table IV) because of the fact that it is a normal commercial practice in the area to harvest bunches early, before complete filling, to avoid the fall in the price of bananas occurring at the beginning of the summer.

These observations once again explain the apparently contradictory observations, already indicated in the introduction, sometimes reported when regarding the effect of bunch covers on the E–H interval length.

bunch characteristics

It is worth mentioning that the increase in bunch weight experimented in all covered bunches, when compared to the controls, although not

always significant, is probably a clear consequence of the increase in temperature. In fact, significance was only obtained at location 2, probably because at the low elevation (location 1) temperature differences between treatments were practically nonexistent, and, additionally, they were higher (table X) at the highest elevation (location 3), where harvesting was earlier than maturity (see last section). These increases in weight are in line with the observations reported by other authors (HEENAN, 1973; BOND, 1974; ITTYEIPE, 1978; TURNER, 1984; SOTO, 1985). It is important to mention that the influence of bunch covers regarding the weight of the bunch is mainly due to the effect of the superior hand (and the same may also apply for the length and caliber of the characteristic fingers, because no differences are detected in the second inferior hand; tables V and VI). Light may also play an important role as the blue closed treatment, which in theory combines higher temperatures and illumination, is the best at locations 2 and 3, while white covers do not perform as well at location 2. This observation may be in contrast to what was reported regarding the E-H interval length, but is only apparent because at, low elevations, where the temperature is very similar for the blue and blue-argent covers, there are no significant differences from the control when regarding the caliber of the bananas. In contrast, at high elevations, even for the second inferior hand, the blue closed cover treatment was significantly better when regarding length and caliber.

These last observations are in contrast to what has been reported elsenwhere showing the advantages of opened bunch covers (KUHNE and KRITZINGER, 1964, in South Africa; SCOTT et al, 1971, in Australia; SOTO, 1985, in Costa Rica; even ALVAREZ DE LA PEÑA, 1981, in the Canary Islands), and illustrate once again the need to conduct local experiments before fully adapting any technological transfer.

conclusion

At low elevations, bunch covers have only a minimal influence, albeit positive when regarding the degree of filling, on the E-H interval length and bunch characteristics, which may not make the use of this practice economically justifiable. At higher elevations the covers significantly improve both bunch weight and quality and the degree of filling, leading to the possibility of reducing the E-H interval length; they should be recommended.

The improvement in bunch characteristics is made mainly in the superior hands of the bunches, the effect being minimal in the second inferior hand.

Generally speaking, blue covers perform better than white covers, except at low elevations where the latter are better regarding the length of the E-H interval. Some controversial results were obtained when comparing blue opened-bottomed bunch covers that reduced the E-H interval with blue closed-bottomed bunch covers which improved the weight and other bunch characteristics, probably through an interaction between the temperature and the illumination.

For future trials, it could be interesting to include white unperforated and blue perforated bunch covers to understand better the light-temperature effect, to make more frequent temperature determinations along the period of bunch filling.

references

Alvarez de la Peña F J (1981) *Cultivo de la platanera*. Madrid, Publicaciones de Extensión Agraria, Ministerio de Agricultura, 255 p

Aubert B (1971) Action du climat sur le comportement du bananier en zones tropicales et subtropicales. *Fruits* 26 (3), 175-188

Berril FW (1956) Bunch covers for bananas. *Queensland Agri J* 82 (8), 435-440

Bond WB (1974) Pre-harvest bunch care. Bunch Sleeving trial. *Ann Rep Banana Board (Jamaica)* 53-62

Daniells JW, O'Farrell PJ, Mulder JC, Campbell SJ (1987) Effects of bunch covering and bunch trimming on bananas in north Queensland. *Queensland J Agric Anim Sci* 44 (2), 101-105

Ganry J (1973) Étude du développement du système folaire du bananier en fonction de la température. *Fruits* 38 (7-8), 499-516

Ganry J (1975) Influence du gainage des régimes de bananier avec une housse de polyéthylène, sur la température des fruits, dans les conditions de Neufchâteau (Guadeloupe). *Fruits* 30 (12), 735-738

Heenan DP (1973) Bunch cover for bananas in the Northen District Papua, New Guinea. *Agric J* 24 (4), 127-132

Israeli Y, Gazit S, Blumenfeld A (1980) Influence of relative humidity on the type of flower in the Cavendish banana. *Fruits* 35 (5), 295-299

Ittyeipe K (1978) Pest control. Evaluation of the efficiency of different types of bunch sleeves in proving bunch weight and fruit quality of bananas. *Ann Rep Banana Board (Jamaica)* 22-26

Johns GG, Scott KJ (1989a) Delayed harvesting of bananas with 'sealed' covers on bunches. 1- Modified atmosphere and microclimate inside sealed covers. *Australian Journal of Experimental Agriculture* 29, 719-726

Johns GG, Scott KJ (1989b) Delayed harvesting of bananas with 'sealed' covers on bunches. 2. Effect on fruit yield and quality. *Aust J Exp Agric* 29, 727-733

Kuhne FA, Kritzinger H (1964) Polyethylene sleeves for bananas. *Farm S Africa* 40, p 37, 39, 41, 52

Lassoudière A, Maubert P (1971) Évolution des dimensions des bananes entre l'émission de l'inflorescence et la récolte du régime. *Fruits* 26 (5), 231-331

Robinson JC (1982) The use of banana bunch covers during summer at Burgershall. *Citrus and Subtropical Fruits Research Institute, Information Bulletin* 118, 8-9

Robinson JC, Nel DJ (1984) Banana bunchs covers in winter. *Citrus and Subtropical Fruit Research Institute, Information Bulletin* 138, 5-6

Romero Rodríguez R, Rodríguez Rodríguez JM, Sosa Molina JL (1975) Ensayo sobre enfundado de racimos de plátanos. *Granja Agrícola experimental Excmo, Cabildo Insular de Gran Canaria. Serie Subtropicales* 75 (1), 163-165

Samson JA (1980) *Tropical Fruits*, 2d edn. New York, USA, Longman, 335 p

Scott KJ, Wills RBH, Rippon LE (1971) The use of sealed polyethylene bunch covers during growth as a retardant to the ripening of bananas. *Trop Agric (Trinidad)* 48 (2)

Soto M (1985) *Bananos. Cultivo y comercialización.* San José, Costa Rica, Lil (Publ), 627 p

Turner DW (1984) *Bunch Covers for Bananas,* 1st edn. Australia, Department of Agriculture New South Wales, Agfact H6.3.4, Agdex 231/25, 2 p

Turner DW, Rippon LE (1973) Effect of bunch covers on fruit growth and maturity if bananas. *Trop Agric (Trinidad)* 50 (3), 235-240