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1974

VOLUME I

BANANAS AND PLANTAINS

AGRIMARK

UNITED BRANDS COMPANY

DIVISION OF TROPICAL RESEARCH

AND

DIVISION EXPERIMENTAL DEPARTMENTS

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BANANA DISEASES

Diseases receiving major attention were nematode root rot and the new race of leaf spot in Honduras called "Black Sigatoka". Fumigation with DBCP (Fumazone) every 6 months became a standard practice in nematode infested areas in the Bocas and Golfito Divisions. As a result, losses from uprooting were substantially reduced. The three granular nematicides approved for use on bananas were extensively studied but cannot yet compete with DBCP.

SIGATOKA

Serious outbreaks of Sigatoka occurred in Costa Rica and Bocas due to a shortage of Dithane M-45. The month long strike in the Golfito Division was also a factor in the buildup of leafspot.

In Honduras, the new virulent race of leaf spot called Black Sigatoka continued to spread. It is now present in all farms from the Guanchias to Coco Bolsa-Palos Blancos, and has mostly replaced Sigatoka in these areas. This new race was discovered in May, 1973 in Naranjo Chino farm. A serious outbreak of spotting occurred over about 3000 acres in December, 1973. Benlate applications began in January (4 oz. in an oil-water emulsion) and by July the disease had been brought under control. In some areas, such as Las Flores, up to 14 cycles of spray 13-18 days apart were required (Figure 1). Even so more than 90% of the plants still had spotting on leaves 9 to 10 (Figure 1).

In August, 1974 a new epidemic of Black Sigatoka appeared. Spotting levels went from leaf 10-11 to around 8 in the Ulua and Progreso districts (Figure 2). Prior to and following "Fifi" spray cycles had been delayed due to bad weather and rescue operations with the helicopters. As a result disease continued to increase with average spotting levels reaching leaves 6 to 7 on mature plants and 5 to 6 on young plants. As an emergency Black Sigatoka areas were put on 12-14 day cycles with 5 oz of Benlate per acre to bring the disease under control. By September Benlate was being applied on about 12,225 acres. Plants with young fruit and less than 5 healthy leaves were cut down in October. The epidemic peaked in November and began to decline in December (Figure 2).

The epidemic of 1973 and 1974 coincided with the period of the year when most fruit was hanging. Shot plants seem particularly susceptible.

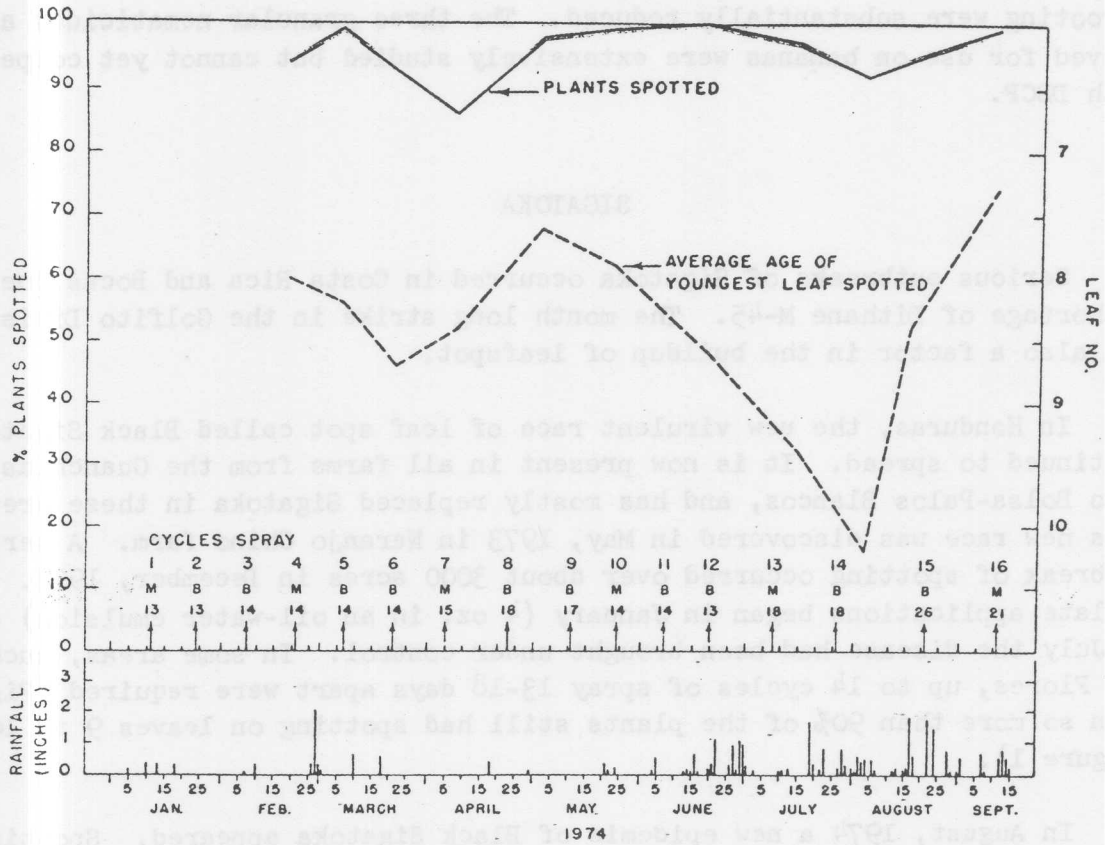

Figure 1. Black Sigatoka levels in Las Flores in relation to spray cycles and rainfall. M = Dithane M-45; B = Benlate. The late 1973 epidemic in this farm was not brought under control until June, 1974 and then another epidemic appeared in August.

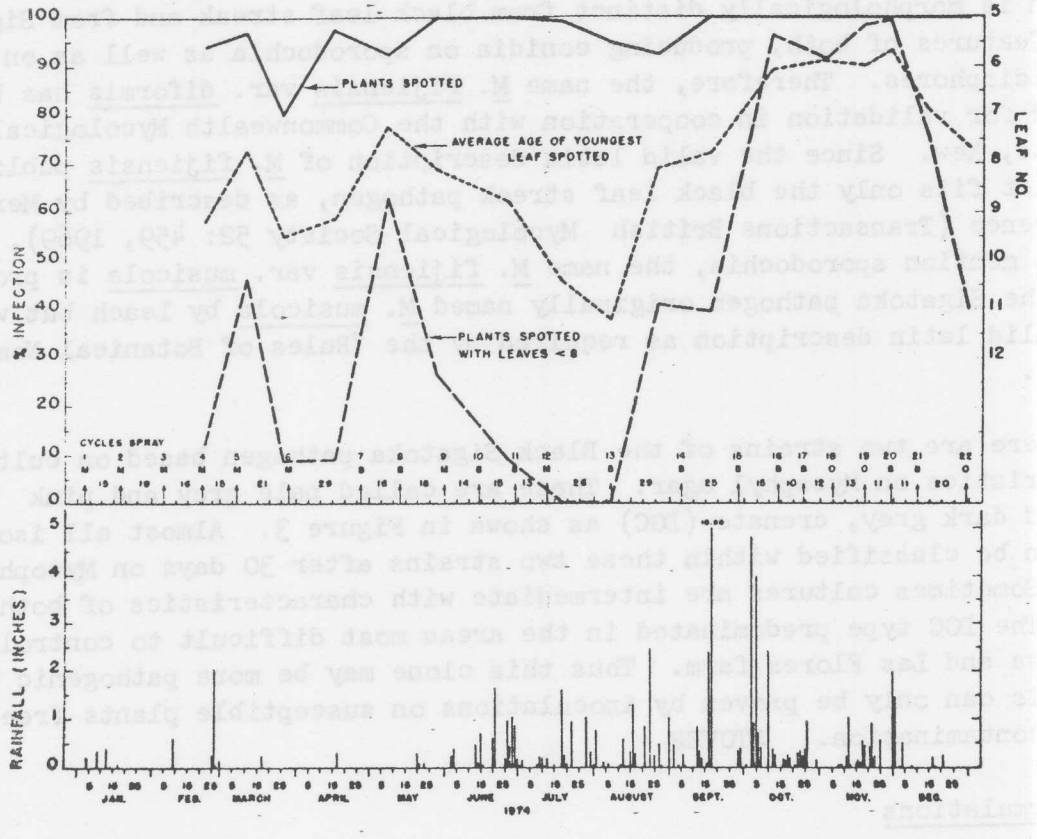

Figure 2. Black Sigatoka levels in Santa Rosa Farm. The December 1973 epidemic began to decline in May, 1974 to be followed by a new epidemic in mid-August that began its decline in December. M = Dithane M-45; B = Benlate; O = Benlate in oil.

Taxonomy and Nomenclature of the Different Leaf Spot Pathogens

Detailed mycological studies were made using leaf spot material collected in Honduras and herbarium material from other parts of the world. It appears that there are three morphological types of Mycosphaerella fijiensis Morelet, now the validly published name replacing M. musicola. The distinguishing features are outlined in Table 1. The Black Sigatoka pathogen is morphologically distinct from black leaf streak and from Sigatoka. It has features of both, producing conidia on sporodochia as well as on simple conidiophores. Therefore, the name M. fijiensis var. difformis has been proposed for validation in cooperation with the Commonwealth Mycological Institute, Kew. Since the valid latin description of M. fijiensis published by Morelet fits only the black leaf streak pathogen, as described by Meredith and Lawrence (Transactions British Mycological Society 52: 459, 1969), and does not mention sporodochia, the name M. fijiensis var. musicola is proposed for the Sigatoka pathogen originally named M. musicola by Leach but without a valid latin description as required by the "Rules of Botanical Nomenclature".

There are two strains of the Black Sigatoka pathogen based on cultural characteristics on Mycophyl agar. These are called pale grey and pink (PGP) and dark grey, crenate (DGC) as shown in Figure 3. Almost all isolates can be classified within these two strains after 30 days on Mycophyl tubes. Sometimes cultures are intermediate with characteristics of both types. The DGC type predominated in the areas most difficult to control in Santa Rosa and Las Flores farm. Thus this clone may be more pathogenic than PGP. This can only be proven by inoculations on susceptible plants free from outside contamination. STOVER

Spray Formulations

Studies were completed comparing Benlate and Dithane with and without oil. The data (Table 2) confirmed field observations that Benlate is superior to Dithane and that the addition of oil greatly enhances the activity of both fungicides.

Benlate is used in oil alone in the French Antilles. Special oil formulations of other benzimidazole compounds have been developed for adding directly to oil. Problems of blending Benlate into the oil on commercial scale were overcome at first by prolonged agitation in the mixing tanks and at the same time passing the mixture through a 420 mesh screen. Using the tank trucks in Honduras, required 3 to 7 hours or longer to get a suspension fine enough to pass the screen. Some batches still remained entirely unsatisfactory. However, it was not necessary to throw these poor suspensions away as they were easily converted to an emulsion by first adding the 0.75%

Table 1

Distinguishing features of the morphological varieties of *Mycosphaerella fijiensis*.

Common name and proposed scientific name	Fasicle of conidiophores on a stroma (Sporodochium)	From 1-4 conidiophores not on a stroma	Conidia shape
Black Leaf Streak (*M. fijiensis*)	No	Yes	Mostly obclava with hilum
Sigatoka (*M. fijiensis* var. *musicola*)	Yes	No	Mostly cylindr no hilum
Black Sigatoka (*M. fijiensis* var. *diformis*)	Yes	Yes	Mostly obclava with hilum

Table 2

Relative performance of different spray formulations in controlling Black Sigatoka.

	Average age youngest leaf spotted	Percentage of plants with leaves younger than No. 8 spotted
Benlate emulsion	8.77	28
Benlate alone	7.73	55
Maneb emulsion	7.41	48
Oil alone	6.70	69
Maneb alone	6.73	76
Control	3.91	100

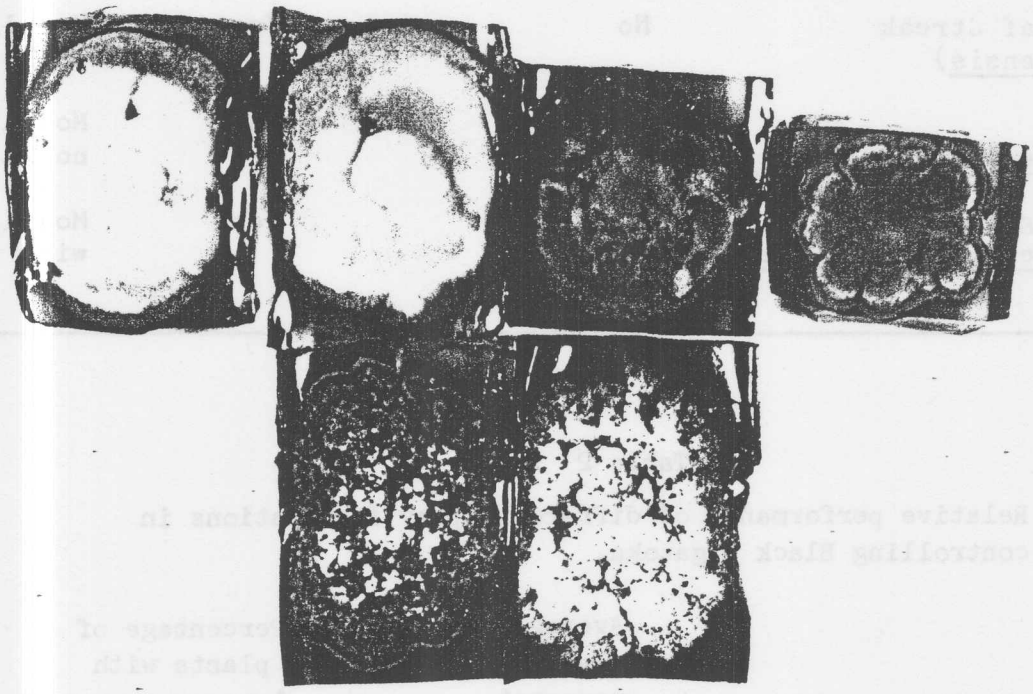

Figure 3. Two strains of black Sigatoka (upper colonies) and the Sigatoka pathogen (lower colonies) on Mycophyl agar after 30 days. The two upper left colonies are called the pale grey and pink strain (PGP) and the two upper right colonies are called the dark grey, crenate strain (DGC) of black Sigatoka.

Triton and then the necessary water. The first commercial-scale Benlate-oil applications were made in November.

To improve suspension preparation, a large blender of French design (IFAC) was fabricated. These blenders were being used by other companies in Costa Rica for the same purpose. A 285-gallon capacity blender (Figure 4) with a 7.5 h.p. electric motor operating at 1760 r.p.m. was fabricated and put into use. With this blender a concentrate of 2 lbs Benlate per gallon of oil can be suspended within 5 minutes from the time the last of the Benlate is added while the oil is being agitated. This concentrate readily passes a 420 micron-mesh screen leaving no residue of any kind.

With the new blender for mixing oil and Benlate we can also mix Dithane M-45 and oil (1.5 lbs of Dithane in 1 gallon of oil). Coverage appears good and this formulation has been tested on a commercial scale. A previous attempt (1965) to suspend a special formulation made by Rohm and Haas - Dithane M-45X - in oil gave poor droplet distribution.

Applying fungicides in oil alone more than doubles the spraying capacity of the aircraft. Also, there is no evidence that the oil-fungicide suspension is any less effective than the emulsion-fungicide. The limiting factor in the use of oil alone is when drought conditions prevail with poor irrigation. Emulsions are preferred under these conditions. STOVER, DICKSON.

Benlate Tolerance

Isolates of the Black Sigatoka fungus were tested as to their sensitivity to Benlate at regular intervals. Spore germination and germ tube growth were inhibited at 0.2 ppm. Germ tubes were also distorted. There has been no change in sensitivity to the fungicide. To help avoid build up of Benlate tolerant strains or other leaf pathogens not sensitive to Benlate, Dithane M-45 has been applied following 2 cycles of Benlate. In the Philippines banana rust (Uredo musae) and freckle (Phyllostictina musae) are tolerant of Benlate and build up to damaging levels if Benlate is used exclusively to control black leaf streak. These pathogens are not present in the Western hemisphere. STOVER

Surfactant Tests

Since the supply of Triton X45 was restricted other sources of emulsifiers were examined during the year. These were:

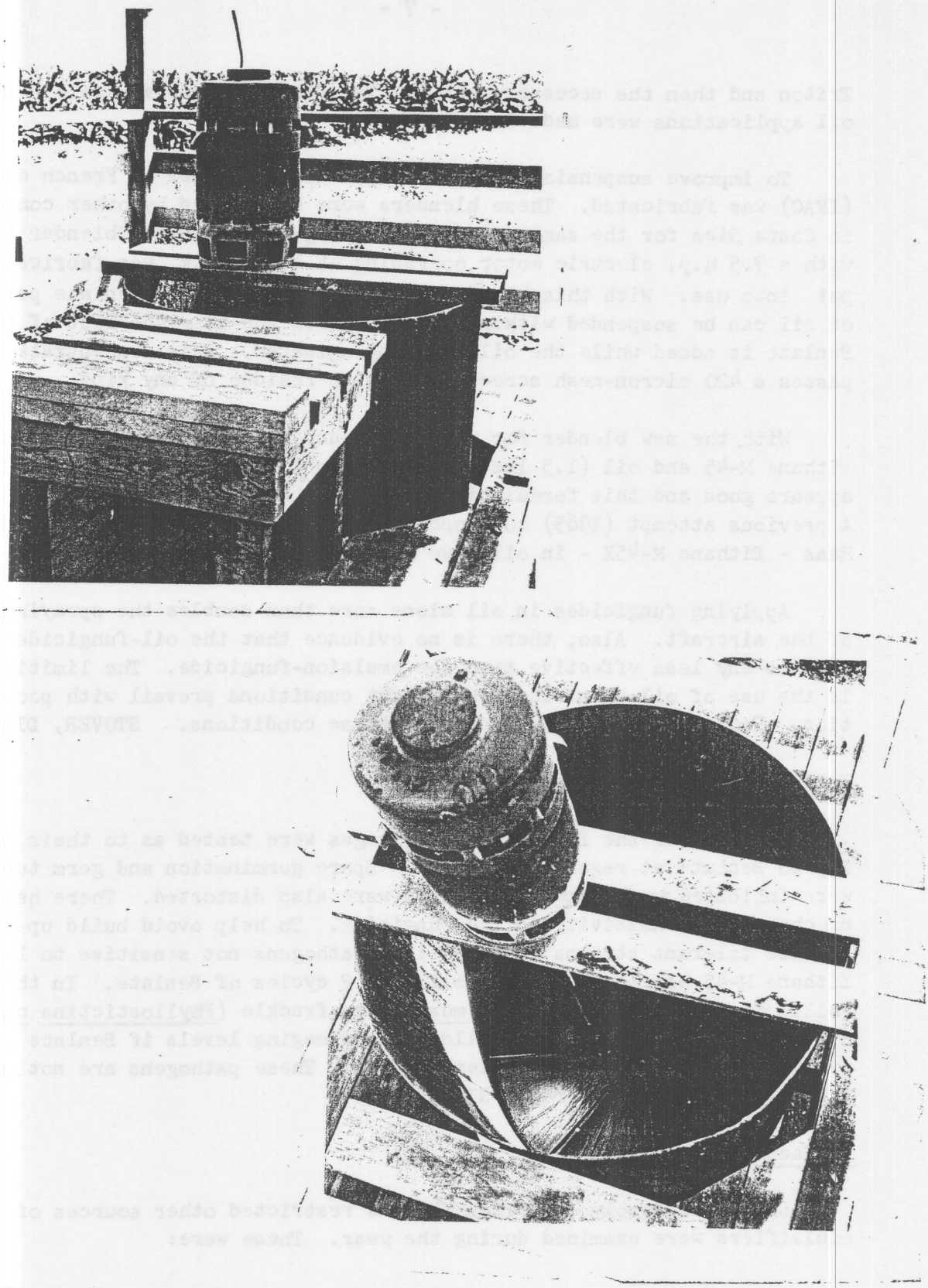

Figure 4. Blender fabricated for suspending Benlate and Dithane M-45 in oil. The 7.5 h.p. motor operates at 1760 r.p.m.

Atlox 3404	(Atlas Chemical Co.)	T-Mulz	(Thompson-Hayward Chemical Co.)
Atlox 62011	(" " ")	TDN-6	(" " " ")
Atlox 62012	(" " ")	Plurofac A-24	(BASF Wyandotte)
Renex 36	(" " ")	Pluronic P-103	(" ")
Igepal CA-520	(GAF Corp.)	Pluronic P-104	(" ")
Igepal CO-520	(" ")	Pluronic L-61	(" ")
Sponto AK16	(Witco Chemical)	Pluronic 31-R-1	(" ")
Sponto 200	(" ")	Agral 90	(Imperial Chemical Industries)
Sponto 2210	(" ")	Atplus 300F	(Atlas Chemical Co.)

Preliminary tests consisted of:

1. Checking the amount of foam
2. Smoothness of emulsion - checking the quickness that small oil globules form upon stopping the agitation.
3. Phytotoxicity of the emulsion made with the different emulsifiers sprayed on banana leaves with a DeVilbus atomizer.
4. Checking the spray deposit
5. Sticking qualities by subjecting leaves sprayed to $\frac{1}{2}$ and 1 inch of artificial rain. (Sprayed using Paasche Airbrush).

After passing these tests the most promising are tested in the field by spraying from a helicopter in a commercial formulation. Samples of sprayed leaves can then be bio-assayed as to which emulsifier is the most effective protectant as weathering proceeds. All emulsifiers were compared with Triton X45 at 0.75% of the volumes of oil in the standard maneb emulsion. None of the above mentioned surfactants showed any phytotoxicity to banana leaves at the rates tested. The following were dropped because of excessive foaming: Atlox 62011, Atlox 62012, Renex 36, Sponto AK16-95, Igepal CO-520, TD N-6, and Plurofac A-24. Sponto 2210 and T-Mulz were dropped because of unsatisfactory spray deposits. Pluronic P103 and P104 were dropped because of their characteristic of becoming solids at room (laboratory) temperature and even in sunshine remain thick. Pluronic L-61 and Pluronic 31-R-1 were dropped because of 1.5% of oil volume required.

It was found that Agral 90 could be used at 0.38% of the volume of oil which thus makes it about 35% less expensive than Triton X45. Two 1000 gallon tank mixes have been sprayed in the field using this emulsifier. In both instances there was less foaming than when Triton X45 is used. Good coverage was obtained on the leaves although the droplets were somewhat more distinct and without a "washed" appearance as shown with the Triton X45 emulsion. Sticking quality of the deposit in the field was found equal to that of Triton X45.

Atlox 3404 has also been shown to give less foaming than Triton X45. It is necessary to mix this emulsifier with the water rather than the oil in

Table 4. Survey of *Radopholus similis* rhizome-infection in some areas of Higuerito District, Honduras.

Farm	Section	No. of Acres	Cable No.	No. of Rhizomes Examined	Percent Infection
Garroba	S-108	22.8	1	34	18
			2	33	24
			3	39	31
			Total	106	25
Garroba	R-110	23.5	1	32	19
			2	28	14
			3	32	31
			4	33	36
			5	30	53
			Total	155	31
Carroba	R-111	20.0	1	33	9
			2	39	0
			3	32	16
			4	2	0
			Total	106	6
Garroba	T-104	12.2	1	29	93
			2	31	90
			Total	60	92
Garroba	T-105	18.4	1	35	63
			2	34	85
			3	35	74
			Total	104	74
Garroba	T-106	24.4	1	32	28
			2	31	26
			3	32	31
			4	32	34
			Total	127	30
Garroba	T-107	24.0	1	35	17
			2	32	16
			3	29	0
			4	31	0
			Total	127	9
Garroba	T-108	10.0	1	27	41
			2	28	21
			Total	55	31
Olivo	J-114	22.9	1	28	86
			2	27	93
			3	25	84
			4	27	70
			Total	107	83
Olivo	L-116	24.7	1	32	53
			2	30	47
			3	32	34
			4	25	28

Table 5. *Radopholus similis* rhizome infection in some sections of the Lima District.

Farm	Section	No. of Acres	Cable No.	No. of Rhizomes Examined	Percent Infection
San Juan	4	27.5	1	46	39
			2	49	43
			3	47	43
			Total	142	43
San Juan	5	21.0	1	33	24
			2	38	26
			3	32	19
			Total	103	23
San Juan	10	20.9	1	42	21
			2	38	13
			3	42	88
			4	39	41
			Total	161	41
San Juan	11	23.7	1	39	82
			2	43	67
			3	42	45
			Total	124	65
San Juan	12	24.3	1	38	34
			2	45	42
			3	39	54
			4	43	35
			Total	165	41
San Juan	19	22.9	1	26	46
			2	33	24
			3	24	13
			Total	83	28
La Curva	16	22.2	1	32	3
			2	30	7
			Total	62	5
La Curva	19	22.9	1	22	10
			2	24	4
			3	27	0
			4	29	0
			Total	102	3
La Curva	18	30.0	1	40	5
			2	41	2
			3	43	2
			4	45	7
			Total	169	4

Table 5. (Continued)

Farm	Section	No. of Acres	Cable No.	No. of Rhizomes Examined	Percent Infection
Tacamiche	27	24.3	1	37	19
			2	41	20
			Total	78	19
Tacamiche	38	18.7	1	35	17
			2	32	3
			3	18	0
			4	22	9
			Total	107	8

J. Ewens Farm, Santiago District, Honduras - A Radopholus rhizome damage survey was carried out in some areas with low production. About 5 rhizomes per acre were examined (Table 6). Even where more than 50% more of the areas examined had percent rhizome infection higher than 40%, cultural practices should be improved before attempting the use of nematicides.

SALAS, OYUELA

DBCP Phytotoxicity

As the large scale use of Fumazone continued to expand in 1974 several cases of phytotoxicity were observed. In Coto and Changuinola splitting of sucker leaf sheaths and sucker distortion occurred in a few areas where injection was too close to young suckers (see photographs in the 1974 Golfito Experimental Dept. Report). Damage caused was minor.

The most serious damage from DBCP occurred in Higueron Farm, Armuelles.

SALAS, STOVER, DONALDSON, STEPHENS

Dow Chemical Co., manufacturers of Fumazone, recommended 21 cc per plant and were carrying out a commercial scale trial at this rate in Higueron Farm, Armuelles. The first cycle was applied between September 29 and December 21, 1973. The second cycle at the same rate was applied May 7-16, 1974. The first cases of phytotoxicity (Figure 4) were observed in May and reached a peak in July with 3,456 plants severely infected. Necrosis of the leaf lamina, peduncle and fruit was present in severe cases. At the end of July many mild cases were apparent with yellow blotches and water-soacked dark green patches along the petiole of leaves 4-6. Most plants recovered from the milder symptoms.

Samples of the fruit stalk, fruit and lamina were taken from diseased and healthy plants for bromide analyses. Samples were also taken from similar tissue in Farm 46, Coto where DBCP had been applied at the recommended rate and no phytotoxicity symptoms were present. Bromide levels in the fruit and leaf lamina were 78 and 104% higher in diseased than in healthy plants. They averaged 66, 216, and 375 ppm in the peduncle (fruit stalk), fruit, and lamina, respectively. These levels in the peduncle and fruit were 5-6 times higher than in Coto. The rate and consequent phytotoxicity is probably related to local environment - light clay soils - water relationships.

Table 6. Radopholus similis rhizome infection in some areas of J. Ewen's Farm, Santiago District.

Cable		No. of Acres		No. of Rhizomes Examined		Percent of Infected	
1A	40	3	2.6	18	15	0	13
1B	41	4	2.6	22	16	0	6
2	42	3.2	3.1	19	19	47	53
3	43	2.5	1.1	19	8	68	63
4	44	2	1.6	12	9	67	22
5	47	2	3.5	12	20	83	35
6	48	3.4	3.1	18	18	61	33
7	49	3.8	2.8	22	15	55	7
8	50	4.3	2.9	23	15	61	7
9	51	8.9	2.9	45	15	56	60
38	52	2.4	2.3	14	15	57	33
39		2.6		15		27	
Total		70.6		404		40	

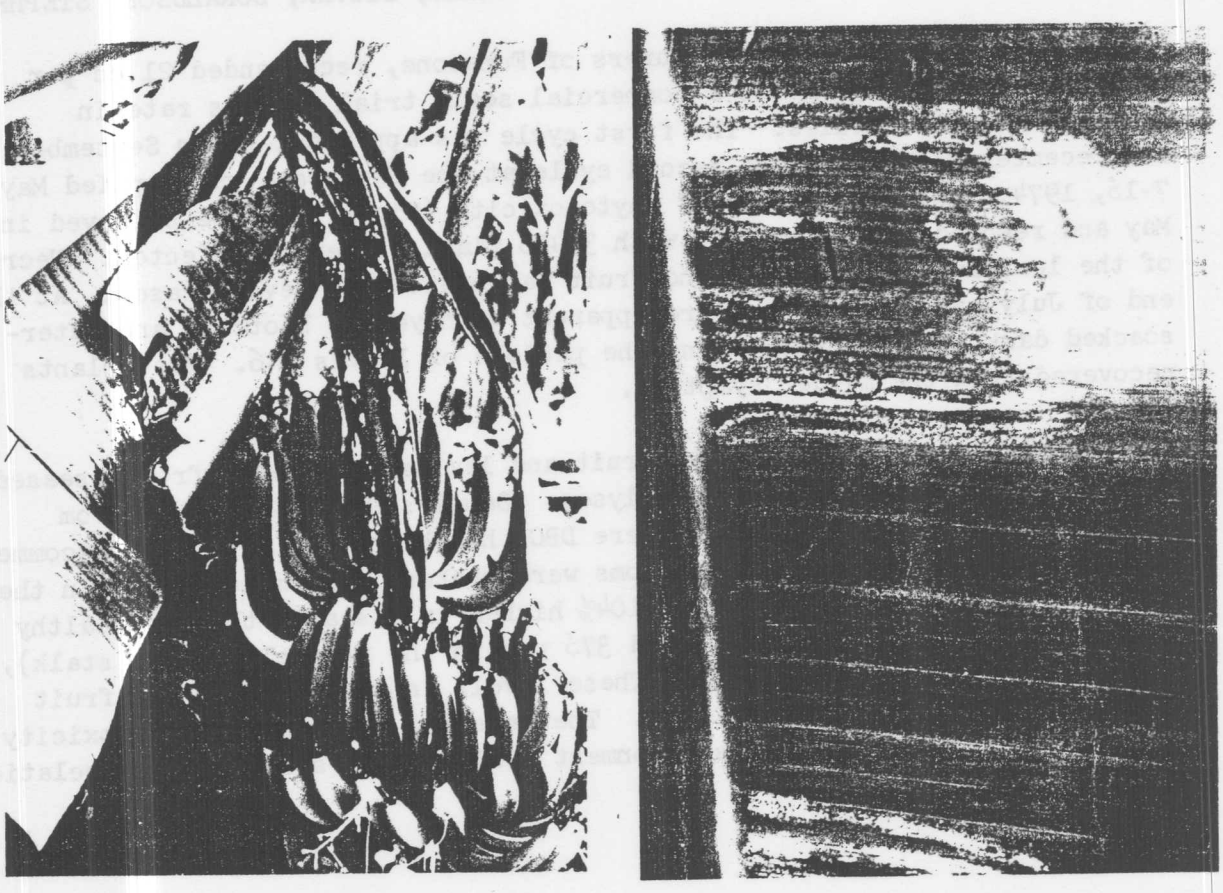

Figure 4. Phytotoxicity from DBCP application in Higueron Farm, Armuelles, left, necrosis and rotting of fruit stalk; right, yellow blotching along main vein of leaf.

DBCP versus Furadan - Farm 59 (58), Coto

On June 1, 1973 the Mocap treatment was replaced with Furadan (50 grams 5% granules per mat, 3 times a year). DBCP (Fumazone) is injected every 6 months at the rate of 14 cc per mat. Potassium sulphate was applied in June, 1973 (2 lbs. per mat). Furadan was applied in June and October, 1973 and in June, 1974. The latter application was 2 months late. The experiment was concluded the end of May because data collected became unreliable due to a severe outbreak of Sigatoka and strike-related problems that followed.

Data on yield and losses are in Table 7. Only DBCP significantly increased stem weight and reduced losses. As in previous experiments in Changuinola, Furadan did not increase stem weight but reduced losses from uprooting. DBCP injection has proved superior to both Mocap and Furadan under Coto conditions. STEPHENS, STOVER

Furadan Trial (Nematicide I), Changuinola

Furadan (150 g 5% granules per year) is applied twice or three times a year. Data on yield and losses for 1974 are in Table 8. There was no significant increase in stem weight. Total weight of fruit harvested was increased 31% over the control in the Furadan twice a year treatment. Losses from uprooting were reduced about 50% but because of high variability among plots the differences were not significant statistically. Applying Furadan twice a year gave a statistically significant increase in stems harvested when compared with applications three times a year or with the control.

In June, DBCP was applied to the Furadan plots that previously had received no potassium. Potassium is now applied to all nematicide treatments. A comparison of the performance of the two nematicides will be available in 1975.

Granular Nematicide Trial (Nematicide II) Changuinola

A reduction in uprooting from granular nematicides is now being obtained in an area of Farm 66, that was moderately infested (26%) with nematodes in 1972 (Table 9). Nematicides were first applied in December, 1972 and no response could be detected in 1973. Total yield has not yet been significantly increased but losses from uprooting have been reduced more than 50%. Uprooting comprised from 40 to 50% of the nematicide treatments losses and 66% of the control losses.

Table 7

Effect of nematicides on yield and losses from January to May, 1974, Farm 59, Coto.

	Furadan	DBCP	Control	LSD 0.01	LSD 0.05
Total weight harvested	1153	1398	1151	--	NS
Average stems harvested per plot	21	22	20	--	NS
Average stem weight	53	64	57	9.31	6.88
Total losses	98	44	137	--	59.26

Table 8

Effect of Furadan on yield and uproot losses, Farm 66, Changuinola (Nematicide I) from January to December, 1974.

Treatment	Stem Weight Lbs	Total Stem Weight Lbs.	Total Stems	Uproots Per Acre
Furadan 5%, 75 g mat 2 times a year	74.3	20,735	279	67
Furadan 5%, 50 g mat 3 times a year	72.9	17,373	239	68
Control	71.6	15,811	221	125
LSD 0.05	NS	-	37.03	NS

Table 9

Yield and uproot losses - Farm 66, Changuinola (Nematicide II) from January to December, 1974.

Treatment	Stem Weight	Total Stem Weight	Total Stems	Uproots per Acre
	Lbs.	Lbs.		
Mocap 10%, 33.3 g mat 3 times a year	89.5	25,857	289	23
Nemacur 10%, 33.3 g mat 3 times a year	87.7	23,242	265	42
Nemacur 10%, 66.7 g mat 3 times a year	86.9	22,933	264	26
Control	87.4	22,284	255	86
LSD 0.05	NS	NS	NS	57.37

Granular Nematicides and Replanting (Nematicide III) - Changuinola

The use of nematicides in a heavily infested area at replanting was studied. At planting (without fallow) 50 g of 10% Mocap or Nemacur granules were distributed in and on top of the planting hole. The nematicides were then applied three times a year. The area was planted in November 1972. Nematicides have increased the yield 18-28% (Table 10) by reducing losses. These increases were not significant statistically, however, because of large variation among plots. For example, stem weights varied 10 lbs. between plots with poor and good drainage. Nemacur reduced losses from uprooting 77% and Mocap 46%. More losses were caused by rhizome rot (snap-off) than by uprooting (Table 10). The nematicides reduced rhizome rot losses from 35 to 55% over the control. Additional studies are required to determine the effect of nematicides on rhizome rot. Rhizome rot is a serious cause of losses during the first 2-3 years following replanting in Costa Rica and Panama.

This experiment was terminated at the end of 1974. The advantages of using a granular nematicide at planting and following planting in heavily infested soil were demonstrated. (TAYLOR, ESPINOZA, STOVER) Evaluating Nematode Populations and Root Injury in Relation to Soil Treatments

Effect of Granular Nematicides At Time of Planting on Nematode Populations and Root Injury. Furadan 5%, Mocap 10%, and Nemacur 10% were applied on January 3, 1974 at the rates of 75 g, 50 g, and 50 g in and around the planting hole for control of Radopholus similis. There were 10 replications per treatment. Four months after planting, a second cycle was applied circum mat. The materials were applied as 1/3 in the bottom of the hole, 1/3 with the soil, and the final 1/3 on the hole. The three treatments and a control were planted around a destroyed mat which was previously checked for infestation of Radopholus. Two observations were made at 3 and 5 months from planting for nematode population assessment. Also, at 4 months, an observation was made on plant height and pseudostem circumference. These data are reported in Table 11.

Nematode populations decreased from the first to second reading. Following the second application, a week passed without rain. This also represents a period of rapid plant growth when roots could out grow the nematode infestation. At the time when the first samples were taken, 45% of the control roots were damaged compared to 6-12% damage to the nematicide treated suckers. It can be concluded that when replanting in areas where Radopholus is present, it is necessary to start at planting with nematicide applications, for any delay results in the nematode becoming well established and thus more difficult to control.

Table 10

Yield and uproot losses following replanting, Farm 66, Changuinola (Nematicide III) January to December, 1974

Treatment	Stem Weight	Total Stem Weight	Total Stems	Losses per Acre	
				Uproots	Rhizome Rot
	Lbs.	Lbs.			
Mocap 10%, 33 g 3 times a year	69.5	19,171	273	33	48
Nemacur 10%, 33 g 3 times a year	64.5	17,616	273	14	33
Control	64.5	14,974	232	61	74
$LSD_{0.05}$	NS	NS	NS	30.92	24.35

Table 11. Radopholus similis/100 g of Root, Percent Control, Lesion Index, and Plant Growth Measurements for Nematicides at Planting Test in Changuinola, Panama.

Treatment	Radopholus/100 g of Roots	Percent Control	Lesion Index (a)	Plant Growth (at 4 Months) Height (cm)	Circumference (cm)
(At 3 Months)					
Furadan	15,440	79%	6	80.9	21.0
Nemacur	8,950	88%	10	80.8	21.0
Nemagon	8,830	88%	12	81.0	21.9
Control	73,910	-	45	71.3	19.4
(At 5 Months)					
Furadan	4,550	82%	4		
Nemagon	7,450	70%	2		
Nemacur	14,500	42%	6		
Control	24,600	-	14		

(a) Lesion Index = length of Radopholus-type lesions devided by length of roots converted to percent or cm/100 cm.

This technique of selecting known nematode infested mats for population and root injury studies could be usefull in preliminary screening tests for nematicides. By destroying the diseased mat and replanting with the treatments in the planting hole, a field evaluation can be made in 3 months. Readings can also be taken on phytotoxicity at this time. This type of experiment required very limited maintenance and thus replicates can be increased. However, final evaluation of nematicides is going to require full scale field testing with yield and loss data collection.

DBCP - Bioassay Analyses Methods

It was the objective of a series of experiments to evaluate the effect of DBCP on bananas using a bioassay scheme. The first step was determining the type of test that would be effective in evaluating distribution of DBCP and duration of DBCP activity.

Comparison of Root Sampling of Bananas with Bean Indicator Plants

Most of the work done with bananas reports the numbers of nematodes per 100 g of roots. In order to gather data on nematodes in the soil rather than the roots of infested banana mats, indicator plants were used to evaluate the presence of Radopholus, Helicotylenchus and Meloidogyne. Banana mats in an abandoned area were checked for Radopholus infestation, the mats destroyed, and four rhizomes planted around the old mat. Three treatments - Furadan, Mocap, and Nemacur - plus an untreated control were included in the test. Initial treatment was on January 3, 1974, and the experiment was evaluated three months later. Suckers were dug and root samples collected for nematode extraction. At the same time, soil samples were collected and transferred to 32 oz ice cream containers. Local beans (butter beans?) were planted at five per pot in the containers and placed under a carport where they received only afternoon sun to avoid excessive drying or heating. At 33 days from planting, the plants were dug and data collected. Root-knot indexing followed Zeck's scheme of 0-10 readings (PELANZENSCHULTS-NACHRICHTEN XXIV (1971): 141-144). Nematodes were extracted from the banana roots by blending-wet screening and from the bean roots by Baermann funnels.

There was no apparent correlation between numbers of nematodes in banana and bean root samples. For Radopholus, 67% (29/39) of the bean samples were positive compared to 82% (32/39) of the banana root samples. Some samples which were negative for bananas were positive for beans and vice versa. With Helicotylenchus, 92% of the bean plants were positive compared to only 44% of the banana root samples. Root-knot larvae were found in 23% of the bean roots and 18% of the banana roots, while 65% of the bean plants had root-knot galls. There was no relationship between past treatment with nematicides and indicator plant readings.

Comparison of DBCP-Treated Areas Using Soil Analysis and Bean Indicator Plants

Using soil from experimental plots treated with DBCP, a soil population evaluation of nematodes was compared to findings from indicator plants grown in the same soil. Samples were collected by using a one-inch soil sampler. The 12 inch deep soil samples were taken at 6, 24, and 48 inches from the sucker. The sample size was small using 2 to 4 plants from plots treated 6, 11, and 14 weeks previously at 21 cc of DBCP per mat. A subsample of 250 cc of soil was processed and the genera of nematodes recorded. The remaining soil was planted to beans and harvested at one month. Higher counts of Radopholus, Helicotylenchus and Meloidogyne were obtained at the 24 and 48-inch distance from the mat. Problems were encountered in obtaining a stand of beans. Root rot and insects began to be a problem in maintaining five bean plants per container.

Comparison of Soil Sampling, Banana Root Sampling, and Indicator Plants in an Area Known to Contain Root-Knot Nematodes - Nematicide II

Since DBCP is injected at 6 inches in Nematicide II, a test was designed to evaluate 1) the nematode populations in the soil at 4 depths and 2) at two distances from the sucker - within and outside the treated area. Using a one-inch soil tube, samples were collected in a semicircle. Samples were taken at 0-6, 6-12, 12-18, and 18-24 inches deep. Two sets of samples were taken, one at 2 feet from the sucker and a second at 6 feet from the sucker. Soil samples were processed by sugar flotation. Bean plants were grown in the soil samples as previously described. At the same time that the soil samples were collected, the standard root sample was collected a foot from the mother-daughter junction of the mat. Nematodes were extracted using blending-wet screening. Counts were made of the nematodes from the bean samples using Baermann funnels for the soil zones 6-12 and 18-24 inches.

Based upon sampling by increments, Helicotylenchus appears to be more prominant in the top 12 inches of the soil and mostly in the top 6 inches, whereas root-knot was more prevalent in the 6-18 inch zone. Radopholus was rare in the soil samples. No pattern was apparent when the banana root samples, the soil samples, and/or the bean samples were compared for numbers of nematodes recovered. At 12 weeks from treatment, the samples of three plants each in the treated and control plots indicated no difference in numbers of nematodes based upon nematicide application.

Comparison of Soil Sampling, Banana Root Sampling and Indicator Plants From an Area with a High Incidence of Radopholus - Nematicide I

Using spacial distribution of nematodes to evaluate the dispersion of DBCP would require preliminary data on the natural dispersion of nematodes

in the soil about banana plants. This study included the standard banana root sample (1 foot from the mat), soil samples 2 feet from the mat in six inch increments in depth, and bean indicator plants. Based upon the root samples, very little difference was noted in the average numbers of Radopholus from the five plants in the treated area and in the control at about three months from treatment (Table 12). The soil of the treated area contained fewer Radopholus than did the control plots, particularly in the top 12 inches. The yield of nematodes from the bean plants was much lower from the soil in the DBCP plots. The Lesion Index used for Radopholus evaluation was fairly uniform for the control plants ranging from 27.6 to 38.0 whereas the plants from the DBCP treated area ranged from 8.6 to 44.7.

Sampling for Nematodes Around Injection Sites of DBCP Near Nematode Infested Bananas and in the Fallow Area

A single injection was made, and then the soil was sampled for the presence of nematodes. If DBCP moved out from the injection point, differences should be detected in nematode populations as the concentration of DBCP decrease. Two study areas were selected, an area of bananas and an area in the fallow project. Open and closed holes of the injection site were included with injections of 1.5 and 3.0 cc of DBCP per site. Samples were taken 21 days from injection at 6 and 12 inches from the injection site and at depths of 0-6 and 6-12 inches. Four additional random samples outside the injection areas were taken to act as controls. The spacial distribution of the nematodes did not lend themselves to this type of analysis for nematicide movement. The fallow area was essentially clean of most nematodes except for Helicotylenchus and some Criconemoides. No conclusions could be drawn on the effectiveness of DBCP at 21 days from injection for nematode control due to the variation in the control samples.

This series of tests showed nematode populations heterogeneous and not uniformly distributed. In order to use a biological organism for evaluation of a pesticide, uniform populations are required with uniform distribution. Since this was not found under natural conditions, the effectiveness of DBCP could not be determined. It appears that indicator plants would be of use in detection of the presence of nematodes but not for quantitative correlation of population levels. For field evaluation, it is going to be necessary to use a chemical analysis for determination of the presence of DBCP and for the evaluation of movement and persistance of this chemical.

From the soil sampling, it was noted that Radopholus tends to be lower in the soil than in the roots whereas Helicotylenchus is more prevalent in the soil than in the roots. No other nematode species was noted that could be substituted for the three banana parasites. When evaluating the control of nematodes, Helicotylenchus would be a better target species since

Table 12. Radopholus Counts in Samples from Soil, Banana Roots, and Bean Indicator Plants - Nematicide I

Treatment Replicate	Soil Depth 0-6"	6-12"	12-18"	18-24"	Banana Roots Nemas/100 g	Lesion Index (a)	Beans - Soil Depth 6-12"	18-24"
DBCP - 1	0	0	0	5	22,500	11.9	5	15
DBCP - 2	9	1	10	10	78,000	44.7	365	15
DBCP - 3	0	2	0	2	62,000	8.6	0	10
DBCP - 4	0	5	7	5	20,500	15.9	X	0
DBCP - 5	5	28	42	135	13,500	27.5	10	55
Mean ($\bar{x}$)	2.8	7.2	11.8	31.4	41,300	21.7	95	19
Control - 1	20	5	44	0	52,500	33.8	75	195
Control - 2	1	23	5	36	57,000	37.5	X	455
Control - 3	4	10	23	36	72,500	27.6	210	370
Control - 4	3	13	7	21	23,000	38.0	165	1040
Control - 5	68	7	0	4	58,000	33.7	740	145
Mean ($\bar{x}$)	19.2	11.6	15.8	19.4	52,600	34.1	298	441

(a) Lesion Index is length of Radopholus-type lesions devided by length of roots converted to percent or cm/100 cm.

it tends to be an ectoparasite and is more exposed to DBCP than is the endoparasitic Radopholus. As Helicotylenchus populations build-up, the effect of the chemical in the soil could be evaluated.

Nematode Population Assessment in Honduras DBCP Experiments

Three trials are being run in Honduras to evaluate DBCP for nematode control. These plots were sampled 18-24 weeks from initial treatment with DBCP. Results were tabulated (Table 13) as to number of Radopholus and Helicotylenchus per 100 g of Roots, Lesion Index, and Percent Control. Based upon the comparisons of nematode counts and root damage, DBCP is giving control. However, in two of the locations, populations of Radopholus are extremely low. This should be investigated since at the time of initiating the experiment, the area had a high incidence of Radopholus damage based upon the rhizome indexing scheme.

Comparison of Methods of Evaluation of Nematode Infestation in Bananas

On September 9, 1974, roots were collected in Higuerito Farm and processed for nematode counts and nematode lesion measurements. Root samples in the range of 20-30 g were split longitudinally and the extent of Radopholus-type lesions measured. The total length of the root sample was recorded and the entire sample processed by blender-wet screening for nematode counts. A total of 30 samples were processed. On September 11, roots were collected in Guaruma II which had been artificially infested with Pratylenchus several years ago. These roots were processed in the same manner.

For each sample there are four measured parameters - Root Weight, Root Length, Number of Nematodes, and Length of Lesions. From this data we can generate several other observations - Nematodes/g of Root, Lesion Index (lesion length/total root length), Nematodes/cm of Root, and Nematodes/cm of Lesion. Any of these four observations can be used to evaluate nematode infestations. The data for the two sample locations and nematode species are in Table 14 with standard deviations.

Of the four measured observations and the four generated observations, only root weight shows a low degree of variation and this value had fixed limits in the range of 20-30 g at the time of sampling.

Correlation coefficients were calculated to determine if there were any relationships between the various parameters. Since the standard method of reporting banana-nematode data is in terms of nematodes per unit weight of roots, this was compared in various forms to the measurement of damage or amount of lesion per unit length of the root sample (Table 15).

Table 13 Population and Root Injury Assessment in Honduras DBCP Trials.

Location & Time After DBCP Applied	Treatment	Radopholus/ 100 g of Roots	Helicotylenchus/ 100 g of Roots	Lesion Index [a/]
Los Limones (24 Weeks)	DBCP	3,167	2,283	3.5
	Control	8,067	19,417	6.0
	% Control	61%	88%	58%
Higuerito (19 Weeks)	DBCP	8,450	3,565	16.4
	Control	36,408	19,415	27.9
	% Control	77%	82%	59%
San Juan (18 Weeks)	DBCP	3,610	4,960	12.5
	Control	6,800	18,650	5.2
	% Control	47%	73%	x

a/ Lesion Index - length of Radopholus-type lesions devided by length or root sample converted to percent or cm/100 cm.

Table 14. Data for 30 Samples Each for Comparison of Assessment and Evaluation of Nematode Infestations.

Observation (unit)	Higuerito - Radopholus	Guaruma II - Pratylenchus
Root Weight (g)	25.9 ± 1.8	26.8 ± 1.7
Root Length (cm)	89.5 ± 18.3	69.8 ± 10.6
Nematodes/Sample	166.1 ± 114.0	149.4 ± 66.2
Length of Lesions (cm)	38.7 ± 14.4	28.9 ± 16.5
Nematodes/g of Root	82.8 ± 58.3	70.0 ± 31.0
Lesion Index (cm/100 cm)	44.3 ± 16.8	41.3 ± 22.6
Nematodes/cm of Root	24.2 ± 17.2	27.7 ± 13.1
Nematodes/ cm of Lesion	58.2 ± 39.8	88.1 ± 59.4
Number of Samples	30	30

Table 15. Correlation coeficients for parameters used to assess nematode infestations.

Correlations	Higuerito *Radopholus*	Guaruma II *Pratylenchus*
Nematodes/g of Root vs Lesion Index	0.17	0.43
Nematodes/g of Root vs Nematodes/cm of Lesion	0.79	0.15
Nematodes/g of Root vs Nematodes/cm of Root	0.93	0.92
Lesion Index vs Nematodes/cm of Lesion	-0.23	-0.68
Lesion Index vs Nematodes/cm of Root	0.28	0.44
cm of Lesion vs Nematodes/g of Root	0.21	0.36
cm of Lesion vs Nematodes/cm of Lesion	-0.24	-0.71
cm of Lesion vs Nematodes/cm of Root	0.14	0.27
Root Weight vs Root Length	0.09	0.10

The only case above where a consistently high correlation was found was in the case of Nematodes/g of Root vs Nematodes/cm of Root. However, since there was a low correlation in the case of Root Weight vs Root Length and each is multiplied by the number of nematodes per sample, this correlation appears to be artificial. It appears any of the parameters now being used for the evaluation of nematode populations or infestations are purely subjective and highly variable. We can use either the counts of nematodes related to root weight and/or root length as a guide to control or else the amount of damage as is measured by the extent of lesion formation. However, these values will be only relative and the final guide will be plant response and yield. TAYLOR

Turbo - Colombia Nematode Populations

Root samples were collected and processed by the standard method (1972 Annual Report, page 6) (Table 16). In most of the samples the populations of *R. similis* and *Pratylenchus* sp. are still low in comparison to those found in Costa Rica and Panama, except in La Union and El Socorro. Without nematicide application these farms had 14,000 and 20,000 *R. similis* per 100 gr of roots, respectively. It is also important to note the low population in La Suerte Farm in Gros Michel 12 year old. The most abundant nematode was *H. multicintus* but this nematode species does not cause severe rotting of the roots as do *R. similis* and *Pratylenchus* sp.

Table 16. Nematodes extracted by the standard method from some Turbo farms

Farm	Variety	Age of Plant in yrs.	Number of Nematodes per 100 g of Roots		
			R. similis	Pratylenchus sp.	H. multicinctus
La Suerte	Gros Michel	12	2,500	0	20,000
La Suerte	Grand Nain	2	3,000	1,000	21,000
La Suerte	VALERY	3	8,000	0	31,500
Sta. Lucia	VALERY	3	0	0	16,000
La Union	VALERY	2	14,000	3,000	6,000
El Retiro Furadan 5% * 50 g/mat, 3 times a year	Giant Cavendish	3	8,000	4,500	26,000
El Retiro Mocap 10 * 50 g/mat, 3 times a year	Giant Cavendish	3	6,000	2,000	17,000
El Socorro Nemacur 5% * 50 g/mat, 3 applications	Giant Cavendish	2	1,000	0	31,000
El Socorro Fumazone * 2 applications	Giant Cavendish	2	3,000	1,500	21,000
El Socorro	Giant Cavendish	2	20,000	0	23,000

*Observation plots

Armuelles - Nematode Populations in the Nematicide Experiments - Higueron Farm

In this experiment in Section 29, 6 plots received Furadan at planting time and then every 4 months afterwards; 6 plots received Furadan at planting followed by Fumazone 4 months later and then every 6 months afterwards (planting time May 1973). The plots in the experiment were sampled as follows: in each plot 4 plants with bunches about 1 week old were selected and the roots in one cubic foot of soil at 1 foot distance from the mat were washed, chopped into 1 cm pieces and then processed by the standard method (Table 17). DBCP was more effective than Furadan in reducing Radopholus populations.

Higueron Farm receives DBCP twice a year (2.75 gals/acre per application). The first application was made between July 1973 and February 1974, and the second (2.50 gals/acre) between March and July 1974. Only one section of Higueron Farm is not under DBCP. This section (No. 2) was compared with an adjacent section with DBCP (No. 4). In each section 4 samples were obtained, each one containing the roots of 4 mats with bunches 1 week old taking the roots in one cubic foot of soil at one foot distance from the mat. The roots were washed, chopped into 1 cm pieces and then processed by the standard method (Table 18). The DBCP treated area showed a reduction of about 40% of R. similis and about 300% reduction for H. multicinctus. SALAS, DONALDSON

Fallow Studies Farm 66 - Changuinola

The details of this experiment were outlined in the 1972 Annual Report (Pages 18-75). One third of each fallow plot was planted in November 1973 (12 months after the fallow period was initiated). Another 1/3 of each plot was planted between February and March 1974 (15 months after fallow), and the last 1/3 was planted in May 1974 (18 months of fallow).

For the first, second and third planting, 10,272; 9,539 and 9,127 heat treated Grand Nain seed were, respectively, planted. At planting time the following amounts of fertilizers wer used per rhizome: 6 ounces of potassium sulphate and 9.7 ounces of triple super-phosphate in the planting hole; 9.7 ounces of triple super-phosphate and 18 ounces of potassium sulphate at the soil surface at 18 inches from the planting hole. Fertilization after planting is done as follows: Potassium sulphate 24 ounces per mat per year, urea 4 ounces as a booster shot, and 4.9 ounces of urea 4 times a year.

To determine the degree of nematode infection, 2 surveys were carried out. The first and second planting was checked in October 1974 (11 months

Table 17

Number of Nematodes Extracted by the Standard Method, Section 29, Higueron Farm, Armuelles

Treatment	Nematodes per 100 g of root 14 months after planting	
	R. similis	H. multicinctus
Furadan at planting and DBCP afterwards	13,667	11,500
Furadan at planting and afterwards	22,000	18,333
Control	37,000	38,667

Table 18

Nematode Population in Root Samples from an Area with and without DBCP in Higueron Farm, Armuelles

Treatment	Average* Number of Nematodes per 100 g of root.	
	R. similis	H. multicinctus
DBCP	15,250	750
No Nematicide	24,250	29,750

* Average from 4 samples

after the first planting and 8 months after the second planting). The second survey for the three planting times was made in January 1975 (14 months after the first planting, 11 months after the second planting, and 8 months after the third planting).

Each survey was made taking 20 rhizomes per plot per planting time, grading them from 0 (no infection) to 4 (very severe damage). Table 19 shows the results obtained. A rice crop with no weed control favored Radopholus survival. Disease incidence declined sharply in all but one treatment after 18 months of fallow. SALAS, OYUELA, ESPINOZA

Nematicide-Fallow Studies Farm 59 - Coto, Costa Rica

The nematicides were applied for the first time in February 1972; fallow began in September 1972, and the area was planted after 11 months of fallow. To determine the degree of nematode infection a damage survey was made taking 10 rhizomes per plot, grading them from 0 (no infection) to 4 (very severe infection). Table 20 shows the results obtained. The per cent rhizome infection is very high in all the treatments except in the fallow plots. However, the fallow plots are one year old and they already have 10-15% infection. Nematicides may have to be used within 2-3 years after planting. Drainage in this experiment is not good and should be improved in order to obtain the full benefits from the nematicide-potassium application. SALAS, STEPHENS

Fallow Studies Majagua Farm, Armuelles

This experiment was initiated in January 1972 when the fallow period began (details are given in the 1972 Annual Report, pages 25-27). The last survey for nematode infection was carried out in September 1974 (Table 21). Infection ranged from 14-38% 9-12 months after planting following 12-14 months of fallow. DONALDSON, SALAS

The fallow experiments to date indicate that it is not only a very expensive method, (it costs about $50 per acre to chop down the banana plantation and the regrowth before the initiation of the fallow period), but that R. similis can survive fallow for long periods. Rapid re-infection of the nematode-free planting material occurs in a relatively short time, unless fallow periods are for 14-15 months or longer and are mostly weed-free. This makes fallow an uneconomical method for the control of R. similis.

Hurricane "Fifi" destroyed the Los Indios fallow experiment in Honduras (1973 Annual Report, page 35).

Table 19

Radopholus similis rhizome infection in the fallow treatments at two intervals after planting, Farm 66 - Changuinola, Panama.

Treatment	Fallow Period in Months	Months After Planting	% Rhizome Infection	Months After Planting	% Rhizome Infection
	12	11	8	14	14
Weeds	15	8	2	11	4
	18	-	-	8	1
	12	11	6	14	2
Disced	15	8	0	11	2
	18	-	-	8	0
	12	11	29	14	45
Rice (one crop)	15	8	3	11	16
no weed control	18	-	-	8	5
	12	11	11	14	7
Herbicide	15	8	3	11	4
weed control	18	-	-	8	1
	12	11	7	14	3
Mocap	15	8	1	11	3
	18	-	-	8	3

Table 20

Nematode damage in the nematicide-dry fallow experiment Farm 59 - Coto, Costa Rica

Treatment	No. of rhizome examined	Infection Index 0	1	2	3	4	Percent Infection	Average Infection
Furadan*	60	5	2	6	10	37	91.7	3.20
Furadan + K	60	0	1	3	9	47	100.0	3.70
DBCP**	60	11	5	6	15	23	81.7	2.57
DBCP + K	60	5	4	6	10	35	91.7	3.10
Fallow	60	54	3	1	0	2	10.0	0.22
Fallow + K	60	51	1	5	1	2	15.0	0.37
Control	60	2	2	5	7	44	96.7	3.65
Control + K	60	5	0	3	7	45	91.7	3.45

*F = Furadan 5%, 50 g per mat, 3 times a year.
**DBCP = Fumazone - 14 c.c. per mat, twice a year.

Table 21

Radopholus similis rhizome infection following various fallow times Majagua Farm - Armuelles, Panama

Fallow Time in months	Months after planting	No. of rhizomes examined	Infection Index 0	1	2	3	4	Percent infection	Average infection index
8-1/2	14-1/2	160	87	12	15	12	34	46.0	1.34
11-1/2	11-1/2	160	100	10	12	12	26	38.0	1.09
14	9	160	137	6	3	4	10	14.0	0.40

RHIZOME ROT

Rhizome rot is a serious cause of losses following planting and in the plantilla and first ratoon crop in Costa Rica and Panama. Studies were undertaken to see what factors might increase or decrease rhizome rot.

Effect of temperature on rotting. Cross sections of banana rhizome approximately 14 cm in diameter x 2 cm in thickness were inoculated by placing a loopful of a bacterial suspension of the pathogen in the center of each slice. Ten slices of each of the varieties VALERY and Grand Nain were then incubated at 24, 26, 28 and 30 C. After 7 days, the slices were observed and rated for rot. In both varieties the amount of rhizome rot increased with increasing temperature (Figure 5). At all temperatures tested, Grand Nain was more extensively rotted than was VALERY.

Effect of Inoculation Site on rotting. One-inch thick slices were removed from the tops, middles, and bottoms of VALERY and Grand Nain rhizomes. Longitudinal sections were removed from the sides (Fig. 6). Each bottom slice was inoculated with softrot bacteria at the cut surface or at the outer, hardened surface. All other sections were inoculated at cut surfaces (Fig. 6). Inoculation consisted of placing a loopful of Erwinia carotovora cells in the center of each slice and pricking the inoculation site several times with a needle.

The slices were incubated at 24 C and examined for rot after 5 days. Each treatment was replicated 10 times (per variety). The upper slices ("cabbage") were rotted much more than were the lower slices (Table 22). More extensive rot was observed in Grand Nain than in VALERY, though in both varieties the order of increasing rot was treatments 4, 5, 3, 2 and 1.

Effect of Seed Height

Since "cabbage" is very susceptible to rot, this tissue may serve as a medium for the build-up of rhizome rot bacterial populations. An experiment was designed to determine if the removal of this pseudostem material would have an effect on rhizome rot incidence. VALERY and Grand Nain were planted in concrete tanks in Guaruma I, utilizing the four treatments: 1) non-inoculated seed of "standard" height, 2) inoculated seed of standard height, 3) inoculated seed with all cabbage removed, and 4) inoculated seed consisting of only the basal portions of rhizomes. Heights of the seed pieces are given in Table 23.

Pieces of rotted rhizomes placed in contact with the tops and bottoms of the seed served as inoculum. Seedling height to the uppermost leaf axil and number of suckers were recorded weekly. After 15 weeks, the plants were removed from the soil and rated for rhizome rot incidence.

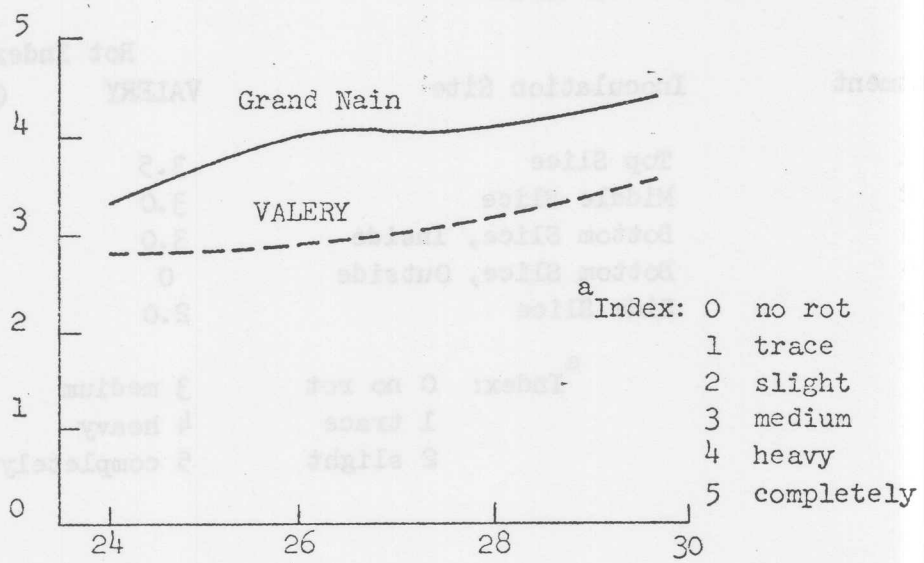

Figure 5. Effect of temperature on the average rhizome rot indices of VALERY and Grand Nain one week after inoculation with soft-rot bacteria.

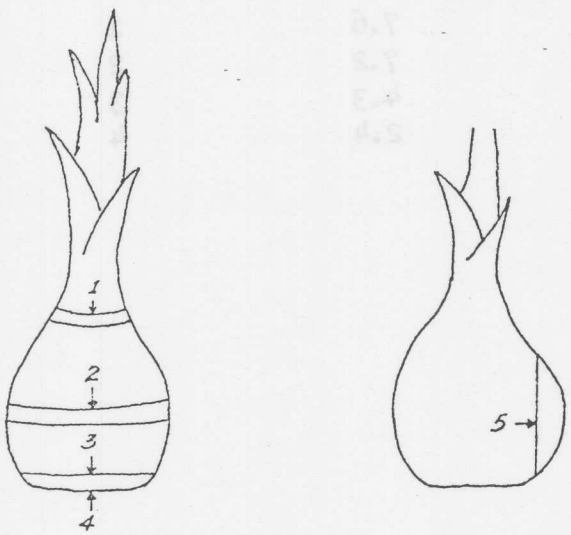

Figure 6. Inoculation sites of banana rhizome slices. Numbers indicate treatments; arrows indicate inoculation sites.

Table 22. Effect of inoculation site on the average rhizome rot indices of VALERY and Grand Nain five days after inoculation with soft rot bacteria.

Treatment	Inoculation Site	Rot Index[a] VALERY	Grand Nain
1	Top Slice	3.5	4.5
2	Middle Slice	3.0	4.0
3	Bottom Slice, Inside	3.0	3.5
4	Bottom Slice, Outside	0	0
5	Side Slice	2.0	3.0

[a] Index: 0 no rot; 1 trace; 2 slight; 3 medium; 4 heavy; 5 completely rotted

Table 23. Average height of seed pieces used in each treatment.

VALERY		Grand Nain	
Treatment Number	Height in Inches	Treatment Number	Height in Inches
1	7.6	1	6.0
2	7.2	2	6.2
3	4.3	3	3.0
4	2.4	4	2.2

At the end of the experiment all VALERY were alive, but five Grand Nain had not started growth. The seed which had not germinated were all less than 2½ inches in height. All of the growing points may have been removed during the trimming procedure. The non-inoculated plants showed as much rhizome rot as did those inoculated, indicating that abundant inoculum is present in the soil.

Relationships between treatment and plant height, treatment and rot index, and rot index and plant height at 15 weeks were sought. There were no clear trends, although especially with VALERY, the smaller seed did not adversely affect seedling development (Table 24).

Effect of Amount of Rainfall on rotting. Bacterial rhizome rot is more prevalent in the divisions with heavier annual rainfalls than in Honduras. To facilitate the study of rhizome rot at La Lima, an experiment was designed to determine the amount of rainfall that would be required to insure rot in a large percentage of test plants.

VALERY seed, free of rot and nematode damage were planted on July 25 in concrete tanks at Guaruma I. Soil in the tanks was classified as a silty clay loam (53.2% silt, 27.2% clay, 19.6% sand). Rotted potato slices, placed immediately below each seed piece, served as inoculum. Inoculum had been obtained from a rotten rhizome at Los Indios; it was extremely virulent in the laboratory, completely rotting potato slices in 16 hours.

Treatments consisted of applying water to the soil surface in different amounts and at different time intervals. Water was added either daily, twice daily, weekly or semi-weekly (Table 25). The control was the natural rainfall that occurred during the experimental period Table 26). Artificial watering was terminated after 8 weeks (on Sept. 19) because of Hurricane Fifi. From this time until the end of the study 6 weeks later, all of the test plants received only natural rainfall water.

Soil temperature and soil moisture contents were measured weekly during the first 8 weeks. Temperatures were measured 6 inches below the soil surface, and core samples for moisture determinations were taken 4-6 inches below the surface. Approximately 20 g of wet soil from each tank were oven-dried at 105-110 C for 48 hours. Moisture content was obtained by dividing the weight of the water removed by the weight of the dry soil and expressing the quotient as a per cent.

Plant height to the uppermost leaf axil was measured after 6 weeks and after 14 weeks. The plants were removed from the soil on October 31 (14 weeks after inoculation), and the rhizomes were examined for rot. The treat-

Table 24

Relationships between treatments, plant heights and rot indices after 15 weeks of plant growth.

	Trt No.	Height (in)	TrT No.	Rot Index[a]	Rot Index[a]	Height (in)
VALERY	1	16	1	3.4	0	24*
	2	14	2	2.8	2	19
	3	16	3	3.8	3	14
	4	17	4	2.4	4	16
Grand Nain	1	18	1	0.8	0	17
	2	16	2	0.4	2	17
	3	17	3	2.5	3	14
	4	9*	4	4.0*	4	9*

*values based on only one sample

[a]Rot Index: 0 no rot
2 slight
3 medium
4 severe

Table 25. Artificial rainfall added to treatments each week for 8 weeks following inoculation.

Treatment	Procedure	Water Added Inches per Week
1	None	0
2	2 inches each Monday	2.0
3	½ inch each day	3.5
4	2 inches each Monday & Thursday	4.0
5	1 inch each day	7.0
6	2 inches each day	14.0
7	½ inch twice each day	7.0
8	1 inch twice each day	14.0
9	same as 4, with Tricidal[a]	4.0
10	same as 5, with Tricidal[a]	7.0

[a]Seed soaked for 10 minutes in the bactericide, Tricidal, before planting

Table 26. Weekly rainfall during the 14 weeks (July 25-October 31) of the experiment.

Week	Rainfall Inches
1	0.00
2	0.69
3	0.00
4	0.67
5	0.49
6	2.50
7	0.82
8	0.70
9	12.52*
10	3.16
11	5.83
12	3.66
13	0.40
14	2.83

*Hurricane Fifi

ments had similar effects on the plants after 6 and 14 weeks, so data will be presented for only the latter determinations.

Soil temperatures in all of the treatments ranged between 78 and 81°F and were not affected by the addition of water. Treatment differences at the 1% and 5% levels of significance were sought among a) moisture contents in the tanks, b) average heights of plants after 14 weeks and c) average indices of rhizome rot 14 weeks after inoculation (Tables 27, 28, and 29, respectively), using a Duncan's New Multiple Range Test.

Moisture content was 19.2% in the non-watered tanks and greater than 34% in those receiving abundant water. Although the moisture contents of several of the treatments were not significantly different (Table 27), the water was added to the tanks in such a manner (Table 25) that the soil in the different treatments was water-saturated for different time intervals.

Plants from treatments 1, 10, 3, 8 and 9 were siginificantly shorter than those from other treatments (Table 28). Treatments 1 contained the least soil moisture, while treatment 8 had the most. Treatment 9 and 10 were the same as treatments 4 and 5, respectively, except that the former were dipped in the bactericide, Tricidal (1000 ppm a.i.), for 10 minutes before planting. The bactericide either retarded germination or had a phytotoxic effect on plant growth.

Nearly all of the seed rhizomes in treatment 1 were moderately or severly rotted, and 6 of 10 seeds in treatment 8 showed considerable rot after 14 weeks. Seeds treated with Tricidal had a higher rhizome rot index than non-treated seeds under the same conditions (Table 29). In nearly all instances of extensive rot, the rot was initiated at the top of the seed--at the growing point--and progressed downward in a "V" pattern. Small pockets of decay were observed in other areas, but they were usually quite shallow. Even when seed rhizomes were completely decayed, the rot had not progressed into the pseudostems of the new plants.

Banana plants inoculated with Radopholus similis had been grown previously in the same concrete tanks. The plants had been removed approximately 18 months previously, and weeds had been growing in the tanks during the intervening period. Even after this long weed-fallow period, sufficient nematodes were present to cause light damage to the seeds. Nematodes damage and rhizome rot were not correlated, however.

Under these test conditions, a high rhizome rot incidence was not associated with heavy rainfall. In contrast, the seeds to which no additional water was added developed the most decay. There was considerable rot when 14 inches of water was added per week, but not when 4 and 7 inches were added.

Table 27. Average soil moisture contents maintained in concrete tanks for the period July 25-September 19, 1974.

Treatment	1	2	4	9	5	3	6	7	10	8
Soil Moisture per cent	19.2	27.8	29.8	30.8	33.0	33.6	34.4	34.6	34.6	35.2
Statistical Significance* (5%)	—	—	—	—	—	—	—	—	—	—
Statistical Significance* (1%)	—	—	—	—	—	—	—	—	—	—

*Duncan's New Multiple Range Test. Values connected by the same line are not significantly different.

Table 28. Average plant height at 14 weeks of age.

Treatment	1	10	3	8	9	5	7	2	4	6
Plant Height inches	15.5	16.7	17.1	18.6	18.9	19.6	20.3	20.6	21.5	22.2
Statistical Significance* (5%)	—	—	—	—	—	—	—	—	—	—
Statistical Significance* (1%)	—	—	—	—	—	—	—	—	—	—

*Duncan's New Multiple Range Test. Values connected by the same line are not significantly different.

Table 29. Average rhizome rot index of plants 14 weeks after inoculation.

Treatment	1	8	10[b]	9[b]	3	2	7	6	5	4
Rhizome rot index[a]	3.2	2.5	2.2	1.9	1.9	1.5	1.2	1.2	1.2	1.0
Statistical Significance* (5%)	—	—	—	—	—	—	—	—	—	—
Statistical Significance* (1%)	—	—	—	—	—	—	—	—	—	—

*Duncan's New Multiple Range Test. Values connected by the same line are not significaty different.

[a]Index: 1 no rot
2 slight
3 moderate
4 severe

[b]with Tricidal. Otherwise, 10 and 9 are the same as 5 and 4, respectively.

Screening of Bactericides. Three new bactericides (Nabac, Isobac and Tricidal) were compared with Agrimycin and Beloran for inhibition of Erwinia carotovora growth on artificial media. Aqueous bactericide concentrations were adjusted to 2,500, 5,000, 10,000 or 20,000 ppm a.i. An aliquot of 0.1 ml of the bacterial suspension was pipetted into 10 ml of the bactericide and agitated. After a prescribed time interval (10, 30, 60 or 120 sec), a loopful of the latter suspension was placed in a tube containing 10 ml of sterile nutrient broth. Treatments were replicated 9 times.

Growth was recorded after 3 days of incubation (Table 30). Results were confirmed by streaking on solid media and checking for subsequent growth.

An attempt was made to protect seed pieces from rhizome rot by incorporating four of these bactericides into rhizome tissues under a partial vacuum. Solutions (Tricidal and Isobac) or suspensions (Agrimycin and Nabac) were prepared at 5000 ppm a.i. Seed rhizomes were placed in a large desiccating jar and covered with the bactericide preparations. A vacuum was drawn and held for 30 minutes or 15 hours. The rhizomes were removed, cut into slices and inoculated with cells of E. carotovora. After incubation at 26 C for four days, the rhizome pieces were observed for the presence of rot. None of the bactericides offered protection; if anything, the vacuum disrupted the outer cells, making them more susceptible to rot.

An alternate screening method was used for determining the effectiveness of 14 chemicals in inhibiting growth of rhizome rot bacteria. Tubes of nutrient broth were prepared with candidate bactericide concentrations adjusted to 20, 50, 100, 200, 500 or 1000 ppm a.i. One half ml of the bacterial suspension was added to each tube. Treatments were replicated 9 times. After five days incubation, the tubes were observed and growth was recorded (Table 31). The results were confirmed by streaking a loopful of medium from tubes onto solid media and checking for growth. Agrimycin, Beloran, HPMTS and Dithane were the best bactericides, followed by Isobac and Nabac.

Rhizome rot should not be a problem except where plants are growing under conditions of stress. In this study, stresses brought on by drought, water-logging and chemical damage predisposed the seed rhizomes to a greater incidence of rot. None of the chemicals tested performed better than Agrimycin, and Agrimycin won't control rhizome rot under adverse growing conditions. FUNK

Table 30. Growth of Erwinia carotovora in liquid media following exposure to bactericides.

Bactericide	Time of exposure (seconds)	Concentration of bactericide (ppm a.i.) 2500	5000	10,000	20,000
Agrimycin	10	-			
	30	-			
	60	-			
	120	-			
Beloran	10	-			
	30	-			
	60	-			
	120	-			
Nabac	10	+	+	+	-
	30	+	+	+	-
	60	+	+	-	-
	120	+	-	-	-
Isobac	10	+	+	+	-
	30	+	+	-	-
	60	+	+	-	-
	120	+	-	-	-
Tricidal	10	+	+	+	+
	30	+	+	+	+
	60	+	+	+	+
	120	+	+	+	+

\- indicates no growth
\+ indicates growth

Table 31. Inhibition of rhizome rot bacterial growth by candidate bactericides at various concentrations.

Candidate Bactericide	ppm a.i.					
	20	50	100	200	500	1000
Difolatan			+	+		+
Tricidal			+	+		+
Agrimycin	+	+	-	-		
Beloran	+	+	-	-	-	
Nabac			+	+	-	
Isobac		+	+	+	-	-
Tris-Nitro			+	+	+	-
HPMTS			-	-		-
Dithane M-45			-	-		-
Kocide 101			+	+		+
Perenox			+	+		+
Daconil			+	+		+
Nemacur			+	+		+
Kauritil			+	+		+

\- indicates no growth

\+ indicates growth

FRUIT SPOTS

Two different methods were used to test the effectiveness of candidate material for the control of fruit spots. All tests were performed three times, five replicates each time, giving a total of 15 observations per treatment.

I Zone of inhibition method. Nine chemicals were tested for their effects against the growth of Pyricularia grisea, Colletotrichum musae and Fusarium moniliforme under laboratory conditions. Fusarium moniliforme was included because it is easy to work with, it is quite tolerant of most fungicides, and we use it as a "standard" in our laboratory.

Spores of P. grisea (100,000/liter), C. musae (500,000/liter, or F. moniliforme (500,000/liter) were mixed into molten PDA medium before plates were poured. A filter paper disc was placed in each plate and 0.05 ml of fungicides concentration (100,500 or 1000 ppm a.i.) was placed on the disc. Four days later the diameter of the zone of fungal inhibition was measured.

Of the chemicals tested (Table 32), Difolatan, Kocide, Benlate and Dithane were the most satisfactory. Pyricularia grisea was considerably more sensitive to the materials than were the other two fungi.

II Complete inhibition of growth method. Seven chemicals were tested against growth of the same three fungi listed above. The materials were incorporated into PDA medium at concentrations of 6, 30 and 60 ppm a.i. Plates were poured and allowed to solidify. One ml of a fungal spore suspension (same conc. as above) was pipetted into each plate and spread evenly over the surface of the medium. After four days, the plates were observed for the presence of growth (+) or no growth (-). Difolatan, Dithane and Benlate were again the most promising (Table 33). Kocide was not included in this test.

Difolatan may be a good candidate for the control of fruit spots. Field tests have been established comparing Dithane, Daconil, Kocide and Difolatan. Difolatan is not compatible with oil, but this should not be a problem in fruit spot control. FUNK

MOKO

Honduras continues to have more Moko cases than the other divisions, although the incidence has decreased to approximately one case per 100 acres per month. Moko incidence has been declining for eight years and is now at the lowest level of that period.

Table 32. Fungal inhibition by candidate materials. Diameter of zones of inhibition (mm) at various fungicide concentrations.

	P. grisea			C. musae			F. moniliforme		
Chemical ppm	100	500	1000	100	500	1000	100	500	1000
Difolatan	59	66	72	48	53	59	30	34	36
Daconil	66	C	C	0	0	0	0	0	24
Kocide 101	64	C	C	30	34	35	24	25	29
Kauritil	64	C	C	0	0	0	0	0	0
Perenox	0	36	C	0	0	0	0	0	0
HPMTS	0	0	0	0	0	0	0	0	0
Benlate	48	70	C	N	N	N	29	35	35
Nemacur	0	0	0	0	0	0	0	0	0
Dithane M-45	50	C	C	19	47	65	16	21	26

C indicates no growth in entire Petri dish
0 indicates no zone of inhibition
N indicates not tested

Table 33. Ability of fungi to germinate and produce growth in solid media containing various concentrations of candidate fungicides.

	P. grisea			C. musae			F. moniliforme		
Chemical ppm a.i.	6	30	60	6	30	60	6	30	60
Difolatan	-	-	-	±(18)*	-	-	±(4)*	-	-
Dithane M-45	-	-	-	+	-	-	+	-	-
Benlate	+	-	-	+	-	-	+	-	-
Nabac	+	+	+	+	+	+	+	+	+
Isobac	+	+	+	+	+	+	+	+	+
Agrimycin	+	+	+	+	+	+	+	+	+
HPMTS	+	+	+	+	+	+	+	+	+

* indicates total number of colonies in plate
\- indicates inhibition (no fungal growth)
\+ indicates no inhibition
± indicates very slight growth (few colonies)

The buffer zone around diseased mats has been eliminated in Honduras except in areas where Moko cases are numerous. Actual research on Moko control has been de-emphasized, but the extension of known control practices has been expanded. Strict adherence to present control recommendations should maintain Moko incidence at a low level. FUNK, CASTRO

FUSARIAL WILT

Until the late 1960's the Panama disease pathogen Fusarium oxysporum f. cubense had never been reported causing serious damage on Cavendish cultivars except on Dwarf Cavendish in the Canary Islands. Then, reports of damage on the Taiwan Cavendish cultivars (probably similar to Giant Cavendish or Robusta) were reported. Tests were made with the pathogens from Taiwan and the Canary Islands using Dwarf Cavendish and other varieties at Perrine, Florida (1971 Annual Report pages 53-57). Subsequent tests have confirmed the first results that the Taiwan pathogen does not infect Central American Cavendish cultivars (VALERY, Grand Nain, Dwarf Cavendish) growing under Central American conditions. Since wilt continued to spread in Taiwan, a visit was made in July to observe the disease in the field.

The following summary is taken from the final report (Diseases and Pests of Taiwan Cavendish Bananas With Special Reference to Fusarial Wilt).

> Fusarial wilt was first recorded on Taiwan Cavendish in 1967. The disease has continued to spread and about 400 of 12,000 hectares have been affected. Number of cases have increased from about 1,500 to more than 20,000 annually. Disease incidence is mostly seasonal, from November to February. A new race of Fusarium oxysporum f. cubense is involved that appears to be virulent only under the environmental conditions of Taiwan. These conditions are believed to involve a combination of stress factors such as three months of minimum temperatures below 14°C during the period of fruit formation and flowering, a heavy monsoon type rainy season, paddy rice culture, and annual replanting. These stress factors could prevent the full expression of the genotypic resistance of the Cavendish group of cultivars to fusarial wilt in Taiwan. It is recommended that drainage and chemical characteristics of soils in wilt and non-wilt areas be studied. The influence of annual replanting and paddy rice culture on wilt incidence should be determined. If wilt "conducive" or "suppressive" soils are present, these should be identified and characterized.

During 1974 the presence of fusarial wilt in Delmonte plantations in Davao on Cavendish originating mostly in Taiwan was confirmed. Studies are underway to determine if Central American Cavendish clones are resistant to this pathogen and if the Taiwan Cavendish is genetically less resistant than

Central American Cavendish to the new race of F.oxysporum f. cubense. In addition, 2 wilt resistant tetraploids and Grand Nain have been sent to Taiwan for testing against the new Taiwan race. STOVER

PUBLICATIONS AND MAJOR REPORTS

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ENTOMOLOGY

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DEFOLIATION

An experiment was conducted from August 1973 to September, 1974 to determine if wind losses could be reduced and speed of ratooning increased. All the leaves were cut off plants when fruit was 2 months old. A similar small scale experiment in Changuinola was successful (See Ann. Rept. 1969, p.115).

Six pairs of plots were set up in Guaruma II each plot containing 25 plants plus two rows of buffer plants each plot.

A total of 248 stems were harvested from the defoliated plot; 231 from the undefoliated.

Results were as follows:

Average	Defoliated	Non-defoliated (Checks)
Fruit weight (lbs)	69.4	80.6
Shoot to harvest (days)	88.7	87.5
Height of hijo at harvest (ft)	7.7	8.3
Circumference of hijo at harvest (in)	17.0	15.9
Calibre at harvest	10.7	12.6
Finger length (in)		
Large hand	9.0	9.2
Small hand	7.5	7.8
Severe sunburn (%)	57	4
Doubled stems (%)	29	9

There was an increase in the speed of ratooning; 13.4% more stems were produced in the defoliated plots. Excluding doubling because the cut leaf stubs rotted and could not support the weight of the fruit only 6.9% more stems were harvested.

Fruit from defoliated plants began ripening within 13-25 days while fruit from check plants ripened only once at 16 days. All other check fruit held for the 30 day holding period.

The system is impractical as a farm practice.

OSTMARK, MELENDEZ

PHILIPPINE INSECTS

In the Tadeco plantations of Mindanao, Philippines, two thrips-caused blemishes on fruit, corky scab and red rust, caused severe losses. From January 1 to June 22, 1974, a total of 127,200 12 kilo boxes were lost as boxing station waste to these two blemishes.

CORKY SCAB

Corky scab is brown scabby blemish found on the outer curve of the lowest (apical) hands of a bunch. This blemish varies in severity from a corky scabbing confined to the crown and pedicels to a severe scabbing covering the entire hand (Figure 7). Rarely are more than the 3 or 4 lowest hands affected.

CAUSE OF CORKY SCAB - Corky scab is initiated by the feeding of the adults and nymphs of Thrips florum. These insects infest the buds just as, or slightly before, they emerge from the plant. All enclosed hands are attacked, but the thrips quickly desert exposed hands continuing to feed and oviposit on developing hands within the bud as the stem elongates. Thus, the apical (last) hands to emerge are the most severely damaged.

As the fruit matures, the areas fed upon by the thrips become roughened, cracked, and the characteristic corky scabbing appears. Some authorities have implicated fungi or mites, but to date neither of these have been found to be contributary or secondary causes of corky scab.

There is much evidence that the formation and severity of corky scab is influenced by factors other than the intensity of thrips feeding. During the drought from January to May 1973, corky scab incidence rose dramatically. Fruit hangs longer during dry weather and could show more severe effects on the original thrips feeding. On the other hand, dry weather is known to favor high thrips populations and extra-severe corky scabbing might simply be caused by heavier feeding of extraordinary numbers of thrips. Also, corky scab develops on younger fruit with greater severity when fruit is not bagged, possibly a moisture relationship.

New thrips feeding is characterized by a roughness or pebbling on the inside surface (nearest the stalk) of 1 to 14-day old fruit. This surface becomes the outer surface when the hands turn up. All stems examined showed varying degrees of thrips feeding although not all stems develop corky scab.

WATER MARKS - There is a strange dark green "water mark" on mature or nearly mature fruit mainly on the crown, but sometimes extending down both sides of the fingers (Figure 8). Microscopic examination frequently discloses slight to pronounced cracked peel within the dark area. This may be incipient corky scab. The water mark itself is not serious and does not downgrade fruit.

BIOLOGY OF THRIPS FLORUM - The emerging bud is extremely attractive to both sexes of T. florum. Before the bud has completely emerged from the plant hundreds of these insects are found on the outside bracts. Here the colorful females (Figure 9) are mated by the smaller males (Figure 9). Females have a yellow or orange head and thorax with a shining blue-black abdomen; males are light yellow with prominant black eyes and a black line down the abdomen formed by the black hair that fringes the wings.

The males are very active and when two meet they frequently vibrate their abdomens in a ritualistic aggressive manner. Females are actively pursued and mating is frequent, one male servicing several females. Although males are common on the outside of the buds they rarely enter under the bracts. The females enter the buds along the edges of tightly closed bracts.

Eggs are laid almost immediately usually on the soft parts of the bract or on fingers within the bud. Later, a favorite site is on the pistils of the flowers although any soft part of the developing fruit may be utilized. Sometimes the edges of the fruit is almost darkened with egg punctures. The female drills a slit with her ovipositor and deposits a single egg at each site. This causes a pimple or raised spot to form. Eggs hatch in approximately 3 days.

Newly hatched nymphs are whitish. They are very active and especially numerous on the inside of the pedicels and flowers and in general shun the area pressing against the bracts. They feed by rasping the soft tissues and sucking the liquid resulting from the rasping injury. Most thrips excrete a substance during their feeding which gives a characteristic appearance to the damage they cause.

As nymphs reach maturity in approximately 6 days they turn a bright orange or tangerine color and drop, not crawl, to the ground directly under hanging fruit. They penetrate the ground to a maximum depth of 4-5 inches although the majority burrow no deeper than the top inch within a meter diameter area under 12-26 day old fruit. Here in the "pupal" stage the nymph develops adult characteristics including tube-like wings. The pupa can crawl weakly when disturbed.

Finally, 3-4 days after entering the soil and approximately 12 days after hatching from the egg the new adult emerges, crawls out of the soil, and in short flights using hair-fringed wings reaches a new bud where the cycle is begun again. Males generally emerge from the soil before the females and arrive first on the new buds.

CONTROL OF CORKY SCAB - Control measures at present are aimed at reducing the numbers of attacking thrips. Alternative approaches, now being tested, are designed to determine if cultural methods can reduce or prevent corky scab from developing even on thrips-damaged fruit.

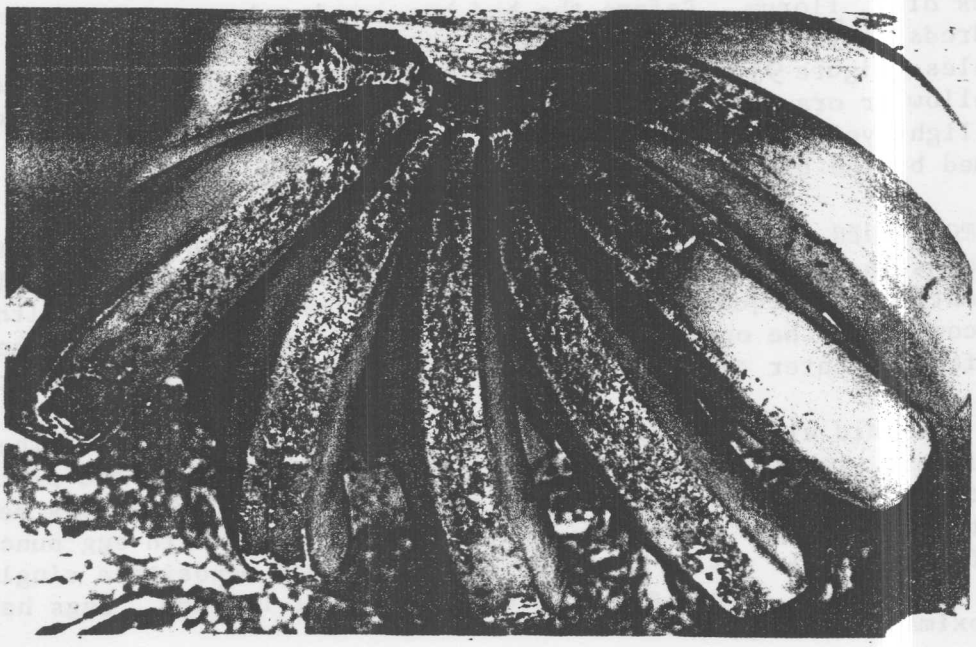
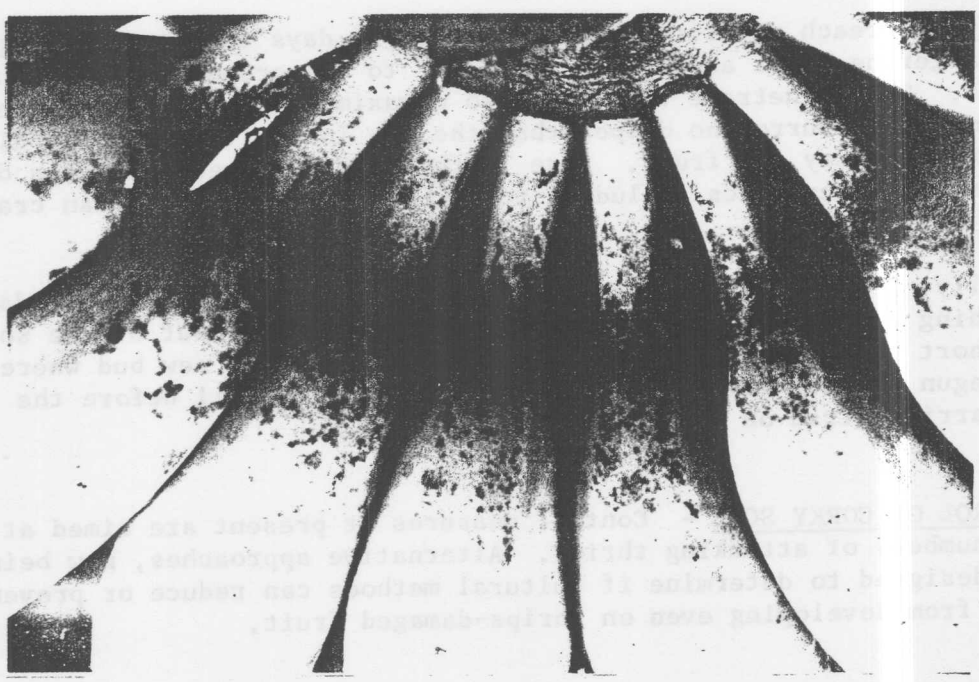


Figure 7 : Severe corky scab - Tagum, Philippines



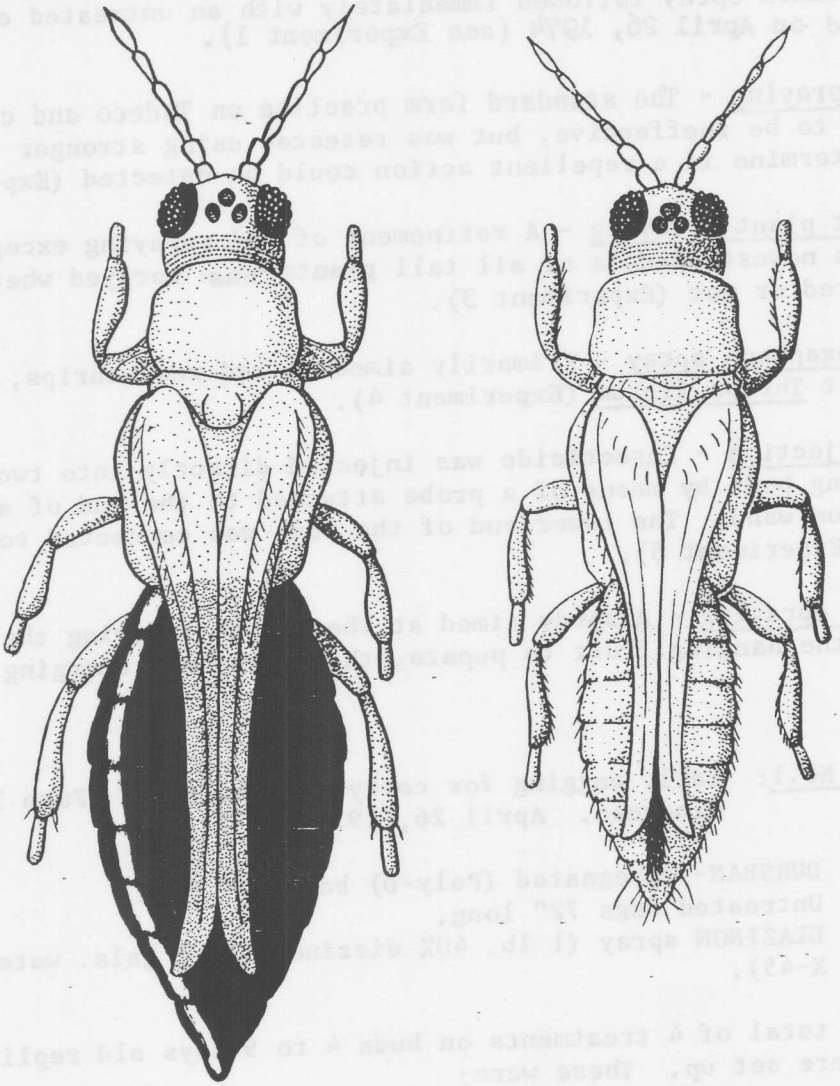


Figure 9: Thrips florum Schmutz (or near)

A. Female B. Male

Six chemical control schemes were tested. They were:

1. Early bagging - Placing an insecticide-impregnated polyethylene tree bag on fruit 5-8 days old in hopes that the fumigating effect will penetrate the bud and kill the thrips before they do too much feeding. In addition, a diazinon spray followed immediately with an untreated early bag was tested on April 26, 1974 (see Experiment 1).

2. Bud spraying - The standard farm practice on Tadeco and competitors' farms. Found to be ineffective, but was retested using stronger rates of diazinon to determine if a repellent action could be detected (Experiment 2).

3. Unshot plant spraying - A refinement of bud spraying except the inside of the newest candela of all tall plants was sprayed whether a bud had appeared or not (Experiment 3).

4. ULV toxaphene spray - Primarily aimed at red rust thrips, but also tested against Thrips florum (Experiment 4).

5. Bud injection - Insecticide was injected directly into two sides of emerging buds by means of a probe attached to the end of a 12 foot aluminum wand. The lower end of the wand was connected to a backpack pump (Experiment 5).

6. Ground spraying - A spray aimed at the nymphs entering the soil directly under the hanging fruit to pupate, the pupae, and emerging adults (Experiment 6).

Experiment No.1: Early bagging for corky scab control. Farm 3B, Tagum, Mindanao. April 26, 1974.

Materials: DURSBAN-impregnated (Poly-D) bags 60" long.
Untreated bags 72" long.
DIAZINON spray (1 lb. 40% diazinon in 20 gals. water - 7cc Triton X-45).

Methods: A total of 4 treatments on buds 4 to 9 days old replicated 6 times were set up. These were:

A - 1% Poly-D bags.
B - The standard diazinon fruit spray mixture, sprayed on the buds then immediately bagged.
C - Bagging with an untreated bag (operative control).
D - No bagging.

The treatments and ages in days of stems were:

Rep. No.	A	B	C	D
1	4	5	4	2
2	7	4	8	8
3	9	5	5	5
4	4	6	9	7
5	5	6	5	4
6	4	5	9	4

Results: In Farm 3B, Tagum, Mindanao, on May 7, 12 days after treatment the fruit was cut and the second hand from the apical (smallest) hand was cut off and examined. Since the standard farm practice is to dehand the false plus one hand, the hand cut in this experiment would normally be the apical hand on harvested fruit and the hand usually most severely infested with corky scab.

A fifth treatment was added and analyzed for comparison. Stems that had been sprayed as buds on 3-day cycles were examined also.

An index system was used to estimate thrips feeding on the outside (of upturned fingers):

0 - clean
1 - trace
2 - thrips feeding on all or almost all fingers determined by the rough feel of the peel.
3 - thrips feeding on all fingers. Readily visible by sight as well as touch.

Severity of Thrips florum feeding (Index)

Treatment	Rep. No. 1	2	3	4	5	6	Ave. Index
Poly-D bags	1	2	2	3	1	2	1.8
Diazinon spray followed by early bagging	2	1	1	1	2	1	1.3
Untreated bag only	2	3	2	2	3	2	2.3
Unbagged stem	2	2	2	3	3	1	2.2
Diazinon bud spray (std. practice)	3	3	3	2	2	3	2.6

In addition, the number of live thrips were counted from two individual flower ends (from flowers nearest the false hand).

Poly-D = 25

Diaz. + bag = 16

Bag only = 4

No bag = 5

There were no conclusions to be drawn from the counting of live thrips.

Conclusions: The only effective treatment was the diazinon spray followed immediately with an early bag. The standard farm practice of bud spraying was no more effective than no treatment at all. The failure of the Poly-D bags was surprising, but they were too short (60") to completely cover the fruit and they had been stored in direct light in a greenhouse.

Early bagging is too labor intensive to recommend as a corky scab control unless all else fails. The need to spray stems for diamond spot adds a significant drawback although stem spraying for diamond spot might be halted during low disease incidence periods.

Experiment No.2: Effects of bud spraying to control Thrips florum and reduce corky scab. Farm 3B, Tagum, Mindanao - May 23-June 6, 1974.

Materials: Diazinon 40% W.P. mixed 1 and 2 lbs in 20 gallons water plus 28cc Triton (this makes a 0.25% and 0.5% spray, respectively).

1 backpack pump with a 12-foot wand attached (double nozzle).

Methods: A total of 40 plants were marked as follows in 4 treatments of 10 plants each.

Treatment	Description
A	1-3 day old bud sprayed with 0.25% Diazinon.
B	1-3 day old bud sprayed with 0.5% Diazinon.
C	Buds not sprayed - stems sprayed 3 times with standard Diazinon-Benlate spray.
D	Buds not sprayed - stems not sprayed.

An index of feeding damage was used since a corky scab evaluation would require a 3-month lapse between treatment and observation.

The index used was:

0 - clean. No trace of pebbling (thrips feeding).
1 - trace of pebbling - no brownish areas.
2 - light feeding damage on crown and all pedicels.
3 - heavy feeding damage on all pedicels and fingers.

Results: On June 5 and 6, 1974 buds were examined that had been treated on May 23-25 along with buds that had not been treated.

Stem No.	Treat A	Treat B	Treat C	Treat D
1	2	1	2	2
2	3	1	2	2
3	2	1	2	2
4	3	2	2	3
5	2	2	2	2

Stem No.	Treat A	Treat B	Treat C	Treat D
6	1	2	3	2
7	2	2	2	2
8	2	1	2	3
9	3	1	2	2
10	1	1	2	2
	2.0	1.4	2.1	2.2

There was a significant difference between the 0.25 and 0.5% diazinon rates in favor of the 0.5% (Treatment B). This may have been caused by a repellent effect of the higher rate.

Experiment No.3: Candelas of unshot plant sprayed in order to prevent corky scab thrips from entering bud. Farm 3B, Tagum, Mindanao.

Materials: Backpack pump with 12 foot wand. Single spray nozzle.
Diazinon 40% W.P.
Dursban 2 E.C.

Methods: All tall plants unshot or with peeping buds were sprayed. Unshot plants were sprayed by poking the single nozzle through the candela and applying insecticide inside. Candelas too tightly rolled to permit the entry of the nozzle were sprayed on the tip if possible, of if not the unfurling candela would be sprayed on the next cycle (figuring 3 day cycles).

Two tests were conducted; one with 0.5% diazinon, the other with 0.5% dursban. These rates were double the usual, but were used for testing purposes. All the plants in 5 ha of Farm 3B north of the cable were treated.

Results: Dursban badly burned the candelas, but not the buds. Neither insecticide reduced thrips injury on treated plants. (This is in disagreement with Experiment No.2 - Treatment B where a 0.5% diazinon bud spray reduced thrips feeding).

By using a Dursban E.C. (emulsifiable concentrate) the chances of phytotoxicity are enhanced. A wettable powder is a better bet because the E.C. has too many emulsifiers. Also, under the light and humidity conditions of the canopy of a banana farm Dursban would only have a half life of 2-3 days.

Experiment No.4: The effects of ULV sprays on red rust thrips in candelas Farm 5 - June 3-July 1, 1974.

Materials: TOXAPHENE 80% (fabricated by the Macondary Corp.) Stearman or Piper Pawnee spray plane equipped with 4 - AU2000 micronairs
1-2 liter graduated beaker for measuring amount of insecticide used.
1 roll aluminum foil for collecting droplets during test runs, Droplets should measure less than 100 microns or fruit can be burned.

Methods: Every time an airplane is used for ULV spraying, the output must be checked. The following is a guide for a starting point:

Stearman biplane.
Inboards #3 adjustment.
Outboards #5 adjustment.
Blades set at minimum angle on all micronairs.
Droplets mainly under 100 u some larger.
Swath width: 60 feet.
Altitude: 20 feet.
Calculated to spray 293 oz/4.55 ha or 26 oz/a.
(A plane flying 95mph with a 60 ft. swath will spray 4.55 ha in 1 minute).
Pressure: 60 psi.
(ULV toxaphene weighs 11.3 lbs./gallon).

Droplets and swath width were checked by placing squares of aluminum foil across the runway. The plane makes one pass over the aluminum foil squares at normal pressure altitude and speed. Droplets can be examined with a handlens and the observer can estimate whether droplets exceed 100 microns.

Airplane tanks must be partially filled and the top level marked with a wax pencil. When test run is over the time flown and insecticide used can be calculated by filling the tanks up to the original mark.

As an alternative to the above, the inboard micronairs can be shut off and the outer ones run at aperture #5 if too much insecticide is being put out.

Farms are in good shape for spray ULV if a leafpruning cycle has just been completed.

Results: The following results were obtained by counting red rust thrips adults and nymphs on 35-40 unfurled candelas on plants 6-8 feet high (measured to leaf base).

	Date	No. suckers	Ave. thrips Nymphs	Ave. thrips Adults
Pre-treatment	June 3	40	33.9	10.7
SPRAYED	June 12			
5-day check	June 17	35	2.4	10.1
RESPRAYED	June 24			
7-day check	July 1	37	0.0	4.2

Results were good, but thrips were not eliminated. There was some mortality of Thrips florum in the crowns of plants just ready to shoot or that had recently shot fruit. An examination of fruit one week after the second ULV spray in Farm 5 disclosed little or no effect on Thrips florum from the spraying.

Conclusion: ULV must be considered non-effective as a corky scab control.

Experiment No.5: Injection of Dursban and Dipterex into the vertical bud in order to kill attacking corky scab thrips. Farm 3, Tagum, Mindanao. June 27, 1974.

Materials: Backpack pump with 12 foot wand.
Standard spray nozzle ground down to a point.
Dursban 2 E.C. (1.32 lbs actual/gal.
Dipterex 95% S.P. (soluble powder).
Rose bengal - a red dye to "tag" the insecticide.

Methods: The insecticides were diluted to 0.25% solutions as follows:

Dursban - 4 tablespoons/gal. water.
Dipterex - 1 teaspoon/gal. water.

Dipterex (under the names Lepidex or trichlophon) is injected into buds of low-growing bananas on Fiji. The rate used is 2 oz. of 60% dipterex in 3 gallons water, a 0.33% solution. A 20cc dose is injected into each of 2 sides of an emerging bud.

The buds to be injected must be vertical, just about 1/3 to 1/2 emerged. We used a non-calibrated dose in preliminary tests, but Fiji workers use a double-action push-pull pump that injects a 20 cc dose with each movement. The pump used in Fiji is manufactured by the White Star Products Ltd. Box 27202, Auckaland 4, New Zealand. It's called the "Fynspray" Scabmoth Unit and costs $13.70 New Zealand in lots of 12 (US $16.30).

In our tests the operator located the emerging bud and injected it from two sides. Although we had planned a largescale test, as the work progressed I realized that the wands were too flimsy to push through the leaves surrounding the bud, much less inject insecticide. Also, locating the buds was slow work. We continued for 20 stems anyway, 10 with Dursban, 10 with Dipterex.

Results: The Dursban badly burned the fruit. Penetration, as marked by the rose bengal dye, was good - many dead thrips were found. Unfortunately, many live ones were also found and feeding damage did not seem to be reduced.

The same applied to the dipterex except fruit was not severely burned.

The method is impractical with present methods.

Experiment No.6: Effects of ground sprays to control Thrips florum. Farm 3B, Tagum, Philippines. July 1-12, 1974.

Materials: 2 backpack pumps.
Dursban (lorsban) 25% W.P. (wettable powder).
Toxaphene 60% E.C. (emulsifiable concentrate).
Diazinon 40% W.P.
500 traps made of plastic ice cream cups with bottoms cut out and a piece of BANAVAC plastic is coated with STICKEM (TANGLEFOOT) or the sticky material from "LION-TIGER FLYPAPER".

Methods: In general, a 1-meter diameter area directly under 5 pendent buds to baggable fruit was sprayed on 4-day cycles with each of 3 insecticides; 5 plants were marked but left unsprayed as checks. The sequence went as follows:

Day 1: Spray ground under 5-8 day old buds. Allow surface vapours to dissipate before placing traps.
2: Place 5 traps under each stem (total 100).
4: Count thrips in traps.
5: Remove traps. Replace sticky plastic. Respray.
6: Replace traps under stems.
8: Count thrips in traps.
9: Remove traps. Replace sticky plastic. Respray.
10: Replace traps.
12: Count thrips in traps for last time.

Note: Missing or tipped over traps should not be divided into total thrips to get averages.

Insecticides: The concentrations of each insecticide tested and the number of teaspoons insecticide (not actual) per gallon were as

40% WP DIAZINON 0.5% 15 teaspoons.

If insecticides of different concentrations than those listed above are used, consult the "Dilution and Conversion Chart".

Results:

Ave. Number of thrips per plant.

Days	4	8	12	Total
TOXAPHENE	1.2	0.8	1.0	3.0
DURSBAN	5.5	3.4	0.2	9.1
DIAZINON	6.6	4.0	0.2	10.8
CHECKS	5.6	4.6	5.2	15.4

Toxaphene makes a promising ground spray for Thrips florum. This should be retested using 10 treated and 10 untreated (check) plants. If results hold up I'd go to a section or larger field test while I repeated the trapping test with lower concentrations (0.5, and 0.25%).

A second test using a 1% toxaphene spray was conducted. Results were inconclusive because of low numbers of thrips emerging from untreated (checks) soil.

The ground was sprayed on July 12; traps placed July 13 and examined on July 15. The 5 traps under each sprayed plant (total 25/treatment) yielded an average of 2.2 thrips/plant; checks 2.0.

Results of a 3rd. trial using Diazinon conducted at 3 rather than 4-day intervals (too often in my opinion) sent to me on August 30 by Dr. L. A. Berg showed the following average thrips emergence per plant:

Days	3	6	9	Total
Diazinon	0	0.5	0.8	1.3
Checks	0.5	3.9	7.5	11.9

I like Diazinon over toxaphene if results are comparable. Diazinon is far more costly, but will not contaminate farms as will toxaphene.

Also, from Dr. Berg's records:

After a slow first cycle because much banana debris had to be removed from under the stems 2 men spent 1 hour 20 minutes to spray 14 gallons of mix under 277 stems (20 stems/gallon) on 5 hectares (12.5 a).

This amounts to 12 "man minutes" per acre - a very reasonable time.

RED RUST

Since November, 1974, when stems showing a "silvering" or russeting of fruit began showing up on fruit from Farm 3, Tadeco, Mindanao, red rust has gradually increased. On June 22, more fruit was being discarded as waste or cut down in the field for red rust than for any other defect. Actually, the defect is not true red rust which is caused by feeding of two species of Chaetanaphothrips thrips.

CAUSE OF RED RUST - Red rust was caused by the feeding of the nymphs and adults of the thrips Elixothrips brevisetis. In addition, a second species tentatively identified as Hercinothrips bicinctus whose nymphs and adults live inside unfurled candelas, might also be implicated.

Red rust adults were found on stems as young as 10-15 days, but the first symptoms of red rust rarely appeared on stems younger than 20-30 days and usually appeared on more mature fruit. Nymphs and adults were common on infested stems ready for harvest and the rust increased in intensity on infested stems right up to harvest. The first signs of red rust were areas of silvering marked with black excrement stains (Figure 10). This was caused by early thrips feeding. Later, severely fed upon areas turned rusty red giving this defect its name. Sometimes rusting was severe enough to "scab" the fruit (Figure 11).

The most favored feeding sites of the red rust thrips were on the exposed outer surfaces of the fingers. True red rust is almost completely confined to the area where adjacent fingers touch. Bagging protected fruit although even a small tear in the bag exposed fruit to thrips feeding.

The poor quality tree bags used by Tadeco throughout this study tore easily and exposed fruit was completely ruined for commercial use (Figures 12 and 13). When the inferior bags were purchased plastic was in short supply and Tadeco was forced to buy whatever was available.

BIOLOGY OF ELIXOTHRIPS BREVISETIS - The silvering (red rust) thrips, Elixothrips brevisetis is a blackish thrips that lives on fruit of both commercial and native varieties and occasionally in small colonies on old (leaf 6-7 or older) open leaves (not candelas). The adult female (males are unknown so far) is a sluggish, dull, blackish thrips approximately 1 mm long. It can be distinguished from the similar appearing Hercinothrips bicinctus by three light areas along its back formed by light brown spots in the wings (Figure 14). Hercinothrips bicinctus is a shinier, fast-moving species with a light brown thorax on an otherwise blackish body (Figure 15). Hercinothrips nymphs and adults live in unfurled candelas; occasionally the adults are found on fruit where their role as red rust producers is unknown.

Figure 10 : Early "silvering" of banana fruit. Note black excremental stains caused by shedding of accumulated excrement by nymphs of silvering rust thrips. Farm 7 Tadeco, Mindanao, Philippines, May, 1974

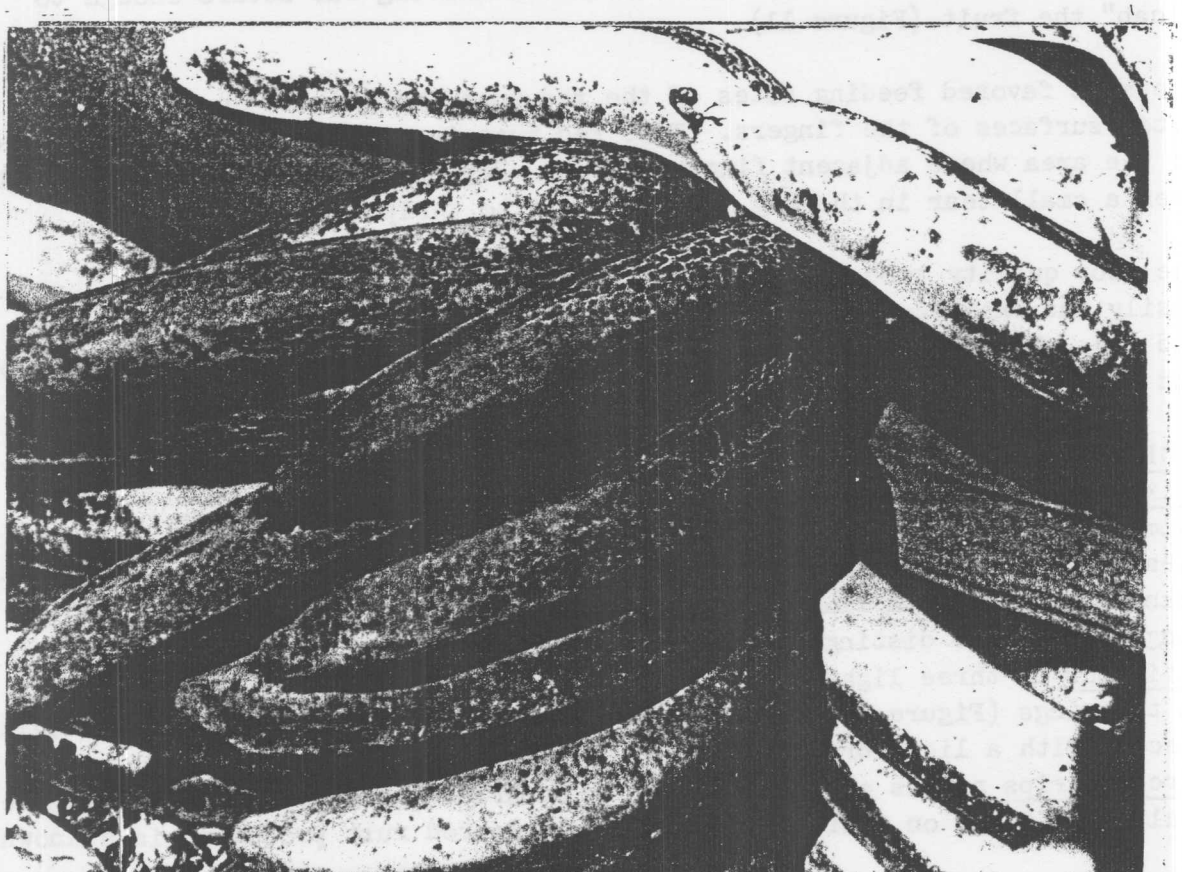


Figure 12 : Fruit rendered unmarketable by silvering rust thrips. Stem shows exposed damaged apical hands.

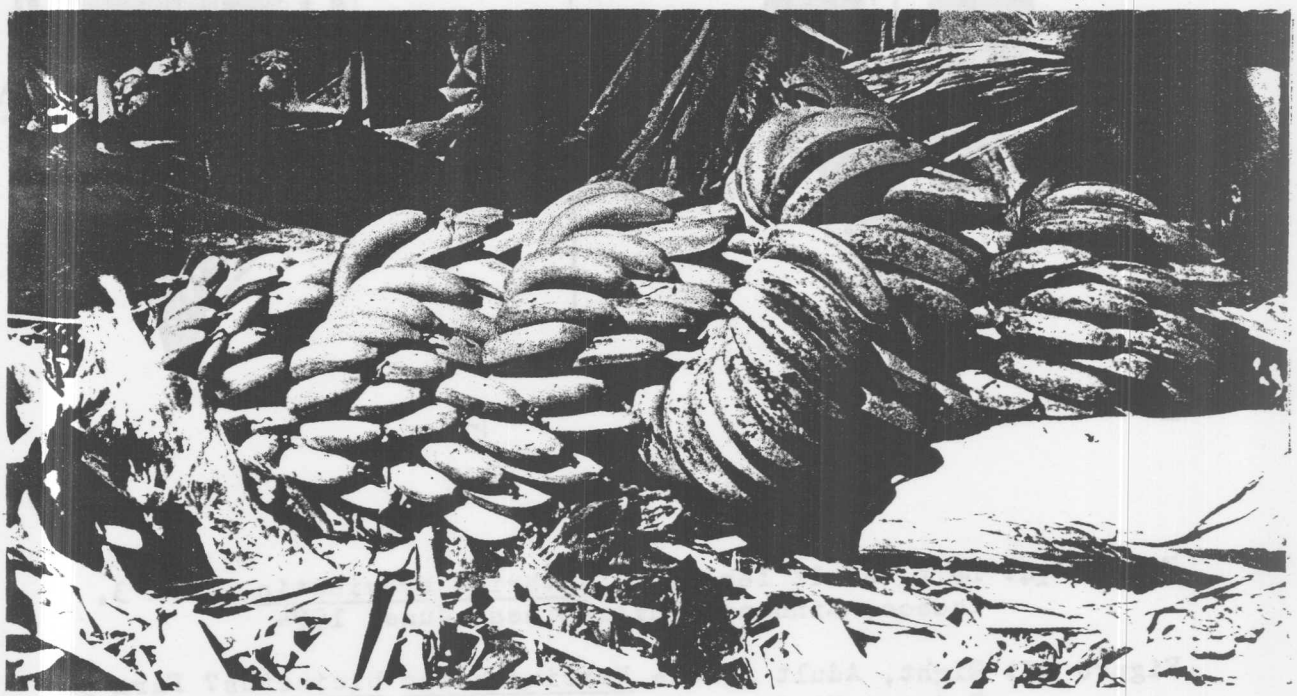


Figure 13: Bag removed to show contrast with covered hands. This is how fruit appears when poor quality bags tear. Tadeco, Mindanao Philippines, May, 1974.

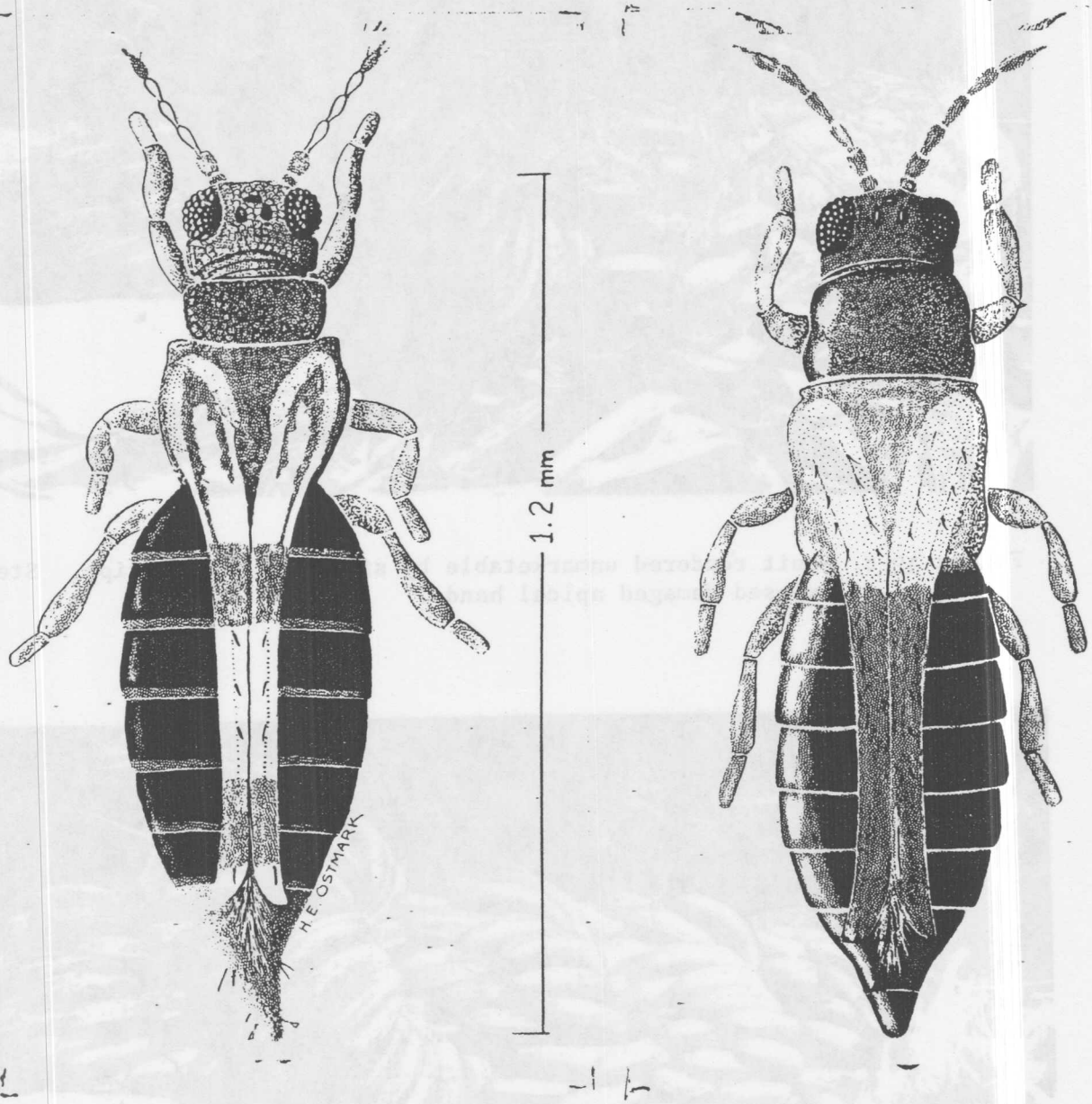


Figure 14: Left, Adult femele Elixothrips brevisetis. Farm 3, Tadeco, Mindanao Philippines, June, 1974

Figure 15: Right, Adult femele Hercinothrips bicinctus? Farm 3, Tadeco, Mindanao Philippines, June, 1974

Eggs of Elixothrips are usually laid on fruit usually no younger than 10-12 days. The nymphs are slow-moving, dirty yellowish, with the unique habit of forming a drop of excrement on the tips of their abdomens. At intervals they curve their abdomens over their backs and place the liquid excrement on their dorsal surface. Eventually the excrement forms a reddish-brown ball giving the nymphs a round, aphid-like appearance. At intervals, or when touched, the excrement is shed, staining the fruit with reddish or black spots. The excrement probably protects nymphs from predators and perhaps desiccation.

The nymphs feed with an up-and-down motion of their heads while their mouth rasp the surface of fruit or leaves. First feeding causes silvery areas turning to red as the severity increases. The characteristic reddish color is even imparted to the underside of infested leaves. Adults feed along with nymphs in the same manner.

When nymphs become mature they drop to the ground and pupate underground. One pupa was collected from an earth sample taken from 4-5 inches below ground, although most nymphs probably transform in shallower depth. New adults fly to fruit or leaves and begin the cycle anew.

Hercinothrips habits are largely unknown. The adults and their whitish nymphs live on unfurled candelas. The life cycle from egg to entering soil to pupate probably takes less than one week since this species is never seen on open leaves or inside tightly rolled candelas.

CONTROL OF RED RUST THRIPS - Four control methods had been tested. These were:

1. Stems spraying with a diazinon-Benlate mix followed by bagging.

2. ULV toxaphene sprays - 2 sprays 10-12 days apart.

3. Ground spraying to kill nymphs entering soil, pupae, and adults leaving soil.

4. Bagging alone with diazinon-dusted or DURSBAN-impregnated tree bags.

Stem spraying - This was the standard farm practice. Since stems were protected against diamond spot with Benlate or Maneb spray at 4-day cycles, Diazinon (1 lb 40% in 20 gallons) was added to the spray to combat red rust. At first, the diazinon was presumed to assist in corky scab control, but when this was found to be untrue the practice was continued for red rust thrips control. Actually, the spray immediately before bagging was of most value and that only when bagging followed within hours.

Conclusions: A night of rain on unbagged fruit removed lethal dosages of insecticide and the fruit was bagged with no insecticidal protection. A return to Diazinon-dusted or POLY-D (DURSBAN-impreganted) bags was necessary.

ULV Toxaphene - Two ultra low volume (ULV) toxaphene sprays at a 10-12 day interval reduced Hercinothrips bicinctus from 45 to 12 to 4 thrips per candela. Thus ULV sprays knocked down high thrips populations, but resultant dangers of contaminating the plantations with insecticides and disrupting populations of other insects made ULV sprays risky. Add to these the danger of resistance buildup and the cost of the project.

Conclusion: I felt that ULV sprays should remain a last resort to knock down exceptionally high thrips populations.

Ground spraying - Spraying the ground to control Thrips florum may have the effect of reducing red rust thrips populations since all fruit-infesting thrips species pupate in the ground mainly under the fruit. The residual insecticide from the sprays for Thrips florum might assist in red rust control, but no additional ground sprays for red rust should be considered.

Conclusion: Not a red rust control, but might aid.

Bagging - Red (silvering) rust can be controlled with insecticide treated bags only. The bags must remain untorn throughout the life of the hanging fruit even if this means conducting regular rebagging cycles. The rebagging must also be done with treated bags. I recommended POLY-D (DURSBAN-impregnated) bags because bag dusting rarely produces a good long-lasting product.

Plants growing near ditches and canals should be pruned so that there is enough room between the ditch and the plant for the ladder used by the bagging crews. If the plants can not be bagged, they should be chopped down since red rust will render them unmarketable anyway and they will serve as sources of infestation of the red rust thrips.

MISCELLANEOUS PESTS

During my 3-month stay in Mindanao I checked Tadeco and plantations of Standard Fruit and Del Monte for potential insects pests. The following is a list of the pests observed together with control measures should any of these become epidemic.

DEFOLIATORS

There were five potentially serious defoliators now present on Tadeco farms in endemic (non-economic) population levels. They were:

Striped saddleback - Thosea sinensis
Trashy bagworm - Mahasena corbetti

Conical bagworm - Metisa plana

Banana leafroller - Erionota thrax

Hairy opsihanes - Opsiphanes sp.

An unidentified tussock moth became abundant in early 1974, then disappeared.

Striped saddleback - This defoliator is a flat light green slug caterpillar with a reddish dorsal stripe (Figure 16). A mature larva measures approximately 3 cms. The spines that margin the larvae cause a burning sensation when touched and fruit cutters sometimes complain as they do in Central American plantation when saddleback populations are high. The larvae fed on the margins of the oldest leaves and finally pupated in a hard, round, dark brown cocoon spun on dead leaves or the pseudostem. The cocoons blended into the plant's coloration and were difficult to find. The pupa was round, yellowish and less than half the size of the larva. The adult was not observed; all the larvae within collected cocoons died before adults emerged.

Control: Control by chemicals should never be necessary. A braconid wasp was observed parasitizing larvae, but the main cause of mortality was a bacterial disease that periodically decimates populations.

On the rare chance chemical control becomes necessary a Sevin spray at 2.5 lbs 80% Sevin/ha will control the larvae. The Sevin may be mixed with the standard Sigatoka spray to save spraying costs.

The trashy bagworm is so called because the larvae spin a bag and adhere large pieces of banana leaf to it (Figure 17). As the larvae pass through their skin molts (instars) they add their shed head capsules to the ends of the trashy bag. Thus, the number of instars can be determined by examining the bags for shed head capsules.

The larvae chewed holes in the leaves similar to those made by Central American bagworms.

Control: If bagworm populations become epidemic a toxaphene ULV spray is the most effective insecticide. Large bagworms are exceedingly difficult to kill unless an insecticide, such as toxaphene, is used that penetrates the leaf.

The conical bagworm is a small (3 cms) caterpillar surrounded by a finely spun erect silk bag (Figure 18). Damage is slight, but extremely high populations could cause economic damage.

Control: If necessary, I would try Sevin as for the striped saddleback. If Sevin fails an ULV toxaphene would control them. Again, only extremely high populations warrant the cost of spraying.

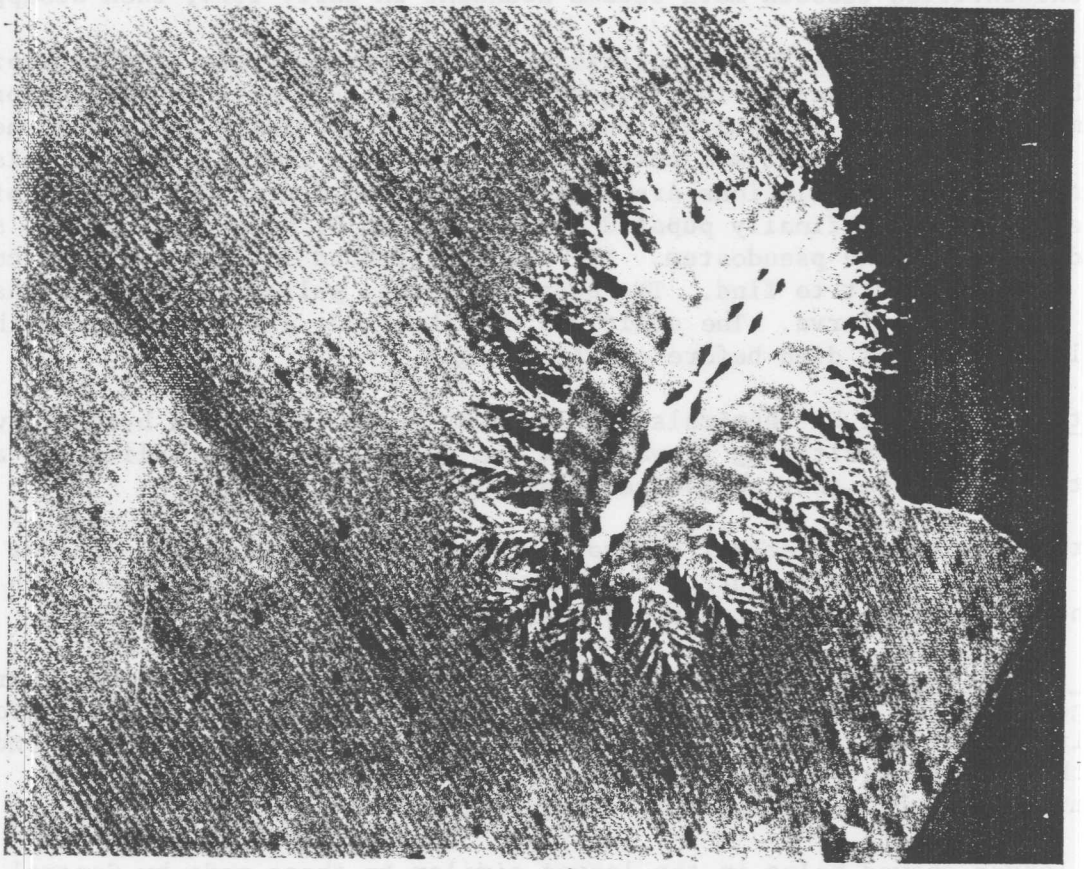


Figure 16: The striped saddleback, Thosea sinensis. Farm 3, Tadeco, Mindanao, Philippines, June, 1974.

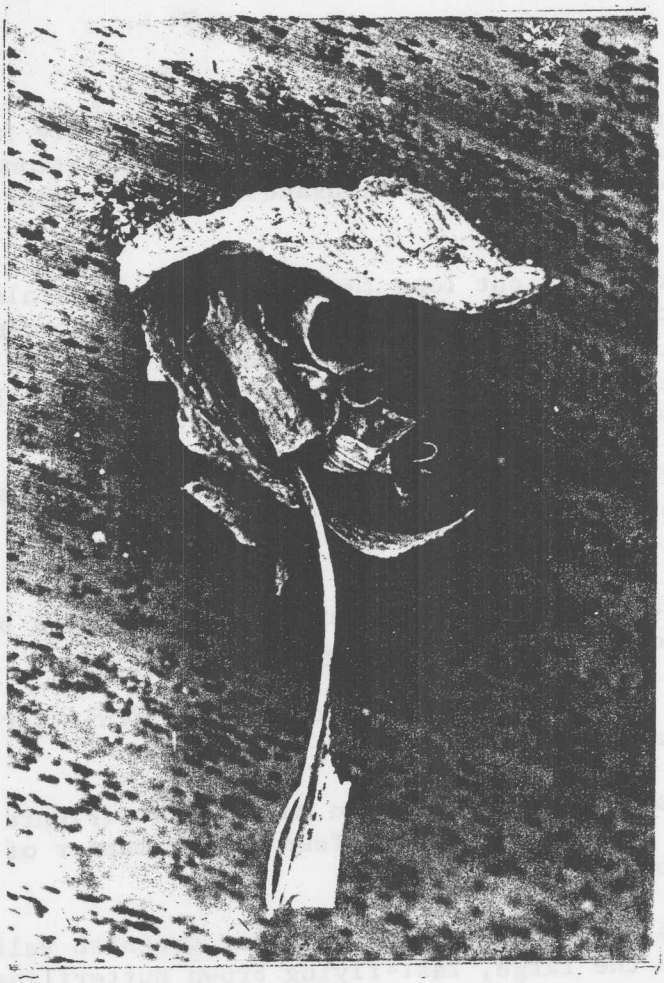


Figure 17: Trashy bagworm, Mahasena corbetti. Farm 3, Tadeco, Mindanao, Philippines, June, 1974

The banana leafroller has been known to require insecticidal control in Fiji. Natural control agents keep the populations at Tadeco under control, but there were sometimes thousands of the skipper butterflies flying through the plantations.

The caterpillars cut long (up to 2 feet) slits along the edges of the leaves. As they cut the leaves they spin silk cords across the leaf (Figure 19) and pull the pieces together rolling the leaves. The inner edge of the rolled leaves are fed upon (Figure 20), but the leaf-rolling habit causes a disproportionate amount of leaf loss.

The older larvae excrete a covering of whitish scaley powder over themselves within the rolled leaves. All-aged larvae may be distinguished by their constricted "neck".

The larvae pupate within the rolled leaves and a brown skipper butterfly with yellow marks on its forewings emerges.

Control: Should natural control fail, a Sevin spray should control the caterpillars.

A large hairy Opsiphanes? type caterpillar (Figure 21) is present in low numbers. These caterpillars feed in the manner of Caligos, eating large sections out of leaf edges.

Two caterpillars pupated into slender greenish yellow pupae (Figure 22). Adults are the large, fast-flying brown butterflies that have the unusual habit of alighting high in banana plants.

Control: At present these insects present no danger, but should populations rise to epidemic proportions a Sevin spray will control them.

PEEL FEEDERS

By farm the most serious banana insect pests were those that fed on banana peel. Besides the thrips pests already described, at least two other potentially serious pests exist in Mindanao, but not yet in Tadeco plantations. They are the Almirante red rust thrips, Chaetanaphothrips signipennis and an unidentified peel-scarring weevil.

The Almirante red rust thrips was found in the banana variety collection in Los Baños outside Manila. Later while checking Davao Fruit's plantations for the peel-feeding weevil I found this thrips ruining much fruit in one boxing station. I was never able to obtain a specimen of an adult, but the "flame-like" pattern of the feeding between the fingers was characteristic

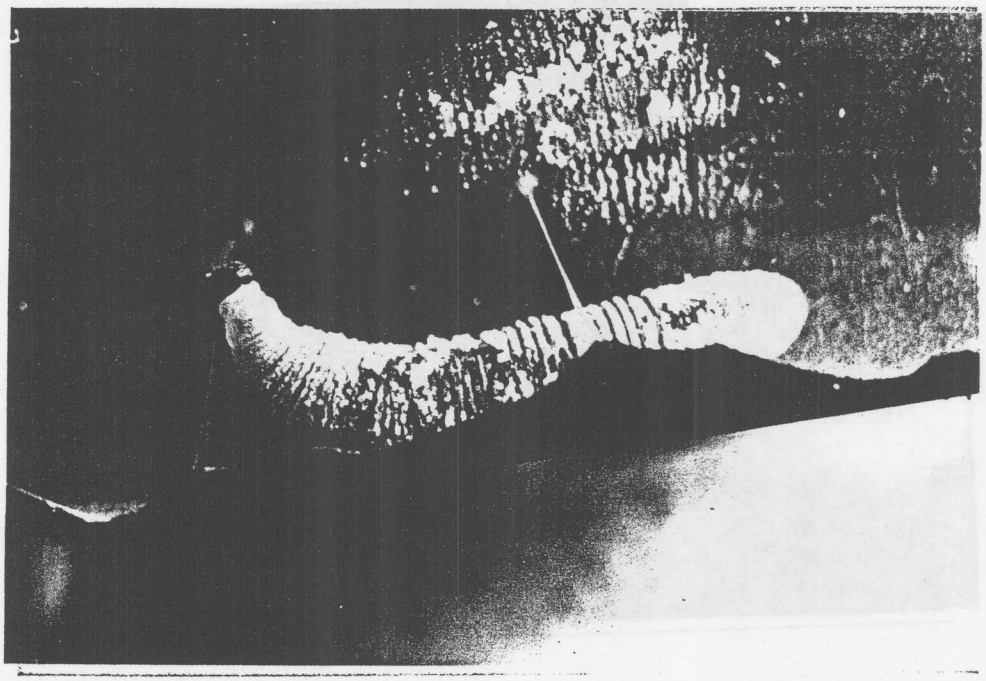


Figure 19: Banana leafroller, Erionota thrax. This photo shows a mature larva spinning the silf strands that it will eventually use to roll the leaf. Farm 3 Tadeco, Mindanao, Philippines, June, 1974.

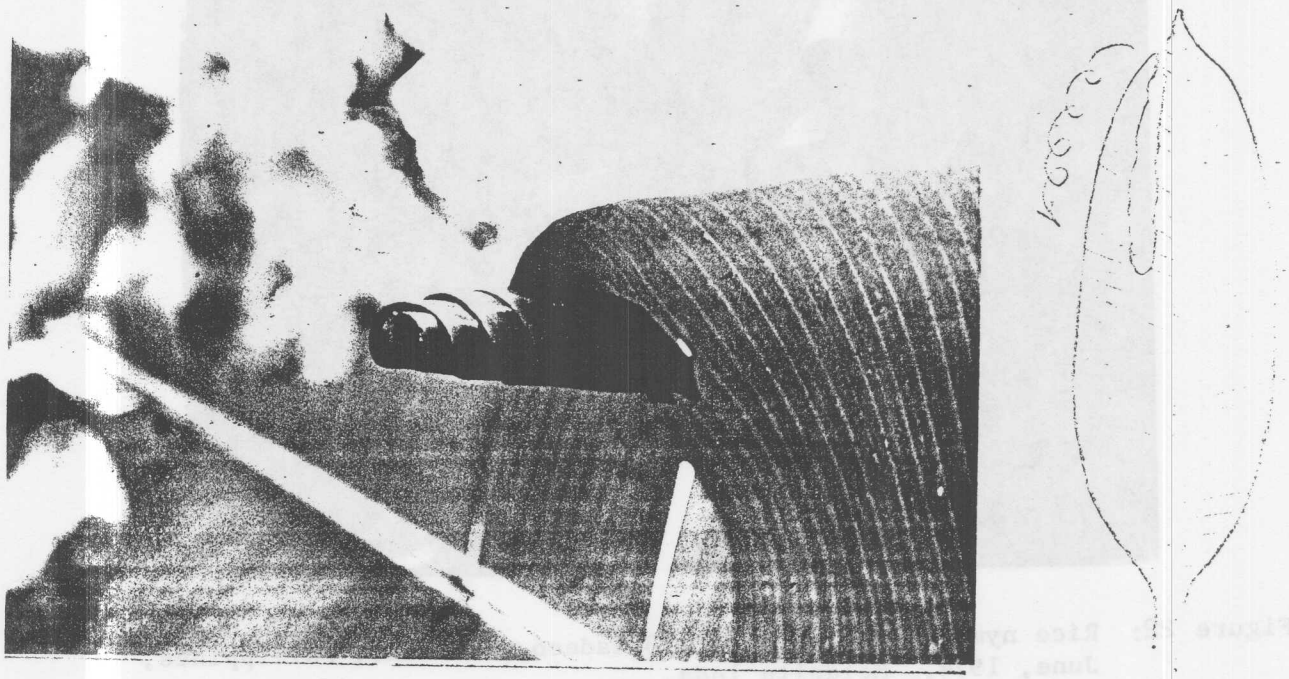


Figure 20: Banana leafroller damage. A. Rolled leaves. B. Diagram of rolled leaf stretched out to show fed-upon area. Farm 3 Tadeco, Mindanao, Philippines, June, 1974.

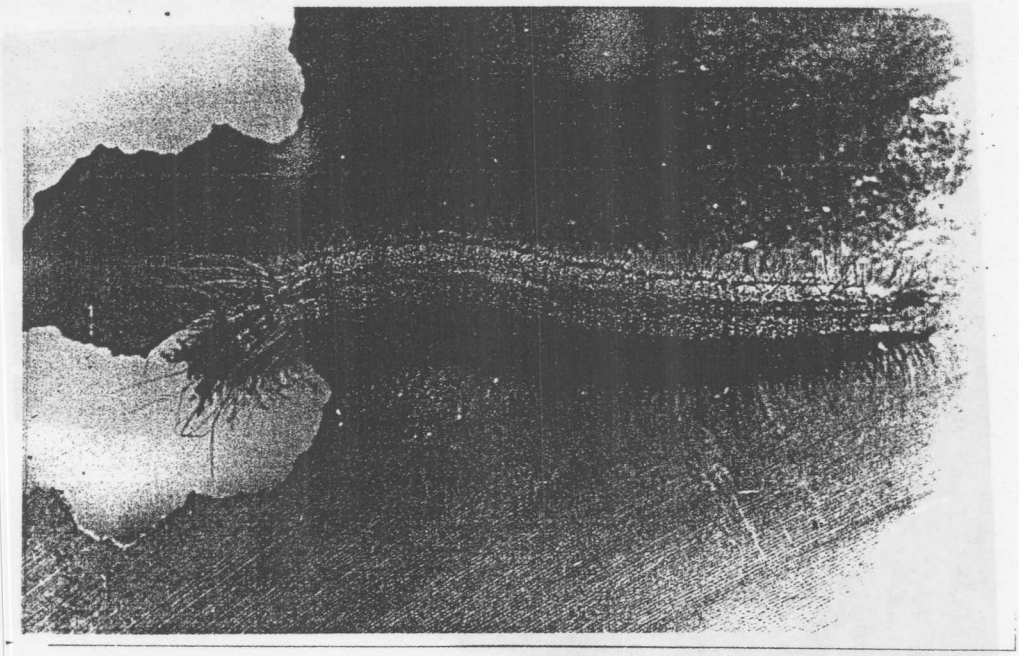


Figure 21: Hairy opsiphanes larva. Farm 3 Tadeco, Mindanao, Philippines, June, 1974.

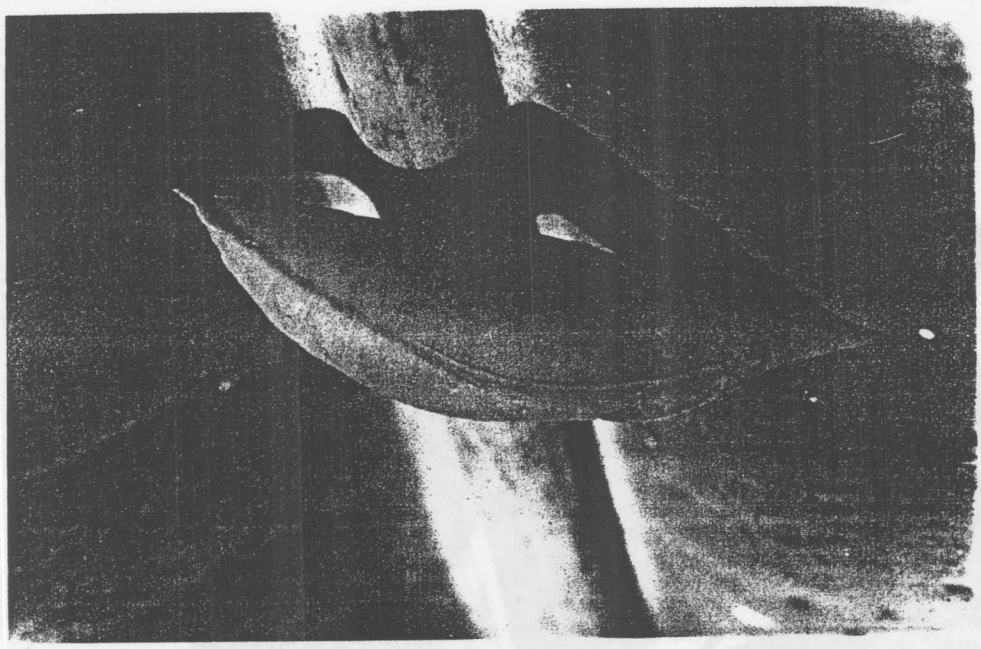


Figure 22: Rice nymphalid pupa. Farm 3 Tadeco, Mindanao, Philippines, June, 1974. Melanita leda.

(Figure 23). Some Del Monte farms report small pockets of infested fruit.

This thrips is probably the most important single persistant pest in any of our Central American plantations and a careful watch should be kept at Tadeco boxing stations for the first signs of damage.

Control: Control is difficult and expensive. Since this thrips lives on suckers and pseudostems as well as on fruit, the suckers and pseudostems must be sprayed with Diazinon using mistblowers. Fruit must be bagged with insecticide treated bags. When the thrips is under control all spraying may cease, but insecticide-treated bags would remain necessary.

The Twin Rivers Research Station, is a private laboratory subscribed to by several banana, papaya and coconut growers. One of their banana projects is a study of a peel-feeding weevil that is destroying fruit in the plantations of the Davao Fruit Co. Their Entomologist, Nicolas Dawi, gave me several weevil specimens and explained what control measures had been attempted. I am concerned that this weevil might invade Tadeco plantations.

The weevil, tentatively identified as Metapocyrtus sp. is covered with metallic green scales (Figure 24). It is flightless, approximately 7 mm long and was originally associated with coffee plants which are interspersed throughout the Davao Fruit Co. banana plantations. Larvae live underground feeding on roots (I suspect of banana). Adults emerge and feed on low-growing sword sucker leaves as well as banana fruit. The weevils are found in the axils of sword suckers. When disturbed, they drop to the ground and feign death. This weevil was also collected by Dr. Ben Waite in his preliminary pest survey in 1964.

In the company of Lloyd Berg, Jake Paredes and the farm foreman, I inspected a severely infected area. I have never seen banana fruit so totally damaged as I did there (Figure 25). When the Davao Fruit Co. ran out of tree bags all unbagged stems were completely ruined.

Control: Suckers and pseudostems have been sprayed successfully with dieldrin. When dieldrin was banned, a Japanese insecticide Sumithion (Malathion) was substituted. This does not seem to be effective. I would use POLY-D bags and a Sevin spray on 4 foot or shorter sword suckers.

NUISANCE FLIES

The nuisance fly, Hermatica illuscens, is a major peel scarring pest. The patches of "alligator hide" that frequently appear on harvested fruit is caused by the glue the female secretes on 1-3 week old fruit to stick her eggs to the fingers. Why she does is a mystery since the hatched larvae fall off the fingers without penetrating the fruit and presumably die.

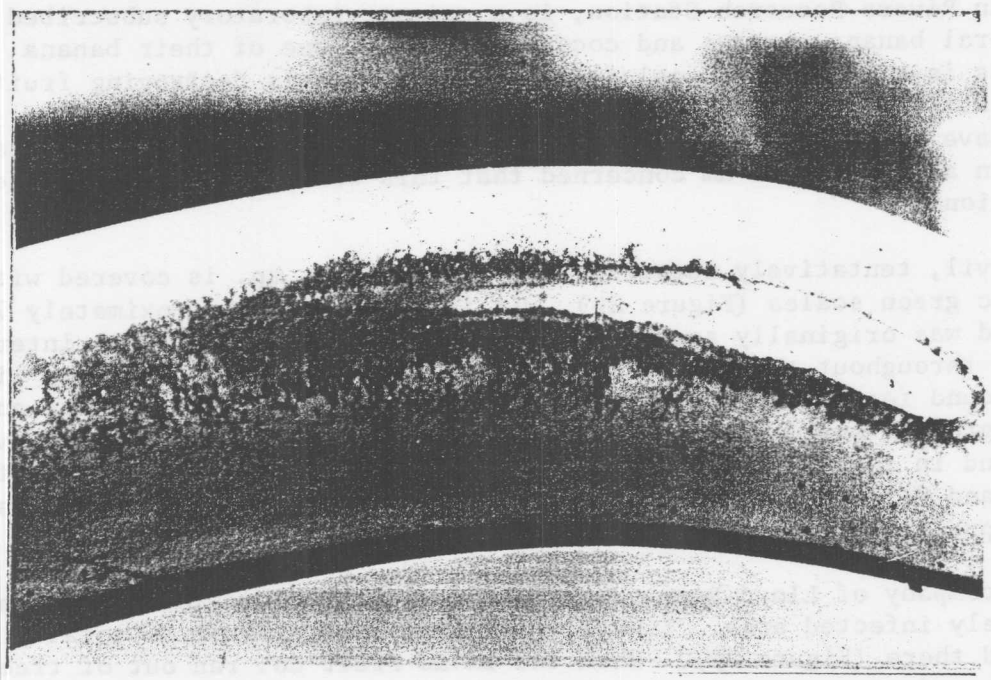


Figure 23 : "Changuinola" red rust thrips damage. Note flame-like marks (arrow) that aid in separating this from the common red rust thrips. Davao Fruit Co. Mindanao, Philippines, May, 1974.

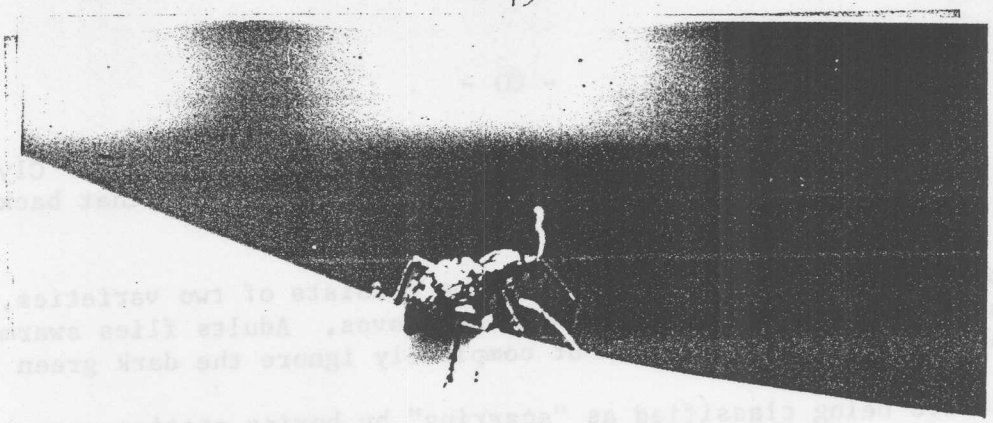


Figure 24. An adult peel - feeding weevil.

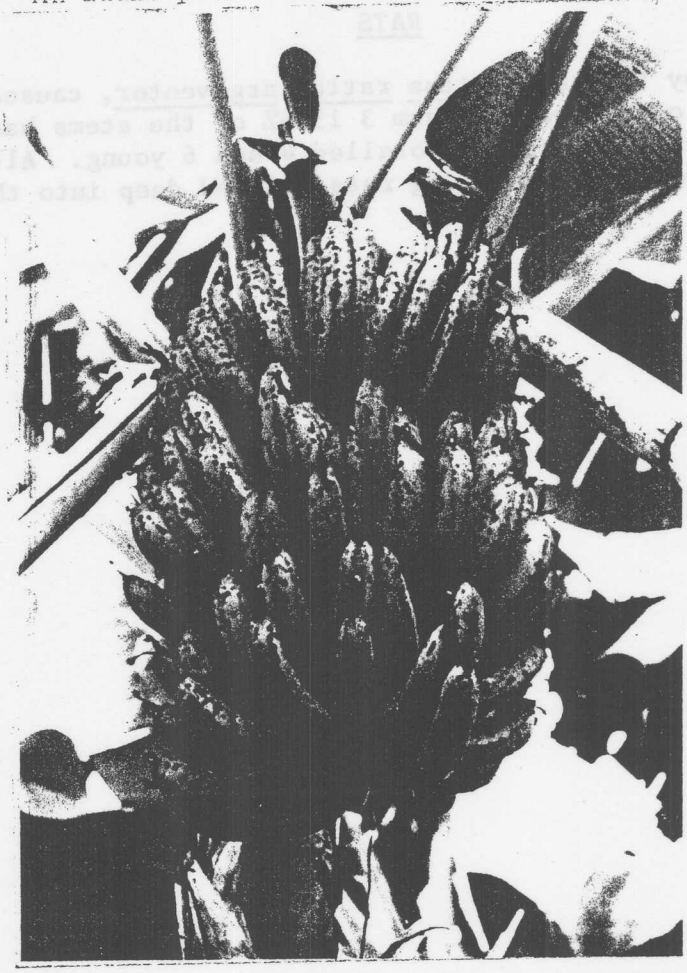


Figure 25. Damage to unbagged fruit. Davao Fruit Co. Mindanao, Philippines, May, 1974. (prob. Philicoptus sp.

The pale yellow-green color of young fruit may be the attraction. Clyde Stephens noted this in Changuinola and I made an observation that backs this up:

The croton hedge bordering a boxing station consists of two varieties, one with green and the other with yellow-green leaves. Adults flies swarm on the yellow-green foliage and all but completely ignore the dark green leaves.

The marks were being classified as "scarring" by boxing station personnel. Since the defect was so common I suggested that the Quality Control designation "NF" be used.

Control: The only practical control is to chop up and scatter all fruit lying on the plantation floor to eliminate breeding places. Toads have been observed frequently sitting on rotting stems and snapping up flies attracted to the fruit.

RATS

Scratches caused by the rat, Rattus rattus argiventor, caused much fruit to be discarded. In one survey in Farm 3 13.5% of the stems had rat nests two with young rats. The two broods totalled 4 and 6 young. Although their eyes were not yet opened, the young rats climbed deep into the fruit bunch when disturbed.

OSTMARK

COLASPIS PEEL FEEDING BEETLE

In 1974 basic biological studies on Colaspis ostmarki were conducted in Changuinola, Panama. A summary of results and techniques follow:

Mating and Oviposition: Adults were observed mating at all hours of the day and night. Pairs were observed copulating for more than 1 hour.

Unsexed adults were field collected and placed in groups of 25 to 50 in half pint Mason jars. A 3-inch section of unrolled candela was placed in the jar for food and a half inch of sifted soil was placed in the bottom as an oviposition site.

Aproximately 92% of the eggs hatched in 9 to 11 days; average, 10.5. In order to protect collected eggs from fungi, the eggs were surface sterilized by the following procedure:

1 min in 10% commercial bleach solution
1 min rinse in distilled water
1 min in 10% sodium thiosulfate solution
2 min rinse in distilled water

A total of 3896 unsexed beetles kept in an outdoor screened lab (85-87°F daytime temperatures; 70°F night. 70% daytime RH; 100% night) produced 11,639 eggs. With a sex ratio of 2 females to 1 male this means each female laid an average of only 4.5 eggs. A total of 1827 beetles produced 6366 eggs in an air conditioned lab; average, 5.2. Low egg production was caused by both high mortalities of captive beetles and the possibility that field-captured beetles had already laid eggs. A total of 5205 eggs were laid in 84 clusters; average, 62 eggs/cluster. In another test, of 33 individual male-female pairs only 28% of the females produced clusters averaging 40.9 eggs. An additional 10 eggs were dissected out of 19 of the females after they died. Only one female was observed to lay more than one cluster, but she was disturbed while ovipositing. Thus, a female Colaspis beetle lays approximately 50-60 eggs.

Eggs are laid in the soil down to a depth of 1.2 cms or the maximum depth a female can reach with her extended ovipositor without actually burrowing completely under the soil. In the field, a few clusters were found at the base of the banana mat up to 2 feet out.

Larvae: Several methods of larval rearing in the lab and field were attempted:

1. Washed banana rootlets were placed in Petri dishes between fine layer of sifted soil and sand. First larvae, then ready-to-hatch eggs were placed on top of the soil-rootlets, but in no case did larvae survive more than 2 days.

2. Live roots were collected and attempts were made to rear larvae on rootlets growing from these. Larvae lived up to 4 days.

3. Neither eggs nor adults beetles placed on growing suckers in pots or ice cream cartons resulted in larvae although adults oviposited down to 3/4 inch under the soil.

4. Over 300 beetles were introduced to 3 growing plants enclosed by a screen cage approximately 6' x 10' high. The idea was to determine by observing feeding marks on new leaves the beetles reproduced themselves. No feeding marks were found after the initial feeding by the introduced beetles indicating that the beetles did not survive.

Adult feeding: Adult colaspis beetles fed on any tender part of the banana plant in lab tests. Groups of 25-50 beetles were placed in 1' x 1' wire cages and left for 2-3 days. Comparisons were made by counting feeding marks on
1) bracts, finger, flowers
2) young and old fingers
3) candelas and fingers
4) Gran Nain and VALERY fingers
5) Fingers, Solanum leaves, Guarumo leaves

Fingers were slightly preferred to bracts, candelas and flowers, highly preferred to leaves of Solanum and Guarumo. Newly shot fingers were preferred to those 2 months old. There was no preference shown between Gran Nain and VALERY.

Five alternate host plants have been found; Sabicea sp. Solanum umbellatum, Solanum verbascifolium, Hamelia patens, Cecropia peltata, and Phenax hirtus. These alternate hosts are part of the weed cover on the floor of the banana plantations and appear to be of secondary importance.

Caged beetles fed with sections of unfurled candelas were kept in the laboratory to determine the rate of feeding. Candelas were used in this study rather than banana fingers for convenience. Beetles ate an average of 12.7 mm^2 per day, slightly more than one feeding scar.

A trial was conducted with 200 caged beetles (July 8, 1974) in the laboratory by using banana fingers for food. Area eaten was not recorded, only the number of marks. The overall number of marks per beetle per day was 0.91, which compares favorable with the figure of 1.09 observed for candela.

Feeding Sequence in the Field. This study was conducted to determine the age of fruit when damage begins, and when the peak of feeding begins. In two trials in Farm 65, Cables 15 of Lake 21 and Cable 1 of Lake 20, twenty-five newly shot mats were selected and tagged along the length of the cables. These stems were subsequently checked 3 times weekly for new beetle damage until no new injury was observed (Figure 26).

Damage to the young hands began when they lifted away from the stalk exposing the bottom fingers. Heavy feeding did not occur until the hand is further extended with some spreading apart of the fingers and rolling back of the bract. There was an increase in feeding noted around day 13.

Upper hands are the most severely damaged, probably because they open first and remain exposed longest.

Rate of Feeding vrs. Age of Fruit: The rate of feeding expressed as fingers per stem damaged per day peaked between 10 and 23 days (Figure 27).

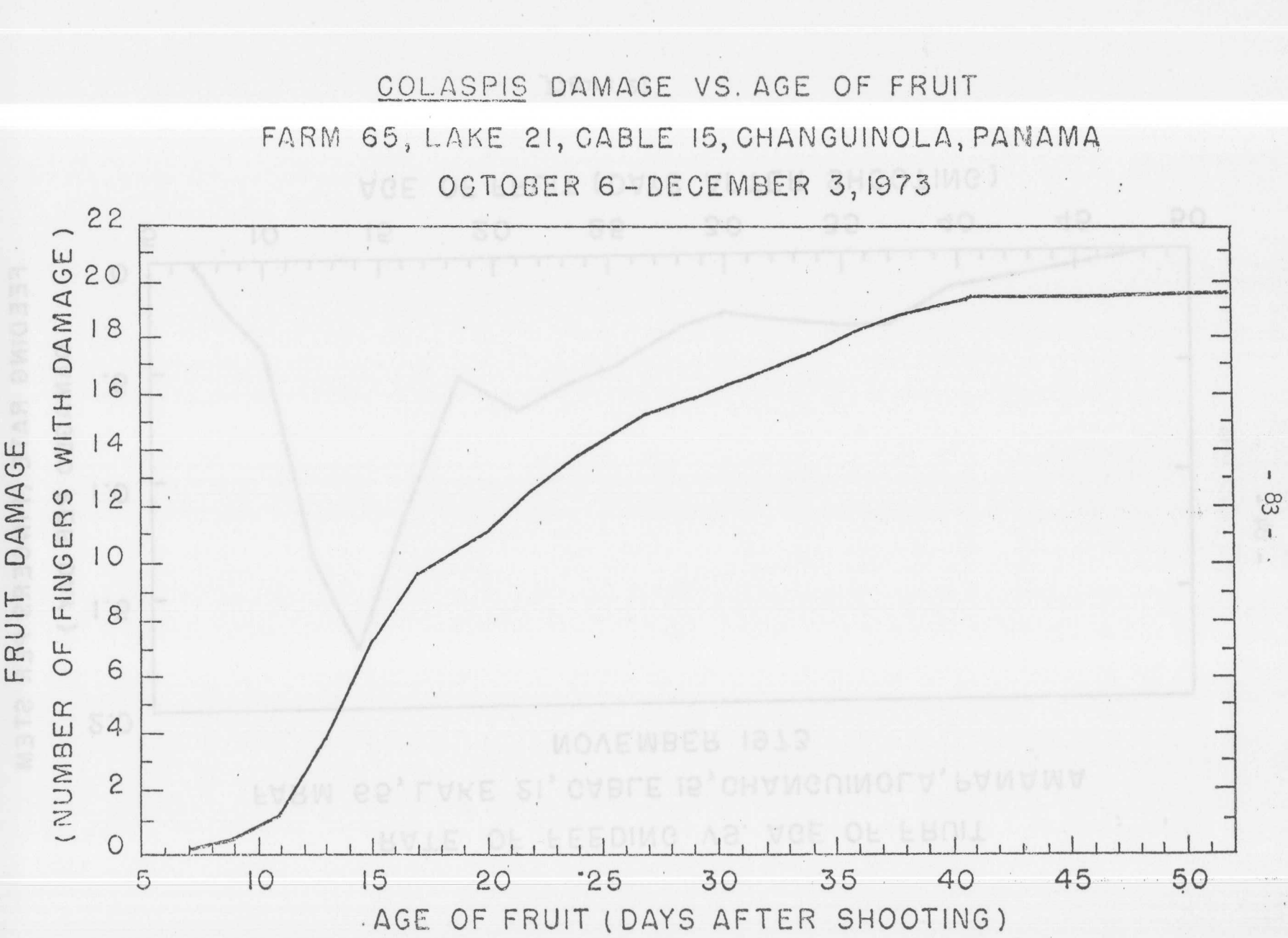

COLASPIS DAMAGE VS. AGE OF FRUIT
FARM 65, LAKE 21, CABLE 15, CHANGUINOLA, PANAMA
OCTOBER 6 - DECEMBER 3, 1973
FRUIT DAMAGE
(NUMBER OF FINGERS WITH DAMAGE)
0
2
4
6
8
10
12
14
16
18
20
22
5
10
15
20
25
30
35
40
45
50
AGE OF FRUIT (DAYS AFTER SHOOTING)

Figure 26

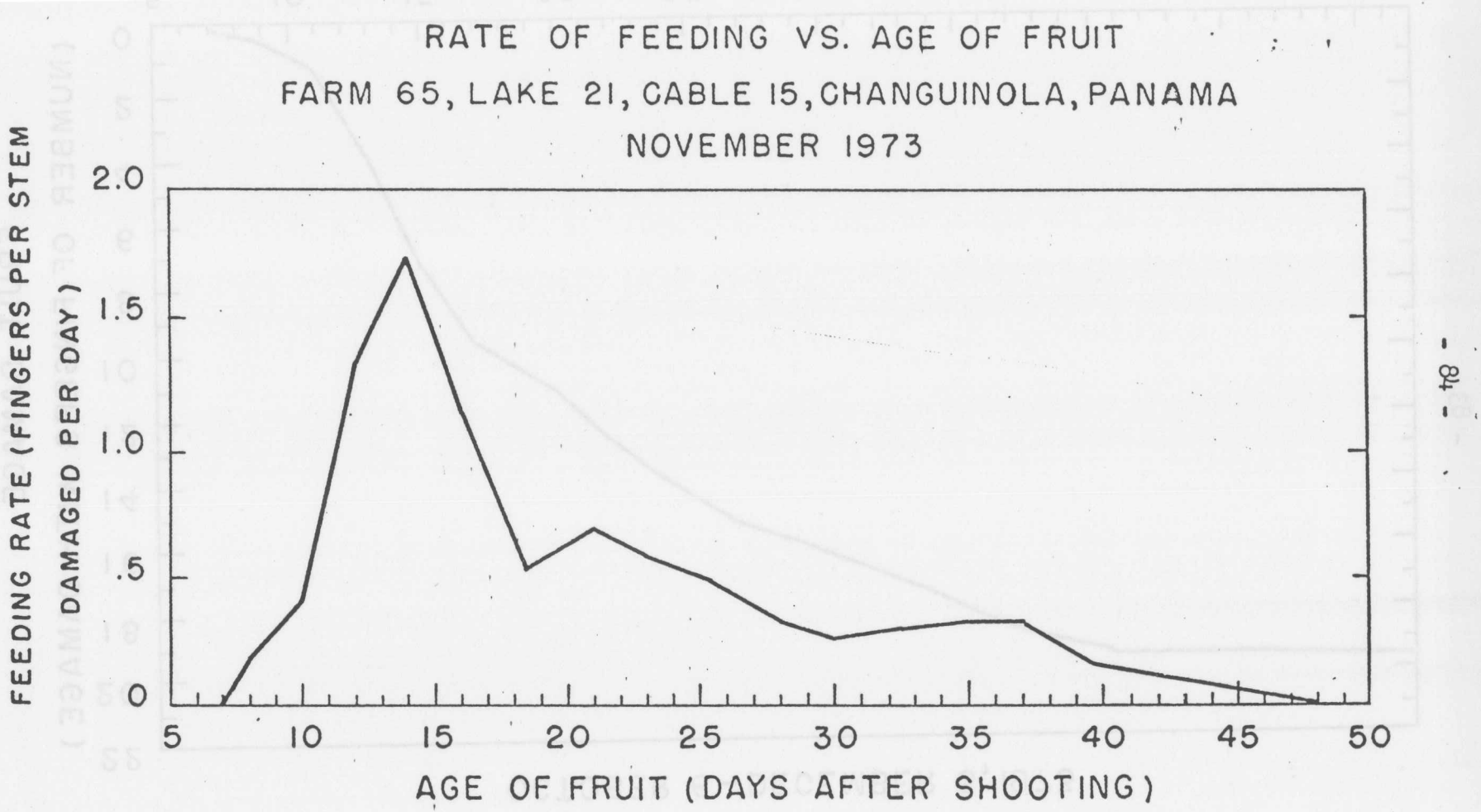

RATE OF FEEDING VS. AGE OF FRUIT
FARM 65, LAKE 21, CABLE 15, CHANGUINOLA, PANAMA
NOVEMBER 1973
FEEDING RATE (FINGERS PER STEM DAMAGED PER DAY)
2.0
1.5
1.0
.5
0
5
10
15
20
25
30
35
40
45
50
AGE OF FRUIT (DAYS AFTER SHOOTING)

Figure 27

Leaf surveys: Leaf surveys were the primary survey method used in Colaspis studies in Changuinola. They provided a quick and convenient method for evaluating the current level of C. ostmarki populations in a given area. Fruit surveys, either at harvest or hanging fruit were time consuming and in the case of fruit cuts can only give information on past activity.

The survey method used consisted of counting all feeding holes on Leaf I on 20 unshot mats. The average for the 20 leaves is referred to throughout this report as the leaf index.

The beetles began to feed when the candela was still tightly furled, feeding on the outside of the candela. At this point the leaf was still very tender and was usually completely perforated. As the leaf unfurled, beetles entered and fed on both sides of the tubular leaf and the midrib. In areas of light to medium infestations the leaves seen from below usually showed marks on the right blade of the leaf looking upward toward the plant. Almost all feeding holes are found near the leaf tip. In severe infestations the whole leaf was perforated. For any given cable, the leaves were generally less damaged along roads, canals, and any open spaces. It appears that the beetles shunned the open exposed areas in favor of the darker interior of the planting.

Surveys on Experimental Areas at Farm 65: Since January 1974, cable by cable leaf surveys were conducted in Lakes 20 and 21, Farm 65, with less frequent surveys in Lake 22. The surveys were made to obtain data on seasonal activity fluctuations, population distribution, and a correlation between leaf damage and fruit damage.

Lake 20 and 21 were set aside and left untreated; Lake 22 was twice treated with dieldrin, in early January at the rate of 1 gal. AI/acre and in March at the rate of 2 gals.AI/acre.

Lake 21 was herbicided during this study while Lakes 20 and 22 both had the normal weed cover, cleaned periodically by machete. Also Lake 22 has been early bagged since the initiation of the study and Lakes 20 and 21 have been under normal bagging since October 1973 (Table 1).

There were very wide differences in leaf indices within this area of some 100 acres from a high of Cable 2 (200 marks/leaf) and a low of Cable 5 and 6 (10 per leaf). These differences have been maintained throughout the study. The inference is that populations are extremely localized, and the overall distribution is in the form of pockets of high and low activity. These pockets seem to be stable over a long period of time.

Herbicide and Ground Dieldrin Treatments Effect on Beetle Populations: The herbicide and grounddieldrin tests in Lakes 20, 21 and 22 were designed to measure the effect of weed cover and the direct effect of insecticide on beetle populations. The leaf indices for the dieldrin treated Lake 22 are very low by comparison with untreated Lakes 20 and 21. The peak area of activity lay between cables 1-4 of Lake 20. It seems unlikely that the dieldrin treatments accounted for the observed differences. Leaf indices as high as those noted in the untreated area have been seen in the other areas that were dieldrin treated. In the herbicide treated area of Lake 21, a lower level of beetle activity was observed than in Lake 20 which was not herbicide treated, but Lake 22 (dieldrin treated) had lower activity still. When the two Lakes were viewed together, high

Table 1. Pattern of Colaspis Feeding, Farm 65, Lake 20 & 21 - December 3-20, 1973

LAKE 20, CABLE 1

Hand	Marks per Finger	% Fingers Damaged	Marks per Damaged Finger
1	1.60	48.4	3.31
2	1.38	42.5	3.26
3	1.31	43.5	3.03
4	1.19	37.8	3.14
5	1.21	39.4	3.06
6	1.19	38.6	3.07
7	1.20	41.4	2.82
8	1.17	39.8	2.87
9	1.22	36.0	3.37
10	1.24	27.4	3.77
11	1.50	51.6	3.14

LAKE 21, CABLE 15

1	0.34	13.0	2.60
2	0.28	12.1	2.32
3	0.32	14.0	2.31
4	0.23	11.3	2.02
5	0.23	12.5	1.87
6	0.22	10.2	2.12
7	0.19	8.4	2.30
8	0.17	8.4	2.03
9	0.19	10.8	1.73
10	0.15	7.4	2.07

Adult emergence: Two types of emergence traps were used in the Colaspis studies in Changuinola. A total of 45 metal (Chiquita puree drums) traps were cut longitudinally with a small collecting jar at one end and placed in the area between Cables 1 and 4 of Farm 65, then were inspected weekly from October 2, 1973, to September 4, 1974. The second type was a cone made of wire screen with a collection jar at the top of the cone. A total of 100 traps of this sort were placed in 5 areas of Farm 65, Cables 1, 8, 9, 15 in groups of 20 and on the banks of the canal separating Lakes 20 and 21 in an area of mixed Gamalote and Wedelia trilobata. These traps were inspected weekly from March 8 through August 31, 1974. The screen traps each covered an area of 7.1 sq.ft; the drum traps 5.4 sq. ft.

The puree drum traps disclosed a weekly emergence of 360 beetles per acre per week (October 1973) to 3600 beetles/acre/week (December, 1973). Trends for adult emergence for both types of traps can be seen in Figure 28.

The emergence seemed to follow no definite seasonal pattern. Total emergence between individual traps was great. Apparently, the larvae are scattered rather than concentrated. Even the most prolific of the traps averaged only 1 beetle every 2 weeks. The traps kept in the same place for 11 months did not show any decline in capture. It appears that a good deal of subsurface larval migration took place or the larvae have the unlikely life span of over 11 months. A total of 314 beetles emerged over a period of 48 weeks, an average of 6.68 beetles/week for all traps. This would indicate an average weekly emergence in the neighborhood of 1,300 beetles/acre/week.

Screen cone trapping for Colaspis beetles adults. Farm 65, Changuinola, January-December 1974.

Cable	Total Beetles Captured	Av./week	Per acre per week	Av. leaf index Jan-Sept.	Type of weed cover
1	57	2.28	702.88	124.8	weedy
8	28	1.12	345.27	51.2	weedy
9	14	0.56	172.64	64.6	herbicide
15	16	0.64	197.30	32.8	herbicide

Note that Cable 1 with a leaf index roughly twice as great as that of Cable 8 had emergence almost double as well. Cable 8, with a leaf index slightly less than that of Cable 9, had double the number of beetles emerge. This could be interpreted as a difference due to herbicide treatments of Cable 9. This supposition ca be discounted because early in June when rank weed growth was covering the traps, all of the screen traps were herbicide treated. Yet, in the three months following the treatment, there was no decline in emergence from traps in the herbicided area.

Leaf Damage vs. Fruit Damage: The ultimate value of a leaf survey system lies in its ability to predict fruit losses. Fruit damage surveys at harvest time were taken at Farm 65 on Lake 20 and 21, with some data from Farm 15 in areas that were under normal bagging at the time of shooting. To make a correlation between fruit damage and leaf damage, the fruit damage was compared with a leaf survey taken in the period between shooting and the first months of age (Table 2).

TOTAL COLASPIS OSTMARKI ADULTS EMERGENCE FROM WIRE SCREEN AND PUREE DRUM TRAPS – FARM 65, CHANGUINOLA, PANAMA.

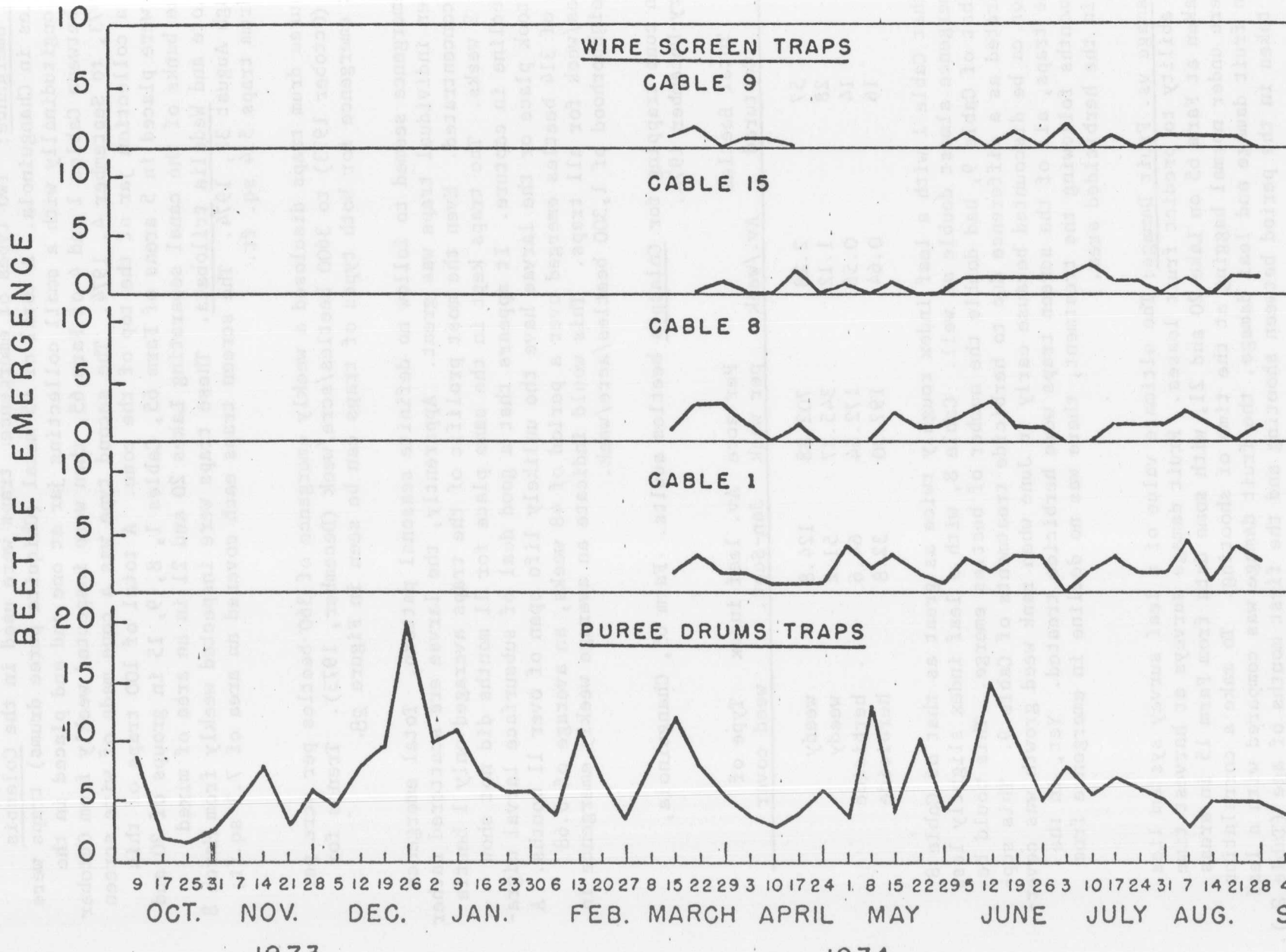


Table 2. Correlation Between Leaf Index and Fruit Damage. Farm 65, Lakes 20 & 21 and Farm 15. Changuinola Panama. January, March and April, 1974.

Leaf Index	Fingers Damaged Per Stem (average)	Std. Dev.	Sample size (stems)	Date of bagging	Cable	Farm
244.7	35.3	10.0	8	Mar 10	2	65
244.7	29.6	14.3	28	Mar 17	2	65
180.2	32.3	14.9	39	Mar 17	3	65
179.4	34.6	16.5	20	Jan 3	2	65
160.1	18.1	14.0	10	Mar 17	1	65
143.9	42.9	30.3	20	Jan 3	1	65
115.6	19.5	10.3	58	Mar 17	4	65
99.8	25.9	21.3	20	Jan 3	11	65
76.5	1.2	1.2	20	Jan 3	15	65
69.1	17.6	11.9	15	Jan 3	10	65
65.0	3.3	4.5	26	Mar 17	15	65
55.3	13.8	14.5	20	Jan 3	9	65
53.5	9.9	10.0	82	Mar 17	7	65
52.8	19.6	11.0	20	Jan 3	8	65
50.5	11.1	13.0	78	Mar 17	8	65
50.1	24.7	18.0	20	Jan 3	14	65
48.9	10.9	4.9	15	Mar 10	11	65
48.9	8.8	8.9	25	Mar 17	11	65
44.4	13.6	15.5	20	Jan 3	7	65
39.9	4.0	6.2	20	Apr 14	102	16
39.9	13.1	11.6	20	Apr 21	102	15
37.8	7.9	8.4	21	Mar 17	10	65
29.1	1.7	2.6	20	Mar 17	12	65
22.6	1.5	2.0	25	Apr 14	114	15
22.6	1.0	1.5	48	Apr 21	114	15
17.7	4.7	6.4	40	Mar 17	5	65
15.2	5.8	9.2	73	Mar 17	6	65
9.8	7.1	11.1	9	Mar 17	14	65
63.0	2.1	2.9	15	Mar 10	9	65
63.0	5.1	8.9	75	Mar 17	9	65

Microhabitats and Environmental Factors: The population distribution for Colaspis ostmarki is found in pockets of high and low activities with gradients of level of activity in between. These population differences tend to be stable in the sense that the proportional differences remain constant over long periods of time.

Colaspis ostmarki seemed to be almost entirely confined to bananas plantations. In the abandonments and areas surrounding the farms, the beetles were never found, even when alternate hosts were present. Although the beetles flew efficiently, they are not what one would consider strong fliers. Emergence trap data tend to show that adults do not fly far from the site of larval development. Areas with high beetle populations tended to be shady with tall robust plants, and a dense canopy. "Hot spots" never occurred in the areas of poorer growth with more open spaces and more light coming through the canopy. An attempt was made to quantify this observation. Measurements of pseudostem diameter, plant height, and number of erect green leaves were taken for selected cables of Farm 65 and 62. (Table 3).

For none of the three factors does there appear to be any correlation with leaf index.

Soil samples taken from selected cables in Farm 65 for chemical and mechanical analysis at a 12 inches depth did not appear to show any relationship to leaf indices.

Attractants: During a two month period, 34 chemicals of known attractiveness to certain insects were screened in Farm 65 for attraction of Colaspis ostmarki. The list of chemicals used is shown in Table 3A.

One gram samples of the chemicals were provided by Dr. Milton Beroza of the USDA facility in Beltsville, Maryland. Ellisco japanese beetle traps were used for field testing. Because of the large number of chemicals to be screened and the limited number of traps, the chemicals were divided into 7 groups, each group run for a period of a week. Every run consisted of 4 replicates of each of the chemicals plus 4 empty traps as controls. The traps were hung from unshot mats at fruit height about 2 feet away from the stem. The traps were set out along Cable 2 in groups of 6, each group consisted of 5 treatments besides the control. This cable was chosen because of consistently high leaf indexes. Every trap contained 0.25 grams of the chemical impregnated in a small piece of cotton dental wick. In none of the trials were any large number of beetles captured. In most of the runs the empty traps with no attractant captured as many as the treatments. There was no indication that any of the chemicals screened showed any attraction at the concentrations used.

Another trial was conducted in June, 1974, with larger quantities of 10 chemical screened in the first trial provided by Dr. Beroza. This time half of the traps in both of the two tests were hung at one meter above ground and fruit level to test for the effect of height on attraction (Table 4). Each of the traps contained a 5 ml sample of the chemical in a corked vial with a slow release wick to prevent rapid loss of the more volatile chemicals.

Even at higher concentrations none of the attractants screened showed any

Table 3A Chemicals Screened Using Japanese Beetle Attractant Traps for Luring Colaspis ostmarki. Changuinola, Panamá - Feb.21-April 25, 1974.

ENT number	Chemicals
28569	Hexyl-acetate
5089	Butyl sorbate
2729	Pentyl acetate
32962 b	2,4 Hexadienyl acetate
33180 c	2,4 Hexadienyl hexanoate
2954 (3-4-70)	Phenethyl butyrate
21486 b	Siglure
33181 c	2,4 Hexadienyl valerate
18544	Phenethyl propionate
26022 b	Ehtyl 1,4 benzoa coxan-2-carboxylate
33951	Amlure
30992 g	Medlure
14189	Methylcyclohexane propionate
2458 (8-12-68)	Ethyl beta-methyl-beta-phenyl glycilate
380	Anethole
33625 d	Octyl 2-methylbutyrate
31012	Ethyl chrysanthemumate
32960 e	2,4 Hexadienyl butyrate
576	Isopentyl acetate
34392 b	Cis-3-hexenyl acetate
18544 / 86	Phenethyl propionate and eugenol (7:3)
3439 b	Trans-2-hexenyl acetate
24202	Octyl butyrate
6124 (7-10-73)	Pentyl butyrate
21505 (7-30-69)	Heptyl butyrate
2954 / 86	Phenethyl butyrate and eugenol (7:3)
21040	Methyleugenol
31833	Cuelure
21466 b	Chrislure
7356 (12-1-67-2)	Ethyl 3-phenylglycidate
31560	Trimedlure
TPM 8-192-1	Prenyl acetate
14189 / 86	Methylcyclohexane propionate and eugenol (7:3)
33624 a	Heptyl 2-methylbutyrate

Table 3. Plant Height, Pseudostem Diameter, Erect Green Leaves and Colaspis ostmarki Incidence. Farm 65, Lakes 20 and 21 - Changuinola, Panamá.

Cable	Av. Leaf Index	Plant Ht.(ft)	Grm. Lvs.	PSD (cm)	PSD (in)
2	211.7			21.7	8.55
3	144.7				
1	124.8	12.9	9.9	24.5	9.66
4	115.2	11.4	8.8	22.2	8.75
7	70.7	11.5	7.9	22.0	8.67
9	64.6	11.2	9.0	20.9	8.24
8	51.2	11.9	10.5	20.6	8.12
11	47.9	11.6	8.1	21.5	8.48
13	47.7	12.1	10.5	22.3	8.79
10	40.5	10.7	7.5	19.4	7.65
12	36.5	10.6	7.6	19.4	7.65
15	32.8	12.1	10.9	23.8	9.38
14	26.1				
6	18.4	11.2	7.5	21.0	8.28
5	13.1			20.2	7.96

Data on plant height, stem diameter and erect green leaves was taken June 3-7, 1974. Sample size is 40 shot mats per cable.

Periodic leaf surveys have been taken from January-August 1974. The leaf index shown in the table is the average value for all sample dates.

ble 4. Results of Chemicals Screened as Possible Attractants for Colaspis ostmarki. Farm 65, Changuinola, Pa. - July 2-9, July 24-Aug. 3,1974.

DATE:	July 2-9, 1974[1/]			July 24-Aug.3, 1974[1/]	
ractants	Fruit height	1 meter height	Attractants	Fruit heights	1m. heights
. No. 7356	0	3	Ent. No. 576	0	0
. No. 31560	2	0	Ent. No.2954	2	1
. No. 2729	2	1	Ent. No.6124	1	0
. No. 21040	0	0	Ent. No.31833	3	0
. No. 31012	1	0	Ent. No.35970	1	0
al	5	4	Total	7	1
trol	2	0	Control	0	0

1/ Each trial consisted of two replicates.

Biological Control: No predation was observed outdoors, although likely suspects attacked and fed on Colaspis ostmarki in captivity. Two reduviids species are commonly found in young banana stems. One is already identified as Repipta sp. near fuscipes. When caged with Colaspis beetles in the laboratory they fed on them.

Another group of suspects are the small tree frogs which are often found in young bananas together with the beetles. As in the case with the reduviids, they will feed on Colaspis in captivity. One frog caught outdoors and kept in the laboratory for observation defecated a complete elytrum and several other sclerotized pieces of Colaspis ostmarki.

Nothing has been observed in the field in the way of larval or egg predators. However, in rearing attempts in the insectary when the eggs were placed in pots with small banana plants, ants were observed feeding on the eggs. It would seem very likely that something similar on occasions occurs under field conditions.

No evidence of parasites or pathogens was seen in either field collected larvae or adults.

Bagging for Fruit Protection: Several experiments with different type bags and variations of bagging cycles were conducted as a means of fruit protection. It should be noted that a bagging scheme does not control Colaspis ostmarki populations, since beetle populations can survice on candelas alone. The protection of fruit by bagging may have some effect on the size of the population by excluding one source of adult food, but the major effect was to change the overall feeding pattern of the adults.

Dursban ribbon bags: Experiments were set up to further investigate the performance of Dursban impregnated bags cut into ribbons to allow dehisced bracts fo fall unaided. In the 3 experiments to test the effectiveness of Dursban the same procedure was used. Recently shot plants were tagged, then bagged in Farm 65, Lakes 20 and 21. The stems were checked for damage at the time of bagging and again one month later. All ribbons bags were knotted at the bottom (Table 5).

Experiment 1 was designed to compare the effectiveness of 1% and 2% Dursban polyethylene bags cut into 4-inch ribbons. The results show that Dursban ribbon bags gives good protection against Colaspis beetles. There was no statistically significant difference between the two concentrations of insecticide; nor between untreated plastic ribbons and no bag.. Since the ribbons actually cover very little of the stem, it would seem that Dursban has either a repellent or fumigant effect.

In Experiment 2 the 1% Dursban bags were cut into ribbons of various widths to see if some sort of compromise could be reached between bract dehiscence and fruit coverage. Bags were cut into 2 (32"), 4 (16"), 8 (8"), and 16 (4") ribbons. Ten bags of each type were set out along with 10 unbagged stems as controls. Since the controls were subsequently early bagged by the Farm crew, the control became early bags. Bracts fell normally without adjustment on

Table 5: Results of Dursban Bagging Experiments

Dursban Experiment I, September 13th-October 15th, 1973

	Treatments			
	1% Dursban	2% Dursban	0% Dursban	No bag
Average [1]	1.42	2.33	18.08	24.17
Std. dev.	1.38	5.11	17.29	19.39
Sample size	12	12	12	12
95% confidence	2.30	5.58	29.07	36.49
Interval	0.54	0.00	7.09	11.85

1) Information given in number of marked fingers per stem average age at bagging, 6.5 days.

Dursban Experiment II, October 31st-November 30th, 1973

	Treatments				
	2 ribbons	4 ribbons	8 ribbons	16 ribbons	Early bag
Ave. fingers with damage	14.40	16.25	11.54	17.72	21.15
% fingers damaged	28.6	27.1	21.4	30.2	37.0
Std. dev.	17.7	23.0	1.47	23.9	29.2
Sample size	7	10	8	10	13
95% confidence	45.0	43.6	33.7	47.3	54.6
Interval	12.2	10.6	9.1	13.1	19.4

Average age at bagging - 4.5 days. All bags, 1% Dursban.

Dursban Experiment III, November 7th-December 7th, 1973

	Treatments	
	1% Dursban ribbon bags	No bags
Ave. damaged fingers	14.71	54.14
% fingers damaged	7.66	26.37
Std. dev.	13.61	35.16
Sample size	45	42
95% confidence	18.80	65.11
Interval	11.63	43.17

Average age at bagging - 5.6 days.

the bags of 4, 8, and 16 ribbons; in the two strip bags the upper bracts tended to stick. In almost all cases the bag was caught up by the curling bracts and the knot was lifted above the bud's point. When all the bracts fell, the bag had effectively been moved to one side of the stem, by the action of the bracts, not by the wind or Farm crew as had previously suspected. Leaf scarring was noted in most cases. This is the main objection to ribbon bags. While they allow the bracts to dehisce, they offer very little physical protection to the fruit. No significant difference is shown in the effectiveness of control between any of the treatments, nor is any significant difference shown between any of the treatments and the early bagged controls.

Experiment 3 is an outgrowth of experimen 1 using 1% Dursban bags on a larger scale with no bags for control. Again Dursban was proven to effectively protect the fruit.

Evaluation of Two Cycle Early Bagging: Early bagging involved 3 bagging cycles per week. In theory, fruit should be bagged when the first and second hands have begun to open at age 7-8 days. In practice it is bagged when the bud first clears the petioles at age 5-6 days.

An experiment was set up in Farm 15 from March-June 1974, to test the effects on beetle damage between the various programs of bagging. Seven cables were selected: Cables 101-104, and Cables 113-115. At the beginning of the experiment all the cables in question and the surrounding ones were under a 3 cycle early bagging program (1 cycle/week, stems bagged when all hands are open and all bracts fallen), Cables 103 and 115 were placed on a two cycle early bagging program and Cables 101, 104, 113, and 115 were left on 3 cycles early bagging. Fruit was inspected at harvest for beetle damage.

Starting March 9 and continuing until July 5, periodic leaf surveys were taken of these cables and adjacent ones to keep tabs on the beetle activity (Figure 29).

The leaf indices of Cables 113-115 remained fairly similar for the duration of the surveys. For Cables 101-104 the situation was somewhat different. While the initial survey showed approximately equal leaf indices for all 4 cables, after the change in bagging programs, Cable 102 (on nomral bagging) separated from the other three.

In Cables 113-115, there was little difference in fruit damage between any of the treatments. In the second group, fruit damage from Cable 102 showed a sharp increase which would be expected since normal bagging offers little or no protection against beetle attack. Cable 103, with the two cycle program, showed fruit damage that was not significantly different from that of the two cables (101, 104) on the three cycles. As a matter of fact, the damage from Cable 104 on the 3 cycles was consistently higher. This cannot be accounted for by a difference in resident beetle populations since leaf indices for Cables 103 and 104 are approximately the same throughout the course of the leaf surveys. Apparently in Cables 113-115 there was not enough beetle activity for the differences between the treatments to show up.

The inference is that in terms of fruit damage, the third bagging cycle is superfluous. However, a side effect of 2 cycles bagging is that the fruit

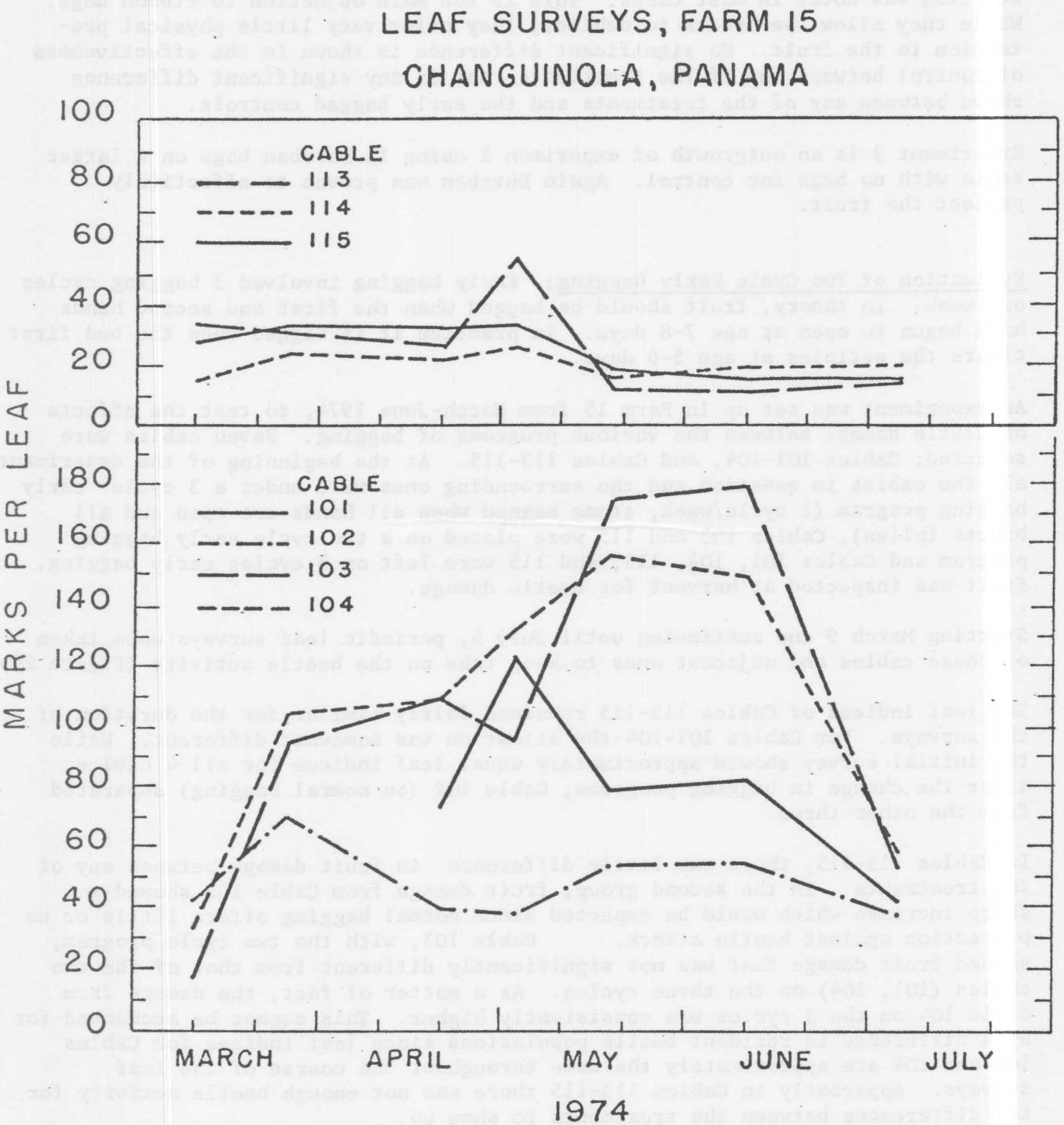

LEAF SURVEYS, FARM 15
CHANGUINOLA, PANAMA
MARKS PER LEAF
CABLE
113
114
115
CABLE
101
102
103
104
100
80
60
40
20
0
180
160
140
120
100
80
60
40
20
0
MARCH
APRIL
MAY
JUNE
JULY
1974

Figure 29

leaves the farm much dirtier because of the longer period that the bracts stay inside the bags. The dirty appearance of the fruit might negate the costs savings of eliminating the bagging cycle.

Colaspis Survey: In April, 1974, a leaf survey was taken over most of the Bocas Division to appraise the Colaspis beetle situation. The inspections were conducted by Roberto Barnett. There were approximately 600 acres considered medium to severe based on leaf damage, 1,8000 with at least a trace of damage, and 4,000 clean, from a total of 6,600 acres inspected.

Early bagging techniques: Early bagging protected the fruit from Colaspis beetles over an area of more than 1,000 hectares. Costs were high, the workers made three passes per week through each inspected area (at $3.20 per cycle per week) to adjust bags, remove bracts, debud and dehand.

A test using dried Camalote grass hoops was conducted to keep the bags open allowing the deshisced bracts to fall free (Figure 30). Similar work in La Lima, Honduras, kept the bags open more than four weeks when the grass was clipped or attached through the holes of the bags, about 8-10 inches from the bottom. Dried camalote hoops (16-18" diameter), fastened to 20 early bags in Farm 65, Lake 20, did not work at all. Bracts turned up the bag sides, the hoops lifted and remained in a slanted position obstructing the passage of loose bracts.

Alvaro Espinoza suggested that a V shaped banana petiole (Figure 31) could replaced camalote hoops. A 47" section of midrib was cut from the petiole end and bent in the middle.

A total of 15 bags with midribs V's were observed for 6 days. A total of 73% of the bracts fell through; 10% remained loose but stuck inside: 17% were loose but trapped along the bag walls. Only two midrib V's became detached from the bags.

Another test was conducted by Alvaro Espinoza (May 17th) with 150 early bagged stems with the same "V" midrib technique. Each bag was evaluated at dehanding time. A total of 74% of the bags produced clean fruit with no trapped bracts and the remaining 26% head a few dry caught on the upper hands. In all cases, the fruit was clean and the bracts inside were dry. Colaspis damage was also evaluated. In 20 stems an average of 2 damaged fingers per stem were found.

There is some promise in using this V devise; the economical aspect of such method has to be studied. The operation is done at the time the fruit is early bagged. The midrib V is heavy, the bag takes a triangular shape on account of its weight, and the spring action maintains the walls tense and open

Figure 30: Dried Camalote hoop fastened to the bag's bottom, used in Honduras. Note releasing of all bracts and inflorescense ready to debudding.

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VALERY vs. Grand Nain Plant Population Density Study - Laurel Farm, Honduras

This experiment was completely destroyed by Hurricane Fifi 4 years and 6½ months from planting. During this period, the area was also subject to two other major windstorms; the first on November 20, 1971, and the second on May 28, 1973.

The shooting and harvesting performance, of the various crops, in Grand Nain and VALERY are given in Table 1. Shooting in both varieties was completed only in six crops and in all population treatments. In the 7th crop, shooting was only completed in the two lowest plant densities. The difference in percent shot among population treatments and between varieties, for the first six crops, reflect primarily the losses of plants without fruit during the two blowdowns mentioned above. The effect of the windstorms is also shown on the recovery (percent harvested) obtained. Normal fruit losses are also included. As an average of all population densities, the cumulative losses/acre with fruit were 740 and 762 stems in Grand Nain and VALERY, respectively. These losses represent all normal and blowdown losses, including those registered during "Fifi". The wind resistance exhibited by Grand Nain is well illustrated by its shooting and harvesting performance.

There was a difference in the shooting pattern between the two cultivars. Grand Nain came to shooting faster than VALERY. An increase in plant density resulted in the lengthening of the time elapsed between the shooting of crops. Table 2 shows the effect of variety and plant density on the average number of days between shooting of crops.

With regard to fruit bunches shot, Grand Nain outyielded VALERY by an average of 12%. Differences between varieties and among plant populations were significant at the 99% probability level. There were no significant interactions between populations and varieties. Table 3 shows the cumulative production of stems shot during the period. These values refer to stems shot per net acre of bananas. The average annual stems shot per acre was as follows:

	Plant Density, P.U./A				
Variety	456	503	621	696	786
	Average Stems Shot/Gross Acre/Year				
Grand Nain	795	841	957	1,032	1,092
VALERY	717	745	858	926	979
% Difference	10.8	12.8	11.5	11.4	11.5

Table 1

Shooting and Harvest Performance of Grand Nain and VALERY Bananas at Five Plant Population Densities[1/]

	Grand Nain					VALERY				
	Population Density, P. U./Acre					Population Density, P. U./Acre				
	456	503	621	696	786	456	503	621	696	786
	Percent Shot Through September 19, 1974[2/]									
la	99.7	99.7	100.0	99.4	99.1	100.0	99.7	99.7	100.0	100.0
on	100.0	100.0	100.0	99.4	100.0	99.7	99.1	99.7	99.4	98.1
on	99.4	98.4	99.7	99.7	99.7	84.3	65.1	69.5	70.1	78.6
on	99.7	99.7	100.0	100.0	98.7	94.3	98.7	98.1	96.5	95.3
on	99.7	99.4	99.7	97.5	96.9	98.1	92.8	75.2	67.6	67.6
on	97.2	99.1	99.1	99.1	96.9	59.4	65.7	86.5	92.8	89.9
on	99.7	99.7	90.3	72.3	39.3	97.2	98.4	84.6	72.3	35.2
on	85.5	62.3	11.3	6.3	.3	78.0	52.8	14.2	5.7	.9
on	11.0	1.3	---	---	---	3.5	.6	---	---	---
	Percent Harvested Through September 19, 1974[2/]									
la	99.4	96.5	98.7	97.2	96.9	97.8	96.2	94.7	95.9	99.5
on	98.4	93.1	95.6	93.1	93.1	95.9	95.3	93.4	85.5	83.6
on	91.8	91.2	95.3	94.3	95.6	60.4	45.0	56.3	62.3	70.8
on	96.5	89.3	93.1	84.9	83.6	86.8	93.4	89.3	86.8	82.1
on	78.6	69.2	82.4	82.4	81.1	79.2	73.3	49.1	45.0	56.3
on	76.4	81.1	89.3	85.2	72.3	38.4	58.5	76.4	81.4	62.9
on	83.0	72.3	39.9	18.6	3.5	85.8	77.4	34.9	21.4	5.3
on	29.2	13.5	.6	---	---	34.9	7.5	.9	---	---

g a period of four years 6½ months from planting.

ssed as percentage of plant population density.

Table 2

Effect of Variety and Plant Density on the Average Days Elapsed Between Shooting of Crops

Variety	Plant Density	Crop 1 to 2	Crop 2 to 3	Crop 3 to 4	Crop 4 to 5	Crop 5 to 6	Crop 6 to 7	Crop 7 to 8
		Shoot to Shoot Time - Days						
Grand Nain	456	199	182	211	183	206	177	209
	503	207	190	217	198	208	196	218
	621	228	218	226	228	210	235	219
	696	238	229	231	243	222	237	219
	786	249	250	239	252	244	243	217
VALERY	456	205	197	212	191	211	180	227
	503	217	212	206	206	211	210	241
	621	240	240	221	239	211	249	250
	696	252	255	229	249	215	256	258
	786	269	275	251	254	250	270	287

Table 3

Effect of Variety and Population Density on the Number of Fruit Bunches Shot[1/]

Variety	Plant Population Density[2/] 456	503	621	696	786	Variety Means
	Fruit Bunches/Acre					
Grand Nain	3,610.7	3,820.0	4,347.0	4,688.2	4,958.2	4,284.8
VALERY	3,257.8	3,385.0	3,895.8	4,206.7	4,446.7	3,838.4
Population Means	3,434.3	3,602.5	4,121.4	4,447.5	4,702.5	

[1/] From planting in February 18-27, 1970 through September, 1974.

[2/] Production units per acre.

Least Significant Difference	.01	.05
1) Between variety means	79.0	50.4
2) Between two population means	80.0	59.8
3) Between two population means in same variety	113.1	84.5
4) Between variety means for a given population	126.3	90.4

Coefficient of Variation

For varieties 1.8%

For populations 1.9%

Based on the stems shot per acre, the average bunches shot per production unit per year was higher in Grand Nain than in VALERY. Plant population increments, however, resulted in a gradual decrease in bunches shot per production unit in both varieties.

Variety	Plant Density, P.U./A				
	456	503	621	696	786
	Average Stems Shot/P.U./Y				
Grand Nain	1.74	1.67	1.54	1.48	1.39
VALERY	1.57	1.48	1.38	1.33	1.25
Difference	.17	.19	.16	.15	.14

The effect of variety and plant population density on cumulative stems harvested per acre are shown in Table 4. The difference between the two varieties, as an average of all plant densities, was highly significant. The stems harvested in Grand Nain over VALERY at any plant population were also significant at the 99% probability level. In an ascending order of population, the amount of fruit harvested in Grand Nain was 13, 11, 20, 16 and 15 percent higher than in VALERY. Except for 456 vs. 503 and 621 vs. 696, all comparisons between plant densities in both cultivars were highly significant. The 456 vs. 503 comparison was not significant, while the 621 vs. 696 was significant only at the 95% probability level.

The average annual production of fruit bunches was:

Variety	Plant Density, P.U./Acre				
	456	503	621	696	786
	Average Stems Harvested/A/Y				
Grand Nain	657	671	814	851	911
VALERY	582	606	677	733	790
% Difference	12.8	10.7	20.2	16.1	15.3

Differences in stems shot and harvested between the two varieties are influenced by blowdown losses. However, a good portion of this difference is attributed to the ratooning speed differential between the two cultivars. Ratooning speed is indicated by the number of stems shot and harvested per production unit. An increase in plant density results in a decrease in stems shot or harvested per production unit per year. The average

Table 4

Effect of Variety and Population Density
on the Number of Fruit Bunches Harvested[1/]

Variety	Plant Population Density[2/] 456	503	621	696	786	Variety Means
	Fruit Bunches/Acre					
Grand Nain	2,982.7	3,046.5	3,694.8	3,867.3	4,135.2	3,545.3
VALERY	2,644.2	2,750.7	3,073.7	3,329.0	3,586.5	3,076.8
Population Means	2,813.5	2,898.6	3,384.3	3,598.2	3,860.9	

[1/] From planting in February 18-27, 1970 through September, 1974.

[2/] Production units per acre.

Least Significant Difference

1)	Between variety means	239.7	152.8
2)	Between two population means	182.0	136.0
3)	Between two population means in same variety	257.4	192.4
4)	Between variety means in same population	326.0	228.6

Coefficient of Variation

For varieties	7.0%
For populations	5.0%

number of stems harvested per "mat" per year was:

Variety	Plant Density, P.U./Acre 456	503	621	696	786
	Average Stems Harvested/P.U./Y				
Grand Nain	1.44	1.33	1.31	1.22	1.16
VALERY	1.28	1.20	1.09	1.05	1.00
Difference	.16	.13	.22	.17	.16

Tables 5, 6 and 7 give the field losses with fruit, normal losses without fruit, and total losses with and without fruit, respectively, which occurred during the 54½-month period. The latter table includes both normal and blowdown losses with and without fruit. Because of the 100% destruction of the experimental area by the hurricane, the significant difference in fruit losses previously observed between the two varieties disappeared. The breakdown of fruit losses by cause is given in Table 8. The main cause of normal losses in both cultivars is doublings. The percent of doubling losses based on total losses, excluding blowdowns, was 87 in Grand Nain and 67 in VALERY. When blowdowns are included doublings amount to 44 and 20 percent, respectively, in Grand Nain and VALERY. Losses due to uproots were essentially the same in both varieties. Breakneck losses were two-fold in VALERY than in Grand Nain. As an average of plant population, blowdown losses of fruit were 46% higher in VALERY than in Grand Nain.

As an average of all plant densities, Grand Nain outyielded VALERY by about 19%. Of the ten possible comparisons between population densities in the same variety, only six were significant (Table 9). Gross yield differences between the two cultivars and at the same level of population show that Grand Nain outyielded VALERY by 16, 16, 24, 21 and 18 percent at the treatments of 456, 503, 621, 696 and 786 production units/acre, respectively. The only adjacent treatments that were significant in both varieties were the 503 vs. 621 production units/acre. When the gross yield, recorded during the 54½-month period is converted to annual production estimates, the following figures are obtained:

Variety	Plant Density, P.U./Acre 456	503	621	696	786
	Gross Yield/Acre/Year - Tons				
Grand Nain	32.01	31.84	36.57	37.48	37.76
VALERY	27.57	27.39	29.39	30.98	31.96
Difference	4.44	4.45	7.18	6.50	5.80

Table 5

Effect of Variety and Population Density on Plant Losses With Fruit[1]

Variety	Plant Population Density[2]					Variety Means
	456	503	621	696	786	
	Plants or Bunches/Acre					
Grand Nain	628.0	773.5	652.2	820.8	823.0	739.5
VALERY	613.7	634.3	822.2	877.7	860.2	761.6
Population Means	620.9	703.9	737.2	849.3	841.6	

[1] From planting in February 18-27, 1970 through September, 1974.

[2] Production units per acre.

Least Significant Difference	.01	.05
1) Between variety means	NS	NS
2) Between two population means	144.5	108.0
3) Between two population means in same variety	204.3	152.7
4) Between variety means in same population	NS	NS

Coefficient of Variation

For varieties	22.8%
For populations	17.4%

Table 6

Effect of Variety and Population Density on Plant Losses Without Fruit[1] (Normal)

Variety	Plant Population Density[2] 456	503	621	696	786	Variety Means
	Plants/Acre					
Grand Nain	23.0	14.2	11.7	32.8	52.0	26.7
VALERY	35.8	38.0	37.2	56.8	103.8	54.3
Population Means	29.4	26.1	24.5	44.8	77.9	

[1] From planting in February 18-27, 1970 through September, 1974.

[2] Production units per acre.

Least Significant Difference	.01	.05
1) Between variety means	20.4	13.0
2) Between two population means	26.1	19.5
3) Between two population means in same variety	36.9	27.6
4) Between variety means in same population	38.3	27.7

Coefficient of Variation

For varieties 48.3%

For populations 58.3%

Table 7

Effect of Variety and Population Density
on Total Plant Losses With and Without Fruit[1/]

Variety	Plant Population Density[2/] 456	503	621	696	786	Variety Means
	Plants/Acre					
Grand Nain	1,056.8	1,290.7	1,284.8	1,551.8	1,663.5	1,369.5
VALERY	1,359.3	1,547.0	1,894.3	2,088.0	2,155.3	1,808.8
Population Means	1,208.1	1,418.9	1,589.6	1,819.9	1,909.4	

[1/] From planting in February 18-27, 1970 through September, 1974.

[2/] Production units per acre.

Least Significant Difference	.01	.05
1) Between variety means	184.2	117.5
2) Between two population means	196.5	146.9
3) Between two population means in same variety	277.5	207.4
4) Between variety means in same population	304.3	218.4

Coefficient of Variation

For varieties 11.1%

For populations 11.2%

Table 6

Effect of Variety and Population Density on Plant Losses Without Fruit[1] (Normal)

Variety	Plant Population Density[2] 456	503	621	696	786	Variety Means
	Plants/Acre					
Grand Nain	23.0	14.2	11.7	32.8	52.0	26.7
VALERY	35.8	38.0	37.2	56.8	103.8	54.3
Population Means	29.4	26.1	24.5	44.8	77.9	

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Variety	Plant Population Density[2] 456	503	621	696	786	Variety Means
	Plants/Acre					
Grand Nain	23.0	14.2	11.7	32.8	52.0	26.7
VALERY	35.8	38.0	37.2	56.8	103.8	54.3
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[1] From planting in February 18-27, 1970 through September, 1974.

[2] Production units per acre.

Least Significant Difference	.01	.05
1) Between variety means	20.4	13.0
2) Between two population means	26.1	19.5
3) Between two population means in same variety	36.9	27.6
4) Between variety means in same population	38.3	27.7

Coefficient of Variation

For varieties 48.3%

For populations 58.3%

Table 7

Effect of Variety and Population Density on Total Plant Losses With and Without Fruit[1/]

Variety	Plant Population Density[2/]					Variety Means
	456	503	621	696	786	
	Plants/Acre					
Grand Nain	1,056.8	1,290.7	1,284.8	1,551.8	1,663.5	1,369.5
VALERY	1,359.3	1,547.0	1,894.3	2,088.0	2,155.3	1,808.8
Population Means	1,208.1	1,418.9	1,589.6	1,819.9	1,909.4	

[1/] From planting in February 18-27, 1970 through September, 1974.

[2/] Production units per acre.

Least Significant Difference	.01	.05
1) Between variety means	184.2	117.5
2) Between two population means	196.5	146.9
3) Between two population means in same variety	277.5	207.4
4) Between variety means in same population	304.3	218.4

Coefficient of Variation

For varieties 11.1%

For populations 11.2%

Table 8

Breakdown of Field Losses from Planting
February 18-27, 1970 through September 19, 1974

Variety	Plant Density	Fruit Field Losses/Acre					
		Doubling	Uproot	Break-neck	Blowdown	Others	Total
Grand Nain	456	314.0	5.7	2.8	285.3	20.2	628.0
	503	398.7	9.5	4.7	327.5	33.1	773.5
	621	220.7	7.8	3.8	378.8	41.1	652.2
	696	324.0	4.3	19.7	450.8	22.0	820.8
	786	365.8	14.8	17.2	383.2	42.0	823.0
	Mean	324.6	8.4	9.6	365.1	31.8	739.5
VALERY	456	170.7	4.3	15.7	401.5	21.5	613.7
	503	121.8	0.0	6.3	473.0	33.2	634.3
	621	140.5	15.7	17.7	599.5	48.8	822.2
	696	144.5	8.8	21.8	632.5	70.1	877.7
	786	190.3	12.3	44.5	561.2	51.9	860.2
	Mean	153.6	8.2	21.2	533.5	45.1	761.6

Table 9

Effect of Variety and Population Density on Gross Yield[1/]

Variety	Plant Population Density[2/] 456	503	621	696	786	Variety Means
	Tons/Acre					
Grand Nain	145.4	144.6	166.1	170.2	171.5	159.6
VALERY	125.2	124.4	133.5	140.7	145.1	133.8
Population Means	135.3	134.5	149.8	155.5	158.3	

[1/] From planting in February 18-27, 1970 through September, 1974.

[2/] Production units per acre.

Least Significant Difference	.01	.05
1) Between variety means	13.7	8.7
2) Between two population means	10.1	7.5
3) Between two population means in same variety	14.2	10.6
4) Between variety means in same population	18.4	12.8

Coefficient of Variation

For varieties 9.0%

For populations 6.2%

Gross yield data at the various levels of population indicate that in both cultivars maximum annual returns are obtained at 621 production units/acre.

Yield in terms of tons/acre of net fruit, CHIQUITA, Specials, and fruit waste are given in Tables 10, 11, 12 and 13, respectively. At all population levels, differences in tons of CHIQUITA produced between the two cultivars were highly significant. The yield difference between the two varieties, from the lowest to the highest population treatments, were 19, 18, 29, 22 and 19 percent, respectively. The degree of significance between two plant densities for the two varieties is given below:

Comparison	Grand Nain	VALERY
456 vs. 503	NS	NS
456 vs. 621	**	NS
456 vs. 696	**	*
456 vs. 786	**	**
503 vs. 621	**	NS
503 vs. 696	**	*
503 vs. 786	**	**
621 vs. 696	NS	NS
621 vs. 786	NS	NS
696 vs. 786	NS	NS

NS= Not significant.
* = Significant at 95% level.
**= Significant at 99% level.

The yield of Specials was essentially the same for both cultivars at any level of plant density. Increasing plant density resulted in an increase in the amount of fruit packed as Specials. Differences in yield of Specials between adjacent treatments were not significant (Table 13).

The amount of fruit waste, recorded during the 54½-month period, was proportional to the volume of fruit harvested. Consequently, a higher waste was obtained with an increase in plant density. Grand Nain produced a higher waste tonnage because of the higher number of stems harvested.

Each increment in plant density resulted in a slight decrease in percent of CHIQUITA (as % of net fruit). On the other hand, the percent of Specials and fruit waste was also increased with population.

Table 10

Effect of Variety and Population Density on Net Yield[1/]

Variety	Plant Population Density[2/] 456	503	621	696	786	Variety Means
	Tons/Acre					
Grand Nain	132.4	131.9	151.9	155.6	157.1	145.8
VALERY	114.1	113.5	121.9	128.6	132.8	122.2
Population Means	123.3	122.7	136.9	142.1	145.0	

[1/] From planting in February 18-27, 1970 through September, 1974.

[2/] Production units per acre.

Least Significant Difference	.01	.05
1) Between variety means	12.5	8.0
2) Between two population means	9.2	6.9
3) Between two population means in same variety	13.1	9.8
4) Between variety means in same population	16.8	11.8

Coefficient of Variation

For varieties 9.0%

For populations 6.2%

Table 11

Effect of Variety and Population Density on Yield of CHIQUITA[1/]

Variety	Plant Population Density[2/] 456	503	621	696	786	Variety Means
	Tons/Acre					
Grand Nain	109.1	107.9	124.3	123.9	123.9	117.8
VALERY	91.9	91.2	96.5	101.4	104.0	97.0
Population Means	100.5	99.6	110.4	112.7	114.0	

[1/] From planting in February 18-27, 1970 through September, 1974.

[2/] Production units per acre.

Least Significant Difference	.01	.05
1) Between variety means	11.1	7.0
2) Between two population means	8.0	6.0
3) Between two population means in same variety	11.3	8.4
4) Between variety means for a given population	14.7	10.2

Coefficient of Variation

For varieties 9.9%

For populations 6.7%

Table 12

Effect of Variety and Population Density on the Yield of Specials[1/]

Variety	Plant Population Density[2/] 456	503	621	696	786	Variety Means
	Tons/Acre					
Grand Nain	11.9	12.2	13.7	16.2	17.1	14.2
VALERY	11.7	11.6	13.5	14.5	14.6	13.2
Population Means	11.8	11.9	13.6	15.4	15.9	

[1/]From planting in February 18-27, 1970 through September, 1974.

[2/]Production units per acre.

Least Significant Difference	.01	.05
1) Between variety means	NS	NS
2) Between two population means	3.0	2.3
3) Between two population means in same variety	4.3	3.2
4) Between variety means for a given population	NS	NS

Coefficient of Variation

For varieties 12.9%

For populations 20.2%

Table 13

Effect of Variety and Population Density on the Amount of Fruit Waste[1/]

Variety	Plant Population Density[2/] 456	503	621	696	786	Variety Means
	Tons/Acre					
Grand Nain	11.5	11.8	13.8	15.6	16.2	13.8
VALERY	10.4	10.7	11.8	12.8	14.3	12.0
Population Means	11.0	11.3	12.8	14.2	15.3	

[1/] From planting in February 18-27, 1970 through September, 1974.

[2/] Production units per acre.

Least Significant Difference	.01	.05
1) Between variety means	1.4	.9
2) Between two population means	.9	.7
3) Between two population means in same variety	1.2	.9
4) Between variety means for a given population	1.7	1.2

Coefficient of Variation

For varieties 10.1%

For populations 6.1%

Variety	Plant Density, P.U./Acre 456	503	621	696	786
	Percent of Net Fruit Weight				
CHIQUITA					
Grand Nain	82.4	81.8	81.8	79.6	78.9
VALERY	80.5	80.3	79.2	78.8	78.3
Specials					
Grand Nain	9.0	9.3	9.0	10.4	10.9
VALERY	10.3	10.2	11.1	11.3	11.0
Fruit Waste					
Grand Nain	8.6	8.9	9.2	10.0	10.2
VALERY	9.2	9.5	9.7	9.9	10.7

Boxes of CHIQUITA, Specials, and total for the period are given in Tables 14, 15 and 16, respectively. Grand Nain outyielded VALERY at all populations. Although the population effect was highly significant, differences between adjacent population means were not significant. This was common in all comparisons except for that in Grand Nain between 503 and 621 production unit/acre. The cummulative differences in favor of Grand Nain were 825, 803, 1,243, 1,087 and 960 boxes/acre for the 456, 503, 621, 696 and 786 production units/acre, respectively. The higher number of boxes packed in Grand Nain was due to more fruit bunches harvested and not to higher bunch weight. The amount of Specials tended to increase with plant density. However, not all possible comparisons gave a statistically significant test. The two highest levels of plant density were the only treatments that gave a significant difference in the yield of Specials between the two cultivars.

The calculated production of average boxes/acre/experimental year (from planting) are:

Plant Density	Variety Grand Nain	VALERY	Difference
	Boxes/Acre/Year		
456	1,283	1,100	183
503	1,274	1,091	183
621	1,466	1,168	298
696	1,487	1,229	258
786	1,495	1,258	237

Table 14

Effect of Variety and Population Density
on the Yield of CHIQUITA Boxes[1/]

Variety	Plant Population Density[2/] 456	503	621	696	786	Variety Means
	Boxes/Acre					
Grand Nain	5,255	5,200	5,993	5,972	5,970	5,678
VALERY	4,430	4,397	4,650	4,885	5,010	4,674
Population Means	4,843	4,799	5,322	5,429	5,490	

[1/] From planting in February 18-27, 1970 through September, 1974.

[2/] Production units per acre.

Least Significant Difference	.01	.05
1) Between variety means	533	340
2) Between two population means	384	287
3) Between two population means in same variety	543	406
4) Between variety means for a given population	707	494

Coefficient of Variation

For varieties 9.9%

For populations 6.7%

Table 15

Effect of Variety and Population Density on the Yield of Specials Boxes[1/]

Variety	Plant Population Density[2/] 456	503	621	696	786	Variety Means
	Boxes/Acre					
Grand Nain	574	586	661	779	822	684
VALERY	566	559	653	696	703	635
Population Means	570	573	657	738	763	

[1/] From planting in February 18-27, 1970 through September, 1974.

[2/] Production units per acre.

Least Significant Difference	.01	.05
1) Between variety means	NS	NS
2) Between two population means	63.4	47.4
3) Between two population means in same variety	89.7	67.0
4) Between variety means for a given population	117.2	81.8

Coefficient of Variation

For varieties 12.9%

For populations 8.7%

Table 16

Effect of Variety and Population Density on the Total Yield of Boxes (CHIQUITA and Specials)[1/]

Variety	Plant Population Density[2/] 456	503	621	696	786	Variety Means
	Boxes/Acre					
Grand Nain	5,829	5,786	6,654	6,751	6,792	6,362
VALERY	4,996	4,956	5,303	5,581	5,713	5,310
Population Means	5,413	5,371	5,979	6,166	6,253	

[1/] From planting in February 18-27, 1970 through September, 1974.

[2/] Production units per acre.

Least Significant Difference	.01	.05
1) Between variety means	564	359
2) Between two population means	416	311
3) Between two population means in same variety	588	440
4) Between variety means for a given population	756	529

Coefficient of Variation

For varieties 9.3%

For populations 6.5%

In both varieties, the CHIQUITA shipped ranged from 88 to 90 percent (as percent of total fruit shipped).

A summary of the cumulative production of boxes of fruit by months by variety and plant density are given in Tables 17 and 18. The effects of blowdowns are clearly shown in these data.

The average bunch weight by crops and plant population for both varieties are shown in Table 19. In both cultivars, there was a reduction in bunch weight when the plant density was increased. Except for the plantilla fruit, this effect was consistent in all ratoon crops. The highest bunch weights are usually obtained during the first three ratoon crops. Differences between these and subsequent crops are not too great; however, it should be noted that the reduction in bunch weight with age of the plantation was greater in VALERY than in Grand Nain.

The average bunch weight of all crops combined is given in Table 20. Although in not all comparisons differences in bunch weight between Grand Nain and VALERY are significant at the 95% probability level. The effect of plant density on bunch weight reduction is also shown in this table. This reduction, however, was not significant in all instances between two contiguous treatments. On the average, increasing the plant density from 621 to 786 production units/acre resulted in a seven-pound bunch weight reduction in Grand Nain and six pounds in VALERY.

The average maturation period of all crops is given in Table 21. The effect of plant density on the lengthening of the shooting to harvest time was only detected in VALERY. Harvesting of age/grade control fruit commenced in February, 1973, in this experiment. Prior to that date fruit was harvested when the caliper grade of the fullest hand was at 15-montado. When age control was instituted, the harvest grade was lowered to 14-montado.

The average of all crops of some plant and fruit bunch characteristics is presented in Table 22. SIERRA, ROSA

Leaf Pruning Experiment - Laurel Farm, Honduras

On September 19, 1974, this experiment completed 53 months. Hurricane Fifi completely destroyed it. The objectives and experimental procedures were described in the 1971 Research Annual Report.

Detaching from a vigorous banana plant a given number of lower functional leaves at shooting time and allowing more sunlight to reach the follower, resulted in higher yields due to faster growth of the follower and a decrease in blowdown losses.

The production data collected during the 53 months are presented in Table 23. Treatment 3 gave a significant increase in stems shot over that

Table 17

Cumulative Yield Comparison of Grand Nain at Various Levels of Plant Population Density 1/

	Plant Population - Production Units/Acre				
	496	503	621	696	786
	Boxes/Acre				
November, 1970	16.2	25.0	19.2	3.2	15.6
December	134.7	91.5	131.4	137.9	98.0
January, 1971	422.2	410.5	475.9	568.8	557.8
February	574.4	575.1	704.8	841.6	880.2
March	617.5	630.7	810.9	922.8	975.9
April	640.1	647.9	823.2	942.9	989.4
May	726.2	705.5	861.8	965.5	1,004.3
June	916.2	895.2	975.0	1,008.0	1,082.5
July	1,103.3	1,085.0	1,106.5	1,129.8	1,147.0
August	1,342.9	1,315.1	1,423.2	1,441.8	1,357.8
September	1,456.5	1,495.1	1,811.0	1,946.9	1,887.3
October	1,500.9	1,538.1	1,928.6	2,100.1	2,166.1
November	1,602.9	1,607.6	1,949.8	2,141.9	2,253.8
December	1,781.5	1,737.0	2,010.2	2,176.4	2,283.5
January, 1972	1,935.6	1,887.5	2,068.7	2,217.6	2,337.5
February	2,102.9	2,114.4	2,199.1	2,271.8	2,404.8
March	2,304.5	2,302.8	2,493.7	2,480.6	2,494.6
April	2,367.6	2,439.5	2,769.0	2,836.8	2,761.9
May	2,465.3	2,501.0	2,971.3	3,135.1	3,107.3
June	2,590.8	2,569.1	3,034.3	3,256.2	3,331.1
July	2,749.5	2,662.8	3,083.7	3,333.1	3,475.5
August	2,966.9	2,908.3	3,170.2	3,431.3	3,564.1
September	3,160.3	3,166.2	3,341.3	3,478.3	3,665.3
October	3,305.5	3,337.8	3,585.5	3,599.6	3,735.2
November	3,418.7	3,459.8	3,910.9	3,928.0	3,914.0
December	3,495.6	3,501.8	4,051.4	4,116.4	4,072.0
January, 1973	3,629.5	3,590.4	4,121.8	4,255.7	4,263.2
February	3,729.5	3,676.2	4,165.8	4,337.2	4,429.1
March	3,910.9	3,813.5	4,271.7	4,430.5	4,599.9
April	4,005.2	3,961.6	4,386.5	4,482.4	4,686.3
May	4,120.1	4,091.6	4,559.9	4,576.0	4,753.3
June	4,180.5	4,131.1	4,695.2	4,708.6	4,811.3
July	4,272.5	4,181.5	4,886.7	4,839.9	4,910.1
August	4,349.8	4,258.9	4,999.8	5,085.5	5,063.4
September	4,449.4	4,366.3	5,117.5	5,242.9	5,261.5
October	4,645.7	4,579.9	5,233.1	5,433.0	5,524.7
November	4,782.7	4,741.8	5,351.7	5,515.5	5,672.9
December	4,865.8	4,825.6	5,461.7	5,566.6	5,761.0
January, 1974	5,048.5	4,999.2	5,651.8	5,753.4	5,850.8
February	5,172.5	5,112.4	5,896.3	5,926.4	5,948.1
March	5,271.3	5,222.9	6,035.3	6,051.2	6,105.9
April	5,444.6	5,387.8	6,173.2	6,328.6	6,279.6
May	5,533.9	5,482.9	6,267.7	6,482.7	6,463.0
June	5,583.0	5,537.5	6,338.3	6,544.4	6,573.9
July	5,664.1	5,622.3	6,458.8	6,618.4	6,671.1
August	5,733.2	5,686.1	6,545.6	6,667.8	6,749.6
September	5,823.0	5,789.1	6,649.6	6,750.8	6,791.1

1/

Table 18

Cumulative Production Comparison of VALERY at Various Levels of Plant Population Density[1/]

	Plant Population - Production Units/Acre				
	456	503	621	696	786
	Boxes/Acre				
November, 1970	13.3	4.2	6.5	19.6	6.6
December	150.9	108.7	97.9	155.6	119.8
January, 1971	476.4	361.1	518.0	570.1	569.9
February	599.3	554.4	723.2	821.8	907.1
March	626.1	636.6	804.8	914.0	1,027.1
April	641.7	655.8	820.7	920.4	1,044.4
May	709.9	688.0	838.7	933.1	1,058.1
June	946.4	799.7	935.7	982.8	1,065.8
July	1,117.8	944.9	1,054.9	1,073.2	1,123.4
August	1,319.1	1,169.7	1,272.7	1,224.6	1,247.3
September	1,467.6	1,468.1	1,678.9	1,700.0	1,614.0
October	1,490.8	1,555.6	1,845.6	1,961.6	2,043.1
November	1,529.1	1,591.3	1,909.1	2,013.5	2,179.2
December	1,606.2	1,614.2	1,930.7	2,033.2	2,198.3
January, 1972	1,750.3	1,682.8	1,961.3	2,053.2	2,219.2
February	1,884.9	1,760.4	2,004.9	2,091.8	2,227.3
March	1,950.8	1,806.3	2,045.9	2,105.0	2,234.5
April	2,049.2	1,866.6	2,144.3	2,158.2	2,245.4
May	2,085.5	1,959.9	2,326.1	2,334.2	2,367.5
June	2,134.8	2,009.6	2,432.6	2,559.4	2,568.1
July	2,299.0	2,128.6	2,538.6	2,727.1	2,898.9
August	2,621.3	2,461.5	2,780.4	2,887.3	3,113.4
September	2,759.0	2,681.9	2,939.7	3,071.7	3,242.8
October	2,832.2	2,748.2	3,028.1	3,138.1	3,306.7
November	2,917.4	2,840.6	3,137.3	3,242.2	3,385.1
December	2,956.2	2,888.3	3,236.2	3,348.4	3,420.9
January, 1973	3,107.9	2,982.8	3,395.5	3,485.2	3,507.1
February	3,245.7	3,082.6	3,500.5	3,637.5	3,629.0
March	3,439.0	3,330.3	3,633.7	3,845.9	3,967.5
April	3,560.7	3,517.6	3,769.8	3,953.1	4,100.3
May	3,645.8	3,627.0	3,953.3	4,103.1	4,270.0
June	3,662.3	3,639.9	3,953.3	4,132.0	4,291.6
July	3,700.5	3,666.9	3,975.8	4,150.5	4,319.3
August	3,704.6	3,684.8	4,003.4	4,174.7	4,329.5
September	3,720.2	3,696.3	4,024.6	4,198.9	4,329.5
October	3,769.0	3,785.9	4,071.3	4,278.5	4,360.3
November	3,832.8	3,867.9	4,135.0	4,351.4	4,506.8
December	3,891.3	3,958.1	4,204.5	4,399.4	4,598.4
January, 1974	4,255.7	4,208.4	4,506.9	4,731.6	4,895.8
February	4,438.7	4,438.9	4,799.4	5,056.2	5,156.0
March	4,495.2	4,501.3	4,904.0	5,179.6	5,289.9
April	4,553.4	4,584.1	4,063.2	5,245.4	5,355.3
May	4,623.3	4,675.0	5,026.8	5,310.7	5,406.9
June	4,673.1	4,725.0	5,067.5	5,352.2	5,465.5
July	4,742.2	4,788.7	5,147.9	5,416.5	5,538.0
August	4,852.3	4,874.8	5,222.5	5,491.0	5,609.9
September (19)	4,996.4	4,955.5	5,307.2	5,588.4	5,712.5

1/

Table 19

Average Bunch of Grand Nain and VALERY

by Crops and Population Density

Variety	Plant Density 1/	Crop						
		Plantilla	First Ratoon	Second Ratoon	Third Ratoon	Fourth Ratoon	Fifth Ratoon	Sixth Ratoon	Seventh Ratoon
		Pounds/Bunch							
and Nain	456	73.3	94.8	105.7	107.9	104.8	100.9	97.2	99.7
	503	72.5	96.6	101.3	104.9	97.9	98.3	93.8	98.0
	621	72.0	94.3	93.1	97.5	90.7	90.8	93.7	100.0
	696	75.2	92.9	88.6	93.4	88.5	88.6	95.3	---
	786	70.9	89.0	84.5	88.0	82.4	83.2	92.4	---
	Mean	72.8	93.5	94.6	98.3	92.9	92.4	94.5	
LERY	456	74.9	96.8	106.9	102.8	104.4	92.6	89.5	95.1
	503	71.7	96.4	96.5	97.3	100.3	88.1	86.0	95.9
	621	73.8	94.3	91.5	93.2	91.9	81.6	81.9	95.0
	696	73.1	93.9	88.6	89.4	85.2	79.2	85.1	---
	786	74.2	88.7	86.3	83.9	77.2	73.3	86.8	---
	Mean	73.5	94.0	94.0	93.3	91.8	83.0	85.9	

Production units per acre.

Table 20

Effect of Variety and Population Density on Mean Bunch Weight[1/]

Variety	Plant Population Density[2/] 456	503	621	696	786	Variety Means
	Pounds/Bunch					
Grand Nain	97.5	94.2	89.9	88.1	82.9	90.5
VALERY	94.4	90.4	86.7	84.4	80.4	87.3
Population Means	96.0	92.3	88.3	86.3	81.7	

[1/] From planting in February 18-27, 1970 through September, 1974.

[2/] Production units per acre.

Least Significant Difference	.01	.05
1) Between variety means	NS	2.2
2) Between two population means	2.8	2.1
3) Between two population means in same variety	3.9	3.0
4) Between variety means in same population	NS	3.4

Coefficient of Variation

For varieties 3.7%

For populations 2.9%

Table 21

Effect of Variety and Population Density
on the Average Days from Shooting to Harvest (Maturation Period)[1/]

Variety	Plant Population Density[2/]					Variety Means
	456	503	621	696	786	
	Days					
Grand Nain	103.1	103.1	100.3	101.7	102.6	102.2
VALERY	106.2	105.4	109.8	107.5	110.2	107.8
Population Means	104.7	104.3	105.1	104.6	106.4	

[1/] From planting in February 18-27, 1970 through September, 1974.

[2/] Production units per acre.

Table 22

Summary of Some Plants and Fruit Bunch Characteristics of Grand Nain and VALERY - February 18-27, 1970 Through September 19, 1974

Variety	Plant Population Density 1/ 456	503	621	696	786	Variety Means
			Functional Leaves at Shooting/Plant			
Grand Nain	14.8	14.8	14.1	13.9	14.0	14.3
VALERY	15.1	14.9	15.0	14.9	14.6	14.9
			Functional Leaves at Harvest/Plant			
Grand Nain	9.0	9.0	8.7	8.7	8.6	8.8
VALERY	8.9	8.7	8.7	8.6	8.5	8.7
			Plant Height at Shooting - Feet			
Grand Nain	10.2	10.0	9.9	9.7	9.5	9.9
VALERY	12.7	12.6	12.7	12.6	12.5	12.6
			Circumference of Pseudostem at Shooting - Inches			
Grand Nain	29.9	29.3	28.5	28.3	27.6	28.7
VALERY	29.7	29.0	29.2	28.8	28.2	29.0
			Potential Hands/Bunch			
Grand Nain	11.6	11.6	11.2	11.1	10.9	11.3
VALERY	11.7	11.1	11.4	11.0	10.8	11.2

Continued on next page...

Table 22 (Con't.)

Variety	Plant Population Density[1] 456	503	621	696	786	Variety Means
			Harvest Hands/Bunch			
Grand Nain	10.3	10.2	9.9	9.8	9.5	9.9
VALERY	10.0	9.7	9.6	9.4	9.3	9.6
			Finger Length, Apical Hand[2] - Inches			
Grand Nain	8.0	8.0	8.0	8.0	8.0	8.0
VALERY	8.1	8.1	8.0	8.1	8.1	8.1
			Finger Length, Middle Hand[2] - Inches			
Grand Nain	9.5	9.5	9.5	9.5	9.5	9.5
VALERY	9.7	9.6	9.5	9.6	9.5	9.6
			Finger Length, Fullest Hand[2] - Inches			
Grand Nain	10.1	10.1	10.1	10.1	10.1	10.1
VALERY	10.2	10.2	10.1	10.2	10.1	10.2
			Harvest Grade (Fullest Hands)[3] - 32nds of One Inch			
Grand Nain	46.29	45.66	45.73	45.50	45.34	45.70
VALERY	46.10	45.58	46.21	45.23	45.44	45.71

[1] Production units per acre.

[2] Middle finger outer whorl.

[3] Fullest hand is the largest hand calipered for harvesting.

Table 23

Summary of Production and Losses From Planting
April 4, 5, 7, 1970 Through September 19, 1974
Leaf Pruning Experiment - Laurel Farm, Honduras

Treatment Leaves Left At Shooting	Fruit Bunches per Acre			Gross Yield	Average Bunch	Average Maturation
	Shot	Harvested	Lost	Tons/Acre	Weight, Pounds	Period, Days
All (15.4)	3,069.0	2,203.3	865.7	99.66	90.54	105.4
11	3,112.8	2,252.6	860.2	101.47	89.79	106.3
9	3,347.9	2,586.1	761.8	121.31	93.79	104.0
7	3,269.5	2,502.2	767.3	111.12	88.43	106.6
Mean	3,199.8	2,386.1	813.7	108.39	90.64	105.6
.01	NS	NS	NS	NS	NS	-
.05	205.4	264.9	NS	15.86	NS	-
%	5.2	9.0	11.7	11.9	3.7	-

obtained by Treatments 1 and 2. Treatment 4 resulted in a reduction in stems shot over those produced by Treatment 3. This reduction, however, was not statistically significant. The percent increase in stems shot over the control (15.4 leaves) by Treatments 2, 3 and 4 was 1.4, 9.0 and 6.5, respectively. The stems harvested also augmented with an increase in leaf pruning at shooting. The percent increase over the control was 2.2, 17.4 and 13.6 for Treatments 2, 3 and 4, respectively. However, the only comparisons that were significant were: Treatment 3 vs. Treatments 1 and 2, and Treatment 4 vs. Treatment 1. The calculated average production of shot and harvested fruit per experimental year is shown in the following table:

Treatment		Stems/Acre/Exptl. Year	
Nº	Leaves Left At Shooting	Shot	Harvested
1	All (15.4)	695	499
2	11	705	510
3	9	758	586
4	7	740	567

The significant difference in fruit shot and harvested obtained by Treatment 3 was attributed to the faster growing rate of the subsequent crops, induced by larger amount of sunlight that reached the follower after the mother plant had been deleafed. The behaviour of Treatment 3 with respect to gross yield was similar to stems shot and harvested. The tonnage obtained with this treatment was about 22% higher than the control (Treatment 1). A reduction in yield over Treatment 3 was obtained in Treatment 4. Treatment 4 outyielded Treatment 1 by about 11%.

Differences in fruit losses that existed among treatments prior to Hurricane Fifi disappeared because of the complete destruction of the experimental area. Blowdown losses, however, were significantly reduced by increasing the number of lower leaves removed at shooting (Table 24). The percent reduction in blowdown losses (three windstorms) between deleafing treatments are shown in the table below:

	Leaves Left at Shooting/Plant			
Leaves Left at Shooting/Plant	Control 15.4	11.0	9.0	7.0
	Percent Reduction			
Control 15.4	-	-	-	-
11.0	.3	-	-	-
9.0	22	22	-	-
7.0	26	26	5	-

Table 24

Distribution of Cumulative Losses From
Planting April, 1970 Through September 19, 1974
Leaf Pruning Experiment - Laurel Farm, Honduras

Treatment	Stems Lost Per Acre					
Leaves Left at Shooting	Doubling	Uprooting	Break-neck	Blowdown[1]	Others	Total
All (15.4)	222.3	18.2	14.6	595.9	14.7	865.7
11	222.3	9.1	21.9	594.1	12.8	860.2
9	247.9	18.2	14.6	462.9	18.2	761.8
7	278.8	9.1	16.4	441.0	22.0	767.3
Mean	242.8	13.7	16.9	523.5	16.9	-
SD .01	NS	-	-	110.3	-	NS
SD .05	NS	-	-	79.8	-	NS
.V., %	27.6	-	-	12.4	-	11.7

[1] Area suffered three blowdowns (11/20/71, 5/28/73, and 9/19/74); the latter one compounded by floods that caused total destruction of plantings.

The data above shows, for example, that when the plants were left with only nine leaves at shooting, the blowdown losses were 22% lower than those recorded in the control. The sail effect of the banana leaf is clearly demonstrated in the relationship between the number of erect leaves on the plant and windstorm fruit losses.

The data indicated that leaf dropping during fruit development is regulated by leaf age. There was an inverse relationship between leaves dropped during fruit development and the number of leaves detached at shooting time. The above relationships are shown on Table 25. SIERRA, ROSA

Grand Nain Plant Population Experiment - Coto District, Costa Rica

The objectives and the experimental design of this study were described in the 1973 Research Annual Report.

A summary of the production for the period of July, 1973 through December 31, 1974, is given on Table 26. Seventeen months after planting, no significant differences in yield have been detected among the population treatments.

The lack of response differences among plant densities may be attributed to the fact that the last resupplying of seed was done in November, 1973; also a considerable amount of fruit was not harvested during the strike that took place in June, 1974. The amount of fruit lost per acre, due only to the strike, amounted to 93, 101 and 119 stems for the 621, 696 and 786 plant densities, respectively. The fruit lost due to the strike only amounted to 67, 60 and 67 percent (as percent of total losses) in the 621, 696 and 786 population treatments, respectively. Head rot was the second main cause of fruit losses (Table 27). STEPHENS, SIERRA

Regression of Bunch Weight on Pseudostem Circumference of Grand Nain at Shooting.

A regression analysis was made on the relationship between bunch weight and pseudostem circumference, at shooting, of the plantilla and first ratoon crop of the Grand Nain cultivar grown in Farm 24, Changuinola, Panamá. The plantilla sample consisted of 1,775 sets of observations and the first ratoon sample was 1,537 pairs.

Figure 1 shows the regressions obtained for both samples. In both crops, the Correlation Coefficient (r) was highly significant (P .01)

Table 25

Average Leaf Canopy at Shooting and During Fruit Development
For All Crops Harvested From Planting in April, 1970 Through September 19, 1974
Leaf Pruning Experiment - Laurel Farm, Honduras

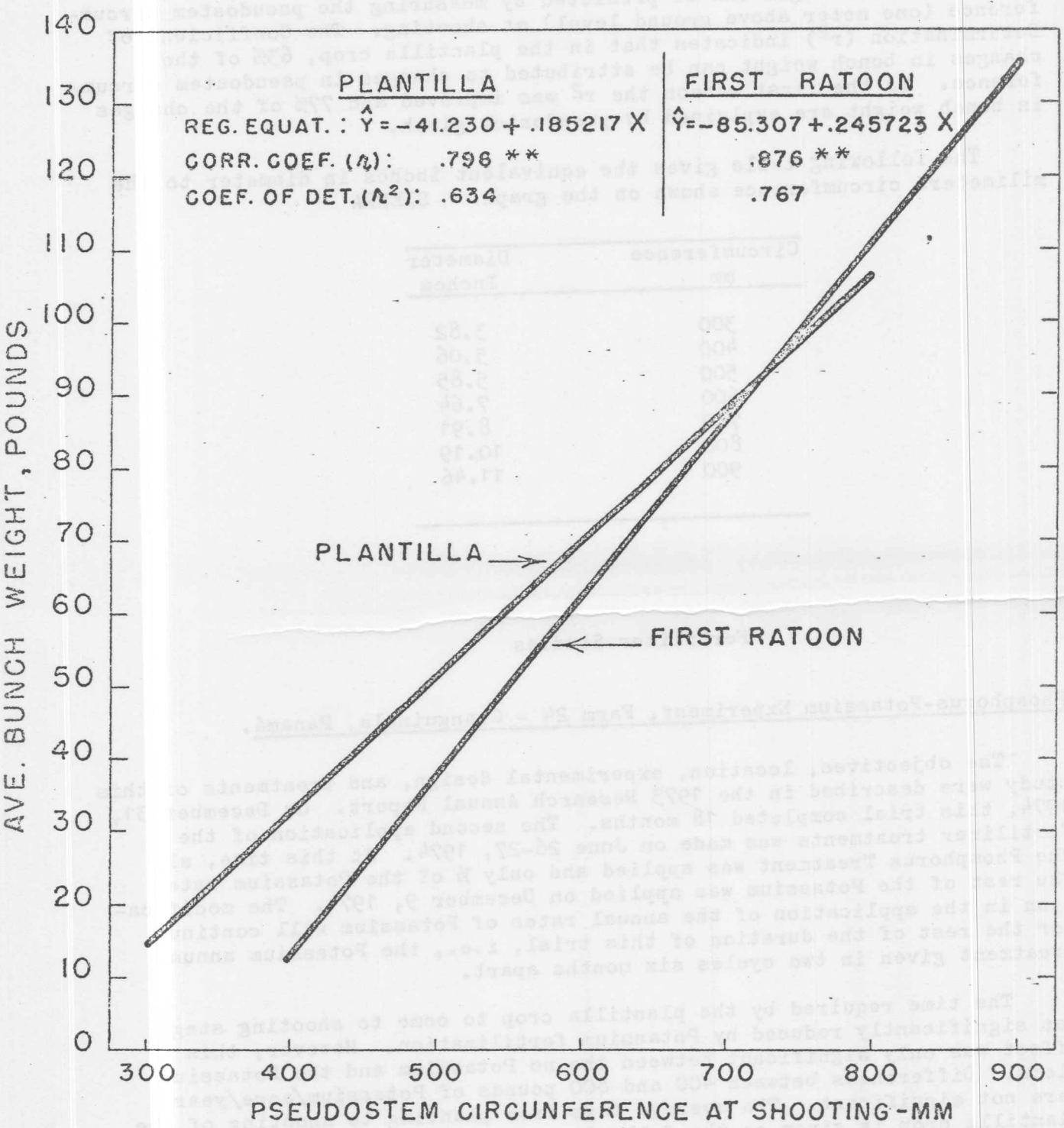
Treatment Number	Plants Harvested	Average Leaves At Shooting	Leaf At Shooting	Removed at Shooting	At Harvest	Lost During Fruit Development
Control	1,209	15.4	15.4	0	9.0	6.4
	1,236	15.2	11.0	4.2	8.9	2.1
	1,419	15.4	9.0	6.4	8.1	0.9
	1,373	15.2	7.0	8.2	6.6	0.4

able 26. Summary of production - Grand Nain Plant Population Experiment. Period from planting July, 1973, through December, 1974. Farm 62, Coto District, Costa Rica.

lant density p.u./acre	Stems harvested per acre	Stems lost/a	Gross yield tons/a	Ave. bunch weight lbs.	Harvested hands per stem	Functional leaves at: shooting	Functional leaves at: harvest	Plant height meters	Pseudostem circumference cm
621	607.7	139.0	17.85	58.8	7.5	12.0	6.6	2.41	56.9
696	661.2	167.4	18.96	57.2	7.4	11.7	6.5	2.39	55.7
786	681.2	177.8	19.79	58.0	7.4	12.2	6.5	2.41	56.4
est of sig.	NS	NS	NS	NS	NS	NS	NS	NS	NS
. V., %	16.6	32.0	18.6	6.4	5.0	5.3	5.1	2.9	3.8

Table 27. Breakdown of field losses by cause. Period from planting July, 1973 through December, 1974. Grand Nain Plant Population Experiment. Farm 62, Coto District, Costa Rica.

Plant density P.U./acre	Stems per acre						
	Doubling	Uproot	Snap-off	Head rot	No tags	Strike	Total
621	1.5	4.4	-	35.5	4.4	93.2	139.0
696	5.0	-	3.3	43.1	14.9	101.1	167.4
786	1.9	1.9	5.6	37.4	11.2	119.8	177.8



REGRESSION OF BUNCH WEIGHT ON PSEUDOSTEM CIRCUNFERENCE OF GRAND NAIN AT SHOOTING.

P.K. EXPERIMENT FARM 24 CHANGUINOLA, PANAMA

indicating that a good relationship exists between the two variables and that bunch weight can be predicted by measuring the pseudostem circumference (one meter above ground level) at shooting. The Coefficient of Determination (r^2) indicates that in the plantilla crop, 63% of the changes in bunch weight can be attributed to changes in pseudostem circumference. In the first ratoon the r^2 was improved and 77% of the changes in bunch weight are explained by pseudostem girth.

The following table gives the equivalent inches in diameter to the milimeters circumference shown on the graph. SIERRA

Circumference mm	Diameter Inches
300	3.82
400	5.06
500	5.85
600	7.64
700	8.91
800	10.19
900	11.46

Fertilizer Studies

Phosphorus-Potassium Experiment, Farm 24 - Changuinola, Panamá.

The objectives, location, experimental design, and treatments of this study were described in the 1973 Research Annual Report. On December 31, 1974, this trial completed 18 months. The second application of the fertilizer treatments was made on June 26-27, 1974. At this time, all the Phosphorus Treatment was applied and only ½ of the Potassium rate. The rest of the Potassium was applied on December 9, 1974. The modification in the application of the annual rates of Potassium will continue for the rest of the duration of this trial, i.e., the Potassium annual treatment given in two cycles six months apart.

The time required by the plantilla crop to come to shooting stage was significantly reduced by Potassium fertilization. However, this effect was only significant between the no Potassium and the Potassium plots. Differences between 400 and 800 pounds of Potassium/acre/year were not significant. The average days from planting to shooting of the plantilla crop is given on the following table:

Pounds/Acre/Year		Ave. Days - Planting
Phosphorus	Potassium	to Shooting[1/]
0	0	213.2 a
0	400	192.8 d
0	800	189.3 d
100	0	202.2 bc
100	400	194.4 cd
100	800	190.4 d
200	0	207.0 ab
200	400	197.0 cd
200	800	190.8 d

[1/] Means followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

On the average, plants receiving 400 lbs. of Potassium/acre/year, reached shooting stage 12.8 days earlier than plants not fertilized with Potassium. Increasing Potassium fertilization from 400 to 800 lbs./a/y resulted in an additional reduction of only 4-½ days. Phosphorus fertilization had no significant influence on the time from planting to shooting. There were no interactions between the two plant nutrients.

Harvesting of the plantilla fruit commenced in March, 1974. In the 72 experimental plots there are 1,800 sampling mats. Of these and in the plantilla crop 1,776 stems were harvested, 21 stems were lost, and 3 plants have not been yet reported as harvested or lost. Also during 1974, of the 1,800 potencial first ratoon sampling mats, 1,537 were harvested, 65 were lost, and 198 have not been reported as harvested or lost. The harvesting performance of the two crops by month, in stems per acre during 1974, is shown on Table 28.

The influence of Phosphorus and Potassium fertilization on the fruit bunches harvested is given on Table 29. There was no effect of Phosphorus on the amount of fruit harvested; however, the application of Potassium resulted in a significant increase. This difference was only significant between the no Potassium and the 800 pounds of Potassium per acre rate. The addition of 400 and 800 pounds of Potassium/acre/year resulted in a 2 and 7 percent increase in fruit bunches harvested, respectively. The equivalent bunches harvested per acre, for the March-December period were 740, 755 and 791 for the no Potassium, 400 and 800 pounds of Potassium per acre per year, respectively.

Total fruit losses tended to decrease with an increase in the rate of Potassium application; however, this differences were not statistically significant (Table 30). As an average of all treatments, the total

le 28. Influence of the fertilizer treatment on the harvesting performance during 1974 of the plantilla and first ratoon ops.* PK Experiment, Farm 24 - Changuinola, Panamá.

./acre/year P	K	March	April	May	June	July	August	September	October	November	December
					Plantilla - stems harvested per acre						
0	0	0	167.7	319.8	74.5	34.2	---	6.2	6.2	3.1	---
0	400	18.6	326.0	208.0	27.9	6.2	6.2	9.3	---	---	---
0	800	52.8	378.8	158.4	6.2	6.2	9.3	3.1	---	---	---
00	0	12.4	229.8	319.8	31.1	6.2	3.1	6.2	3.1	---	---
00	400	43.5	263.9	226.7	46.6	9.3	9.3	3.1	6.2	---	---
00	800	34.2	400.5	155.3	15.5	---	3.1	---	3.1	---	---
00	0	18.6	192.5	285.7	59.0	34.2	12.4	3.1	6.2	3.1	---
00	400	18.6	301.2	226.7	27.9	12.4	9.3	15.5	6.2	---	---
00	800	43.5	344.7	198.7	12.4	3.1	3.1	6.2	3.1	3.1	---
					First Ratoon - stems harvested per acre						
0	0							---	68.3	211.1	214.2
0	400							---	158.4	217.4	139.7
0	800							---	267.0	204.9	77.6
00	0							---	86.9	236.0	198.7
00	400							---	183.2	217.4	105.6
00	800							---	254.6	229.8	83.8
00	0							---	93.2	208.0	167.7
00	400							---	183.2	242.2	93.2
00	800							---	208.0	229.8	124.2

anted in June 27-29, 1973.

Table 29. Effect of phosphorus and potassium fertilization on fruit bunches harvested. From planting June 27-29, 1973 through December, 1974. PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y			Mean effect of potassium 1/
	0	100	200	
	bunches/acre			
0	1,105.4	1,139.5	1,083.6	1,109.5 b
400	1,133.3	1,124.0	1,139.5	1,132.3 ab
800	1,183.0	1,186.1	1,192.3	1,187.1 a
Mean effect of phosphorus	1,140.6	1,149.9	1,138.5	

1/ Potassium means followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

Table 30. Effect of phosphorus and potassium fertilization on fruit losses. From planting in June 27-29, 1973 through December, 1974. PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y			Mean effect of potassium [1]
	0	100	200	
	bunches/acre			
0	40.4	40.4	40.4	40.4
400	40.4	31.1	21.7	31.1
800	18.6	15.5	18.6	17.6
Mean effect of phosphorus [1]	33.1	29.0	26.9	

[1] Differences among phosphorus or potassium means are not statistically significant.

fruit losses amounted to approximately 30 bunches per acre.

Increasing the rate of Phosphorus in the application did not result in an increase in gross yield. Application of Potassium fertilizer, however, gave a significant increase in gross yield (Table 31). The difference in yield among treatments was significant. As an average of the period, the application of 400 and 800 pounds of Potassium/acre/year resulted in a 26 and 43 percent yield increase over the control, respectively. The yield response to Potassium application was more accentuated in the first ratoon crop than in the plantilla (Table 32). The degree of response over the control was as follows:

Applied K Lbs./A/Y	Plantilla		First Ratoon	
	% Harvested	% Yield Inc.	% Harvested	% Yield Inc.
0	98.8	-	79.8	-
400	98.2	15	84.2	36
800	99.0	24	92.2	61

It is obvious that the increase in yield, caused by Potassium fertilization, is not due only to a larger number of fruit bunches harvested but also to an increase in bunch weight. The application of 400 and 800 lbs. of Potassium/acre/year resulted in an increase of 15 and 25 percent over the control, in the plantilla fruit, respectively; whereas, in the first ratoon the bunch weight increase caused by Potassium fertilization amounted to 29 and 39 percent. Table 33 gives the average effect of treatments on bunch weight of all fruit harvested through December, 1974; while Table 34 shows the average plantilla and first ratoon bunch weight as affected by the fertilizer treatments. Data also show that Phosphorus application had no influence on the weight of the bunch. There were no interaction effects between the two nutrients.

The average stem size (hands/bunch) was also significantly increased by Potassium application. As an average of all fruit, the application of 400 pounds of Potassium/acre/year resulted in a 0.6 hand/stem increase over the control, while 800 pounds of Potassium/acre/year gave an average increase of one hand/stem over the control (Table 35). The average effect of the fertilizer treatments on stem size of the plantilla and first ratoon fruit is given on Table 36.

Neither Phosphorus nor Potassium fertilization had any influence on the number of days from shooting to harvest (Table 37).

The number of functional leaves at shooting were not influenced by either Phosphorus or Potassium (Tables 38 and 39); however, visual observations indicated that leaf area was increased by the application of Potassium. In this trial, Grand Nain gave an average of 13.7 functional

Table 31. Effect of phosphorus and potassium fertilization on gross yield. From planting June 27-29, 1973 through December, 1974. PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y			Mean effect of potassium 1/
	0	100	200	
	tons/acre			
0	28.07	29.29	28.15	28.50 c
400	35.92	35.58	36.08	35.86 b
800	40.57	40.86	41.01	40.81 a
Mean effect of phosphorus	34.85	35.24	35.08	

1/ Potassium means followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

Table 32. Effect of phosphorus and potassium fertilization on average gross yield of plantilla and first ratoon crop. PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y 0	100	200	Mean effect of potassium 1/
	tons/acre - plantilla			
0	13.6	13.7	14.0	13.7
400	15.4	15.8	16.2	15.8
800	17.0	17.1	17.1	17.0
	tons/acre - first ratoon			
0	14.4	15.6	14.2	14.7
400	20.5	19.8	19.9	20.0
800	23.5	23.7	23.9	23.7
Mean effect of phosphorus				
Plantilla:	15.3	15.5	15.7	
First ratoon:	19.4	19.7	19.3	

Table 33. Effect of phosphorus and potassium fertilization on average bunch weight. PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y			Mean effect of potassium 1/
	0	100	200	
	pounds/bunch			
0	50.7	51.4	51.8	51.3 c
400	63.4	63.2	63.3	63.3 b
800	68.6	68.9	68.8	68.7 a
Mean effect of phosphorus	60.5	61.1	61.3	

1/ Potassium means followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

Table 34. Effect of phosphorus and potassium fertilization on average bunch weight of plantilla and first ratoon fruit. PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y 0	100	200	Mean effect of potassium 1/
	plantilla bunch wt., lbs.			
0	44.6	44.5	45.4	44.8
400	51.1	51.8	52.3	51.7
800	55.3	55.7	55.6	55.5
	first ratoon bunch wt., lbs.			
0	58.4	59.4	60.5	59.4
400	77.3	76.8	76.3	76.8
800	82.9	83.0	82.7	82.8
Mean effect of phosphorus				
Plantilla:	50.3	50.6	51.1	
First ratoon:	72.8	73.0	73.1	

Table 35. Effect of phosphorus and potassium fertilization on the average hands per bunch at harvest.* PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y			Mean effect of potassium**
	0	100	200	
	hands/bunch			
0	6.9	7.0	7.0	7.0 c
400	7.6	7.6	7.6	7.6 b
800	7.9	8.0	8.0	8.0 a
Mean effect of phosphorus	7.5	7.5	7.5	

* Average of plantilla and first ratoon fruit.

**Potassium means followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

Table 36. Effect of phosphorus and potassium fertilization on the average hands per bunch of plantilla and first ratoon fruit. PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y 0	100	200	Mean effect of potassium
	plantilla - hands/bunch			
0	6.5	6.5	6.6	6.5
400	6.9	6.9	7.0	6.9
800	7.1	7.2	7.2	7.2
	first ratoon - hands/bunch			
0	7.5	7.6	7.5	7.5
400	8.4	8.4	8.3	8.4
800	8.7	8.8	8.9	8.8
Mean effect of phosphorus				
Plantilla:	6.8	6.9	6.9	
First ratoon:	8.2	8.3	8.2	

Table 37. Effect of phosphorus and potassium fertilization on average days from shooting to harvest. From planting June 27-29, 1973 through December, 1974. PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y			Mean effect of potassium [1]
	0	100	200	
	shooting to harvest - days			
0	102.1	103.3	103.9	103.1
400	102.5	102.8	102.6	102.6
800	101.8	103.4	102.9	102.7
Mean effect of phosphorus [1]	102.1	103.1	103.1	

[1] Differences among phosphorus or potassium means are not statiscally significant.

Table 38. Effect of phosphorus and potassium fertilization on the number of functional leaves at shooting.* PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y			Mean effect of potassium
	0	100	200	
	functional leaves/plant			
0	13.5	13.6	13.5	13.5
400	13.8	13.7	13.7	13.7
800	13.7	13.8	13.7	13.7
Mean effect of phosphorus	13.6	13.7	13.6	

*Average of plantilla and first ratoon crop.

Table 39. Effect of phosphorus and potassium fertilization on the number of functional leaves at shooting of plantilla and first ratoon crops. PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y 0	100	200	Mean effect of potassium
	plantilla - functional leaves/plant			
0	13.4	13.7	13.4	13.5
400	13.6	13.2	13.5	13.4
800	13.7	13.8	13.7	13.7
	first ratoon - functional leaves/plant			
0	13.6	13.5	13.6	13.6
400	14.0	14.1	14.0	14.0
800	13.6	13.8	13.7	13.7
Mean effect of phosphorus				
Plantilla:	13.6	13.6	13.5	
First ratoon:	13.7	13.8	13.8	

leaves at shooting.

Tables 40 and 41 show the average functional leaves at harvest for all crops and the plantilla and first ratoon separately. There were more leaves dropping in the plantilla than in the first ratoon during the fruit development period. An average of 6.9 leaves were lost in the plantilla, while only 5.4 in the first ratoon.

There was a significant increase in plant height with each increment of Potassium (Tables 42 and 43). The magnitude of the effect was higher between the zero Potassium and the 400 pounds per acre rate. The difference between the second and third Potassium rate was smaller but statistically significant. The application of Phosphorus fertilizer had no significant effect on plant height.

The influence of Phosphorus and Potassium on pseudostem girth (circumference) of the average of all crops, the plantilla and first ratoon are given on Tables 44 and 45. There was no increase in pseudostem circumference by increasing the rate of Phosphorus application. Potassium, however, gave a significant increase. This effect was obtained in both plantilla and first ratoon plants.

Tables 46, 47 and 48 show the effect of both nutrients on finger length of the apical, middle, and basal hands, respectively. Phosphorus did not show any beneficial nor detrimental effect on this characteristic. On the three hands measured, the application of 400 pounds of Potassium per acre resulted in a significant increase in finger length. The application of 800 pounds of Potassium/acre/year gave no further significant increase over the 400-pound Potassium level. SIERRA, ESPINOZA

Nitrogen-Potassium Experiment, Farm 64 - Changuinola, Panamá.

This trial was terminated on December 31, 1974, after completing three years. The effect of the Nitrogen treatments with and without Potassium on cumulative production is given on Table 49. The cumulative fruit shot per acre ranged from 2,409 to 2,533 stems per acre in the only Nitrogen plots, and from 2,371 to 2,544 stems per acre for the Nitrogen plus Potassium treatments. When the bananas were fertilized only with Nitrogen, the significant difference in stems shot only occurred between the two lowest Nitrogen treatments (150 and 300 pounds of Nitrogen per acre per year) and the two highest Nitrogen levels (600 and 750 pounds of Nitrogen/acre/year). There was, however, no difference between the two highest Nitrogen levels. When 400 pounds of Potassium were added to the Nitrogen rates, the significant difference in stems shot occurred only between 150 and 300 pounds of Nitrogen and the remaining treatments. Differences among 450, 600 and 750 pounds of Nitrogen plus Potassium were not significant.

Table 40. Effect of phosphorus and potassium fertilization on the number of functional leaves at harvest.* PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y			Mean effect of potassium
	0	100	200	
	functional leaves at harvest			
0	7.4	7.3	7.4	7.4
400	7.5	7.7	7.6	7.6
800	7.4	7.4	7.6	7.5
Mean effect of phosphorus	7.4	7.5	7.5	

*Average of plantilla and first ratoon crop.

Table 41. Effect of phosphorus and potassium fertilization on the number of functional leaves at harvest of plantilla and first ratoon crops. PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y 0	100	200	Mean effect of potassium
	plantilla - functional leaves/plant			
0	6.8	6.7	6.8	6.8
400	6.6	6.8	6.6	6.7
800	6.6	6.3	6.7	6.5
	first ratoon - functional leaves/plant			
0	8.0	8.0	8.1	8.0
400	8.5	8.6	8.7	8.6
800	8.4	8.5	8.5	8.5
Mean effect of phosphorus				
Plantilla:	6.7	6.6	6.7	
First ratoon:	8.3	8.4	8.4	

Table 42. Effect of phosphorus and potassium fertilization on average plant height at shooting.* PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y 0	100	200	Mean effect of potassium**
	plant height - meters/plant			
0	2.19	2.20	2.20	2.20 c
400	2.38	2.36	2.36	2.37 b
800	2.46	2.44	2.45	2.45 a
Mean effect of phosphorus	2.34	2.33	2.34	

* Average of plantilla and first ratoon crop.

**Potassium means followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

Table 43. Effect of phosphorus and potassium fertilization on average plant height at shooting of plantilla and first ratoon. PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y 0	100	200	Mean effect of potassium
	plantilla - meters/plant			
0	1.92	1.93	1.95	1.93
400	2.04	2.04	2.04	2.04
800	2.11	2.09	2.10	2.10
	first ratoon - meters/plant			
0	2.52	2.51	2.50	2.51
400	2.76	2.72	2.72	2.73
800	2.83	2.82	2.82	2.82
Mean effect of phosphorus				
Plantilla:	2.02	2.02	2.03	
First ratoon:	2.70	2.68	2.68	

Table 44. Effect of phosphorus and potassium fertilization on the average pseudostem circumference at shooting.* PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y			Mean effect of potassium**
	0	100	200	
	pseudostem circumference - cm			
0	52.6	52.7	52.2	52.5 c
400	57.6	57.0	57.1	57.2 b
800	59.9	59.7	59.9	59.8 a
Mean effect of phosphorus	56.7	56.5	56.4	

* Average of plantilla and first ratoon crops. Measurements taken at one meter above ground surface.

**Potassium means followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

Table 45. Effect of phosphorus and potassium fertilization on the average pseudostem circumference at shooting of plantilla and first ratoon crops. PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs/a/y	Applied phosphorus - lbs/a/y 0	100	200	Mean effect of potassium
	plantilla - pseudostem circumference - cm			
0	46.7	46.8	46.6	46.7
400	50.0	49.8	50.1	50.0
800	52.3	52.2	52.2	52.2
	first ratoon - pseudostem circumference - cm			
0	60.0	59.6	59.5	59.7
400	66.2	65.5	65.4	65.7
800	68.0	67.7	68.2	68.0
Mean effect of phosphorus				
Plantilla:	49.7	49.6	49.6	
First ratoon:	64.7	64.3	64.4	

Table 46. Effect of phosphorus and potassium fertilization on average finger length of apical hand.* PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y 0	100	200	Mean effect of potassium**
	centimeters			
0	19.5	19.6	19.6	19.6 b
400	20.3	20.2	20.1	20.2 a
800	20.3	20.2	20.2	20.2 a
Mean effect of phosphorus	20.0	20.0	20.0	

* Taken on middle finger outer whorl. Plantilla on first ratoon fruit.

**Potassium means followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

Table 47. Effect of phosphorus and potassium fertilization on average finger length of middle hand.* PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y			Mean effect of potassium**
	0	100	200	
	centimeters			
0	22.5	22.6	22.6	22.6 b
400	23.8	23.6	23.6	23.7 a
800	24.0	23.9	23.9	23.9 a
Mean effect of phosphorus	23.4	23.4	23.4	

* Taken on middle finger outer whorl. Plantilla and first ratoon fruit.

**Potassium means followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

Table 48. Effect of phosphorus and potassium fertilization on average finger length of basal hand.* PK Experiment, Farm 24 - Changuinola, Panamá.

Applied potassium lbs./a/y	Applied phosphorus - lbs./a/y 0	100	200	Mean effect of potassium**
	centimeters			
0	23.9	24.0	24.1	24.0 b
400	25.3	25.2	25.0	25.2 a
800	25.4	25.4	25.5	25.4 a
Mean effect of phosphorus	24.9	24.9	24.9	

* Taken on middle finger outer whorl. Plantilla and first ratoon fruit.

**Potassium means followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

Table 49. Effect of nitrogen and potassium fertilization on a three-year cumulative production (January, 1972 through December, 1974). NK Experiment, Farm 64 - Changuinola, Panamá.

Treatment - lbs./a/y		Stems per acre[1]				Gross yield
Nitrogen	Potassium	Shot	Harvested	Hanging[2]	Lost[2]	tons/a
150	0	2,409.3 bc	2,016.6 b	225.0	167.7	92.6 d
300	0	2,431.4 bc	2,087.2 ab	205.2	139.0	99.6 abcd
450	0	2,486.6 ab	2,036.5 ab	227.3	222.8	98.3 bcd
600	0	2,532.9 a	2,122.5 ab	231.7	178.7	101.7 abc
750	0	2,532.9 a	2,142.4 a	225.1	165.5	98.7 bcd
150	400	2,374.1 c	2,025.4 ab	203.1	145.6	96.4 cd
300	400	2,413.7 bc	2,029.8 ab	211.8	172.1	98.9 bcd
450	400	2,508.6 a	2,124.7 ab	242.7	141.2	106.6 a
600	400	2,541.9 a	2,109.3 ab	209.6	222.8	106.6 a
750	400	2,543.9 a	2,091.6 ab	244.9	207.4	104.3 ab
Nitrogen mean		2,478.6	2,081.0	222.9	174.7	98.2
Nitrogen + Potassium mean		2,476.4	2,076.2	222.4	177.8	102.6
C.V., %		2.5	4.2	26.4	38.0	5.7

1/ Means within columns followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

2/ Differences not statistically significant.

The amount of fruit harvested was only significant between 150 and 750 pounds of Nitrogen/acre/year when plants were fertilized only with Nitrogen. There were no significant differences among Nitrogen rates when Potassium was included in the fertilizing program. This indicates that in an exceptionally good area, the number of stems harvested is not the most suitable parameter to evaluate response to Nitrogen rates. At any of the Nitrogen rates under study, the addition of 400 pounds of Potassium/acre/year did not result in a significant increase in stems harvested.

The amount of fruit that remained hanging at the termination of the study (December 31, 1974) was not related to treatment.

Cumulative fruit field losses were also independent of the treatment. The average annual losses for the only Nitrogen treatments were 58 stems per acre; while losses in the Nitrogen plus Potassium plots were 59 stems per acre.

Gross yield response clearly shows that when Nitrogen is used alone, no substancial (statistically significant) increase in tonnage is obtained beyond the application of 300 pounds of Nitrogen per acre per year. But when Potassium was incorporated into the fertilizing program, the level of Nitrogen fertilization had to be increased to 450 pounds/acre/year. It must be remembered that this experiment was conducted on an exceptionally good area, and the interpretation of data applies only to the experimental area or very similar areas of bananas growing on sediments deposited by the Changuinola River.

Comparisons of the data by Nitrogen level with Potassium and without Potassium show that the only comparison in which the difference was attributed to Potassium was at 450 pounds of Nitrogen/acre/year. The addition of 400 pounds of Potassium/acre/year resulted in an average annual increase of 2.8 tons of stem fruit; this is equivalent to approximately 104 boxes of fruit/acre/year.

The average annual production in boxes per net acre was as follows:

Nitrogen Lbs./A/Y	With Potassium 400 Lbs./A/Y	Without Potassium	Difference (NK-K)
		Boxes/Net Acre/Year	
150	1,238	1,191	+ 47
300	1,272	1,280	- 8
450	1,369	1,265	+104
600	1,369	1,307	+ 62
750	1,342	1,268	+ 74

The data indicate that in the best soils developed from sediments deposited by the Changuinola River, response to the application of 400 pounds of Potassium/acre/year becomes statistically significant when the increase in production, due to Potassium, is at least 100 boxes per acre per year.

The breakdown of plant losses with and without fruit are given on Tables 50 and 51, respectively. Although the magnitude of fruit losses (Table 50) in each cause was different between the Nitrogen and the Nitrogen plus Potassium treatments, the main causing contributors in order of importance were: 1) undetermined (others), 2) snap-off, 3) uproots, and 4) doublings.

Table 52 shows the effect of the fertilizer treatments on certain characteristics of the bunch. No significant differences were obtained in bunch weight when the Nitrogen rates were applied alone. The addition of 400 pounds of Potassium/acre/year, however, resulted in a significant difference among Nitrogen levels. A significant increase in bunch weight was recorded when the Nitrogen application (plus Potassium) was augmented from 150 to 450 pounds/acre/year. As an average of all Nitrogen treatments, the mean bunch weight without Potassium was 94.3 pounds, and with Potassium 98.8 pounds. The effect of Potassium became significant only at the 600 and 750 pounds of Nitrogen/acre/year.

The average number of hands per stem was gradually augmented by increasing the Nitrogen rate. However, not all possible comparisons were statistically significant.

An increase in the rate of Nitrogen application resulted in a slight increase in days from shooting to harvest. Potassium had no effect on the maturation period of the bunch.

The finger length of the fruit was not influenced by Nitrogen nor Potassium rates. All fruit from the apical hand was classified as CHIQUITA.

The effect of Nitrogen rates with and without Potassium on some plant characteristics is given on Table 53. There was an increase in average number of leaves between the first two Nitrogen rates and the remaining ones. No significant differences were found between the no Potassium and Potassium plots.

Response with regard to average hands harvested per stem was essentially the same for all Nitrogen levels with and without Potassium.

Plant height was significantly increased only by changing the rate of Nitrogen from 150 to 300 pounds per acre per year. The addition of Potassium did not significantly change the plant height at any of the Nitrogen levels tested. Plant girth was essentially the same for all treatments except between the 150 pounds Nitrogen plus 400 pounds Potassium and 450 pounds Nitrogen plus 400 pounds Potassium. SIERRA, ESPINOZA

D. Breakdown of plant losses with fruit that occurred during a three-year period (January, hrough December, 1974). NK Experiment, Farm 64 - Changuinola, Panamá.

nt - lbs./a/y		Plants with fruit lost/acre							
n	Potassium	Doublings	Uproots	Snap-off	Head rot	Yellow mat	Blowdown	Others	Total
	0	15.4	30.9	33.1	6.6	6.6	4.4	70.6	167.6
	0	15.4	24.3	41.9	2.2	---	---	55.2	139.0
	0	11.0	55.2	39.7	4.4	---	15.4	97.1	222.8
	0	22.1	13.2	22.1	---	---	8.8	112.5	178.7
	0	24.3	13.2	50.7	---	---	2.2	75.0	165.4
	400	19.9	37.5	46.3	---	---	---	41.9	145.6
	400	15.4	35.3	44.1	8.8	---	4.4	64.0	172.0
	400	15.5	35.3	22.1	2.2	---	2.2	64.0	141.3
	400	28.7	39.7	55.2	---	---	6.6	92.7	222.9
	400	26.5	46.3	59.6	4.4	---	---	70.6	207.4
n mean		17.6	27.4	37.5	2.6	1.3	6.2	82.1	174.7
ean		21.2	38.8	45.5	3.1	---	2.6	66.6	177.8
nce (NK-N)		+3.6	+11.4	+8.0	+ .5	-1.3	-3.6	-15.5	+3.1

51. Breakdown of plant losses without fruit that occurred during a three-year period (January, through December, 1974). NK Experiment, Farm 64 - Changuinola, Panamá.

ent - lbs./a/y		Plants lost without fruit/acre							
en	Potassium	Doublings	Uproots	Snap-off	Head rot	Yellow mat	Blowdown	Others	Total
	0	4.4	6.6	11.0	---	2.2	2.2	50.7	77.1
	0	11.0	4.4	4.4	---	4.4	2.2	55.2	81.6
	0	13.3	11.0	4.4	---	6.6	2.2	68.4	105.9
	0	2.2	2.2	---	---	---	---	46.3	50.7
	0	2.2	---	---	6.6	---	---	44.1	52.9
	400	8.8	---	2.2	---	---	6.6	41.9	59.5
	400	4.4	6.6	---	---	---	---	33.1	44.1
	400	6.6	6.6	---	2.2	---	2.2	53.0	70.6
	400	11.0	4.4	4.4	---	2.2	---	28.7	50.7
	400	8.9	4.4	4.4	---	---	4.4	48.5	70.6
en mean		6.6	4.8	4.0	1.3	2.6	1.3	52.9	73.6
nean		7.9	4.4	2.2	.4	.4	2.6	41.0	59.1
ence (NK-N)		+1.3	- .4	-1.8	- .9	-2.2	+1.3	-11.9	-14.5

2. Effect of nitrogen rates with and without potassium on certain characteristics of the fruit (average of three years - January, 1972 through December, 1974). NK Experiment, Farm 64 - Anola, Panamá.

t - lbs./a/y Potassium	Bunch weight lbs.	Hands harvested per stem	Maturation period days	Finger length - inches Hand Apical	Middle	Basal
0	91.7 d	9.2 d	100.2 d	8.6	10.2	10.5
0	95.4 bcd	9.5 bcd	100.7 cd	8.5	10.1	10.5
0	96.6 abcd	9.6 abc	102.7 ab	8.4	10.1	10.5
0	95.8 bcd	9.6 abc	102.7 ab	8.4	10.0	10.4
0	92.2 d	9.4 cd	103.8 a	8.4	9.9	10.3
400	95.1 cd	9.4 cd	100.1 d	8.5	10.2	10.6
400	97.5 abc	9.8 ab	102.0 bc	8.6	10.1	10.5
400	100.4 ab	9.9 a	102.7 ab	8.4	10.0	10.5
400	101.2 a	9.9 a	103.7 a	8.4	10.1	10.6
400	99.6 abc	9.9 a	103.4 ab	8.5	10.0	10.5
n mean	94.3	9.5	102.2	8.5	10.1	10.4
ean	98.8	9.8	102.4	8.5	10.1	10.5
	4.1	3.1	1.2	---	---	---

ithin columns followed by the same letter are not significantly different at the 5% level uncan's Multiple Range Test.

Table 53. Effect of nitrogen rates with and without potassium on certain plant characteristics (average of three years - January, 1972 through December, 1974). NK Experiment, Farm 64 - Changuinola, Panamá.

Treatment - lbs./a/y		Functional leaves at:		Plant height	Pseudostem diameter
Nitrogen	Potassium	Shooting	Harvest	feet	inches
150	0	13.3 d	9.0 c	13.4 c	9.9 c
300	0	13.4 cd	9.1 bc	13.7 b	10.0 bc
450	0	13.8 ab	9.2 ab	13.9 ab	10.2 abc
600	0	13.9 a	9.4 a	13.9 ab	10.1 abc
750	0	14.0 a	9.4 a	13.9 ab	10.1 abc
150	400	13.4 cd	9.1 bc	13.7 bc	10.0 bc
300	400	13.6 bc	9.2 ab	13.9 ab	10.3 ab
450	400	13.9 a	9.3 ab	14.2 a	10.4 a
600	400	13.9 a	9.3 ab	14.2 a	10.4 a
750	400	13.9 a	9.3 ab	14.1 a	10.5 a
Nitrogen mean		13.7	9.2	13.8	10.1
N + K mean		13.7	9.2	14.0	10.3
C.V., %		1.4	1.8	2.2	3.2

Means with columns followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

Phosphorus-Potassium Experiment (Fertica), Farm 46 - Coto District, C. R.

The application of treatments started on August 29, 1973, and data collection on January 1, 1974. Table 54 gives a summary of the production through December, 1974, in this experiment. The only treatment that had a significant effect on fruit harvested was Treatment 5. In this treatment the amount of fruit harvested was 20% higher than that obtained in the control. Treatment 5 also gave a significant increase in gross yield over the control; in this instance it amounted to 36%. Since there was no significant difference between the control and either Treatments 2 or 4, the effect cannot be clearly attributed to the application of 200 pounds of Phosphorus/acre/year.

The application of 400 and 800 pounds of Potassium/acre/year resulted in a substancial increase in bunch weight over that of the control. However, the increase obtained by the 800-pound level was not statistically significant from that of the 400-pound treatment. The application of 400 pounds of Potassium without Phosphorus gave an average increase in bunch weight of 7.6% over the control. The addition of 800 pounds of Potassium with and without Phosphorus resulted in a 12.6 and 14.3 percent increase in bunch weight over the control, respectively. The increase in bunch weight, due to Phosphorus fertilization, was small and not statistically significant.

The independent effects of Phosphorus and Potassium on bunch weight are given in the following tables:

Independent effect of Phosphorus:

Lbs./acre/year		Average bunch	Percent gain
Phosphorus	Potassium	weight pounds	over control
0	0	69.8	---
100	0	73.4	5.2
200	0	71.4	2.3

Independent effect of Potassium:

Lbs./acre/year		Average bunch	Percent gain
Phosphorus	Potassium	weight pounds	over control
0	0	69.8	---
0	400	75.1	7.6
0	800	79.8	14.3

Table 54. Combined and independent effect of phosphorus and potassium on production. Fertilizer (Fertica) Experiment , Farm 46 - Coto District, Costa Rica.

Nº	Treatment[1] Pounds/acre/year Potassium	Phosphorus	Stems harvested per acre[2]	Gross yield tons/acre[2]	Bunch weight pounds[2]	Losses/acre With fruit	Without fruit	Total
1	400	0	685.0 b	25.86 b	75.1 abc	198.0	50.4	248.4
2	800	0	700.6 b	27.89 b	79.8 a	159.2	67.9	227.1
3	0	100	727.7 b	26.64 b	73.4 bc	130.0	85.4	215.4
4	0	200	708.3 b	25.28 b	71.4 c	128.0	83.5	211.5
5	800	200	830.6 a	32.60 a	78.6 ab	100.9	67.9	168.8
6	0	0	690.9 b	24.00 b	69.8 c	139.7	73.8	213.8
Mean			723.9	27.04	74.7	142.6	71.5	214.1
C.V., %			13.2	14.5	6.8	---	---	---

[1] First application of treatments: August 29, 1973. Collection of agronomic data started January, 1974.

[2] Means followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

Table 55 gives the breakdown of fruit losses per acre through December, 1974. There is no relationship between fertilizer treatments and the losses occurred in any of the loss categories. Of the total losses registered 14% were due to doublings, 29% to uproots, 19% to undetermined causes, and 32% to the strike that occurred in July, 1974. The losses per acre, due to the strike, only amounted to 46 stems. SIERRA, STEPHENS

Complete Fertilizer Experiment - Palmar, Costa Rica

A summary of the independent effects of Nitrogen, Phosphorus, and Potassium on production during the period is given on Table 56. A considerable amount of fruit was not harvested and records of normal losses were taken during the strike in July, 1974. Therefore, stems harvested cannot be used satisfactorily, at this time, to measure response due to the variability that existed among plots. This also has an effect in any other parameter used to evaluate response. Nevertheless, the yield response was proportional to the amount of Nitrogen applied. The response in yield obtained over the control, by the application of 125, 250, 375 and 500 lbs. of Nitrogen/acre/year was 7.5, 11.1, 10.2 and 18.0 percent, respectively. With regard to bunch weight increase these treatments, and in the same order, gave a 2.3, 5.8, 4.5 and 8.8 percent increase over the control. There was no yield or bunch weight improvement with the application of Phosphorus. A gradual increase in gross yield and bunch weight was obtained by increasing the level of Potassium applied.

Table 57 shows the breakdown of losses recorded during the period. There appears to be no relationship between losses and treatment.

The data was not analyzed statistically because this trial will be terminated on March 31, 1975. At this time the data will be thoroughly analyzed. SIERRA, STEPHENS

Lime Rate Experiment - Palmar District, Costa Rica

The objectives, treatments, and experimental design were given in the 1973 Research Annual Report. On December 31, 1974, this trial completed 32½ months from planting. The data reported here are that accumulated during this period.

Bananas have not responded to liming in any of the parameters used for evaluation. However, a numerical yield and bunch weight difference exist between the limed and unlimed plots, but the differences are not statistically significant.

Table 55. Breakdown of fruit losses per acre by cause. PK Experiment, Farm 46 - Coto District, Costa Rica. (From September, 1973 through December, 1974).

Treatment number	Stems lost per acre							
	Doubling	Uproot	Snap-off	Moko	Head rot	Wind	Strike	Others
1	27.2	56.3	3.9	---	---	1.9	52.4	56.3
2	19.4	50.5	---	1.9	---	7.8	46.6	33.0
3	23.3	33.0	---	---	7.8	1.9	44.6	19.4
4	5.8	42.7	1.9	---	1.9	---	58.2	17.5
5	13.6	31.0	3.9	2.0	1.9	1.9	27.2	19.4
6	27.2	36.9	1.9	1.9	1.9	2.0	46.6	21.3
Mean	19.4	41.7	1.9	1.0	2.3	2.6	45.9	27.8

Table 56. Summary of independent effects of nitrogen, phosphorus, and potassium on production. From planting April, 1971 through December, 1974. NPK Experiment - Palmar, Costa Rica.

Nº	Treatment Pounds/acre/year N	P	K	Stems harvested per acre	Fruit losses per acre	Gross yield tons/acre	Average bunch weight pounds[1/]
Nitrogen Effect							
16	0	50	200	2,089.6	347.5	77.15	73.7
10	125	50	200	2,191.6	333.6	82.90	75.4
9	250	50	200	2,200.8	495.8	85.78	78.0
11	375	50	200	2,191.6	403.1	85.05	77.0
17	500	50	200	2,270.4	505.1	91.05	80.2
Phosphorus Effect							
18	250	0	200	2,251.8	379.9	87.03	77.4
12	250	25	200	2,126.7	616.2	86.00	81.0
9	250	50	200	2,200.0	495.8	85.78	78.0
13	250	75	200	2,214.7	454.1	87.05	78.5
19	250	100	200	2,219.4	338.3	84.85	76.5
Potassium Effect							
20	250	50	0	2,372.3	352.1	85.45	72.1
14	250	50	100	2,237.9	389.2	87.48	78.2
9	250	50	200	2,200.8	495.8	85.78	78.0
15	250	50	300	2,293.5	356.8	91.40	79.5
21	250	50	400	2,228.7	375.3	91.08	81.7

[1/] Includes plantilla fruit.

Table 57. Breakdown of fruit losses in the NPK Experiment - Palmar, Costa Rica[1/]. From planting April, 1971 through December, 1974.

Treatment				Stems lost per acre							
	Pounds/acre/year										
Nº	N	P	K	Doubling	Uproot	Snap-off	Moko[2/]	Head rot	Wind	Farm	Others
Nitrogen Effect											
16	0	50	200	162	88	32	---	42	---	---	23
10	125	50	200	111	102	23	(2)	28	---	---	60
9	250	50	200	167	139	51	(4)	60	---	5	56
11	375	50	200	157	125	23	---	23	---	23	51
17	500	50	200	232	144	51	(3)	32	5	---	28
Phosphorus Effect											
18	250	0	200	162	130	19	(1)	28	---	9	28
12	250	25	200	195	241	60	(1)	56	---	23	37
9	250	50	200	167	139	51	(4)	60	---	5	56
13	250	75	200	116	204	28	(1)	28	---	9	65
19	250	100	200	139	125	9	(2)	14	---	---	42
Potassium Effect											
20	250	50	0	116	125	28	(2)	37	---	5	32
14	250	50	100	167	139	28	(2)	14	---	9	23
9	250	50	200	167	139	51	(4)	60	---	5	56
15	250	50	300	74	130	42	(5)	23	---	28	37
21	250	50	400	139	144	28	(1)	19	---	5	37

[1/] Fruit not harvested or lost during the strike is not included.

[2/] Not reported on per acre basis; numbers in parenthesis are total Moko cases in four replications.

Table 58 shows the response obtained during the period. The two controls (Treatment 1 plowed and Treatment 6 unplowed) show some difference in response. More stems were harvested in the plowed than in the unplowed plots; gross yield was also proportional to the stems harvested since the difference in stem weight was only about two pounds.

Field losses in the plots that received lime are approximately one-fourth lower than any of the controls. Differences among rates, however, are not statistically significant. The average losses/acre in the limed plots were approximately 473 stems while in the control they amounted to 600 during the 32½-month period. Uprootings in the limed plots are also one-fourth less than those obtained in the controls (Table 59). This is an indication that liming improves the root system of the banana plant and consequently provides better anchorage to the plant. There were no differences in uproot losses among lime rates. The equivalent weekly losses were 4 for the controls and about 3.1 for the limed plots.

Liming has not influenced the number of leaves at shooting or harvest time. Plant height and pseudostem diameter was essentially the same in all treatments (Table 60).

Based on the results obtained, one can conclude that liming the Palmar soils does not result in a significant yield increase. SIERRA, STEPHENS

Chemical Analyses of the Banana Leaf

Leaf lamina samples (3rd leaf) for chemical analyses were collected from recently shot plants in the experiments in Farms 24 (PK) and 64 (NK), Changuinola, Panamá. Sampling was made in September, 1974.

The average chemical composition of the banana leaf lamina in the Phosphorus-Potassium Rate Experiment in Farm 24 is given on Table 61. Nitrogen fertilization in this trial was constant in all PK combinations. Neither Phosphorus nor Potassium rate had an effect on the concentration of Nitrogen in the lamina. The overall average Nitrogen content was 3.06 percent. The Phosphorus content ranged from .14-.15 percent. Changing the level of Potassium fertilization did not influence the concentration of Phosphorus in the leaf. The amount of Potassium accumulated in the leaf was directly proportional to the level of Potassium applied. There were no significant interactions between applied levels of Phosphorus and Potassium on the Potassium concentration in the lamina tissue. The average Potassium content for the 0, 400 and 800 pounds of Potassium per acre per year was 1.46, 2.54 and 2.93, respectively. The Potassium concentrations in the controls (no Potassium) are definitely at a deficient level; those found in plants fertilized with 400 pounds of Potassium per acre per year are somewhat below the level of adequacy and those that received 800 pounds of Potassium/acre/year are slightly above the level of adequacy.

ble 58. Cumulative response of VALERY bananas to liming in Palmar soils.[1] Lime rate study - Palmar District, Costa Rica.

Treatment Limestone Short tons/acre	Stems harvested/acre	Field losses per acre	Gross yield tons/acre	Ave. bunch weight, lbs.	Hands/stem at harvest	Maturation period days
0[2]	1,876.8	600.3	68.04	72.8	8.2	97.4
1	1,984.9	460.0	74.58	75.2	8.2	97.3
2	1,952.7	455.4	75.37	77.0	8.3	101.8
4	1,920.5	552.0	75.59	78.7	8.5	99.0
8	1,987.2	423.2	76.32	77.1	8.4	98.1
0[3]	1,734.2	600.3	64.94	75.2	8.1	96.8
Mean	1,909.4	515.2	72.47	76.0	8.3	98.4
st. Significance	NS	NS	NS	NS	NS	----
V., %	8.8	28.9	10.2	5.1	3.0	2.1

From planting April 12-17, 1972 through December, 1974.

Plowed control.

Unplowed control.

Table 59. Breakdown of field losses from planting April 12-17, 1972 through December, 1974. Lime rate study, Palmar District, Costa Rica.

Treatment		Field losses per acre										
No	Limestone Short tons/acre	Doubling	Uproot	Snap-off	Head rot	Wind	Moko	Strike	Harvested by farm	Others	Plants without fruit	Total with and without fruit
1	0[1/]	147.2	202.4	78.2	64.4	2.3	0	32.2	2.3	71.3	96.6	696.9
2	1	131.1	154.1	50.6	48.3	0	4.6	20.7	2.3	48.3	108.1	568.1
3	2	128.8	151.8	57.5	43.7	0	11.5	16.1	4.6	41.4	128.8	584.2
4	4	149.5	165.6	71.3	43.7	2.3	11.5	23.0	0	85.1	119.6	671.6
5	8	117.3	151.8	39.1	34.5	2.3	9.2	25.3	0	43.7	103.5	526.7
6	0[2/]	177.1	200.1	46.0	46.0	2.3	16.1	27.6	0	85.1	128.8	729.1
	Mean	141.8	171.0	57.1	46.8	1.5	8.8	24.2	1.5	62.5	114.2	629.4

[1/] Plowed control.

[2/] Unplowed control.

Table 60. Effect of liming on some characteristics of the VALERY plant.[1] Lime rate study - Palmar District, Costa Rica.

Treatment Nº	Limestone Short tons/acre	Average functional leaves at: shooting	harvest	Average plant height, feet[2]	Ave. pseudostem diameter, inches[2]
1	0[3]	13.2	6.9	10.8	7.6
2	1	13.3	7.0	10.9	7.6
3	2	13.5	7.0	11.0	7.7
4	4	13.5	7.1	11.1	7.8
5	8	13.3	7.2	11.0	7.8
6	0[4]	13.2	6.9	11.0	7.7
	Mean	13.3	7.0	11.0	7.7

[1] Average of all crops harvested from planting April 12-17, 1972 through December, 1974.

[2] Measurements taken at time of shooting.

[3] Plowed control.

[4] Unplowed control.

Table 61. Average chemical composition of the lamina tissue of the third youngest leaf.[1/] PK Experiment, Farm 24 - Changuinola, Panamá. Grand Nain variety sampled on September 12-14, 1974.

Treatment - lbs/acre/year[2/]			Percent - oven dry basis					Parts per million			
N	P	K	N	P	K	Ca	Mg	Fe	Mn	Cu	Zn
350	0	0	3.03	.14	1.53	.82	.42	128	380	28	35
350	0	400	3.17	.15	2.52	.81	.38	116	627	31	35
350	0	800	3.10	.14	3.04	.83	.35	130	844	33	35
350	100	0	3.12	.15	1.41	1.01	.47	163	536	31	32
350	100	400	3.09	.15	2.56	.84	.40	131	681	38	36
350	100	800	3.07	.15	2.88	.79	.36	113	792	29	34
350	200	0	3.04	.14	1.44	.95	.44	146	483	33	33
350	200	400	3.01	.15	2.53	.88	.40	103	758	34	32
350	200	800	2.96	.15	2.86	.75	.35	121	702	29	36

[1/] Plants sampled were 1st ratoon. Means are averages of eight replications and in each replication the sample was composited from four recently shot plants.

[2/] Treatments first applied on June 27-29, 1973.

The concentration of Calcium was not influenced by the amount of Phosphorus applied. Potassium fertilization had a depressing effect on Calcium accumulation only in the presence of Phosphorus in the fertilizer mixture. This indicates an interaction between Phosphorus and Potassium on Calcium accumulation.

The Magnesium concentration tended to increase slightly by augmenting the rate of Phosphorus application. Increasing the level of Potassium fertilization, however, tended to reduce the concentration of Magnesium in the leaf lamina.

Table 62 shows the chemical composition of the leaf lamina of the VALERY plant in the NK Experiment in Farm 64, Changuinola, Panamá. The Nitrogen concentration in the leaf lamina increased slightly with an increase in Nitrogen applied. There appears to be no definite indication that the application of Potassium in the combination with Nitrogen results in a higher Nitrogen concentration in the leaf. The Phosphorus concentration was essentially the same for all treatments. The addition of 400 pounds of Potassium/acre/year to the Nitrogen treatments resulted in a higher concentration of Potassium in the leaf lamina. No interaction effect between Nitrogen and Potassium occurred.

There are not clear trends of the Nitrogen and Potassium fertilization effect on the content of Calcium and Magnesium in the leaf lamina.

The levels of Potassium found in the plants receiving only Nitrogen indicate that plants are obtaining sufficient Potassium for their metabolic needs. The application of 400 pounds of Potassium/acre/year gives a higher concentration of Potassium in the tissue; this increase amounts to about 12% over that found in the no Potassium plots.

A comparison in the average Potassium content of the leaf lamina of plants fertilized with only Nitrogen, in Farm 64 and 24, show that in Farm 64 plants take up sufficient Potassium from the soil for their needs (leaf Potassium content 2.76 percent); while in Farm 24 the soils do not have an ample supply of Potassium for normal growth (leaf Potassium content 1.46 percent). Plants receiving 400 pounds of Potassium per acre per year had a concentration of 3.11 percent in Farm 64 and 2.54 percent in Farm 24. The difference in Potassium content between the two locations may reflect the level of available Potassium in the soil. The level of available Potassium in the soil is influenced by certain chemical and physical properties of the soil, such as Potassium fixation power of the soil, degree of aeration, and prevailing soil-moisture relationships.

The preliminary information on Potassium content of the banana leaf, stresses the importance of mapping the Potassium status of the various soils in order to elaborate an adequate Potassium fertilization program for the different areas. Prices of fertilizer materials are continually increasing and we must be absolutely sure that we are applying the amount required to meet the plant needs for an economic production of quality bananas. Reports in the literature indicate that the Potassium level of adequacy in the leaf lamina of the banana plant is 2.75 percent and that severe deficiency symptoms occur when it falls below 2.08 percent. SIERRA

Table 62. Average chemical composition of the lamina tissue of the third youngest leaf.[1/] NK Experiment, Farm 64 - Changuinola, Panamá. VALERY variety sampled on September 16-18, 1974.

Treatment - lbs/a/y[2/]		Percent - oven dry basis					Parts per million			
N	K	N	P	K	Ca	Mg	Fe	Mn	Cu	Zn
150	0	2.46	.15	2.81	.55	.29	93	241	32	33
150	400	2.45	.16	3.25	.60	.29	98	365	33	34
300	0	2.53	.16	2.98	.57	.30	114	273	33	35
300	400	2.62	.15	3.05	.60	.30	107	359	32	35
450	0	2.73	.15	2.65	.69	.32	102	278	38	38
450	400	2.66	.16	3.19	.66	.30	113	382	35	38
600	0	2.79	.16	2.71	.69	.35	112	372	37	36
600	400	2.71	.16	3.06	.66	.29	105	374	33	39
750	0	2.67	.17	2.65	.65	.35	128	330	37	38
750	400	2.85	.15	3.00	.70	.31	101	478	38	35

[1/] Ratoon plants sampled. Means are averages of six replications and in each replication the sample was composited from four recently shot plants.

[2/] Treatments first applied on January, 1972.

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During 1974 the following analyses were made:

1) 1,083 soil samples for complete chemical analyses.
2) 206 soil samples for grain size analyses.
3) 1,737 plant tissue samples for chemical analyses.
4) 536 samples (peanuts 435, soybean 88, and cowpea 13) were analyzed for moisture, oil, and protein content.
5) 140 banana fruit samples for bromine determination.
6) 104 plant extracts from oil palm fertilizer studies for calcium and magnesium determinations.
7) 234 sand samples from Ornamental Project, Campin for analyses.
8) 59 plant tissue samples from Campin for chemical analyses.
9) 51 fertilizer solution samples for analyses.
10) Miscellaneous analyses - grasses, palm kernels, water, river sediments, plant ashes, lime, and oil palm fruit.

MANZANARES

HERBICIDE TRIALS - HONDURAS

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HERBICIDE TRIALS - HONDURAS

EXPERIMENT 100 - INDIANA FARM, CONDE

Mixes of Karmex (1.5 lbs/A), Triazines, Spray oil (16 lt/A), and WK surfactants (.5%) were tested on Conde. The variable component of the basic mix was the form of the Triazine herbicide. Gesapax (2 lbs/A) was compared with Gesatop (2 lbs/A), Gesatop Z (2 lbs/A) and Gesatop Z (4 lbs/A).

At the 11 day stage the mix with the double rate of Gesatop Z showed best control followed by Gesapax. The poorest treatment in terms of early contact effects was Gesatop (simazine). At the 21-day stage the comparative results of the different Triazines were the same as earlier. At the 32-day stage the mix containing the double rate of Gesatop Z still gave best Conde control. The mix containing Gesapax was considerably inferior, but still second best. At the 42-day stage only the mix containing the double rate of Gesatop Z was still giving reasonable Conde control. In the other treatments Conde was recovering.

It should be pointed out that 4 lbs. Gesatop Z contains the same amount of ametryne as 2 lbs of Gesapax, but the 4 lbs of Gesatop Z contains, in addition, 1.6 lbs active simazine. The mix containing Gesatop (simazine) was the least effective in the series. Nevertheless the Triazine combination of ametryne + simazine (Gesatop Z) was much more effective than the same amount of ametryne without simazine when applied in this particular mix.

EXPERIMENT 101 - INDIANA FARM, CONDE

This experiment tested the effect of various pre-treatments of the weed cover under three different herbicides mixes. Treatments were chopping 1 week before spraying and beating Conde 1 week, 1 day and immediately before spraying. A control plot without pre-treatment was included.

Series A was sprayed with Weedazol TL (2 lt/A) + Gesapax (2 lbs/A) + Texaco spray oil (16 lt/A) + WK (.5%). At the 9-day stage the chopped plot looked best and the control plot worst in Conde control. The three beaten treatments were intermediate between these two extremes. At the 19-day stage control on all plots had improved. Again best control was seen in the pre-chop treatment. At the 26-day stage the check plot continued to improved in weed control till it was almost equal to the treated plots. At the 36-day stage the check plot was excellent, better than plots receiving a chop or mechanical beating prior to herbicide application. At the 60-day stage Conde control is good in the check plot and only slightly poorer in treated plots.

With the Weedazol-Gesapax-Spray oil-WK mixture there is apparently no long lasting advantage to a chopping or mechanical beating pre-treatment.

Possibly this very effective, proven Conde herbicide mix experiences no serious barriers to absorption as we apparently get with some less effective mixtures.

Series B was sprayed with Gesapax (2 lbs/A), Urea (100 lbs/A) and WK (.5%). The same pre-treatments were used in this series. At the 9-day stage the chopped plot and the Conde beaten immediately before herbicide application showed best early contact effects. At 19 days the chopped plot again showed best Conde control followed by beating immediately before application. The check plot without pre-treatment showed poorest Conde control. At 36-days again the chopped and beaten (immediately before) plots showed best Conde control. At the 60-day stage results were consistent with earlier observations.

In the Gesapax + Urea + WK series pre-application chopping or beating assisted in obtaining better weed control, presumably thry increased absorption of the herbicide, at least, in the case of beating.

Series C was sprayed with Gesapax (2 lbs/A) + Spray oil (16 lt/A) + WK (.5%). The same pre-application treatments were used in this series. At the 9-day stage the chopped and beaten immediately prior to application treatments showed the best control of Conde. Poorest control was seen in the check plot and the plot beaten one week before application. At 19-26 days comparable results were observed. At the 36 and 60 day stages the pre-chopped plot still showed very good Conde control. Poorest results were seen in the check plot.

This series gave results similar to Gesapax-Urea series, with the pre-application treatments proving beneficial to weed control when compared with the check plots. Gesapax with only adjuvants is apparently limited in its effectiveness by the completeness of absorption into the Conde plant. The Weedazol - Gesapax mixture, on the other hand, appears to have no absorption problems.

EXPERIMENT 102 - INDIANA FARM, CONDE

In this test Gesapax (2 lbs/A) and WK (.5%) were uniform in all treatments, while different quantities of Spray oil and Diesel oil were the variables being tested. Adjuvant quantities were as follows: Spray oil (16 lt/A), Spray oil (8 lt/A), Diesel oil (16 lt/A), Spray oil (8 lt/A) + Diesel oil (8 lt/A), Spray oil (4 lt/A) + Diesel oil (12 lt/A), Spray oil (16 lt/A) + Diesel oil (16 lt/A). Controls with no adjuvants were included. Two replications were used.

At the 10-day stage differences between treatments are relatively small and agreement between the results of the two replications is not good. At this stage the treatments with no adjuvants were generally inferior to those with adjuvants. At the 21-day stage the no adjuvant but double surfactant check gave better Conde control than the normal level of surfactant without adjuvants. Differences in control between different adjuvant treatments were

not large enough or consistent enough to draw reliable conclusions. At 31 days treatments with adjuvants gave slightly better Conde control than checks with surfactant at the .5% level, but no better than checks with the double rate of surfactant. At the 52-days stage Conde control in general was only mediocre in this experiment, but the differences between treatments remained consistent with earlier observations.

The amount of sunlight reaching the Conde level has a more profound effect on Conde control than do the different adjuvant levels used in this experiment.

EXPERIMENT 103 - INDIANA FARM, CONDE

This test compared Weedazol TL (2 lt/A) + Gesapax (2 lb/A) with Weedazol TL + Gesatop Z (2 lbs/A) with Weedazol TL + Gesatop Z (4 lbs/A). All mixes included Spray oil adjuvant at (16 lt/A) and WK surfactant at(.5%). In addition the Weedazol + Gesapax combination was tested with Urea as an adjuvant. The plots were split and the left half received a pre-treatment of beating immediately before application. At the 10-day stage all treatments showed better Conde control in the beaten half. The mixes which gave best early effects on Conde were Weedazol TL + Gesapax with the Urea adjuvant and the treatment with the high rate of Gesatop Z. The treatment with Urea showed mainly a leaf-burn response whereas the Gesatop Z symptoms were principally leaf yellowing. At 21 days the Urea adjuvant with Weedazol TL + Gesapax still showed slightly better Conde control than the same herbicides with the Spray oil adjuvant. The beaten halves continued to show better control than the unbeaten portions, although in some cases the early lead of the beaten portions seemed to be diminishing. At the 31-day stage the best Conde control was given by the mix with the higher rate of Gesatop Z, and the beating pre-treatment assisted considerably in Conde control with this mix. At 52 days the beaten portion with the Weedazol TL + Gesatop Z (4 lb/A) mix was still giving excellent control of Conde, although all mixes tested in this test were giving good control even at this late stage. The Gesatop Z mixes gave considerably more control of Calica (Momordica charantia) than the Gesapax mixes. This is apparently due to the presence of the simazine component of Gesatop Z.

EXPERIMENT 104 - INDIANA FARM, CONDE

In this trial the effects of various adjuvant levels were tested on Gesapax (2 lb/A) with surfactant WK (.5%). Adjuvants were Spray oil at 16 and 32 lt/A, Diesel oil at 32 and 48 lt/A and Spray oil (16 lt/A) + Urea (50 lb/A). At the 10-day stage none of the treatments were showing a satisfactory level of control and the differences between adjuvants were small. At 21 and 31 days control continued mediocre in all treatments.

A complication due to early irrigation on recently treated plots was suspected as the cause of the low level of control obtained here.

EXPERIMENT 105 - INDIANA FARM, CONDE

Gesatop Z at (4 lbs./A) was tested with (1) no surfactant, no adjuvant, (2) surfactant WK (.5%), (3) Urea (100 lb/A) + WK (.5%), and (4) Spray oil (16 lt/A) + WK (.5%). A comparison plot of Gramoxone (.75 lt/A) + WK (.5%) was included. The plots were replicated twice. At the 12-day stage the surfactants and adjuvants appear to have no beneficial effect. All plots receiving Gesatop Z showed better Conde control than Gramoxone even at the early stage. At the 28-day stage just before the application of a second cycle of the same treatments all Gesatop Z treatments showed satisfactory Conde control, but no beneficial effects of the surfactant or adjuvants used were detected. Twelve days after the second cycle of herbicides similar results were obtained. By this stage the Gesatop Z plots were considerably better than the Gramoxone plots. Observations were terminated 39 days after the second herbicide cycle. At this point the treatment with the Urea adjuvant appeared to be slightly better than the other Gesatop Z treatments, and much better than the Gramoxone treatment.

EXPERIMENT 106 - INDIANA FARM, CONDE

This trial tested lower rates of Weedazol TL in Weedazol TL + Triazine mixtures. In Series A Weedazol TL at 1.5 lt/A was tested with Gesapax (2 lb/A), Gesatop Z (2 lb/A) and Gesatop (2 lb/A). In Series B Weedazol TL at 1.0 lt/A was tested with the same three Triazines. Series C tested the same rates of Weedazol TL and Triazines as Series A, but a Spray oil (16 lt/A) adjuvant was included in the mix. The surfactant WK (.5%) was included in all mixes.

At the 12-day stage Gesapax gave the best early contact effects in the Series A Weedazol TL mix. Gesatop on the other hand showed poor Conde control at this early stage. At the lower level of Weedazol TL Conde control was again best with Gesapax. The level of control was not affected, however, by reducing the level of Weedazol TL from 1.5 to 1.0 lt/A. In Series C with Spray oil adjuvant again Gesapax gave best early Conde control.

At 22 days similar results were obtained. The Weedazol TL (1 lt/A) + Gesapax (2 lb/A) gave surprisingly good Conde control considering the low level of herbicides used. The Gesatop Z mixes gave control only slightly inferior to Gesapax, but the Gesatop mixes were noticeably poorer at these early stages. The Spray oil adjuvant (Series C) did not help materially in Conde control.

At the 28-day stage there was little change in the plot ratings. At the 43-day and 69-day stages most of the plots still have a good level of weed control with little recovery of Conde. Best control was realized with Weedazol TL + Gesapax of Series B and poorest control with Weedazol + Gesatop. The Spray oil adjuvant showed a deleterious effect on Conde control in this test.

EXPERIMENT 107 - INDIANA FARM, CONDE

Roundup at 3 lt/A. was tested with no surfactant, WK and Triton X-45, all of these with and without Urea (100 lb/A). In addition Agral 90 was used as a surfactant without Urea.

At the 12-day stage mostly yellow leaf symptoms were observed. The Roundup-Urea no surfactant plot appeared to have the least leaf chlorosis of all the treatments. At the 22-day stage, Roundup control of Conde was not impressive in general, but yellowing of the Conde leaves was still progressing. Best treatments were Roundup with WK surfactant, but without Urea and Roundup with Triton X-45 and Urea. At the 28-day stage the same two treatments continued to look slightly better than the others. At the 43-day stage Conde control is still not satisfactory in this test as compared to Roundup effectiveness in earlier trials. Best control at this stage resulted from the Roundup + Urea + Triton X-45 mix. At the 69-day stage Conde control is poor and the addition of adjuvants and surfactants seemed to have helped very little.

EXPERIMENT 108 - INDIANA FARM, CONDE

In this trial herbicide recommendations for Conde supposedly originating from Del Monte, Guatemala were tested against our best cleared Conde mix. Gesapax (2 lb/A) + Karmex (1.5 lb/A) + Urea (100 lb/A) + Triton X-45 (.25%) was tested against Gramoxone (.75 lt/A) + Triton X-45 (1.0%) + Water at 60 gal/A, and Gramoxone (.75 lt/A) + Karmex (1.5 lb/A) + Triton X-45 (1.0%) + Water (60 gal/A). Two replications were used.

At 11 days good early Conde control was obtained by all three treatments. The two Gramoxone mixes gave surprisingly good results when used with double the usual levels of water and surfactant. At the 15-day stage Conde control is very good with all three mixes. At the 30-day stage the Gramoxone mix containing Karmex gave slightly better Conde control than the same mix without Karmex. Our Gesapax-Karmex mix showed an equivalent level of Conde control. At the 58-day stage Conde is recovering in the Gramoxone mix treatments and somewhat longer lasting control is seen in the Gesapax-Karmex treatments. The results of this experiment suggest that we should continue testing Gramoxone in high volume mixes for Conde control.

EXPERIMENT 109 - GUARUMA I FARM, LECHE GRASS

Leche grass (Ixophorus unicetus) is a troublesome grass in the Honduras division, partly because the standard grass herbicides Dowpon and Gramoxone are not very effective on this particular species. Ansar (MSMA) at 2 lt/A, Broadside (MSMA + Phytar) at 4 lt/A, Dowpon (5 lb/A) and Gramoxone (1 lt/A) were compared for leche grass control in mixes containing Karmex (1.5 lb/A) and WK (.5%).

At the 8-day stage very good contact effects were seen on the Ansar and Broadside treatments. The Gramoxone treatment showed some contact effects, but Dowpon revealed meager effects in this initial stage. At the 28-day stage Broadside gave excellent leche grass control with Ansar nearly as good. The Dowpon and Gramoxone treatments were vastly inferior. At 37 days the results continued the same. Bermuda grass and nut-sedge are prospering in the Broadside and Ansar treatments, but the leche grass has been controlled. Recovery of the leche grass in the Dowpon and Gramoxone treatments is almost complete at this stage. At the 56-day stage leche grass is completely eliminated in the Broadside plots, but a few sporadic clumps are recovering in the Ansar plot.

MSMA is a very effective herbicide for the hard to kill leche grass.

EXPERIMENT 110 - INDIANA FARM, CONDE

This trial compared different levels of surfactants WK and Triton ACT in a Weedazol TL (1 lt/A) + Gesapax (2 lb/A) mix applied on Conde. Surfactant levels were .25%, .5%, 1.% and 3% on a volume basis.

At the 11-day stage wilting of the Conde occurred and some new leaves were turning white in all treatments. At 19 days judged by the frequency of white leaves increasing levels of surfactant gave progressively better control. WK was better than ACT at the same levels of surfactant. At the 38-day stage the experiment as a whole gave poor control of Conde compared to earlier results. The cause for this failure of control was not determined.

EXPERIMENT 111 - INDIANA FARM, CONDE

In this trial various mixtures of Karmex + Gesatop Z and Weedazol TL + Gesatop Z were tested as follows:

T_1 - Karmex (1.5 lb/A) + Gesatop Z(4 lb/A) + WK (.5%)
T_2 - Karmex (1.5 lb/A) + Gesatop Z(4 lb/A)+ Urea (100 lb/A) + WK (.5%)
T_3 - Karmex (1.5 lb/A) + Gesatop Z(4 lb/A)+ Spray oil (16 lt/A) + WK (.5%)
T_4 - Karmex (1.5 lb/A) + Gesapax (4 lb/A)+ Urea (100 lb/A) + WK (.5%)
T_5 - Weedazol (1.5 lt/A) + Gesatop Z (3 lb/A) + WK (.5%)
T_6 - Weedazol TL (1.5 lt/A) + Gesatop Z (3 lb/A) + Urea (100 lb/A) + WK (.5%)
T_7 - Weedazol TL (1.5 lt/A) + Gesatop Z (3 lb/A) + Spray oil (16 lt/A) + WK (.5%)
T_8 - Weedazol TL (1.5 lt/A) + Gesapax (3 lb/A) + WK .5%

A heavy rain occured in this area about 12 hours after the application was made and apparently resulted in reduced weed control in this experiment.

At the 10-day stage wilting and burning of Conde leaves was occurring. Treatments 2 and 6 and especially T_4, containing Urea, showed more early burn than other treatments. At the 18-day stage the Urea treatments still looked best, although Conde control in general was poor in this experiment. At 37 days Conde control is unsatisfactory in all plots.

EXPERIMENT 112 - INDIANA FARM, CONDE

In this experiment many of the best Conde herbicide mixtures from earlier experiments were compared. The mixes were:

T_1 - Modown 3 lt/A + Gesapax (3 lbs./A) + Urea (100 lb/A) + WK (.5%)
T_2 - Weedazol TL (2 lt/A) + Gesapax (2 lb/A) + WK (.5%)
T_3 - Weedazol TL (2 lt/A) + Gesatop Z (4 lb/A) + WK (.5%)
T_4 - Modown (3 lt/A) + Ammate -X (25 lb/A) + Urea (100 lb/A) + WK (.5%)
T_5 - Roundup (3 lt/A) + Gesapax (3 lb/A) + Urea (100 lb/A) + WK (.5%)
T_6 - Roundup (3 lt/A) + Weedazol TL (3 lt/A) + Urea (100 lb/A) + WK (.5%)
T_7 - Gesapax (2 lb/A) + Devrinol (4 lb/A) + Urea (100 lb/A) + WK (.5%)
T_8 - Gesapax (3 lb/A) + Karmex (2 lb/A) + Urea (100 lb/A) + WK (.5%)
T_9 - Gramoxone (1.5 lt/A) + WK 1% + Double Water

At the 5-day stage treatments 4 and 9 were showing best early contact effects. At the 24 day stage the best treatments were T_5, T_2, and T_6. At this point the plots were inadvertently chopped and the observations were discontinued.

EXPERIMENT 113 - GUARUMA 1 FARM, LECHE GRASS

Since Ansar + Karmex proved so effective on leche grass in an earlier trial, this test was devised to see if reductions could be made in the levels of the herbicides used. The treatments were:

T_1 - Ansar (2 lt/A) + Karmex (1.5 lb/A) + X-45 (.5%)
T_2 - Ansar (1 lt/A) + Karmex (1.5 lb/A) + X-45 (.5%)
T_3 - Ansar (2 lt/A) + Karmex (.75 lb/A) + X-45 (.5%)
T_4 - Ansar (2 lt/A) + X-45 (.5%)
T_5 - Ansar (2 lt/A) + Gesapax (2 lb/A) + X-45 (.5%)

At the 8-day stage T_2 with the lower rate of Ansar showed considerably less contact effects on leche grass. The Karmex is apparently responsible for some early contact burn as well since T_4 has slightly less burn than T_1 and T_3. At the 35-day stage only T_1 gave complete control of leche grass. Reductions below 2 lt. of Ansar or 1.5 lb. of Karmex interfere with weed control.

The Ansar + Gesapax (T_5) mixture gave poor control of leche grass.

POST HARVEST PHYSIOLOGY

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BLOTCH

Blotch, known also as fungal scald, is best known as Almirante scald (a term which should be avoided as it implies a disorder unique to this specific production area) and is caused primarily by Colletotrichum musae. This disorder was first observed in Banavac shipments of Almirante bananas to Europe in 1968. It was determined at that time (1969 Annual Report) that blotch could be controlled by postharvest applications of Benlate or Thiabendazole. However, Almirante bananas have not been shipped in Banavac since 1969. In 1974, four experiments were conducted in Changuinola and two experimental shipments were made to Rotterdam to verify that blotch could be controlled in Banavac shipments of Almirante bananas. (See Table 1).

Green inspections of fruit in these experiments revealed that blotch symptoms were evident on control clusters, but virtually absent on those clusters treated with fungicide.

In the first experiment (Table 1A) blotch was present on over 75% of the control clusters (23.6% M ≠ S), but was only observed on 22% of those clusters treated with 300 ppm Benlate (0.8% M ≠ S). All other forms of peel and finger rotting were also significantly reduced by Benlate. Blotch control differences between farms were minimal, as seen in the table.

In the second experiment (Table 2) blotch affected 76% of the control clusters (10.8% M ≠ S), but only 19.6% of those treated with Benlate and 26% of those treated with Mertec. All other forms of peel and finger rotting were also significantly reduced by both fungicides. Between-farm differences were minimal, as in the first experiment.

In the third experiment (Table 3) blotch affected a much higher percentage of the clusters. Almost 95% of the alum-treated control clusters had blotch symptoms (71.1% M ≠ S). Thirty-six percent of those treated with 300 ppm Benlate were affected (10.5% M ≠ S) and over 46% of those treated at 500 ppm had blotch (12.8% m ≠ S). The incidence of finger rot was considerably higher than in the first two experiments; 29.3%, 11.6% and 7.1% for controls, 300 ppm and 500 ppm treatments, respectively.

Even though blotch was reduced by the postharvest applications of fungicides, this disorder was present at unacceptable levels. Ripe inspections for this experiment were performed at three different times, which was considered to have influenced the development of blotch and finger rot. Results of blotch evaluations were, therefore, separated according to inspection time (Table 4). Presented in this manner, it is obvious that blotch and finger rotting increased in severity and frequency of incidence as the storage and/or ripening time increased. While longer holding periods no doubt influence the development of blotch, poor ripening (retarded, uneven) was probably also a factor.

Blotch and finger rot were also more prevalent in this experiment than previously because of poor post-harvest chemical applications. In the first two experiments, all clusters were dipped, while in this, the clusters were sprayed to run-off in the fruit tray. Much of that blotch observed in

Table 1. Experimental Blotch Control Treatments - Changuinola, 1974

Experiment/Table	Date	Farms	Treatments	Method of application	No. clusters
1 (1)	4/16/74	11	Alum (1%)	dip	597
		33	Alum + 300 ppm Benlate	dip	597
		42			
		64			
2 (2)	4/26/74	11	Alum (1%)	dip	448
		33	Alum + 300 ppm Benlate	dip	403
		64	Alum + 500 ppm Mertect	dip	407
3 (3 & 4)	5/22/74	11	Alum (1%)	spray	318
		64	Alum + 300 ppm Benlate	spray	294
			Alum + 500 ppm Benlate	spray	312
4 (5)	7/9/74	64	Alum (1%), spray	spray	162
			Alum (1%)	dip	173
			Alum + 300 ppm Benlate	spray	173
			Alum + 300 ppm Benlate	double spray	163
			Alum + 300 ppm Benlate	dip	170
			Alum + 500 ppm Benlate	spray	169
			Alum + 500 ppm Benlate	double spray	165
			Alum + 500 ppm Benlate	dip	160

Table 1 A. Incidence of Blotch (Fungal Scald) on Almirante Valery Bananas in Banavac as Affected by Postharvest application of Benlate - First Local Experiment.

			Ripe Inspection - Percentage of Clusters											
			BLOTCH[b]						WET[c]		FINGER[e]	Assoc.[f] with		AVERAGE
TREATMENT	FARM	GREEN[a]	N	T	L	M	S	M&S	SCARRING	LESIONS[d]	ROT	LATEX	NO. CLUSTERS	CALIPER GRADE
Alum (1%)	11	T-S (T)	17.3	33.0	24.3	9.8	15.6	25.4	17.9	18.5	4.0	0.6	173	9.5
	33	N-S (T)	21.6	20.9	28.4	17.6	11.5	29.1	10.1	21.6	10.8	0.7	148	10.8
	42	N-S (T)	20.8	35.1	18.8	11.7	13.6	25.3	14.0	15.0	1.9	8.4	154	11.9
	64	N-T (T)	35.2	32.8	17.2	4.1	10.7	14.8	11.3	14.3	1.9	0	122	12.6
Alum + 300 ppm Benlate	11	N-M (N)	73.6	22.3	3.4	0	0.7	0.7	3.4	0	0	0	148	9.4
	33	N-T (N)	77.6	21.0	0.7	0.7	0	0.7	0	0	0.7	0	143	11.3
	42	N	91.8	8.2	0	0	0	0	0	0	0	0	159	10.5
	64	N	69.4	25.1	4.1	0.7	0.7	1.4	1.0	0.2	0.7	0	147	12.7
Alum		T	23.7	30.5	22.2	10.8	12.8	23.6	11.3	14.3	4.7	2.4	597	11.2
Alum & Benlate		N	78.0	19.1	2.1	0.4	0.4	0.8	1.0	0.2	0.4	0	597	11.0

a/ Green inspection on May 17, 31 days after harvest, was made by examining the fruit as the Banavac bags were opened (without removing clusters). The range of incidence is noted, with "mostly" in parenthesis.

b/ Blotch ratings; N (none) - clean, T (trace) - up to 1 in^2/cluster, L (light) - up to 2 in^2/cluster, M (medium) - up to 3 $in.^2$/cluster, S (severe) - over 3 in^2/cluster. Ripe inspection on May 24 & 25, 38 & 39 days after harvest.

c/ Wet scarring - rated also as trace or light blotch; caused by Colletotrichum musae, resembles scarring.

d/ Lesions - rated also as medium or severe blotch; caused by Colletotrichum musae, deep, sporulating wound.

e/ Finger rot - clusters rated separately for blotch; generally originating from tip.

f/ Associated with latex - blotch incidence on areas of peel covered by latex.

Table 2. Incidence of Blotch (Fungal Scald) on Almirante Valery Bananas in Banavac as Affected by Postharvest applications of Fungicides - Second Local Experiment.

			Ripe Inspection - Percentage of Clusters											
			BLOTCH[b]						WET[c]		FINGER[e]	ASSOC.[f] WITH		AVERAGE
TREATMENT	FARM	GREEN[a]	N	T	L	M	S	M&S	SCARRING	LESIONS[d]	ROT	LATEX	NO. CLUSTERS	CALIPER GRADE
Alum	11	N-L (T)	32.2	49.0	15.4	2.0	1.4	3.4	18.8	3.4	2.0	0.7	149	10.4
	33	N-S (T)	20.8	47.7	19.2	6.9	5.4	12.3	18.5	12.3	2.3	0.8	130	10.9
	64	T-M (T)	18.9	46.1	18.2	11.9	4.9	16.8	21.0	15.4	6.3	4.2	143	12.8
Alum & 300 ppm Benlate	11	N	78.0	21.3	0.7	0	0	0	4.0	0	0	1.3	150	9.9
	33	N-T (N)	79.1	20.9	0	0	0	0	1.4	0	0	0	139	10.4
	64	N	84.1	15.9	0	0	0	0	3.0	0	0	0	132	12.5
Alum & 500 ppm MERTEC	11	N-L (N)	74.5	24.8	0	0	0.7	0.7	6.0	0.7	0	0	149	10.0
	33	N-T (N)	70.1	28.4	1.5	0	0	0	6.7	0	0	0	134	10.6
	64	N-T (N)	77.3	20.4	2.3	0	0	0	8.3	0	0	0.8	132	12.4
Alum		N-S (T)	24.0	47.6	17.6	6.9	3.0	10.8	19.4	10.4	3.5	1.9	448	11.4
Alum & Benlate		N-T (N)	80.4	19.4	0.2	0	0	0	2.8	0	0	0.4	403	10.9
Alum & MERTEC		n-L (N)	74.0	24.5	1.3	0	0.2	0.2	7.0	0.2	0	0.3	407	11.0

a/ Green inspection May 25, 29 days after harvest, was made by examining the fruit as the Banavac bags were opened (without removing clusters). The range of incidence is noted, with "mostly" in parentheses.

b/ Blotch ratings: N (none) - clean, T (trace) - up to 1 in.^{2}/cluster, L (light) - up to 2 in.^{2}/cluster, M (medium) - up to 3 in.^{2}/cluster, S (severe) - over 3 in.^{2}/cluster. Ripe inspection on May 31, 35 days after harvest.

c/ Wet scarring - rated also as trace or light blotch; caused by Colletotrichum musae, resembles scarring.

d/ Lesions - rated also as medium or severe blotch; caused by Colletotrichum musae, deep sporulating wounds.

e/ Finger rot - clusters rated separately for blotch; generally originating from tip.

f/ Associated with latex - blotch incidence on areas of peel covered by latex.

Table 3. Incidence of Blotch (Fungal Scald) on Almirante Bananas in Banavac as Affected by Post-harvest Applications of Benlate. Third Local Experiment.

TREATMENT	FARM	RIPE INSPECTION; PERCENTAGE OF CLUSTERS										
		GREEN[a]	BLOTCH[b]						Finger Rot[c]	Assoc. With Latex[d]	No. Clusters	Average Caliper Grade
			N	T	L	M	S	M&S				
ALUM (1%)	11	T-M (L)	10.6	17.6	9.4	16.5	45.9	62.4	27.7	5.3	170	11.6
	64	L-S (M)	0	6.8	12.2	18.2	62.8	81.0	31.6	17.6	148	13.0
ALUM & 300 ppm BENLATE	11	N-T (T)	65.1	13.0	7.5	2.7	11.7	14.4	15.8	2.1	146	11.9
	64	N-T (T)	62.8	21.6	8.8	2.7	4.1	6.8	8.1	0.7	148	11.9
ALUM & 500 ppm BENLATE	11	N-L (N)	54.5	17.3	10.2	5.8	12.2	18.0	10.3	0.6	156	11.1
	64	N-T (T)	51.9	28.2	12.2	4.5	3.2	7.7	3.9	0	156	12.7
ALUM (1%)		T-S (L)	5.6	12.6	10.7	17.3	53.8	71.1	29.3	11.0	318	12.3
ALUM & 300 ppm BENLATE		N-T (T)	64.0	17.3	8.2	2.7	7.8	10.5	11.6	1.4	294	11.9
ALUM & 500 ppm BENLATE		N-L (T)	53.2	22.8	11.2	5.1	7.7	12.8	7.1	0.3	312	11.9

a/ Green inspection was made on June 24, 33 days after harvest, by examiming the fruit as the Banavac bags were opened for ripening (without removing clusters). The range of incidence is noted, with "mostly" in parenthesis.

b/ Blotch ratings; N (none) = clean, T (trace) = up to 1 $in.^2$/cluster, L (light) = up to 2 in^2/cluster, M (medium) = up to 3 $in.^2$/cluster, S (severe) = over 3 in^2/cluster. Ripe inspection was made on July 1, 2 & 4; 40, 41 & 43 days after harves.

c/ Finger rot, generally originating from flower end; clusters rated separately for blotch.

d/ Associated with latex = blotch incidence on areas of peel covered by latex.

Table 4. Incidence of Blotch (Fungal Scald) on Almirante Bananas in Banavac as Affected by Post Harvest Applications of Benlate and as Influenced by Ripe Inspection Time. Third Local Experiment

	Farm	Inspection Time *	No. Clusters	Percentage of Clusters Affected with BLOTCH: N	T	L	M	S	M+S	Finger Rot
Alum (1%)	11	R+T	50	24.0	34.0	18.0	18.0	6.0	24.0	2.0
		1&2	50	12.0	22.0	10.0	12.0	44.0	56.0	28.0
		4	70	0	2.9	2.9	18.5	75.7	94.2	45.7
	64	R+T	14	0	35.7	7.2	21.4	35.7	57.1	7.2
		1&2	73	0	6.9	21.9	21.9	49.3	71.2	32.9
		4	61	0	0	1.6	13.2	85.2	98.4	34.4
Alum & 300 ppm Benlate										
	11	R+T	42	71.4	19.1	9.5	0	0	0	2.4
		1&2	60	90.0	5.0	3.3	1.7	0	1.7	10.0
		4	44	25.0	18.2	11.4	6.8	38.6	45.4	36.4
	64	R+T	16	100.0	0	0	0	0	0	2.4
		1&2	46	65.2	19.6	8.7	6.5	0	6.5	8.7
		4	86	54.6	26.7	10.5	1.2	7.0	8.2	8.2
Alum & 500 ppm Benlate										
	11	R+T	0	-	-	-	-	-	-	-
		1+2	107	59.8	16.8	8.4	5.6	9.4	15.0	12.1
		4	49	42.8	18.4	14.3	6.1	18.4	24.5	6.1
	64	R+T	33	84.8	15.2	0	0	0	0	0
		1+2	15	73.3	26.7	0	0	0	0	6.7
		4	108	38.9	32.4	17.6	6.5	4.6	11.1	4.6
Alum (1%)		R+T	64	18.7	34.4	15.6	18.8	12.5	31.3	3.1
		1+2	123	4.9	13.0	17.1	17.9	47.1	65.0	30.9
		4	131	0	1.5	2.3	16.0	80.2	96.2	40.5
Alum & 300 ppm Benlate										
		R+T	58	79.3	13.8	6.9	0	0	0	3.4
		1&2	106	79.2	11.3	5.7	3.8	0	3.8	9.4
		4	130	44.6	23.8	10.8	3.1	17.7	20.8	17.7
Alum & 500 ppm Benlate										
		R+T	33	84.8	15.2	0	0	0	0	0
		1&2	122	61.5	18.0	7.4	4.9	8.2	13.1	11.5
		4	157	40.1	28.0	16.6	6.4	8.9	15.3	5.1

* R+T = < 33 Days
1&2 = (July 1&2) = 40-41 Days (6-7 Days Ripening)
4 = (July 4) = 43 Days (Regassed, 9 Days Ripening)

the Benlate treatments was located on the outer whorl fingers and between fingers. These were the areas not directly sprayed and apparently not adequately covered. This observation was most prominent on the last fruit inspected (July 4th). Even though the sprayer was frequently shaken to continuously mix the Benlate solutions, it is possible that mixing was not adequate and some of the Benlate settled out.

In the fourth local experiment (Table 5) a double spray treatment was incorporated because spray applications proved to be inferior to dipping in the third experiment. Samples of the same treatments were sent to Rotterdam as an experimental shipment (Table 6).

Blotch (medium and severe) was observed on 66.7 and 61.2% of the spray and dip control clusters, respectively, in the Changuinola experiment. Benlate-treated clusters only had this severity of blotch in the spray treatment; 11.6 and 0.6% for 300 and 500 ppm, respectively. Rotterdam inspection (20 vs. 37 days after harvest for Changuinola) revealed 25.2 and 13.2% medium and severe blotch on the spray and dip control clusters, respectively. No blotch was observed on Benlate-treated clusters.

Note that the percentage of blotch-free clusters was uniformly high (84.1-90.6%) for the double spray and dip applications of Benlate at both concentrations. The single spray application of Benlate was considerably more effective at 500 than at 300 ppm. This indicates that 300 ppm Benlate will provide effective blotch control only when applied as a dip or as a double spray.

Finger rot was observed on 14.8 and 5.2% of the spray and dip control clusters, respectively, in the Changuinola experiment. No Benlate-treated clusters had finger rot. Rotterdam reported only four control clusters with finger rot and none on those that were treated with Benlate.

Blotch associated with latex staining was recorded only in Changuinola; on 7.4 and 5.8% of the spray and dip control clusters, respectively and on only 1.2% of the 300 ppm Benlate double spray clusters.

Crown rot was light to severe (mostly severe) on control clusters, but absent on Benlate-treated clusters in Changuinola inspections. In Rotterdam, crown rot was observed on approximately 30% of the control clusters and only on 0-5% of the Benlate-treated clusters.

Neck rot, recorded only in Rotterdam, was observed on about 20% of the control clusters and on about 1-5% of those clusters treated with Benlate.

Peel rot, recorded only in Rotterdam was also observed on about 20% of the control clusters and on only a couple Benlate-treated clusters (300 ppm, spray and double spray).

Mold growth on flower tips and crown was only recorded in Changuinola; trace to medium (mostly light) and none to trace (mostly none) on control and Benlate-treated clusters, respectively.

Table 5. Incidence of Blotch (Fungal Scald) on Almirante Bananas (Farm 64) in Banavac as Affected by Postharvest Applications of Benlate. - Fourth Local Experiment.

TREATMENT	Green[a]	RIPE INSPECTION[b] Percentage of Clusters BLOTCH[c] N	T	L	M	S	M/S	Finger Rot[d]	Assoc. with Latex[e]	No. Clusters	Average Caliper Grade
Alum (1%)											
Spray	S	3.1	21.0	9.2	11.1	55.6	66.7	14.8	7.4	162	11.6
Dip	S	3.5	19.7	15.6	14.4	46.8	61.2	5.2	5.8	173	10.9
Alum + 300 ppm Benlate											
Spray	T-L(L)	59.5	24.3	4.6	5.2	6.4	11.6	0	0	173	11.4
Double Spray	N-T(T)	84.1	15.9	0	0	0	0	0	1.2	163	11.2
Dip	N-T(T)	90.6	9.4	0	0	0	0	0	0	170	10.9
Alum + 500 ppm Benlate											
Spray	N-T(T)	81.1	17.7	0.6	0.6	0	0.6	0	0	169	10.9
Double Spray	N-T(N)	88.5	11.5	0	0	0	0	0	0	165	11.1
Dip	N-T(N)	90.0	9.4	0.6	0	0	0	0	0	160	11.2

a/ Green inspection was made on August 8th, 30 days after harvest, by examining the fruit as the Banavac bags were opened for ripening (without removing clusters). The range of incidence is noted, with "mostly" in parenthesis.

b/ Ripe Inspection made on August 15th, 37 days after harvest; color index = 4-6 (mostly 5).

c/ Blotch ratings: N (None) = clean; T (Trace) = up to 1 in.^{2}/cluster; L (Light) = up to 2 in.^{2}/cluster; M (medium) = up to 3 in.^{2}/cluster; S (Severe) = over 3 in.^{2}/cluster.

d/ Finger Rot; generally originating from flower end; clusters rated separately for blotch.

e/ Associated with latex; blotch incidence on areas of peel covered with latex

Table 6. Incidence of Blotch (Fungal Scald) on Almirante Bananas (Farm 64) in Banavac as Affected by Postharvest Applications of Benlate; Experimental Shipment to Rotterdam.

	PERCENTAGE OF CLUSTERS AFFECTED[a/]																								
	BLOTCH					FINGER ROT					CROWN ROT					NECK ROT					PEEL ROT				
TREATMENT	N	T	L	M	S	N	T	L	M	S	N	T	L	M	S	N	T	L	M	S	N	T	L	M	S
Alum																									
Spray	54.2	10.7	10.1	4.2	20.8	98.8	1.2	-	-	-	67.3	19.6	9.5	2.4	1.2	80.8	5.4	4.8	4.2	4.8	79.1	13.7	4.8	1.8	0.6
Dip	67.5	13.9	5.4	4.8	8.4	98.8	0.6	-	0.6	-	71.7	16.9	10.2	1.2	-	81.4	9.0	6.6	-	3.0	85.6	8.4	3.0	3.0	-
Alum + 300 ppm Benlate																									
Spray	100	-	-	-	-	100	-	-	-	-	95.8	4.2	-	-	-	94.6	3.6	1.2	-	0.6	99.4	0.6	-	-	-
Double spray	100	-	-	-	-	100	-	-	-	-	98.8	0.6	0.6	-	-	96.4	1.2	1.8	0.6	-	99.4	0.6	-	-	-
Dip	99.4	0.6	-	-	-	100	-	-	-	-	98.2	1.2	0.6	-	-	98.8	1.2	-	-	-	100	-	-	-	-
Alum + 500 ppm Benlate																									
Spray	100	-	-	-	-	100	-	-	-	-	99.4	0.6	-	-	-	98.8	0.6	0.6	-	-	100	-	-	-	-
Double Spray	100	-	-	-	-	100	-	-	-	-	100	-	-	-	-	95.7	1.2	2.5	0.6	-	100	-	-	-	-
Dip	100	-	-	-	-	100	-	-	-	-	98.8	0.6	0.6	-	-	99.4	-	0.6	-	-	100	-	-	-	-

a/ After ripening inspection performed by Quality Control personnel in Rotterdam on July 29th, 20 days after harvest.

b/ Clusters sprayed in trays to "run-off" (knapsack sprayer).

c/ Clusters immersed in solution.

d/ Same as b/, plus packed clusters sprayed to "run-off".

Ripes and turnings were not observed in Changuinola, nor reported from Rotterdam. Only an occasional pin hole was found in Banavac bags in Changuinola inspections, probably due primarily to improved crown beveling.

Withered pedicels (medium and severe) were observed on about 10% of all clusters (Changuinola) without any apparent relationship to treatment.

Oxygen and carbon-dioxide contents of the Banavac bags (Changuinola) were within normal limits for bananas in this system.

The last two observations were typical of results of the other blotch experiments.

It was found that blotch was still a serious postharvest problem of Almirante bananas in Banavac, if not treated with a fungicide at packing. Medium and severe blotch can be eliminated by the application of 300 or 500 ppm Benlate or 500 ppm Mertec in conjunction with 1% alum.

Good application of the fungicide is extremely important. Dipping clusters in the solution is best. The spray booth method is inferior because coverage is incomplete and some blotch was found to occur on the insides of fingers, especially those of the outer whorl. This problem was overcome by making a second spray application to the top row clusters of the completed package. Irregardless of the system of application, good mixing of materials is essential. Other postharvest disorders, such as crown rot, finger rot and mold are well-controlled with these same treatments.

In conclusion, Almirante bananas can be successfully shipped in Banavac provided postharvest fungicides are well-applied. Flowers remmants provide an excellent source of inoculum and should be completely removed in the dehanding tank. To prevent Banavac bag ruptures, it is important that crowns be properly beveled, corner clusters are packed first and care should be taken not to overevacuate as this will promote polyethylene film rupturing.

CRITICAL AGE

A two year project was initiated in Changuinola in July 1974 to determine more precisely how long fruit can be allowed to hang without having ripes and turnings (R / T). This "critical age" is being determined by harvesting selected areas by grade only. Each week, boxes of bananas from each age group (ribbon color) representing clean-up and older stems, are harvested and stored (after 48 hours at ambient temperatures) at 56-58°F until R / T are observed. By establishing "critical age" limits of bananas grown under representative good (Farm 45), average (Farm 63) and poor (Farm 13) agronomic conditions, this Division should be able to improve its yields. This could be accomplished by shifting the age/grade harvest schedule during certain seasons, thereby permitting heavier grade and improved box/stem ratios.

The data for weeks 28 through 49 of 1974 (Table 6A &Figures 1-4) indicate that clean-up and older bananas do have acceptable holding capacity at times. Older fruit generally has R / T somewhat sooner than younger fruit, as expected. It would be premature to make any harvesting adjustments based on the present data. Furthermore, the sharp declines in holding capacity are most likely attributable to ethylene contamination from R / T fruit which has not been removed from the storage rooms as soon as observed. Ripening operations in the four Research refrigerated rooms have been suspended until these experiments have been completed.

Greater precision is being obtained in Farm 45 by tagging stems at time of shooting. Weekly growth measurements of these stems will also provide fruit development data. This will be correlated with meteorological information (temperatures, solar radiation, rainfall and pan evaporation) collected in this area.

Maturity stain data is being collected for all stems harvested in the Critical Age plots. This information will be correlated with fruit age. Preliminary data indicate that maturity stain is more prevalent in older fruit harvested at a constant 14 grade (Farms 45 and 63). This pattern is not observed in Farm 13 where the constant harvest grade is 13.

Small scale R / T studies are being conducted in Armuelles and Golfito also. In these divisions clean-up fruit from good and poor farms is being held for up to 28 days, or until R / T clusters are observed. Preliminary results indicate, as expected, that fruit from poor farms has shorter green life than that from good farms:

Division	Farm	Harvest Date	R / T Results
Golfito	44	8/13/74	10% of boxes R / T in 13 days.
	51	"	90% of boxes R / T in 13 days.
Armuelles	Majagua	10/10/74	8% of boxes R / T in 28 days.
	Ceiba	"	67% of boxes R / T in 28 days.

Table 6A. Average Number of Days to R / T - Critical Age Study - Changuinola

Fruit Age (wks)	11			12			13			14			15			16		
Farm	13	45	63	13	45	63	13	45	63	13	45	63	13	45	63	13	45	63
WEEK/ 74																		
28				38.0														
				c			g		e									
29				35.8	34.3	30.4	35.0		26.3									
									c									
30				25.6	26.6	27.2	28.0	27.2	25.3									
			g	b			b					f						
31			25.0	24.2	21.6	24.2	23.4	20.0	17.8		18.4	21.0						
							f							e				
32				20.8		21.0	19.5	19.2	19.8		14.0	14.8		13.0				g
								b						b				
33						25.0	10.4	12.2	13.4		11.4	12.0		10.8			7.0	
							bc			bc								
34							25.8	20.6	25.4	26.8		21.4		11.0				
								b			b							
35							20.6	23.0	21.6		19.8	22.4		7.6	15.0			
							h	bh	h	bh	bh	h		bh	h			
36							16.0	16.0	16.0	16.0	15.4	16.0		16.0	16.0			
					b	gh	f	b	h		b	h		h	eh			
37				6.6	6.6	9.0	7.5	7.2	9.0		6.6	7.8		6.0	9.0			
					bh	h		bh	h		bh	h			gh			gh
38				24.2	23.4	23.0		22.6	23.4		22.6	23.0			23.0			23.0
											e							
39					22.2			20.4	20.0		20.0	16.2						
							d								e			
40					16.0		15.0	15.2	14.6			15.2			14.3			
											g							
41				17.0	10.2	9.4	15.4	10.2	10.2		9.0	9.8						
					h			h	h		dh	h		d	eh			
42				15.0	10.6	13.2		10.0	10.6		10.0	10.0		10.0	10.0			
				e	i	h		i	h		ei	h						
43				16.0	14.4	14.0		12.4	13.2		12.0	14.0						
44	20.2			17.4	13.4	16.6		13.4	15.0		11.4	12.0						
											f			g				
45				19.6	17.2			14.0			4.0			4.0				
															e			
46				29.2	28.4	20.4	26.4	23.2	23.4			7.8			7.0			
					h			h			h							
47				20.6	25.0	22.2	15.2	25.0	21.0		25.0	10.4						
							f					d			g			
48				19.2	17.8	18.0	18.0	16.8	17.2		15.2	16.0			6.0			
49							17.8	13.4	12.0		11.0	12.8		f 10.0	g 8.0			g 11.0

a - only 24 hours at ambient temps
b - packed in polypack
c - > 5 boxes in sample
d - only 4 boxes in sample
e - only 3 boxes in sample
f - only 2 boxes in sample
g - only 1 box in sample
h - ethylene contamination?
i - > 48 hours at ambient temps.

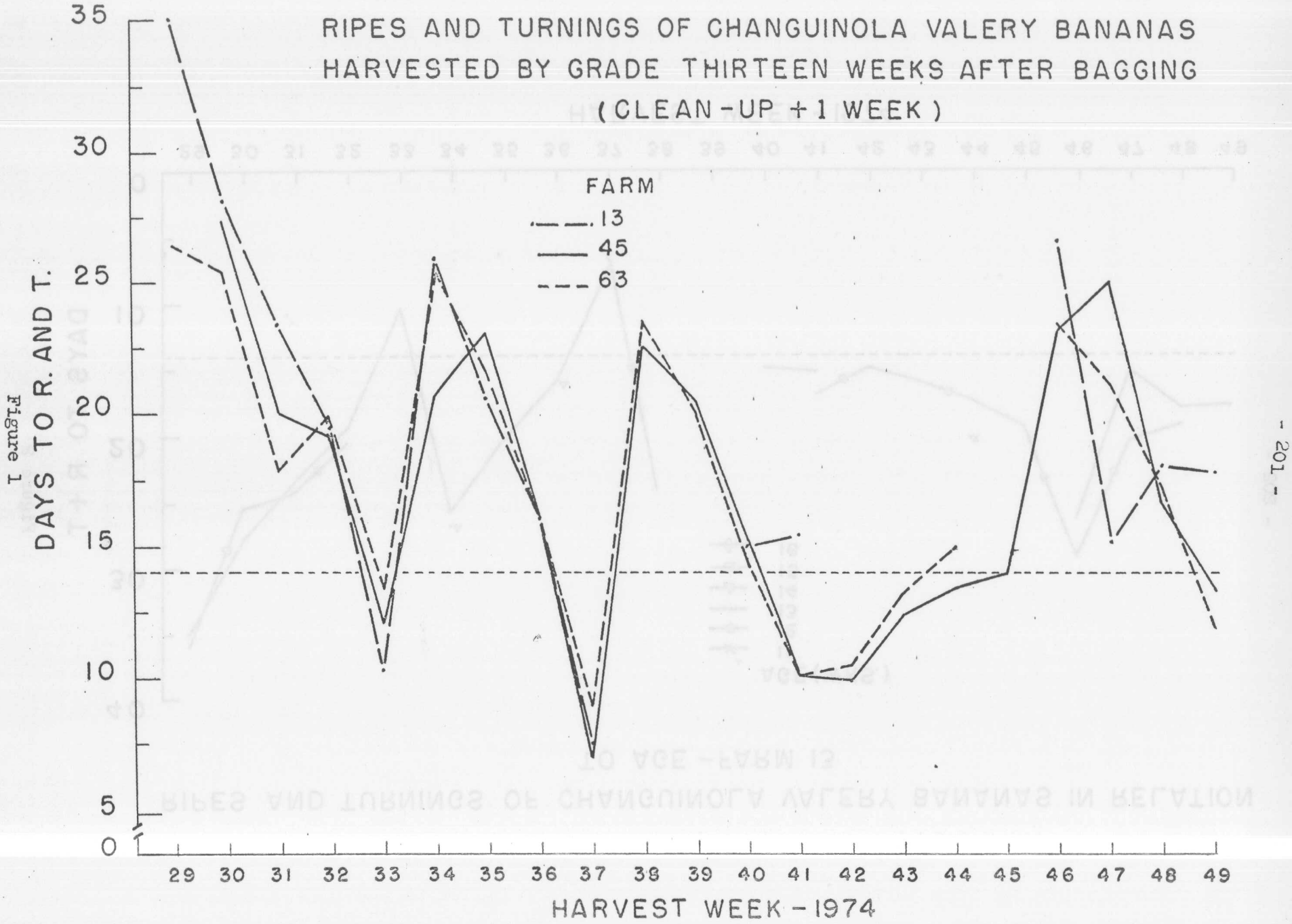
RIPES AND TURNINGS OF CHANGUINOLA VALERY BANANAS
HARVESTED BY GRADE THIRTEEN WEEKS AFTER BAGGING
(CLEAN-UP +1 WEEK)
FARM
13
45
63
DAYS TO R. AND T.
HARVEST WEEK - 1974
35
30
25
20
15
10
5
0
29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49

Figure 1

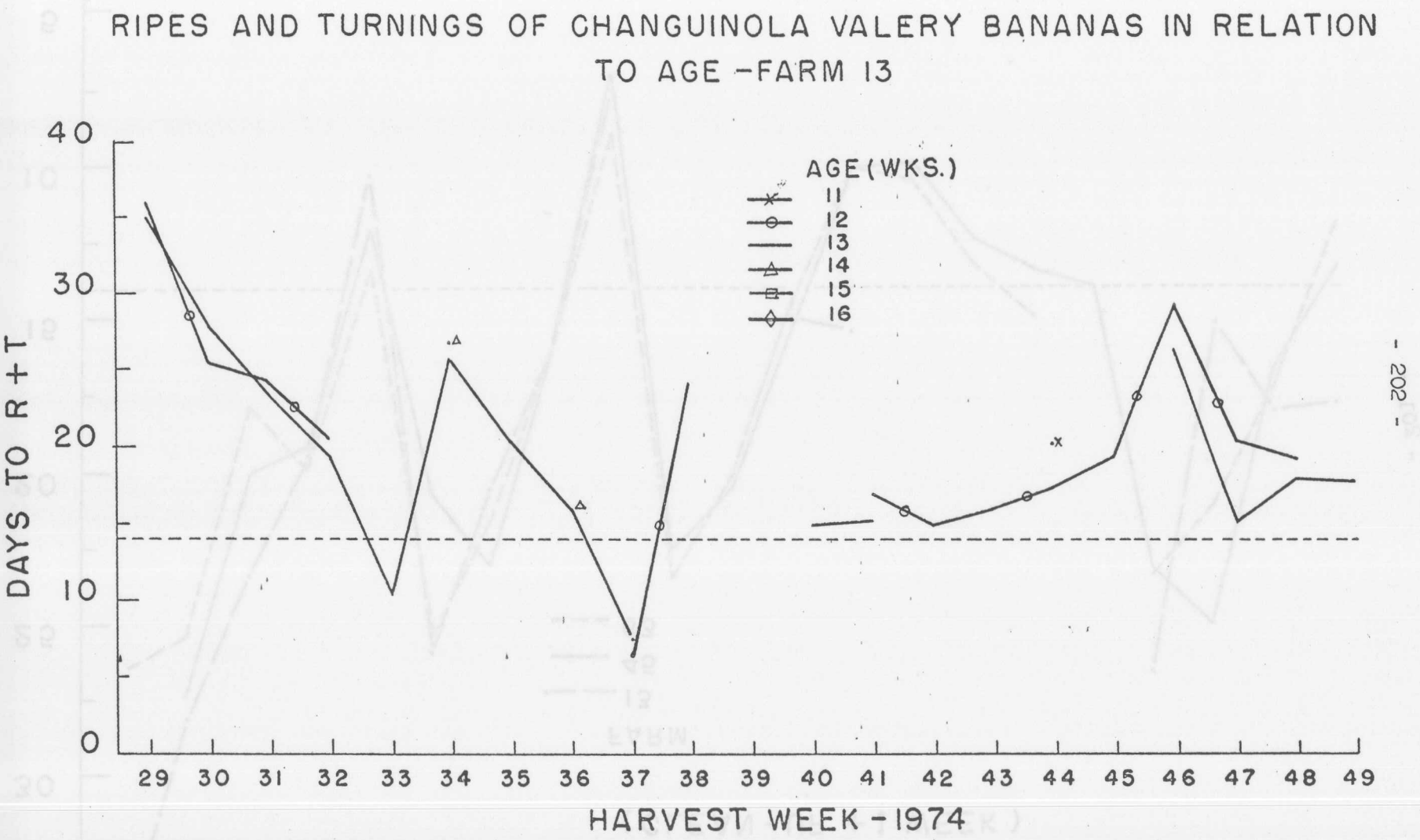
RIPES AND TURNINGS OF CHANGUINOLA VALERY BANANAS IN RELATION TO AGE - FARM 13
AGE (WKS.)
11
12
13
14
15
16
DAYS TO R + T
0
10
20
30
40
29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
HARVEST WEEK - 1974

Figure 2

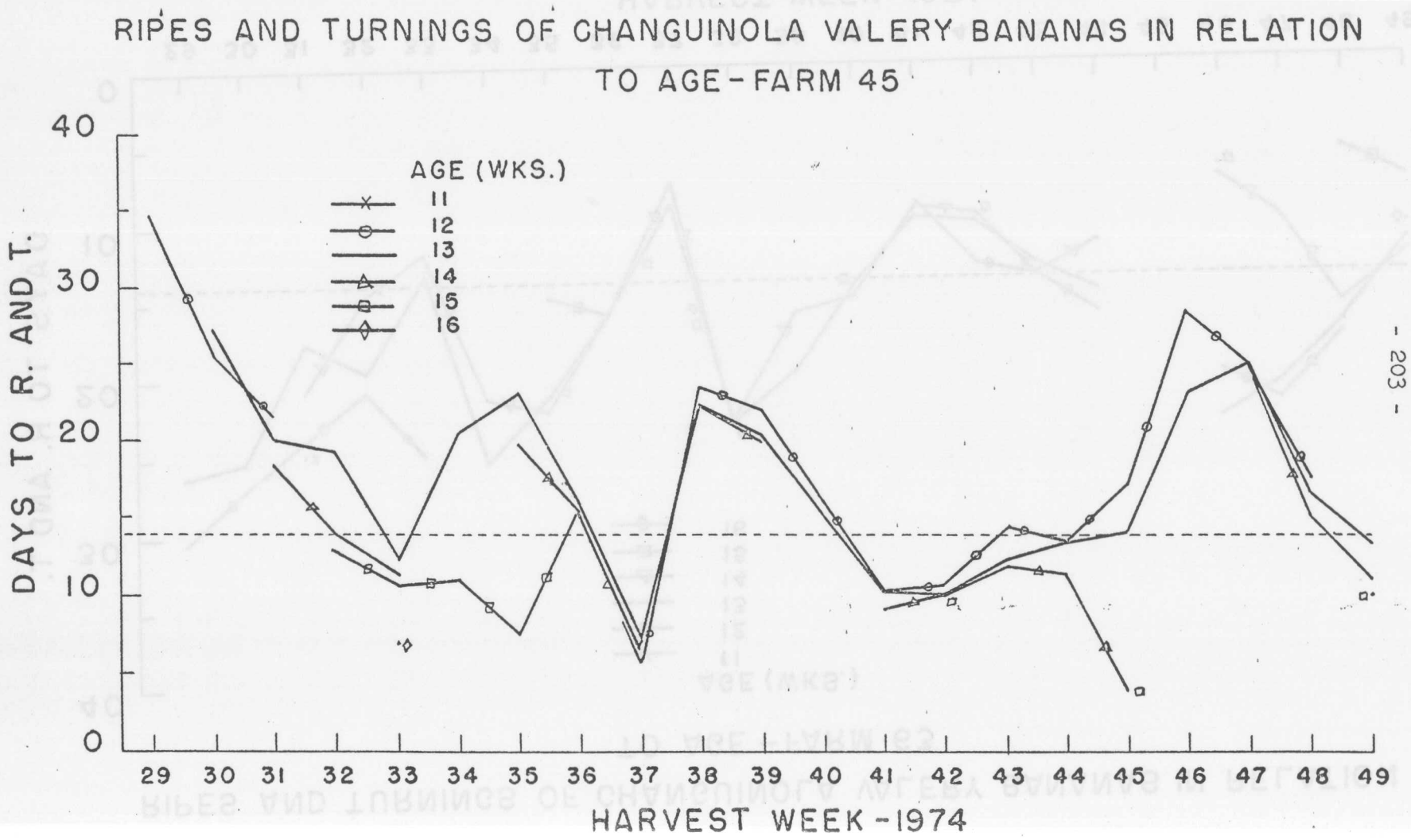
RIPES AND TURNINGS OF CHANGUINOLA VALERY BANANAS IN RELATION TO AGE - FARM 45
AGE (WKS.)
11
12
13
14
15
16
DAYS TO R. AND T.
0
10
20
30
40
29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
HARVEST WEEK - 1974

Figure 3

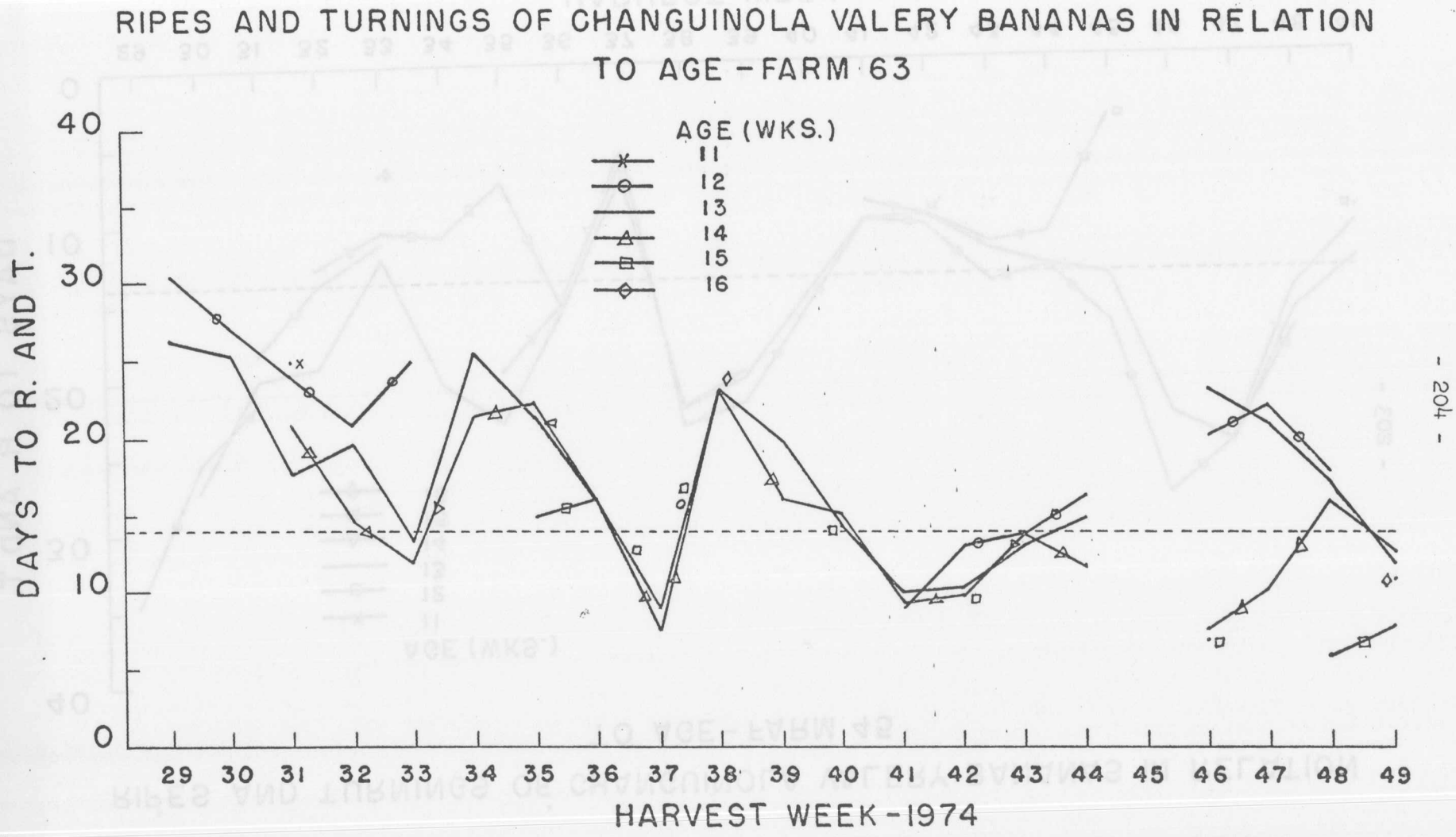
RIPES AND TURNINGS OF CHANGUINOLA VALERY BANANAS IN RELATION TO AGE - FARM 63
AGE (WKS.)
11
12
13
14
15
16
DAYS TO R. AND T.
0
10
20
30
40
29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
HARVEST WEEK - 1974

Figure 4

POTASSIUM & FRUIT QUALITY

The application of potassium to our banana plantations has resulted in agronomic benefits discussed elsewhere in this report. Since this element is closely associated with many metabolic processes in the plant and developing fruit, its application to potassium deficient areas should improve banana quality.

In Farm 15, Changuinola K_2SO_4 was incorporated into the soil 2 lbs/mat on October 11, 1972 and broadcast at 1 lb/mat on April 21, 1973. Withered pedicels and Sinker observations made on Fruit harvested in November 1973 indicated that potassium reduced the incidence of these physiological disorders.

		Withered Pedicels % clusters (M&S)		Sinkers % stems	
Harvest Date	Boxes/treatment	K	CK	K	CK
11/1/73	21/23	11	62	-	-
11/21/73	17/24	40	99.7	0	12.5

Fruit from cable plots in Farm 15 which received phosphorous and potassium applications every 6 months starting mid 1973 was observed in April 1974 (harvested March 25, 1974) to have less withered pedicels in response to potassium applications.

Percentage of clusters with M & S Withered Pedicels

	Potassium*		
Phosphorous*	0	400	800
0	35.5	6.4	-
150	-	20.8	6.0

* Lbs./A

Fruit harvested on April 10, 1974 (10 boxes/treatment) from other plots in Farm 15 which received phosphorous and potassium applications on the same schedule also had less withered pedicels in response to potassium applications.

Percentage of Clusters with M & S Withered Pedicels

	Potassium*			
Phosphorous*	0	400	800	P Avg.
0	40.0	21.2	8.9	23.4
100	79.9	28.8	3.6	37.4
200	47.2	19.5	13.4	26.7
K Avg.	55.7	23.2	8.6	

* Lbs./A

I n Farm 2, Palmar 2 lbs K_2SO4/mat was applied to potassium deficient areas on September 5, 1973. Fruit observed from these areas six and 12 months later, confirmed that potassium applications result in less withered pedicels and sinkers.

Harvest Date	No. Stems (Boxes) /Treatment	Withered Pedicels (% Clusters with M & S) K	CK	Sinkers (% Stems with) K	CK
2/28/74	50	-	-	0	34
3/5/74	25	18.8	44.4	0	68
6/3/74	25	0.6	22.7	4	64
9/17/74	50	-	-	36	96

Withered pedicels and sinkers can be expected to diminish in response to a potassium fertilization program. While banana carrying quality is expected to show a market increase, data to date do not reveal specific trends in the incidence of ripes and turnings.

The effect of phosphorous fertilization on withered pedicels is not as evident as that of potassium.

BANANA RIPENING

The Ethylene Gas generator has been found to satisfactorily ripen bananas in volumes ranging from 20 to over 4000 boxes. This is a system which catalytically converts Ethylene Generator Concentrate (primarily ethyl alcohol) to ethylene over an 18 hours period. Continuous ethylene production compensates for leaky ripening rooms and promotes ripening uniformity. Ethylene concentrations are in the range of 50 to 150 ppm, thus eliminating the danger of explosions.

Due to safety, ripening uniformity, and simplicity of operation, this system has been recommended for use in all of our tropical ripening operations; puré plants and experimental ripening rooms. Modern banana ripening techniques, using the Ethylene Gas Generator, have been successfully introduced to commercial banana handlers in Bogotá, Colombia.

GIBBERELLIC ACID

In the past year there has been renewed interest in the use of postharvest applications of gibberellic acid to bananas to reduce ripes and turnings (R / T) in transit. Other workers report dramatic extensions of the green life of bananas. Therefore, it is important that we verify these results, as ripes and turnings represent significant annual losses to the Company.

If a box contains one or more clusters of ripe or turning bananas that box is considered R / T and the buyer makes a claim against the Company. Therefore, the initial approach was to test the effect of the plant growth regulator on a box by box basis. Unless otherwise indicated the experiments consisted of stems of the same age and grade. Each hand was divided into three clusters. Each of which was treated with either one of the concentrations of gibberellic acid (plus alum and Benlate) or was used as a control (treated only with alum and Benlate). Other details of each experiment are included in the respective tables (7-23).

RESULTS:

In the first experiment (Table 7) it was established that neither alum nor Benlate incorporated with gibberellic acid (A_4 / A_7) caused any phytotoxicity. Later tests (Tables 14 and 15) confirmed that alum was not interfering with the possible action of gibberellic acid (A_4 / A_7).

Ripes and turnings in all experiments were only slightly reduced, if at all, by gibberellic acid dips (Tables 7-20). Five and 10 ppm were the concentrations recommended by Plant Protection, Ltd. personnel. Concentrations of 2.5 (Table 7) and 20 ppm (Table 13) were also tested with no apparent influence on effectiveness.

Merck, Sharp and Dohme recommends that their gibberellic acid (GA_3) be applied as a postharvest dip at 50 to 200 ppm (Tables 17-20). In two of the experiments (Tables 18 and 19) there appeared to a greater effect on R / T than seen in any of the other experiments, even though the holding period was only two weeks.

Shelf life of ripened Valery bananas appeared to be unaffected by postharvest gibberellic acid applications (Tables 21 and 22).

Quality of ripened Valery bananas, as influenced by postharvest gibberellic acid applications, was observed on two occasions. Crown rot was observed at low levels in the first experiment (Table 7) and was lowest when gibberellic acid (A_4 / A_7) was applied in combination with alum and Benlate. In the other experiment (Table 23) crown rot and scarring appeared to be greater in relation to gibberellic acid (A_4 / A_7) applications, while withered pedicels, latex staining and bruising appeared to be reduced.

Table 7. Ripes and Turnings and Crown Rot of Valery Bananas* as Affected by Postharvest Dips of Gibberellic (A_4 + A_7) - Honduras.

TREATMENT			Days to R + T		Caliper Grade		Crown Rot Index
GA4 + 7 (ppm)	Alum (1%)	Benlate (200 ppm)	Average	Range	Average	Range	(Ripe Inspection)
2.5	+	+	29.9	19-35	10.7	7-14	1.5
5.0	+	+	29.9	21-33	10.8	7-15	1.5
5.0	+	-	33.8	28-37	9.2	5-14	1.5
5.0	-	+	32.4	22-37	10.0	7-14	1.5
5.0	-	-	33.3	27-37	10.0	7-13	1.8
10.0	+	+	33.9	31-41	9.3	6-12	1.0
-	+	+	27.3	19-34	9.8	5-14	2.2
-	+	-	31.3	22-37	10.0	8-14	2.0
-	-	+	29.3	24-34	10.1	6-14	1.2
-	-	-	28.5	22-33	9.9	6-14	1.5

* Harvest date: 4/18/74

Farm: Mopala(08)

Age: Clean-up

Time at ambient temperature: 24 hours.

10 boxes/treatment (each box represented one stem, minus apical and basal hands).

Table 8. Ripes and Turnings of Honduras Valery Bananas* As Affected by Postharvest Dips of Gibberellic Acid ($A_4 + A_7$).

TREATMENT			Days to R + T		Caliper Grade	
GA 4 + 7 (ppm)	Alum (1%)	Benlate (200 ppm)	Average	Range	Average	Range
5	+	+	14.9	1-30	14.1	9-18
10	+	+	15.4	1-29	14.1	10-18
-	+	+	13.9	1-29	14.1	10-18

TREATMENT	DAYS TO R + T BY BOX (STEM)									
	1	2	3	4	5	6	7	8	9	10
5	23	4	25	1	11	15	25	11	4	30
10	12	9	27	1	25	14	13	12	12	29
CK	11	11	25	1	15	11	12	20	4	29

* Harvest Date: 10/17/74

Farm: Corozal (07)

Age: Clean-up (yellow)

Time at ambient temperature: 24 hours

10 boxes/treatment

Table 9. Ripes and Turnings of Honduras Valery Bananas* As affected by Postharvest Dips of Gibberellic Acid ($A_4 + A_7$).

TREATMENT			Days to R + T		Caliper Grade	
GA 4 + 7 (ppm)	Alum (1%)	Benlate (200 ppm)	Average	Range	Average	Range
5	+	+	16.0	1-25	14.4	9-18
10	+	+	15.6	1-27	14.3	10-18
-	+	+	15.7	1-25	14.0	10-17

	DAYS TO R + T BY BOX (STEM)									
TREATMENT	1	2	3	4	5	6	7	8	9	10
5	23	25	11	1	23	21	11	11	22	12
10	23	25	27	1	15	22	11	9	12	11
CK	22	25	25	1	15	15	11	11	11	11

* Harvest Date: 10/17/24

Farm: Corozal (07)

Age: 2nd. Caliper (black)

Time at ambient temperature: 24 hours

10 boxes/treatment

Table 10. Ripes and Turnings of Honduras Valery Bananas* As Affected by Postharvest Dips of Gibberellic Acid ($A_4 + A_7$).

TREATMENT			Days to R + T		Caliper Grade	
GA 4 + 7 (ppm)	Alum (1%)	Benlate (200 ppm)	Average	Range	Average	Range
5	+	+	8.4	4-11	14.3	10-18
10	+	+	9.2	6-10	14.4	9-21
-	+	+	8.7	4-11	14.2	9-19

TREATMENT	DAYS TO R + T BY BOX (STEM)									
	1	2	3	4	5	6	7	8	9	10
5	4	4	11	6	10	11	10	11	8	9
10	6	10	9	10	10	10	10	10	7	10
CK	4	7	10	9	9	11	9	9	9	10

* Harvest Date: 10/29/74

Farm: Corozal (07)

Age: Clean-up (blue)

Time at Ambient Temperature: 24 hours

10 boxes/treatment.

Table 11. Ripes and Turnings of Honduras Valery Bananas* As Affected by Postharvest Dips** of Gibberellic Acid (A_4 + A_7).

TREATMENT			Days to R + T		Caliper Grade	
GA 4 + 7 (ppm)	Alum (1%)	Benlate (200 ppm)	Average	Range	Average	Range
5	+	+	9.6	9-10	14.6	11-18
10	+	+	9.4	9-10	14.5	10-18
-	+	+	9.0	8-10	14.6	10-18

TREATMENT	DAYS TO R + T BY BOX (STEM)				
	1	2	3	4	5
5	10	10	10	9	9
10	10	10	9	9	9
CK	9	10	9	8	9

* Harvest Date: 10/29/74
Farm: Corozal (07)
Age: Clean-up (blue)
Time at Ambient Temp: 24 hours
5 boxes/treatment

** Treatment time: 30 seconds.

Table 12. Ripes and Turnings of Honduras Valery Bananas* As Affected by Postharvest Dips of Gibberellic Acid ($A_4 + A_7$).

TREATMENT			Days to R + T		Caliper Grade	
GA 4 + 7 (ppm)	Alum (1%)	Benlate (200 ppm)	Average	Range	Average	Range
5	+	+	10.8	9-13	12.8	8-16
10	+	+	11.2	9-14	12.4	8-16
-	+	+	10.2	4-16	12.3	8-16

TREATMENT	DAYS TO R + T BY BOX (STEM)				
	1	2	3	4	5
5	11	11	10	9	13
10	10	10	14	13	9
CK	10	16	4	11	10

---

* Harvest Date: 10/29/74

Farm: Corozal (07)

Age: Mixed - commercial fruit

Time at ambient temp: 24 hours

5 boxes/treatment

Table 13. Ripes and Turnings* of Honduras Valery Bananas** As Affected by Postharvest Dips of Gibberellic Acid ($A_4 + A_7$).

TREATMENT			Days to R + T		Caliper Grade	
$GA_4 + 7$ (ppm)	Alum (1%)	Benlate (200 ppm)	Average	Range	Average	Range
10	+	+	26.1	22-28	14.7	10-19
20	+	+	27.6	26-28	14.7	10-20
-	+	+	25.9	23-28	14.6	8-19

	DAYS TO R + T BY BOX (STEM)														
TREATMENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
10	28	26	22	28	28	26	26	26	23	23	28	28	26	28	25
20	28	28	26	28	28	26	28	28	28	28	28	28	28	28	26
CK	26	26	23	26	26	26	26	26	26	28	26	26	26	26	26

* Suspect contamination due to uniformity of R + T

** Harvest Date: 11/25/74

Farm: La Curva (06)

Age: Clean-up (brown)

Time at ambient temp: 24 hours

15 boxes/treatment

Table 14. Ripes and Turnings of Honduras Valery Bananas* As Affected by Postharvest Dips of Gibberellic Acid ($A_4 + A_7$).

TREATMENT			Days to R + T		Caliper Grade	
GA_{4+7} (10 ppm)	Alum (1%)	Benlate (200 ppm)	Average	Range	Average	Range
+	+	+	20.9	20-23	14.1	10-19
+	-	+	21.2	20-24	14.0	9-18
-	+	+	19.8	19-22	14.0	9-18

TREATMENT	DAYS TO R + T BY BOX (STEM)									
	1	2	3	4	5	6	7	8	9	10
GA + Alum + Benlate	20	20	21	20	21	23	21	20	22	21
GA + Benlate	20	20	21	22	20	24	23	20	21	21
Alum + Benlate (CK)	19	19	20	20	20	22	19	19	20	20

* Harvest Date: 12/4/74

Farm: La Curva (06)

Age: Clean-up (green)

Time at ambient temp.: 24 hours

10 boxes/treatment

Table 15. Ripes and Turnings of Honduras Valery Bananas* as Affected by Postharvest Dips of Gibberellic Acid ($A_4 + A_7$).

TREATMENT				Days to R + T		Caliper Grade	
$GA_4 + 7$ (10 ppm)	Alum (1%)	Benlate (200 ppm)	Dipping Time	Average	Range	Average	Range
+	+	+	instant	21.0	20-22	13.7	9-16
+	+	+	30 sec.	22.3	21-23	13.3	9-16
+	-	+	instant	21.0	20-22	13.4	10-17
+	-	+	30 sec.	21.0	21	13.8	9-20
-	+	+	instant	20.7	20-21	12.5	9-16
-	+	+	30 sec.	19.3	19-20	13.0	9-17

* Harvest Date: 12/4/74

Farm: La Curva (06)

Age: Mixed (commercial frint)

Time at ambient temp: 24 hours

3 boxes/treatment

Table 16. Ripes and Turnings of Honduras Valery Bananas* as Affected by Postharvest Dips of Gibberellic Acid (A_3).

TREATMENT			Days to R / T		Caliper Grade	
GA_3 (ppm)	Alum (1%)	Benlate (200 ppm)	Average	Range	Average	Range
50	/	/	9.3	4-18	14.0	10-19
200	/	/	9.2	4-12	14.1	10-18
-	/	/	9.9	7-11	14.4	10-19

	DAYS TO R / T BY BOX (STEM)									
TREATMENT	1	2	3	4	5	6	7	8	9	10
50	12	11	4	18	4	12	4	4	15	9
200	7	11	10	15	4	12	8	11	7	7
CK	8	11	11	11	11	10	12	8	7	10

* Harvest Date: 10/1/74

Farm: Corozal (07)

Age: Clean-up - stems with field ripes (ripes not packed)

Time at Ambient Temp: 48 hours

10 boxes/treatment

Table 17. Ripes and Turnings of Honduras Valery Bananas* as Affected by Postharvest Dips of Gibberellic Acid (A_3).

TREATMENT			Days to R / T		Caliper Grade	
GA_3 (ppm)	Alum (1%)	Benlate (200 ppm)	Average	Range	Average	Range
50	/	/	11.4	5-18	16.6	11-21
200	/	/	10.2	5-18	16.8	12-21
-	/	/	10.9	4-18	16.7	12-21

	DAYS TO R / T BY BOX (STEM)									
TREATMENT	1	2	3	4	5	6	7	8	9	10
50	18	12	7	11	8	12	12	11	18	5
200	18	11	5	10	7	10	12	7	18	4
CK	18	11	8	9	4	4	13	10	18	4

* Harvest Date: 10/1/74

Farm: Corozal (07)

Age: Clean-up (gold)

Grade: Stems with largest hand measuring over 19.

Time at ambient temp: 48 hours

10 boxes/treatment

Table 18. Ripes and Turnings of Honduras Valery Bananas* As Affected by Postharvest Dips of Gibberellic Acid (A_3).

TREATMENT			Days to R / T		Caliper Grade	
GA_3 (ppm)	Alum (1%)	Benlate (200 ppm)	Average	Range	Average	Range
50	/	/	12.7	1-30	12.8	8-17
200	/	/	14.3	1-31	13.4	9-18
-	/	/	12.7	1-27	13.4	9-20

	DAYS TO R / T BY BOX (STEM)									
TREATMENT	1	2	3	4	5	6	7	8	9	10
50	30	16	12	12	1	10	1	9	17	19
200	31	24	13	12	5	10	1	10	13	24
CK	27	16	13	10	5	10	1	10	16	19

* Harvest Date: 10/16/74

Farm: Corozal (07)

Age: Second Caliper (yellow)

Time at ambient temp: 24 hours

10 boxes/treatment

Table 19. Ripes and Turnings of Honduras Valery Bananas* as Affected by Postharvest Dips of Gibberellic Acid (A_3).

TREATMENT			Days to R / T		Caliper Grade	
GA_3 (ppm)	Alum (1%)	Benlate (200 ppm)	Average	Range	Average	Range
50	/	/	10.6	5-16	14.0	10-20
200	/	/	13.6	7-24	13.8	8-19
-	/	/	10.1	1-16	13.9	10-20

TREATMENT	DAYS TO R / T BY BOX (STEM)									
	1	2	3	4	5	6	7	8	9	10
50	10	5	10	12	10	16	6	9	12	16
200	12	7	12	13	12	24	10	12	10	23
CK	10	1	12	12	10	13	3	12	12	16

* Harvest Date: 10/16/74

Farm: Corozal (07)

Age: Clean-up (black)

Time at ambient temp: 24 hours

10 boxes/treatment

Table 20. Ripes and Turnings of Honduras Valery Bananas* as Affected by Postharvest Dips of Gibberellic Acid (A_3)

TREATMENT			Days to R / T		Caliper Grade	
GA_3 (ppm)	Alum (1%)	Benlate (200 ppm)	Average	Range	Average	Range
50	/	/	8.3	7-12	14.2	11-18
200	/	/	8.3	5-12	13.7	10-17
-	/	/	8.3	5-12	13.9	10-19

TREATMENT	DAYS TO R/T BY BOX (STEM)			
	1	2	3	4
50	12	8	10	7
200	12	8	8	5
CK	12	8	8	5

* Harvest Date: 10/16/74

Farm: Corozal (07)

Age: Clean-up plus one week (white)

Time at ambient temp: 24 hours

10 boxes/treatment

Table 21. Shelf Life of Honduras Valery Bananas* As Affected by Postharvest Dips of Gibberellic Acid ($A_4 + A_7$).

TREATMENT	Days at Room Temp:	Color Index (Average) 0	1	2	3	4
5		4.0	5.0	6.0	6.8	7.5
10		4.0	4.9	6.0	6.9	7.5
CK		4.3	5.2	6.0	6.8	7.5

	0	1	2	3	4
5	3^{+}-4^{+}	4-6^{+}	4^{+}-7^{+}	5^{+}-8	7-8
10	3^{+}-4^{+}	4-6^{+}	4^{+}-7^{+}	5^{+}-8	7-8
CK	3^{+}-5	4-6^{+}	4^{+}-7^{+}	5-8	6^{+}-8

* Harvest Date: 10/29/74

Farm: Corozal (07)

Age: Clean-up (blue)

Time at 56-58°F: 7 days

2 boxes/treatment (20 clusters/treatment).

Table 22. Shelf Life of Honduras Valery Bananas* As Affected by Postharvest Dips of Gibberellic Acid ($A_4 + A_7$).

TREATMENT	Days at Room Temp:	Color Index (Average) 0	1	2	3	4	5
10		4.2	4.8	5.5	6.9	7.4	7.8
20		4.2	4.7	5.4	6.9	7.5	8.0
CK		4.3	4.9	5.8	7.2	7.7	8.3

	Color Index (Range) 0	1	2	3	4	5
10	4-4$^+$	4$^+$-5	5-6	6$^+$-7	7-8	7$^+$-8
20	4-5	4$^+$-5	5-6	6-7$^+$	7-8	7$^+$-8$^+$
CK	4-4$^+$	4-5	5$^+$-6	7-7$^+$	7$^+$-8	8-8$^+$

---

* Harvest Date: 11/25/74

Farm: La Curva (06)

Time at 56-58°F : 21 days

One box/treatment (10 clusters/treatment)

Table 23. Quality of Honduras Valery Bananas* As Affected by Postharvest Dips of Gibberellic Acid ($A_4 + A_7$).

TREATMENT					PERCENTAGE OF CLUSTERS AFFECTED				
GA_{4+7} (ppm)	Alum (1%)	Benlate (200 ppm)	Clusters No.	Color Index	Crown Rot** (total)	Withered Pedicels** (total)	Latex Stain (total)	Bruising (total)	Scarring (M & S)
10	+	+	48	4-5	25.0	-	23.0	2.1	12.6
20	+	+	47	4-5	14.9	-	25.5	2.1	6.4
-	+	+	47	4-5	8.5	6.4	57.4	6.4	2.1

* Harvest Date: 11/25/74

Farm: La Curva (06)

Age: Clean-up (brown)

Time at 56-58°F: 28 days

5 boxes/treatment

** Blemishes (Defects) not observed at medium and severe levels.

The manufacturers of gibberellic acid persist in their recommendation that this plant growth regulator reduces ripes and turnings and generally helps to maintain the quality of bananas (reduced crown rot, scarring and bruising, and improved shelf life). The dramatic results obtained to date have not been obtained with semi-commercial postharvest applications to Valery bananas. however, such claims warrant exhaustive investigations. Experiments are continuing on a cluster by cluster scale to establish whether such benefits can be realized. Uptake of this material may be impeded by VALERY peel characteristics. Uptake and effectiveness may be enhance by incorporating other compounds in the postharvest dip solution.

PHYTOTOXICITY OF AMMONIUM HYDROXIDE ON BANANAS

It has been proposed that the Company consider applying nitrogen to banana plantations in the form of anhydrous ammonia, injected into overhead irrigation systems. To determine if such applications would be phytotoxic to banana peel surfaces, anhydrous ammonia was applied to several stems of VALERY bananas before bagging. Concentrations of 0.01, 0.1 and 1.0% were used. Several additional stems were left unprotected (no tree bags) and weekly applications of these concentrations were made from shooting through harvest.

Field observations gave no indications of phytotoxicity. Before Hurricane Fifi interrupted this study, a few stems were harvested for closer observations. No phytotoxicity symptoms were observed.

BANANA FINGER PRUNING

Various finger pruning schemes have been studied in Honduras and Bocas Divisions. At the time of bagging a stem, the fused fingers and various combinations of inner and outer whorl fingers were removed from the basal (largest) hand to, theoretically, allow the remaining fingers to be more uniformly oriented within the general shape and limits of this hand. Such a practice should permit a greater percentage of the remaining bananas developed here to be utilized. It was predicted that more Chiquita, and possibly more Specials, would be packed out, with a concurrent reduction in the number of fingers designated as waste because they do not conform to cluster shapes.

In preliminary trials, fused fingers (if present) plus one or two pairs of fingers (one each from the inner and outer whorl) were removed from basal hands at the time of bagging. These treatments provided neither improved basal hand shape, nor increased percentage of usable fruit as clusters.

In subsequent experiments, fused fingers (if present) plus three pairs of fingers (one each from the inner and outer whorl) or two triplets (two inner and one outer whorl fingers) were removed. In addition, the first finger of each of the five subsequent, sub-basal hands was removed. This finger is normally excessively curved and causes point scarring of the finger(s) it comes in contact with the adjacent hand.

The results of these experiments on Valery (Table 24; April-September 1974) and Grand Nain (Table 25; December 1973 - April 1974) indicated that the percentage usable fruit (Chiquita and Specials) in basal hands could be increased by 5-7%. However, this increase was at the expense of total fruit weight (basal hands) which decreased by up to 30%. Stem weights also decreased more than was compensated for by the increase in usable fruit (clusters).

As intended, fused fingers were eliminated. Wild fingers, which seldom conform to cluster shape, were virtually eliminated in these finger pruning schemes on both Valery and Grand Nain.

Even though the better finger pruning schemes yielded "better looking", more apparently-uniform, basal (largest) hands, the data have not shown an actual increase in usable fruit. Removal of the first finger of sub-basal hands reduced this source of point scarring. Sample sizes were inadequate to verify if this practice affected stem weights.

Labor would undoubtedly resist the introduction of finger pruning schemes, even if they proved to be beneficial. Finger pruning does not appear to be a feasible agricultural practice.

Table 24. Effect of Finger Pruning on Valery[a/] Fruit Quality

	TREATMENT[b/]		
	Control	Fused /2/2/2	Fused /3/3
Number of Stems	47	54	73
Average Stem Weight (lbs)	92.2	85.2	87.7
Average Number of Hands	10.1	10.5	10.3
Average Age (Days from shooting)	105.6	106.2	103.7
BASAL HANDS			
Average Weight (lbs)	13.7	9.7	10.2
Average Number of Fingers[c/]	27.7	27.6	27.2
Average Finger Length (in.)	10.2	9.7	10.0
	PERCENTAGE OF BASAL HAND WEIGHT		
CHIQUITA	86.1	89.2	90.2
SPECIALS	4.6	7.6	5.4
WASTE			
Handling	4.8	3.0	4.2
Pests	0.3	0.1	0.2
Wild Fingers	2.1	-	-
Malformed fingers	-	0.1	-
Fused Fingers	2.1	-	-

a/ Valery at 621 p.u./A (buffer), Laurel Farm, Honduras.

b/ Fingers removed from basal hands at time of bagging.

c/ Original number, before finger pruning.

Table 25. Effect of Finger Pruning on Grand Nain[a/] Fruit Quality

	TREATMENT[b/]		
	CONTROL	FUSED /2/2/2	FUSED /3/3
Number of stems	129	88	114
Average stem weight (lbs)	94.1	91.4	93.1
Average number of hands	10.9	10.8	11.0
Average age (days from shooting)	117.3	115.6	115.4
BASAL HANDS			
Average weight (lbs)	12.2	10.1	10.0
Average number of fingers[c/]	28.1	27.9	27.8
Average finger length	9.7	9.8	9.9
	PERCENTAGE OF BASAL HAND WEIGHT		
CHIQUITA	78.1	83.5	83.5
SPECIALS	5.7	7.5	6.4
WASTE			
Handling	8.7	7.4	7.2
Pests	1.3	0.6	1.5
Wild Fingers	2.0	0.1	-
Malformed fingers	0.4	0.4	0.7
Fused Fingers	3.3	0.2	0.3
Selector[d/]	0.5	0.4	0.5

a/ Grand Nain at 696 p.u./A (buffer) Laurel Farm, Honduras.

b/ Fingers removed from basal hands at time of bagging.

c/ Original number before finger pruning.

d/ Good fingers inadvertantly removed by selector.

BANAVAC

Banavac bags manufactured from film containing 15-17% ethylene vinyl acetate (EVA) have been reported to have "greater air permeation" (three times that of low density polyethylene - LDPE). This characteristic reportedly provides "slower ripening", or greater green life, of bananas contained therein.

An experiment was established on November 26, 1974. Forty UF-42 boxes of Valery bananas were packed in Banavac bags made of each of these films (20 boxes with LDPE and 20 boxes with EVA). Large stems, calipering 15-17 on the largest hand, were used. Each hand was divided into halves which were packed in each of the films. All boxes were held at ambient temperatures for one day prior to storage at 56-58°F.

Orsat gas analyses for carbon-dioxide and oxygen were made three times each day for the first three days and daily for the remaining 45 days holding period. Four different Banavac bags of each film were sampled each time. Each point of the datad plotted in Figure 5 represents the average of four samplings.

RESULTS: Carbon-dioxide and oxygen values observed were similar for both the LDPE and EVA films. The earliest R / T observations of bananas in both films were made on the 22nd. day after harvest (Table 26). Both boxes represented the same stem of fruit, which had clusters calipering as high as 20. The next R / T observations were made 39 and 34 days after harvest, in LDPE and EVA films, respectively. All quality observations made after ripening were similar and no differences were detected between bananas stored in LDPE and EVA. Based on these findings, Banavac bags made from EVA can be substituted for those of LDPE film.

Table 26. Quality of Honduras Valery Bananas Ripened on a Five Day Schedule After Being Held for 45 Days in Banavac Bags made of Low Density Polyethylene (LDPE) vs. Ethylene Vinyl Acetate (EVA).

	Film Material	
	LDPE	EVA
No. Boxes:	20	20
R / T:		
No. Boxes	3	5
Earliest Observation (Days)	22	22
Color Index:		
Range	3 - 5	3 - 5
Average	4.2	4.1
Scald:		
Range	None-Trace	None-light
Mostly	None	None
Weak Necks:		
Range	None	None
Mostly	None	None
Withered Pedicels:		
Range	None	None-Trace
Mostly	None	None
Split Fingers:		
Range	None-one	None
Mostly	None	None

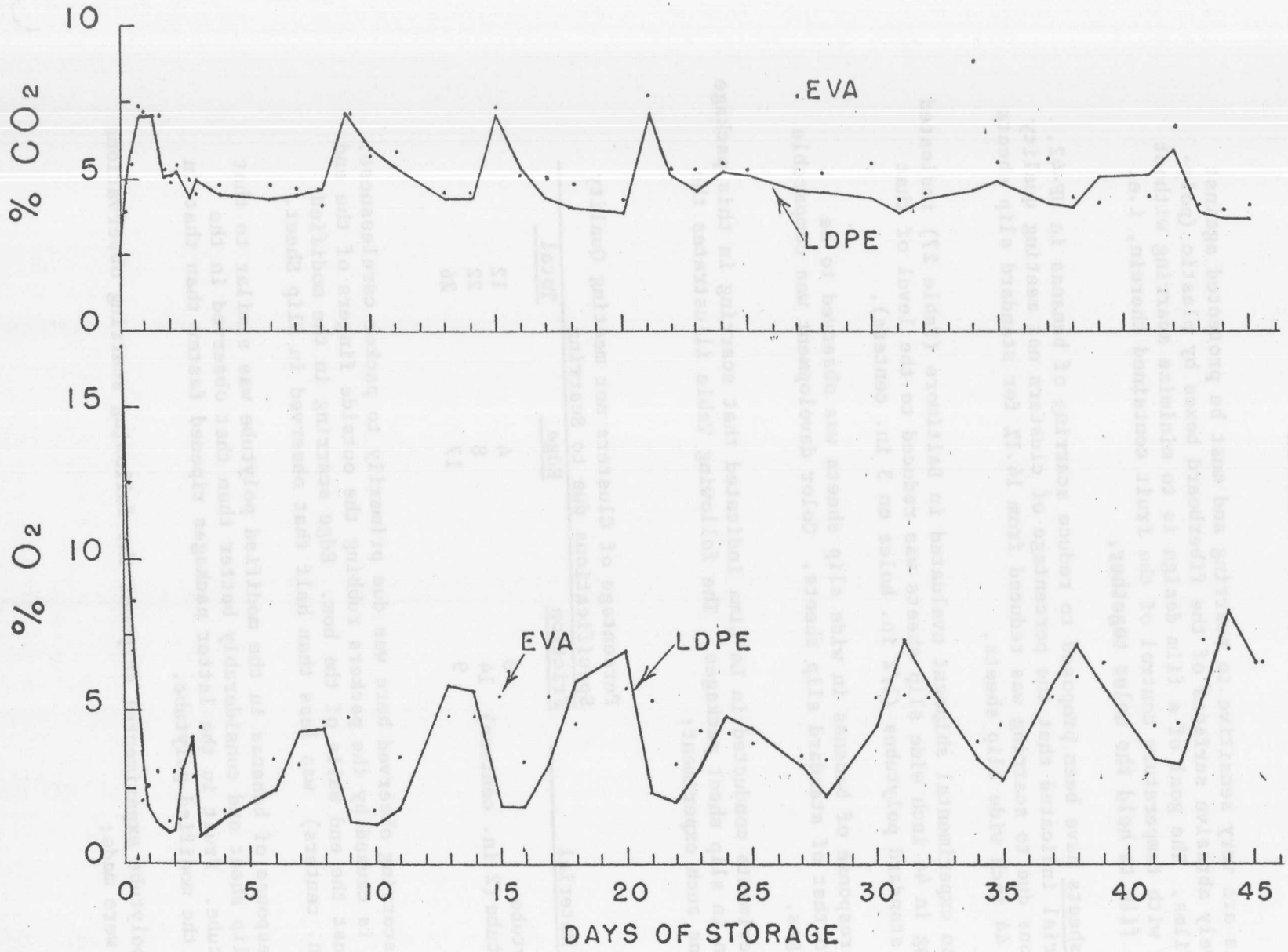

Figure 5

CARBON DIOXIDE AND OXIGEN CONTENT IN BANAVAC BAGS (1.5 MIL, VALERY BANANAS) MADE OF LOW DENSITY POLYETHYLENE (LDPE) VS. ETHYLENE VINYL ACETATE (EVA).

SCAR PROTECTION FOR BOXED BANANAS

Banana peels are very sensitive to scarring and must be protected against the relatively abrasive surfaces of the fiberboard boxes by plastic (polyethylene) films. The goal of a film design is to minimize scarring without interfering with temperature control of the fruit contained therein, i.e. just enough film to hold the holes together.

Wider slip sheets have been proposed to reduce scarring of bananas in UF-42. A La Lima trial indicated that the percentage of clusters not meeting quality specifications due to scarring was reduced from 14.1% for standard slip sheets to 3.7% for 44 inch wide slip sheets.

Results of an experimental shipment evaluated in Baltimore (Table 27) indicated that scarring in 44 inch wide slip sheets was reduced to the level of that observed in standard polytubes (1/2 in. holes on 3 in. centers).

Temperature response of bananas in wide slip sheets was observed to be comparable to that of standard slip sheets. Color development was comparable in all packages.

Polytube experiments conducted in La Lima indicated that scarring in this package was less than in slip sheet packages. The following Table illustrates the results of one such experiment:

Packaging Material	Percentage of Clusters not meeting Quality Specifications due to Scarring		
	Friction	Edge	Total
Standard Polytube	8	4	12
Modified Polytube (2 in. centers)	14	8	22
Slip sheet	9	17	26

The friction scarring observed here was due primarily to packer carelessness. Edge scarring is caused by the packers rubbing the outside fingers of the end clusters against the end walls of the box. Edge scarring in the modified polytube (2 in. centers) was less than half that observed in Slip Sheet.

Temperature response of bananas in the modified polytube was similar to that observed in slip sheet and considerably better than that observed in the standard polytube. Fruit in the latter packages ripened faster than that in slip sheet or the modified polytube.

In the first polytube experimental shipment the following scarring observations (5 boxes/lot) were made:

Table 27. Scarring Comparisons of Wide and Standard Slip Sheet vs. Standard Polytubes (5 boxes/lot) - Experimental Shipment to Baltimore, March 8, 1974.

LOT	ENDWALL CLUSTERS ONLY			TOTAL CLUSTERS			
	TOTAL SCARRING (In^2)	No. OF FINGERS AFFECTED	TOTAL FINGERS	TOTAL SCARRING (In^2)	No. of FINGERS AFFECTED	TOTAL FINGERS	FILM AREA (In^2)
WIDE SS 44" x 72"	4.4	105	318	6.9	154	520	3168
REG SS 32" x 72"	6.8	120	308	9.5	177	487	2304
REG PT 42" x 38"	4.7	94	297	7.2	149	459	3192

Packaging Material	Total Scarring (sq. in.) Edge	Total
Standard Polytube	6.8	11.5
Modified Polytube (2 in. centers)	5.8	10.1
Slip Sheet	7.8	13.4

Scarring observations of the second polytube experiment are presented in Table 28.

While these scarring results were variable, temperature response was better in the modified polytube than in either the standard polytube or slip sheet (Figure 6). Little package to package color variation was observed after ripening.

Slip sheets have been in common use for shipments to North American markets, but, regardless of the dimensions, scar protection is not always complete. Polytubes completely envelope the fruit and thus provide maximum scar protection. Furthermore, polytubes reduce the human error in the placement of the protective film and the subsequent packing of the clusters.

Polytubes, however, interfere with fruit temperature control more than do slip sheets. Modifying polytubes to more-than-double the open area of the film (1/2 in. perforations on 2 in. rather than 3 in. centers) has provided an acceptable compromise. Experimental results have repeatedly shown that the most desireable characteristics of slip sheets (temperature control) and polytubes (scar protection and reduced jumbling) are combined in this modification. It has been recommended that modified polytubes be used year around to replace slip sheets in our standard UF-42 packages.

Table 28. Scarring Comparisons of Bananas in Modified and Standard Polytube vs. Slip Sheets (5 boxes/lot) - Experimental Shipment to Baltimore, March 29, 1974.

LOT	ENDWALL CLUSTERS ONLY			TOTAL CLUSTERS		
	TOTAL SCARRING (In^2)	NO. OF FINGERS AFFECTED	TOTAL FINGERS	TOTAL SCARRING (In^2)	NO. OF FINGERS AFFECTED	TOTAL FINGERS
Modified Polytube (2 in. centers)	4.1	78	276	9.1	157	498
Standard Polytube	2.8	64	287	5.3	113	518
Poly Slip Sheet	4.7	83	294	7.1	122	477

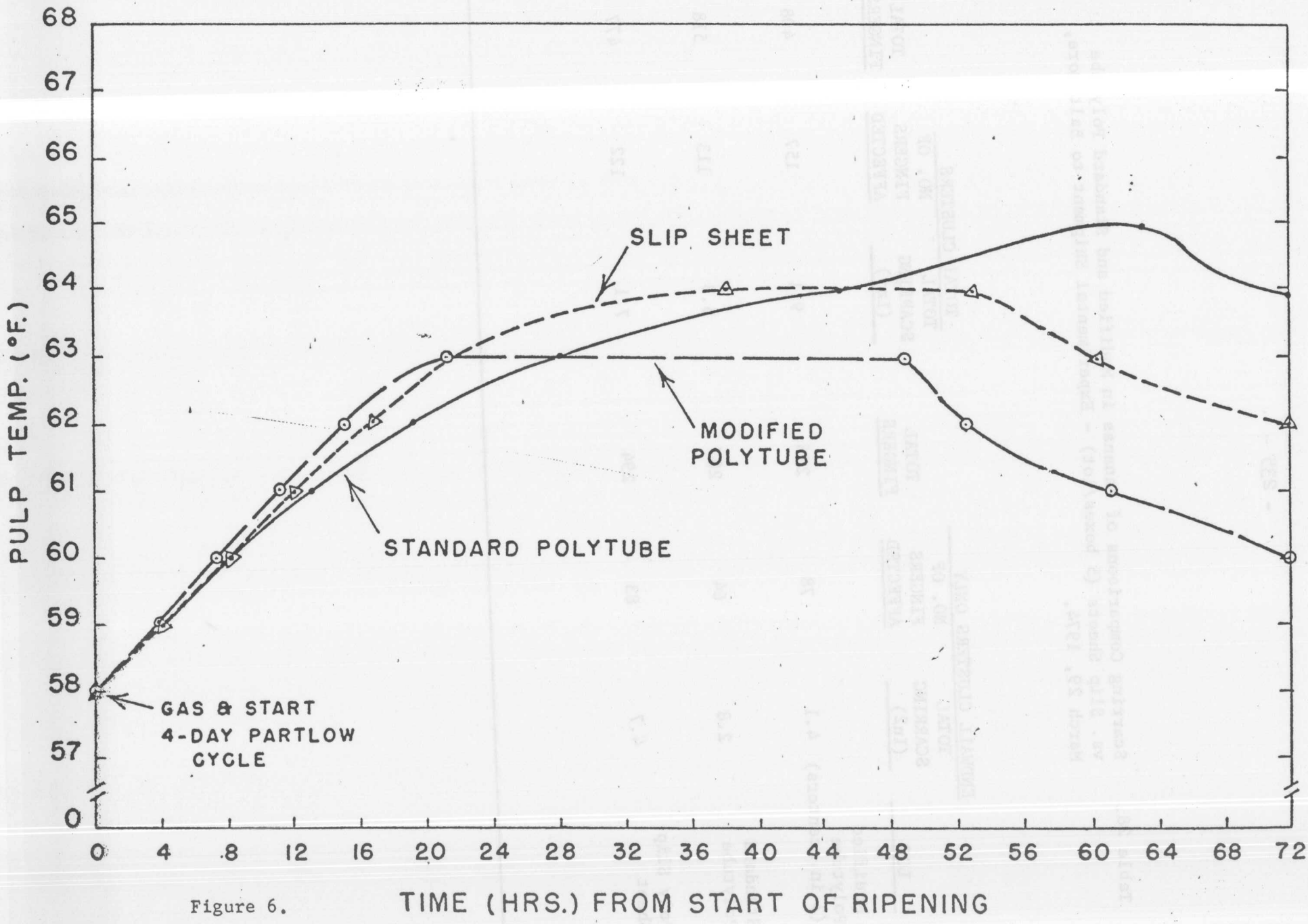
PULP TEMP. (°F.)
68
67
66
65
64
63
62
61
60
59
58
57
0
SLIP SHEET
MODIFIED
POLYTUBE
STANDARD POLYTUBE
GAS & START
4-DAY PARTLOW
CYCLE
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
68
72
TIME (HRS.) FROM START OF RIPENING

Figure 6.

POSTHARVEST ANTITRANSPIRANT APPLICATIONS FOR BANANAS

Many of the postharvest quality maintenance problems of boxed bananas, such as withered pedicels and crown rot, can generally be attributed to agronomic and cultural practices. These deficiencies should be corrected by management. Meanwhile, it has been considered feasible to reduce these problems through postharvest applications of antitranspirants.

On June 24, 1974 several candidate antitranspirants were applied to commercial fruit in Copen Farm (03), Honduras. All materials were sprayed to run-off on clusters in trays. All bananas were packed in slip sheets in UF-42 boxes, held for 48 hours at ambient temperatures, then stored at 56-58°F for four weeks before ripening. The results of these treatments are presented in Table 29.

All-Safe at 1% was one of the best antitranspirants due primarily to its superior reduction of crown rot. At 10% this material was questionable because of slightly more desiccation and phytotoxicity.

Clear Spray at 1% was superior because of its effect on reducing withered pedicels and crown rot. However, at 10% this material coagulated giving a slightly shiny appearance to the peel surface. The highest levels of medium withered pedicels were observed with this treatment.

Foli-Gard would not stay in solution at either concentration unless alum was eliminated. Results obtained were generally equal to or only slightly superior to the treated controls (except for increased latex staining at the 10% concentration).

Mobileaf at 1% was slightly superior to the non-treated controls in all respects except possibly withered pedicels and peel desiccation. At 10% Mobileaf reduced weight loss, retarded color development and reduced the incidence of withered pedicels, crown rot and latex staining. However, trace to light chlorophyll retention was observed.

Vapor Guard at 1% appeared to be the best antitranspirant because of superior crown rot control, retarded color development and reduced withered pedicels. The trace of chlorophyll retention observed could be overlooked in view of the other benefits. The lowest levels of withered pedicels, weight loss and color development were observed with Vapor Guard at 10%. However, this treatment was inferior because of excessive chlorophyll retention and resulted in sticky, shiny banana peel surfaces.

Wilt Pruf at 1% appeared to be one of the better antitranspirants since it was equal to or slightly better than the treated controls in all respects. The 10% level gave even better results, especially in controlling crown rot. However, this concentration was apparently too strong as it caused some chlorophyll retention and sticky, shiny peels.

These experiments should be repeated at the 1% and 5% concentrations, but not at 10%. TAG and Epolene should also be evaluated.

Table 29. Valery Banana Quality Maintenance as Affected by Postharvest Antitranspirant Treatments in Honduras.

Material/ Concentration[a/]	Manufacturer/Distributor (Antitransp. Ingredient)	No. Clust.	Weight Loss (%)	Color Index Range	Color Index Mostly	WITHERED PEDICELS (% clusters affected) N	T	L	M	S	Desiccation Range	Desiccation Mostly	Crown Rot Index	Latex Stain Range	Latex Stain Mostly	Phytotoxicity Range	Phytotoxicity Mostly	Caliper Grade (Ave)	COMMENTS
All-Safe 1%	Certified Laboratories, Inc. (Latex)	79	6.47	4-6	4+	25.3	54.5	17.7	2.5	-	N - L	T	2.89	N - L	N	N - T	N	9.5	-
All-Safe 10%	"	75	5.76	3-6+	4+	45.3	38.7	16.0	-	-	N - M	N	3.21	N - L	N	N - L	N	10.1	Trace chlorophyll retention.
Clear Spray 1%	W. A. Cleary Corp. (Latex)	79	6.21	4-5+	5	49.4	38.0	12.6	-	-	N - L	T	3.47	N - L	N	N - T	N	9.3	-
Clear Spray 10%	"	71	5.74	3-6	4	40.9	39.4	15.5	4.2	-	N - L	N	3.13	N - L	N	N	N	9.4	Slightly shiny, coagulation.
Foli-Gard 1%	E-Z-Flo Chemical Co. (Acrylic copolymer)	72	5.28	4-6	5	22.2	47.2	26.4	4.2	-	N - L	T	3.15	N - L	N	N - T	N	10.2	-
Foli-Gard 10%	"	73	5.29	4-6+	5	31.5	53.4	13.7	1.4	-	N - T	N	3.48	N - S	L	N - T	N	11.1	-
Mobileaf 1%	Mobil Res. & Develop. Corp. (Wax)	76	5.80	4-6	4+	36.8	47.4	14.5	1.3	-	N - M	N	4.37	N - L	N	N	N	9.2	-
Mobileaf 10%	"	81	5.02	3-5+	4	51.0	37.0	12.0	-	-	N - L	N	3.41	N - T	N	N - T	N	9.1	Trace-light chlorophyll retention.
Vapor Guard 1%	Miller Chemical & Fertilizer Corp. (polyterpene)	80	5.52	3-6+	4	51.2	37.5	11.2	-	-	N - L	N	2.86	N - L	N	N - T	N	9.8	Trace chlorophyll retention.
Vapor Guard 10%	"	70	4.82	3-6+	3	67.1	32.9	-	-	-	N - T	N	4.19	N - T	N	N - L	T	10.5	Sticky, shiny - Medium-severe chlorophyll retention.
Wilt Pruf 1%	Nursery Speciality Products, Inc. (polyvinyl chloride)	72	5.73	4-6	5+	29.2	41.7	26.3	2.8	-	N - L	N	3.43	N - L	N	N	N	10.0	-
Wilt Pruf 10%	"	69	4.80	3-5	4+	33.3	60.9	5.8	-	-	N - T	N	2.74	N - L	N	N - T	N	10.8	Trace-light chlorophyll retention, sticky, shiny
Treated Control	—	141	6.46	4-6+	5	53.2	31.9	13.5	0.7	0.7	N - L	T	5.43	N - M	N	N - T	N	9.7	-
Non-treated Control	—	126	5.98	4-8	5+	58.7	32.5	7.2	1.6	-	N - M	N	7.42	N - M	N	N	N	10.8	-

a/ All treatments included alum (1%) plus Benlate (100 ppm, a.i.) except Foli-Gard (1 & 10%) and non-treated control.

PLASTIC TUNNEL PADS

Polymer, Ltd. has determined that they can produce plastic tunnel pads of up to 10 mil tickness for a price competitive with our current 69 lb. kraft paper pad. Two trials were conducted in La Lima to determine if they would provide scar and bruise protection equivalent to paper pads.

In each trial the plastic pads were handed to the packers with instructions to pack the clusters in the normal manner. The boxed fruit was transported by truck to La Lima Research, held for 24 hours at ambient temperatures, then treated as follows:

	Trial 1		Trial 2*
Harvest Date:	Nov. 19, 1974		Dec. 10, 1974
Packing Station:	San Juan (01)		La Curva (06)
Treatment	A	B	
Complete roll ("side-over-side")	1	-	1
Controlled drop (upright)	2	-	1
Controlled drop (upside down)	1	-	-
Transit simulator (shaker)	2 min.	-	1 min.

* Treatments too severe in trial 1; modified for trial 2.

All fruit was held one week at 56-58°F, ripened on a one week schedule to color index 4-5 and evaluated by Honduras Division Quality Control personnel. The results of their observations are reported in Table 30. Table 31 compares the more important levels of each criterion.

Overall, the eight mil plastic pads appeared to protect the bananas about as well as the 10 mil plastic and the 69 lb. paper tunnel pads. However, these pads are very flexible and "slippery". They didn't remain in position while packing the bottom rows of clusters and were easily forced out of position during the packing of the top rows. These pads slide out of position (get "displaced") during handling. For these reasons the eight mil pad is probably inadequate and should receive no further consideration.

Scarring and bruising of bananas in 10 mil plastic and 69 lb. paper tunnel pads did not consistently favor either material. However, it was felt that the plastic pads permitted more fourth row, inner whorl point scarring because these areas were inadequately protected from the points of second row clusters.

If used, the 10 mil plastic pads might have to be lengthened to compensate for characteristics similar to those described for the eight mil samples (flexibility and "slipperiness"). Neck injury observed was similar for these materials. In both tests, there were more mutilated fingers in those boxes using the 10 mil plastic pads. Jumbling was reduced in the second trial, but was still greater in the boxes with 10 mil plastic pads.

CONCLUSIONS: Plastic tunnel pads may compete cost-wise with 69 lb paper, but banana quality maintenance appears to suffer somewhat. To get a better idea of their relative performance these materials should be evaluated in an experimental shipment.

Table 30. Comparisons of the Effects of Plastic vs. Paper Tunnel Pds on Banana Quality Maintenance in UF-42 Boxes.

TEST 1 A	Clusters (No.)	SCARRING[a/] HANDLING T	L	M	S	POINT T	L	M	S	BRUISES[a/] Total	Neck Injury[a/] T	L	M	S	Mutilated Fingers Total	Jumbling[a/] T	L	M	S	Tunnel pad orientation Displaced[b/]
8 mil plastic	71	14.1	8.5	14.1	40.8	-	8.5	15.5	29.6	71.8	2.8	8.5	4.2	18.3	7	-	1.4	-	4.2	100
10 mil plastic	66	12.1	22.7	21.2	18.2	-	12.1	31.8	10.6	71.2	4.5	4.5	10.6	13.6	10	1.5	1.5	-	3.0	60
69 lb. paper	64	12.5	9.4	12.5	35.9	-	15.6	31.3	28.1	75.0	3.1	9.4	12.5	14.1	6	-	1.6	1.6	-	0
TEST 1 B																				
8 mil plastic	71	19.7	5.6	8.5	1.4	9.9	7.0	4.2	-	28.2	2.8	1.4	-	1.4	0	-	4.2	-	-	40
10 mil plastic	64	20.3	9.4	4.7	6.4	6.3	4.7	3.1	1.6	34.4	3.1	4.7	1.6	-	0	-	3.1	-	-	20
69 lb. paper	65	26.2	7.7	-	-	30.8	-	3.1	-	23.1	3.1	1.5	-	4.6	2	-	-	-	-	0
TEST 2										T L M S										
10 mil plastic	140	26.4	51.4	17.9	2.1	5.7	32.1	7.9	5.7	17.1 4.3 10.0 10.7	4.3	5.0	3.6	9.3	8	-	0.7	-	-	20
69 lb. paper	141	27.0	43.3	14.2	7.1	6.4	22.0	5.7	2.1	18.4 10.8 10.8 6.4	6.4	1.4	4.3	9.2	5	-	0.7	-	-	0

a/ Percentage of clusters affected.

b/ Percentage of boxes affected.

Table 31. Summary Comparisons of the More Important Levels of Each Criterion of the Effects of Plastic vs. Paper Tunnel Pads on Banana Quality Maintenance in UF-42 Boxes.

	Scarring[a/]						
	Handling	Point	Bruises[b/]	Neck injury[a/]	Mutilated Fingers[b/]	Jumbling[b/]	Displaced Tunnel Pads[c/]
TEST 1 A							
8 mil plastic	54.9	45.1	71.8	22.5	7	5.6	100
10 mil plastic	39.4	42.4	71.2	24.2	10	6.0	60
69 lb. paper	48.4	59.4	75.0	26.5	6	3.2	0
TEST 1 B							
8 mil plastic	9.9	4.2	28.2	1.4	0	4.2	40
10 mil plastic	11.1	4.7	34.4	1.6	0	3.1	20
69 lb. paper	-	3.1	23.1	4.6	2	0	0
TEST 2							
10 mil plastic	20.0	13.6	20.7	12.9	8	0.7	20
69 lb. paper	21.3	7.7	17.2	13.5	5	0.7	0

a/ Percentage of clusters affected; medium and severe.

b/ Percentage of clusters affected; total.

c/ Percentage of boxes affected.

CONTAINER OPERATIONS

Controversy has existed as to whether banana field heat removal is more effective when the container's refrigeration operates continuously from the start of loading or when refrigeration is started only after loading is completed and the doors are closed.

A comparison of field heat removal in two York containers was conducted. Three thermocouples were installed in boxes in each container; top, fourth layer and bottom. Pulp temperatures during loading were 79-80°F for both containers. Temperature readings were made (remotely by potentiometer) periodically over the period of loading and until the containers departed for Cortés. Figure 7 illustrates in-box temperature observations of the middle box.

From these observations there appears to be little difference in field heat removal. In fact, once the refrigeration was started, that which was off during loading, pulled the middle box, in-box temperature down 15°F in four hours. Within 24 hours temperature in both containers were at approximately the desired holding temperature. Admittedly, these are limited data and give little information on how fruit in other areas of the containers cooled. Nonetheless, this is sufficient evidence to support the recommendation to only start container refrigeration after loading is completed. This is especially important for fuel economy.