

THE JOURNAL OF AGRICULTURE OF THE UNIVERSITY OF PUERTO RICO

Issued quarterly by the Agricultural Experiment Station of the University of Puerto Rico, for the publication of articles by members of its personnel, or others, dealing with any of the more technical aspects of scientific agriculture in Puerto Rico or the Caribbean Area.

Vol. LIV

April 1970

No. 2

Effect of Zone and Climate on Yields, Quality and Ripening Characteristics of Montecristo Bananas Grown in Puerto Rico

F. Sánchez Nieva, G. Colom Covas, I. Hernández, C. Bueso de Viñas, R. Guadalupe and A. Torres¹

INTRODUCTION

Two studies were conducted by Sánchez Nieva *et al.* (3, 4)² to determine the effect of time of planting and flowering on fruit development, production patterns, fruit quality and ripening characteristics of the Montecristo bananas grown on the southern coast of Puerto Rico, and in the mountainous area of the Adjuntas region. Because part of these studies were made concurrently at both locations, it also was possible to compare the behavior of these bananas when grown under appreciably different climatic conditions.

EXPERIMENTAL PROCEDURE

Monthly plantings of 100 plants each were established under full sunlight at the Fortuna Substation at sea level on the southern coast, and at the Adjuntas Substation in the mountainous area of Puerto Rico at an elevation of about 1,800 feet above sea level. At the Fortuna Substation the first plot was planted in October, 1963 followed by monthly plantings until the last plot was established in September, 1964. At the Adjuntas Substation the first plot was planted in December, 1963. Successive plots were established monthly at about 30-day intervals thereafter until November, 1964. Planting material of the cultivar known in Puerto Rico as Montecristo Grande was obtained for both plots from commercial plantations in

¹ Technical Director, Associate Horticulturist, Assistant Chemical Engineer, Assistant Food Technologist, Assistant Horticulturist, respectively, Food Technology Laboratory, Agricultural Experiment Station, Mayagüez Campus, University of Puerto Rico, Río Piedras, P.R.; Horticulturist in Charge, Fortuna Substation, formerly Associate Horticulturist, Adjuntas Substation, Agricultural Experiment Station, Ponce, P.R. The authors wish to express their gratitude to the staff of the Fortuna and Adjuntas Substations for the assistance given in the field experiments.

² Numbers in parentheses refer to Literature Cited, pp. 209-10.

the Adjuntas area. The seeds (pseudo-rhizomes) chosen were of similar size and weight, and planted at a distance of 10 × 10 feet. The corms were peeled and treated with a 2.5 percent solution of aldrin to control the borer, *Cosmopolites sordidus* G. The planting holes also were treated. The plots were treated again with the solution 180 days after planting.

Fertilizer formula 12-6-10 was applied according to the following schedule: 1 pound 60 days after planting, followed by 1 pound every 60 days until shooting, the last application being applied at the time of shooting.

To control the Sigatoka leaf spot disease (*Cercospora musae*), the plants were sprayed with orchard spray oil every 15 days at the rate of 3 to 4 liters per cuerda³. The plantations were weeded as needed. No shoots were allowed to grow until flowering. At the Fortuna Substation, the plots were irrigated once a week by flooding the furrows.

A second experiment was established at both Substations in August, 1965. Two plots, 100 plants each, were planted at each location, using for one plot seed obtained from one of the experimental plots previously established at the Adjuntas Substation. The same agronomical practices described previously were used, except that Fumarone was used as a soil fumigant for nematode control.

The plots at the Adjuntas Substation were destroyed by gale winds before harvesting. On October, 1966, the plots were pruned and only one sucker was allowed to grow to obtain a uniform plantation.

Dates of shooting were recorded. Bunches were harvested at pre-determined ages measured from flowering. The bunches were transported to the Laboratory wrapped in padded cotton mats to avoid bruising. The bunches were weighed with the stem attached, but with both the male bud and the stem cut off near the last hand. The number of hands and fingers were counted. Fingers from the second hand were sampled for chemical analyses and to determine the weights of pulp and peel. Pulp:peel ratios were calculated from average weights of pulp and peel.

To study the ripening characteristics, the bunches were left overnight at room temperature and placed in the ripening room next morning. The temperature of the ripening room was adjusted to 68° F. with a relative humidity of 95 to 100 percent. After staying 1 day in the ripening rooms, ethylene was applied at the rate of 1 cubic foot per 1,000 cubic feet of room space. A second ethylene dosage was applied 7 to 8 hours later. Following the ethylene application, the room was ventilated with an exhaust fan through a bunk door for 15 minutes every 24 hours. After turning, the temperature was lowered to 66° F. until the fruit reached a peel color of 4-5 according to the color chart published by the Fruit Dispatch Co. (1).

³ One cuerda = 0.9712 acre.

The average weight of fingers from all hands were recorded. Fingers from the second hand were removed for analyses when required, to follow the course of the ripening treatment.

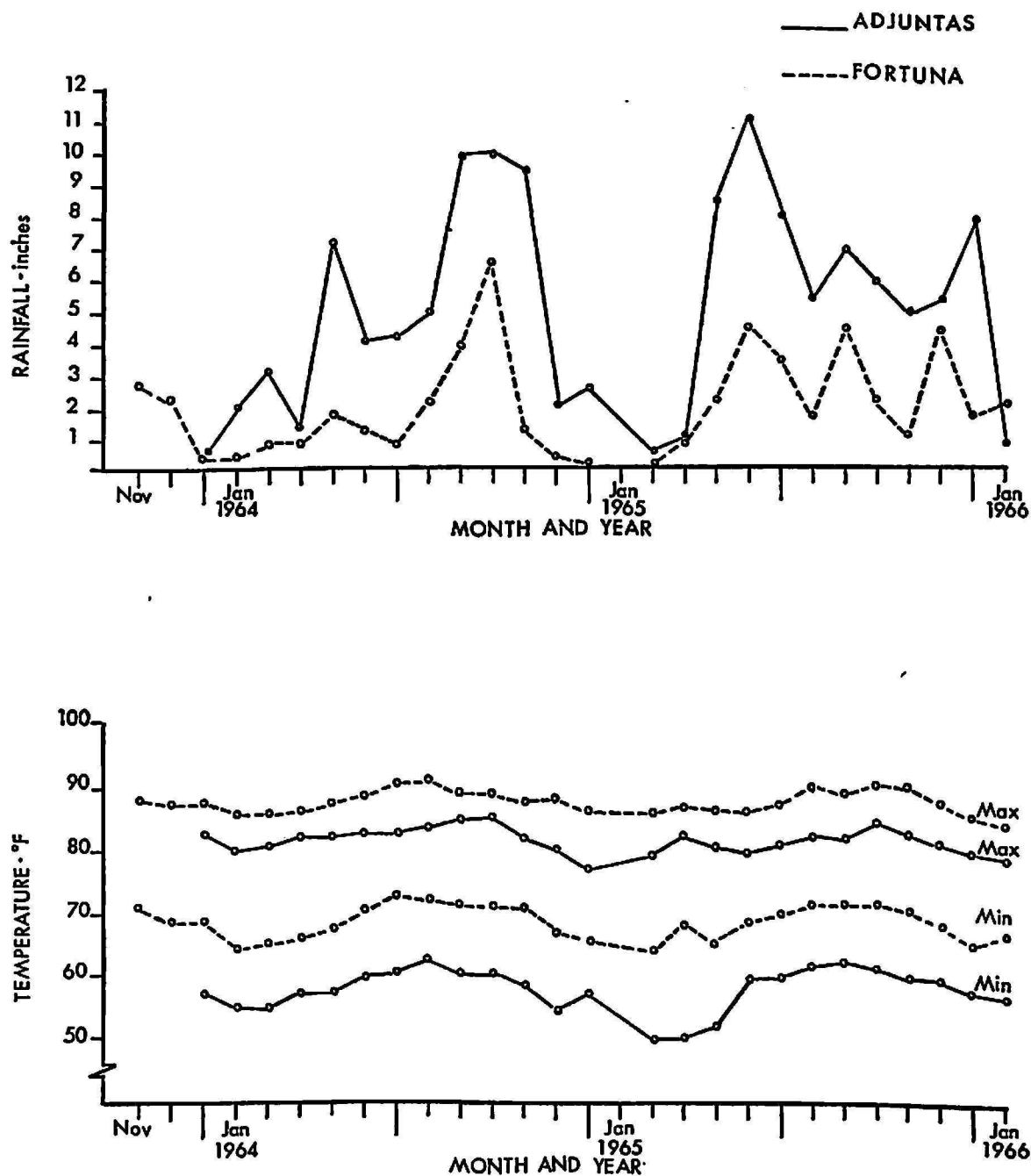


FIG. 1.—Temperature and rainfall data for the Adjuntas and Fortuna Substations.

RESULTS AND DISCUSSION

Maximum and minimum temperature and rainfall data for the Fortuna and Adjuntas Substations for the period corresponding to the comparative study are given in figure 1. At the Adjuntas Substation, the minimum temperature ranged from 7° to 18° F. below the minimum temperature

recorded at the Fortuna Substation. The maximum temperature at Adjuntas ranged from about 4° to 7° F. below the maximum at Fortuna. Of a total of 24 months, during which time rainfall was measured at both locations, only 12 months at the Fortuna Substation had rainfall of 2 inches or more, while at the Adjuntas Substation, only 5 months had a rainfall of less than 2 inches. According to Simmonds (5), 4 inches of rain per month may be considered satisfactory for banana growth, and below 2 inches the bananas are seriously short of water. In regard to temperature, Simmonds indicates that a monthly average temperature of less than 70° F. results in some check in growth, a mean temperature of 80° F. being considered satisfactory. Based on these presumed satisfactory levels for growth, the bananas at the Fortuna Substation developed under fairly satisfactory conditions with the average temperature close to 80° F., and although rainfall was less than 2 inches for several months, supplementary irrigation provided more than the minimum water required for normal growth. At the Adjuntas Substation the rainfall was adequate most of the year, but the average temperature was near 70° F.; about 10° F. lower than that said to be satisfactory.

The characteristics of the period of flowering for plots planted the same month at both Substations are shown in table 1. The mean days from planting to shooting for the plots at Adjuntas range from 371 to 448 days, for an average for the whole period of 406.6 days. At Fortuna, the mean days for planting to shooting ranged from 319 to 388 days, with a mean value of 360 days for the whole period. The plots planted from December to February at both locations have similar values from the mean days from planting to shooting, but the plots at Fortuna from March on, bloomed from 41 to 115 days earlier than at Adjuntas.

The main difference in the flowering characteristics observed was in the duration of the flowering period. At Adjuntas, the length of the flowering period ranged from 107 to 200 days, while at Fortuna it ranged from 102 to 147 days. At Adjuntas, the length of the flowering period varied with the time of planting, increasing steadily from the plot planted during December to reach a maximum of 200 for the plot planted in April, while decreasing thereafter to reach a low value for the plot planted in September. In two other plots planted during October and November, 1964, and not included in table 1, the same trend was observed, the length of the flowering period reaching a value of 104 days for the plot planted in November.

At Fortuna, the relationship of the length of flowering period with the time of planting was not as direct as at Adjuntas; this is shown in the curves in figure 2. The length of the flowering period increased from a low value of 102 days for the plot planted in December, to values of 147, 137, and 142 days for the plots planted in September. Aside for the trend for

TABLE 1.—*Characteristics of the flowering period at Fortuna and Adjuntas Substations*

Planting date		Date of first shooting		Mean days from planting to shooting		Duration of flowering	
Adjuntas	Fortuna	Adjuntas	Fortuna	Adjuntas	Fortuna	Adjuntas	Fortuna
Dec. 5, 1963	Dec. 23, 1963	Oct. 30, 1964	Nov. 5, 1964	376	371	107	102
Jan. 7, 1964	Jan. 24, 1964	Nov. 18, 1964	Nov. 10, 1964	375	353	126	147
Feb. 9, 1964	Feb. 28, 1964	Dec. 2, 1964	Jan. 1, 1965	371	374	163	130
March 6, 1964	March 26, 1964	Feb. 1, 1965	Feb. 5, 1965	427	376	193	114
April 10, 1964	April 9, 1964	Feb. 8, 1965	Feb. 22, 1965	403	388	200	126
May 7, 1964	May 26, 1964	April 21, 1965	Feb. 11, 1965	426	319	156	137
June 10, 1964	June 25, 1964	June 9, 1965	April 30, 1965	423	353	162	111
July 7, 1964	July 29, 1964	June 21, 1965	June 3, 1965	417	354	150	113
Aug. 6, 1964	Aug. 31, 1964	Aug. 13, 1965	June 26, 1965	448	356	154	142
Sept. 9, 1964	Sept. 29, 1964	Aug. 13, 1965	Aug. 10, 1965	400	359	147	104

the flowering period to be shorter at both extremes, the variation during the year was cyclic and shows no direct relationship with time of planting.

The percentage distribution of plants flowering at 10-day intervals throughout the duration of the experiment at both locations is in figure 3.

The flowering distribution patterns are different at both locations. At Adjuntas, two flowering cycles are observed with the highest percentage of

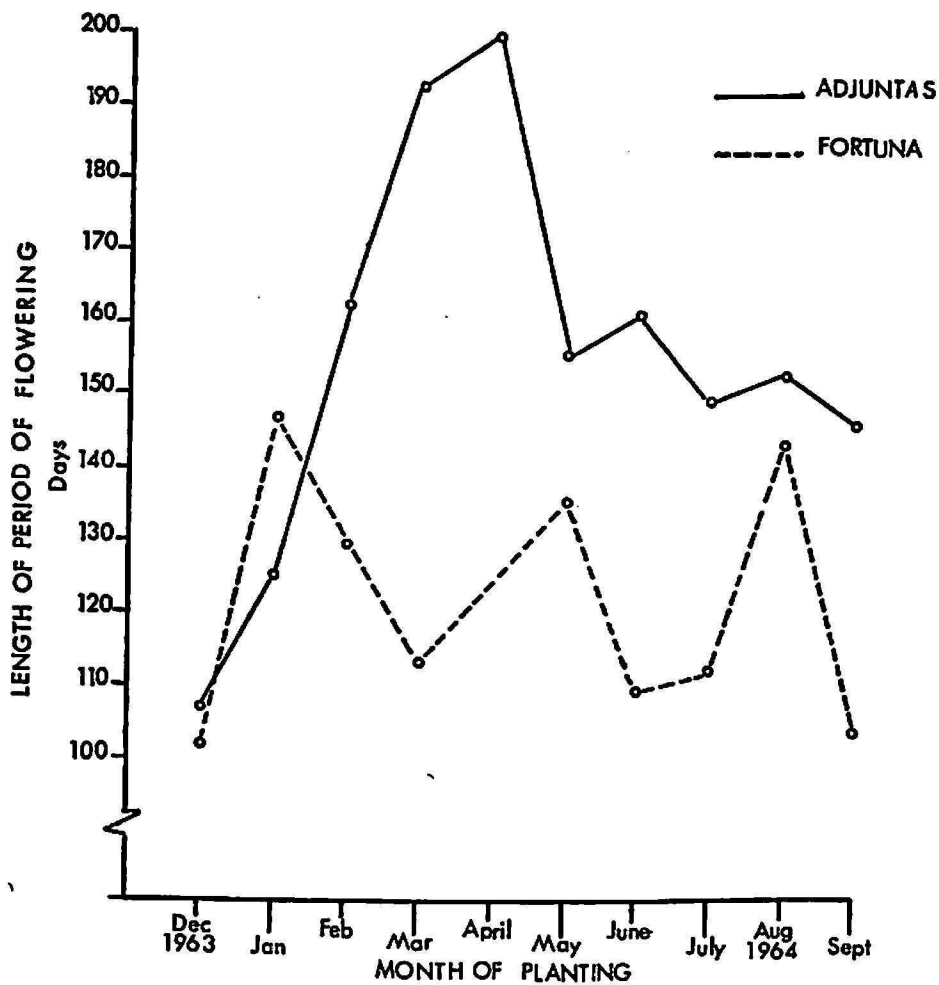


FIG. 2.—Relation of the length of the flowering period to the time of planting.

plants flowering during the second cycle from June to December. At Fortuna, although three cycles are apparent with approximately equal maximum peaks, the flowering distribution is in general similar to a normal distribution. Undoubtedly, at Adjuntas, the higher percentage of plants flowering during the second cycle is the result of the variation of the length of the period of inflorescence with the time of planting. The long flowering span for the plots planted earlier, and the shorter flowering span of the plots planted later, have the combined effect of grouping the plants flowering in the second cycle.

Cold weather reduces development of the banana bunch. According to

Champion (2), the period from flowering to harvesting in the Canary Islands and in Australia may range from 120 to 180 days during periods of cold weather. With the low temperatures prevailing at Adjuntas, it is to be expected that bunches develop more slowly than at Fortuna. To measure the development of the fruit, the pulp:peel ratio was measured at different

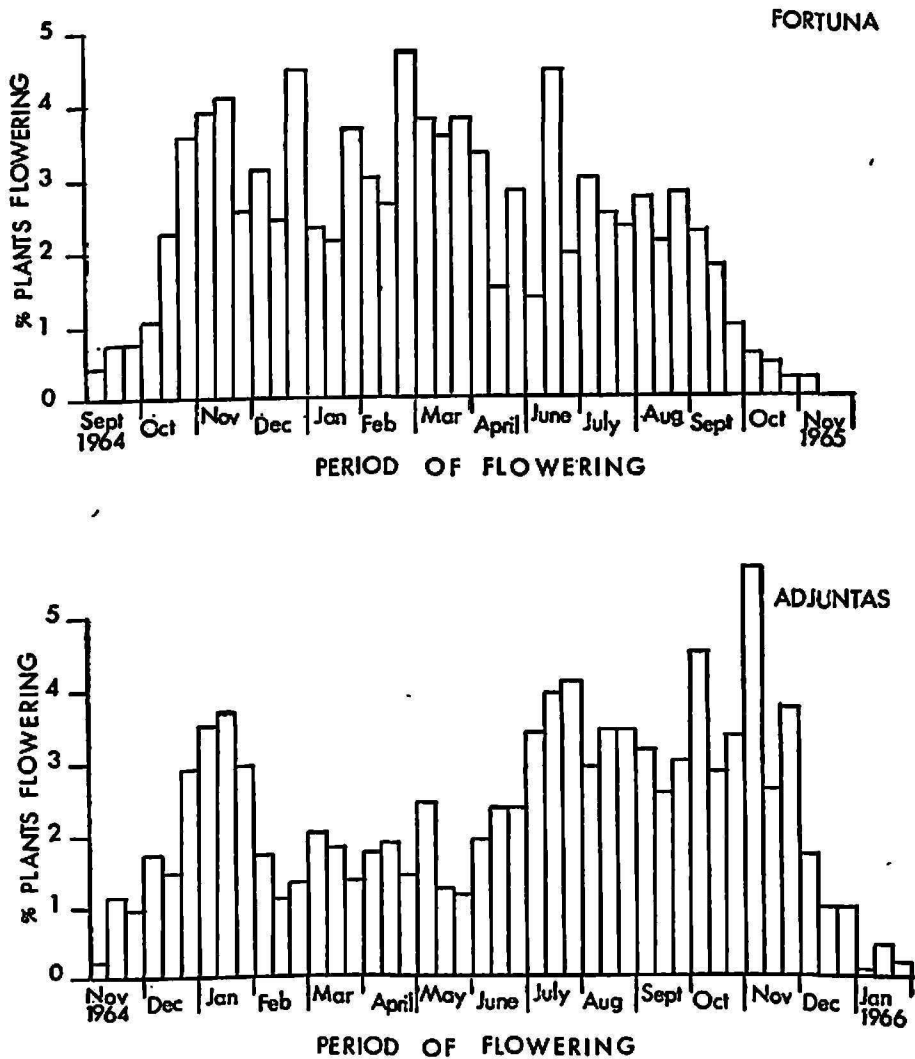


FIG. 3.—Percentage distribution of plants flowering at 10-day intervals at Adjuntas and Fortuna Substations.

intervals after shooting. Since the pulp:peel ratio changes linearly with age (3, 4), for the purpose of this study it can be assumed that fruit with similar pulp:peel ratio would be at similar stages of development.

The age of the bunches harvested from plants blooming within calendar months, grouped according to their pulp:peel ratio, is given in table 2. For the 6 groups of pulp:peel ratios shown in the table, the age at harvesting measured from shooting always was higher at Adjuntas than at Fortuna. The slower rate of development of the bunches at Adjuntas is best seen

from the data given in table 2 for the months of flowering of November, December, and January. For a pulp:peel ratio of 1.30 to 1.39 corresponding to a "three-quarters" fruit, the bunches had to be harvested from 148 to 160 days at Adjuntas, while fruit at a similar stage of development at Fortuna, was harvested at 106 days after shooting. During the summer months with higher temperatures at both locations, the difference in age for harvesting at a given stage of development was not so great, but during this period the fruit also developed more slowly at Adjuntas.

The age at which fruit was harvested with a pulp:peel ratio of 1.30 to

TABLE 2.—Age of bunches harvested from plants blooming within a calendar month at Adjuntas (A) and Fortuna (F), the pulp:peel ratio as indicated

Month of flowering	Age in days for pulp:peel ratio indicated												
	1.20 to 1.29		1.30 to 1.39		1.40 to 1.49		1.50 to 1.59		1.60 to 1.69		1.70 to 1.79		
	A	F	A	F	A	F	A	F	A	F	A	F	
1963													
November	139	97	160	98.5	—	104.0	—	107.0	175	109.0	—	—	
December	147	102	152	105.8	162	106.0	164	111.0	172	110.5	—	113.0	
1964													
January	141	108	148	103.0	157	104.5	—	122.0	—	114.0	—	130.5	
February	125	99	—	105.7	—	108.0	—	111.0	—	115.0	124	119.0	
March	—	—	139	93.0	148	—	147	109.0	149	113.5	183	—	
April	—	—	122	—	139	104.5	131	101.0	144	—	149	—	
May	—	106.5	123	101.8	123	99.6	132	105.0	130	109.0	—	102.0	
June	117	97.0	119	99.6	124	100.0	137	102.0	137	103.0	136	102.0	
July	112	90.0	116	98.8	124	97.3	129	96.8	129	100.5	138	97.5	
August	121	106.0	124	98.2	122	99.5	131	102.9	131	104.4	145	105.3	
September	126	98.5	131	100.3	132	102.6	131	108.7	131	117.0	—	—	
October	128	99.7	130	104.0	146	99.6	172	102.0	172	—	—	—	

1.39 at both locations has been plotted in figure 4 against the month in which shooting occurred. This figure shows that the interval from shooting to harvesting at Adjuntas varies with the month of flowering, being much greater during the colder than warmer months. At Fortuna, however, the age at harvesting marketable fruit remained fairly constant throughout the year. When fruits with higher pulp:peel ratios were harvested at Fortuna, an effect of the time of flowering on the development of the fruit was observed. (5) This effect is similar to the one indicated for Adjuntas in figure 4, but because the variation in age throughout the year for a given stage of development was much less than at Adjuntas, as shown by the data in table 2, fruit could be harvested in a fairly uniform stage of development without much variation in age.

The characteristics of the fruit produced at both Substations grouped by month of flowering are given in table 3. The characteristics of fruit harvested at Adjuntas were quite different from those of fruit harvested at Fortuna. The bunches were much heavier, they had more hands and fruits per bunch, and the fruit weighed more. As to quality, the fruit at Fortuna was of much better quality from both standpoints of appearance and flavor. The Fortuna fruit ripened much more evenly and had a brighter yellow color.

The variation in weight of the bunches, the weight of the fruit and the

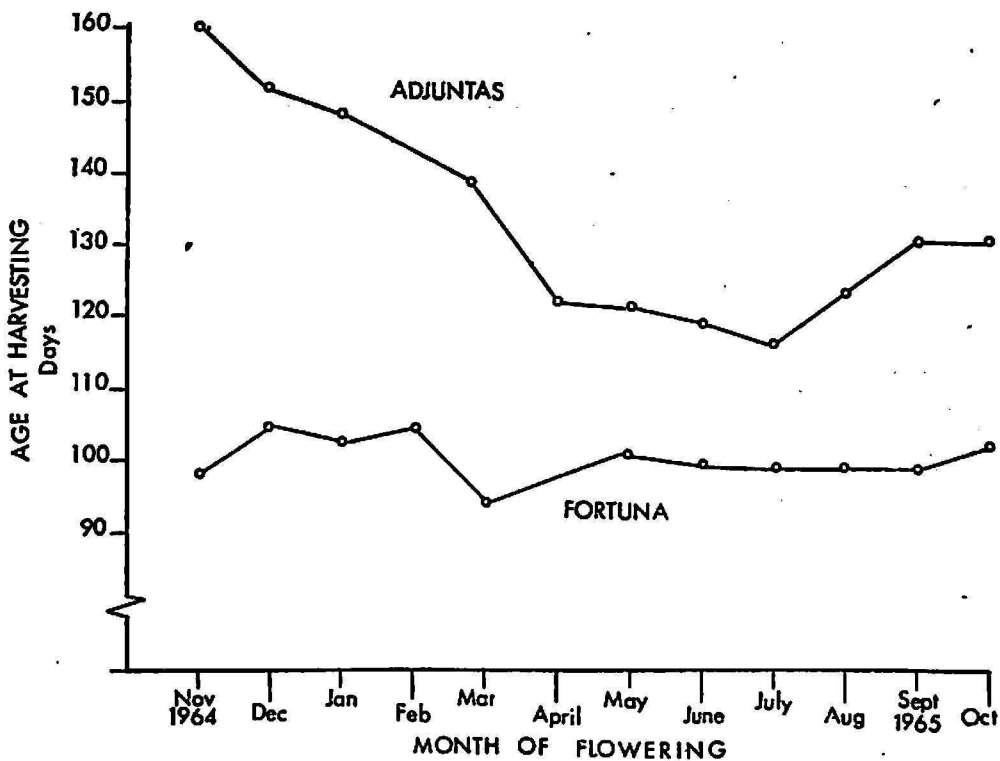


FIG. 4.—Variation in age in relation to the month of flowering in fruit with a pulp:peel ratio of 1.30–1.39.

number of fruit per bunch in relation to the month of flowering at both Substations are shown by the curves in figure 5. At Adjuntas, the weight of the bunch remained fairly constant throughout the year, while at Fortuna a change was observed in weight related to the month of flowering. The weight of the fruit at both locations varied with the month of flowering and showed the same pattern of variation throughout the year. At Fortuna, the average number of fruit per bunch remained fairly constant throughout the year, but at Adjuntas the number of fruit per bunch varied with the month of flowering.

Because the seeds used in these studies were obtained from two farms in the Adjuntas region, this may have introduced a variation in the data due to clonal characteristics. The studies thus were extended to compare

plots planted from seeds of the same origin at both Substations. Seeds in this latter study were taken from one plot at the Fortuna Substation and planted at both Substations and seeds were taken similarly from a plot at Adjuntas and planted at both locations. The plots at Adjuntas were destroyed, unfortunately, by gale winds. These plots were pruned and one sucker was allowed to grow.

The agronomical characteristics of these plots are shown in table 4. At either location, the seeds from each of the two Substations behaved alike by having the same height at shooting. It should be noted that the

TABLE 3.—*Characteristics of fruit produced by plants flowering within a calendar month at Adjuntas (A) and Fortuna (F)*

Month of flowering	Age at harvesting		Weight of bunch		Weight of fingers		Hands per bunch		Fruit per bunch	
	A	F	A	F	A	F	A	F	A	F
	<i>Days</i>		<i>Pounds</i>		<i>Grams</i>		<i>Number</i>		<i>Number</i>	
1964										
November	156	103.1	58.1	28.8	175.7	129.4	9	7	153	99
December	145	107.6	55.8	36.3	167.2	141.5	8	7	150	120
1965										
January	136	106.3	50.6	37.7	151.0	148.5	8	7	153	114
February	148	109.3	56.1	37.2	195.2	161.1	8	7	135	100
March	149	109.3	55.9	40.4	182.7	164.4	8	7	139	109
April	142	102.4	59.2	37.7	212.6	156.7	8	7	132	105
May	126	103.8	52.8	35.9	193.5	149.6	8	8	129	106
June	124	101.9	48.5	39.4	185.1	174.7	8	7	121	101
July	121	97.9	52.8	47.7	172.6	178.9	8	7	137	123
August	125	100.2	53.1	44.0	173.7	172.5	8	8	142	117
September	130	102.7	50.5	27.0	158.8	144.9	8	7	145	115
October	127	100.7	49.1	26.8	141.2	103.6	8	7	153	110

plants were about 3 feet taller at Adjuntas, while the plants at Fortuna had a larger number of leaves at shooting.

At both Substations, the plots from seeds of the same origin showed similar flowering characteristics, blooming within the same period, and having flowering spans of similar duration.

Likewise, the characteristics of the fruit harvested at each location were similar irrespective of seed origin. Bunch development was slower at Adjuntas. The bunches from Adjuntas were inferior in ripening characteristics to those harvested at Fortuna. Under similar ripening treatments, all bunches from Fortuna ripened evenly while 2 to 4 percent of the bunches harvested at Adjuntas failed to ripen or ripened unevenly. The bunches harvested at Adjuntas had an average weight of 38 pounds while those

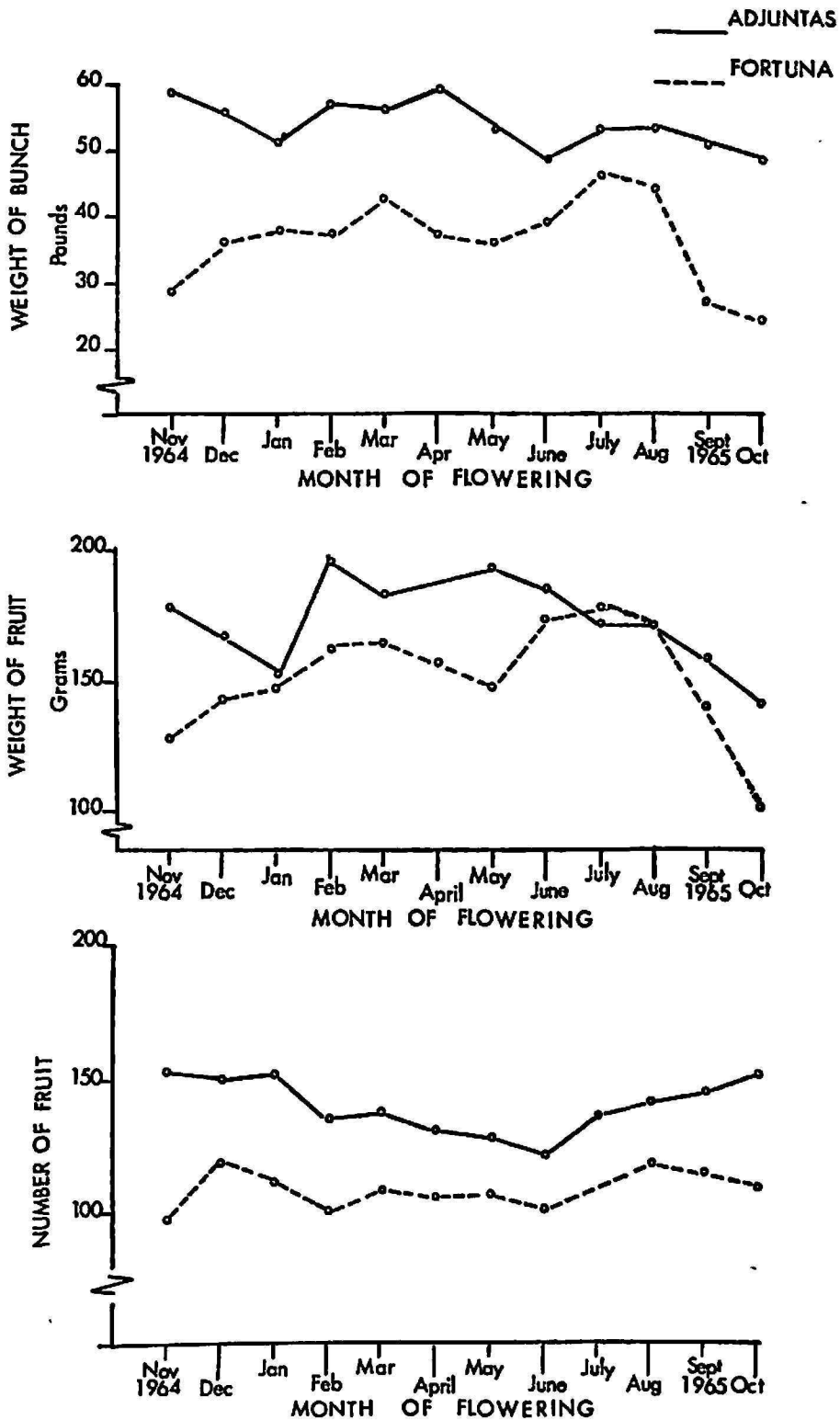


FIG. 5.—Variation in the weight of bunches and fruits, and in the number of fruits per bunch in relation to month of flowering.

harvested at Fortuna had an average weight of 51 pounds. Bunches harvested at Adjuntas in previous experiments always weighed more than those harvested at Fortuna. The lower weights recorded at Adjuntas in this experiment may have been due to unfavorable weather or because these plots were grown from suckers.

Concurrently with these studies, experiments were conducted in this Laboratory on the processing of banana puree. These experiments provided the opportunity to test the processing characteristics of bananas from both Substations. The fruit from Fortuna produced a light yellow color puree, while the puree prepared from the fruit from Adjuntas was yellower. In regard to flavor, the puree from the fruit from Adjuntas had a more pronounced banana flavor. Both purees were of good quality and in general the fruit exhibited good processing characteristics.

TABLE 4.—*Agronomical characteristics of plots planted at the Adjuntas and Fortuna Substations*

Location of plot	Seed origin	Height at shooting		Average number of leaves at shooting
		Range	Mean	
		<i>Inches</i>	<i>Inches</i>	
Fortuna	Fortuna	131-91	107.9	17
Fortuna	Adjuntas	125-96	108.9	17
Adjuntas	Fortuna	153-130	137.7	12
Adjuntas	Adjuntas	146-127	136.2	12

Several hundred bunches were harvested at each location in the course of these studies. The data from these bunches makes it possible to estimate the production of fruit which can be expected at each location under conditions similar to those prevailing during the present experiment. The weight distribution of the bunches harvested at both locations is shown in figure 6. At Fortuna, approximately 70 percent of the bunches harvested weighed from 25 to 50 pounds and the average weight for all bunches harvested was 35 to 40 pounds. At Adjuntas, 81 percent of the bunches weighed from 40 to 65 pounds and the average weight ranged from 50 to 55 pounds.

SUMMARY

A study was conducted to determine the effect of zone and climate on yields, ripening characteristics and quality of Montecristo bananas. Experimental plots were established at the Fortuna Substation on the southern coast of Puerto Rico at sea level, and the Adjuntas Substation located in the humid mountainous area at an elevation of 1,800 feet. In

plots planted monthly throughout the year, the interval from planting to flowering ranged at the Adjuntas Substation from 371 to 448 days and from 319 to 388 days at the Fortuna Substation. At Fortuna, the length of the flowering period ranged from 120 to 147 days, while at Adjuntas it ranged from 107 to 200 days. A direct relationship was observed at Adjuntas between the length of the flowering period and time of planting.

The flowering pattern of the combined monthly plots was different for

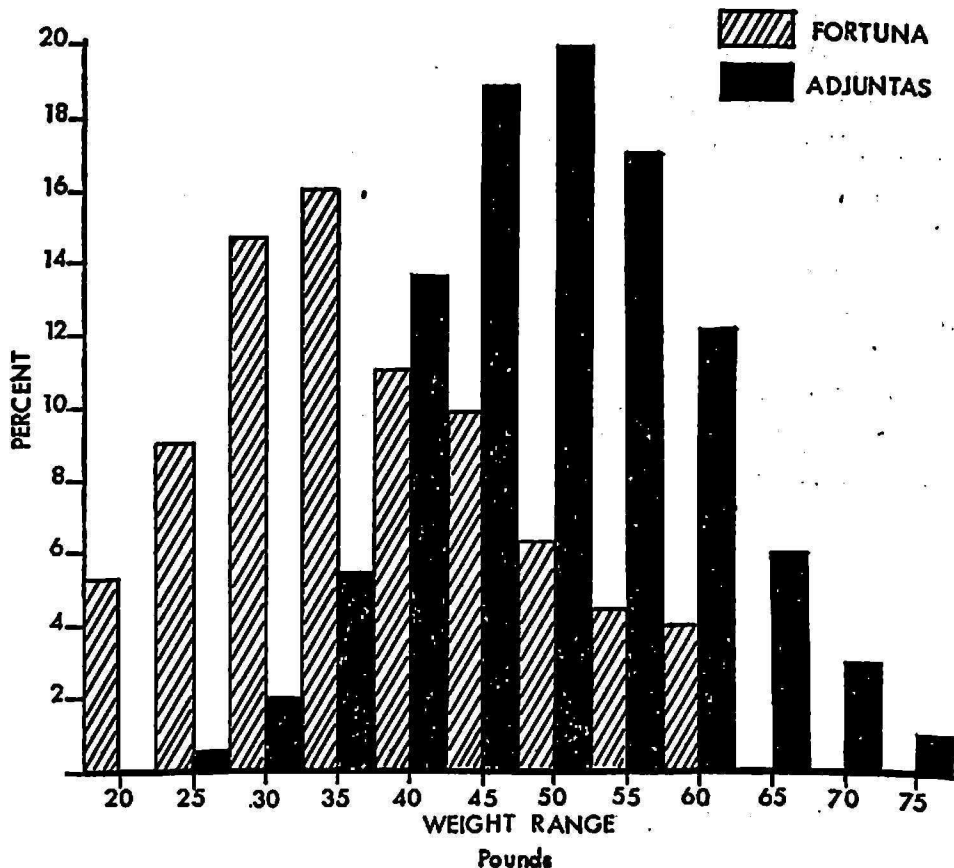


FIG. 6.—Weight distribution of bunches harvested at Adjuntas and Fortuna Substations.

the two zones. Two flowering cycles were observed at Adjuntas, with the highest percentage of plants flowering from June to December. Although three flowering cycles were observed at Fortuna, the distribution was similar to a normal frequency distribution.

Bunch development was much slower at Adjuntas than at Fortuna. The age for harvesting at a given stage of development varied with the time of flowering, but this relationship was more marked at Adjuntas than at Fortuna.

The fruit harvested at Adjuntas was quite different in characteristics from the fruit harvested at Fortuna. The bunches were heavier and the

fruit weighed more. The bunches also had more hands and more fruit than those harvested at Fortuna. At Adjuntas, the weight of the bunch remained fairly constant throughout the year, while at Adjuntas the weight of the bunch varied with the month of flowering. The weight of the fingers at both locations varied with the time of flowering while the number of fruit per bunch at Fortuna varied only slightly throughout the year.

Because the seed material used in these studies was obtained from two farms in the Adjuntas region, another set of experiments was conducted to study the behavior of the Montecristo bananas produced from seed from the experimental plots from each Substation when planted on the other. The results from these experiment showed that the seed material used in our previous studies were of uniform character and that differences observed in flowering patterns, yields, fruit quality and other characteristics were due to the effect of ecological conditions and not to clonal variation.

The fruit from both locations when processed into purees gave products of good quality. Fruit from Adjuntas produced purees of a more pronounced yellow color and the flavor was better than fruit from Fortuna. From the standpoint of fresh fruit quality, however, the fruit from Fortuna was better than the fruit from Adjuntas. The fruit from Fortuna had better ripening characteristics, ripening more evenly and with a more attractive yellow color, than the fruit from Adjuntas.

RESUMEN

Se llevó a cabo un estudio para determinar cómo afectan la zona y el clima la producción y la calidad de los guineos Montecristo de Puerto Rico. Para estos estudios se establecieron siembras experimentales en la Subestación de Fortuna en la costa sur de Puerto Rico a nivel del mar y en la Subestación de Adjuntas en la zona montañosa húmeda a 1,800 pies de altura. En predios que se sembraron mensualmente durante un año, el intervalo entre la siembra y el punto medio de la florecida varió entre 371 y 448 días en la Subestación de Adjuntas y entre 319 y 388 días en la Subestación de Fortuna. En la Subestación de Adjuntas la duración del periodo de florecida fluctuó entre 107 y 200 días, encontrándose que la variación en la duración de este periodo estaba relacionada con la fecha de la florecida. En Fortuna, el periodo de florecida fluctuó entre 120 y 127 días sin que hubiera relación aparente alguna entre la variación observada y la fecha de la florecida.

Cuando se consideraron todas las siembras mensuales en conjunto, la florecida en Adjuntas tuvo lugar en dos ciclos definidos, con el mayor porcentaje de las plantas habiendo florecido de junio a diciembre. En Fortuna se observaron tres ciclos de florecida, pero la distribución de la fre-

cuencia con que florecieron las plantas, expresada en porcentaje, se acercó a una distribución normal.

Los racimos se desarrollaron más lentamente en Adjuntas que en Fortuna. La edad para cosechar la fruta en determinado estado de desarrollo varió según la época de la florecida, pero la relación entre la edad al tiempo de la cosecha y la época de la inflorescencia fue más marcada en Adjuntas que en Fortuna, lo que dió lugar a que en la última se pudiese cosechar la fruta a una misma edad durante todo el año.

Los racimos cosechados en Adjuntas pesaron más que los cosechados en Fortuna. El peso medio de la fruta en Adjuntas fue también mayor que en Fortuna. Los racimos en Adjuntas tenían más manos y mayor número de frutas que los de Fortuna. En Adjuntas, el peso de los racimos varió muy poco durante el año, mientras que en Fortuna varió con la época de la florecida. En ambas Subestaciones el peso de la fruta varió a través del año con la época de la florecida. En Fortuna el número de frutas por racimo varió muy poco durante el año, mientras que en Adjuntas se observó una variación mayor en el número de frutas que se relacionase con la época de la florecida.

Como en estos estudios se utilizó para la siembra de los predios experimentales semilla obtenida de dos fincas en el área de Adjuntas, se creyó conveniente llevar a cabo un experimento en ambas Subestaciones para comparar el comportamiento de los predios sembrados con semilla procedente de la otra Subestación. Los resultados obtenidos del experimento indicaron que los guineos que se sembraron en ambas Subestaciones tenían características similares, por lo que se confirmó que las diferencias observadas en los guineos producidos en las dos Subestaciones eran el resultado de diversas condiciones ecológicas más bien que de diferencias clonales.

De los guineos de ambas localidades se hicieron purés de muy buena calidad. Los guineos procedentes de Adjuntas, sin embargo, produjeron purés de un color amarillo más subido y de mejor sabor que los que se prepararon de los guineos de Fortuna. Cuando se consideró la calidad de los guineos como fruta fresca, los de Fortuna siempre resultaron mejores que los de Adjuntas. Esto se debió, principalmente, a que los guineos de Fortuna maduraban más uniformemente que los de Adjuntas, y además tenían una cáscara de color más atractivo.

LITERATURE CITED

1. Banana Ripening Manual, Fruit Dispatch Co., Boston, Mass., 32 pp., 1961.
2. Champion, J., *Le Bananier*, G. P. Maisonneuve and Larose, Paris, France, 263 pp., 1963.
3. Sánchez Nieva, F., Colom Covas, G., Hernández, I., Guadalupe, R., Bueso de

- Viñas, C., Torres, A., Studies on the production of the Montecristo banana grown on the Adjuntas Region of Puerto Rico, *J. Agr. Univ. P.R.* 53 (4): 307-328, 1969.
4. Sánchez Nieva, F., Colom Covas, G., Hernández, I., Bueso de Viñas, C., Guadalupe, R., Torres, A., Studies on the production of the Montecristo banana grown on the South Coast of Puerto Rico, *J. Agr. Univ. P.R.* 53 (4): 284-307, 1969.
 5. Simmonds, N. W., Bananas, Longmans Green and Co. Ltd., London, England, 466 pp., 1960.