AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

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0089

1. SUBJECT CLASSIFICATION

A. PRIMARY: Agriculture — AF00-1110-G536

B. SECONDARY: Plant production--Tropical fruits--Bananas--Venezuela

2. TITLE AND SUBTITLE

Irrigation-fertility studies with cambur in Los Llanos,Venezuela,1969-1971

3. AUTHOR(S)

Miller,R.W.; Martinez,E.J.; Gonzalez,J.A.; Guilarte,Tito; Chavez,E.E.

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1971	104p.	ARC VE634.772.M649

7. REFERENCE ORGANIZATION NAME AND ADDRESS

Utah State

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT

10. CONTROL NUMBER

PN-RAA-038

11. PRICE OF DOCUMENT

12. DESCRIPTORS

Bananas
Cambur?
Fertilizers
Field tests
Irrigation
Venezuela

13. PROJECT NUMBER

14. CONTRACT NUMBER

CSD-2167 Res.

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

Miller, R.W.

IRRIGATION-FERTILITY STUDIES WITH CAMBUR IN LOS LLANOS, VENEZUELA

for

INTER-AMERICAN CENTER FOR THE INTEGRAL DEVELOPMENT OF LAND AND WATER RESOURCES

Project 213
OFFICE OF REGIONAL DEVELOPMENT
ORGANIZATION OF AMERICAN STATES

in cooperation with

GOVERNMENT OF VENEZUELA
UNIVERSITY OF LOS ANDES
UTAH STATE UNIVERSITY

December 12, 1969 to June 23, 1971

IRRIGATION-FERTILITY STUDIES WITH CAMBUR IN LOS LLANOS, VENEZUELA

Study period: December 12, 1969 to June 23, 1971

Raymond W. Miller[1]

Evaristo J. Martinez[2]

J. Alberto Gonzalez[2]

Tito Guilarte[2]

Eduardo E. Chavez[2]

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[1]Professor of Soils, Centro Interamericano del Desarrollo Integral de Aguas y Tierras (CIDIAT), Mérida, Venezuela and Utah State University, Logan, Utah, U.S.A.

[2]Agronomy Engineer, Ministerio de Obras Públicas, Oficina Edafológica de Occidente, Guanare, Venezuela, South America.

INTRODUCTION

The banana is a large herbaceous perennial, with a short underground rhizome, producing aerial shoots from lateral buds on the rhizome. The aerial shoot, called the pseudostem, consists of closely overlapping leaf bases forming a solid tapering cylinder. New leaves are forced up through the center of the pseudostem, and the blades expand at the top to form the crown. The inflorescence (fruiting) is carried terminally on a long smooth stem which is pushed up through the center of the pseudostem. The fruits develop parthenocarpically. On the average there is a plant-growing period of nine months followed by a three-month fruit production period. When fruit is mature, the plant is cut at the base, and a new shoot is usually already on its way, perhaps 5 to 8 months old.

The nature of the plant greatly affects the influence of treatments on the plantation. A weak plant will most often produce weak buds (suckers) which will have stunted growth during the early months while they are still dependent on the food reserves of the old plant. The influence of treatments on growth of these buds at this young stage is largely unstudied.

The banana has an adventitious root system. The roots are shallow, 15-25 cm. deep, but may extend laterally as far as 5 m. A considerable number of roots will penetrate more than a meter deep in well-aerated soils.

The climate should be warm and humid with over 1000 mm. of well-distributed annual rainfall, or there should be irrigation available.

The Llanos of Venezuela is well-adapted for banana growing if supplementa irrigation is available. Also, the banana is a popular food and a profitable crop for large and small operators.

At the present time the major banana disease has been Sigatoka which is caused by the fungus Cercospora musae Zimm. It attacks younger leaves, eventually causing dead spots which in severe cases may cause all the leaves to dry up. It must be continuously kept under control by periodic spraying.

LITERATURE REVIEW

The "banana" in Central and South America includes a large variety of fruits. McIlroy (1963) divides them into broad classes called bananas: sweet fresh and eating bananas; and plantains, a less sugary, cooking banana. Von Loesecke (1950) emphasizes the vagueness of the term "banana" by quoting data from the Indian Central Marketing Department at Delhi in 1945. This source stated that there are 400 varieties of banana in the Madras province of India alone. Haarer (1964) says this is exaggerated, that there may be 50 in all India.

The export banana primarily has been the sweet banana, generally called cambur in Venezuela. It includes several varieties grown extensively by large companies such as United Fruit Company. These plantations supply large quantities of the fresh bananas eaten in the United States. Probably the most important commercial varieties are the Gros Michel, the Lactan and the Canary or Cavendish varieties.

In comparing the important commercial varieties, McIlroy (1963) says that the Gros Michel grows to a height of 20 to 25 feet and produces more and bigger fruit than the Cavendish which grows only 5 to 8 feet tall. The Lactan is very similar to the Gros Michel, but like the Cavendish, has apparent resistance to the catastrophic Panama disease. The thin skin of the Cavendish is less desirable for shipping, but the shorter plant makes windfall losses much less. According to Haarer (1964), the United Fruit Company is considering converting to the Cavendish cambur in many locations because of blowdown problems with the taller varieties.

Irrigation Requirements

Bananas do best in warm, humid areas. Haarer (1964) recommends that bananas be planted in areas having no less than 1250 mm. of precipitation annually, and usually more than 1250 mm. of rainfall per year is better. Commercial plantations are seldom cleaned and graded. Consequently, most irrigation needed in dry periods is by sprinklers. Both gigantic systems, shooting a spray of water over the tops of the plants and the more common under-foliage sprinkler system, are used.

The amount of water needed depends on many factors: density of planting type of cultivar planted, relative humidity, sunshine heat units, thus day length and cloud cover, and soil characteristics. Arscott, Bhangoo and Karon (1965) working with the Standard Fruit Company in India claimed increased bunch weights with increased application of water up to 2.60 inches per week or 6.6 cm. It seems likely that this need would certainly vary with differen addition frequencies, soil fertility and other growth aspects.

Christiansen and Hargreaves (1968) list consumptive use data for "plátano (cooking banana or plantain) in Colombia as 70% to 110% times the Class A pan evaporation. In dry months in Guanare this would be mostly 90-110% times evaporation or 175-250 mm. per month needed. Guanare climate would have many similarities to that of the banana sites of Colombia.

Most references simply say as does Haarer (1964), "the banana plant with its huge leaves and succulent pseudostems requires more moisture throughout the year than do most plants. ...the surface soil must never be allowed to dry out; if it does, there will be severe losses of crop." Certainly, water requirements are high, but exact values will be tied to specific conditions.

In contrast to the suggestion of Arscott, Bhangoo and Karon to apply up to 216 inches of water per week, Penella (1962) makes the statement that

in deep clayey soils irrigation each 3 or 4 weeks is enough, or perhaps each 10 to 12 days in shallow or compacted clay soils. Certainly, this is a minimum amount and is a very general recommendation for many varieties and locations.

In some dry areas such as Israel, bananas have been grown using mostly irrigation (Hilgeman and Reuther, 1967). They describe dry matter losses by leaves of from 0.96 to 0.81 g/cm^2 when water decreased from 86% to 51% of the available water. Reduced photosynthesis because of restricted stomatal opening was believed to be the cause of reduced loss at lower available moisture. In one example a 13 to 17% yield increase occurred when irrigation intervals were changed from 12 to 6 days. These authors also report practice in Australia which include irrigations applied at 3 to 7 day intervals, depending on soil texture, for an annual application of about 5 m. of water.

Fertilizer Needs

As indicated under irriation requirements, specific needs depend on the situation. Jacob and von Uexküll (1966) calculate that the amount of nutrients extracted is approximately as follows in a yield of 30 toneladas (metric tons).

Element		Kg. of Element
Nitrogen	(N)	50-75
Phosphorous	(P)	7-9
Potassium	(K)	148-190

This quantity of nutrients in the fruit and its need in a short period of time (4 months) during fruit growth at each site indicates a large amount is needed in the soil. The recommendation of Jacob and von Uexküll is:

Nitrogen	(N) :	45-90 kg. of N
Phosphorous	(P) :	30-60 kg. of P
Potassium	(K) :	115-230 kg. of K

Penella (1962) has recommended for cambur and "plátano" in Venezuela the use of mixtures 10-6-15 and 12-8-15. He suggests 120 g. of the mixture per plant at the time of planting, plus 180 g. four or five months later. This equals totally about 40 kg. N/ha, 10 kg. P/ha and 48 kg. K/ha. If the plantation has been growing six or seven months, add 240 g. per site (60% of the above). However, it is obvious that these recommendations consider only even-age plantations and do not consider constant yield systems.

The Guía Agrícola '68, published by M.A.C. (Ministry of Agriculture and Animal Husbandry, Venezuela) recommends 12-8-15 and 10-6-15 mixes, thus emphasizing also the high demand for potassium. They recommend 120 g. per plant when setting the young plants, plus 180 g. per site 4 months later. At a common planting rate of 1200 plants per hectare, this is about:

Element		Kg. of Element	
Nitrogen	(N)	40	kg. of N
Phosphorous	(P)	10-12	kg. of P
Potassium	(K)	48	kg. of K

Haarer (1964) states that Messrs. Geest Industries Ltd. in the Windward Islands use the small rates per year of 4.5 kg. of N, 5 kg. of phosphate (P_2O and 9 kg. of potash (K_2O?). These are volcanic soils. Even so, the rates seem very low.

Foliar analysis to predict fertilizer needs as the crop progresses have been studied by Hewitt (1955) and Dumas (1955 and 1958), and they have recommendations.

It seems clear that fertilization of bananas until this date has been done using relatively low rates of a mixture of N-P-K, low in P and highest in K. When tall plants with large bunches are involved, perhaps high fertilizer rates increase blowdown because of size and increases fruit weight. In contrast, the shorter Cavendish cambur has a smaller bunch and may be heavily discounted commercially if it is not well fertilized. According to McIlroy (1963) "Payment is usually based on the standard 'count' bunch of 9 'hands' or clusters per stem. Smaller bunches are heavily discounted." Only the well growing Cavendish camburs consistently have 9 or more hands.

It is also known that drought delays fruiting, sometimes several months. No literature relative to delayed fruiting as a result of low fertility was encountered. The possibility of this exists. Also, with higher fertility rates, perhaps a larger number or greater frequency of fruits may be grown at a single site.

Production Problems

Besides special local problems such as strong winds, poor drainage and marginal climates, the greatest problem in production of cambur is disease. The two major diseases are Sigatoka and Wilt (Panama disease). The Cavendish variety seems to be immune to Panama disease (McIlroy, 1963)which is a serious and widespread problem without a good control. Flooding 6-18 months has removed its infection from some areas for a year or so. Presently, the growin of resistant varieties is the best solution.

The second major disease is Sigatoka, caused by a fungus Cercospora musae Zimm. Haarer (1964) says that the disease organism is Mycosphaerella musicola Leach. McIlroy (1963) states that in one year in 1936 the disease "arrived" and infected 80% of the Honduras crop. It reduces the size of the bunch, development of fingers, total weight and causes splitting of fingers. Infection takes place extensively.

Sigatoka can be controlled by spraying. Usually only the frequency and the material used vary. Frequency recommendations vary from every 10 days to every 3 to 4 weeks year around. The time of year alters the frequency needed. Drier periods need less frequent spraying.

The chemical for control is usually a copper-base or zinc material (Maneb, Zineb, Bordeaux mixture) with one of the various wetting agents such as Triton X-114. Also fine mineral oil spray has been tried (Haarer, 1964), but it can cause plant damage and usually reduces yields. In Ecuador a low volume (20-25 gallon/hectare) mist sprayer applying cuprous oxide was the cheapest control (Haarer, 1964).

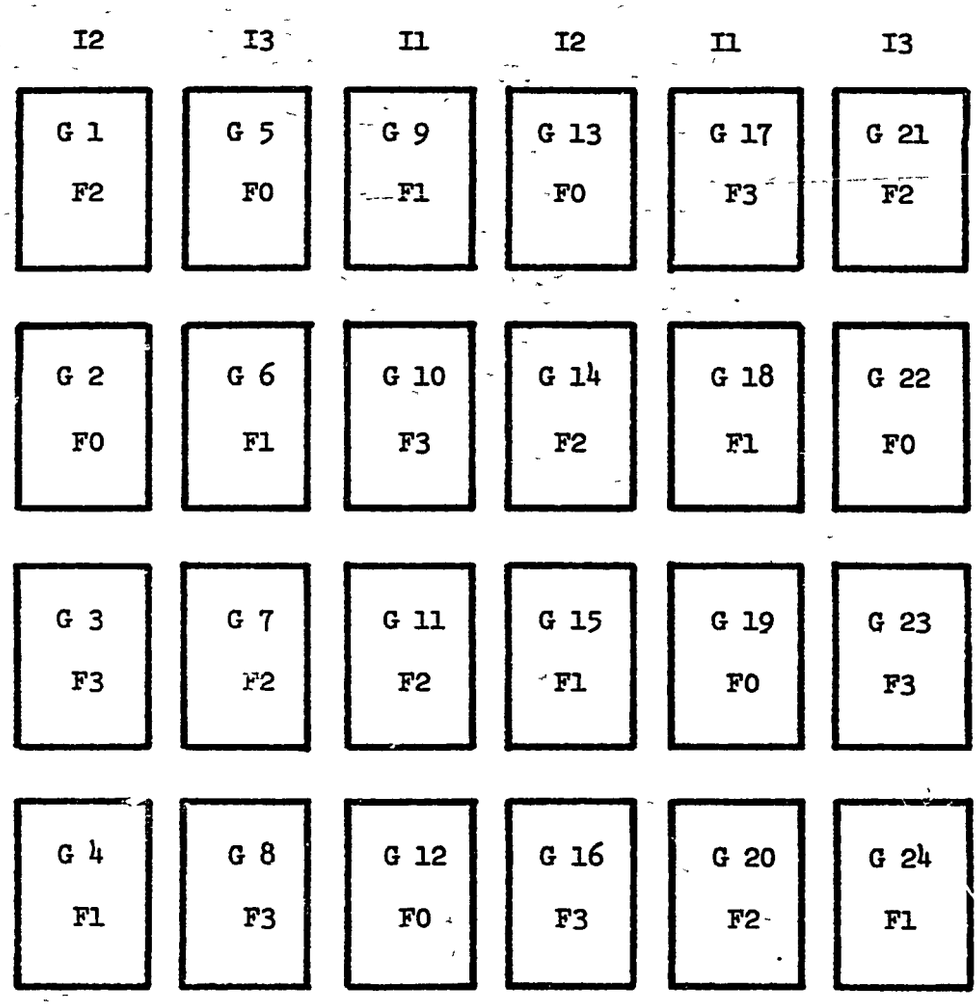
EXPERIMENTAL METHOD

Origin of the Plantations and Experimental Design

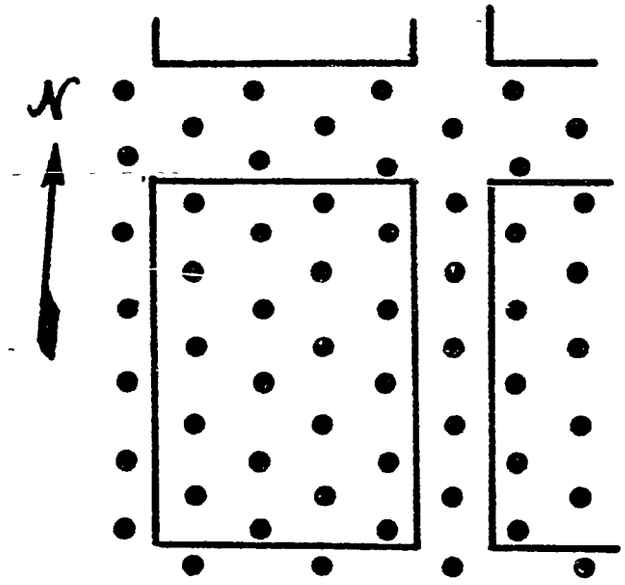
The Cavendish cambur was planted in the Sabaneta experimental plots in 1967, and starts from this plantation were planted in Guanare in 1968. The experimental variables were first applied at the end of November, 1969. Previously no treatments had been imposed at Sabaneta and only the method of irrigation, furrow versus border, was done at Guanare. No one seemed to be sure whether or not fertilizer had been applied after the initial application at planting time.

The Guanare plantation had obvious growth differences. The western and northwestern one-third was quite good. The eastern one-third and southeastern one-half was in much poorer condition. The several extreme eastern rows of the area had plants less than one-third the height of the better sites. A visual estimate of site condition was made of each delineated lot in early December. Plots had 20 sites each (4 rows by 5 sites) separated by one row as a border (5.2 m. between treatment sites). Originally, 2 rows for separation had been planned, but a portion of the area was wanted for cocoa growth. So the number of border rows was reduced to one each. This was a bad choice because leaking dikes allowed some "dry-treatment" plants to get water when they were supposed to stay dry. The head-to-foot directio lots were separated by 3 rows of plants (6.0 meters from treatment A to B pl The details of the plan are given in Figure 1.

The Sabaneta plantation was more than twice the size of the one in Guanare, and double the number of plots were established. Also, plots were 20 sites but occupied a smaller area due to closer planting, separated in both directions by 2 rows of plants. This separated the closest "treated" plants by 6.75 meters. The plan of the Sabaneta cambur experiment is given in Figure 2.



Plot Detail



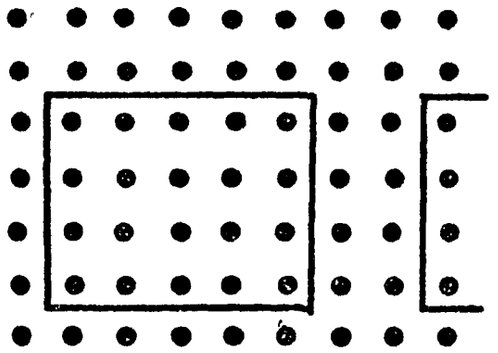
Irrigation and Fertilizer Levels

I1 No irrigation
I2 Irrigation each 13-14 days
I3 Irrigation each 6-7 days

F0 No fertilizer
F1 20 Kg N, 10 Kg P, 50 Kg K — Per hectare per year 1/4 added each 3 months
F2 Double F1
F3 Double F2

Figure 1. Experimental layout for Cavendish cambur (banana) plantation in Guanare, Venezuela. Planted in patterns of equilateral triangles with sides three meters long. December 1969-February 1971. In plot detail each dot is one growing site. Irrigation borders are each a block of 4 vertical plots as shown.

Plot Detail



Top Half

I3	I1	I2
17 F1	9 F3	1 F0
18 F0	10 F2	2 F2
19 F2	11 F1	3 F3
20 F3	12 F0	4 F1
21 F1	13 F2	5 F2
22 F3	14 F0	6 F1
23 F2	15 F3	7 F0
24 F0	16 F1	8 F3

Lower Half

I2	I1	I3
41 F0	33 F3	25 F1
42 F1	34 F2	26 F0
43 F2	35 F0	27 F3
44 F3	36 F1	28 F2
45 F2	37 F2	29 F3
46 F3	38 F0	30 F1
47 F0	39 F1	31 F0
48 F1	40 F3	32 F2

Irrigation and Fertility Levels

I1 No irrigation
I2 Irrigation each 11-12 days
I3 Irrigation each 5-6 days

F0 No fertilizer
F1 30 Kg N, 15 Kg P, 75 Kg K — Per hectare per year, 1/4 each three months
F2 Double F1
F3 Double F2

Figure 2. Experimental layout for Cavendish cambur (banana) plantation in Sabaneta, Venezuela. Planted in square pattern 2.25 meters between plants. February 1970-June 1971. In plot detail, each dot is one growing site. Irrigation blocks are eight plots long as shown vertically in the plan.

The plot layouts are shown in Figures 1 and 2. The designs were planned to include irrigation and fertilizer variables. The limited time available to perform the needed measurements resulted in selecting only 4 levels of fertilizer which differ only in amount added but not in composition. Three frequencies of irrigation were imposed on the large blocks in duplicate, with fertilizer treatments randomized in each block. (Fertilizer treatments were duplicated in each irrigation block in the Sabaneta plantation.)

A lack of exact values and the complexity of irrigating to leave a desired moisture content in the soil resulted in abandoning plans to irrigate at certain moisture contents. From February to May, 1970 all irrigation was scheduled on a day-frequency basis. The established frequency was:

	I1 (Dry)	I2 (Intermed.)	I3 (Wet)
Guanare	None	Each 13-14 days	Each 6-7 days
Sabaneta	None	Each 12 days	Each 5-6 days

Irrigation in December, 1970 to April, 1971 was established on a more precise form. Irrigation frequencies were:

I1 (Dry) Each 14 days the plot was irrigated.

I2 (Intermed.) Each 10 days the plot was irrigated.

I3 (Wet) Each 7 days the plot was irrigated.

In this latter irrigation season, irrigation water was carefully measured and added in order to approximate consumptive use. Consumptive use was considered a maximum. According to Christiansen and Hargreaves (1968), "plátano" in Colombia would have a consumptive use factor of 1.0 to 1.1. This means consumptive use equals Class A pan evaporation or 1.1 times the pan evaporation. Considering that distribution is not 100% efficient, a 25% excess was added for unequal distribution. The amounts added weekly (and proportionately larger for the 10 or 14 day interval) were:

SABANETA

Month	Class A pan evaporation	25% excess	Total added weekly
December	4.2 cm.	1.0 cm.	5.2 cm.
January	4.5 cm.	1.1 cm.	5.6 cm.
February	5.1 cm.	1.3 cm.	6.4 cm.
March	6.2 cm.	1.5 cm.	7.7 cm.
April	5.1 cm.	1.3 cm.	6.4 cm.

GUANARE

Month	Class A pan evaporation	25% excess	Total added weekly
December	3.6 cm.	0.9 cm.	4.5 cm.
January	3.9 cm.	1.0 cm.	4.9 cm.
February	4.8 cm.	1.2 cm.	6.0 cm.
March	5.0 cm.	1.3 cm.	6.3 cm.
April	4.4 cm.	1.1 cm.	5.5 cm.

Fertilizer Treatments

Fertilizer mixtures and levels were equal in both stations on a per-site basis. The levels used were:

Guanare

F0	Control, no fertilizer
F1	20 kg. N per hectare per year 10 kg. P per hectare per year 50 kg. K per hectare per year
F2	Double F1 rate
F3	Four times F1 rate

Sabaneta

The same rate per tree site was used here as at Guanare, but because of closer spacing, the rate is 1.53 times greater per hectare.

All fertilizer rates were divided into four equal parts; each quarter part was added each 3 months by putting it into 8 to 12 holes around the tree about half to three-quarters of a meter from the plant base.

Because of a fertilizer error on March 9, 1970 in which eight times too much fertilizer was added in each plot in about half of the plots, a rearrangement of irrigation blocks was done to have some plots at all fertilizer levels (F0, F1, F2, F3, F4, F5 and F6) and at all irrigation levels. This rearrangement is shown in Figure 3.

Measurements Recorded

A limited source of literature was available. However, none of the literature read suggested methods of measuring treatment effects other than to measure fruit production. It was obvious that a method was needed to measure short-time treatment influence. Fruit has a composite influence of 9 to 11 months, plus 3 months of fruit growth. To measure the influence of 3 months of irrigation, some method other than fruit must be used. The obvious alternative is to measure the the growth of the plants. The problem was to decide what to measure and how to report it. Preliminary measurements were simply the height of the "stem" and circumference of the stem at the base. But some plants grew short and thick; others grew tall but slender. Volume of the stem seemed a possibility. In comparison of racime yields versus plant size there seemed to be a fairly good relation between stem volume and racime size. Other factors altered the correlation such as having 2 plants on the same site producing fruit at the same time, or having no young plants to compete with the fruiting plant. For this reason, only sites having a single fruit and none harvested 3 months prior and 2 months afterwards were plotted. This provides a less confused picture of the racime weight-stem size relation. It was decided to record both plant volume and fruit yields.

Volume Calculations

Plant Volume. Volume was considered to be a measurement more related to plant growth and eventual fruit production than any other simple diameter-height relation tried. The somewhat uniformly tapered stem suggested the use of the formula for a truncated cone which is:

$V = 1/6\ H\ (S_0 + 4S_1 + S_2)$ where, H = Height
S_0 = Base Area
S_1 = Mid-Height Area
S_2 = Top Area
V = Volume

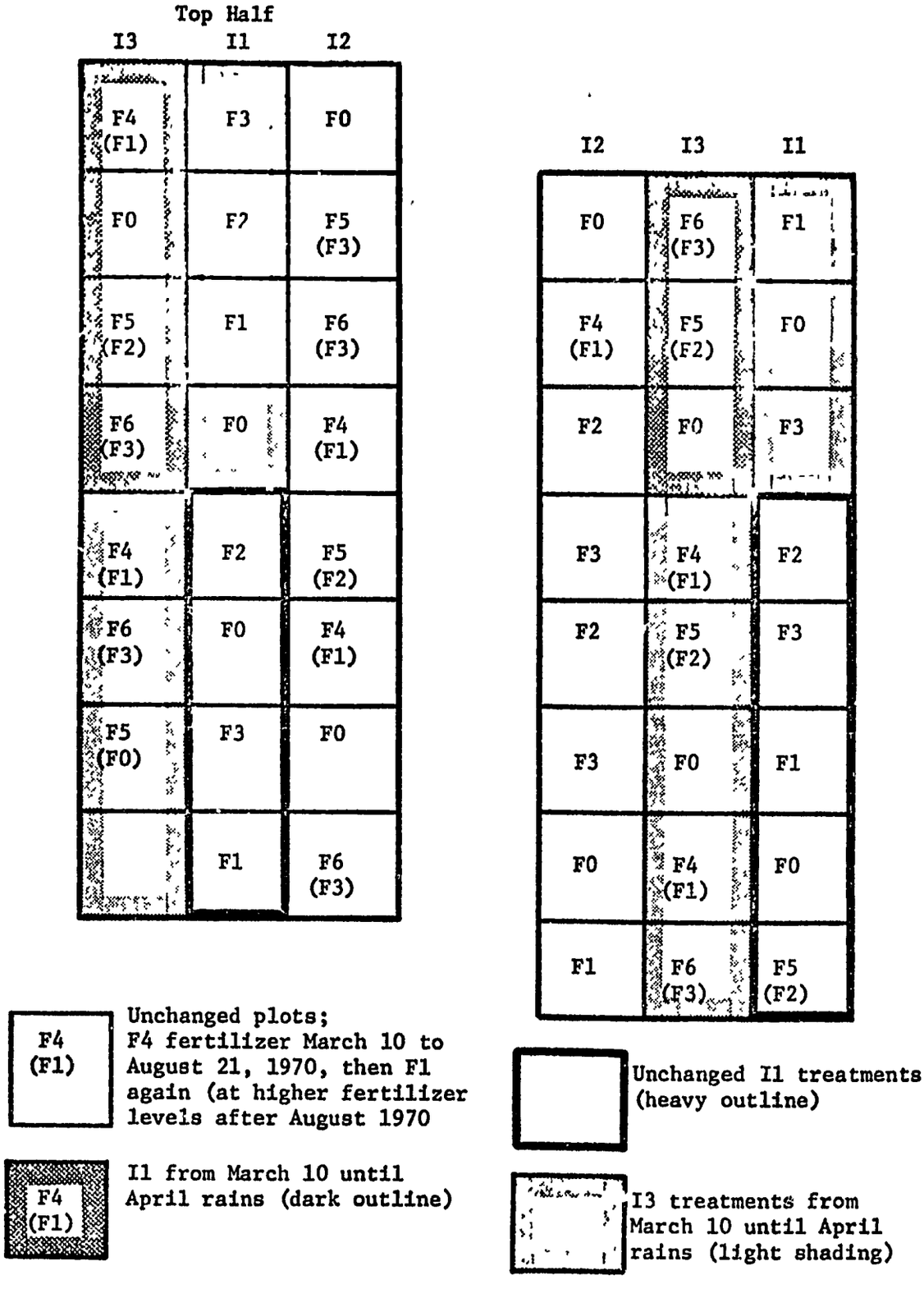


Figure 3. Plot layout for Sabaneta cambur, indicating irrigation changes made for March 10 to April 10, 1970, to have all combinations of fertilizer-irrigation treatments. Irrigation in 1971 continued as shown in Figure 2.

The formula is much too complicated to justify its use on the hundreds of plants to be measured monthly. A simple approximation was desired. To do so several assumptions were made:

Assumption 1. All plants have the same rate of taper; only diameters and height vary. This is obviously in error, but less than would be expected. The greatest error exists between old and young plants. This age effect is reduced because the total volume of young plants is relatively small compared to that of the older plants. Thus, they contribute little to volume totals.

Assumption 2. Base circumference as measured about 10 cm. above ground level (and above the "bulb") has the following relations to circumference measured at other heights:

Base	1/2 Height	Top of Stem
100%	70%	60%

Measurements vary within young and old plants. For 1/2 height measurements, percentages varied between 76% and 62% of the base measurement with the average near 69%. The circumference at the top was between 58% and 69% and is at a point a short distance below the cross of the 2 youngest full leaves which is the point measured for height. A relation of 60% is used for this value, but this diameter is impossible to measure well in reality because of the spreading leaf ribs that are flexible.

Assumption 3. Although the two assumptions already made are in some error, the measurement of several sites for each plot will tend to even out the errors so that relative changes in growth will be usable. Each plot measurement averaged about 12-15 plants until June, 1970 and is double this number after June.

Using these assumptions, the equation of the truncated cone was solved using the following substitutions:

r (radius) $= x/2\pi$ where x = circumference at base, $\pi = 3.14$

$S_0 = \pi r^2 = \pi (x/s\pi)^2$ = area of base cross-section

$S_1 = \pi r^2 = \pi (0.7x/2\pi)^2$ = area of stem section at 1/2 height

$S_2 = \pi r^2 = \pi (0.6x/2\pi)^2$ = area of stem section at top

The result is a simplified equation of the truncated cone which is:

$$\text{Vol.} = 1/6 \text{ height } [\pi (x/2\pi)^2 + 4\pi(0.7x/2\pi)^2 + \pi(0.6x/2\pi)^2]$$

$$\boxed{V = 0.044\ hx^2}$$ where base circumference is used.

For volume calculations using 1/2 height circumference measurements, substitute for "x" in each factor the value "y = 0.7x" and solve for "y".

$$\boxed{V = 0.088\ hy}$$ where y = circumference at 1/2 h.

In a recheck of plants and conversion factors it was decided that the formula presented here is more closely representative of the plants studied. A different factor, 0.08, was estimated earlier and was used in this study. The reason a correction was not made in the factor for data presented is because of the large number of previous calculations done. The error is a value 11% too low for volume. However, all plants have been calculated on the same basis. The difference is not considered serious for the interpretations of this study, but will affect any comparisons of data to other studies using the correct factors. A sample graph of a family of curves used to convert circumference readings to volume is given in Figure 4.

Fruit Volume. After a few months of measurements it was noticed that no further volume growth was made by a plant with fruit, and often growth stopped even several weeks prior to fruiting. To include fruit in the volume increase of the site seemed necessary. The fruit has a density slightly less than 1.0 (it barely floats), so an approximation of density, 1.0, was used. With this estimate, weight in kilograms equals volume in liters, or thousands of cubic centimeters.

A much greater error than the density estimates exists in estimating the fruit size. All calculations could be made using actual fruit weights, but this requires waiting for harvests. A more convenient but less accurate method is to predict the weight from the line average of the graph plot of "fruit weight" versus "plant volume". Because fruit requires approximately 3 months to develop and ripen, one-third of this predicted yield is listed as fruit growth each month. Graphs of fruit size versus plant size are given for the two stations in Figures 5 and 6. In the plots great differences exist for fruit sizes because of drought, double or triple fruits, soil variation, plant genetic differences and fertilizer variables. However, the more recent use of 8 sites for each plot average tends to equalize some of these differences.

Total Records Accumulated

With some uncertainty about what records would prove useful, what variations in soils existed and what interpretations might be made over long periods of time, certain records were kept without a planned use intended for all of them. The data obtained with comments on possible uses is as follows:

1. Fruit yield per site including date, weight, hands and for several months, size of fingers (bananas). This is site inventory of production, the amount and frequency.

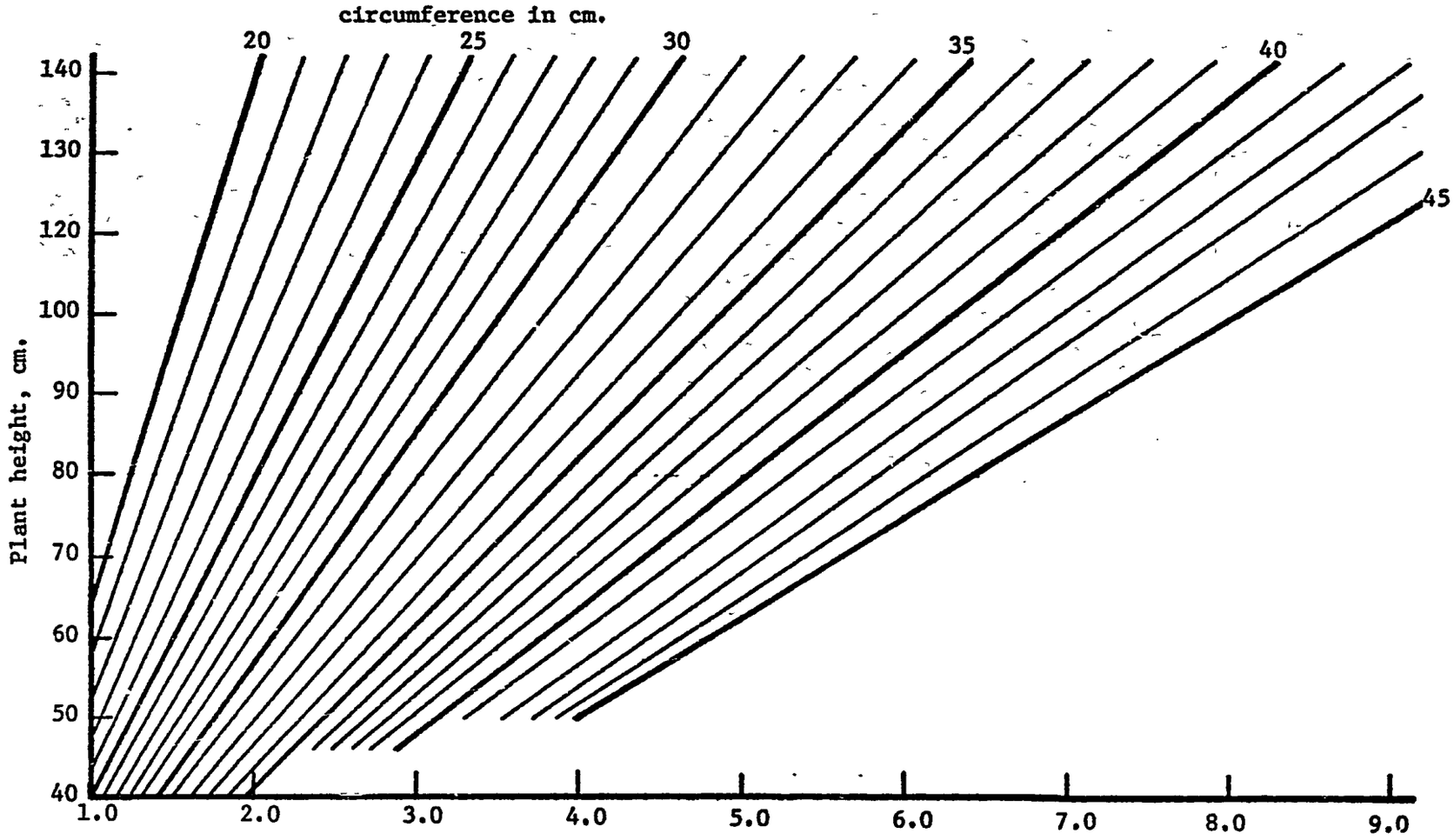


Fig. 4. Example of a family of curves used to determine the plant volume from a measurement of the circumference of the base (10 cm. above the ground level) and the height of the plant. The lines are calculated using: Volume = $\pi r^2 h$, where $\pi r^2 = x^2/12.5$ and "x" is circumference of the base.

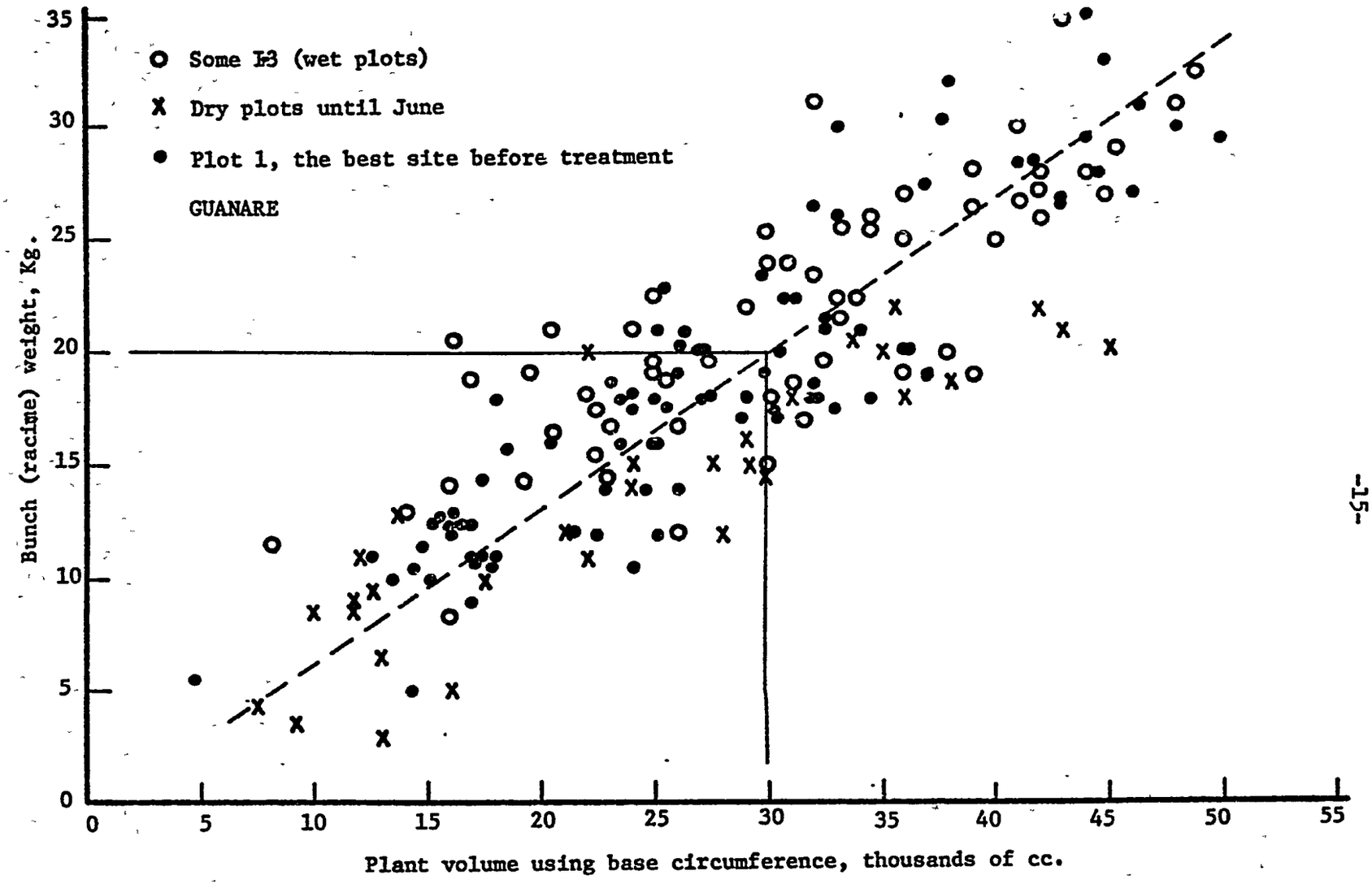


Fig. 5. Cambur bunch weight vs. plant volume using base circumference. The site had no fruit 3 months prior or within 2 months after the fruit which is plotted. Guanare station, Venezuela 1970.

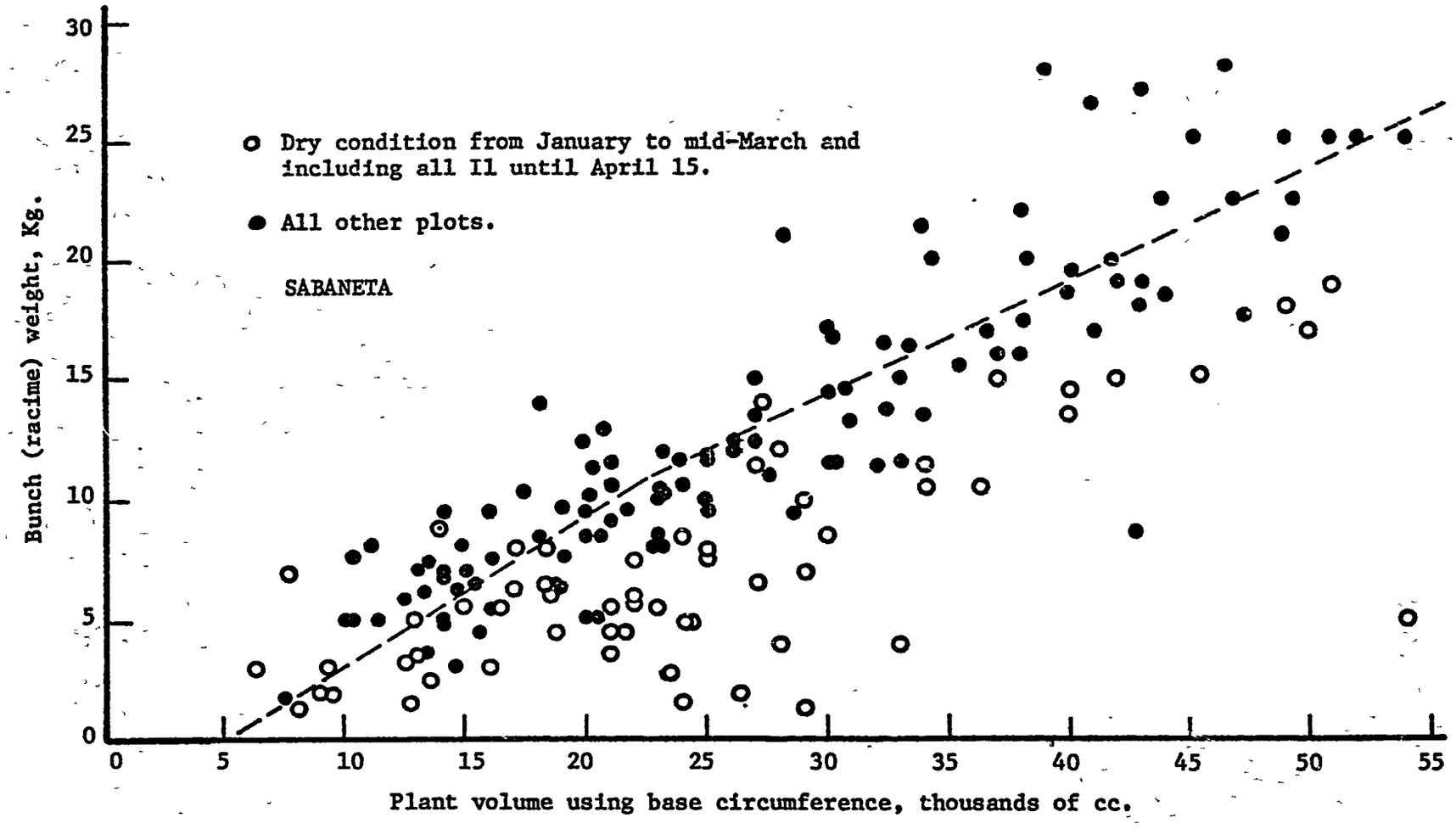


Fig. 6. Cambur bunch weight vs. plant volume using base circumference. Sabaneta station, Bocono Irrigation System, Venezuela, 1970.

2. Plant base circumference and height of each harvested plant. This is a record of plant volume - fruit size for hundreds of plants. Also recorded is the treatment and fruiting frequency of the site to use for comparisons. The possible soil and plant variations make it possible to compare treatment effects on each site (whether or not the production of the site has increased, stayed the same or decreased).

3. Growth measurements were made monthly on 4 sites of each plot. In June, 1970 this number of observations was increased to 8 sites, and in August to 16 sites with one-half of the sites measured each month. These data make it possible to follow the growth of many plants. Perhaps it is possible to determine the growth stage of the plant during which drought or low fertility is most damaging. Between 1500 and 2000 plants were measured monthly in the final 10 months. However, time does not permit complete evaluation of these data for this report.

4. Various meteorological summaries and irrigation data were collected.

Chronology of Experimental Plots

Sabaneta

Planted: 1967

1967 to February, 1970:	Lower fertility levels applied November, 1969 during dry periods. Very poor condition.
February, 1970 to March, 1970:	Lower fertility levels used, irrigated.
March, 1970 to August, 1970:	Several fertility levels or patterns, irrigated until April rains.
August, 1970 to November, 1970:	Higher fertility levels used.
November, 1970 to April, 1971:	Higher fertility levels used and irrigated.
April, 1971 to June 23, 1971:	Higher fertility levels used; measurements ceased after June readings.

Guanare

Planted: 1968, used young plants of Sabaneta station.

1968 to November, 1969:	No treatments except study of irrigation by borders versus furrows in dry period, 1969.
November, 1969 to April, 1970:	Lower fertility levels and irrigation variables applied.
April, 1970 to August, 1970:	Four lower fertility levels; no irrigation; had pale, wilted appearance; chlorotic.
August, 1970 to November, 1970:	Four higher fertility levels; no irrigation; plantation still looks poor.
November, 1970 to March 30, 1971:	Four higher fertility levels; irrigated regularly; a bacterial disease, Erwinia, identified and has no known cure.
March 30-31, 1971:	Plantation destroyed to reduce spread of bacterial disease, Erwinia.

RESULTS AND DISCUSSION

Guanare Station.

The Guanare station seemed to do well until June, 1970. When the senior author returned from a three-week trip in early June, he was appalled at the chlorotic appearance of the plantation. In the next several months the group checked previous irrigation, the spraying frequency for Sigatoka disease and tried several liming and fertilizer additions. All checks were mostly unfruitful in elucidating the cause of the poor appearance of the plantation. In October soil samples were sent to a plant pathologist to check for nematode; results were normal. Finally, a new bacterial disease seldom observed in Venezuela, Erwinia, was diagnosed by a visiting M.A.C. pathologist. With Erwinia infection, trees putrified in the stalk and often would double over because of fruit weight. The plantation was destroyed in March, 1971 to reduce spreading of the disease in the area. For this reason, only the first year produced data that could be considered "normal". Data will be presented only through September, 1970 (nine months).

Fruit Yields

The fruit yield is the ultimate measure of the value of any treatment. Unfortunately, the production time (over 12 months) is too long to isolate the effects of treatments that are applied for only a few months. Furthermore, the absence of definitive data on the stage of growth at which various treatments most affect fruit yield makes interpretation of data using only fruit yields difficult. This has been discussed in the earlier section on Experimental Method.

Figure 7 shows fruit yields graphically. Only Borders C and E had no irrigation during February, March and April and had to depend solely on rainfall for moisture. As can be seen in Figure 8, May and much of April were dry periods following 3 dry months, January, February and March. Table 1 presents a more definitive picture of the climate for this period of time. Only in June, July, August and September did rainfall exceed pan evaporation.

As expected, yield weights were low in unirrigated plots. This characteristic of reduced yield occurred even in bunches harvested in September, four months after rainfall began to exceed evaporation. This is likely an effect of producing smaller plants during the non-irrigated dry season. Perhaps, other factors such as low plant vigor during flower formation because of the harsh dry period reduced the number of hands and fingers in the bunch.

At the beginning of the study, the top portion of the plantation appeared better than other parts. The lower right corner (see plots 16, 19, 20, 23, 24 of Figure 7) was in very poor condition. This area is flatter than other portions, and growth is poor. The low quantities of fertilizer added (F3, the highest rate, had only 60 kg/ha of N added in 9 months) did not solve whatever problem existed. Plots 23 and 24 were in the wettest irrigation regime but still did not grow as did other wet sites. Even wet plots without fertilizer grew better than plots 23 and 24. (See growth on F_0 which is lot 5.)

Border B (4 vertical plots of Figure 7)particularly and plots 21 and 22 suggest a benefit of frequent irrigation. Borders A and D which were irrigated less frequently (at about 12-day intervals) also have several well producing plots. In appearance in December, 1969, plot 1 in the upper left was the best. It continued to grow and produce well during the study period even though it had neither the highest fertilizer level nor the most frequent irrigation.

A general picture of plantation improvement is tabulated in Table 2. It lists the number of sites with fruit and the percentage of total sites which bore fruit at that time.

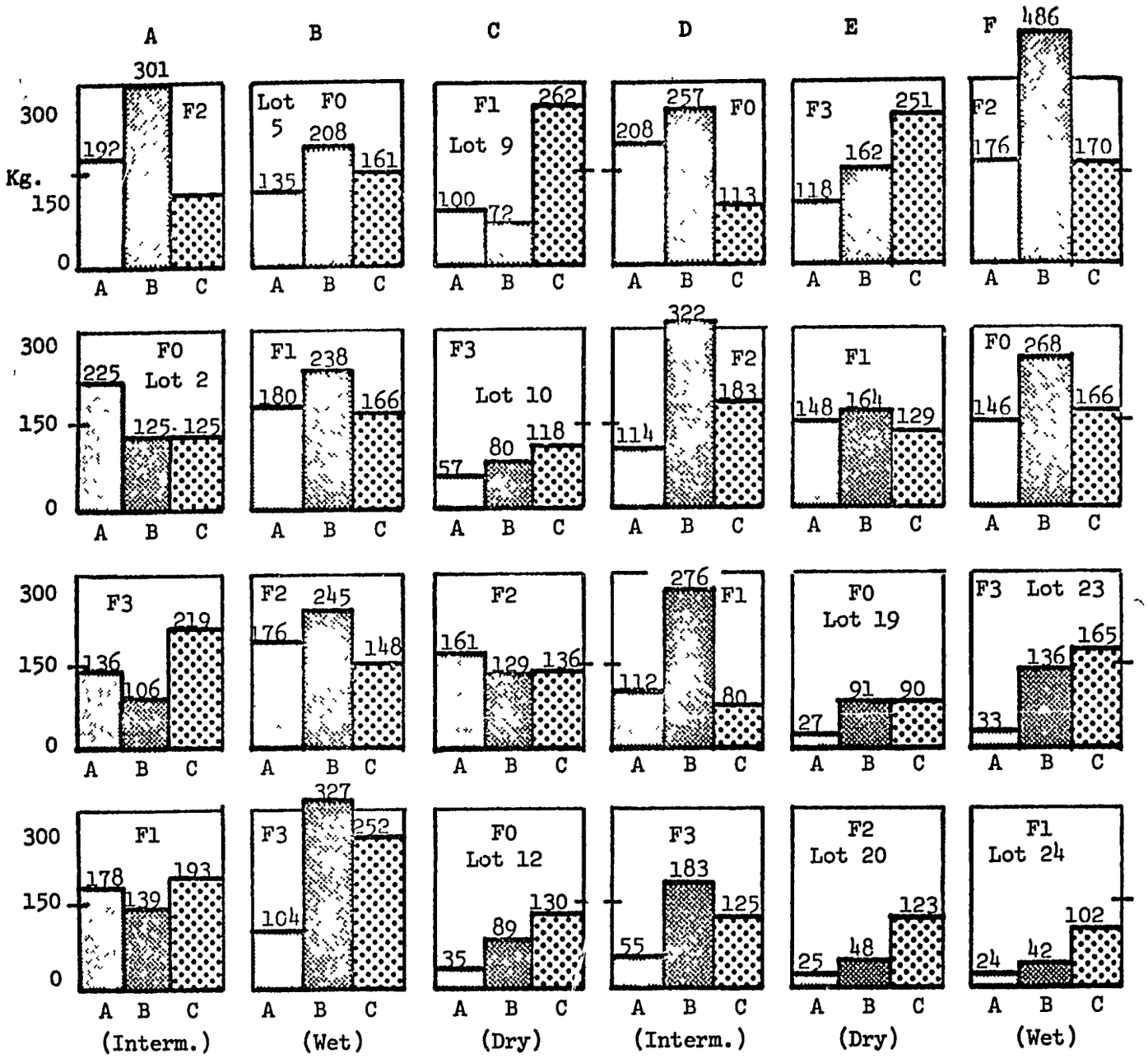


Fig. 7. Fruit production of Cavendish cambur in Guanare, Venezuela. Each bar represents a 3-month summary of kilogram yields (actual number is above the bar) and the number of bunches harvested (number not shown, but available). Bars from left to right, respectively, are (A) January-February-March 1970, (B) April-May-June 1970, and (C) July-August-September 1970. The "F" letters indicate fertilizer treatment of that lot: F0 is No Fertilizer, F1 is low, F2 is double F1 and F3 is double F2 levels. Dry months are mid-December to mid-April. In 1970, May also was dry.

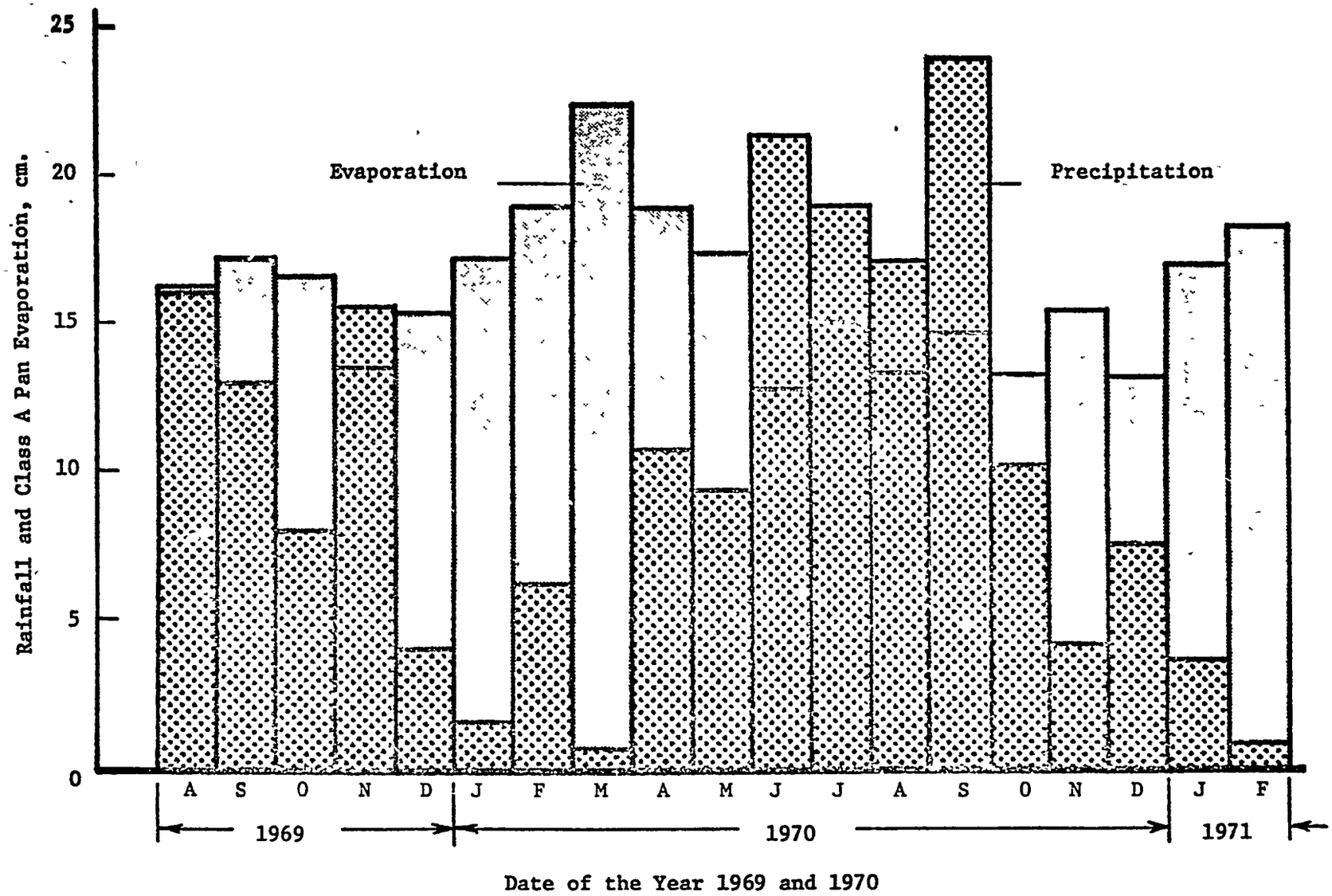


Fig. 8. Rainfall and Class A pan evaporation by months for the period August 1969 through February 1971. Guanare Station, Guanare, Venezuela.

Table 1. Summary of climatic data by month for the period December, 1969, to March 1, 1971. Guanare Experimental Station, Portuguesa State, Venezuela. The temperature and relative humidity data are averages of daily readings taken at the hours 0800, 1400 and 2000 during the day.

Month	Rain (mm.)	Evaporation (mm.)	Temperature (°C)	Relative Humidity (%)	Radiation (cal./cm^2)
December 1969	40.6	160.0	26.5	78	10,666
January 1970	20.9	171.7	26.3	74	10,679
February 1970	62.5	189.5	26.5	69	10,939
March	7.2	224.9	28.0	62	12,237
April	107.6	188.7	28.2	67	10,070
May	94.0	173.8	27.2	71	10,347
June	213.3	128.4	26.0	83	8,903
July	189.9	150.2	25.3	85	9,974
August	171.6	134.1	25.4	86	10,085
September	239.8	146.9	25.2	85	9,528
October	102.1	133.6	26.5	81	10,342
November	42.1	154.9	26.5	78	10,235
December 1970	76.0	131.5	25.4	80	8,634
January 1971	37.1	175.2	25.4	74	10,634
February 1971	8.8	183.4	26.3	65	9,865

Table 2. Change in condition of cambur plantation as indicated by a change in the percentage of sites producing fruits. First measurements in December, 1969 included all 20 sites in all treatments. The August, 1970 counts included only the 16 measured sites in each treatment. August counts were corrected to the 20 sites by multiplying actual counts by 5/4 to have them comparable to December readings. Guanare Station, Venezuela.

Description	December, 1969		August, 1970	
	Racimes	%	Racimes	%
Young and middle aged fruit racimes	152	31.9	260	54.2
Nearly mature fruit	34	7.1	56	11.7
Total Racimes	186	39.0	316	65.9

Total sites in Guanare were 480; 4 were barren of plants.

Growth Increases

To estimate growth rates both plant-volume increase and fruit growth were included. Plant volume was calculated from height and circumference measurements using graphs as illustrated in Figure 4. In the early months the method was not developed, and only a few plants were measured. Most data are from measurements of 4 sites per plot beginning in February, 1970. Undoubtedly errors also exist in more than the usual number of measurements in early data because of lack of experience.

The decision on how fruit production would be included in growth was also made later. Many earlier measurements with less emphasis given to recording all plants with fruit probably had some fruits overlooked. Low growth values would result.

A summary of cambur growth in Guanare is given in Tables 3 and 4. Both plant and fruit contributions are listed. At first glance there seems to be glaring inconsistencies such as in Plot 1 (medium irrigation and fertility) which has much higher growth than Plot 3 which has more fertilizer, or in Plot 8 which has the highest fertilizer level and is frequently irrigated. These "inconsistencies" suggest field variation.

Table 3. Growth summation of Cavendish variety cambur in the experimental station in Guanare, Venezuela. Total growth is based upon fruit weight in grams (which is equivalent to cc. of volume) plus measurements of the plant stem assuming a truncated cone shape (Page 1 of 2). Data for 1970. Per site average.

Plot[a]		Growth increases in thousands of cc.; F = fruit contribution, P = plant (stem) contribution																Total
		23/2 - 23/3		23/3 - 23/4		23/4 - 23/5		23/5 - 23/6		23/6 - 23/7		23/7 - 23/8		23/8 - 21/9				
1	I2 F2	P14.3 F4.1	18.4	P8.7 F4.1	12.8	P5.3 F2.7	8.0	P11.2 F4.8	16.0	P5.5 F6.5	12.0	P6.4 F7.1	13.5	P8.3 F4.9	13.2			93.9
2	I2 F0	P7.6 F1.4	9.0	P1.3 F3.7	5.0	P1.3 F4.0	5.3	P4.1 F5.0	9.1	P1.7 F4.6	6.3	P1.8 F4.7	6.5	P1.9 F2.5	4.4			45.6
3	I2 F3	P8.6 F0.0	8.6	P3.2 F2.7	5.9	P0.1 F3.7	3.6	P6.3 F5.3	11.6	P4.7 F7.2	11.9	P4.9 F4.0	8.9	P6.9 F4.7	11.6			62.1
4	I2 F1	P15.0 F1.8	16.8	P7.0 F0.0	7.0	P1.5 F1.6	3.1	P5.6 F7.1	12.7	P3.1 F7.7	10.8	P6.8 F7.7	15.5	P4.9 F8.7	13.1			79.0
5	I3 F0	P8.1 F1.6	9.7	P6.2 F1.4	7.6	P2.0 F4.1	2.1	P10.3 F2.9	13.2	P1.2 F4.6	5.8	P4.5 F2.3	6.8	P5.9 F6.5	12.4			57.6
6	I3 F1	P10.5 F1.7	12.2	P4.6 F7.5	12.1	P4.4 F5.8	10.2	P6.2 F5.3	11.5	P3.1 F3.2	6.3	P3.9 F3.9	7.8	P5.8 F3.5	9.3			69.4
7	I3 F2	P13.6 F1.8	15.4	P6.8 F1.7	8.5	P4.3 F2.4	6.7	P7.3 F2.4	9.7	P4.5 F9.1	13.6	P2.1 F4.2	6.3	P4.4 F4.2	8.6			68.8
8	I3 F3	P10.0 F6.2	16.2	P5.8 F3.6	9.4	P3.1 F6.2	9.3	P8.4 F1.9	10.3	P7.8 F6.0	13.8	P6.3 F3.4	9.7	P4.3 F5.7	10.0			78.7
9	I1 F1	P5.6 F4.0	9.6	P1.1 F5.5	6.6	P3.5 F1.8	5.3	P5.4 F4.6	10.0	P5.7 F7.3	13.0	P6.3 F7.5	13.8	P6.6 F3.4	10.0			68.3
10	I1 F3	P2.7 F3.8	6.5	P0.0 F4.1	4.1	P0.2 F1.9	2.1	P2.8 F2.9	5.7	P5.6 F3.3	8.9	P6.1 F4.1	10.2	P6.5 F2.6	9.1			46.6
11	I1 F2	P8.5 F1.4	9.9	P0.8 F2.6	3.4	P1.2 F2.7	3.9	P10.0 F4.3	14.3	P4.1 F4.6	8.7	P2.4 F2.9	5.3	P4.8 F3.6	8.4			53.9
12	I1 F0	P5.5 F0.0	5.5	P3.4 F4.6	8.0	P0.5 F5.8	5.3	P4.4 F4.9	9.3	P0.5 F3.9	4.4	P1.9 F4.2	6.1	P1.9 F2.8	4.7			43.3

[a] Each lot has 20 sites. I1, I2, I3 are unirrigated, irrigated each 12 days and irrigated each 6 to 7 days, respectively, during February to April 1970. F0 = no fertilizer, F1 = 20 Kg.N, 10 Kg.P and 50 Kg.K per hectare per year added in split applications each 3 months. F2 = double F1, and F3 = double F2.

Table 4. Growth summation of Cavendish variety cambur in the experimental station in Guanare, Venezuela. Growth based on fruit weight in grams = cc. of volume and measurements of stem assuming a truncated cone shape. (Page 2 of 2). (cont. table)

Plot[a]	Growth increases in thousands of cc.; F = fruit contribution, P = plant (stem) contribution																Total
	23/2 - 23/3		23/3 - 23/4		23/4 - 23/5		23/5 - 23/6		23/6 - 23/7		23/7 - 23/8		23/8 - 23/9				
13 I2 F0	P4.3 F9.4	13.7	P0.6 F8.1	8.7	P4.2 F5.6	9.8	P7.6 F0.9	8.5	P5.7 F0.9	6.6	P3.3 F2.4	5.7	P4.3 F4.7	9.0			62.0
14 I2 F2	P10.8 F5.3	16.1	P4.2 F5.8	10.0	P6.0 F3.0	9.0	P8.1 F2.7	11.0	P4.3 F5.2	8.3	P5.3 F2.5	10.5	P4.5 F2.5	7.0			71.9
15 I2 F1	P8.0 F5.8	13.8	P2.6 F5.8	8.4	P0.6 F5.8	6.4	P4.1 F2.6	6.7	P5.2 F2.8	8.0	P2.1 F3.5	5.6	P6.5 F0.0	6.5			55.3
16 I2 F3	P8.2 F5.8	14.0	P1.8 F5.8	7.6	P2.1 F5.1	7.2	P6.2 F3.5	9.7	P4.0 F1.3	5.5	P2.0 F1.6	3.6	P8.6 F2.7	11.3			58.9
17 I1 F3	P5.6 F1.5	7.1	P0.0 F1.6	1.6	P2.6 F2.9	5.5	P10.1 F3.9	14.0	P7.5 F4.4	11.9	P4.8 F4.9	9.7	P6.3 F7.5	13.8			63.9
18 I1 F1	P4.3 F1.6	5.9	P4.2 F4.6	8.8	P1.6 F4.9	6.5	P9.5 F2.9	12.4	P5.7 F0.0	5.7	P5.3 F1.8	7.1	P5.5 F6.2	11.7			58.1
19 I1 F0	P0.7 F1.2	1.9	P0.3 F3.2	2.9	P1.7 F0.4	2.1	P4.4 F0.9	5.3	P1.7 F1.1	2.8	P1.1 F2.8	3.9	P1.7 F2.3	4.0			22.9
20 I1 F2	P2.0 F0.0	2.0	P0.5 F1.6	1.1	P1.7 F1.6	3.3	P6.5 F3.1	9.6	P3.4 F2.4	5.8	P3.7 F1.6	5.3	P3.0 F0.7	3.7			30.8
21 I3 F2	P4.7 F4.0	8.7	P4.9 F7.5	12.4	P2.1 F4.0	6.1	P9.4 F6.3	15.7	P4.6 F4.8	9.4	P3.5 F2.3	5.8	P9.4 F1.8	11.2			69.3
22 I3 F0	P5.2 F3.8	9.0	P6.5 F3.9	10.4	P4.1 F0.0	4.1	P12.6 F0.0	12.6	P3.1 F2.1	5.2	P1.6 F4.3	5.9	P3.3 F2.7	6.0			53.2
23 I3 F3	P3.0 F1.1	4.1	P5.4 F5.1	10.5	P0.3 F4.2	4.5	P9.4 F3.6	13.0	P7.4 F1.4	8.8	P4.0 F4.3	8.3	P6.1 F2.6	8.7			57.9
24 I3 F1	P3.9 F1.1	5.0	P5.6 F1.1	6.7	P1.7 F1.1	2.8	P4.0 F2.1	6.1	P4.6 F2.3	6.9	P3.6 F3.4	7.0	P2.8 F4.1	6.9			41.4

[a]Each lot has 20 sites. I1, I2, I3 are unirrigated, irrigated each 12 days and irrigated each 6 to 7 days, respectively during February to April 1970. F0 = no fertilizer, F1 = 20 Kg N, 10 Kg P and 50 Kg K per hectarea per year added in split applications each 3 months. F2 = double F1, and F3 = double F2.

As mentioned earlier, non-uniformity of the land area was apparent at the beginning of the study. Selecting only treatments for comparison without regard to field position masks the true picture somewhat.

Table 5 tabulates several comparisons. The top four comparisons are al adjacent plots along the top of the field. Both plots with no fertilizer (F have poorer growth. Plot 9, a non-irrigated plot, doesn't have much greater growth. The most spectacular numbers are the growth values of plots with initially poor growth (Plots 19, 20 23, 24). The non-irrigated and non-fertilized Plot 19 grew only about 40% as much as Plot 23 (maximum irrigation and fertilization).

Other selected data from Tables 3 and 4 illustrate similar conclusions. Compare in sequence Plots 10, 3 and 8, all with high fertilizer, but ranging from none to frequent irrigation. Growth increases as expected with increased frequency of irrigation (47, 62 and 79 thousand cc. respectively). Plots 17, 16 and 23, in order of increasing irrigation frequency, have apparently erratic growth values -- 64, 59 and 58 thousand cc. The poor soil area of Plots 16 and 23 cause apparently poor growth when in reality growth has improved considerably. Plot 17 on the other hand is a top-of-field plot where growth without fertilizer is considerably better than on Plots 16 and 23. If Plot 20 (a soil area comparable to 16 and 23) is substituted for Plot 17 in Table 3 (dry, and F2 rather than F3), the total seven months' growth is 30,800 cc. instead of 63,900 cc. This is a more realistic comparison of treatment effects. The latter comparison illustrates growth increases as a result of both irrigation and fertilizer.

The same conclusions for irrigation effects is reached if control (F0) plots are compared. Consider plots ranging from dry to frequent irrigation:

Plot No.	12	2	5	
Treatment	I1, F0	I2, F0	I3, F0	
Growth	43	46	58	(thousands of cc.)
Plot No.	19	13	22	
Treatment	I1, F0	I2, F0	I3, F0	
Growth	23	62	53	(thousands of cc.)

Some erratic plot data also are evident here. But various reasons help explain logically these apparent differences. Plot 12 is a bottom plot which might have had water subbing to it, as the Guanare soil series has gravel at about 1 to 1.5 meters in depth. Plot 2 was a second-from-the-top plot with a slope greater than the general land surface of the plantation; wetting was often not as good as in the top or bottom plots. In the second group, Plots 19 and 22 are in the "poor soil" area at the bottom of the field where growth before treatments was very poor. In contrast Plot 13 is in a good growth area at the top of the field. Thus, higher irrigation frequency in Plot 22 results in higher growth values than in the dry Plot 19, but the "better soil area", Plot 13, had higher growth value than did the more irrigated Plot 22.

Table 5. A comparison of growth of cambur on plots adjacent to each other to reduce the effects of soil variation that exists over the whole plantation. Guanare Station, Portuguesa State Venezuela. Growth for February 23 to September 21, 1970.

Item	Comparison 1	Comparison 2	Comparison 3	Comparison 4	Description and Observations
Treatment*	I2, F2	I3, F0	I1, F1	I2, F0	All are adjacent top-of-the field plots. Both irrigation and fertilizer differ but fertilizer seems most to increase yields.
Plot No.	1	5	9	13	
Volume increase	94	58	68	62	
Treatment*	I2, F3	I3, F2	I1, F2	I2, F1	All are plots adjacent to field bottom. Most growth occurred in high fertility, frequently irrigated plots.
Plot No.	3	7	11	15	
Volume increase	62	69	54	55	
Treatment*	I2, F0	I2, F2	I1, F3	I1, F1	A square of four adjacent plots: watering frequently or added fertilizer results in increased growth.
Plot No.	13	14	17	18	
Volume increase	62	72	64	58	
Treatment*	I1, F0	I1, F2	I3, F3	I3, F1	A square of four adjacent plots in the poorest growth area. Fertilizer additions plus water increases growth.
Plot No.	19	20	23	24	
Volume increase	23	31	58	41	

*Higher numbers indicate more frequent irrigations or high fertilizer additions, respectively. Volumes are in thousands of cc per site.

Plotted monthly growth rates graphed growth of selected plots and are given in Figures 9, 10 and 11. In Figure 9, growth in the replicate plots for the highest fertilizer treatment and the three irrigation levels is illustrated. The two non-irrigated plots (10 and 17) had small growth values for March, April and May, but grew as much as others during the rainy period and in the final dry period of January and February, 1971, when it was irrigated every two weeks.

In Figure 10, Plot 1, the best one before treatments, is shown; it continued to grow well. The two adjacent plots along the top of the field, 5 and 9, grew less. Plot 5 had no fertilizer but had the wettest irrigation. Plot 9 was the driest and was also at a low fertilizer level. Plots 2, 6 and 10 are the three plots adjacent and below Plots 1, 5 and 9. Plot 10 with its high fertilizer application did not grow as it was expected, but the growth retardation is mostly before higher fertilizer rates were added in late August. Perhaps nutrient deficiency existed in this plot before the higher rates were begun.

Figure 11 shows growth values in six adjacent plots in the lower quarter of the field where poorest growth occurred when the study began. The poor growth in the first two dry months, March and April, without irrigation in Plots 19 and 20 and the low fertility (F0) in Plot 19 illustrate fertility and moisture stress effects. However, other causes of poor growth must exist. Plot 20 has poor growth even with F2 fertilizer rates, and Plot 16 exhibits retarded or equal growth after the higher fertilizer levels were added in August.

A non-accumulated monthly growth rate is plotted in Figure 12. The first noticeable pattern is a growth drop in May and a rebound in June. Irrigation water as usual was turned out of the canal in late April. But as seen in Table 1, May was quite a dry month -- 94 mm. of rain but 174 mm. of pan evaporation. The last three weeks of June were adequately wet. It seems obvious that growth loss was affected considerably by a lack of water in May. This is emphasized by the fact that growth increased in June as water again became adequate.

The seven-month growth averages are summarized in Table 6. Irrigation increased growth when irrigated and non-irrigated plots were compared. The data would favor twelve-day irrigation intervals (36% growth increase) over six-day intervals (28% increase). Several experimental observations discount this idea. First, more I2 irrigation plots exist in areas producing better growth before treatments began. Thus, more of the I2 plots exist on relatively well producing soil areas. Second, the I3 or wettest regime had one border in the poorest growth area of the field, especially in Plots 23 and 24. This would lower I3 irrigation plot yield averages. Third, there were enough known errors made in irrigation timing and application rates to reduce the actual differences previously scheduled between I2 and I3 irrigations for February and March of 1970.

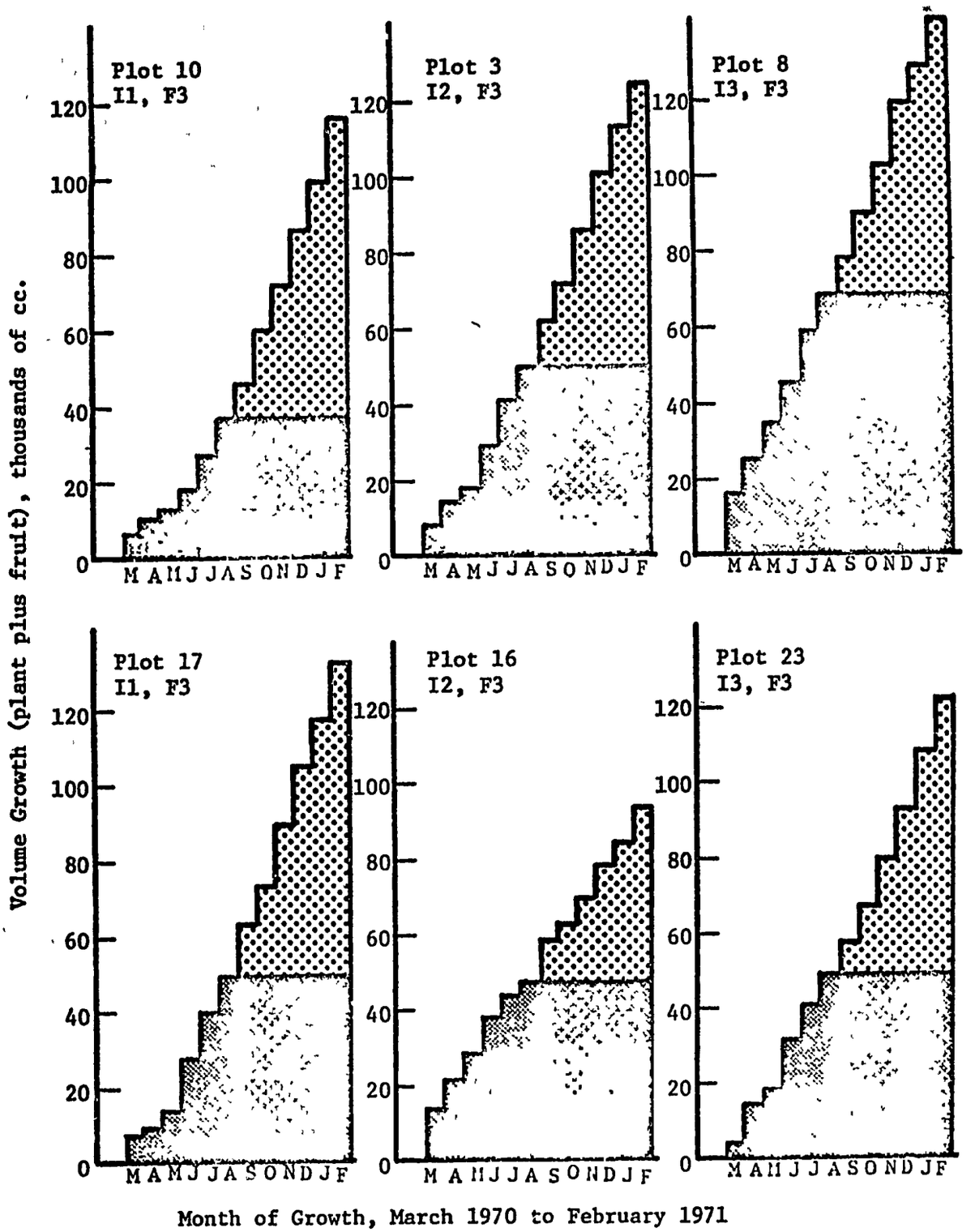


Fig. 9 . Accumulative growth of Cavendish cambur (banana) in volume of fruit plus plant, Guanare Station, Venezuela. Treatments shown emphasize high fertility (F3) at different irrigation regimes (I1 is driest, I3 is wettest).

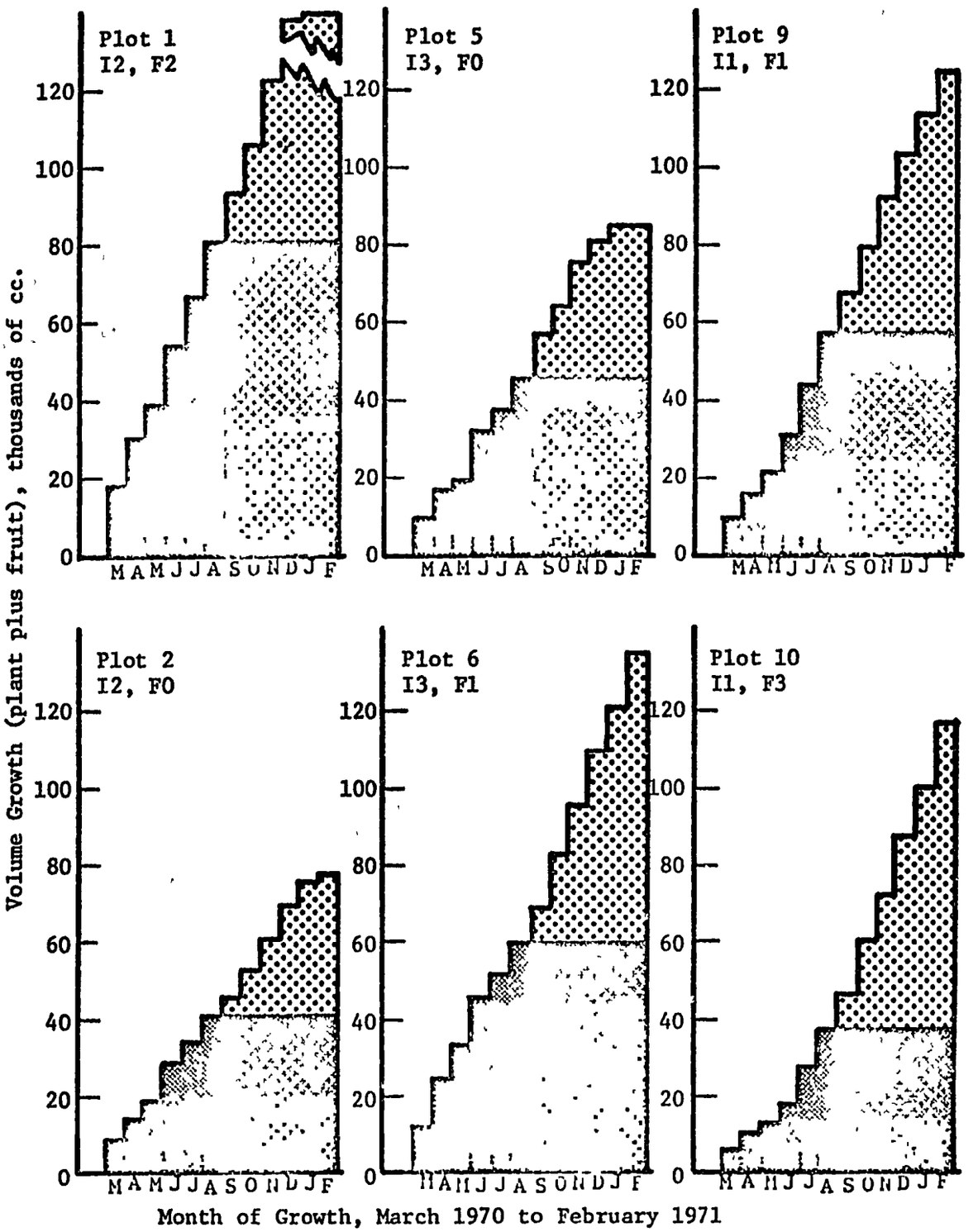


Fig. 10 . Accumulative growth of Cavendish cambur (banana) in volume of fruit plus plant, Guanare Station, Venezuela. Treatments shown are six adjacent plots in the pattern shown in the best growing area of the plantation. Plots shown vary in irrigation (I1 is driest) and fertility (F0 is no fertilizer added).

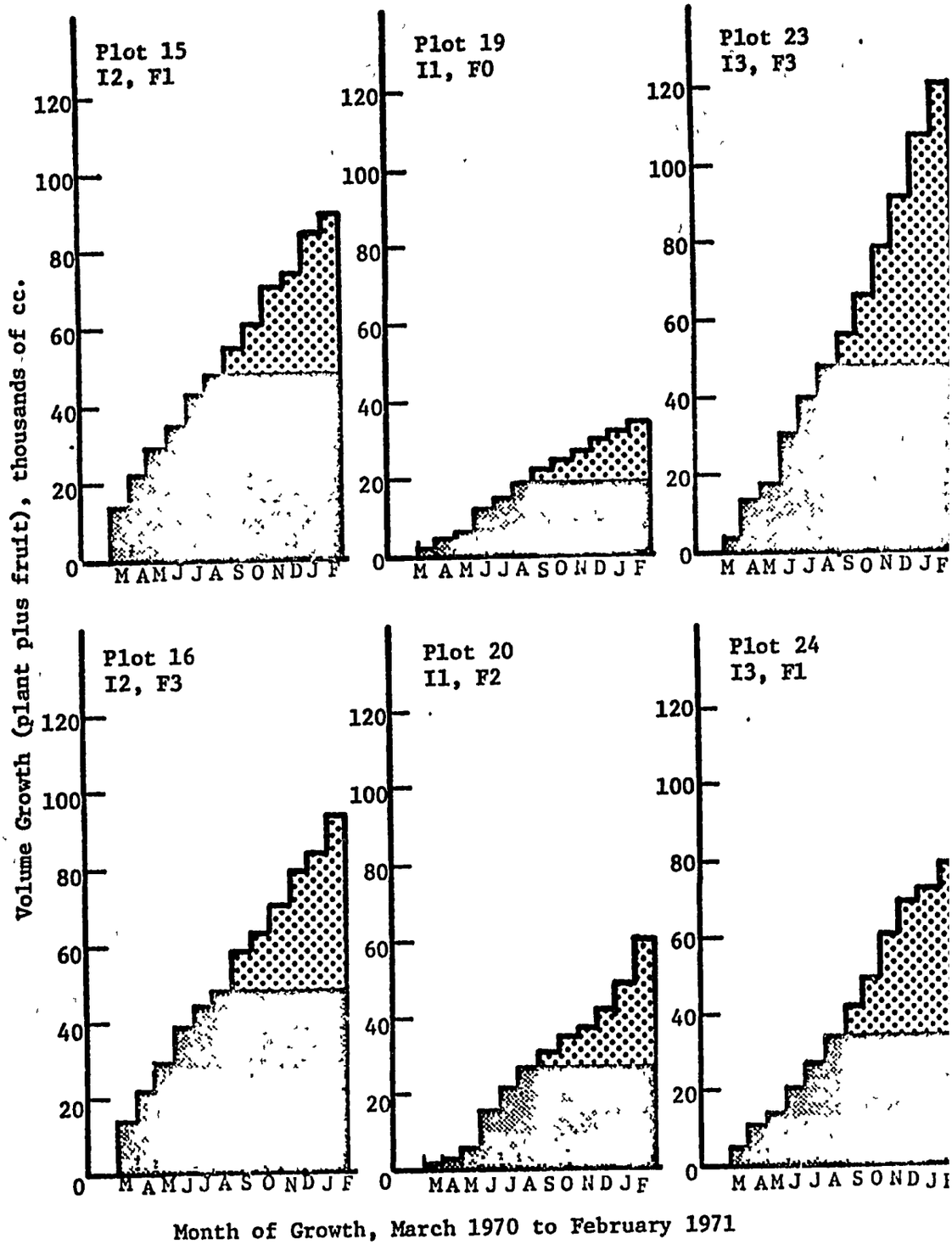


Fig. 11 . Accumulative growth of Cavendish cambur (banana) in volum of fruit plus plant, Guanare Station, Venezuela. Treatme shown emphasize six adjacent plots in a poor growing area with both irrigation and fertility variables shown. I1 is driest irrigation; F0 is no fertilizer added.

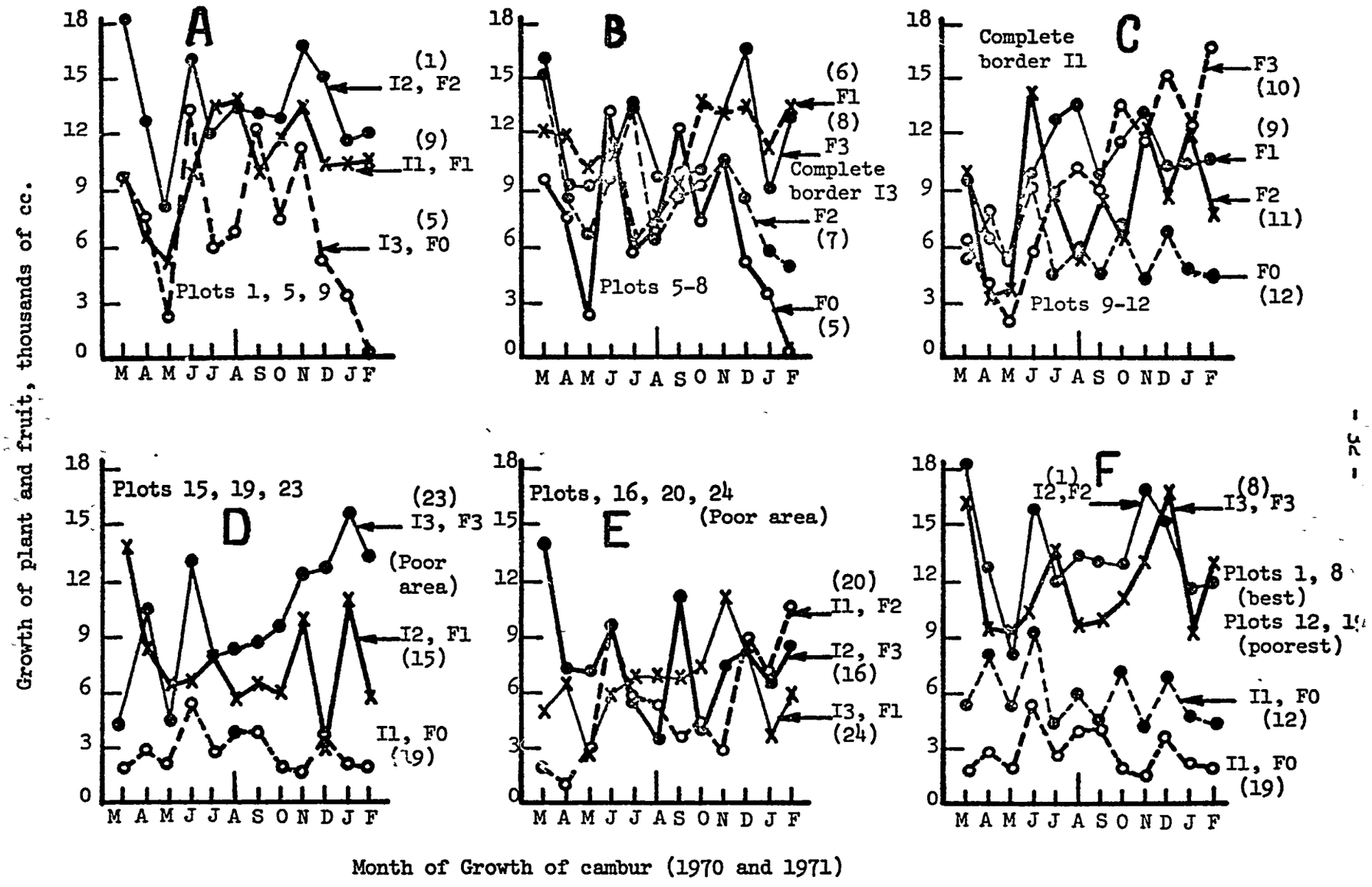


Fig. 12. Monthly growth of Cavendish in Guanare Station, Venezuela. F0 = no fertilizer, F1 = 20 Kg. N, 10 Kg. P and 50 Kg. K per hectarea per year added. F2 = double F1, F3 = double F3, F4 = double F3, F5 = F4 but only added twice a year instead of 4 times. In August, sites increased so F1 = 80 Kg. N, 40 Kg. P and 95 Kg. K per hectare per year, and only F1, F2, F3 rates were used.

Table 6. Summary of growth of Cavendish cambur (bananas) in Guanare, Venezuela, during February 23 to September 23, 1970. Each value is a summation of seven monthly averages. Each monthly average is an average of four sites (8 to 12 plants of all ages) in the first four months and an average of eight sites (16 to 25 plants) in the last three months.

Fert. level	Irrigation level, in field order						Total	Ave. per lot	% over control
	Med.	Wet	Dry	Med.	Dry	Wet			
Fo Control	(2)* 45.6	(1) 56.6	(4) 43.0	(1) 62.0	(3) 22.9	(2) 53.2	283.3	47.2	0.0
F1	(4) 79.0	(2) 69.4	(1) 68.3	(3) 55.3	(2) 58.1	(4) 41.4	371.5	61.9	31
F2	(1) 93.9	(3) 68.8	(3) 53.9	(2) 71.9	(4) 30.8	(1) 69.3	388.6	64.8	37
F3 high	(3) 62.1	(4) 78.7	(2) 46.6	(4) 59.9	(1) 63.6	(3) 57.9	367.8	61.3	30
Total	280.6	274.5	211.8	247.1	175.4	221.8	1411.2	58.9	
Ave.	70.1	68.6	53.0	61.3	43.8	55.4	58.9		

Irrigation level	Dry	Med.	Wet
% over control	0.0	36	28

* Numbers in parenthesis are positions of the treatment in that irrigation border, i.e., (1) is the lot at the top of the border, (4) is the bottom lot, at the end of the border. All growth figures are thousands of cubic centimeters of volume growth, plant plus fruit.

In addition to the reasons just given for a lack of growth differential because of irrigation schemes, the growth summations include only two irrigation months. The data of the two irrigation months are diluted by including in each total value five months of growth with rainfall as the only source of water. Thus, the data are heavily weighted in favor of "uniform moisture" -- rainfall on all plots. If only "irrigation months" are considered the data are somewhat different. During only the months having irrigation variables, growth in wet plots was about double the growth occurring in non-irrigated plots. Even if 2 non-irrigated months, May and June, are included, the "wet" borders had greater growth than the intermediate-wet borders. Perhaps a "lag" effect of growth conditions from April occurs into May and June. It seems clear that irrigation markedly increases growth during the dry months.

February 23 to April 23 (Months of Irrigation)			
	Dry	Intermed.	Wet
Growth per lot*	10.6	22.0	19.7
% over control	100%	207%	186%
February 23 to June 23			
Growth per lot*	24.9	38.8	46.9
% over control	100%	156%	188%

* Growth in thousands of cc.

Data of fertilizer effects shown in Table 6 illustrate a marked difference between none and added fertilizer (30% more growth) but no obvious influence between different fertilizer levels. Normally, increased fertilizer levels have gradually lower growth increments. There is no explanation presently available to explain this apparent inconsistency with many fertilizer trials. All levels were equal to or less than 60 kg. N/ha in nine months which are quite low additions. The highest fertilizer level, F3, did occur in more bottom-of-the-field plots where growth was poor before treatments. This result would make growth rates due to F3 appear lower than is correct for "average effects." Also, four of the F0 treatments were in the upper field plots where growth was best before treatments were applied. This plot location accident would increase F0 growth averages more than would be expected on a field average.

Rate of Growth Needed

In an effort to predict plot condition and relative growth, it seemed desirable to know approximately what growth rate was possible. Also, the growth rate was needed for the estimation of a certain production rate. The assumptions made and the growth rate-production relationships are show in Table 7. From the lower portion of this table it is possible to make comparisons to growth data listed in Tables 3 and 4. The monthly averages are shown in Figure 13. For the bunch size of 20 kg. only one plot in Guanare, Plot 1, had grown enough to produce one bunch per site per three months. Nine plots have grown too little to produce a 20 kg. bunch per si even twice a year.

Production of racimes smaller or larger than 20 kg. can be evaluated in a similar manner. A site such as Plot 2, I2, F0 (near the top) could produce about 12 kg. bunch of bananas each 4.5 months. In order to determine this, estimate average growth from Figure 13 or divide total growth (45,600 cc.) from Table 3 or 4 by the seven months involved. Then, look at the lower part of Table 7. A 12 kg. bunch each 4.5 months needs a growth rate of about 6,500 cc. per month. The single Guanare site, Plot 1 I2-F2, with measured growth capable of producing a 20 kg. racime per site each three months had an eight-month yield of 832 kg. in 37 racimes. This is a rate of 15.7 kg. for each site each three months, a value lower than that predicted. However, this yield includes fruit harvested one month before and during the first month of treatments when present treatment effects were not imposed or were too early for any appreciable effects to be seen.

Checking the Need for Calcium

The obvious decrease in growth and poor appearance of Guanare Station cambur in early June were not readily explained. Although the problem is now attributed to (1) an increase of Sigatoka because of neglected sprayin in March, April and May, (2) a dry May and (3) the attack of Erwinia, a bacterial disease; the problem at that time was still unidentified. Chlor was very evident on June 7 and could possibly have been a result of defici of Mn, Zn, Mg, Fe or Cn. The use of Zn, Cu or Mn in sprays for Sigatoka control seemed to rule out these deficiencies. Most references suggested need of cambur for a soil pH which is nearly neutral. The Guanare Station has a pH of 5.6 - 6.0, but with use of ammonium fertilizers, the pH could be much lower. Determinations done personally on moist, undried samples gave:

F0 . . . . . pH 5.85 *
F2 . . . . . pH 5.65 *
F3 . . . . . pH 5.15 *
F3 . . . . . pH 5.20 * * All are soil paste value

Table 7. Calculations of the needed volume growth and growth rate to produce one bunch of bananas (Cavendish cambur) in each planted site in a predicted time frequency. Based on the relation of plant volume versus fruit size calculated by plotting bunch weights of single fruits per site without other fruits harvested at least three months prior or two months after the fruit plotted from that site. Guanare and Sabaneta experimental stations, Venezuela.

Basic Assumption No. 1

The plant volume needed to produce various sized bunches are as follows, taken from actual data after plotting fruit versus plant volume:

	Guanare	Sabaneta
35 kg. bunch . . .	56,000 cc.	74,000 cc.
30 kg. bunch . . .	47,500 cc.	63,500 cc.
25 kg. bunch . . .	38,700 cc.	53,000 cc.
20 kg. bunch . . .	30,000 cc.	42,500 cc.
15 kg. bunch . . .	21,000 cc.	32,000 cc.
10 kg. bunch . . .	15,000 cc.	22,000 cc.

Basic Assumption No. 2

The fruit produced in kilograms equals the fruit volume in thousands of cubic centimeters (cc) and is produced during a three month period of time from visible flowers to harvest.

Estimating Yield from the Growth Rates

To estimate the yield, assume that a new fruit and a new plant must be produced each fruiting interval selected. Distribute this growth requirement equally over the selected time interval.

Bunch size	Guanare			Sabaneta		
in kg.	each 3 months	each 4.5 months	each 6 months	each 3 months	each 4.5 months	each 6 months
35	29,700*	19,800	14,800	36,300	24,200	18,200
30	25,000	16,700	12,500	31,200	20,800	15,600
25	20,300	13,100	10,100	26,000	17,200	13,000
20	16,300	10,900	8,200	20,800	13,900	10,400
15	11,700	7,800	5,800	15,700	10,400	7,800
10	8,300	5,600	4,200	10,700	7,100	5,300

*All volumes are given in cubic centimeters, (growth + fruit)/month

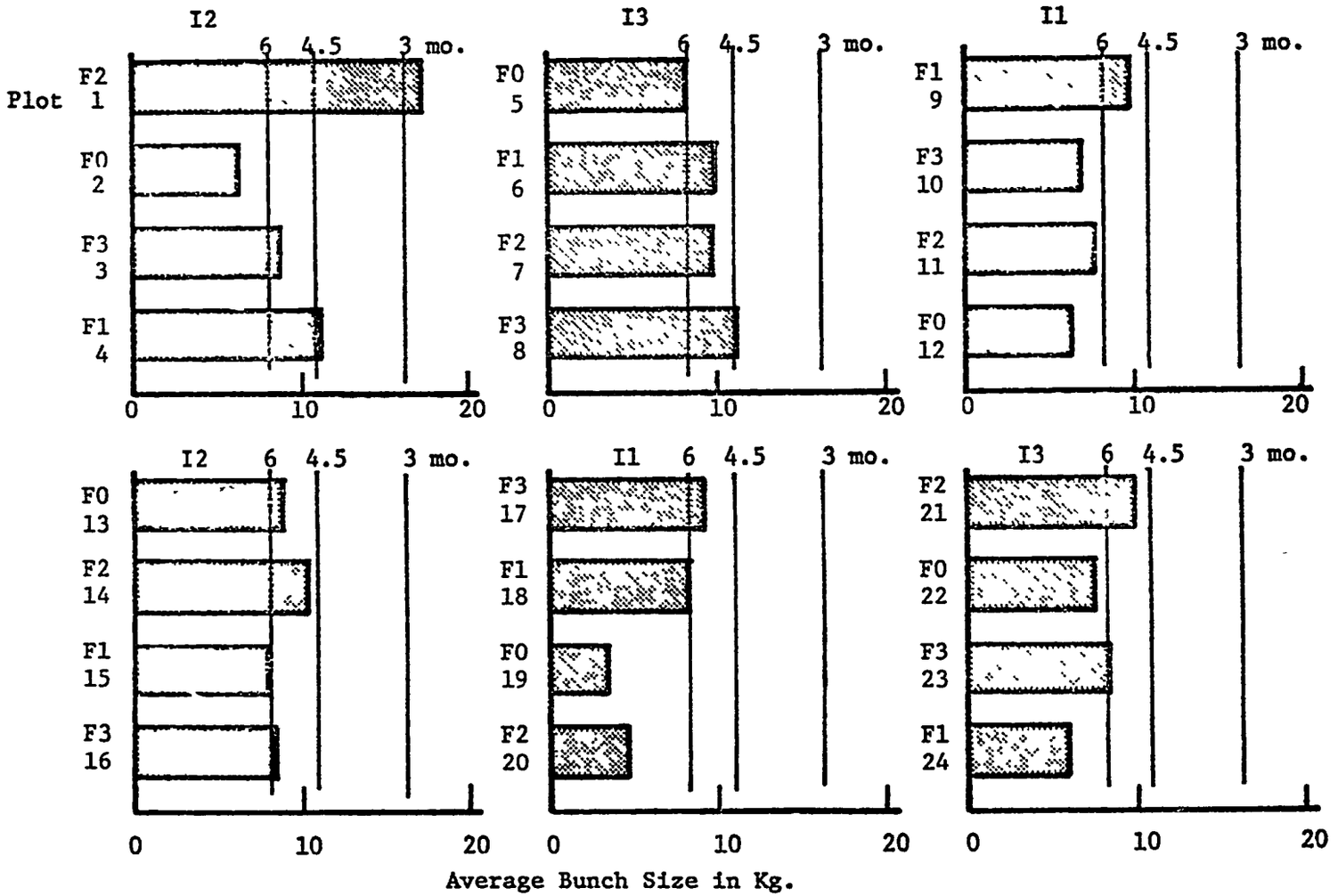


Fig. 13. Estimated production rate of Guanare banana plantation using average monthly growth values from February 20, 1970, to September 22, 1970. Vertical lines are the growth rates needed to produce a 20 kg bunch each 6 months, 4.5 months or 3 months as indicated. I1 is non-irrigated, I2 is irrigated each 12 days, I3 is irrigated each 6 days. F0 is no fertilizer, F1 is 5 kg N, 2.5 kg P and 12.5 kg K each 3 months, F2 is double F1, and F3 is double F2. Irrigation only to April 2. Portuguesa State, Venezuela.

These values were few and inconclusive. Other samples taken later, dried and measured in the laboratory all gave values greater than 6.0. This pH variation was not pursued further because plots with added CaO for raising pH (added in several holes around the site and also scratched into the surface soil) had already been set out. Table 8 contains the treatments and results; plant growth was measured monthly for two months. Rainfall during these months was adequate for growth but did not cause excess water There should not have been problems of dryness or excess ponding of water.

At the higher rates of fertilizer addition there is a tendency for growth acceleration in the second month, but the change is not marked. No evidence exists to suggest that the application of CaO had a beneficial effect. A similar study in Sabaneta gave these data (values in thousands of cc. per site):

	July	August	Total
1500 kg. $CaCO_3$/ha + 45 kg. N/ha	11.6	13.7	25.3
45 kg. N/ha	11.8	13.9	25.7
1500 kg. $CaCO_3$/ha	10.5	11.2	21.7
Nothing added	10.3	8.6	18.9

These data do not clearly demonstrate a need for $CaCO_3$. The tests were not prolonged any further.

Statistical Analysis

Statistical analyses are given in Tables 9, 10 and 11. Growth or fruit yields in different time periods were compared with treatments in order to evaluate early treatment effects, long-time effects and certain "seasonal" effects. In attempts to eliminate somewhat the field variability, some "growth-minus-the-control plot" calculations were also used in comparisons.

In the first few months of the study, growth was probably influenced by irrigation but not much by fertilizer. (See Table 9, Comparisons A and However, the statistical data indicate less than 90% confidence level for this conclusion. This positive effect of irrigation but not of fertilizer is not surprising because the fertilizer was added in small amounts. Also, one of the irrigation treatments was a "no irrigation" during a dry season which is a very harsh treatment. Fruit yields (Table 9, Comparison K) were significantly affected at a 2% level (98% confidence) by the addition of

Table 8. Growth of various sites as affected by amount of fertilizer and of added CaO worked into the soil surface. Both plant (P) and fruit (F) volume increases are given. Each value an average of 4 sites. Cavendish cambur (banana), Guanare, Venezuela, 1970.

Code Number	Treatment	Volume increase in 1000's of cc. *					
		July		August		Total	
G-1+	1500 Kg. $CaCO_3$ /ha plus 30 Kg. N/ha	P 7.3 F 2.9	10.2	P 4.8 F 2.9	7.7	P12.1 F 5.8	17.9
G-2n	30 Kg. N/ha (=25 g/N/site)	P 4.6 FO	4.6	P 7.2 F 2.4	9.6	P11.8 F 2.4	14.2
G-30	Nothing added	P 3.6 F 4.4	8.0	P 4.7 F 2.9	7.6	P 8.3 F 7.3	15.6
G-4+	1500 Kg. $CaCO_3$/ha plus 60 Kg. N, 30 Kg. P, 69 Kg. K per hectare	P 1.1 F 4.5	5.6	P 3.2 F 4.4	7.6	P 4.3 F 8.9	13.2
G-5n	As G-4+ without lime	P 3.5 F 2.3	5.8	P 5.6 F 1.1	6.7	P 9.1 F 3.4	12.5
G-60	Nothing added	P 3.4 F 2.4	5.8	P 3.7 F 1.6	5.3	P 7.1 F 4.0	11.1
G-7+	1500 Kg. $CaCO_3$ /ha plus 100 Kg. N, 50 Kg, 115 Kg. K per hectare	P 6.9 F 1.6	8.5	P 8.8 FO	8.8	P15.7 F 1.6	17.3
G-8n	As G-7+ without lime	P 4.9 P 7.0	11.9	P 8.9 F 4.3	13.2	P13.8 F11.3	25.1
G-90	Nothing added	P 7.4 F 1.4	8.8	P 4.0 F 4.3	8.3	P11.4 F 5.7	17.1

* Volume for plant (P), without leaf portions, and the fruit (F).

Table 9. Analysis of variance for cambur in Guanare, Venezuela, with the variables of irrigation, fertilizer differences, and irrigation-fertilizer interaction. These variables are compared to yields or growth of the plants for different time periods or different manner of calculation. All growth values in the input were in thousands of cc; yield input was in kilograms.

Source	D.F.	Sum of Squares	Mean Square	F-Distribution
A. Plant Growth from February 23 to April 23, 1970, each plot value minus the respective F0 plot's growth value.				
Replications	1	76.68	76.68	1.09
Irrigations	2	23.69	11.84	0.170
Error A	2	140.7	70.34	
Fertilizers	3	82.44	27.48	1.53
I x F	6	155.4	25.90	1.45
Error B	9	161.3	17.92	
Total	23	640.2	27.83	
B. Plant Growth from February 23 to April 23, 1970, absolute values.				
Replications	1	3,675	3,675	1.08
Irrigations	2	54,795	27,395	8.08 nearly 10% level
Error A	2	6,789	3,394	
Fertilizers	3	7,308	2,436	1.57
I x F	6	22,018	3,669	2.36 nearly 10% level
Error B	9	13,966	1,551	
Total	23	108,553	4,719	
C. Plant Growth from February 1970 to February 1971, each plot value minus its respective F0 plot's growth value.				
Replications	1	173.8	173.8	0.268
Irrigations	2	133.0	66.50	0.102
Error A	2	1298	649.3	
Fertilizers	3	1297	432.4	3.32 about 7% level
I x F	6	950.7	158.5	1.22
Error B	9	1171	130.2	
Total	23	5025	218.5	

Table 9 continued
Page 2

Source	D.F.	Sum of Squares	Mean Square	F-Distribution
D. Plant Growth February 1970 to February 1971, each plot value minus the closest FO value geographically in the field.				
Replications	1	36,348	36,348	3.92
Irrigations	2	70,045	38,522	4.15
Error A	2	18,571	9,285	
Fertilizers	3	12,397	41,325	6.34*nearly 1%
I x F	6	76,914	12,819	1.97 level
Error B	9	58,682	6,520	
Total	23	391,536	17,023	
E. Plant Growth February 1970 to February 1971, absolute values.				
Replications	1	225,040	225,040	138**about 0.3%
Irrigations	2	194,557	97,278	59.8*about 2%
Error A	2	3,261	1,630	level
Fertilizers	3	800,895	266,965	6.10*nearly 1%
I x F	6	419,761	69,960	1.60 level
Error B	9	394,316	43,813	
Total	23	2.0×10^6	88.601	
F. Plant Growth February 23,1970, to September 21, 1970				
Replications	1	60,501	60,501	47.5*about 2.5%
Irrigations	2	135,457	67,728	53.3*about 2% lev
Error A	2	2,546	1,273	
Fertilizers	3	107,944	35,981	2.49 nearly 10%
I x F	6	129,387	21,564	1.50 level
Error B	9	129,645	14,405	
Total	23	565,482	24,586	
G. Plant Growth from September 21, 1970, to February 21, 1971.				
Replications	1	65,730	65,730	12.6 about 8%
Irrigations	2	9,811	4,905	0.918 level
Error A	2	10,695	5,347	
Fertilizers	3	441,019	147,006	8.93**about 0.5%
I x F	6	147,655	24,609	1.50 level
Error B	9	148,206	16,467	
Total	23	823,117	35,787	

Table 9 continued
Page 3

Source	D.F.	Sum of Squares	Mean Square	F-Distribution
H. Plant Growth from November 23, 1970, to February 21, 1971.				
Replications	1	6,868	6,868	3.82
Irrigations	2	2,317	1,158	0.645
Error A	2	3,595	1,797	
Fertilizers	3	181,702	60,567	11.95 **about 0.3%
I x F	6	40,383	6,730	1.32 level
Error B	9	45,738	5,082	
Total	23	280,606	12,200	
I. Fruit Yield from January 23, 1970, to September 21, 1970.				
Replications	1	1,788,696	1,788,696	2.80
Irrigations	2	2.02×10^7	1.01×10^7	1.58
Error A	2	1,276,468	638,234	
Fertilizers	3	4,765,704	1,588,568	0.707
I x F	6	1.55×10^7	2,592,929	1.15
Error B	9	2.02×10^7	2,247,354	
Total	23	6.38×10^7	2,775,391	
J. Average Bunch (racime) Size, January 23 to September 21, 1970				
Replications	1	3,978	3,978	8.84 about 10% lev
Irrigations	2	11,124	5,562	12.4 about 9% level
Error A	2	900.0	450.0	
Fertilizers	3	3,239	1,079	1.15
I x F	6	7,924	1,320	1.41
Error B	9	8,448	938.7	
Total	23	35,613	1,548	
K. Fruit Yields from March 23 to May 23, 1970.				
Replications	1	554,192	554,192	13.5 about 7% level
Irrigations	2	3,889,537	1,944,768	46.6* about 2% "
Error A	2	82,116	41,058	
Fertilizers	3	1,555,436	518,479	0.579
I x F	6	3,811,168	635,194	0.710
Error B	9	8,068,367	896,485	
Total	23	1.79×10^7	780,905	

Table 9 continued
Page 4

Source	D.F.	Sum of Squares	Mean Square	F-Distribution
Replications	1	6,048	6,048	5.02
Irrigations	2	30,066	15,033	12.5 about 9% level
Error A	2	2,408	1,204	
Fertilizers	3	629.1	209.7	0.147
I x F	6	12,584	2,097	1.48
Error B	9	12,789	1,421	
Total	23	64,525	2,805	

Table 10. Analysis of Variance for cambur in Guanare, Venezuela, assuming the short irrigation period (3 months) when compared to rainy period (9 months) results in eliminating irrigation as a variable. Irrigation plots were bunched as replications.

	Measurement Used	F-Distribution for	
		Reps.	Fertility
1	Plant growth, February 23 to April 23, 1970, each plot value minus the respective F0 plots growth value	2.28#	1.30
2	Plant growth from February 23 to April 23, 1970	5.44**	1.02
3	Plant growth, February, 1970 to February, 1971, each plot value minus its respective F0 plots growth value	2.27#	3.06#
4	Plant growth, February, 1970 to February, 1971, each plot value minus the closest F0 plot value geographically in the field	2.92*	4.57*
5	Plant growth, February, 1970 to February, 1971	1.56	4.92*
6	Plant growth, February 23 to September 21, 1970	2.30#	2.08
7	Plant growth, September 21, 1970 to February 21, 1971.	0.874	7.45**
8	Plant growth, November 23, 1970, to February 21, 1971	0.445	10.5***
9	Fruit yield, January 23 to September 21, 1970	1.95	0.665
10	Average bunch (racime) size, January 23 to September 21, 1970	2.93*	0.989
11	Fruit yields, March 23 to May 23, 1970	1.14	0.655
12	Average bunch (racime) size, March 23 to May 23, 1970	4.55**	0.124

Symbols used for statistical significance
= significant at the 10% level of probability
* = significant at the 5% level of probability
** = significant at the 1% level of probability
*** = significant at the 0.1% level of probability

TABLE 11. Duncan multiple range tests for selected analyses of the Guanare Station cambur study, Guanare Irrigation System, Venezuela

1. Plant Growth February 23, 1970, to February 21, 1971 - thousands of cc/site

FERTILIZER TREATMENTS						CRITICAL VALUES	
CODE No.	MEANS	$\bar{x}_i-\bar{x}_1$	$\bar{x}_i-\bar{x}_2$	$\bar{x}_4-\bar{x}_3$	RANGE	5%	1%
F3	122.00	57.33**	11.40	7.23	Range of 4	29.2	41.9
F2	114.77	40.10*	4.17		Range of 3	28.5	40.8
F1	110.60	35.93*			Range of 2	27.3	39.2

$$\text{Critical value} = Q\ (\text{d.f. range})\sqrt{\frac{438.13}{6}} = Q\ (8.545)$$

2. Plant Growth September 21, 1970, to February 21, 1971 - thousands of cc/site

FERTILIZER TREATMENTS						CRITICAL VALUES	
CODE No.	MEANS	$\bar{x}_i-\bar{x}_1$	$\bar{x}_i-\bar{x}_2$	$\bar{x}_4-\bar{x}_3$	RANGE	5%	1%
F3	71.45	37.47**	13.20	12.77	Range of 4	17.84	25.60
F2	58.68	24.70*	0.43		Range of 3	17.42	24.98
F1	58.25	24.27**			Range of 2	16.70	24.00
F0	33.98						

$$\text{Critical value} = Q\ (\text{d.f. range})\sqrt{\frac{164.67}{6}} = Q\ (5.22)$$

3. Plant Growth November 23, 1970, to February 21, 1971 - thousands of cc/site

FERTILIZER TREATMENTS						CRITICAL VALUES	
CODE No.	MEANS	$\bar{x}_i-\bar{x}_1$	$\bar{x}_i-\bar{x}_2$	$\bar{x}_4-\bar{x}_3$	RANGE	5%	1%
F3	38.66	24.26**	10.91*	8.58	Range of 4	9.95	14.28
F2	30.08	15.68**	2.33		Range of 3	9.51	13.90
F1	27.75	13.35**			Range of 2	9.30	13.38

$$\text{Critical value} = Q\ (\text{d.f. range})\sqrt{\frac{50.82}{6}} = Q\ (2.91)$$

* Significantly different, at the 95% confidence level.
** Significantly different, at the 99% confidence level.

irrigation water during these two months. When irrigation effects are pooled and only fertilizer is considered, this effect of irrigation during the first two months of the study shows up as a difference within both error and replications (Table 10, Item 12). If irrigation regimes alter growth, but the growth changes within an irrigation block are not uniform because of soil variation, much of this "field variance or error" will show up as variation in replications (reps); thus, "reps" will be significantly different. Such a significant difference is obtained when growth is considered with irrigation treatments pooled in Items 1 and 2 of Table 10.

A second conclusion from the statistical data is that at the level of water control used in the second irrigation season, the frequency of irrigation (weekly, each 10 days or every 2 weeks) was not significant in altering growth (Table 9, Comparison H). During this comparison period, November 23 to February 21, there was rain during about three weeks; during the rest of the time irrigation was required. Perhaps the less frequent but deeper irrigations each two weeks were as effective as less water at each weekly irrigation. Also keep in mind that the plantation had increasingly more bacterial infection, Erwinia, during the six months previous to November, 1970. The attack was so intense that from November, 1970 to February, 1971 bunch sizes decreased and fruit yields were less than half the normal yield previously measured on the sites.

An illustration of the field variation in soil is evident in the statistical values for Comparisons C, D and E of Table 9. In Comparison E, growth during one year indicates that the greatest statistical significance is growth variation within replications (significant at the 0.3% level of confidence). Yet, if absolute growth values for each plot are subtracted from the nearest control plots, Comparison D, or from the control plot for that respective block, Comparison C, this error within replications is eliminated somewhat. Thus, soil variation, such as inherent fertility, aeration, drainage or other factors, is an important error in the use of this field for plot work.

The general absence of high significance of fertility-irrigation interactions is surprising. The highest statistical significance for fertilizer treatment was for the time period, November 23, 1970 to February 21, 1971, (Table 9, Comparison H). During this same time period, the irrigation season after one year of imposed treatments, there was no significant difference among the three irrigation regimes or irrigation-fertility interactions.

Fertilizer treatments caused the greatest growth differences. From February, 1970 to September, 1970, the heaviest fertilizer additions were at 80 kg. N, 40 kg. P and 200 kg. K per hectare per year. In late August, 1970, the rates were changed to values about 4.5 times higher. By pooling all irrigation variables with replications, the effect of the higher fertilizer levels was statistically significant at the 0.1% level (99.9% confidence level) as shown in line 8 of Table 10. The level of confidence decreases

as the period of measurement (1) includes all the time since application of higher fertilizer rates and (2) includes the time befor the higher fertilizer rates were added. (See Table 10, lines 8, 7 and 6 respectively.)

In an attempt to see what fertilizer addition levels were different, a Duncan multiple range test was made for three comparisons (see Table 11). All three comparisons made indicate that the greatest growth difference was between fertilized and unfertilized plots (see under $\overline{xi}-\overline{x1}$ columns). Comparisons of growth at different fertilizer levels ($\overline{x1}-\overline{x2}$ and $\overline{x4}-\overline{x3}$) has statistical significance only between the highest level (F3) and the lowest addition (F1) as shown in Item 3 of Table 11. These data and other observations justify the statement that additional growth increases likely occurred at the higher fertilizer levels, but field and management variations were large enough to mask these smaller growth increments.

As shown in Table 11, the last time period studied (November 23, 1970 to February 21, 1971) had fertilizer-treated plots different in growth from the control plots, F0, at a confidence level of 99%. Although growths in F1 and F2 plots were not significantly different, growths in F1 plots were different from growths in F3 plots. Thus, higher fertilizer levels increased growth but not as much as the first fertilizer increment did.

Sabaneta Station

The Sabaneta Station camburs in December, 1969, could hardly do anything but die or improve. Two previous years without irrigation during the dry seasons and a heavy current attack of Sigatoka fungus had the plantation looking like the best plan was a lot of kerosene and a match. An example of how severe the condition was is shown in Table 12. Although Sabaneta Station has more than double the plants of the Guanare Station, in December, 1969 Sabaneta had 8 bunches (less than 1% of the sites) nearly mature in the 905 sites inventoried. In contrast Guanare with about half as many sites had 34 (7.1%) bunches nearly mature. Eight months later both plantations improved with Sabaneta mushrooming to 180 bunches nearly mature (18.8%) and Guanare increasing to 56 (11.7%). Data on the 384 regularly measured sites in December, 1970 are interesting to compare with those of the plantation on December, 1969. The "flush of fruiting" in August, 1970, caused by rainfall in April following the dry period of January through March, had levelled off to more year-around production by December. Also, the dry December, 1969 and January and February, 1970 resulted in fewer young starts during the dry period which would be the plants maturing the following December.

Table 12. The change in condition of cambur plantation as indicated by the change in percentage of sites producing fruits. First measurements were made in December, 1969 and last readings were in August, 1970 Sabaneta Station, Portuguesa State, Venezuela.

DESCRIPTION	DECEMBER 1969		AUGUST 1970	
	RACIMES	%	RACIMES	%
Young and middle-aged fruit racimes	139	15.3	662	69.0
Nearly mature fruit	8	0.9	180	18.8
Total racimes	147	16.2	842	87.8

Sabaneta had a total of 960 sites, 55 of these without plants or with only recently planted starts. These sites were avoided for measurements and do not need to be included as corrections for the percentages given.

The comparative data are given in the following tabulation:

DESCRIPTION	DECEMBER 1969		DECEMBER 1970*	
	RACIMES	%	RACIMES	%
Young fruit in Sabaneta	139	15.3	251	27.7
Nearly mature fruit	8	0.9	154	17.0
Total racimes	147	16.2	405	44.7

* Counted 384 random sites; data extrapolated to 905 total sites that exist in the plantation with growing plants.

The production of fruit was about three times greater in December, 19 than in the previous year. Similar values measured during June, 1971 are:

	Racimes	%
Young fruit	322	35.6
Nearly mature fruit	149	16.6
Total racimes	471	52.2

This is about half of the sites producing fruit at any given time. At this rate the plantation would produce about two racimes (stalks) per site per year.

A more extensive picture of plantation growth improvement is given in Table 13. A 50 mm. rainfall on February 10 and at the beginning of irrigation on February 17 showed up as increased racime weight and total racime in March and April, 1970. Also as has just been discussed, it is likely that the dry periods in previous years cycled new young plants to begin growth in June and July, 1969 with the subsequent heavy fruit production in the following year after the needed 12 months of growth. Notice that average racime weights are only 13 to 15 kg. The drop in average bunch weight in September is probably due to several factors. First, many young plants had poor growth in the dry period of December-February 10 when they were young. Their poor growth was also a result of Sigatoka. This effect on growth of the young plant and on the final plant and bunch size is not known. This early effect probably would reduce bunch sizes 12 months later

A second cause of reduced bunch weight could be that May, the month of flower development for most of these plants, was quite dry, and irrigation water was unavailable. Third, many sites were producing two bunches at the same time. In September there could have been a higher than usual percentage of these. Individual weights of double bunches (2 per site at the same time) are usually lower than sites producing single fruits.

Several important happenings altered the data collected. First, the Sabaneta (Bocono) irrigation system has not been completed, but some major canals have been finished. It was said that there would be water in the completed portion of the canal for December, 1969 or certainly in January, 1970. Neither date was met. After applying the first portion of fertilize on November 28, 1969, the whole project was abandoned because of lack of irrigation water. When water was finally available in early February, the project was reactivated and irrigation was begun on February 19, 1970. This was after two dry months had passed, but there were still two months for irrigation treatments.

A second factor that affected the data was a misunderstanding in the application of fertilizer. Instead of distributing the amount of fertilize per site in the 8 holes around each site, the amount of fertilizer needed

Table 13. The change in racimes harvested of Cavendish cambur (banana) fr initiation of the treatments of fertilizer (November, 1969) and irrigation (February 19, 1970) to the end of September, 1970. early February the plantation was very dry and heavily damaged Sigatoka fungus disease. Some fruiting plants had no green lea left; few had more than 4 good leaves. Sabaneta Station, Bocon system, Venezuela.

HARVEST MONTH	TOTAL FRUIT* KG.	NUMBER OF RACIMES	AVERAGE RACIME WEIGHT, KG.	MAXIMUM RACIME KG.
December	174	14	12.4	17.0
January	208	28	7.4	18.0
February	587	68	8.6	19.5
March	987	114	8.6	27.0
April	826	79	10.5	24.0
May	1242	119	10.5	26.5
June	1682	108	15.6	32.5
July	4230	287	14.7	43.0
August	3944	269	14.6	39.0
September	5925	450	13.2	36.0

* About 2150 sites for fruit exist. Had also over 50 mm. of ra on February 10 to help February fruit weights some.

in the 8-hole total was added to each hole, making the application 8 times too concentrated. The senior author had been teaching a course in Mérida and returned ten days later than the date scheduled for fertilizing. Additions were just then being made. Fortunately, the ten-day delay in applyi fertilizer was a benefit. Only about half of the area had been fertilized It was possible to rearrange the watering patterns in order to retain duplicated treatments of almost all irrigation-fertilizer interactions. Now the study had fertilizer levels of F0, F1, F2, F3, F4, F5 and F6. Each successive level was double the preceding one, except that F4 equals F5 with a frequency-of-addition difference. The result was an application of what seemed to be excessive rates of nitrogen at the highest level (480 kg of N per hectare per year for F6). But it did permit observation of the influence of high and low fertilizer levels. This error in the applicatio was made on March 9, 1970.

A third problem was the incorrect totals of harvested fruit because of the robbery of bunches (racimes), especially in Sabaneta, and because of losses of fingers (bananas) through rotting, falling during harvest and being eaten by animals as they began to ripen. These losses are difficult to control or to make corrections for. Weight corrections were made on the basis of the number of bananas lost compared to the total number on the racime and the resulting weight of the racime. Robbed racimes were no corrected for because they often were unnoticed for several months.

Before treatments were begun, the lower third of the plantation had good growth. Observations resulted in two conclusions concerning this "good growth" area. First, the soil texture was finer and in places was a clay loam, ir contrast to the loam or sandy loam in the upper portion of the field. Second, it was concluded that water from rainfall accumulated at the lower part and perhaps even was available from subsoil sources during some periods of the year to keep the lower field area moist during much of the dry season. Whatever the cause, the lower third of the plantation exhibited less moisture stress than the upper two thirds of the area.

Because of a major change made in the fertilizer levels in late August 1970, the data of Sabaneta will be presented in two sections, the first seven months and the final nine months.

GROWTH OBSERVATIONS - FIRST SEVEN MONTHS

Field Variation

Growth summaries for bananas of the Sabaneta Station for the first seven months are given in Tables 14, 15, 16 and 17. As was observed at the Guanare Station, added fertilizer increases growth. One unfertilized plot, Plot 7, did have exceptionally good growth; it had the second highest

Table 14. Growth summation of Cavendish variety cambur in the experimental station in Sabaneta, Venezuela. Total growth is based upon fruit weight in grams (which is equivalent to cc. of volume) plus measurements of the plant stem assuming a truncated cone shape. Per site average. Totals do not include growth from 19-12-69 to 20-2-70.

Plot[a]		Growth increases in thousands of cc.; F = fruit contribution, P = plant (stem) contribution																Total
		12-69 to 2-70		20/2 - 23/3		23/3 - 23/4		23/4 - 23/5		23/5 - 23/6		23/6 - 23/7		23/7 - 23/8		23/8 - 23/9		
1	I2 F0	P3.2 F0	3.2	P4.4 F0.8	5.2	P5.7 F0	5.7	P5.4 F0	5.4	P5.2 F1.2	6.4	P2.1 F1.6	3.7	P10.5 F4.8	15.3	P5.0 F2.1	7.1	48.8
2	I2 F5	P1.2 F0	1.2	P5.0 F2.0	7.0	P15.8 F1.7	17.5	P12.4 F0.0	12.4	P6.0 F2.1	8.1	P1.3 F0.5	1.8	P4.2 F7.0	11.2	P1.5 F5.1	6.6	64.6
3	I2 F6	P3.1 F0	3.1	P2.6 F0	2.6	P16.2 F0	16.2	P6.1 F0	6.1	P5,6 F2,8	8,4	P2.3 F7.5	9.8	P8.7 F9.7	18.4	P4,4 F6.9	11.1	72.6
4	I2 F4	P1.1 F0	1.1	P2.6 F0	2.6	P8.8 F1.1	9.9	P5.4 F2.7	8.1	P2.4 F3.6	6.0	P6.8 F0.5	7.3	P9.4 F3.7	13.1	P7.1 F3.7	10.8	57.8
5	I2 F5	P2.0 F0	2.0	P3.3 F0.5	3.8	P13.0 F0.3	13.3	P6.9 F0.8	7.7	P4.8 F0.8	5.6	P3.8 F4.1	7.9	P6.7 F4.9	11.6	P3.6 F4.3	7.9	57.8
6	I2 F4	---		P1.1 F0	1.1	P6.3 F0	6.3	P6.6 F0.9	7.5	P6,1 F0,9	7.0	P13.8 F1.2	15,0	P7.5 F3.5	11.0	P5.8 F1.9	7.7	55.6
7	I2 F0	---		P3.6 F3.1	6.7	P16.6 F0.5	17.1	P6.6 F0.9	7.5	P5.7 F4.4	10.1	P10.0 F2.4	12.4	P5.6 F7.2	12.8	P8.0 F3.2	11.2	77.8
8	I2 F6	---		P5.5 F0	5.5	P12.6 F0	12.6	P11.1 F0.9	12.0	P4.9 F3.7	8.6	P10.4 F4.3	14.7	P7.6 F7.8	15.4	P9.2 F3.8	13.0	81.8
9	I3 F3	---		P1.9 F1.0	2.9	P10.6 F0.9	11.5	P3.6 F0	3.6	P5.2 F2.1	7.3	P7.1 F3.3	10.4	P3.4 F5.2	8.6	P5.0 F3.8	8.8	53.1
10	I3 F2	P2.0 F2.6	4.6	P0.9 F0	0.9	P10.4 F3.0	13.4	P5.8 F2.2	8.0	P6.5 F2.9	9.4	P6.9 F2.1	9.0	P8.2 F5.7	13.9	P2.1 F3.8	8.8	63.4
11	I3 F1	---		P2.9 F0	2.9	P11.2 F0	11.2	P6.8 F0.9	7.7	P5.0 F0.9	5.9	P7.3 F2.4	9.7	P4.6 F6.5	11.1	P3.3 F5.3	8.6	57.1
12	I3 F0	P1.4 F1.1	-0.3	P0.6 F0.7	1.3	P6.0 F0.7	6.7	P2.6 F0.8	3.4	P2.4 F0.9	3.3	P2.5 F1.3	3.8	P3.8 F2.8	6.6	P5.0 F3.1	8.1	33.2

[a] Each lot has 20 sites. I1, I2 and I3 are unirrigated, irrigated each 12 days and irrigated each 6 to 7 days respectively during February 17 to April, 1970. F0 = no fertilizer, F1 = 30 kg. N, 15 kg. P and 75 kg. K per hectare per year added in split applications each 3 months. F2 = double F1; F3 = double F2; F4 = double F3, etc

Table 15. Growth summation of Cavendish variety cambur in the experimental station in Sabaneta, Venezuela. Growth based on fruit weight in grams = cc. of volume and measurements of stem assuming a truncated cone shape. Per site average.

Plot [a]	Growth increases in thousands of cc.; F = fruit, P = plant (stem)																Total
	12-69 to 2-70		20/2 - 23/3		23/3 - 23/4		23/4 - 23/5		23/5 - 23/6		23/6 - 23/7		23/7 - 23/8		23/8 - 22/9		
13 I1 F2	---		P1.3 F0	1.3	P1.8 F0.6	2.4	P2.6 F0.5	3.1	P3.0 F0.6	3.6	P5.2 F0	5.2	P5.6 F2.8	8.4	P7.1 F2.8	9.9	33.9
14 I1 F0	---		P-0.7 F0	-0.7	P2.3 F0	2.3	P1.8 F0	1.8	P0.9 F0.4	1.3	P4.5 F0.9	5.4	P5.1 F1.3	6.4	P4.0 F2.2	6.2	22.7
15 I1 F3	P3.7 F0	3.7	P0.2 F0	0.2	P4.0 F0	4.0	P5.6 F0	5.6	P6.4 F0	6.4	P7.6 F1.1	8.7	P9.2 F5.7	14.7	P4.0 F7.0	11.0	50.8
16 I1 F1	P4.5 F0	4.5	P0.2 F1.0	1.2	P3.2 F1.0	4.2	P4.4 F0	4.4	P3.2 F1.6	4.8	P8.8 F1.6	10.4	P6.2 F4.9	11.1	P7.6 F3.7	11.3	47.4
17 I1 F4	----		P2.3 F0.6	2.9	P4.4 F1.1	5.5	P4.0 F1.3	5.3	P7.1 F0	7.1	P14.9 F2.1	17.0	P7.6 F3.7	11.3	P7.9 F4.3	12.2	61.3
18 I1 F0	P-1.0 F0	-1.0	P4.0 F0	4.0	P3.9 F0	3.9	P3.9 F0	3.9	P6.0 F0.7	6.7	P9.2 F3.9	13.1	P3.7 F4.5	8.2	P5.1 F3.1	8.2	48.0
19 I1 F5	P0.9 F0	0.9	P6.1 F0	6.1	P6.4 F1.2	7.6	P5.9 F1.1	7.0	P6.7 F2.3	9.0	P8.6 F5.3	13.9	P1.5 F6.7	8.2	P5.2 F4.0	9.2	61.0
20 I1 F6	P1.2 F1.2	2.4	P4.6 F0	4.6	P6.0 F0	6.0	P4.8 F0	4.8	P4.8 F0.9	5.7	P11.2 F4.1	15.3	P3.9 F7.8	11.7	P7.2 F6.2	13.4	61.5
21 I3 F4	P5.0 F0	5.0	P5.4 F1.0	6.4	P12.7 F1.7	14.4	P12.1 F4.0	16.1	P8.1 F4.0	12.1	P9.6 F3.8	13.4	P6.2 F8.0	14.2	P8.8 F7.1	15.9	92.5
22 I3 F6	P2.9 F1.2	4.1	P5.9 F1.6	7.5	P12.3 F1.6	13.9	P9.6 F2.7	12.3	P5.7 F1.4	7.1	P7.1 F1.4	8.5	P5.3 F4.6	9.9	P4.0 F6.6	10.6	69.8
23 I3 F5	P1.8 F0	1.8	P3.5 F0	3.5	P11.8 F0	11.8	P7.7 F0	7.7	P6.7 F1.5	8.2	P6.8 F2.6	9.4	P5.9 F6.7	12.6	P2.8 F7.5	10.3	63.5
24 I3 F0	---		P4.0 F0.8	4.8	P5.3 F0.6	5.9	P4.0 F1.6	5.6	P6.4 F1.1	7.5	P4.2 F2.3	6.5	P4.7 F3.8	8.5	P4.5 F2.6	7.1	45.9

[a] Each lot has 20 sites. I1, I2, I3 are unirrigated, irrigated each 12 days and irrigated each 6 to 7 days, respectively during Feb. 17 to April 1970. F0 = no fertilizer, F1 = 30 Kg. N, 15 Kg. P and 75 Kg. K per hectare per year added in split applications each 3 months. F2 = double F1, F3 = double F2, F4 = double F3, etc.

Table 16. Growth summation of Cavendish variety cambur in the experimental station in Sabaneta, Venezuela. Growth based on fruit weight in grams = cc. of volume and measurements of stem assuming a truncated cone shape. Per site average.

Plot [a]		Growth increases in thousands of cc.; F = fruit, P = plant (stem)																Total
		12-69 to 2-70		20/2 - 23/3		23/3 - 23/4		23/4 - 23/5		23/5 - 23/6		23/6 - 23/7		23/7 - 23/8		23/8 - 22/9		
25	I3 F1	---		P1.0 F2.4	3.4	P3.7 F2.1	5.8	P4.0 F0	4.0	P3.8 F0	3.8	P4.8 F0.7	5.5	P4.4 F5.6	10.0	P4.3 F3.3	7.6	49.3
26	I3 F0	---		P0.5 F0.6	1.1	P4.9 F0.6	5.5	P3.0 F0.8	3.8	P2.0 F1.6	3.6	P4.3 F0.8	5.1	P6.2 F3.3	9.5	P3.6 F2.7	6.3	34.9
27	I3 F3	---		P0.1 F1.0	1.1	P5.6 F1.9	7.5	P6.5 F1.8	8.3	P4.4 F3.4	7.8	P5.9 F1.4	7.3	P4.8 F2.9	7.7	P6.3 F3.4	9.7	49.4
28	I1 F2	P5.1 F0	5.1	P0.1 F1.5	1.6	P-2.4 F1.7	-0.7	P0.2 F2.2	2.4	P1.4 F3.0	4.4	P6.8 F2.1	8.9	P8.7 F5.7	14.4	P8.8 F4.7	13.5	44.5
29	I1 F3	P8.2 F3.0	11.2	P-1.0 F1.8	0.8	P-0.4 F0	-0.4	P5.0 F1.5	6.5	P7.1 F2.6	9.7	P13.0 F3.8	16.8	P12.0 F4.6	16.6	P11.2 F5.7	16.9	66.9
30	I1 F1	P18.6 F0	18.6	P1.7 F1.8	3.5	P2.9 F1.7	4.6	P3.4 F3.2	6.6	P4.2 F4.0	8.2	P11.2 F5.3	16.5	P13.4 F17.3	20.7	P7.8 F8.1	15.9	76.0
31	I1 F0	P14.5 F3.2	17.7	P0.5 F3.1	3.6	P2.0 F3.1	5.1	P3.4 F3.0	6.4	P6.2 F1.1	7.3	P12.2 F1.0	13.2	P7.5 F5.5	13.0	P7.1 F7.4	14.5	63.1
32	I1 F5	P17.8 F0	17.8	P-4.1 F2.0	-2.1	P0.6 F3.4	4.0	P5.0 F3.4	8.4	P7.3 F3.7	11.0	P13.7 F1.4	15.1	P9.8 F5.3	15.1	P7.1 F6.4	13.5	65.0
33	I1 F6	---		P3.8 F2.2	6.0	P3.4 F2.0	5.4	P3.9 F0.8	4.7	P2.5 F2.7	5.2	P12.0 F1.2	13.2	P6.8 F5.2	12.0	P8.4 F5.9	14.3	60.8
34	I1 F5	---		P4.8 F0	4.8	P6.3 F0	6.3	P8.6 F1.6	10.2	P6.3 F4.3	10.6	P10.8 F5.7	16.5	P9.2 F5.3	14.5	P7.7 F3.1	10.8	73.7
35	I1 F0	---		P1.9 F0.9	2.8	P0.8 F1.7	2.5	P6.8 F4.0	10.8	P5.1 F3.8	8.9	P8.2 F2.3	10.5	P9.0 F4.1	13.1	P6.7 F4.6	11.3	59.9
36	I3 F4	P0.7 F0	0.7	P4.1 F2.8	6.9	P6.0 F2.7	8.7	P9.6 F0	9.6	P8.5 F0	8.5	P13.5 F2.6	16.1	P5.7 F7.3	13.0	P8.3 F5.4	13.7	76.5

[a] Each lot has 20 sites. I1, I2, I3 are unirrigated, irrigated each 12 days and irrigated each 6 to 7 days, respectively during Feb. 17 to April 1970. F0 = no fertilizer, F1 = 30 Kg N, 15 Kg P and 75 Kg K per hectare per year added in split applications each 3 months. F2 = double F1, F3 = double F2, F4 = double F3, etc.

Table 17. Growth summation of Cavenidsh variety cambur in the experimental station in Sabaneta, Venezuela. Growth based on fruit weight in grams = cc. of volume and measurements of stem assuming a truncated cone shape. Per site average.

Plot[a]		Growth increases in thousands of cc.; F = fruit, P = plant (stem)																Total
		12-69 to 2-70		20/2 - 23/3		23/3 - 23/4		23/4 - 23/5		23/5 - 23/6		23/6 - 23/7		23/7 - 23/8		23/8 - 22/9		
37	I3 F5	P5.7 F0	5.7	P5.4 F3.5	8.9	P4.7 F4.6	9.3	P6.6 F4.6	11.2	P2.8 F4.6	7.4	P6.2 F1.3	7.5	P7.6 F4.1	11.7	P7.8 F3.3	11.1	67.1
38	I3 F0	P13.0 F0.0	13.0	P6.7 F0	6.7	P5.6 F3.5	9.1	P6.0 F3.6	9.6	P6.1 F3.6	9.7	P5.4 F3.8	9.2	P6.2 F5.1	11.3	P4.7 F6.0	10.7	66.3
39	I3 F4	P11.4 F3.4	14.4	P5.0 F0	5.0	P11.6 F0	11.6	P10.1 F1.8	11.9	P6.9 F1.8	8.7	P4.5 F3.0	7.5	P7.4 F8.0	15.4	P6.1 F7.1	13.2	73.3
40	I3 F6	P9.2 F1.8	11.0	P7.8 F2.1	9.9	P11.5 F3.4	14.9	P11.8 F5.7	17.5	P12.3 F3,6	15.9	P8.8 F0	8.8	P9.7 F4.1	13.8	P8.5 F11.5	20.0	100.8
41	I2 F0	---		P6.1 F0	6.1	P4.8 F0	4.8	P7.0 F0	7.0	P5.4 F1.1	6.5	P6.1 F1.2	7.3	P5.0 F6.2	11.2	P5.6 F3.6	9.2	52.1
42	I2 F4	---		P4.4 F0	4.4	P8.3 F0	8.3	P8.7 F0	8.7	P12.6 F4.0	16.6	P11.6 F5.9	17.5	P10.1 F8.7	18.8	P6.3 F6.4	12.7	87.0
43	I2 F2	---		P4.9 F0.9	5.8	P4.3 F0	4.3	P7.3 F1.5	8.8	P5.2 F1.5	6.7	P7.6 F4.9	12.5	P7.6 F6.9	14.5	P3.1 F7.3	10.4	63.0
44	I2 F3	---		P4.2 F0	4.2	P4.3 F1.5	5.8	P2.5 F2.7	5.2	P2.2 F4.5	6.7	P5.9 F2.7	8.6	P9.0 F5.2	14.2	P5.2 F4.4	9.6	54.3
45	I2 F2	P2.6 F3.1	5.7	P4.2 F1.9	6.1	P5.5 F5.2	10.7	P6.6 F4.7	11.3	P3.7 F4.7	8.4	P6.7 F2.7	9.4	P6.4 F3.0	9.4	P4.1 F2.2	6.3	61.6
46	I2 F3	P9.0 F6.8	15.8	P1.9 F4.0	5.9	P2.2 F2.6	4.8	P6.3 F1.8	8.1	P3.0 F0	3.0	P8.8 F3.5	12.3	P9.0 F8.9	17.9	P3.6 F5.0	8.6	60.6
47	I2 F0	P8.8 F0	8.8	P1.4 F0	1.4	P4.3 F0	4.0	P8.0 F0	8.0	P4.7 F1.3	6.0	P8.2 F1.3	9.5	P9.1 F4.0	13.1	P3.5 F4.1	7.6	49.6
48	I2 F1	P1.5 F6.3	7.8	P1.2 F3.6	4.8	P0.5 F1.8	2.3	P5.4 F3.1	8.5	P3.5 F5.8	9.3	P6.6 F3.8	10.4	P9.5 F2.5	12.0	P5.4 F3.7	9.1	56.4

[a] Each lot has 20 sites, I1, I2, I3 are unirrigated, irrigated each 12 days and irrigated each 6 to 7 days, respectively during Feb. 17 to April 1970. F0 = no fertilizer, F1 = 30 Kg N, 15 Kg P and 75 Kg K per hectarea per year added in split applications each 3 months. F2 = double F1, F3 = double F2, F4 = doubleF3, etc

growth of that border. Differences in soil are visually obvious in this plantation. In the inventory of sites at the initiation of treatments, this unusually good growth was noted on unfertilized Plot 7, and the senior author wrote at that time that it "appears to be the best of the area," meaning that it was the best of the upper portion of the plantation. It was also obvious that the bottom third of the plantation did best overall in the untreated state. As illustration, the average plant heights of all harvested plants prior to March are given below. The banana plant would have had its full size by mid-December before any treatments had been applied.

Top 4 plots, center border	173 cm. tall	(9 plants)
Middle 5 plots, center border	157 cm. tall	(4 plants)
Bottom 4 plots, center border	215 cm. tall	(6 plants)

The appearance in the field was even more marked than the height difference would suggest. The lower field area does considerably better than the rest of the plantation in the untreated state.

Treatment Differences

Using the data of Tables 14-17 and comparing sites adjacent to each other, a clearer picture of growth due to fertilizer is possible. These are some of those comparisons in pairs with growth given in thousands of cc.

PLOT	TREATMENT	GROWTH	PLOT	TREATMENT	GROWTH
1	I2-F0	49,000 cc.	25	I3-F1	49,000 cc.
2	I2-F5	65,000 cc.	33	I1-F6	61,000 cc.
1	I2-F0	49,000 cc.	26	I3-F0	35,000 cc.
9	I3-F3	53,000 cc.	34	I1-F5	74,000 cc.
3	I2-F6	73,000 cc.	41	I2-F0	52,000 cc.
11	I3-F1	57,000 cc.	42	I2-F4	87,000 cc.
14	I1-F0	23,000 cc.	39	I3-F4	73,000 cc.
15	I1-F3	51,000 cc.	47	I2-F0	50,000 cc.

Growth as a result of fertilizer levels appears to completely overshadow the effects of irrigation differences. However, keep in mind that a rainfal on February 10 of 50 mm., a changed irrigation pattern on March 10 and the rainy season beginning on April 16 all reduced the effect of irrigation this

first dry season. Additional comparisons could be given showing other marked treatment effects. Some less convincing examples of treatment effects are also available, such as:

Plots	37	38	6	7
Treatment	I3-F5	I3-F0	I2-F4	I2-F0
Growth	67,000 cc.	66,000 cc.	56,000 cc.	78,000 cc.
	(No difference)		(Less growth with fertilizer)	

Average Growth Versus Treatments

Table 18 summarizes growth averages by treatments. Several irrigularities are evident, and most are interpretable in general terms. For example, the non-irrigated F2 plots had very low growth (33,900 cc.). This is a value from a plot in a poor growing area. Its neighboring F0 plot (No. 14) has a value of 22,700 cc. (See Table 15.)

Differences shown in Table 18 which are a result of irrigation are diluted by the five months during which rainfall wet all sites equally. If only the irrigation months from February 20 to April 23 are used, the difference due to irrigation is as expected -- much more growth with irrigation:

	DRY	INTERMED.	WET
Average growth	6.4	14.6	14.8
Relative growth	100%	226%	229%

Even this two-month irrigation period included one half of the dry plots which were later changed to wet (I3)plots. Likewise, one half of the initially wet (I3) plots were irrigated until March 10. On March 9, a fertilizer error made it desirable to change the irrigation regime of some plots to have some of all fertilizer levels in each irrigation treatment. This change would tend to reduce and obscure the observed growth differences. Some I1 plots were changed to I3, and some I3 to I1.

Accumulative Growth Rates

Drought conditions are noted for their reduction of plant growth in general and for causing low efficiency in the use of fertilizer. Irrigation canal water was turned out of the Bocono irrigation canals following a heavy

Table 18. Summary of volume growth by treatments for fertilizer and irrigation in Cavendish cambur (banana). All F0 (no fertilizer) are an average of 4 replications. All others are an average of 2 reps except F2-I1, F4-I1 and F1-I2 which are single values. Data are volume in thousands of cubic centimeters. Data for February 23 to September 22, 1970. Irrigation used only until April 20. Sabaneta, Irrigation System, Bocono, Venezuela.

Fertilizer level*	No Irrigation	Irrigated each 12 days	Irrigated each 6 days	Totals	Average Growth	Relative Growth
F0 (control)	40.9	57.1	45.1	143.1	47.7	100
F1 30 Kg N 15 Kg P 75 Kg K	61.7	56.4	53.2	171.3	57.1	120
F2 double F1	33.9	62.3	53.9	150.1	50.0	105
F3 double F2	58.8	57.4	51.2	167.4	55.8	117
F4 double F3	61.3	66.8	80.8	208.9	69.6	146
F5 Same as F4*	67.2	61.2	65.3	193.7	64.6	135
F6 double F5	61.1	77.2	85.3	223.6	74.5	156
Totals	384.9	438.4	434.8			
Average Growth	64.1	73.1	72.5			
Relative Growth	100	114	113			

*Rates given are per year per hectare, but added 1/4 each 3 months. F5 and F6 have the rate per year indicated, but were added 1/2 each 6 months.

rain in mid-April. Yet, evaporation (class A pan) continued to exceed rainfall until early June (Figure 14), and growth was retarded. Only plots in the lower portion of the plantation seemed to be slightly less affected by the presence or absence of added moisture. (Compare growth from Tables 14-17 for the upper, center wet plots 9-12 with the lower, center wet plots 37-40.) Growth in several "no fertilizer" plots is less than that in plots with high fertilizer levels close by during the period of May to July, but not in all cases. The plots at the lower end of the field (31, 32, 42) have less growth retardation in the drier May and June than plots closer to the top of the field. A sandy top-of-the-field area (Plots 1-4) illustrates drought problems. Growth was good only after enough rain had occurred for the plant to recuperate from drought; growth was good by the time August measurements were made.

Figure 15 depicts accumulative fruit-plus-plant growth plotted in simple "same fertilizer but different irrigation" sequences. There is no clear difference in growth because of irrigation. The lack of irrigation, I1, results in poor growth for a time period considerably beyond the end of the dry season (Plot 14). Plot 31, at the lower end of the field, wasn't as affected by dry seasons. This is partly a result of natural soil variation. To reduce error from field variation, Figure 16 has been made using adjacent plots for comparisons. Fertilizer differences show better and the differences in irrigation regimes result in a considerable difference in growth.

Although the measured differences are not great, higher amounts of fertilizer (F6 or F3) and frequent irrigation (I3) maintains an active growth condition. All of the plots in Figure 16 are the six adjacent plots across the bottom of the field in the best natural growing area. Even without irrigation this area seemed able to obtain adequate moisture to grow well. All plots, even those without fertilizer (F0), illustrate this condition.

In contrast to plots in Figure 16, Figure 17 illustrates growth in six adjacent plots at the upper third of the field. The poorest growing area, generally, is in the field's center plots (13 and 14). In these two plots, the lack of water and fertilizer (Plot 14) results in small increments of growth, not just during the three dry months, but all year long. Plot 13, also dry but with fertilizer added, had increased growth when rains supplied moisture. In fact, the growth since August (area above the double shaded rectangle) is almost as great as for any other treatment. Plots 21 and 22, having both weekly irrigations and considerable fertilizer (F4 and F6) during all the months, had good continual growth.

Figure 18 shows the growth of 6 of the 8 plots having the lowest growth during the first 6 months through August. It is interesting that these 8 were all of the plots listed as I1 (lowest irrigation). After August, when fertilizer rates were increased over 4-fold, Plots 15, 16 and 28 grew rapidly and well as rain supplied equal moisture to all plots from April until December. The two unfertilized plots (12 and 26) continued with poorer growth

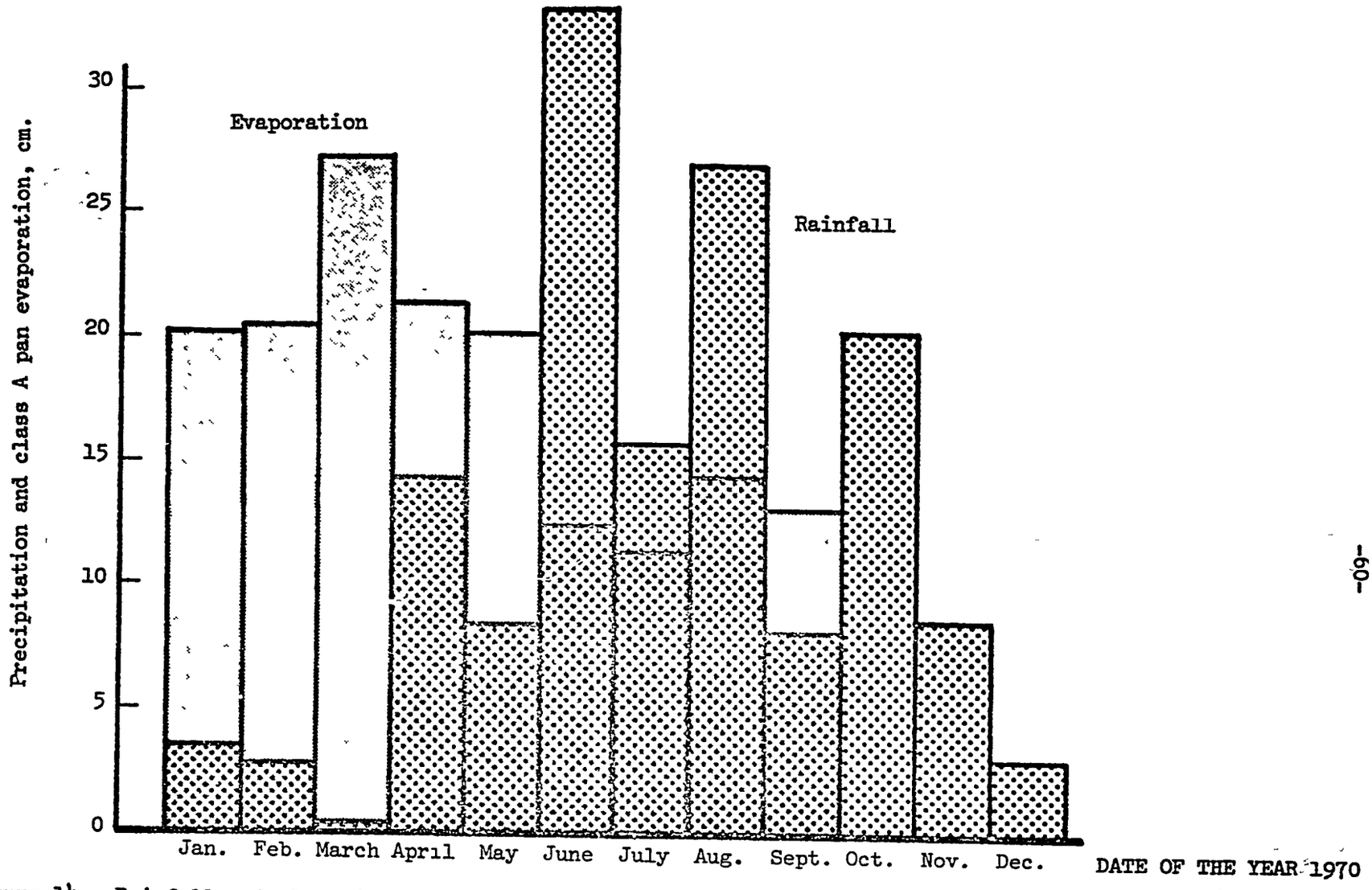


Figure 14. Rainfall and class A pan evaporation by month for the year 1970. Sabaneta station, Bocono Irrigation System, Venezuela. Data is from a nearly Hacienda Marqueseña except the months October through December which are from 18-year averages of the area.

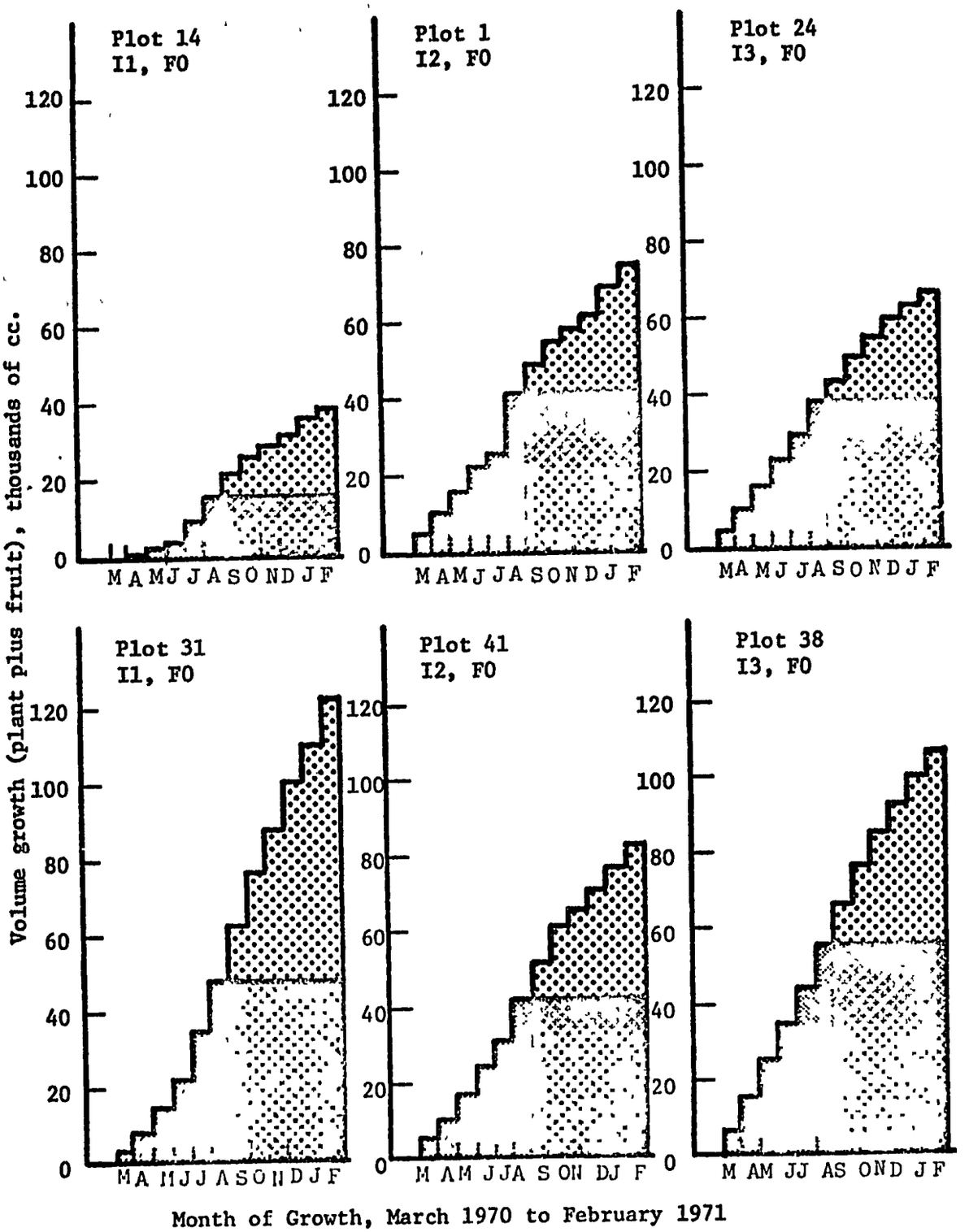


Fig. 15. Accumulative growth of Cavendish cambur (banana) in volume of fruit plus plant, Sabaneta station, Bocono Irrigation System, Venezuela. Treatments shown are two each of the four control plots (no fertilizer) in each irrigation regime. I1 is the driest, I3 is the wettest. Plots 24 and 41 are nearly adjacent plots and are close to plot 14. Plots 31 and 38 are close to each other.

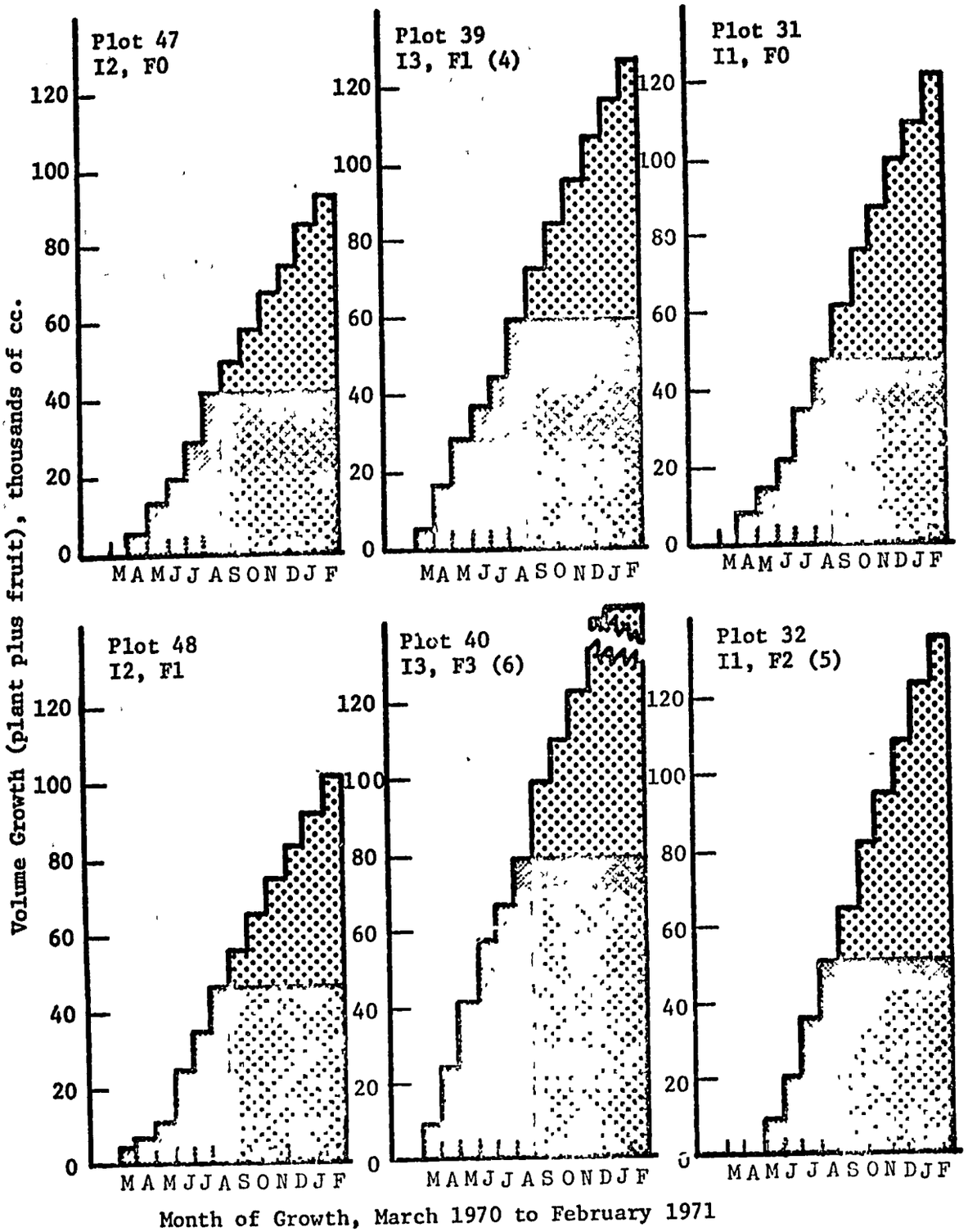


Fig. 16. Accumulative growth of Cavendish cambur (banana) in volume of fruit plus plant, Sabaneta station, Bocono Irrigation System, Venezuela. Treatments shown are six adjacent plots in the best growing area of the plantation. I1 is the driest irrigation, I3 is the wettest. F0 is no fertilizer added, F3 is the highest. The 4, 5 and 6 in parenthesis indicate higher fertilizer levels added during the first 6 months before all levels were increased in August.

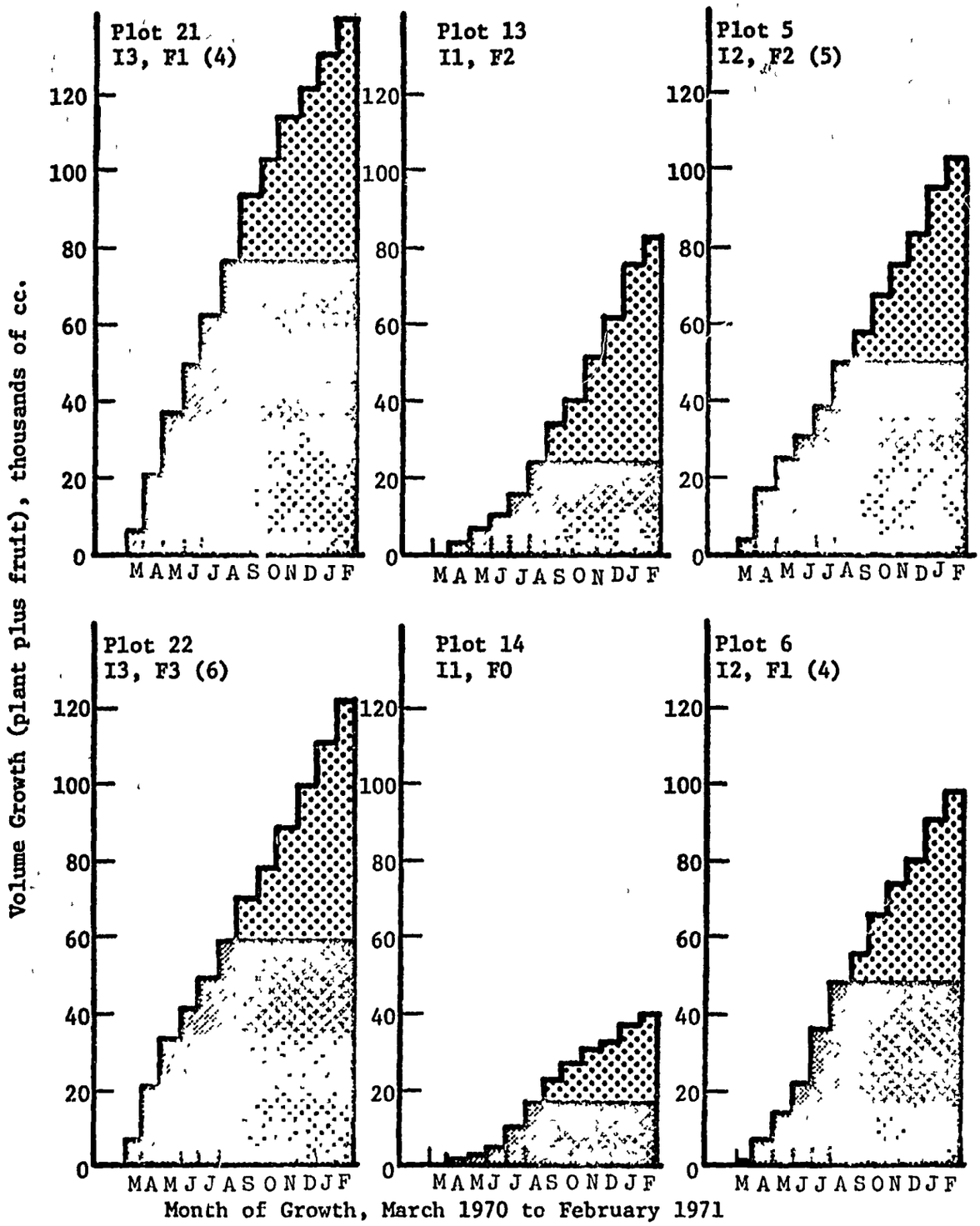


Fig. 17. Accumulative growth of Cavendish cambur (banana) in volume of fruit plus plant, Sabaneta station, Bocono Irrigation System, Venezuela. Treatments shown are six adjacent plots in the area having poorest growth. I1 is the driest irrigation, I3 is the wettest. F0 is no fertilizer added, F3 is the highest. The 4, 5 and 6 in parenthesis indicate higher fertilizer levels added during the first 6 months before all levels were increased in August.

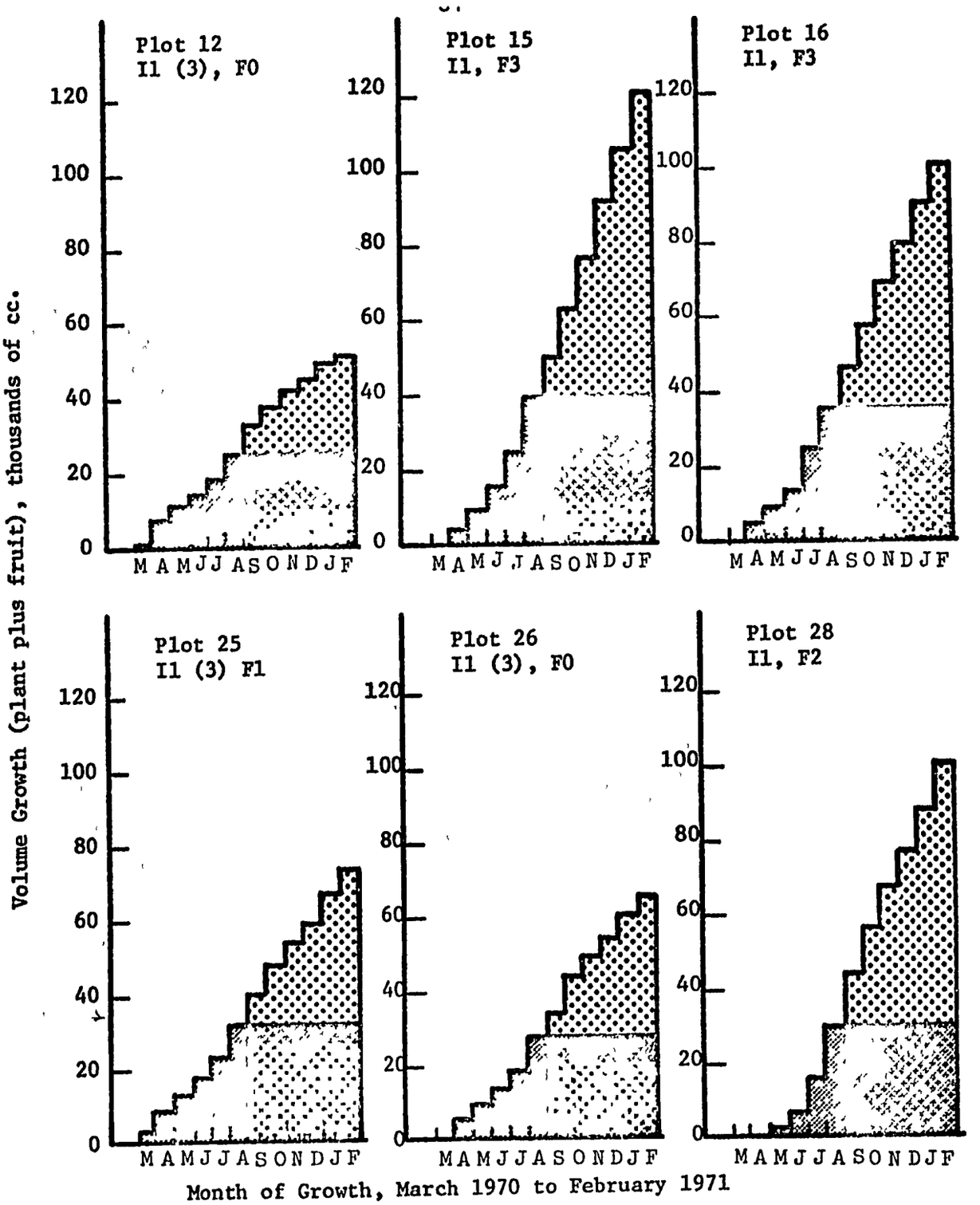


Fig. 18. Accumulative growth of Cavendish cambur (banana) in volume of fruit plus plant, Sabaneta station, Bocono Irrigation System, Venezuela. Treatments shown are six of the eight lowest growth totals up to August 1970. Plots 13 and 14 were also low but are graphed in other figures. All are in the driest irrigation regime, I1. Those with higher fertilizer additions (F3 highest, F2 second highest) had increased growth after August when fertilizer rates were increased and rainfall was equal in all plots until January.

The monthly growths are shown for some plots in Figure 19. There are many non-regular patterns. Graph A shows 3 middle-of-the-field, unfertili plots. Peak growths were August and September, the months with good moisture. (Each is a summation of two months: so August equals growth in July and August divided by 2 for a monthly average.) Less growth occurs in the drier periods. This is partly because the months of October, November, April and May are often too dry for good growth, and irrigation water is not available in the canals.

Monthly growth at high fertilization is shown in Graph B. The relative fertilizer levels after August are 3 times higher for Plots 15 and 46 as for Plot 21. The relatively less monthly growth in Plot 21 after Augus illustrates this. Prior to August, Plot 21 had double the amount of fertilizer given to the other two. Its growth was greater during those six months.

Almost all plotted growth curves in Figure 19 have a great reduction in growth in June. This growth is for the period, April 23 to June 23 and divided by 2. These months had low rainfall. The plants appeared dry, an growth obviously was greatly reduced. The drier October and December also caused lower growth averages, even though they are each averages of 2 mont growth.

Graph D is descriptive. These 3 plots were not irrigated weekly in March and early April; they were left unirrigated. (See Figure 3.) High rates of growth occurred only after the heavy rains began in late June. Weekly irrigations in the good growing area (Graph E) showed a somewhat similar pattern but with better early growth.

Graph F of Figure 19 illustrates the hindered early growth (Plot 13) because of no irrigation followed by the later growth surge when rainfall and fertilizer are both adequate. The lack of growth because of a lack of fertilizer is clear in Graphs A, D (Plot 35), E (Plot 38) and F (Plot 14). Plot 7 is one site that did well before treatments (Graph C) and continued to do well generally, even though it did grow less than many others half the year.

Rate of Growth Needed

The assumptions and a discussion of the growth rate needed to predict a given yield rate was presented in a previous section and in Table 7. Early growth data for the Sabaneta Station are given in Figure 20. Only 2 plots of the 24 that are graphed had growth rates to produce a 20 kg. racin each 4.5 months. Of the 24 plots, 75% could not produce a 20 kg. racime twice a year. For example, Plot 1 (F0-I2) was a poor plot. It should produce about a 14 kg. racime each six months (7000 cc. per month growth). Its actual production from February through August was 117 kg. in 9 racimes for 20 sites, an average of 5.8 kg. per site. However, fruiting was increasing in September. Most will produce about 15 kg. of fruit each 6 months at the rate of growth measured.

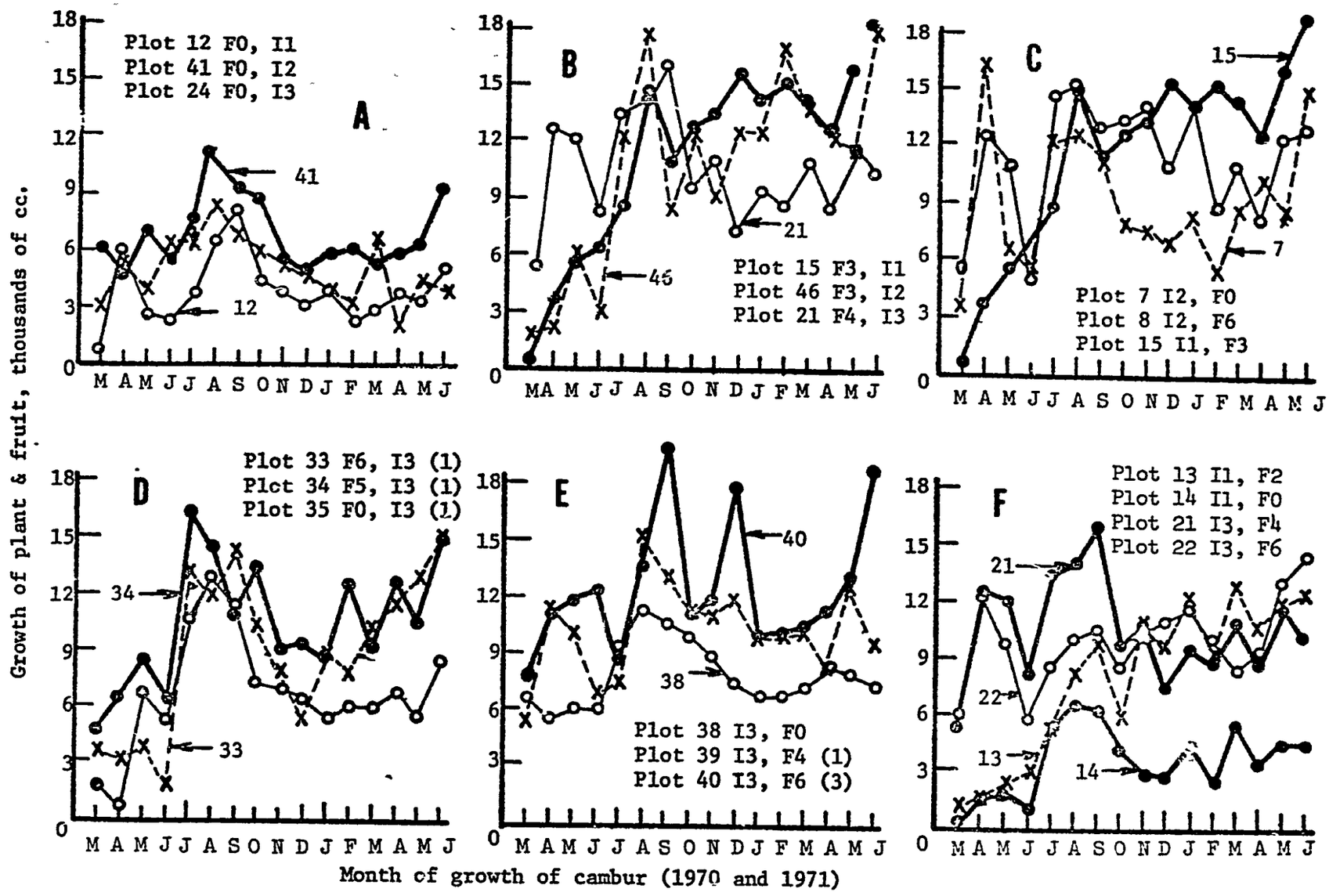


Fig. 19. Monthly growth of Cavendish cambur in Sabaneta station, Venezuela. F0=no fertilizer, F1=30 Kg N, 15 Kg P and 75 Kg K per hectarea per year added. F2=double F1, F3=double F2, F4=double F3, F5=F4 but only added twice a year instead of 4 times. In August, fertilizer increased so F1=120 Kg N, 60 Kg P and 140 Kg K per hectarea per year, and only had F1, F2, F3. F4 then = F1, F5=F2, F2, F6=F3.

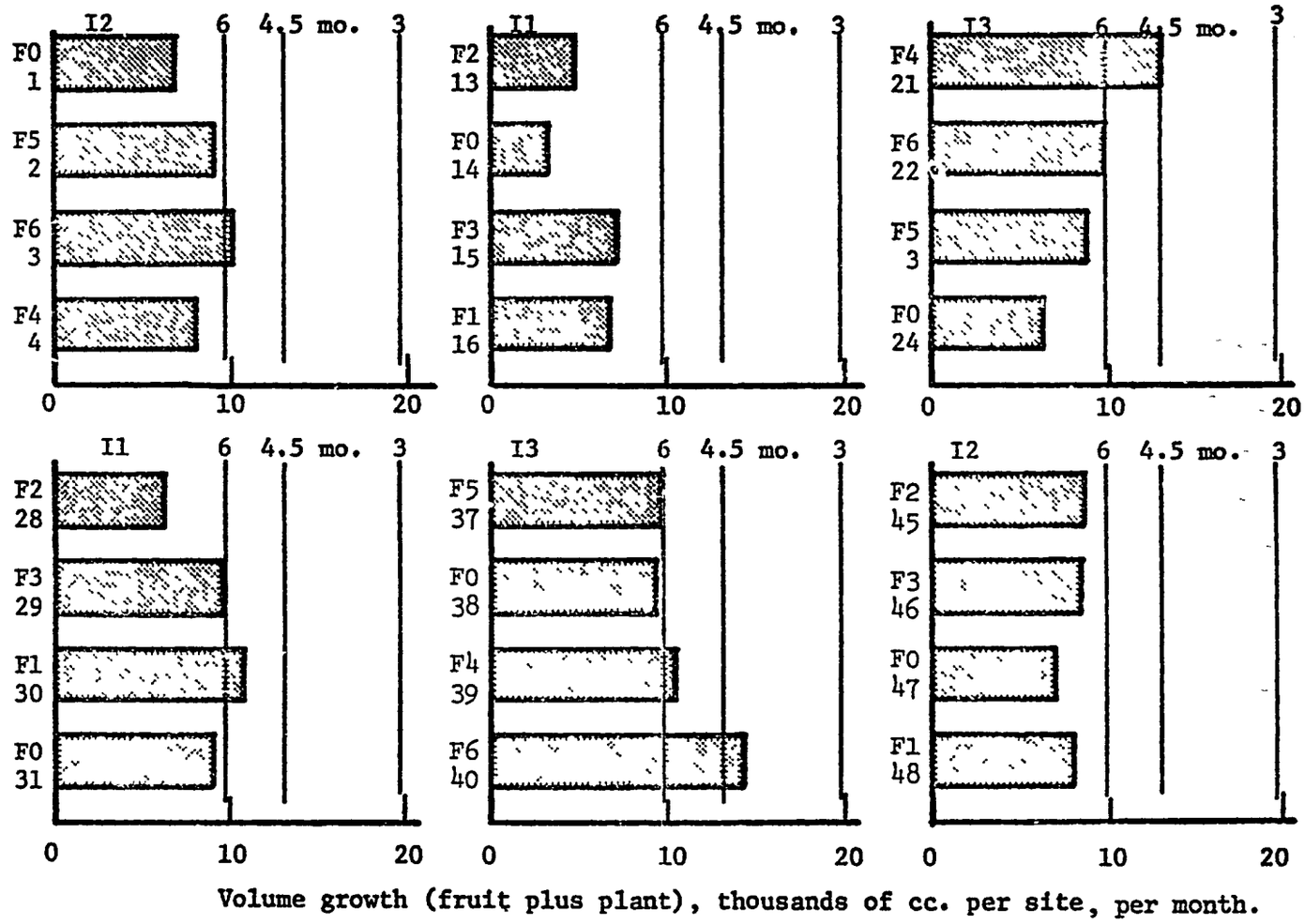


Fig. 20. Estimated production rate of Sabaneta banana plantation using average monthly growth rates from February 20, 1970, to September 22, 1970. Vertical lines are the growth rates needed to produce a 20 Kg. bunch each 6 months, 4.5 months or 3 months as indicated. I1 is non-irrigated, I2 is irrigated each 11 days, I3 is irrigated each 5-6 days (only irrigated until April 20). F0 is no fertilizer, F1 is 7.5 Kg. N, 3.75 Kg P and 18.75 Kg K each 3 months, F2 is double F1, F3 is double F2, F4 is double F3, F5 is equal F4 but fertilizer added each 6 months, and F6 is double F5. Irrigation system Bocono, Portuguesa State, Venezuela.

GROWTH OBSERVATIONS -- THE LAST NINE MONTHS

Plant and fruit growths for the 48 plots in Sabaneta from September 21, 1970 to June 23, 1971 are given in Tables 19-26. Growth overall is best illustrated by the 19 plots graphed in Figure 19, given previously. Generally, the higher levels of fertilizer rates used after August 23, 1970 resulted in a growth increase for many fertilized plots. Much of the confusion in growth totals is a result of the fertilizer error made March 9, 1970. One example can be seen in Figure 19, Graph F, Plot 21 which was growing well in early months at a high F4 fertilizer level but dropped to a lower level when fertilizer was reduced to an F1 level in August, even though F1 in the last nine months was 120 pounds N/acre. Almost all F0 plots did poorly, having a peak growth approximately in July which is usually the wettest month. In fact if one looks at Figure 19, the growth peaks seem to follow patterns; high rainfall results in best growth. This suggests that either 1) the bananas need a more moist environment than was provided by irrigation, or 2) the heat or light intensity during rainy periods is more desireable than during drier periods.

Another interesting set of curves in Figure 19 is for Plots 13, 14 and 15. (See Graphs C and F.) These plots initially had very poor growth. Plants in Plot 15 began growing better immediately after treatment but those in Plots 13 and 14 with no irrigation grew little. After rains came in April, growth in all three plots increased. After the higher fertilizer levels were added in August, Plot 15 maintained good growth, dropping in March and April before the rains began, and then began a new growth increase with rainfall in May and June of 1971.

It should be emphasized again that the apparent "up and down" pattern of growth after August is partly a result of measuring growth each month on a different set of 8 sites per plot. So alternate months' readings are on the same sites. If the same sites had been measured each month, the curves would probably be smoother.

Data of Tables 23-26 list generally a lower growth in the February-April, 1971 measurement period than either before or after it. The measurement was for the dry and irrigation period, and the senior author has no information about possible problems from low irrigation or rainfall. No explanation is offered for this drop in growth. If radiation or sunlight intensities are undesirable factors at the high levels occurring in the area, March is the month likely to be the warmest, driest and highest in radiation. Although data is not available for radiation in Sabaneta, the Guanare Station is only 65 km. away and is quite similar. Table 1, given previously, lists radiation values for Guanare. A 1970 maximum for radiation occurred in March. A minimum occurred in December with gradually increased radiation in June, September, July and April.

Tables 23-26 also indicate some interesting facts when certain individual plot growths are compared. In non-fertilized Plots 12, 14 and 26 the lack of fertilizer results in low growth values. Yet the fourth replication,

TABLE 19. Growth rate of cambures (bananas) in Sabaneta, Venezuela.* Monthly and four-month totals are given. Most values are each an average of 8 sites (15-25 plants) and for a one-month period (bimonthly data divided by 2). The 2-months included in the measurement is indicated in each instance.

Lot No.	Treat-ment+	Sept - Nov 1970			Oct - Dec			Nov - Jan			Dec - Feb			4-month Totals		
		Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total
12	F0, W1	1.4	2.5	3.9	1.5	1.7	3.2	2.6	1.2	3.8	1.0	1.3	2.3	6.5	6.7	13.2
14		1.4	1.5	2.9	1.2	1.5	2.7	4.1	0.3	4.4	1.7	0.7	2.4	8.4	4.0	12.4
26		2.6	2.2	4.8	4.9	0.7	5.6	4.2	1.7	5.9	5.1	0.2	5.3	16.8	4.8	21.6
31		5.3	6.0	11.3	9.5	2.9	12.4	8.3	1.2	9.5	9.8	2.8	12.6	32.9	12.9	45.8
11	F1, W1	7.8	4.3	12.1	8.7	3.4	12.1	9.3	1.9	11.2	11.2	3.2	14.4	37.0	12.8	49.8
16		9.7	2.1	11.8	8.1	2.0	10.1	9.5	2.0	11.5	4.7	4.9	9.6	32.0	11.0	43.0
25		4.5	1.5	6.0	4.6	0.6	5.2	6.4	1.9	8.3	6.1	0.1	6.2	21.6	4.1	25.7
30		9.2	3.7	12.9	10.6	3.2	13.8	13.8	0.3	14.1	12.1	2.4	14.5	45.7	9.6	55.3
10	F2, W1	9.3	1.7	11.0	8.4	1.6	10.0	9.6	2.4	12.0	7.0	3.1	10.1	34.3	8.8	43.1
13		8.9	2.2	11.1	8.9	0.9	9.8	9.1	3.2	12.3	7.4	1.8	9.2	34.3	8.1	42.4
28		8.6	2.3	10.9	8.4	0.9	9.3	9.9	1.0	10.9	10.2	2.3	12.5	37.1	6.5	43.6
32		9.0	4.0	13.0	8.7	4.9	13.6	12.4	2.2	14.6	10.5	1.7	12.2	40.6	12.8	53.4

* All data of lots 1 and 2 are monthly; lots 3-48 are each 2 months and divided by 2 for a monthly estimate. Alternate months are different sites from the same lots. Abbreviations: Pl = plant growth in thousands of cubic centimeters of trunk (no leaves) per site; Fr = fruit yield estimate in thousands of cubic centimeters per site.

\+ Fo = no fertilizer, F1 low, F2 medium, F3 highest fertilizer. Irrigation: Driest I1, intermediate I2 and wettest I3.

TABLE 20. Growth rate of cambures (bananas) in Sabaneta, Venezuela.* Monthly and four-month totals are given. Most values are each an average of 8 sites (15-25 plants) and for a one-month period (bimonthly data divided by 2). The 2-months included in the measurement is indicated in each instance.

Lot No.	Treat-ment+	Sept - Nov 1970			Oct - Dec			Nov - Jan			Dec - Feb			4-month Totals		
		Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total
9	F3, W1	9.2	1.6	10.8	14.1	2.4	16.5	8.3	0.9	9.2	11.2	4.0	15.2	42.8	8.9	51.7
15		11.0	2.5	13.5	12.1	3.4	15.5	13.8	0.4	14.2	11.5	3.8	15.3	48.4	10.1	58.5
27		10.2	2.0	12.2	9.0	3.3	12.3	10.5	1.7	12.2	8.9	3.2	12.1	38.6	10.2	48.8
29		10.5	2.6	13.1	10.1	3.1	13.2	12.0	2.3	14.3	9.2	3.0	12.2	41.8	11.0	52.8
1	F0, W2	3.0	3.4	6.4	-0.3	3.7	3.4	7.0	0.7	7.7	3.7	2.0	5.7	13.4	8.8	23.2
7		4.7	2.9	7.6	4.0	3.1	7.1	5.1	3.1	8.2	4.4	0.9	5.3	18.2	10.0	28.2
41		3.7	1.7	5.4	2.5	2.4	4.9	4.7	1.2	5.9	4.6	1.5	6.1	15.5	6.8	22.3
47		5.8	3.7	9.5	5.6	1.2	6.8	7.1	3.5	10.6	5.8	2.2	8.0	24.3	10.6	34.9
4	F1, W2	5.6	2.9	8.5	6.9	1.6	8.5	6.3	2.1	8.4	9.7	1.4	11.1	28.5	8.0	36.5
6		5.8	2.1	7.9	4.4	1.5	5.9	7.7	3.2	10.9	6.4	0.8	7.2	24.3	7.6	31.9
42		7.4	2.0	9.4	8.1	1.6	9.7	8.2	1.4	9.6	9.9	1.6	11.5	33.6	6.6	40.2
48		7.3	2.6	9.9	7.4	0.9	8.3	8.2	0.4	8.6	7.0	1.9	8.9	29.9	5.8	35.7

* All data of lots 1 and 2 are monthly; lots 3-48 are each 2 months and divided by 2 for a monthly estimate. Alternate months are different sites from the same lots. Abbreviations: Pl = plant growth in thousands of cubic centimeters of trunk (no leaves) per site; Fr = fruit yield estimate in thousands of cubic centimeters per site.

\+ Fo = no fertilizer, F1 low, F2 medium, F3 highest fertilizer. Irrigation: Driest I1, intermediate I2 and wettest I3.

TABLE 21. Growth rate of cambures (bananas) in Sabaneta, Venezuela.* Monthly and four-month totals are given. Most values are each an average of 8 sites (15-25 plants) and for a one-month period (bimonthly data divided by 2). The 2-months included in the measurement is indicated in each instance.

Lot No.	Treat-ment+	Sep - Nov 1970			Oct - Dec			Nov - Jan			Dec - Feb			4-month Totals		
		Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total
2	F2, W2	9.7	2.6	12.3	10.8	3.1	13.9	7.8	1.0	8.8	12.3	5.1	17.4	40.6	11.8	52.4
5		5.8	2.0	7.8	7.0	1.1	8.1	9.4	0.6	10.0	9.2	0.4	9.6	31.4	4.1	35.5
43		6.6	3.3	9.9	5.2	2.5	7.7	8.4	2.3	10.7	5.8	1.8	7.6	26.0	9.9	35.9
45		6.5	1.3	7.8	4.6	1.0	5.6	6.5	3.1	9.6	3.1	0.6	3.7	20.7	6.0	26.7
3	F3, W2	7.5	3.7	11.2	8.2	1.7	9.9	12.2	1.1	13.3	10.8	1.3	12.1	38.7	7.8	46.5
8		11.8	2.4	14.2	8.6	2.4	11.0	12.2	2.2	14.4	6.9	1.9	8.8	39.5	8.9	48.4
44		7.8	1.8	9.6	7.7	1.1	8.8	8.1	0.8	8.9	6.1	2.4	8.5	29.7	6.1	35.8
46		8.4	0.7	9.1	11.5	1.2	12.7	12.0	0.7	12.7	13.2	3.9	17.1	45.1	6.5	51.6
18	F0, W3	2.1	2.8	4.9	2.3	1.2	3.5	4.6	0.6	5.2	6.0	0.8	6.8	15.0	5.4	20.4
24		3.2	2.0	5.2	2.2	2.7	4.9	1.9	2.0	3.9	2.4	0.8	3.2	9.7	7.5	17.2
35		4.4	2.5	6.9	5.4	1.0	6.4	4.5	1.0	5.5	4.8	1.2	6.0	19.1	5.7	24.8
38		3.8	5.1	8.9	3.7	3.8	7.5	5.9	1.1	7.0	5.6	1.5	7.1	19.0	11.5	30.5

* All data of lots 1 and 2 are monthly; lots 3-48 are each 2 months and divided by 2 for a monthly estimate. Alternate months are different sites from the same lots. Abbreviations: Pl = plant growth in thousands of cubic centimeters of trunk (no leaves) per site; Fr = fruit yield estimate in thousands of cubic centimeters per site.

\+ Fo = no fertilizer, F1 low, F2 medium, F3 highest fertilizer. Irrigation: Driest I1, intermediate I2 and wettest I3.

TABLE 22. Growth rate of cambures (bananas) in Sabaneta, Venezuela.* Monthly and four-month totals are given. Most values are each an average of 8 sites (15-25 plants) and for a one-month period (bimonthly data divided by 2). The 2-months included in the measurement is indicated in each instance.

Lot No.	Treat-ment+	Sept - Nov 1970			Oct - Dec			Nov - Jan			Dec - Feb			4-month Totals		
		Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total
17	F1, W3	3.8	4.4	8.2	4.4	3.6	8.0	5.0	2.7	7.7	9.1	3.3	12.4	22.3	14.0	36.3
21		6.6	4.6	11.2	5.1	2.2	7.3	6.9	2.5	9.4	8.0	0.8	8.8	26.6	10.1	36.7
36		5.7	2.3	8.0	4.4	2.7	7.1	4.5	2.8	7.3	5.1	2.9	8.0	19.7	10.7	30.4
39		6.8	4.3	11.1	7.6	4.3	11.9	9.3	0.6	9.9	6.0	4.0	10.0	29.7	13.2	42.9
19	F2, W3	5.4	2.8	8.2	9.3	2.1	11.4	5.9	1.6	7.5	11.6	1.0	12.6	32.2	7.5	39.7
23		8.3	5.7	14.0	7.5	0.8	8.3	11.0	2.9	13.9	9.1	0.7	9.8	35.9	10.1	46.0
34		5.8	3.1	8.9	7.3	1.9	9.2	6.7	2.0	8.7	8.7	4.0	12.7	28.5	11.0	39.5
37		7.8	2.4	10.2	6.7	2.2	8.9	10.3	1.6	11.9	9.1	1.0	10.1	33.9	7.2	41.1
20	F3, W3	6.4	4.9	11.3	8.1	1.7	9.8	6.5	2.3	8.8	11.6	1.0	12.6	32.6	9.9	42.5
22		6.1	4.2	10.3	8.0	3.0	11.0	8.4	3.3	11.7	8.2	1.8	10.0	30.7	12.3	43.0
33		5.5	2.5	8.0	4.1	1.4	5.5	7.4	1.5	8.9	6.5	1.4	7.9	23.5	6.8	30.3
40		5.7	6.0	11.7	15.1	2.7	17.8	8.5	1.5	10.0	6.2	4.0	10.2	35.5	14.2	49.7

* All data of lots 1 and 2 are monthly; lots 3-48 are each 2 months and divided by 2 for a monthly estimate. Alternate months are different sites from the same lots. Abbreviations: Pl = plant growth in thousands of cubic centimeters of trunk (no leaves) per site; Fr = fruit yield estimate in thousands of cubic centimeters per site.

\+ Fo = no fertilizer, F1 low, F2 medium, F3 highest fertilizer. Irrigation: Driest I1, intermediate I2 and wettest I3.

TABLE 23. Growth rate of cambures (bananas) in Sabaneta, Venezuela.* Monthly and four-month totals are given. Most values are each an average of 8 sites (15-25 plants) and for a one-month period (bimonthly data divided by 2). The 2-months included in the measurement is indicated in each instance.

Lot No.	Treat-ment+	Jan - Mar 1971			Feb - April			Mar - May			April - June			4-month Totals		
		Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total
12	F0, W1	2.4	0.5	2.9	2.9	0.9	3.8	3.0	0.5	3.5	3.7	1.4	5.1	12.0	3.3	15.3
14		5.2	0.2	5.4	3.2	0.2	3.4	3.4	1.0	4.4	4.3	0.0	4.3	16.1	1.4	17.5
26		4.1	0.8	4.9	4.6	0.7	5.3	6.0	0.0	6.0	5.9	1.3	7.2	20.6	2.8	23.4
31		7.8	2.0	9.8	10.6	2.6	13.2	7.6	2.7	10.3	10.9	4.4	15.3	36.9	11.7	48.2
11	F1, W1	8.2	2.6	10.8	9.7	1.5	11.2	7.4	2.7	10.1	10.7	2.3	13.0	36.0	9.1	45.1
16		8.0	3.2	11.2	6.8	3.8	10.6	6.5	6.6	13.1	11.3	3.6	14.9	32.6	17.2	49.8
25		5.3	2.5	7.8	7.6	1.1	8.7	7.7	1.6	9.3	10.1	2.5	12.6	30.7	7.7	38.4
30		13.8	4.3	18.1	8.6	3.5	12.1	8.7	5.4	14.1	8.8	6.3	15.1	39.9	19.5	59.4
10	F2, W1	10.4	4.3	14.7	6.2	3.4	9.6	9.8	1.2	11.0	10.2	1.8	12.0	36.6	10.7	47.3
13		7.6	5.5	13.1	5.4	5.3	10.7	10.0	2.1	12.1	7.4	5.1	12.5	30.4	18.0	48.4
28		8.8	3.1	11.9	5.7	3.6	9.3	8.9	5.8	14.7	8.7	7.3	16.0	32.1	19.8	51.9
32		7.7	5.5	13.2	11.4	1.1	12.5	9.7	2.6	12.3	17.5	3.5	21.0	46.3	12.7	59.0

* All data of lots 1 and 2 are monthly; lots 3-48 are each 2 months and divided by 2 for a monthly estimate. Alternate months are different sites from the same lots. Abbreviations: Pl = plant growth in thousands of cubic centimeters of trunk (no leaves) per site; Fr = fruit yield estimate in thousands of cubic centimeters per site.

\+ Fo = no fertilizer, F1 low, F2 medium, F3 highest fertilizer. Irrigation: Driest I1, intermediate I2 and wettest I3.

TABLE 24. Growth rate of cambures (bananas) in Sabaneta, Venezuela.* Monthly and four-month totals are given. Most values are each an average of 8 sites (15-25 plants) and for a one-month period (bimonthly data divided by 2). The 2-months included in the measurement is indicated in each instance.

Lot No.	Treat-ment+	Jan - Mar 1971			Feb - April			Mar - May			April - June			4-month Totals		
		Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Totals
9	F3, W1	9.6	4.2	13.8	7.9	8.2	16.1	8.2	4.0	12.2	10.8	4.5	15.3	36.5	20.9	57.4
15		11.1	3.3	14.4	9.0	3.7	12.7	12.1	4.0	16.1	16.0	2.9	18.9	48.2	13.9	62.1
27		11.0	3.9	14.9	10.2	4.0	14.2	9.6	4.9	14.5	11.6	4.2	15.8	42.4	17.0	49.4
29		15.8	4.4	20.2	7.1	3.7	10.8	7.1	10.2	17.3	10.3	4.3	14.6	47.3	22.6	69.9
1	F0, W2	3.8	1.5	5.3	3.7	1.2	4.9	2.0	2.5	4.5	7.7	1.1	8.8	17.2	6.3	23.5
7		6.5	2.2	8.7	7.5	2.7	10.2	5.5	3.3	8.8	11.9	3.2	15.1	31.4	11.4	42.8
41		3.8	1.6	5.4	4.2	1.7	5.9	4.8	1.5	6.3	8.3	1.0	9.3	21.1	5.8	26.9
47		6.1	2.6	8.7	3.3	1.1	4.4	5.7	3.1	8.8	7.5	2.2	9.7	22.6	9.0	31.6
4	F1, W2	3.6	1.8	5.4	3.4	2.2	5.6	5.7	3.0	8.7	2.2	4.1	6.3	14.9	11.1	26.0
6		5.0	3.0	8.0	6.0	1.2	7.2	5.6	1.9	7.5	5.4	2.7	8.1	22.0	8.8	30.8
42		8.9	2.8	11.7	5.7	4.1	9.8	5.2	4.1	9.3	9.6	4.6	14.2	29.4	15.6	45.0
48		8.8	3.1	11.9	4.8	3.7	8.5	5.7	5.0	10.7	10.8	3.5	14.3	30.1	15.3	45.4

* All data of lots 1 and 2 are monthly; lots 3-48 are each 2 months and divided by 2 for a monthly estimate. Alternate months are different sites from the same lots. Abbreviations: Pl = plant growth in thousands of cubic centimeters of trunk (no leaves) per site; Fr = fruit yield estimate in thousands of cubic centimeters per site.

\+ Fo = no fertilizer, F1 low, F2 medium, F3 highest fertilizer. Irrigation: Driest I1, intermediate I2 and wettest I3.

TABLE 25. Growth rate of cambures (bananas) in Sabaneta, Venezuela.* Monthly and four-month totals are given. Most values are each an average of 8 sites (15-25 plants) and for a one-month period (bimonthly data divided by 2). The 2-months included in the measurement is indicated in each instance.

Lot No.	Treat-ment+	Jan - Mar 1971			Feb - April			Mar - May			April - June			4-month Totals		
		Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total
2	F2, W2	4.1	2.2	6.3	6.6	2.6	9.2	10.7	2.0	12.7	10.1	5.6	15.7	31.5	12.4	43.9
5		5.2	3.4	8.6	6.1	1.3	7.4	3.9	5.1	9.0	5.2	3.6	8.8	20.4	13.4	33.8
43		6.8	2.3	9.1	4.4	2.1	6.5	8.1	0.9	9.0	8.6	1.6	10.2	27.9	6.9	34.8
45		6.1	4.6	10.7	6.8	1.1	7.9	5.0	4.2	9.2	8.9	2.4	11.3	26.8	12.3	39.1
3	F3, W2	6.7	4.8	11.5	5.8	2.5	8.3	12.7	6.1	18.8	16.3	5.1	21.4	41.5	18.5	60.0
8		5.6	5.4	11.0	3.7	4.4	8.1	7.3	5.2	12.5	9.5	3.5	13.0	26.1	18.5	44.6
44		9.0	1.4	10.4	7.5	3.4	10.9	8.9	3.7	12.6	12.5	4.2	16.7	37.8	12.7	50.5
46		10.8	3.1	13.9	8.7	3.7	12.4	5.0	6.7	11.7	13.2	4.9	18.1	37.7	18.4	56.1
18	F0, W3	3.4	0.4	3.8	3.7	0.7	4.4	3.5	1.1	4.6	3.9	2.0	5.9	14.5	4.2	18.7
24		4.8	2.0	6.8	2.0	0.0	2.0	2.3	2.1	4.4	4.1	0.0	4.1	13.2	4.1	17.3
35		5.7	0.6	6.3	4.3	2.5	6.8	4.9	0.6	5.5	5.9	2.6	8.5	20.8	6.3	27.1
38		6.0	1.3	7.3	6.5	1.8	8.3	5.4	2.6	8.0	5.3	2.2	7.5	23.2	7.9	31.1

* All data of lots 1 and 2 are monthly; lots 3-48 are each 2 months and divided by 2 for a monthly estimate. Alternate months are different sites from the same lots. Abbreviations: Pl = plant growth in thousands of cubic centimeters of trunk (no leaves) per site; Fr = fruit yield estimate in thousands of cubic centimeters per site.

\+ Fo = no fertilizer, F1 low, F2 medium, F3 highest fertilizer. Irrigation: Driest I1, intermediate I2 and wettest I3.

TABLE 26. Growth rate of cambures (bananas) in Sabaneta, Venezuela.* Monthly and four-month totals are given. Most values are each an average of 8 sites (15-25 plants) and for a one-month period (bimonthly data divided by 2). The 2-months included in the measurement is indicated in each instance.

Lot No.	Treat-ment+	Jan - Mar 1971			Feb - April			Mar - May			April - June			4-month Totals		
		Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total	Pl.	Fr.	Total
17	F1, W3	8.8	0.8	9.6	5.1	1.6	6.7	8.2	0.8	9.0	7.9	6.5	8.4	30.0	9.7	39.7
21		8.4	2.5	10.9	8.2	0.4	8.6	8.1	3.6	11.7	9.2	1.1	10.3	33.9	7.6	41.5
36		10.8	1.3	12.1	6.3	1.5	7.8	6.0	2.6	8.6	7.5	2.6	10.1	30.6	8.0	38.6
39		8.5	1.7	10.2	6.3	2.1	8.4	8.8	4.0	12.8	8.2	1.6	9.8	31.8	9.4	41.2
19	F2, W3	7.6	3.2	10.8	8.5	4.7	13.2	8.1	4.0	12.1	11.1	4.8	15.9	35.3	16.7	52.0
23		13.3	0.9	14.3	8.0	2.3	10.3	13.2	4.6	17.8	7.9	4.2	12.1	42.5	12.0	54.5
34		7.1	1.9	9.0	8.1	4.5	12.6	6.6	3.9	10.5	10.3	4.4	14.7	32.1	14.7	46.8
37		8.9	3.7	12.6	8.8	2.9	11.7	5.6	6.4	12.0	7.0	4.8	11.8	30.3	17.8	48.1
20	F3, W3	7.6	2.4	10.0	7.4	3.1	10.5	7.9	4.0	11.9	9.5	5.5	15.0	32.4	15.0	47.4
22		7.2	1.3	8.5	7.7	1.6	9.3	11.5	1.6	13.1	13.6	0.8	14.4	40.0	5.3	45.3
33		7.7	2.6	10.3	8.1	3.3	11.4	7.6	5.4	13.0	12.2	2.9	15.1	35.5	14.2	49.7
40		8.8	1.8	10.6	7.8	3.6	11.4	12.0	1.1	13.1	16.8	1.9	18.7	45.4	8.4	53.8

* All data of lots 1 and 2 are monthly; lots 3-48 are each 2 months and divided by 2 for a monthly estimate. Alternate months are different sites from the same lots. Abbreviations: Pl = plant growth in thousands of cubic centimeters of trunk (no leaves) per site; Fr = fruit yield estimate in thousands of cubic centimeters per site.

\+ Fo = no fertilizer, F1 low, F2 medium, F3 highest fertilizer. Irrigation: Driest I1, intermediate I2 and wettest I3.

Plot 31, exists in a portion of the field where growth was good before treatments were started. Its growth was nearly double that of any of the other three replications Plot 7 (without fertilizer, Table 24) was one of the best growing areas before treatments in the upper half of the field. It is still growing better than most other comparable F0 plots (1, 41) and better than some fertilized plots (4, 5, 6, 42, 43, 45 as examples). However, the greatest growth does generally occur in the plots with higher fertilizer levels.

Needed Growth Rates

Figure 21 tabulates average growth data per site per month for the time period, January 21 to June 23, 1971. The same 24 plots as given in Figure 2 for an earlier period of time are plotted. These plots include an upper quarter and a bottom quarter of the plantation. The bottom quarter (12 plots) had good growth before applied treatments (fertilizer or irrigation). This is evident in the amount of growth occuring in Plot 31, and less so by other F0 plots (38 and 47).

Growth rates in all plots with the same fertilizer level are nearly the same, particularly at F3 levels (14,000 cc/site/month). This indicates that the poor condition of some sites at the beginning of the study was partly due to a lack of fertilizer and water in the dry season. Good growth was possible in nearly all field areas if adequate fertilizer were applied. One surprise was the lack of much growth increase in Plots 37, 39 and 40 which had fertilizer added. Apparently, the growth was already near maximum and what were thought to be improvements in growth conditions, irrigation and fertilizers, were really not improvements, and therefore, did not increa growth very much.

Growth Versus Actual Yields

In Table 27 fruit yields are given for Novemver 1, 1970 to June 4, 1971 and growth for the period, September 23, 1970 to February 21, 1971. These staggered time periods were chosen to measure the growth rate of plants and then later the fruit that those same plants would produce. Plant growth measured at least three months before fruit was harvested would be a minimum time difference. The graph of fruit-bunch weight versus plant growth is shown in Figure 22. The spread of points do not fit a correlation line closely. This may be a result of many things. Some of these are:

1. Some sites had two fruits producing at the same time. This would reduce the bunch weight average.

2. Some sites had only one or two large plants, rather than three or four plants of mixed ages. This would give low per-site growth, but a large bunch weight average.

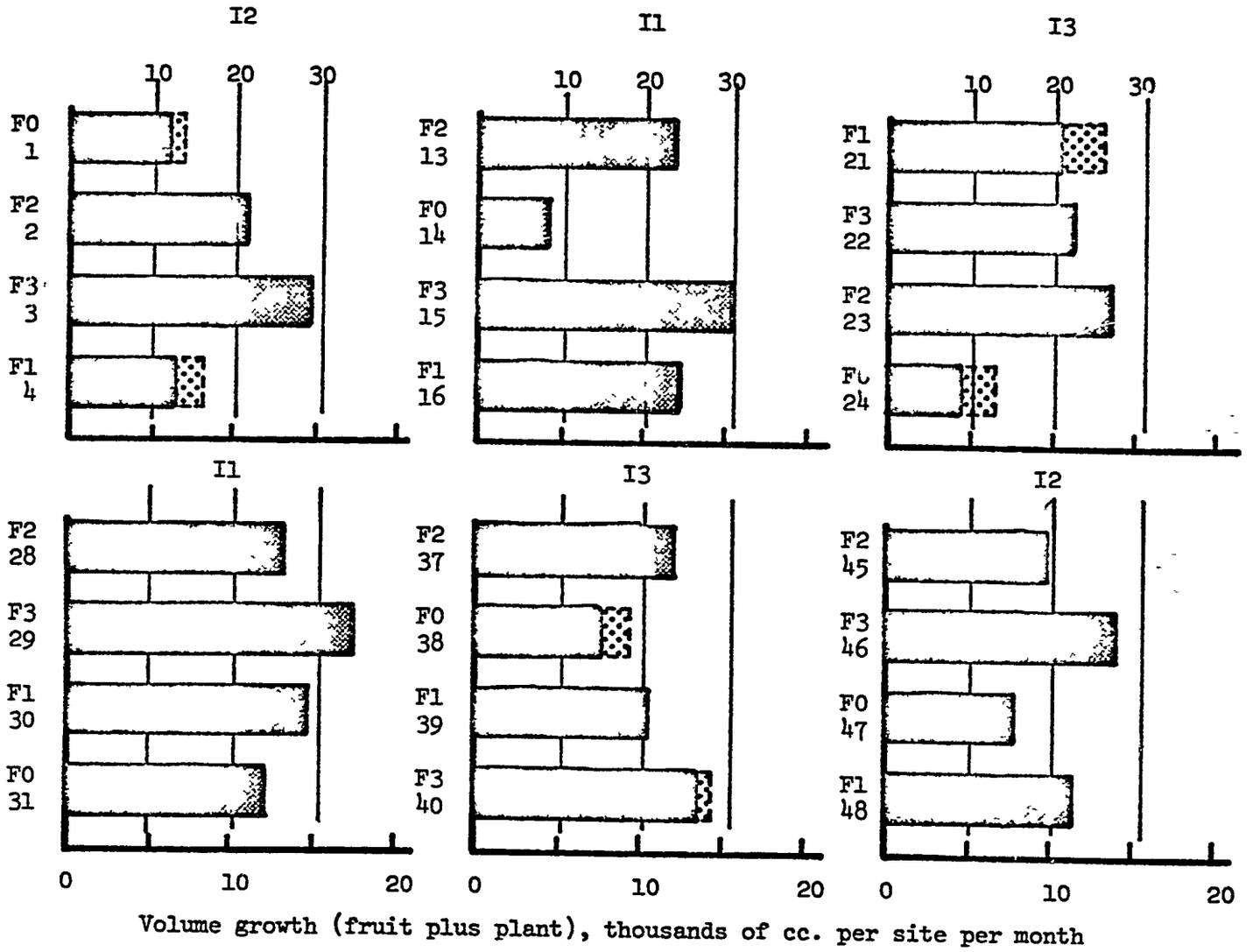


Figure 21. Estimated production rate of Sabaneta Cambur Plantation, using monthly average growth rates from January 21, 1971 to June 23, 1971. Vertical lines are the growth rates needed to produce the bunch sizes indicated (10, 20, or 30 kg.) each 6 months. I1 is irrigated each 14 days; I2 is irrigated each 10-11 days; I3 is irrigated weekly (Irrigation season December 1 to April 15). F0 is no fertilizer; F1 is 180 kg. N/ha/yr plus 90 kg. P plus 210 kg. K; F2 is double F1; F3 is triple F1. Irrigation project Bocono, Portuguesa State, Venezuela. The coursely dotted area was growth from February to September, 1970, the first seven months. F-values in parentheses following a bar refer to fertilizer treatments during those first seven months. The crosshatched lengths are growth for January to June, 1971.

TABLE 27. Growth of cambur, fruit yield and average bunch size for cambur in Sabaneta Experimental Station, Bocono Irrigation System, Portuguesa State, Venezuela. Fruit yields are for November 1, 1970, to June 4, 1971; growth is for September 23, 1970, to February 21, 1971.

Ferti. Treat.	Replication 1			Replication 2			Replication 3			Replication 4		
	Gth*	Yld*	Ave*	Gth	Yld	Ave	Gth	Yld	Ave	Gth	Yld	Ave
LEAST FREQUENT IRRIGATION REGIME - I1												
F0	15.5	125	8.3	14.8	78	6.0	26.9	106	8.8	58.4	343	20.2
F1	64.2	321	14.5	52.6	284	16.7	31.9	157	9.8	69.8	274	19.6
F2	53.2	282	14.1	51.6	359	15.0	56.1	249	16.6	6[illegible].6	444	21.1
F3	66.9	343	22.9	73.8	331	17.4	60.9	223	14.9	65.0	312	18.3
INTERMEDIATE IRRIGATION REGIME - I2												
F0	28.9	222	12.6	33.5	258	11.7	28.4	270	11.7	42.9	197	13.1
F1	47.6	252	14.0	39.1	217	11.3	51.7	294	14.7	44.6	220	13.8
F2	69.8	279	13.9	45.1	390	15.0	43.5	153	13.9	30.4	257	11.7
F3	58.6	354	14.1	57.2	438	15.6	44.3	101	16.9	68.7	259	17.3
MOST FREQUENT IRRIGATION REGIME - I3												
F0	27.2	181	11.3	20.4	158	7.1	30.8	226	13.3	37.6	259	16.2
F1	48.7	360	15.0	45.5	313	15.6	38.4	314	17.4	52.9	255	17.0
F2	52.3	238	14.8	55.8	177	13.5	52.2	299	15.7	51.2	272	19.4
F3	55.1	316	15.8	53.0	377	13.5	38.2	320	18.8	59.9	349	21.8

*Gth = growth/site in thousands of cc. for 5 months (September to February); yld = the yield/20 sites in Kg. for seven months (November through May); Ave = average bunch weight of the yield.

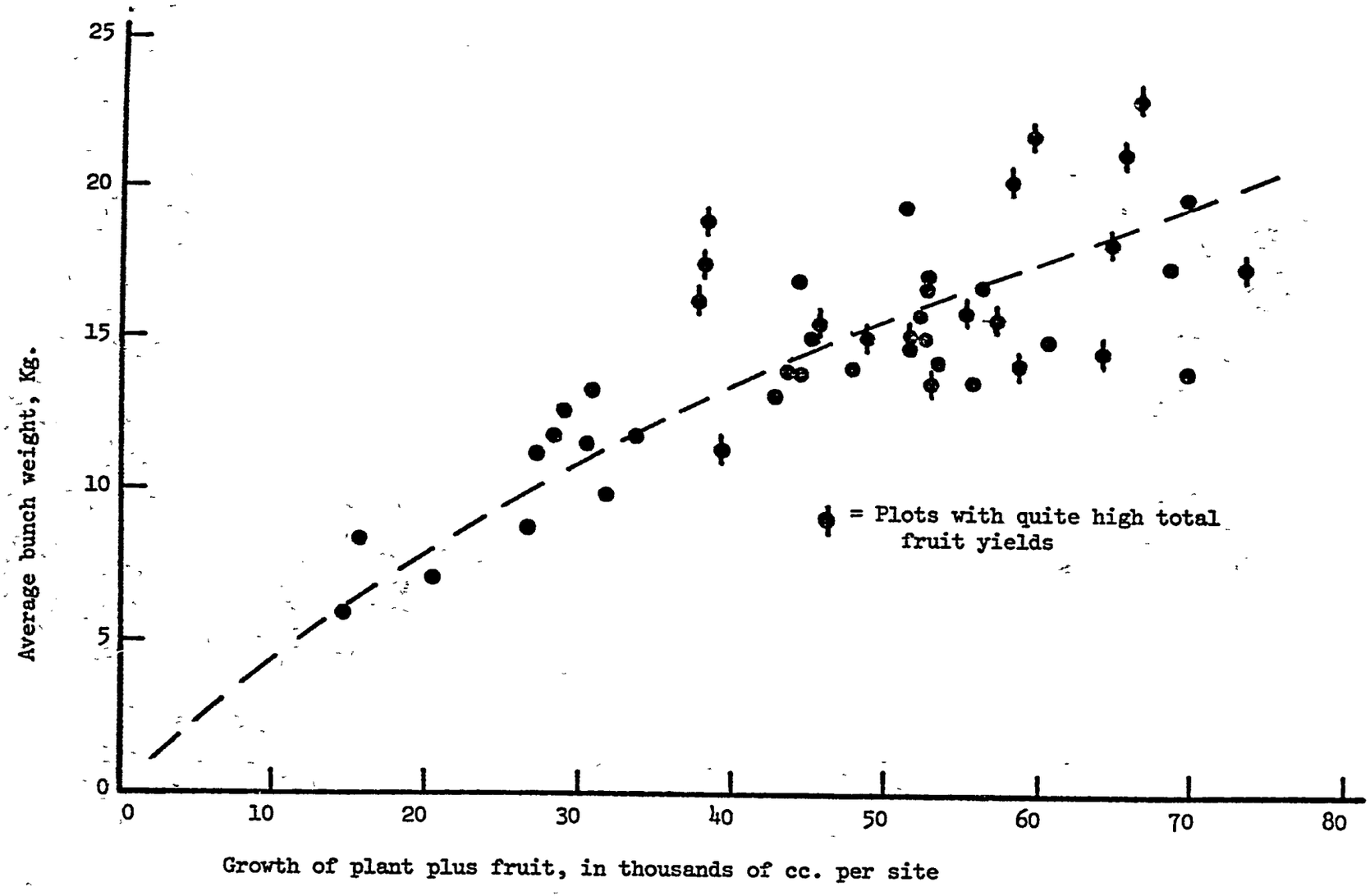


FIGURE 22. Average bunch weights of cambur versus growth of plants plus fruit for the period of January 21, 1971, to June 23, 1971. Sabaneta experimental station, Bocono Irrigation Project, Portuguesa State, Venezuela.

3. There are three irrigation frequencies confounded in the data. The better moisture regime may cause relatively higher bunch weight averages per unit of plant growth.

4. No measure of early plant growth is considered. Some investigators believe that growth of the new plant during its early stages greatly influences its final size.

5. Lost fruit bunches will alter bunch weight averages. Much fruit was stolen from this easily accessible plantation. Also, some plants blew down which resulted in harvesting young fruits which had not reached full growth.

In order to compare fruit yields in Table 27 with yield rates predicted from growth, divide growth values of Table 27 by 5 (5 months) and yield values by 140. The 140 figure is obtained from 7 months of yields for 20 sites. The resulting growth values are per site per month. Yield values are per site per six months. A reference to Table 8 permits a comparison of measured growth and actual yields. The results are as follows:

FERTI-LIZER TREAT-MENT	LEAST IRRIGATION			MODERATE IRRIGATION			MOST IRRIGATION		
	Gth.*	Calc. Yld.*	Act. Yld.*	Gth.*	Calc. Yld.*	Act. Yld.*	Gth.*	Calc. Yld.*	Act. Yld.*
F0	6.8	13.0	7.0	6.7	12.9	10.2	5.8	11.2	8.9
F1	10.9	20.9	11.1	9.1	17.5	10.5	9.3	17.8	13.4
F2	10.2	19.5	14.3	9.4	18.0	11.6	1.0	19.2	10.6
F3	13.3	25.6	13.0	11.4	21.9	12.4	1.0	19.2	14.6

* Growth = thousands of cc/site/month; yield = kg. fruit/site.six months

Only in a few examples does actual yield approach the predicted values. The low actual yields are about 50 to 60% of those predicted. This is too low. This apparent lack of agreement can be partially explained by several facts:

1. Thinning of plants per site was not as well controlled as was planned. A thinning in late fall, 1970 during the growth measurements resulted in removal of some intermediate-sized plants. These had been included in growth values but would never produce a fruit.

2. An appreciable number of bunches were stolen by neighboring "parceleros."

3. Fruit weighing sessions that the senior author observed but did not help with often had these fruit weight losses: (a) no record made of lost fingers ("dedos") to permit weight corrections, (b) no record made of young, immature fruit from fallen plants, and (c) some lost bunches because they were not labeled with a number.

It seems reasonable that the better check on the validity of the growth-yield relation proposed here is: (1) the plant size - yield relation as given in Figures 5 and 6, and (2) the growth rates of only those plants which are eventually harvested which is almost the same item as (1). There are obviously many factors during the 12 months that a plant grows which affect the bunch weight finally produced.

STATISTICAL ANALYSES

Irrigation Effects

Statistical treatment of the data is tabulated in Tables 28-30. In Table 28 the growths for various time periods and the various fruit yields, as affected by irrigation and fertilizer, are shown. Only when the short growth period during irrigation was compared was there a significant difference in growth because of irrigation. (See Comparisons A and B.) This fact suggests that drought periods may have slight long-term effects. Comparisons A and B during irrigation periods also indicated statistically significant "irrigation-fertilizer" interactions. It is significant that when enough rainy months were included with the months of irrigation, there was no significant effect evident of irrigation or of an irrigation-fertility interaction of the growth. This emphasizes two apparent facts:

1. In order to measure the effect of irrigation, one must measure the growth only during the period of irrigation.

2. In the case of these camburs, growth recovery in the rainy season and perhaps "dilution" of the values by many months of equal moisture (rainfall), will erase the relatively small differences in growth caused by irrigation variables imposed for just a few months each year.

Fertilizer Effects

The comparisons listed in Table 28 resulted in highly significant or very highly significant differences in growth or in fruit yield as a result of fertilizer variables. In all four comparisons of growth (A, B, C and D) the level of confidence that fertilizer treatments affected yield was 99.9%. The effect of fertilizer was also visually evident in the field.

TABLE 28. Analysis of variance for cambur in Sabaneta, Venezuela, with the variables of irrigation, fertilizer differences and irrigation-fertilizer interaction. These variables are compared to yields or growth of the plants for different time periods or manner of calculations. A single, double or triple asterisk indicates significant at the 5%, 1% or 0.1% levels respectively.

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARE	F - DISTRIBUTION
A. Plant Growth from December 23, 1970 to March 23, 1971				
Replications	3	429.7	143.2	3.34 (barely 10%)
Irrigation	2	359.5	179.7	5.08* (about 5.1%)
Error A	6	212.4	35.40	
Fertilizers	3	2281	760.5	33.9***
I x F	6	495.7	82.62	3.53* (almost 1%)
Error B	27	632.1	23.41	
Total	47	4411.	93.85	
B. Plant Growth December 23, 1970 to April 23, 1971, after each plot value was subtracted from it the respective F0 plot value.				
Replications	3	64,750	21,583	2.01
Irrigation	2	81,397	40,698	3.80 (just over 10%)
Error A	6	64,316	10,719	
Fertilizers	3	342,414	114,138	33.6***
I x F	6	53,160	8,860.1	2.61*
Error B	27	91,874	3,402.7	
Total	47	697,914	14,849	
C. Plant Growth July 1970 to June 1971, after each plot value was subtracted from it the respective F0 plot value.				
Replications	3	707,463	235,821	1.69
Irrigation	2	622,430	311,215	2.24
Error A	6	833,480	138,913	
Fertilizers	3	3,485,770	1,161,923	29.7***
I x F	6	357,030	59,505	1.52
Error B	27	1,056,616	39,134	
Total	47	7,062,791	150,272	

*** = Significant at the 0.1% level (99.9% confidence level)
** = Significant at the 1% level (99% confidence level)
* = Significant at the 5% level (95% confidence level)

(Cont. of Table 28)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARE	F - DISTRIBUTION
D. Plant Growth from July 1970 to June 1971.				
Replications	3	461,228	153,742	2.20
Irrigation	2	106,004	53,002	0.758
Error A	6	419,573	69,929	
Fertilizers	3	2,417,957	805,986	27.4***
I x F	6	300,157	50,026	1.70
Error B	27	793,887	29,403	
Total	47	4,498,808	95,719	
E. Yield of Fruit March 1 to June 4, 1971.				
Replications	3	360.7	120.2	2.81
Irrigation	2	107.2	53.58	1.25
Error A	6	257.9	42.98	
Fertilizers	3	503.9	167.9	7.45***
I x F	6	86.11	14.35	0.638
Error B	27	608.6	22.54	
Total	47	1,924	40.94	
F. Yield of Fruit November 1, 1970 to June 4, 1971.				
Replications	3	2,235,548	745,182	0.54
Irrigation	2	633,451	316,725	2.29
Error A	6	8,291,957	1,381,993	
Fertilizers	3	7,212,365	2,404,122	4.61**
I . F	6	4,848,464	808,077	1.55
Error B	27	1.4×10^7	521,689	
Total	47	3.7 x	793,774	
G. Fruit Bunch Weight Average November 1, 1970 to June 4, 1971				
Replications	3	11,947	3,982	2.66
Irrigation	2	2,490	1,245	0.83
Error A	6	8,996	1,499	
Fertilizers	3	19,054	6,351	11.13***
I x F	6	2,867	477.9	0.834
Error B	27	15,438	571.8	
Total	47	60,794	1,293	

*** = Significant at the 0.1% level (99.9% confidence level)
** = Significant at the 1% level (99% confidence level)
* = Significant at the 5% level (95% confidence level)

TABLE 29. Analysis of variance for cambur in Sabaneta, Venezuela assuming the short irrigation period (3 months) when compared to the rainy period (9months) could justify eliminating irrigation as a variable and bunching irrigation plots as replications.

	MEASUREMENT USED	F-DISTRIBUTION FOR	
		REPS	FERT
1	Plant growth from December 1970 to March 1971	2.67*	22.2***
2	Plant growth December 23, 1970, to April 30, 1971, after each plot value was subtracted from it the respective F0 plot value	4.37***	26.1***
3	Plant growth July 1970, to June 1971, after each plot value was subtracted from it the respective F0 plot value	4.59***	27.2***
4	Plant growth from July 1970, to June 1971	2.88**	24.3***
5	Yield of fruit March 1, to June 4, 1971	3.13**	7.99***
6	Yield of fruit November 1970, to June 4, 1971	1.77	4.19*
7	Fruit bunch weight average, November 1, 1970, to June 4, 1971	3.84**	11.5***

Symbols used for statistical significance

* = Significant at the 5% level of probability
** = Significant at the 1% level of probability
*** = Significant at the 0.1% level of probability

TABLE 30. Duncan multiple range tests for selected analyses of the Sabaneta Station cambur study, Bocono Irrigation System, Venezuela.

1. Plant Growth December 23, 1970 to March 23, 1971 - thousands of cc/site.

FERTILIZER CODE No.	TREATMENTS MEANS	$\bar{x}1-\bar{x}1$	$\bar{x}1-\bar{x}2$	$\bar{x}4-\bar{x}3$	5%
F3	36.74	18.29**	5.24*	3.73	Range of 4 = 3.140x1.393 = 4.375
F2	33.01	14.56**	1.51		Range of 3 = 3.045x1.393 = 4.245
F1	31.50	13.05**			Range of 2 = 2.900x1.393 = 4.040
F0	18.45				For 1% level use 4.09, 3.92, respectively ratter than 3.140, and 2.800.

Critical value = mean difference (d.f. of error, range) $\sqrt{\frac{\text{mean square of error}}{\text{number of observations}}}$

$$= Q\ (\text{d.f., range})\sqrt{\frac{23.41}{12}} = Q\ (1.393)$$

2. Plant Growth July 1970 to June 1971 - thousands of cc/site.

FERTILIZER CODE No.	TREATMENTS MEANS	$\bar{x}1-\bar{x}1$	$\bar{x}1-\bar{x}2$	$\bar{x}4-\bar{x}3$	RANGE	5%	1%
F3	148.9	61.6**	21.8**	18.6*	Range of 4	15.5	20.7
F2	130.3	43.0**	3.16		Range of 3	15.0	20.0
F1	127.2	39.8**			Range of 2	14.3	19.3
F0	87.3						

$$\text{Critical value} = Q\ (\text{d.f., range})\sqrt{\frac{294.0}{12}} = Q\ (4.94)$$

3. Plant Growth December 23, 1970 to March 23, 1971 - thousands of cc/site
Each mean value minus the respective F0 value.

FERTILIZER CODE No.	TREATMENTS MEANS	$\bar{x}1-\bar{x}1$	$\bar{x}1-\bar{x}2$	$\bar{x}4-\bar{x}3$	RANGE	5%	1%
F3	225	22.5**	7.3**	4.6	Range of 4	5.28	7.05
F2	17.9	17.9**	2.7		Range of 3	5.11	6.87
F1	15.2	15.2**			Range of 2	4.88	6.59
F0	0						

$$\text{Critical value} = Q\ (\text{d.f., range})\sqrt{\frac{34.03}{12}} = Q\ (1.68)$$

* Significantly different at 5% level (95% confidence level)
** Significantly different at the 1% level (99% confidence level)

Because of low statistical significance for irrigation effects, an analysis of variance was done by pooling all fertilizer treatments across irrigations giving 12 replications per fertilizer treatment (Table 29). In most comparisons, replication uniformity can be reduced by non-uniform differences occurring within an irrigation level as a result of irrigation. So, if irrigation differences were significant in their effect, but all identical plots in a given irrigation treatment did not respond equally, this variation would show up partly as variation in replications (reps). Part of this variation in reps is known to be an effect of soil differences in the field. The senior author believes, however, that much of this rep variation is irrigation effects. If true, the data illustrate two things: First, irrigation variables did cause appreciable differences in growth and were not controlled carefully enough to result in uniform growth responses within each irrigation regime.

Duncan's Multiple Range Test

Duncan's Multiple Range Test was used on fertilizer treatments to determine the fertilizer levels which resulted in significant growth differences. These are given in Table 30 for three of the comparisons. To interpret the table, data in columns $\bar{x}i-\bar{x}1$ compare the value of the respective fertilizer treatment on the same horizontal line with the value for F0. For example, in Comparison 1, the F3 treatment grew 18,299 cc. more than the F0 treatment. Under column $\bar{x}i-\bar{x}2$, comparisons are made between values of F3 and F1, or between F2 and F1. The $\bar{x}4-\bar{x}3$ is a comparison between values for F3 and F2. F3-F0 is a range of 4; F3-F1 and F2-F0 are ranges of 3,and F3-F2, F2-F1 and F1-F0 are ranges of 2.

Data of Comparison 2 indicate a highly significant difference between growth on plots with added fertilizer and plots without fertilizer (F0). Also, growth on F3 plots compared to that on F1 plots is significantly larger. There is even a significant difference between growths with F3 and F2 treatments. This indicates that a growth response occurs between even the higher fertilizer additions. The F1 rates are 89 g. N/site, 39 g. P/site and 104 g. K/site. F2 is double F1; F3 is triple F1. At 2.25 m. spacings between sites, these rates are 180 kg. N/ha, 90 kg. P/ha and 210 kg. K/ha per year for F1.

A value of 540 kg. of N per hectare is a high rate. It is surprising to have an increase in growth between the F1 level of 180 kg. N/ha and either the 360 kg. N/ha of F2 or the 540 kg. N/ha of F3. The economics of adding this F1 increment of N plus P and K is approximately $150.00 per hectare. Yield is increased between the F2 and F3 treatment levels by about 10 to 12%. An average yield at this growth rate is about 100,000 kg. of fruit per year. (See Figure 22.) The F3 fertilizer rates increase yields over F2 rates about 10,000 to 12,000 kg/ha. At prices of about 2 cents/kilo, an unconfirmed field price observed in Portuguesa State, Venezuela, this increment of fertilizer (from F2 to F3) would increase gross income about $200.00 to 240.00 per hectare. From these very general approximations, the fertilizer additions may or may not prove economical. This deserves more detailed study

on the effect of fertilizer on fruit quality, bunch size and problems of weed control, to name a few factors. The above calculations are assuming no losses. Prices may be different than estimated here. Greater growth increases give larger profits; less growth may not produce a profit.

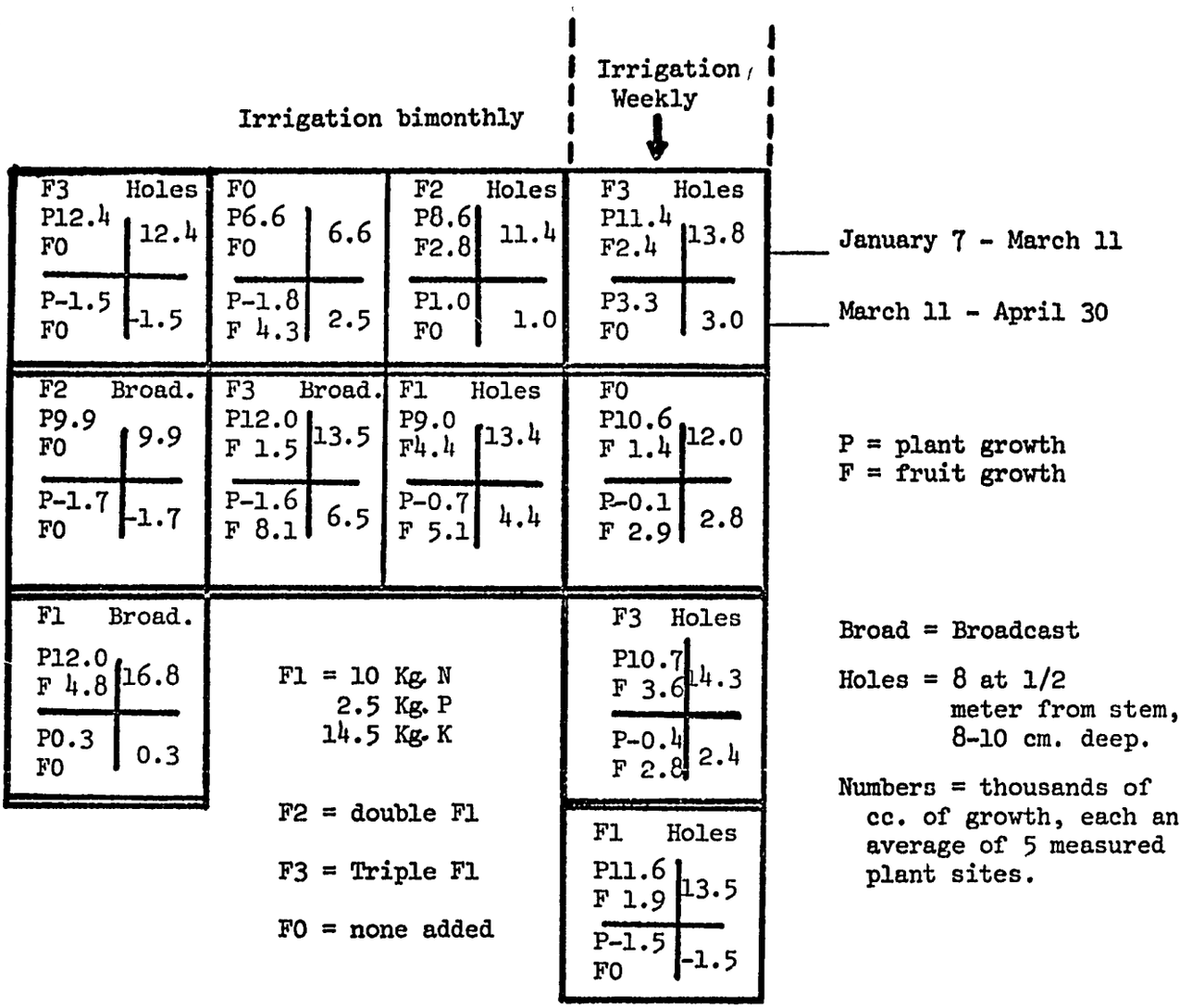
Comparisons 1 and 3 of Table 30 are for a short time period of 3 months Both are the same period, but from Comparison 3 the respective F0 value has been subtracted in order to eliminate as much field variation (error) as possible. The statistical signigicance is only slightly improved by that process. There is no evident difference in growth between F1 and F2 plots nor between F2 and F3 plots. Most growth difference is between plants on plots with no fertilizer (F0) and lowest fertilizer (F1).

FINCA SANTA ANA

A mutual interest by the owner of the Finca Santa Ana and CIDIAT in research on cambur growth resulted in initiating an irrigation-fertilizer study on the finca. It was laid out as shown in Figure 23 with two simple time intervals of irrigation, weekly and biweekly, and 4 fertilizer levels. Failure by the finca personnel to irrigate regularly, to take note of the date and time of irrigation, to record racimes picked and to determine their weights made it impossible to continue the program. Two irrigations were said to have been done in the January 7-March 11, 1970 period but none in the period of March 11-April 30. However, only parts of the scheduled area were irrigated in these irrigations, and none of it was wet uniformly.

Growth values reflect the water availability. The January period was still moist from December rains. Also, tobacco was not yet planted on the finca so some irrigation water was available and was diverted to camburs in January and February. The result was growth rates from 6,600 cc. for F0 to 16,800 cc. for one F1 plot. However, the lack of irrigation in dry March and the relatively dry April resulted in rapid growth losses. Less growth occurred with values ranging from -1,700 cc. for an F2 plot to 6,500 cc. for one F3 plot which had a heavy fruit production. Of the 11 plots, 8 had negative plant growth values. Only the few fruits known to be harvested had increased 5 of those 8 plot growth values into low positive growth values instead of showing up as negative growth.

The effect of fertilizer, even on plots suffering drought, is evident in the growth averages (Figure 23). Both F1 and F3 plot growth averages are 31% and 34% more growth than the F0 values. F2 is no different than F0. This apparent discrepancy can be explained in part by the site selection Plants to be measured were predetermined by a grid pattern and changes in the field were made only to avoid newly planted sites. The March 11 total volume of the two low F2 plots was 209,000 cc. compared to a more mature and vigorous F0 plot having 369,000 cc. for the 2 plots. The smaller and



	F0	F1	F2	F3
4 Month total, Average	11.9	15.6	12.5	16.0
Per month total, Average	3.0	3.9	3.1	4.0
Relative growth	100	131	103	134

Fig. 23. Summary of growth rates of cambur (banana) during the period January 7 to April 30, 1970, on the Finca Santa Ana located near Guanare, Venezuela.

fewer plants in the F2 plots resulted in less average growth than would be expected from the difference in fertilizer. For comparison, total volumes of plots on March 11 were:

F3 199,000	F0 131,000	F2 75,000	F3 118,000
F2 129,000	F3 213,000	F1 127,000	F0 238,000
F1 194,000			F2 169,000
			F1 169,000

The results add confirmation of several observations made in the larger studies at Guanare and Sabaneta. First, lack of irrigation slows or stops growth of cambur during the three dry months. Dryness apparently retards growth during any low moisture month of the year. Second, fertilizer additions when moisture is adequate will increase plant growth. Third, to use growth as a guide, attention must be given to the plant ages and the numbers of plants involved in the measurements in order to have confidence in plot averages.

CONCLUSIONS

Definitive conclusions are not possible on all aspects of this study at this time. Reasons are several. First, treatment influences are integrated over a 12 to 15-month period of growth and fruit production. Because the plant age at which growth conditions most affect the final fruit produced is not known, several plant cycles need to be observed. Second, development of the growth measurement method hasn't been extensively tested. All readings prior to June, 1970 were taken on only 4 sites per lot. It is believed that a minimum of about 8 sites is necessary to better evenly distribute fruit production as a part of the growth. By using about 8 sites, a single bad or good site has less effect on the average value obtained. Therefore, data used here is for less than 12 months for most sites. Third, generally inadequate irrigation water in the early 1970 irrigation season, and low precision control of the 1970 irrigations markedly reduced the real difference in water relations of different plots. Fourth, a fertilizer error at Sabaneta and low levels used at Guanare until August, 1970 confounded early data and responses to fertilizer. Fifth, the excessive occurrence of Sigatoka in December, 1969 at Sabaneta and the outbreak of Erwinia bacterial disease at Guanare in June-July, 1970 reduced the normal activities of the plants during those periods. Sixth, the inherent differences in soil that exist in the experimental plots reduce the precision of the data.

With this negative note given, there are several conclusions that seem justified.

1. The growth measurements (volumes) are related to fruit yields. The use of growth volume changes is a simpler method for measuring short-term effects of treatments than is fruit production. Treatments such as a 3 or 4-month irrigation treatment is a typical short period treatment that may deserve to be evaluated.

2. The growth measurement should be a plant volume calculation plus fruit. In this study only the plant stem was measured without leaves. The volume of the stem was calculated from the equation:

$$\underline{V = 0.09\ hy}$$

(The factor 0.08 was actually used in this study -- See pages 15, 16.)

Where V = volume of stem in thousands of cubic centimeters.

h = height in centimeters from the soil to the point of separation of the two youngest open leaves.

y = circumference in centimeters of the stem at 1/2 h.

Fruit volume was calculated using: Fruit volume numerically equals fruit weight and one kilogram equals 1000 cc. Fruit growth was assumed to be distributed equally over the three months during which it was forming outsid the plant.

3. Fruit yields matched relatively well with measured plant growth, but predicted yields were higher than actual yields. Sites with low growth rate also produced smaller average racime weights.

4. Irrigation during the dry months, December through April, is absolutely necessary for commercial production of bananas. In non-irrigated plots many sites had no measureable volume increase of the plant in the later dry month March and April. Fruiting is also retarded and bunch (racime) size is reduc by dryness. The effect of dryness is still noticeable in months as late as September which is after several months of adequate rain. In effect, non-irrigated plantations would have yield reductions from at least February through July each year (half the year), and probably the effect would be lon Evidence suggests that any effect of drought which occurs (stunting ?) in ea growth stages may prolong the effect of a short dry period to a year-round influence. This effect is most severe from March through July, the actual end of the period of dryness and the following two months.

5. Effects between irrigation application frequencies of 6-day intervals and 12-day intervals were not obvious. Water control and measurement must be improved to better determine any effects that might exist. The two month of growth data available during the 1970 irrigation season are summarized as follows:

	LOCATION	DRY	INTER-MEDIATE	WET
Growth compared to the dry control plots	Guanare	100	207	186
	Sabaneta	100	226	229

During the 1971 irrigation season, the "dry" irrigation was only a less frequently irrigated regime, rather than non-irrigated as in 1970. All treatments, however, had the same total water per month added. A smaller difference in growth because of the lower frequency (dry) and higher frequency (wet) irrigations would be expected. The data are:

SABANETA EXPERIMENT STATION

	DRY (Irrigated each 2 weeks)	INTERMEDIATE (Irrigated each 10-11 days)	WET (Irrigated each week)
Growth compared to the control (dry) plots	100%	86.5%	83.8%

The growth in the plots with the two-week irrigation interval is the great The same total amount of water per month was added in the three irrigation frequencies, so it appears that perhaps better deep wetting in the every-two-weeks application is as good as frequent irrigation. The Sabaneta sta does have a problem of water infiltration. Various irrigations observed d have unequal moisture distribution with too much water accumulating at the bottom of the border.

6. Fertilizer effects were obvious. Some inconsistencies did occur betw distant,widely separated plots, partly because of soil variation and partl due to initial site inequalities when treatments were begun. Generally, p without fertilizer did more poorly than all other treatments close to that site. In a few instances untreated plots did do well. An adequate explan tion for these difference is not available, although some were recorded at the beginning of treatments as being excellent sites. Most differences ar attributed to soil variations.

7. Differences in growth averages during the first 7 to 9 months as a re of different fertilizer variables were not consistent. Higher fertilizer additions didn't always result in higher growth values. The overall averag of growth as influenced by fertilizer levels during the first 9 months are

Fertilizer	GUANARE		SABANETA	
	N rate (Kg/ha/3 mo)	Growth	N rate (Kg/ha/3 mo)	Growth
F0	0	100%	0	100%
F1	5	131	7.5	120
F2	10	137	15	105
F3	20	130	30	117
F4	No treatment	---	60	146
F5	No treatment	---	60/6 mo.	136
F6	No treatment	---	120/6 mo.	156

The F4, F5 and F6 treatments were not applied until March 9 through an error. Thus, they were effective only over a 6-month period.

8. Growth differences occur in both Guanare and Sabaneta as a result of large differentials of added fertilizer. Growth averages in thousands of cc. per site are as follows:

FERTILIZER TREATMENT	GUANARE STATION		
	Feb. 23, 1970 to Feb. 23, 1971	Sept. 23, 1970 to Sept. 23, 1971	Nov. 23, 1970 to Nov. 23, 1971
F0	74.7^{a}	34.0^{a}	14.4^{a}
F1	110.6^{b}	58.2^{b}	27.7^{b}
F2	114.8^{b}	58.7^{b}	30.1^{bc}
F3	122.0^{b}	71.4^{b}	38.7^{c}

FERTILIZER TREATMENT	SABANETA STATION		
	June 23, 1970 to June 23, 1971	Dec. 23, 1970 to Mar. 23, 1971	Dec.23,1970 to Mar. 23, 1971 Minus F0*
F0	87.3^{a}	18.4^{a}	0.0^{a}
F1	127.2^{b}	31.5^{b}	15.2^{b}
F2	130.3^{b}	33.0^{bc}	17.9^{bc}
F3	149.0^{c}	36.7^{c}	22.5^{c}

* Increases over F0 values obtained by subtracting F0 values from treatment values.

Treatment averages with a common letter superscript are not significantly different from each other.

9. Growth rates were highly affected by fertilizer additions. The last few months which should best illustrate continual fertilizer effects result in the following growth and projected yield rates:

FERTILIZER TREATMENT	GUANARE STATION		SABANETA STATION	
	GROWTH RATE*	YIELD	GROWTH RATE*	YIELD
F0	4.8	31,600	6.1	47,400
F1	9.2	59,600	10.5	81,000
F2	10.0	67,000	11.0	86,000
F3	12.9	82,500	12.2	93,100

* Growth in thousands of cc. per site per month; predicted yield is in kg. of fruit per hectare per year. Guanare has about 1,340 sites/ha; Sabaneta has about 2,025 sites/ha.

Even though Cabaneta Station with its greater number of sites per hectar had more fertilizer added per hectare than did Guanare, it also produced more total kilograms of fruit on the same fertilizer. For example, on a per hectare basis, Guanare F3 plots had the same fertilizer rate as Saba F2 plots; the predicted yields of fruit per hectare are very similar.

10. Actual bunch weight averages compare well with predictions based on early measurements of individual plants and their fruits. The following summary is based on the " best fit " curve of the graph, " bunch weight "growth".

AVERAGE WEIGHT OF BUNCH	GROWTH VALUES FOR FRUIT YIELDS	
	PREDICTED	MEASURED*
10 kg.	32,000 cc.	29,000 cc.
15 kg.	47,000 cc.	49,000 cc.
20 kg.	62,500 cc.	72,000 cc.
25 kg.	78,000 cc.	No average this great

* Total fruit, all sites, No ember 23, 1970 to June 4, 1971.

Measured yields and bunch weights may be low at higher rates of growth be of (1) stolen bunches that are unaccounted for, (2) premature fall of so plants with large but immature bunches, and (3) non-uniform spread of bu production. The non-uniform bunch production refers to double bunch gro on the same site during nearly the same time period. This reduces bunch but increases total yield in kilograms.

11. Additions of CaO used for control of soil acidity did not appear to affect growth. Soil pH was mostly between 5.5 and 6.2. Treatment respo were measured in July nd August, 1970.

12. Fertilizer effects as measured are thought to be real and quite goo The authors have much less confidence in the conclusions of the effects to moisture. Better control of moisture needs to be studied.

C O N C L U S I O N E S

Conclusiones definitivas no son posibles en todos los aspectos de esta investigación, por varias razones. La primera, es que las influencias de tratamiento son integradas sobre un período de 12 a 15 meses de crecimiento y producción de la fruta. Algunos ciclos de las plantas necesitan ser observados debido a que no tenemos conocimiento sobre a que edad la planta puede ser mayormente afectada por ciertos tratamientos. La segunda, es que el método de medida del crecimiento no ha sido extensivamente experimentado. Todos los datos anteriores a Junio de 1970, fueron tomados en solamente 4 sitios por parcela. Se cree que el mínimo de 8 sitios es necesario para más uniformemente distribuír la producción de fruta como parte del crecimiento. Con este número de sitios, un sitio bueno ó malo tiene un efecto menor en el valor promedio obtenido. Por tanto, los datos usados aquí son por un período menor de 12 meses para la mayoría de los sitios. Tercera, generalmente agua de riego inadecuada en el principio de la estación de riego de 1970 y bajo control de precisión de los riegos de 1970, redujeron marcadamente las relaciones de agua en distintas parcelas. Cuarto, un error en la aplicación de fertilizante en Sabaneta y bajos niveles usados en Guanare hasta Agosto de 1970, embrolló datos y respuestas tempranas al fertilizante. Quinta, el desarrollo excesivo de Sigatoka en Diciembre de 1969, en Sabaneta y la epidemia de la enfermedad bacteriana Erwinia, en Guanare en Junio-Julio de 1970, redujo actividades normales de las plantas durante estos períodos. Sexta, las diferencias inherentes en suelos, las cuales existen en parcelas experimentales reducen la precisión de los datos.

Con esta nota negativa dada, hay varias conclusiones que parecen justificadas.

1. Las medidas de crecimiento (volúmenes) están relacionadas con los rendimientos de la fruta. El uso del cambio de crecimiento del volumen, es el método más fácil para medir los efectos de los tratamientos que el de la producción de fruta. Tratamientos como aquellos de 3 ó 4 meses de irrigación es un típico período corto de tratamiento que merecería ser evaluado.

2. La medida de crecimiento debería ser el cálculo del volumen de la planta más la fruta. En este estudio se midió solamente el tallo de la planta sin incluir las hojas.

El volumen del tallo fue calculado de la ecuación:

$$V = 0.09\ hy$$

(El factor 0.08 fue actualmente usado en este estudio. Ver p.15-16)

Donde V = volumen de tallo en miles de centímetros cúbicos

h = La altura en centímetros desde el suelo hasta el punto de la separación de las hojas abiertas más jóvenes.

y = Circunferencia en centímetros del tallo a media altura.

El volumen de la fruta fue calculado usando: El volumen de la fruta numericamente es igual al peso de la fruta y un kilogramo iguala 1000 cc. El crecimiento se asume que fue distribuído igualmente sobre los 3 meses durante el cual se estaba formando fuera de la planta.

3. El rendimiento de la fruta iguala relativamente bien con el crecimiento de la planta, pero los rendimientos pronósticados fueron más altos que los reales rendimientos. Sitios con bajas tasas de crecimiento también producen promedios más pequeños de pesos del racimo.

4. Irrigación durante los meses secos, Diciembre hasta Abril, es absolutamente necesarios para la producción comercial de bananas. En parcelas no irrigadas, muchos sitios no tenían un aumento mensurable en el volumen del tallo de la planta en los posteriores meses secos, Marzo y Abril. La fruta es también retardada y los racimos reducidos por la sequedad. El efecto de la sequedad es todavía notable en los meses posteriores como Septiembre, el cual viene después de muchos meses de lluvia adecuada. En efecto, plantaciones sin irrigación podrían tener reducciones de rendimiento de por lo menos entre Febrero y Julio de cada año (la mitad del año) y probablemente el efecto podría ser más largo. Evidencias sugieren que cualquier impedimento en el crecimiento causado por la sequía durante las etapas de temprano crecimiento podría ser prolongado por un período de un año.

5. No se evidenció ningún efecto a causa de la diferencia entre intervalos de riego de 6 y 12 dias. Deberá de mejorarse el control y medida del agua si se quiere determinar cualquier efecto que pueda existir. A continuación se resumen los datos para los 2 meses de crecimiento disponible para la temporada de riego de 1970.

	UBICACION	SECO	INTER-MEDIO	HUMEDO
Crecimiento comparado a las parcelas de control secas.	Guanare	100	207	186
	Sabaneta	100	226	229

Durante la temporada de irrigación de 1971, la irrigación "seca" fue solamente un régimen menos frequentemente irrigado, en vez de no irrigado como en 1970. Todos los tratamientos, sin embargo, tuvieron el mismo total de agua añadida. Una pequeña diferencia en crecimiento debido a la baja frecuencia de riego por mes (seca) y la alta frecuencia (húmeda) de irrigaciones debiera ser esperada. Los datos son:

	SECO (Irrigado cada dos semanas)	INTERMEDIO (Irrigado cada 10 u 11 dias)	HUMEDO (Irrigado cada semana)
Crecimiento comparado a las parcelas de control secas.	100%	86.5%	83.8%

El crecimiento en las parcelas con el intervalo de 2 semanas de irrigación es el más grande. La misma cantidad total de agua por mes fue añadida en las 3 frecuencias de irrigación así que parece que quizás una saturación profunda en cada una de las dos semanas de aplicación es tan buena como la irrigación frequente. La estación de Sabaneta tiene un problema de infiltración de agua. Algunas irrigaciones observadas tenían una distribución de humedad con mucha agua acumulada al fondo del borde.

6. Efectos del fertilizante eran evidentes. Ocurrieron entre parcelas distantes algunas inconsistencias, grandemente separadas, en parte porque las variaciones de suelos y en parte debido a la diferencia inicial entre los sitios cuando comenzaron los tratamientos. Comunmente, parcelas sin fertilizante fueron más pobres que todos los otros tratamientos cerca de ese sitio. En algunos casos las parcelas no tratadas dieron buenos resultados. No tenemos una explicación adecuada del porque de estas diferencias, aunque algunos sitios fueron registrados al principio de los tratamientos como excelentes. La mayor parte de las diferencias son atribuídas a la variación de suelos.

7. Todas las diferencias en los primeros 7 a 9 meses producidas en el promedio de crecimiento durante diferentes variables de fertilizantes no fueron consistentes. A consecuencia del uso de altos aumentos de fertilizante no siempre resultaron en más altos valores de desarrollo. El promedio total de desarrollo influenciado por niveles de fertilizante durante los primeros 9 meses son:

Fertilizante	GUANARE		SABANETA	
	Proporción N (Kg/ha/3 meses)	Crecimiento	Proporción N (Kg/ha/3 meses)	Crecimiento
F0	0	100%	0	100%
F1	5	131	7.5	120
F2	10	137	15	105
F3	20	130	30	117
F4	Sin tratamiento	---	60	146
F5	Sin tratamiento	---	60/6 m.	136
F6	Sin tratamiento	---	120/6 m.	156

Los tratamientos F4, F5 y F6, no fueron aplicados hasta el 9 de Marzo por un error. Por la tanto, estos fueron efectivos solamente por un período de 6 meses.

8. Diferencias en el crecimiento ocurrieron en ambas Guanare y Sabaneta como resultado de las grandes diferencias de fertilizante añadido.

Los promedios de crecimiento en miles de cc. por sitio son como siguen:

TRATAMIENTO CON FERTILIZANTE	GUANARE STATION		
	Febrero 23, 1970 a Febrero 23, 1971	Septiembre 23, 1970 a Febrero 23, 1971	Noviembre 23, 1970 a Febrero 23, 1971
F0	74.7[a]	34.0[a]	14.4[a]
F1	110.6[b]	58.2[b]	27.7[b]
F2	114.8[b]	58.7[b]	30.1[bc]
F3	122.0[b]	71.4[b]	38.7[c]

TRATAMIENTO CON FERTILIZANTE	SABANETA STATION		
	Junio 23, 1970 a Junio 23, 1971	Diciembre 23, 1970 a Marzo 23, 1971	Diciembre 23, 1970 a Marzo 23, 1971 Menos F0*
F0	87.3[a]	18.4[a]	0[a]
F1	127.2[b]	31.5[b]	15.2[b]
F2	130.3[b]	33.0[bc]	17.9[bc]
F3	149.0[c]	36.7[c]	22.5[c]

* El aumento sobre los valores F0 fueron obteneidos substrayendo los valores F0 de los valores de tratamiento.

Los promedios de tratamiento con una letra común sobreescrita no son significantemente diferentes una de las otras.

9. Las tasas del crecimiento fueron grandemente afectadas por adiciones de fertilizante. Los últimos meses, los cuales deberían ilustrar mejor los efectos contínuos de la fertilización, resultan en el siguiente crecimiento y en las tasas proyectadas de rendimientos.

TRATAMIENTO DE FERTILIZANTE	ESTACION GUANARE		ESTACION SABANETA	
	TASA DE CRECIMIENTO	RENDIMIENTO	TASA DE CRECIMIENTO	RENDIMIENTO
F0	4.8	31,600	6.1	47,400
F1	9.2	59,600	10.5	81,000
F2	10.0	67,000	11.0	86,000
F3	12.9	82,500	12.2	93,100

* Crecimiento en miles de cc. por sitio por mes; rendimiento pronósticado en kg. de fruta por hectárea por año. Guanare tiene cerca de 1,340 sitios/há; Sabaneta tiene cerca de 2,025 sitios/há.

Aunque la Estación Sabaneta con su mayor número de sitios por hectárea tiene más fertilizante añadido por hectárea que Guanare, también produjo en total más kilogramos de fruta en la misma fertilización. Por ejemplo, en una hectárea por bases, las parcelas de Guanare F3, tuvieron la misma tasa de fertilizante que la parcela F2 de Sabaneta. Los pronósticos de rendimientos de fruta por hectárea son muy parecidos.

10. Los promedios del peso de los racimos se comparan bien con las predicciones basadas en medidas tempranas de plantas individuales y sus frutas. El siguiente sumario es basado en la mejor curva adjustada de la gráfica, "peso de racimo" contra "desarrollo".

PESO PROMEDIO POR RACIMO	VALORES DE CRECIMIENTO DE LOS RENDIMIENTOS DE FRUTA	
	ESTIMADO	MEDIDO
10 kg.	32,000 cc.	29,000 cc.
15.kg.	47,000 cc.	49,000 cc.
20 kg.	62,500 cc.	72,000 cc.
25 kg.	78,000 cc.	No hay un promedio de este tamaño.

* El total de la fruta, todos los sitios, del 23 de Noviembre de 1970 hasta el 4 de Junio de 1971.

Rendimientos medidos y el peso por racimo pueda que sean bajos a tasas más altas de crecimiento porque (1) algunos racimos fueron robados, (2)

caída prematura de algunas plantas con racimos grandes pero inmaduros y (3) una producción no uniforme en el área investigada. La desigualdad de producción de racimos se refiere a la producción de un racimo doble en el mismo sitio durante casi el mismo período. Esto reduce el tamaño de los racimos per aumenta el total de kilogramos producidos.

11. Adiciones de CaO usados para controlar la acidez del suelo no pareció afectar el desarrollo. El pH del suelo estaba casi entre 5.5 y 6.2. Reacciones al tratamiento fueron medidos en Julio y Agosto de 1970.

12. Se piensa que los efectos de fertilizante medidos fueron reales y bastante buenos. Los autores tienen menos confianza sobre las conclusiones que se derivan de los efectos de aplicación de humedad. Es necesario que se estudie un mejor control de humedad.

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