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PRODUCTIVIDAD DE DOS TIPOS DE AJI PICANTE (*CAPSICUM* spp.) PARA INDUSTRIA DE ENCURTIDO, SEMBRADO EN DOS EPOCAS, DOS MODALIDADES Y TRES DENSIDADES DE SIEMBRA[1] /

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Summary

*The experiment was conducted at CATIE, Turrialba, Costa Rica (April to November 1981) with the types of hot pepper (*Capsicum *spp.) Jalapeño and Serrano. The plots were direct seeded and transplanted during two seasons at tree planting densities (41 666, 83 333 and 20 833 plants/ha). The density of 20 833 plants/ha is commonly used in the area and served as the local check.*

The ten harvests between September 4 and November 25, 1981) were grouped as: early (N° 1 to 5), intermediate (N° 6 and 7) and late (N° 8 to 10). Fruits were classified as green commercial (less than 70 mm long) according to local standards for pickled peppers of the canning industry and non commercial (more than 70 mm). Quality was determined by fruit diameter, pulp thickness and average fresh weight.

There was a positive correlation between fresh weight of total fruit and number of fruits per unit area for the different harvest periods and for the different categories of fruits.

The highest yield as fresh weight commercial peppers, number of fruits and net income of the economic biomass were obtained with 83 333 plants/ha (average across harvest periods), regardless of the planting system and the plant type. Commercial and non-commercial early fruit yields were highest when both transplanted in June. The Jalapeño type produced earlier than the Serrano type. Harvest of Serrano was concentrated in the late period.

Introducción

El chile (*Capsicum* spp.) pertenece a la familia de las solanáceas. Se adapta a gran variabilidad de condiciones climatológicas, encontrándose en zonas templadas, tropicales y sub-tropicales tanto húmedas como secas. La especie (*Capsicum pubescens*) prospera de preferencia en zonas de altura (8) o templadas (1, 4). La gran diversidad de especies dulces y picantes han difundido su cultivo, consumiéndose como salsas, conservas, fresco, seco, polvo o como materia prima para la extracción de la capsicina en la industria de alimentos o en farmacología (2, 7).

El trópico húmedo, debido a las frecuentes precipitaciones y de las altas temperaturas, presenta condiciones favorables para la siembra de chile del tipo picante durante todo el año (5). En Costa Rica la industria lo consume en encurtido y en salsa.

La falta de información referente a una adecuada modalidad de siembra y los serios problemas de mortalidad de plantas que afectan la densidad de muchas zonas, originó la presente investigación para (i) evaluar el efecto de altas densidades de siembra sobre el rendimiento en peso fresco de chile picante; (ii) determinar el efecto de la siembra directa y transplante so-

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bre el rendimiento y (iii) determinar la época más adecuada de siembra.

Materiales y métodos

El experimento se instaló en "La Montaña", CATIE, Turrialba, Costa Rica. La zona corresponde a la formación ecológica de bosque muy húmedo tropical premontano, con una precipitación anual de 2 662 mm. El suelo es de textura franco arcillo-limosa, con pH 5.2, bajo en nitrógeno total (0.3%) y 30 ppm de *P* y 0.5 meq K/100 ml de suelo. Las parcelas midieron de 4.80 x 5 m de largo, siendo la parcela útil de 6 m^2.

Se usó un arreglo factorial (2 x 2 x 2 x 3) distribuido completamente al azar. Esto correspondió a dos épocas de siembra; una lejana (junio) y otra cercana al período de alta precipitación (julio); dos modalidades de siembra (directa y transplante); dos tipos de aji para industria de encurtido (Jalapeño y Serrano) y tres densidades de siembra (20 833; 41 666 y 83 333 plantas/ha). Como testigos zonales se tuvieron el jalapeño sembrado a baja densidad (20 833 plantas/ha) en forma directa o transplante en las dos épocas (junio y julio). Las variables agronómicas evaluadas en la parcela útil se observan en el Cuadro 1.

Resultados y discusión

Agrupamiento de cosechas

Las cosechas se agruparon en función del tiempo que tomaron los diferentes tratamientos para entrar en cosecha (Cuadro 2). Los frutos verdes por parcela en los períodos de cosecha total, precoz, intermedia y tardía se clasificaron en las categorías comercial y no comercial. El fruto maduro se consideró en la categoría de desecho ya que la industria de encurtido local usa el fruto verde. *Biomasa económica* (peso fresco total de frutos verdes y maduros).

El peso fresco de frutos (kg/6 m^2) y el número de frutos por parcela de la biomasa económica, correlacionaron en forma positiva (r = 0.70); el número de frutos por parcela y el peso promedio por fruto (g/fruto), lo hicieron en forma negativa (r = 0.78). Esto indica que el número de frutos en las parcelas de mayor rendimiento fue el mayor, porque disminuyó el peso promedio por fruto en esa misma área.

El peso de la biomasa económica se repartió en la siguiente forma: 51 por ciento para fruto comercial, 32 por ciento para fruto no comercial y la diferencia (17 por ciento) para fruto maduro (Cuadro 3).

Cuadro 1. Variables agronómicas evaluadas en la parcela útil (6 m^2) en el cultivo de aji (*Capsicum* spp).

Variable	Metodología y frecuencia de evaluación	Tiempo que duró la evaluación
Supervivencia	Conteo de número de plantas vivas cada 15 días	60 días desde el establecimiento de la población hasta el final de la cosecha
Rendimiento	Se pesaron y contaron todos los frutos de la parcela útil de las 10 cosechas (cada 15 días) diferenciando los verdes de los maduros	82 días
Calidad	En cada cosecha, sea de fruto verde o maduro, se estimó:	
	– Longitud de fruto comercial (menos que 70 mm) y fruto no comercial (mayores que 70 mm)	82 días
	– Se cortó transversalmente 10 frutos en cada cosecha y se midió el diámetro del fruto y la pulpa con una regla milimetrada	82 días
	– El peso promedio por fruto se generó dividiendo el número de frutos entre su peso respectivo en cada cosecha	
	– Fruto caído: Se recogieron los frutos del suelo y se pesaron y contaron cada 15 días	60 días

Cuadro 2. Agrupamiento de cosechas y categorías de frutos de ají picante en la fase experimental.

Agrupamiento de cosechas	Categoría de fruto	Número de cosecha	Período que corresponde
Biomasa económica		Total + fruto maduro	4 set. a 25 nov. 81
Total	Verde comercial y no comercial	1 a 10	4 set. a 25 oct. 81
Precoz	Verde comercial y no comercial	1 a 5	4 set. a 16 oct. 81
Intermedia	Verde comercial y no comercial	6 y 7	17 oct. a 2 nov. 81
Tardía	Verde comercial y no comercial	8 a 10	3 nov. a 25 nov. 81
Maduro	Desecho	8 a 10	3 nov. a 25 nov. 81

Cuadro 3. Peso (kg/6 m^2) y porcentaje del peso de frutos por categorías y períodos de cosecha en función de la biomasa económica y de la cosecha total de ají picante (La Montaña, CATIE, Turrialba; 4 set. a 25 nov. de 1981).

Períodos de cosecha	Peso (kg/6 m^2) y porcentaje del peso de frutos por categorías									
	Verde comercial			Verde no comercial			Maduro		Biomasa económica (BE)	
	Peso	% BE	% Total	Peso	% BE	% Total	Peso	% BE	Peso	% BE
Total	7.4	51.4	61.7	4.6	31.9	38.3	2.4	16.6	14.4	100
Precoz	2.3	16.0	19.2	3.0	20.8	25.0	–	–	–	–
Intermedia	2.0	13.9	16.7	1.0	6.9	8.3	–	–	–	–
Tardía	3.1	21.5	25.8	0.6	4.2	5.0	–	–	–	–

El peso fresco de frutos verdes (kg/6 m^2) de biomasa económica fue mayor para el transplante de junio, debido a que dicho tratamiento obtuvo mayor peso fresco por parcela y número de frutos verdes comerciales y no comerciales durante la cosecha total.

La densidad de siembra influyó en el rendimiento de la biomasa económica. Esto se justifica porque se tuvo mayor sobrevivencia de plantas por unidad de área en las densidades altas en relación a la densidad baja. Poblaciones de 83 333 y 41 666 plantas/ha registraron incrementos en peso fresco de 73 y 38 por ciento respectivamente con respecto a la densidad de 20 833 plantas/ha. Estos ámbitos están próximos a los obtenidos por Szepesy (10) quien logró incrementos de 63 por ciento con poblaciones de 214 000 plantas/ha.

El tipo Jalapeño, por características genéticas inherentes, tuvo mayor diámetro de fruto y grosor de pulpa (28 mm y 6 mm) en relación al Serrano (19 mm y 3 mm). El peso fresco por fruto del Jalapeño fue 20 g y del Serrano 8 g.

Cosecha total (peso fresco total de frutos verdes)

El peso fresco (kg/6 m^2) y el número de frutos por parcela de las categorías comercial y no comercial, presentó una correlación positiva de $r = 0.67$ y $r = 0.62$

El peso del fruto verde comercial y no comercial significó el 62 por ciento y 38 por ciento respectivamente con relación al peso de la cosecha total. En función de la biomasa económica el peso del fruto comercial fue de 51 por ciento y para el no comercial 32 por ciento. El transplante de junio (lejano al período de altas precipitaciones), registró el mayor peso y número de frutos verdes comerciales y no comerciales por parcela, por haberse obtenido en dicho tratamien-

Cuadro 4. Indice de cuaje y floración por parcela (6 m²), en relación a la densidad baja (20 833 plantas/ha), en dos modalidades y tres densidades de siembra, en dos tipos de ají picante, al inicio de la cosecha precoz. (La Montaña, CATIE, Turrialba; 4 set. de 1981).

Evaluación	Siembra	Tipo de ají	Densidad de siembra (plantas/ha)				S	Media (T)
			83 333	41 666	20 833	Sxt		
Indice de floración por parcela	Directo	Jalapeño	83	131	55	90	146 Directo	112 Jalapeño
		Serrano	234	240	129	201		
	Transplante	Jalapeño	220	115	67	134	169 Transplante	202 Serrano
		Serrano	334	129	149	204		
Media (D)			218	154	100			
Indice de cuaje por parcela	Directo	Jalapeño	132	107	58	99	148	126 Jalapeño
		Serrano	227	263	101	197		
	Transplante	Jalapeño	214	130	118	154	163	184 Serrano
		Serrano	306	86	124	172		
Media (D)			220	146	100			

Floración por parcela $\bar{x} = 157$ $\bar{\bar{x}}$ = Cuaje por parcela 155

to una significativa producción precoz de ambas categorías de frutos verdes.

El peso y número de frutos verdes (kg/6 m^2) fue menor a medida que la densidad de plantas disminuyó de 83 333 a 20 833 plantas/ha. Esto estuvo relacionado al porcentaje de sobrevivencia de plantas por parcela y concuerda con los resultados obtenidos por Yoshida (11).

Cosecha precoz (cosechas N° 1 a 5 de frutos verdes)

El peso fresco y el número de frutos por parcela, comerciales y no comerciales, mostraron una correlación positiva ($r = 0.84$ y $r = 0.74$). El aumento de frutos por parcela implicó también que el peso promedio (8) por fruto fuera menor.

El peso fresco de este período significó el 16 por ciento y 21 por ciento de la biomasa económica para el fruto comercial y no comercial respectivamente. Con respecto al peso total de frutos por parcela de ambas categorías representó el 19 por ciento para el fruto comercial y 25 por ciento para el no comercial

El peso del fruto comercial y no comercial fue significativamente mayor ($P = 0.01$) para el transplante de junio en relación a las siembras directa de junio y julio y transplante de julio, esto estuvo relacionado al mayor número de flores cuajadas y el número de frutos a la cosecha precoz por unidad de área (Cuadro 4).

Por definición de estado juvenil, las plantas transplantadas en junio entraron en la etapa productiva más temprano y se tuvo mayor floración y fructificación. Posiblemente consiguieron completar sus requerimientos mínimos necesarios para estos procesos con anticipación. Entre estos factores está la temperatura, cuyo efecto fue estudiado por Cochran (3) y Song (9). Las plantas transplantadas en junio al inicio de la cosecha precoz recibieron un 54 por ciento más de grados días en °C que las plantas sembradas en julio, sobre 10°C considerados para el cultivo de ají.

Cosecha tardía (cosechas N° 1 a 6 de frutos verdes)

El peso fresco y número de frutos comerciales por parcela y no comerciales mostraron una correlación altamente significativa ($r = 0.92$ y $r = 0.84$). El peso promedio y el número de frutos por parcela estuvieron altamente correlacionados ($r = 0.85$ y $r = 0.75$). Posiblemente en la cosecha tardía los frutos fueron más pequeños en relación a las otras cosechas. El peso de frutos comerciales y no comerciales en función de la biomasa significó el 21 y 4 por ciento respectivamente. En función del peso total fue de 26 por ciento y 25 por ciento para el fruto comercial y no comercial, respectivamente.

El peso y el número de frutos verdes comerciales por parcela para el transplante de junio fue estadísticamente similar a la siembra directa de junio y julio y el transplante de julio.

Posiblemente hubo un buen establecimiento de las plantas en el campo para dichos tratamientos. En función del tiempo representó una mejor formación de la zona radicular, lo cual permitió una buena estabilización de la producción en este período de cosechas

Las altas precipitaciones afectaron a todos los tratamientos en el período de cosecha tardía (3 nov. a 25 nov.) pero no todos fueron desfavorecidos por igual, ya que el transplante de junio consiguió completar su etapa reproductiva en ese mayor tiempo. Esto probablemente pudo ser conseguido por las siembras directa de junio y julio o transplante de julio. Las excesivas precipitaciones propiciaron condiciones favorables para la infección del hongo *Colletrotrichum* sp. que redujo seriamente el área foliar y mató las plantas.

Los porcentajes en peso de frutos comerciales en este período fueron mayores para las densidades de 83 333 y 41 666 plantas/ha en relación a los períodos de cosecha anterior. No sucedió lo mismo para el fruto no comercial; ya que durante la cosecha tardía se recogieron todos los frutos de las plantas. Ello aumentó significativamente el número de fruto comerciales por parcela, que fueron más pequeños y tuvieron un menor peso promedio por fruto.

El tipo Serrano incrementó significativamente el peso de frutos verdes comerciales por parcela, ya que necesitó un mayor tiempo para entrar a cosecha en relación al Jalapeño. El peso de frutos tipo Serrano, en este período de cosechas significó el 59 por ciento del total del fruto comercial cosechado

Fruto maduro

El tipo Serrano fue el único que tuvo frutos maduros. Posiblemente su proceso de maduración fue más rápido que el Jalapeño.

El peso y el número de frutos por parcela mostraron alta correlación ($r = 0.98$); en función de la biomasa económica representó el 17 por ciento en peso de frutos por parcela. Se tuvo mayor peso y número de frutos por parcela a medida que se aumentó la densidad de siembra de 20 833 a 83 333 plantas/ha. El aumento de plantas por unidad de área produjo una mayor competencia por nutrimentos, agua y luz, lo

Cuadro 5. Análisis beneficio-costo/ha de ají picante obtenido en condiciones de La Montaña CATIE, Turrialba, Costa Rica; 1 abril a 25 noviembre 1981.

VALOR DE LA PRODUCCION (VP)*

Producto	Cantidad/ha	Precio Univ. (₡)	Total ₡**
Chile verde	31 300 kg	7.50	234 750

COSTOS VARIABLES/ha (C.V.)

A Insumos/ha

1. Plaguicidas (₡ 17 591)

Producto	Cantidad	Precio Unit (₡)	
Tamarón	8 3 lt	100	
Benlate	6 0 kg	500	
Adherente	3.8 lt	35	
Dithane	12 7 kg	88	
Dipterex	4.8 kg	100	
Sevin	0.7 kg	100	
Azúcar	17.0 kg	10	
Sub total			₡ 17 591

2 Fertilizantes (₡ 6 385)

10–30–10	261	5.5	
10–30–10	435	5.5	
10–30–10	174	5 5	
Nitrato de Amonio	87	8.0	
Sulfato de Amonio	113	8 0	
Sub total			₡ 6 385

3 Semilla	(0.5 kg)	667	
4 Insumos mercadeo		4.900	
5 Varios		2 295	
6 Interés (C/V (15% de ₡ 31 838)		1 592	
Sub total			₡ 9 454

B. Mano de obra/ha contratada	Cantidad	Costo	
Jorn 6 hr			
Preparación de suelo	(17)	850	
Transplante y recalce	(70)	3 500	
Atomización	(65)	3 250	
Amarre	(121)	6 050	
Deshierbo	(48)	2 400	
Abono y aporque	(57)	2 850	
Cosecha	(174)	8 700	
Sub total	(552)		₡ 27 600

COSTOS FIJOS

Interés/inversión (12%)	1 050
Renta de Tierra	1 000
Depreciación equipo y herramienta	1 200
Depreciación vehículo	1 875
Depósito plaguicidas	70
Total	6 195

Continuación Cuadro 5

VALOR DE LA PRODUCCION (VP)*

Producto	Cantidad/ha	Precio Univ. (₡)	Total ₡**
Chile verde	31 300 kg	7.50	234 750

EFICIENCIA ECONOMICA

Ingreso neto = ₡ 167 525

Ingreso bruto = ₡ 173 720

Margen bruto/días hombre 314

Ingreso neto/días hombre 303

Ingreso neto/costo total (incluye interés S/c.V.) = 2.5

* Se calculó con base en el mayor rendimiento: Jalapeño transplantado en junio 83 333 plantas/ha.

** 1 ₡ = $\frac{1}{40}$ de dollar

cual hizo acelerar su proceso metabólico y condujo a una mayor maduración de frutos (6). La dificultad para reconocer la coloración próxima a la cosecha en el ají Serrano, motivó que mayor cantidad de frutos verdes se queden sin cosechar.

Análisis económico

El ingreso neto (Cuadro 5), fue significativamente mayor en la densidad de 83 333 plantas/ha y esto estuvo en función del mayor peso-fresco de frutos de ají, y menor costo de producción a esa densidad de siembra (menor mortandad y mayor cantidad de frutos comerciales). La densidad de 20 833 plantas/ha produjo menores ganancias.

Conclusiones

1. El mayor número de grados días en °C acumulados favorecieron una producción temprana de ají en la época de junio.

2. La alta precipitación influyó en la sobrevivencia de plantas e impidió el control de *Colletrotricum* sp en las siembras tardías.

3. Hubo mayor porcentaje de sobrevivencia en las densidades de 83 333 plantas/ha (1.2 m entre surcos x 0.1 m entre plantas individuales) y 41 666 plantas/ha (1.2 x 0.20 m entre plantas).

4. Se encontró correlación positiva entre el peso fresco de frutos (kg/6 m^2) y número de frutos por parcela en las diferentes agrupaciones de cosecha.

5. El peso fresco y número de frutos de ají comerciales y de la biomasa económica fueron significativamente mayores usando 83 333 plantas/ha.

6. El peso fresco de frutos de ají comerciales y de la biomasa económica fueron mayores en el tipo Serrano en relación al Jalapeño.

7. El peso fresco de la biomasa económica y de los frutos comerciales de la siembra en transplante fue ligeramente superior a la siembra directa.

8. El peso fresco y número de frutos de ají comerciales y de la biomasa económica fueron significativamente mayores en las combinaciones de 83 333 y 41 666 plantas/ha transplantadas en junio comparados con los tratamientos contrastantes.

9. El peso total del fruto caído no fue significativo y alcanzó sólo el 7 por ciento del total de frutos cosechados.

10. El tipo Jalapeño fue más precoz que el Serrano.

11. Mayor ingreso neto se obtuvo usando densidades de 83 333 plantas/ha en relación a 41 666 y 20 833 plantas/ha.

Resumen

El experimento se realizó en el CATIE, Turrialba, Costa Rica (abril a noviembre de 1981), utilizando dos tipos de aji (*Capsicum* spp.) picante (Jalapeño y Serrano), en siembra directa y transplante, en dos

épocas y a tres densidades de siembra (41 666, 83 333 y 20 833 plantas). La densidad de 20 822 plantas/ha sirvió como testigo local, siendo la más usada en la zona.

Se realizaron 10 cosechas entre el 4 de setiembre y 25 de noviembre de 1981 y se agruparon en los períodos precoz (N° 1 a 5), intermedio (N° 6 y 7) y tardío (N° 8 a 10). Los frutos se clasificaron de acuerdo a los requerimientos de la industria de encurtido para enlatado, en fruto comercial (menor de 70 mm) y no comercial (mayor de 70 mm de largo). La calidad se evaluó en función del diámetro del fruto, el grosor de la pulpa y el peso promedio fresco.

Se encontró una correlación positiva entre el peso fresco de los frutos y el número de frutos por parcela para los diferentes períodos y las categorías de fruto cosechado.

El mayor rendimiento en peso fresco y en número de frutos e ingreso neto de la biomasa económica se obtuvo a la densidad de 83 333 plantas/ha, esto sin considerar la época, la modalidad de siembra y el tipo de ají. Cuando se transplantó en junio, ambos tipos de ají, se obtuvo un rendimiento precoz de fruto comercial y no comercial. El tipo Jalapeño fue más precoz que el Serrano, el cual concentró su cosecha durante el último período.

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EFFECTIVENESS OF REDUCED RATES OF CUPROUS OXIDE AND CUPRIC HYDROXIDE IN CONTROLLING COFFEE LEAF RUST IN KENYA[1] /

*Z. JAVED**

Resumen

Se encontró que la aplicación de 0.35 por ciento (3.8 kg/ha) óxido cuproso (Perenox y Copper Nordox) e hidróxido cúprico (Kocide 101) son eficientes en el control de la roya del café en tres sitios con alta infestación de roya durante los periodos 1979 y 1980.

Con la atomización con niveles bajos (0.35%) de Perenox, Copper Nordox y Kocide 101 se obtuvo rendimiento tan alto como los obtenidos al aplicar los resultados al 0.7 por ciento. Por lo tanto, se recomienda aplicar 3.8 kg/ha de Perenox, Copper Nordox y Kocide 101 para el control de la roya del café en Kenia.

Introduction

Coffee Leaf Rust caused by the fungus *Hemileia vastatrix* Berk. et. Br. is the most serious leaf disease of coffee particularly in low and medium altitude districts of Kenya. Although berries are not directly affected and trees are rarely killed, the main damage can result from premature leaf-fall which may reduce future yields.

Copper based fungicides and various organic fungicides are currently used to control leaf rust (2). The anti-rust sprays are applied immediately before and just after the onset of the two rainy seasons in Kenya (3, 6). In field trials a 50 percent formulation of cuprous oxide (Copper Sandoz MZ) was found effective against leaf rust at 0.35 percent (3.8 kg/ha) compared with the previously recommended full rate of 0.7 percent (5). Therefore, the reduced rate of 0.35 percent of Copper Sandoz MZ was recommended to the growers in 1977 to control leaf rust (1). It was not known whether or not lower application rates of other cuprous oxide formulations (Perenox and Copper Nordox) and cupric hydroxide (Kocide 101) containing 50 percent copper would also control leaf rust effectively. In view of this, trials were carried out during 1978/79 to investigate whether or not the application rates of 0.35 percent, 0.4 percent and 0.5 percent of Perenox, Copper Nordox and Kocide 101 could control leaf rust as effectively as the full rate of 0.7 percent of the same product.

Perenox 50 percent WP 0.7 percent and Copper Sandoz MZ 50 percent WP 0.35 percent were included in these trials as standard treatments. The trials were repeated during the 1979/80 period.

Materials and methods

Experimental design

The trials were laid down on the standard randomized complete block design with 14 treatments replicated four times. Individual plot consisted of twenty five trees (5 x 5). An unsprayed plot served as a control.

Sites

The trials were carried out on three different Estates namely, Jacaranda Estate (CRS plot 14 Trial I), Thika River Estate (Thika River Trial I) and Azania Estate (Azania Trial I).

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Jacaranda Estate is situated at an altitude of 1 608 m on the Eastern slopes of Aberdare range (1.06° South, 36.4° East of Greenwick). Thika River Estate is situated at an altitude of 1 496 m on the Eastern slopes of Aberdare range (1.0° South, 37.0° East of Greenwick) Azania Estate is situated at an altitude of 1 464 m on the Eastern slopes of Aberdare range (1.05° South, 37 0° East of Greenwick).

The annual rainfall for all aforementioned three sites is bimodally distributed, with the main rainy seasons being March – May (Long Rains) and November – December (Short Rains).

The experimental area was the same in both years at each site. All coffee trees were without shade. The spacing of the coffee at three sites was 2 74 m x 2.74 m.

Cultivar

At Jacaranda Estate planting consisted of the cultivar SL – 34, at Azania Estate the trees were of cultivar SL 28 and at Thika River Estate the trees were of Cultivar SL – 34. Both SL – 34 and SL – 28 are very susceptible to leaf rust infection.

Leaf rust recording

Records of leaf rust infection were made at 4 – week intervals throughout the experimental period. Leaf Rust recording was achieved by taking 70 leaves randomly selected from each 9 central trees per plot. The total number of leaves infected in relation to the total number of leaves picked, was used to calculate the percent leaf rust infection (7).

Statistical analysis

A standard analysis of variance was computed for each recording and for analysis actual mean percentages (infection) were converted to transformed percentages (Arcsin $\sqrt{\%}$) but in figures actual mean percentages were used

Yield recording

Ripe cherries were harvested at 10 – day intervals from all 25 trees per plot and yield recorded at each harvest as fresh weight of cherry and were converted to yield of clean coffee in kg/ha based on 1 330 trees per hectare and assuming that cherry yields on seventh of its weight as clean coffee (4).

Spraying equipment

The fungicides were applied with motorised knapsack sprayers at the rate of 80 litres per 100 trees (approximately 800 ml per tree).

On each site, to control coffee berry disease (CBD) the whole experimental area was blanket sprayed with 4.4 kg/ha of Daconil 75 percent WP following the CBD control programme which was recommended for the period under review for the control of CBD.

The spraying dates at three sites the fungicides used and their rates of application are summarized in Table 1.

Results

CRS Plot 14 Trial I (Jacaranda Estate)

The leaf rust epidemic at Jacaranda Estate during 1978/79 was moderately severe. The peak of the rust epidemic occurred in August 1979 when the percent leaf rust infection was 45 percent (41.98% transformed) in the control (unsprayed) plots. The reduced rates of Perenox (0.35%), Copper Nordox (0.35%) and Kocide 101 (0.35%) controlled leaf rust as effectively as the full rate of 0 7% of the same product. There was no statistical difference (P = 0.05).

In the following year 1979/80, the leaf rust epidemic was low and the peak of the rust epidemic occurred in September 1980 when the percent rust infection was 8.49 percent (17.57% transformed) in the control plots. The levels of leaf rust infection were not high enough in the control plots to draw any conclusion from data obtained in 1979/80. The results are summarized in Table 2.

Effect on yield: During 1978/79 in CRS plot 14 Trial I, plots treated with reduced rates of Perenox (0.35%), Copper Nordox (0.35%) and Kocide 101 (0.35%) gave yields lower than the standard treatment Perenox (0.7%) but the difference in yield was not significant statistically (at P = 0.05).

During 1979/80, plots treated with Perenox, (0 35%) and Copper Nordox (0.35%) gave yields as high as the standard treatment Perenox (0.7%) but plots sprayed with Kocide 101 (0.35%) and Copper Sandoz (0.35%) had yields significantly (at P = 0.05) lower than the standard treatment Perenox (0 7%). The results are shown in Table 3.

Thika River Trial II (Thika River Estate)

The leaf rust epidemic at Thika River Estate during the 1978/79 period was considered severe. The peak of the rust epidemic occurred in July 1979, when the percent leaf rust infection was 68.46 percent (55.95% transformed) in the control (unsprayed) plots. There was a significant (at P = 0.05) reduction in the incidence of leaf rust on plots sprayed with

Table 1. Date and rate of application of Perenox, Copper Nordox and Kocide 101 on various sites.

Treatments	% rate of application	Active ingredients	Spraying Dates		
			Jacaranda Estate (CRS Plot 14 Trial I)	Azania Estate (Azania Estate Trial I)	Thika River Estate (Thika River Estate Trial I)
			(1978/79)	(1978/79)	(1978/79)
Perenox 50% WP	0 70	Cuprous oxide	October 28, Nov.	October 19,	October 18,
Perenox 50% WP	0 50	Cuprous oxide	18, 1978, Feb. 20,	Nov. 9, 1978;	November 8, 1978;
Perenox 50% WP	0 40	Cuprous oxide	March 13, April 25,	Feb. 15, March 6,	Feb. 27, March 23,
Perenox 50% WP	0 35	Cuprous oxide	May 17, 1979	April 21, May	April 12, May 6,
Copper Nordox 50% WP	0 70	Cuprous oxide		12, 1979	1979
Copper Nordox 50% WP	0 50	Cuprous oxide			
Copper Nordox 50% WP	0 40	Cuprous oxide	(1979/80)	(1979/80)	(1979/80)
Copper Nordox 50% WP	0 35	Cuprous oxide			
Kocide 101 50% WP	0 70	Cupric hydroxide	October 16,	October 18, Nov	October 23,
Kocide 101 50% WP	0 50	Cupric hydroxide	November 6, 1979;	9, 1979; Feb. 16,	November 11, 1979;
Kocide 101 50% WP	0 40	Cupric hydroxide	February 11, March 3,	March 7, April 3,	February 20,
Kocide 101 50% WP	0 35	Cupric hydroxide	March 28, May 18,	May 18, 1980	March 12,
Copper Sandoz MZ 50% WP	0 35	Cuprous oxide	1980		April 10,
					May 2, 1980

Table 2. Percent (Arcsin $\sqrt{\%}$) leaf rust infection at Jacaranda Estate (CRS Plot 14 Trial I) on plots spraved with reduced rates of application of Perenox, Copper Nordox and Kocide 101 during 1979–80.

Treatments	% rate of application	Analysis of % (Arcsin $\sqrt{\%}$) Leaf Rust infection on: 1979				1980			
		2.7.79	24.7.79	15.8.79	6.9.79	21.7.80	12.8.80	1.9.80	22.9.80
Perenox 50% WP	0 70	4 9	3 0	2 0	5 5	3 9	5 5	5 8	4 2
Perenox 50% WP	0 50	6 7	3 8	5 0	7 9	7 5	9 8	9 8	8 7
Perenox 50% WP	0 40	7 9	5 0	5 2	7 3	6 8	10 5	11 2	8 5
Perenox 50% WP	0 35	6 5	6 5	7 0	7 9	9 3	10 0	10 9	9 6
Copper Nordox 50% WP	0 70	5 9	6 2	4 5	7 5	5 4	6 5	7 0	3 7
Copper Nordox 50% WP	0 50	5 8	5 6	3 3	6 1	6 8	6 8	8 0	6 8
Copper Nordox 50% WP	0 40	6 4	5 3	6 4	7 1	7 2	9 1	10 5	7 3
Copper Nordox 50% WP	0 35	7 1	6 7	6 4	8 3	8 6	10 3	10 9	7 1
Kocide 101 50% WP	0 70	7 2	6 3	4 6	5 4	6 5	6 5	7 0	6 6
Kocide 101 50% WP	0 50	5 7	6 1	4 3	7 1	7 1	8 6	9 4	8 6
Kocide 101 50% WP	0 50	6 8	5 4	4 7	5 8	7 0	10 6	12 5	8 9
Kocide 101 50% WP	0 35	7 5	6 5	6 8	7 6	11 7	12 2	13 9	12 2
Copper Sandoz MZ 50% WP	0 35	5 6	6 8	5 2	7 1	9 2	11 4	11 9	7 8
Unsprayed (control)	–	23 7	34 1	41 9	37 6	13 1	16 7	17 5	13 2
LSD P = 0 05	–	4 0	4 4	5 9	4 5	2 9	3 1	3 5	3 1
CV	–	37 4%	41 1%	37 6 %	34 5%	26 2%	22 8%	23 3%	26 9%

Table 3. Yield and Peak % leaf rust infection in plots sprayed with reduced rates of application of Perenox, Copper Nordox and Kocide 101 in CRS Plot 14 Trial I.

Treatments	% rate of application	Peak % leaf rust infection (transformed) 15.8.79	Clean coffee yield kg/ha 1978/79	Peak % leaf rust infection (transformed) 1.9.80	Clean coffee yield kg/ha 1979/80
Perenox 50% WP	0.70	2.0	1 450.0	5.8	1 449.0
Perenox 50% WP	0.50	5.0	873.0	9.8	1 451.2
Perenox 50% WP	0.40	5.2	1 155.5	11.2	1 451.4
Perenox 50% WP	0.35	7.0	874.1	10.9	1 351.3
Copper Nordox 50% WP	0.70	4.5	1 934.0	7.0	1 260.8
Copper Nordox 50% WP	0.50	3.3	1 122.7	8.0	1 316.9
Copper Nordox 50% WP	0.40	6.4	924.5	10.5	1 547.7
Copper Nordox 50% WP	0.35	6.4	1 039.1	10.9	1 381.5
Kocide 101 50% WP	0.70	4.6	946.6	7.0	1 411.6
Kocide 101 50% WP	0.50	4.3	1 135.4	9.4	1 328.7
Kocide 101 50% WP	0.40	4.7	1 240.1	12.5	1 157.6
Kocide 101 50% WP	0.35	6.8	1 026.0	13.9	967.2
Copper Sandoz MZ 50% WP	0.35	5.2	1 255.6	11.9	1 021.0
Unsprayed (control)	–	41.9	908.1	17.5	946.2
LSD P = 0.05	–	5.9	NS	3.5	329.5
CV	–	37.6%	41.9%	23.3%	17.9%

One hectare = 1 330 trees.

reduced application rates of Perenox (0.35%), Copper Nordox (0.35%) and Kocide 101 (0.35%). The reduced rates of Perenox, Copper Nordox and Kocide 101 were as effective as the standard treatment (Perenox 0.7%) in controlling leaf rust (Figure 1).

In the following year 1979/80 the leaf rust epidemic in Thika River Trial II was not severe. The peak of rust epidemic occurred in July 1980 when the percent leaf rust infection was 19.64 percent (26.47% transformed) in the control plots. There was significant (at P = 0.05) reduction in the incidence of leaf rust on plots sprayed with reduced application rates of Perenox (0.35%). Copper Nordox (0.35%) and Kocide 101 (0.35%). The results are summarized in Table 4 and Figure 1.

Effect on yield: During 1978/79 in Thika Trial II plots treated with reduced application rates of Perenox (0.35%), Copper Nordox (0.35%) and Kocide 101 (0.35%) gave yields as high as the standard treatment Perenox (0.7%) and also 0.7% of the same product. There was no statistical difference at P = 0.05. In the following year (1979/80) plots sprayed with reduced rates of (0.35%) of Perenox, Copper Nordox and Kocide 101 gave yields as high as the standard treatment Perenox (0.7%) and also the full rates of (0.7%) of the same product. The results are summarized in Table 5.

Azania Trial I (Azania Estate)

The leaf rust incidence for this trial site at Azania Estate during 1978/79 was also severe. The peak of leaf rust infection occurred in July 1979 when the percent leaf rust infection on the control (unsprayed) plots reached 54.69 percent (48.16% transformed) levels.

The reduced rates of application (0.35%) of Perenox, Copper Nordox and Kocide 101 controlled leaf rust as effectively as the standard treatment Perenox (0.7%). There was no statistical difference (at P = 0.05) between the full rate (0.7%) and the reduced rate of the same product in controlling leaf rust (Figure 2).

In the following year (1979/80) the leaf rust epidemic in Azania Trial I was again severe. The peak of rust epidemic occurred in July 1980 when the percent leaf rust infection was 66.55 percent (54.89% transformed) in the control (unsprayed plots; Figure 3). There was significant (at P = 0.05) reduction in the incidence of leaf rust on plots sprayed with

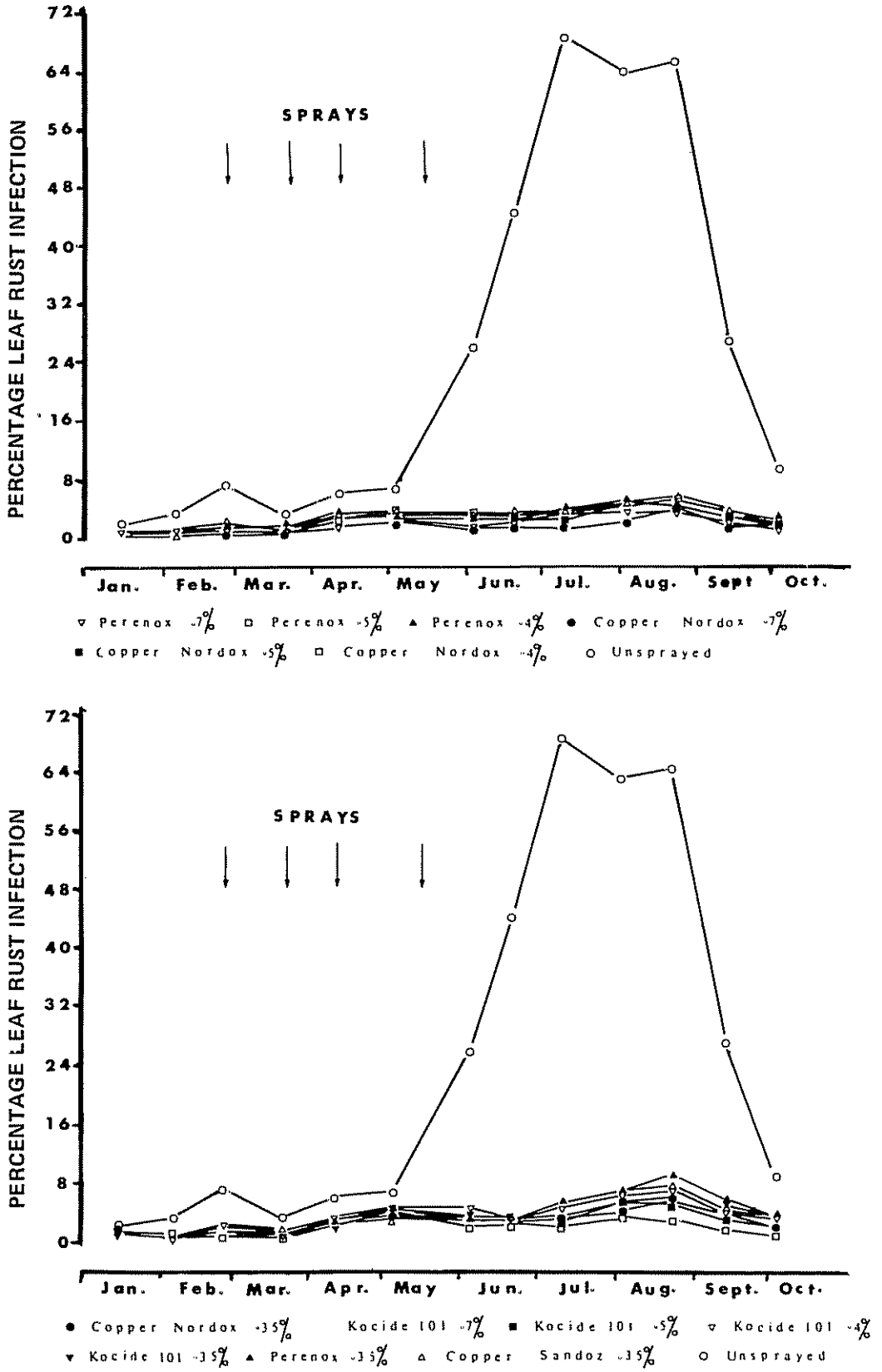

Fig. 1. Mean percent leaf rust infection at Ihika River Estate on plots sprayed with reduced rates of application of Perenox, Copper Nordox and Kocide 101 during 1979.

Table 4. Percent (Arcsin $\sqrt{\%}$) leaf rust infection at Thika River Estate (Thika River Trial II) on plots sprayed with reduced rates of application of Perenox, Copper Nordox and Kocide 101 during 1980.

Treatments	% rate of application	Analysis of % (Arcsin $\sqrt{\%}$) Leaf Rust infection on:					
		9.6.80	30.6.80	18.7.80	5.8.80	27.8.80	15.9.80
Perenox 50% WP	0.70	3.4	3.1	3.4	2.9	3.4	1.4
Perenox 50% WP	0.50	1.4	2.7	1.8	2.8	2.1	2.3
Perenox 50% WP	0.40	3.2	3.1	3.4	4.1	4.4	3.1
Perenox 50% WP	0.35	4.6	4.8	4.5	5.8	4.2	2.2
Copper Nordox 50% WP	0.70	2.1	2.1	2.6	2.8	2.1	3.3
Copper Nordox 50% WP	0.50	4.4	3.6	2.5	3.0	3.5	2.9
Copper Nordox 50% WP	0.40	4.6	4.0	4.3	3.9	3.0	3.2
Copper Nordox 50% WP	0.35	2.4	4.5	4.4	5.2	3.5	3.4
Kocide 101 50% WP	0.70	3.1	2.7	4.2	1.9	2.2	2.4
Kocide 101 50% WP	0.50	3.0	2.9	3.6	5.8	5.0	3.5
Kocide 101 50% WP	0.40	4.1	5.8	4.6	6.0	3.4	5.0
Kocide 101 50% WP	0.35	5.1	5.9	4.7	6.1	5.8	3.9
Copper Sandoz MZ 50% WP	0.35	3.1	6.9	6.6	7.7	6.5	5.8
Unsprayed (control)	–	12.6	23.7	26.4	25.2	21.7	19.2
LSD P = 0.05	–	2.5	3.8	4.5	4.1	4.0	3.3
CV	–	43.0%	49.3%	57.7%	48.8%	55.7%	52.2%

Table 5. Yield and Peak % leaf rust infection in plots sprayed with reduced rates of application of Perenox, Copper Nordox and Kocide 101 in Thika River Trial II.

Treatments	% rate of application	Peak % leaf rust infection (transformed)	Clean coffee yield kg/ha	Peak % leaf rust infection (transformed)	Clean coffee yield kg/ha
		10.7.70	1978/79	18.7.80	1979/80
Perenox 50% WP	0.70	10.0	1 933.6	3.4	1 824.5
Perenox 50% WP	0.50	10.0	1 909.8	1.8	1 846.8
Perenox 50% WP	0.40	11.1	1 964.05	3.4	1 785.7
Perenox 50% WP	0.35	13.2	1 892.3	4.5	1 797.6
Copper Nordox 50% WP	0.70	6.4	2 105.8	2.6	1 746.1
Copper Nordox 50% WP	0.50	8.3	1 961.6	2.5	1 772.4
Copper Nordox 50% WP	0.40	10.5	1 789.1	4.3	2 068.5
Copper Nordox 50% WP	0.35	10.5	1 923.9	4.4	1 693.0
Kocide 101 50% WP	0.70	8.1	2 035.4	4.2	1 944.1
Kocide 101 50% WP	0.50	9.1	2 009.4	3.6	1 965.3
Kocide 101 50% WP	0.40	12.0	1 790.1	4.6	1 899.8
Kocide 101 50% WP	0.35	10.7	1 702.2	4.7	2 080.6
Copper Sandoz MZ 50% WP	0.35	12.9	1 787.1	6.6	1 616.0
Unsprayed (control)	–	55.9	1 493.9	26.4	1 370.8
LSD P = 0.05	–	3.7	302.9	4.9	266.1
CV	–	19.5%	11.2%	57.7%	10.2%

One hectare = 1 330 trees.

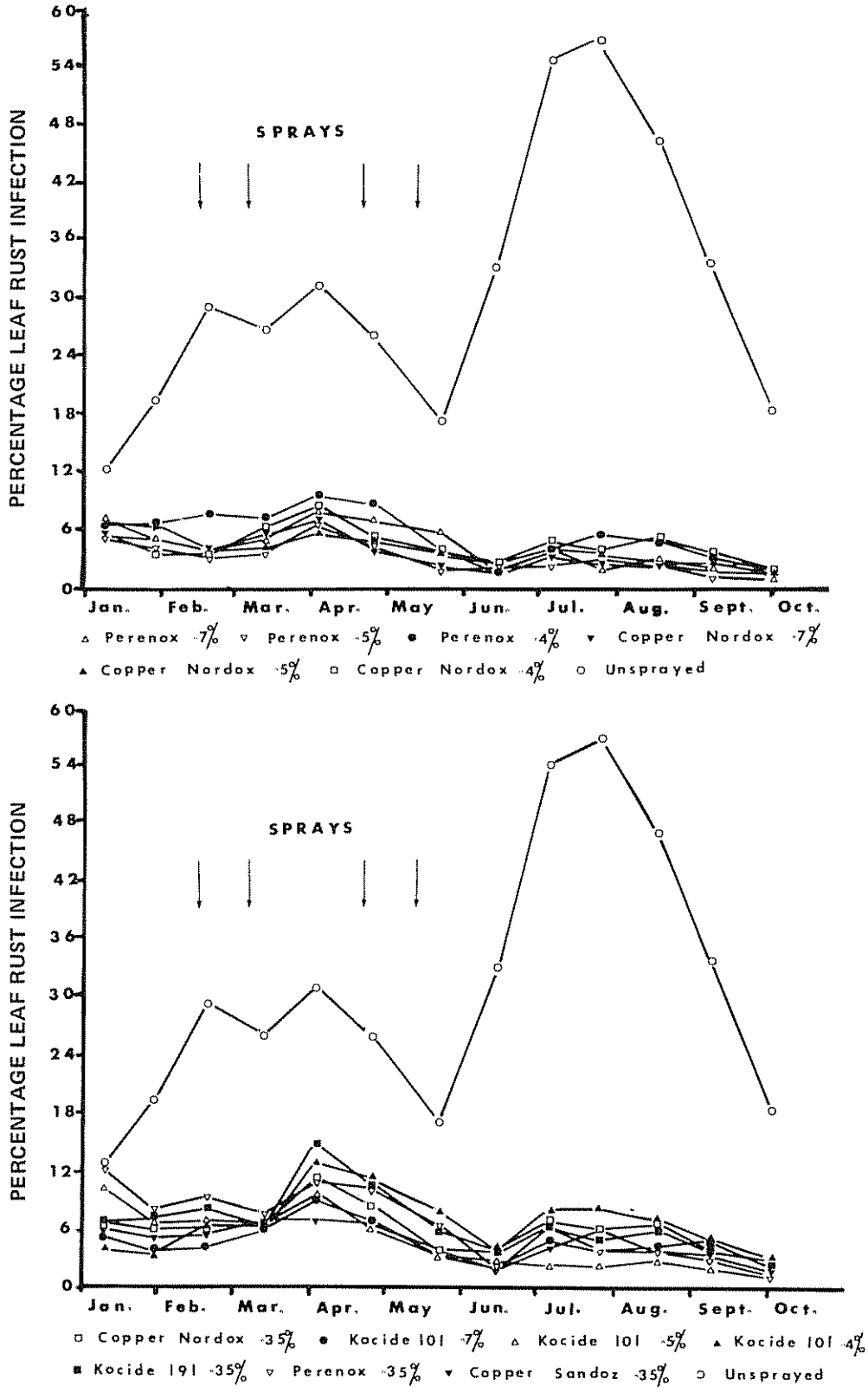

Fig. 2. Mean percent leaf rust infection at Azania Estate on plots sprayed with reduced rates of application of Perenox, Copper Nordox and Kocide 101 during 1979.

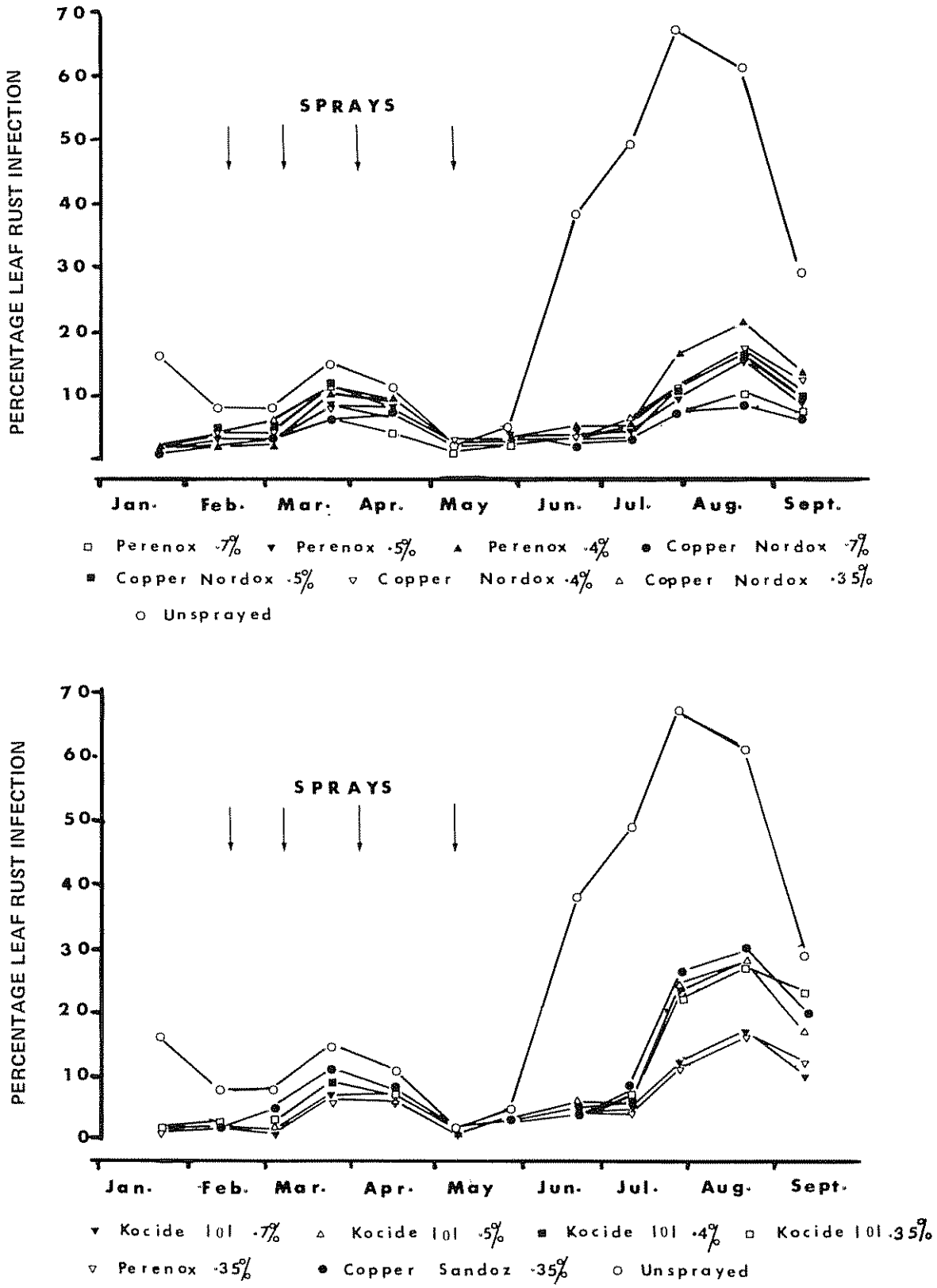

Fig 3. Mean percent leaf rust infection at Azania Estate on plots sprayed with reduced rates of application of Perenox, Copper Nordox and Kocide 101 during 1980

reduced application rates (0.35%) of Perenox and Copper Nordox but Kocide 101 at 0.35 percent did not give significant control of leaf rust compared to the standard treatment Perenox (0.7%).

Effect on yield: During the period 1978/79 in Azania Trial I, plots treated with reduced application rates (0.35%) of Perenox, Copper Nordox and Kocide 101 gave yields as high as the standard treatment Perenox (0.7%) but none of the treatments in this experiment gave yields significantly (at P = 0.05) higher than the unsprayed plots. During 1979/80 again the reduced application rates (0.35%) of Perenox, Copper Nordox and Kocide 101 gave yields as high as the standard treatment Perenox (0.7%) but none of the treatments gave yields significantly (at P = 0.05) higher than the unsprayed (control) plots. The results are given in Table 6.

Discussion

The earlier part of the year 1979 at all three different sites was particularly wet. The long rains during 1979 commenced earlier than usual in January 1979 at all three sites and continued until May. Therefore, favourable conditions for leaf rust infection occurred between January and May 1979. During 1980 the earlier part of the year was not very wet but favourable conditions for leaf rust development occurred in April and May 1980 in all three sites Table 7).

On the basis of the trials reported here the efficacy of Perenox (0.35%), Copper Nordox (0.35%) and Kocide 101 (0.35%) tested over 2 years period against leaf rust under high epidemic at three different sites was found equal to the previously recommended application rate of 0.7 percent of the same product. Therefore, the application rates of Perenox, Copper Nordox and Kocide 101 against rust could be reduced to 0.35 percent (3.8 kg/ha).

The reduced rates of application (3.8 kg/ha of Perenox, Copper Nordox and Kocide 101 had no adverse effect on the final yields. Plots treated with reduced application rates of Perenox, Copper Nordox and Kocide 101 recorded yields as high as the plots treated with the previously recommended rate of 0.7 percent (7.7 kg/ha) of the same product. There was no statistical difference at P = 0.05. The reduced rates of (3.8 kg/ha) application of Perenox, Copper Nordox and Kocide 101 have been recommended to the growers to control leaf rust in Kenya (2).

Table 6. **Yield and Peak % leaf rust infection in plots sprayed with reduced rates of application of Perenox, Copper Nordox and Kocide 101 in Azania Trial I.**

Treatments	% rate of application	Peak % leaf rust infection (transformed) 5.7.79	Clean coffee yield kg/ha 1978/79	Peak % leaf rust infection (transformed) 28.7.80	Clean coffee yield kg/ha 1979/80
Perenox 50% WP	0.70	12.1	1 580.8	15.2	800.5
Perenox 50% WP	0.50	9.3	1 545.9	16.6	1 066.6
Perenox 50% WP	0.40	11.6	1 659.2	23.3	782.7
Perenox 50% WP	0.35	14.0	1 534.9	18.7	994.3
Copper Nordox 50% WP	0.70	10.6	1 591.8	14.7	867.1
Copper Nordox 50% WP	0.50	11.5	1 491.4	19.4	1 047.5
Copper Nordox 50% WP	0.40	12.0	1 775.0	19.7	813.5
Copper Nordox 50% WP	0.35	14.1	1 321.9	18.9	885.4
Kocide 101 50% WP	0.70	12.6	1 669.3	19.7	817.0
Kocide 101 50% WP	0.50	9.1	1 406.4	29.9	921.3
Kocide 101 50% WP	0.40	16.5	1 645.0	27.8	786.8
Kocide 101 50% WP	0.35	14.4	1 679.1	27.6	788.5
Copper Sandoz MZ 50% WP	0.35	12.0	1 700.0	30.4	759.6
Unsprayed (control)	–	48.1	1 559.5	54.8	639.2
LSD P = 0.05	–	5.8	NS	5.9	NS
CV	–	27.6%	21.9%	17.3%	30.2%

One hectare = 1 330 trees.

Table 7. Monthly totals of rainfall from trial sites.

Months	Jacaranda Estate Rainfall mm)		Thika River Estate Rainfall (mm)		Azania Estate Rainfall (mm)	
	1979	1980	1979	1980	1979	1980
January	61.5 (13*)	46.1 (5*)	70.0 (13*)	62.0 (5*)	64.7 (12*)	64.0 (5*)
February	229.9 (7)	4.0 (1)	172.0 (6)	6.0 (2)	138.8 (6)	0.0 (0)
March	108.1 (5)	75.7 (5)	172.0 (5)	72.5 (6)	122.9 (5)	51.5 (4)
April	341.0 (23)	139.8 (12)	236.0 (22)	64.0 (9)	164.3 (17)	88.6 (12)
May	149.3 (10)	323.8 (21)	195.5 (16)	244.0 (15)	176.3 (12)	345.3 (18)
June	26.9 (4)	8.5 (4)	47.0 (4)	7.9 (3)	48.8 (4)	1.8 (1)
July	27.3 (7)	3.8 (2)	3.1 (2)	1.0 (1)	1.3 (1)	2.5 (1)
August	21.1 (5)	18.3 (4)	8.9 (2)	13.0 (2)	25.7 (5)	6.7 (1)
September	2.4 (1)	5.4 (3)	3.9 (2)	0.0 (0)	1.3 (1)	0.0 (0)
October	31.4 (8)	38.6 (5)	29.8 (7)	39.5 (4)	30.0 (5)	25.8 (4)
November	159.2 (12)	383.1 (16)	199.5 (12)	280.5 (21)	214.2 (13)	407.6 (16)
December	38.1 (10)	40.1 (6)	8.9 (4)	10.0 (4)	9.5 (3)	30.7 (4)
Total	1 196.2 (107)	1 087.2 (84)	1 156.7 (95)	800.4 (72)	997.8 (84)	1 024.5 (66)

* Figures in parenthesis are number of rainy days.

Summary

During the 1979 and 1980 seasons and under high Coffee Leaf Rust epidemic, Cuprous oxides (Perenox and Copper Nordox) and Cupric hydroxide (Kocide 101) were found effective against leaf rust at reduced application rate of 0.35 percent (3.8 kg/ha) at three different sites

Plots sprayed with reduced rates of application (0.35%) of Perenox, Copper Nordox and Kocide 101 gave yields as high as the plots sprayed with the previously recommended rate of 0.7 percent of the same product. Therefore, it has been recommended to use 3.8 kg/ha of Perenox, Copper Nordox and Kocide 101 to control leaf rust in Kenya.

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VARIACION EN EL NUMERO DE AGUJAS POR FASCICULO EN *Pinus caribaea* var. *hondurensis* BARR. Y GOLF. BAJO CONDICIONES DE AMBIENTE CONTROLADO[1] /

*R. SALAZAR**

Summary

The assessment of the variation in juvenils needles per fascicle in Pinus caribaea *var.* hondurensis *Barr. and Golf. at 18 months under greenhouse conditions, was not significantly different between populations. Nevertheless the populations Limones and Melinda present the highest values of fascicles with four and five needles with respect to the average, and Guanaja the lowest.*

It looks the genes responsible for the expresion of fascicles with four and five needles are present along the natural distribution of this variety, and that its expression is under control of climatic factors.

Introducción

Variación en la forma del árbol, sistema de ramificación, altura total, rectitud del fuste, color de las agujas y características de los conos, ha sido reportada en los bosques naturales de *Pinus caribaea* var *hondurensis* Barr y Golf. que crece en forma discontinua en la costa Atlántica de América Central, desde los 18°00' norte en Belize, hasta los 12°13' al norte de Nicaragua y desde el nivel del mar hasta 800 msnm (1, 4, 8, 11).

Burley (2) sugiere que la cantidad de variación genética entre poblaciones depende en parte del rango de distribución natural, la variación del clima a lo largo del área de distribución, y de la facilidad de intercambio de polen y semillas entre poblaciones.

Estudios sobre la variabilidad de las agujas en plantas juveniles en otras especies de coníferas, indican que algunas características varían con la edad (6, 10, 16, 19).

No obstante estudios sobre la variación anatómica y morfológica de las agujas en varias especies de pinos duros y suaves, han mostrado ser de gran valor taxonómico, principalmente cuando no se dispone de conos o flores (5, 14, 20).

Mergen, Snyder y Burley (15) detectaron una tendencia clinal norte-sur en la variación de características morfológicas de las agujas en *P. elliottii* Engelm. En las áreas más secas encontraron agujas más cortas, más canales reciníferos y mayor número de estomas

Variación genética en algunas especies en híbridos de pinos suaves fue reportada con relación a número de dientes a lo largo de los vértices de las agujas, número de estomas, posición y número de canales resiníferos. Algunas de esas variables pueden ser utilizadas para identificar poblaciones híbridas o híbridos producidos bajo cruces controlados. También algunas variables varían según la edad y la posición de las agujas en el árbol (10, 12, 13).

Recientemente Salazar (17) analizando agujas de *P. caribaea* var. *hondurensis* de los bosques naturales, encontró mayor frecuencia de fascículos con cuatro y cinco agujas en las procedencias Limones y Santa Clara; mientras que Poptun, Melinda y Mountain Pine Ridge presentaron la frecuencia más baja.

El objetivo de esta investigación es cuantificar el grado de variación genética entre procedencias, en cuanto al número de agujas por fascículo, en plantas jóvenes creciendo bajo condiciones de ambiente controlado.

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Cuadro 1. Detalles climatológicos y de localización de las procedencias.

No.	Almacenamiento[1] de la semilla	Origen			Latitud (°N)	Longitud (°W)	Altitud (msnm)	Precipitación (mm)	Meses[2] secos	Temperatura media (°C)
		País	Localidad							
1	PC–4	Nicaragua	Pinar	(PIN)	12°13'	83°42'	10	4 187	1	26.4
2	PC–2	Nicaragua	Karawala	(KAR)	12°58'	83°43'	10	3 897	0	26.4
3	PC–59*	Nicaragua	Pantasma	(PAN)	13°20'	85°57'	475	1 400	5	20.7
4	PC–3	Nicaragua	Alamicamba	(ALA)	13°34'	84°17'	25	2 610	3	27.3
5	PC–21*	Nicaragua	Santa Clara	(STA)	13°48'	86°12'	700	1 818	5	23.4
6	PC–52*	Honduras	Trojes	(TRO)	14°03'	85°58'	720	1 649	5	23.0
7	PC–13*	Honduras	Los Limones	(LIM)	14°03'	86°42'	700	663	7	22.2
8	PC–51*	Honduras	Azacualpa	(AZA)	14°25'	86°07'	240	2 131	3	25.7
9	PC–5	Nicaragua	Rio Coco	(RIO)	14°45'	83°55'	75	2 863	2	30.4
10	PC–53*	Honduras	Yojoa	(YOJ)	14°58'	87°54'	600	2 995	2	24.0
11	PC–14*	Honduras	Culmí	(CUL)	15°06'	85°37'	550	1 325	6	24.3
12	PC–17*	Honduras	Potosí	(POT)	15°20'	88°25'	650	1 205	7	23.7
13	PC–12*	Honduras	Los Briones	(BRI)	15°34'	86°44'	600	912	6	24.0
14	PC–7	Honduras	Brus Lagoon	(BRU)	15°45'	84°40'	10	2 840	2	26.5
15	PC–6*	Guatemala	Poptún	(POP)	16°21'	89°25'	500	1 688	4	24.2
16	PC–8	Honduras	Guanaja Island	(GUA)	16°27'	85°54'	75	2 308	3	27.1
17	PC–10	Belize	Las Lomitas	(LOM)	16°28'	68°33'	30	2 398	3	27.1
18	PC–20*	Belize	Mountain Pine Ridge	(MPR)	16°58'	89°00'	487	1 558	3	23.8
19	PC–23	Belize	Melinda	(MEL)	17°01'	88°20'	12	2 137	2	26.9
20	PC–19	Belize	Santos Pine Ridge	(SAN)	17°34'	88°33'	30	1 818	2	26.2

1 El número de almacenamiento es el mismo utilizado por CFI para identificar las procedencias.

2 Meses secos se consideran los que tengan menos de 75 mm de precipitación.

* Procedencias de las tierras altas.

Styles *et al* (18) han reportado la presencia de posibles híbridos entre poblaciones contiguas de *P. caribaea* var. *hondurensis* y *P. oocarpa* Schiede en Honduras, utilizando características de las agujas y conos.

Materiales y métodos

Las 20 procedencias utilizadas para estudiar la variabilidad genética de semillas y plántulas bajo condiciones de invernadero en la estación experimental de Wytham, Universidad de Oxford, UK, se presentan en en Cuadro 1.

La Figura 1 muestra la distribución de las procedencias a lo largo de América Central, y el Cuadro 1 resume la información climatológica de los sitios de origen. Las semillas fueron colectadas entre 1970 y 1978 por el Commonwealth Forestry Institute, y almacenadas a 3 ± 1°C y 8 por ciento de contenido de humedad en la Estación Experimental Alice Holt, Forestry Commission, Inglaterra.

Las semillas se sembraron directamente en envases de 10 centímetros (cm) de diámetro, con una mezcla de arena y turba (1:1). El experimento fue evaluado por 12 meses y durante este período sólo temperatura, humedad, y humedad relativa fueron parcialmente controladas. La luz siguió la intensidad natural; las siguientes fueron las horas luz durante el período de observación de abril 1979 a marzo 1980: 126,4, 190.9, 166.6, 192.2, 167.4, 171.0, 117.0, 70.0, 59.2, 84.0, 58.8, 86.7. La temperatura media durante todo el año fue 21 ± 3°C, y la humedad relativa fue aproximadamente 45 por ciento durante el día y 75 por ciento durante la noche. Después de la germinación las plántulas fueron regadas manualmente con agua del tubo cada tres o cuatro días. Cada dos meses se aplicaron 75 centímetros cúbicos (cc) por árbol de un

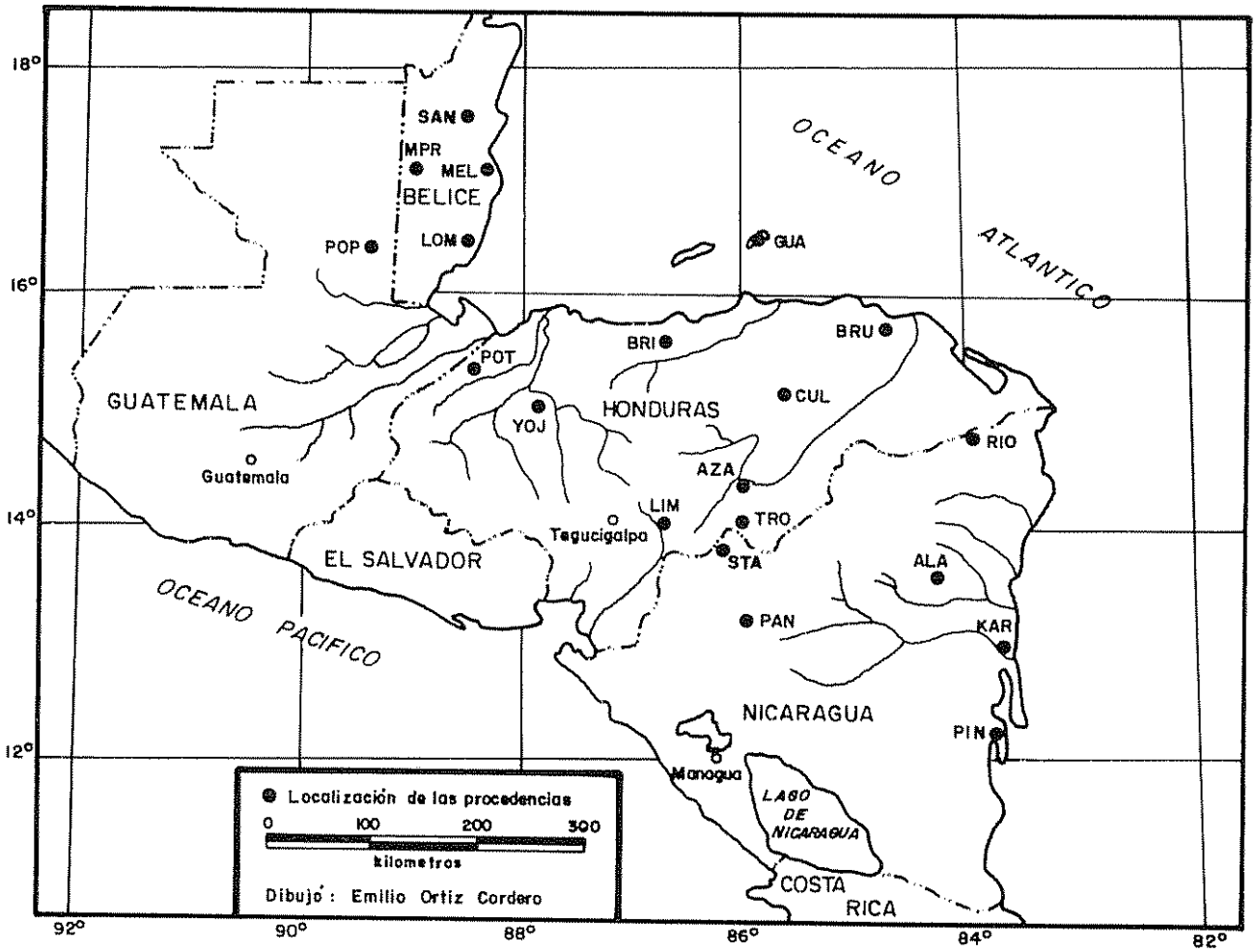

Fig. 1. Mapa de América Central mostrando la localización de las procedencias

fertilizante líquido comercial (Maxicrop)[1] (50 cc/4,5 litros de agua).

Para estudiar la variación de las semillas y las plántulas se utilizó un diseño de bloques completos al azar con 20 procedencias, tres repeticiones y cinco árboles por repetición. La variabilidad del número de agujas por fascículo se analizó en las mismas plantas a los 18 meses, ya que a esta edad la mayoría de ellas presentaban agujas secundarias. Se practicó un muestreo preliminar utilizando tres árboles (uno por repetición) de las procedencias Melinda, Mountain Pine Ridge, Guanaja, Los Limones y Río Coco, ya que desde el punto de vista climatológico estas representan las condiciones extremas en la distribución de la especie. Para detectar el punto de muestreo a lo largo del árbol, el eje fue sub-dividido en secciones de 5 cm, empezando 5 cm arriba del nivel del suelo, y se contó el número de fascículos con tres, cuatro y cinco agujas.

Con base en los resultados del análisis preliminar, se practicó un análisis más profundo considerando en esta oportunidad la procedencia Poptún. El estudio se concentró en una sección de 5 cm del árbol a 25 cm del suelo. En esta oportunidad se utilizó el diseño descrito anteriormente, considerando las seis procedencias ya mencionadas, tres repeticiones y cuatro árboles por repetición. El siguiente modelo matemático completamente al azar se utilizó para cuantificar el grado de variación genética entre procedencias:

$$Y_{ijk} = \mu + P_i + R_j + (TR)_{ij} + T_{ijk}$$

Donde

Y_{ijk} = promedio de la variable en k^{th} árbol en j^{th} repetición en i^{th} procedencia.

μ = efecto del promedio;

P_i = efecto de i^{th} procedencia; i = 1, 2 -------6

R_j = efecto de j^{th} repetición; j= 1, 2, 3

$(PR)_{ij}$ = efecto de la interacción de i^{th} procedencia con i^{th} repetición;

T_{ijk} = efecto de k^{th} árbol en j^{th} repetición de i^{th} procedencia; k = 1, 2, 3

1 Maxicrop International Ltd., England.

Resultados y discusión

El Cuadro 2 muestra el resultado del análisis preliminar en el que se observa que en la sección correspondiente a los 25 cm de altura desde la base del árbol, aproximadamente el 50 por ciento de los fascículos presentan tres agujas, el otro 50 por ciento presentan entre cuatro y cinco agujas. Razón por la que se decidió realizar el muestreo más detallado en esa sección.

El Cuadro 3 resume el resultado del análisis de varianza, donde se observa que no existen diferencias significativas entre procedencias en cuanto al número de fascículos con tres agujas y fascículos con cuatro y cinco en la sección de 5 cm muestreado a 25 cm de altura; también se encontró que la variación genética entre procedencias es prácticamente cero; mientras que entre árboles se detectó el 82 y 95 por ciento de variación. Los resultados anteriores son soportados por la prueba de Tukey ($P < 0.05$) (Cuadro 4) que tampoco detectó diferencias significativas entre procedencias.

En la sección de 5 cm muestreada se detectó un promedio general de 15.3 fascículos con tres agujas y de 9.3 cm con cuatro y cinco (Cuadro 4); en el primer caso se encontró un coeficiente de variación de 23.2 por ciento y en el segundo de 35.7 que se consideran bastante altos. Como ya se indicó, la mayor parte de esta variación se debe a variación entre árboles y no entre procedencias; no obstante dado que el ensayo se desarrolló bajo condiciones de ambiente controlado, la variación entre árboles puede considerarse como variación genética; y esto indica que algunas procedencias presentan mayor variación genética que otros con respecto a esta característica. Con base en los porcentajes reportados anteriormente, la mayor variación se detectó en el número de fascículos con cuatro y cinco agujas. En el Cuadro 4 claramente se puede observar que aunque la prueba de Tukey no es significativa, si existe una diferencia bien marcada entre las procedencias que presenten mayor y menor número de fascículos con cuatro y cinco agujas.

Las procedencias Los Limones y Melinda que crecen bajo condiciones de clima diferentes (Cuadro 1), presentan el mayor número de fascículos con cuatro y cinco agujas. En promedio estas dos procedencias presentan hasta 10 fascículos más que Poptún que se caracteriza por tener el menor número (4, 3). Resultados similares fueron reportados por Salazar (17) al analizar muestras de los bosques naturales y material juvenil de una prueba de procedencias establecidas en Costa Rica.

A los ocho meses de edad y bajo condiciones de invernadero Jara (7) encontró también en la procedencia

Cuadro 2. Número de agujas por fascículo en secciones de 5 cm a lo largo de la planta.

Procedencia	Agujas por fascículo	5 cm			10 cm			15 cm			20 cm			25 cm			30 cm		
		3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5
LIM	$\overline{X}$	–	–	–	5	–	–	1.33	9.33	1.0	6.33	14.33	1.0	9.0	19.67	–	13.33	13.0	0.66
	(%)	–	–	–	100.0	–	–	11.41	80.02	8.58	29.22	66.16	4.62	31.39	68.61	–	49.39	48.17	2.44
MEL	$\overline{X}$	–	–	–	5.33	3.33	–	4.00	3.00	–	6.33	12.67	0.67	14.67	14.67	1.00	6.67	1.33	–
	(%)	–	–	–	61.54	38.45	–	57.14	42.86	–	32.18	64.41	3.41	48.35	48.35	3.30	83.38	16.02	–
RIO	$\overline{X}$	–	–	–	6.67	3.33	–	10.64	2.00	–	14.67	9.33	0.33	7.33	9.00	–	2.67	4.00	0.33
	(%)	–	–	–	66.70	33.30	–	84.21	15.79	–	60.29	38.55	1.36	48.89	55.11	–	38.14	57.14	4.71
GUA	$\overline{X}$	–	–	–	7.00	1.33	–	17.67	3.00	–	19.67	4.67	–	16.00	8.00	–	11.33	6.33	–
	(%)	–	–	–	64.03	15.97	–	85.49	14.51	–	80.81	19.19	–	66.67	33.33	–	64.16	35.84	–
MPR	$\overline{X}$	–	–	–	8.67	1.00	–	8.67	6.33	–	13.67	10.00	–	9.33	11.33	0.67	4.00	3.00	–
	(%)	–	–	–	89.66	10.34	–	57.80	42.20	–	57.75	42.25	–	43.74	53.12	3.14	57.14	42.86	–

Cuadro 3. Análisis de varianza y componentes de varianza.

No.	Fuentes de variación	GI	Cuadrados medios esperados	Prueba	3 agujas			4 y 5 agujas		
					CM**	F***	CO(%)****	CM	F	CO(%)
1	Procedencia (P)	5	$\sigma^2 + a\sigma^2_{PR} + ar\sigma^2_P$	3	127 7	NS	0 00	143 3	NS	0 43
2	Repetición (R)	2	$\sigma^2 + a\sigma^2_{PR} + ap\sigma^2_R$	3	109.2	NS	0.00	201.9	NS	4 09
3	P * R	10	$\sigma^2 + a\sigma^2_{PR}$	4	301 6	NS	17 66	107 9	NS	0.00
4	Arboles (A) en R en P	49*	σ^2	–	162 3	–	82.34	136.3	–	95 57

* La diferencia entre 54 49 se debe a árboles perdidos.

** CM = Cuadrado medio

*** F = Prueba de F

**** CO(%) = Componentes de la varianza

Cuadro 4. Prueba de Tukey, ($P < 0.05$) y promedio de número de agujas por fasciculo.

Tres agujas			Cuatro y cinco agujas		
Procedencia	Promedio	Test	Procedencia	Promedio	Test
POP	18.9	–	LIM	14 7	–
GUA	17.7	–	MEL	13.3	–
LIM	15.9	–	RIO	10.0	–
MEL	15.4	–	GUA	6.7	–
MPR	13.2	–	MPR	6.6	–
RIO	10.7	–	POP	4.3	–
$\bar{X}$	15 3	–		9.3	–
S	5.0	–		3 3	–
CV(%)	32.8	–		35 7	–

cia Los Limones mayor número de agujas por fasciculo, y menor en la procedencia Guanaja Bin Chen Yeon (3) encontró en Malaya mayor número de agujas por fasciculo en las procedencias de Honduras que en las de Guatemala. La Figura 2 presenta la distribución en porcentaje por procedencia de fasciculos con tres, cuatro y cinco agujas. Se observa que con excepción de Guanaja las restantes cinco procedencias presentan distribuciones muy similares. En la procedencia Guanaja también se encontró un árbol con 44 por ciento de los fasciculos con cuatro y cinco agujas.

Conclusiones

La variación en el número de agujas por fasciculo a lo largo de la planta hace suponer que esta caracterís-

Cuadro 3. Análisis de varianza y componentes de varianza.

No.	Fuentes de variación	Gl	Cuadrados medios esperados	Prueba	3 agujas			4 y 5 agujas		
					CM**	F***	CO(%)****	CM	F	CO(%)
1	Procedencia (P)	5	$\sigma^2 + a\sigma^2_{PR} + ar\sigma^2_P$	3	127.7	NS	0.00	143.3	NS	0.43
2	Repetición (R)	2	$\sigma^2 + a\sigma^2_{PR} + ap\sigma^2_R$	3	109.2	NS	0.00	201.9	NS	4.09
3	P * R	10	$\sigma^2 + a\sigma^2_{PR}$	4	301.6	NS	17.66	107.9	NS	0.00
4	Arboles (A) en R en P	49*	σ^2	–	162.3	–	82.34	136.3	–	95.57

* La diferencia entre 54.49 se debe a árboles perdidos.

** CM = Cuadrado medio

*** F = Prueba de F

**** CO(%) = Componentes de la varianza.

Cuadro 4. Prueba de Tukey, ($P < 0.05$) y promedio de número de agujas por fascículo.

Tres agujas			Cuatro y cinco agujas		
Procedencia	Promedio	Test	Procedencia	Promedio	Test
POP	18.9	–	LIM	14.7	–
GUA	17.7	–	MEL	13.3	–
LIM	15.9	–	RIO	10.0	–
MEL	15.4	–	GUA	6.7	–
MPR	13.2	–	MPR	6.6	–
RIO	10.7	–	POP	4.3	–
$\overline{X}$	15.3	–		9.3	–
S	5.0	–		3.3	–
CV(%)	32.8	–		35.7	–

cia Los Limones mayor número de agujas por fascículo, y menor en la procedencia Guanaja. Bin Chen Yeon (3) encontró en Malaya mayor número de agujas por fascículo en las procedencias de Honduras que en las de Guatemala. La Figura 2 presenta la distribución en porcentaje por procedencia de fascículos con tres, cuatro y cinco agujas. Se observa que con excepción de Guanaja las restantes cinco procedencias presentan distribuciones muy similares. En la procedencia Guanaja también se encontró un árbol con 44 por ciento de los fascículos con cuatro y cinco agujas.

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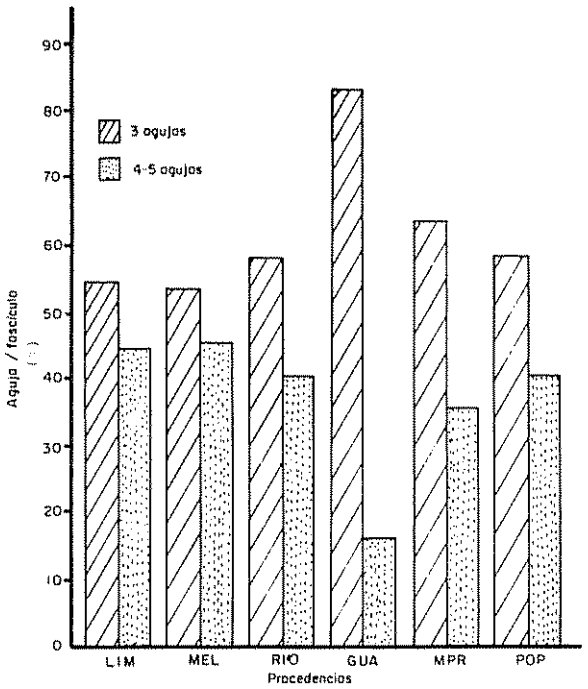

Fig. 2. Variación en el número de agujas por fascículo a 25 cm de altura del árbol

tica es sensible a cambios fisiológicos en el árbol; sería interesante comprobar si la variación se presenta a lo largo de la copa de árboles mayores, y si obedece a cambios climáticos. Si esto fuese cierto esta variable no tendría mucho valor para describir híbridos intra o inter-específicos.

No obstante en el caso de la procedencia Los Limones que crece en contacto con *P. oocarpa*, la presencia a una alta proporción de fascículos con mayor número de agujas, no descarta la posibilidad de una mayor introducción de genes del *P. oocarpa*.

La expresión en proporción variable entre las procedencias estudiadas de fascículos con más de tres agujas, también puede interpretarse como una característica poligénica sensible a cambios climáticos, que se ha mantenido presente y con una variación relativamente poca en el proceso migratorio de las coníferas hacia el sur

Resumen

El análisis de la variación en la proporción de fascículos con tres y más de tres agujas, en plántulas de 18 meses de *Pinus caribaea* var. *hondurensis* Barr y Golf., creciendo bajo condiciones de ambiente controlado; demostró que no existen diferencias significativas entre procedencias. No obstante las procedencias Los Limones y Melinda mostraron mayor frecuencia de fascículos con más de tres agujas y la procedencia Poptún la incidencia más baja.

Los resultados indican que es posible que los genes responsables de la presencia de fascículos con cuatro y cinco agujas, están presentes a lo largo de toda la distribución natural de esta variedad, pero su expresión posiblemente está controlada por factores climáticos

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SALINITY INDUCED CHANGES IN KETO ACIDS, AMINO ACIDS AND ENZYMES OF TRANSAMINATION SYSTEM IN PIGEON PEA (*Cajanus indicus* SPRENG) AND GINGELLEY (*Sesamum indicum* L.) LEAVES[1] /

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Resumen

Se determinó el nivel de cetoácidos, aminoácidos y la actividad de las enzimas amino transferencias (azpartato y alanina) y la deshidragenasa (glutamato) en hojas de Cajanus indicus *y* Sesamun indicum, *sometidas a condiciones de salinidad con NaCl. Se encontró una acumulación de cetoácidos como el ácido oxaloacético y el ácido fosfoenol pirúvico bajo condiciones de salinidad, mientras que los ácidos α cetoglutárico y pirúvico se acumularon en el testigo. Se notó un marcado aumento en el contenido de ácido glutámico, glutamina, ácido aspártico, asparagina, glicina/serina, prolina y alanina con el aumento de la salinidad. La baja en concentración de algunos cetoácidos como el ácido α cetoglutárico, piruvato y oxaloacetato con el aumento paralelo de glutamato alanina y ácido aspártico se atribuyen al aumento de actividad de la deshidrogenasa glutamato, la amino transferasa alanina y la amino transferasa aspartato, respectivamente. Se discute la importancia de estos cambios en relación al mecanismo de adaptación de estas plantas a condiciones de salinidad.*

Introduction

Keto acids are important intermediary metabolites which provide carbon skeletons for the synthesis of amino acids and proteins (2). Earlier reports refer essentially to the occurrence of these metabolites in different plant parts (14, 17) and their role in different plant fractions (22). Although relative changes in amino acids and proteins with growth and development have been studied in detail, reports on changes in keto acids and amino acids in maturing leaves are very few. Salt induced changes in keto acid and amino acid content have been shown in pea and corn sprouts (18) and groundnut leaves (7). Studies on enzymes of transamination system under saline conditions received inadequate attention. The present study, therefore, has been undertaken to find out the changes in keto acids, amino acids and enzymes of the transamination system in pigeon pea and gingelley during progressive maturation of the leaves under NaCl salinity

Materials and methods

Pigeon pea (*Cajanus indicus* Spreng Var. LRG-30) and gingelley (*Sesamum indicum* L. Var TMV-1) were screened for tolerance to varying levels of salinity ranging from 0.1% to 0.6% NaCl in the soil. A salinity level of 0.4% has been selected in the present study at which pigeon pea was tolerant and gingelley was susceptible. The plants were raised in 18 centimeter diameter carthenware pots containing soil and manure in the ratio of 3:1. The plants were thinned to 3 plants per plot before applying the salt treatment. Salt treatment was given at two stages of growth, 15 and 30 days after sowing. The salt content of the soil was raised to 0.4% by adding NaCl solution on air dry weight basis of the soil.

The first formed trifoliate leaf from pigeon pea and first pair of leaves from gingelley were collected at the following stages for analyses.

Stage 1: 7 days after first NaCl treatment (when the leaves showed full opening);

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Stage 2: 15 days after first NaCl treatment (active period of growth);

Stage 3: 7 days after second NaCl treatment (maturation phase); and

Stage 4: 15 days after second NaCl treatment (initiation of senescence). The physiological changes induced by salinity showed recovery symptoms at stage 2 (30 days after sowing), and a second treatment was therefore given to maintain the same level of inhibition and to elicit a clear response from the plants (6).

Amino acids were extracted (3) and estimated (5) by following standard procedures. Extraction, chromatographic analysis and quantitative estimation of keto acids were done according to Mukherjee (16). Preparation of enzyme extract i e.; Aspartate amino transferase (Glutamate oxaloacetate transaminase – GOT – EC 2.6.1.1) and Alanine amino transferase (Glutamate pyruvate transaminase – GPT – EC 2 6 1 2) (11) and their assay (19) were carried out on all the stages. Glutamate dehydrogenase (GDH – EC 1 4 1 3) activity was determined by the method of Joy (13). Protein content of these enzyme extracts was estimated according to Lowry *et al* (15). Triplicate samples were analysed for each experiment.

Results

Levels of different amino acids present in pigeon pea and gingelley leaves are given in Tables 1 and 2 respectively. In gingelley glutamine and hydroxyproline were found to be absent (Table 2). Amino acids such as asparagine, aspartic acid, glycine/serine, glutamic acid, glutamine (in pigeon pea), alanine and proline were found to be accumulating both in pigeon pea and gingelley under salinity. Hydroxyproline also showed accumulation in pigeon pea under salinity. Of all the amino acids, glutamic acid showed greater accumulation in pigeon pea leaves under salinity.

γ-aminobutyric acid, valine phenylalanine and threonine showed a decrease under salinity in both species. Leucine/iso-leucine showed a decrease in pigeon pea and increase in gingelley under salinity.

Tables 3 and 4 indicate the levels of keto acids in pigeon pea and gingelley, respectively. Oxaloacetic acid was found to be absent in gingelley but present in pigeon pea. Keto acids such as phosphoenol pyruvic acid (PEP) and oxaloacetic acid (OAA) showed a high degree of accumulation in both species under salinity on all the stages of growth. Pyruvic acid (Pyr) showed a slight degree of accumulation up to stage 2 and a decrease up to stage 4 in both species under salinity. α-ketoglutaric acid (α-KGA) showed a slight degree of increase at stage 1 and decrease stages 2, 3 and 4 in pigeon pea and gingelley under salinity. Glyoxylic acid (Gly) showed a slight degree of accumulation at stage 1 followed by a decline up to stage 4 in gingelley and a decrease from stage 1 to stage 4 in pigeon pea under salinity. Oxalosuccinic acid and two unidentified spots were found to be present in gingelley only.

All the three enzymes, GPT, GOT and GDH showed increased activity in both the plants under salinity

Table 1. Levels of amino acids in pigeon pea leaves under control and NaCl salinity (μg/g fresh weight).

Amino acid	Stage 1		Stage 2		Stage 3		Stage 4	
	Control	Salinized	Control	Salinized	Control	Salinized	Control	Salinized
Asparagine	45	136	56	157	78	198	96	214
Aspartic acid	125	254	146	283	177	318	192	326
Glycine/Serine	265	284	288	312	325	335	348	352
Hydroxyproline	36	68	49	89	75	112	58	136
Arginine	57	75	74	89	88	109	72	126
Glutamic acid	256	362	294	398	305	427	326	459
Alanine	165	224	188	258	196	270	224	296
γ-aminobutyric acid	112	98	132	115	147	126	128	103
Proline	46	158	58	176	74	197	86	224
Valine	64	51	78	63	96	78	121	90
Phenylalanine	65	74	79	89	82	98	76	108
Glutamine	98	136	114	168	129	193	108	216
Threonine	47	59	58	61	70	77	108	60
Leucine/iso-leucine	87	78	98	83	112	85	104	94

Table 2. Levels of amino acids in gingelley leaves under control and NaCl saline conditions (μg/g fresh weight).

Amino acid	Stage 1		Stage 2		Stage 3		Stage 4	
	Control	Salinized	Control	Salinized	Control	Salinized	Control	Salinized
Asparagine	45	64	57	89	74	108	89	126
Aspartic acid	98	128	114	152	126	179	133	195
Glycine/Serine	165	179	180	216	212	235	224	245
Arginine	108	137	112	159	147	184	136	193
Glutamic acid	102	154	124	183	136	198	128	216
Alanine	84	142	96	158	119	172	106	164
γ-aminobutyric acid	36	24	47	36	52	49	64	37
Proline	TRACE	46	TRACE	89	27	124	38	136
Valine	64	58	89	62	97	86	108	74
Phenylalanine	64	72	89	96	94	120	112	137
Threonine	57	59	65	74	76	84	83	92
Leucine/iso-leucine	65	84	93	93	86	113	97	132

Table 3. Levels of keto acids in pigeon pea leaves under control and NaCl conditions (mg/g fresh weight).

Keto acid	Stage 1		Stage 2		Stage 3		Stage 4	
	Control	Salinized	Control	Salinized	Control	Salinized	Control	Salinized
Phosphoenolpyruvic acid	–	1 90	0 45	2 20	0 48	2 50	0.49	2 35
Pyruvic acid	2.60	3 00	2.80	3 30	3 20	2 98	3 05	2 74
Oxaloacetic acid	1 00	2 35	1 45	2 96	1.62	3 45	1 50	3 25
Glyoxylic acid	1 35	1 30	1.40	1 16	1.52	0.95	1 25	0 56
α-ketoglutaric acid	0 58	0.95	0 95	0.72	1.25	0.56	1.45	0 45

Table 4. Levels of keto acids in gingelley leaves under control and NaCl saline conditions (mg/g fresh weight).

Keto acid	Stage 1		Stage 2		Stage 3		Stage 4	
	Control	Salinized	Control	Salinized	Control	Salinized	Control	Salinized
Phosphoenolpyruvic acid	0.28	0 56	0.30	0 85	0 46	1 15	0 58	1.06
Pyruvic acid	1 98	2 50	2 10	2 20	2 25	1 98	2.46	1 60
Oxaloacetic acid	–	0 30	–	0 56	–	0.95	–	0 72
Glyoxylic acid	0 95	1 30	1.10	1.05	1 20	0 80	0 80	0 65
α-ketoglutaric acid	0 36	0 45	0 59	0 39	0 98	0.30	1 15	0 21
Oxalosuccinic acid	1 20	1.10	1 35	1 05	1 20	0 96	0 95	0 64
Unidentified 1	–	0 50	0.15	0.62	0 20	0 75	0 36	0 45
Unidentified 2	0.26	0 37	0 48	0.69	0.64	0.96	0 54	1.10

(Figura 1). GPT showed an increase from stage 1 to stage 3 followed by a decrease at stage 4 and a decrease from stage 1 to stage 3 followed by an increase at stage 4 in pigeon pea under control and salinized conditions, respectively. An increase from stage 1 to stage 4 and an increase from stage 1 to stage 3 and a decline at stage 4 was observed in gingelley under control and salinized conditions, respectively.

GOT showed a continuous increase from stage 1 to stage 4 and a slight decrease from stage 2 to stage 3 followed by an increase at stage 4 in pigeon pea under control and saline conditions, respectively. GOT showed a similar trend as GPT in gingelley both under control and salinized conditions.

GDH showed a decrease from stage 1 to stage 3 with an increase at stage 4 in pigeon pea; and a decrease from stage 1 to stage 2 followed by an increase up to stage 4 in gingelley both under control and saline conditions.

Discussion

Keto acids represent a link between the carbohydrate and nitrate metabolism explaining the great importance in the keto acid metabolism in plants growing under saline conditions. Strogonov (20) emphasised that keto acids play a protective role in saline habitats in addition to the metabolic functions. These protective functions consist in binding the excess ions absorbed by the plant and in maintaining the electrical neutrality of the cells and finally neutralising the basic compounds.

Generally, in plants growing under saline conditions ammonia tends to accumulate enormously which is said to be toxic to the plant growth (18). Keto acids play a pivotol role by participating in amination and transamination reactions, thus detoxifying ammonia to form amino acids. Generally, the process of detoxification proceeds via the amination and transamination system (7):

KETO ACIDS ⇌ DICARBOXYLIC AMINO ACIDS (GLUTAMIC AND ASPARTIC ACIDS) ⇌ AMIDES (GLUTAMINE AND ASPARAGINE).

From the present study it is presumed that α-KGA, Pyr and OAA in salinized plants participate in the above reactions. In this case alanine can be formed pyruvate, glutamic acid from α-ketoglutarate and aspartic acid from oxaloacetate. Conversely, no such greater accumulation of amino acids is evident in controls. These reactions are in turn regulated by the enzymes, alanine amino transferase (GPT), glutamate dehydrogenase (GDH) and aspartate amino transferase (GOT), respectively. The enhanced activity of these enzymes under salinity results in the formation of higher amounts of amino acids and amides such as alanine, glutamate, glutamine, aspartate and asparagine, there by decreasing the toxicity of ammonia. Thus the enhanced activity of

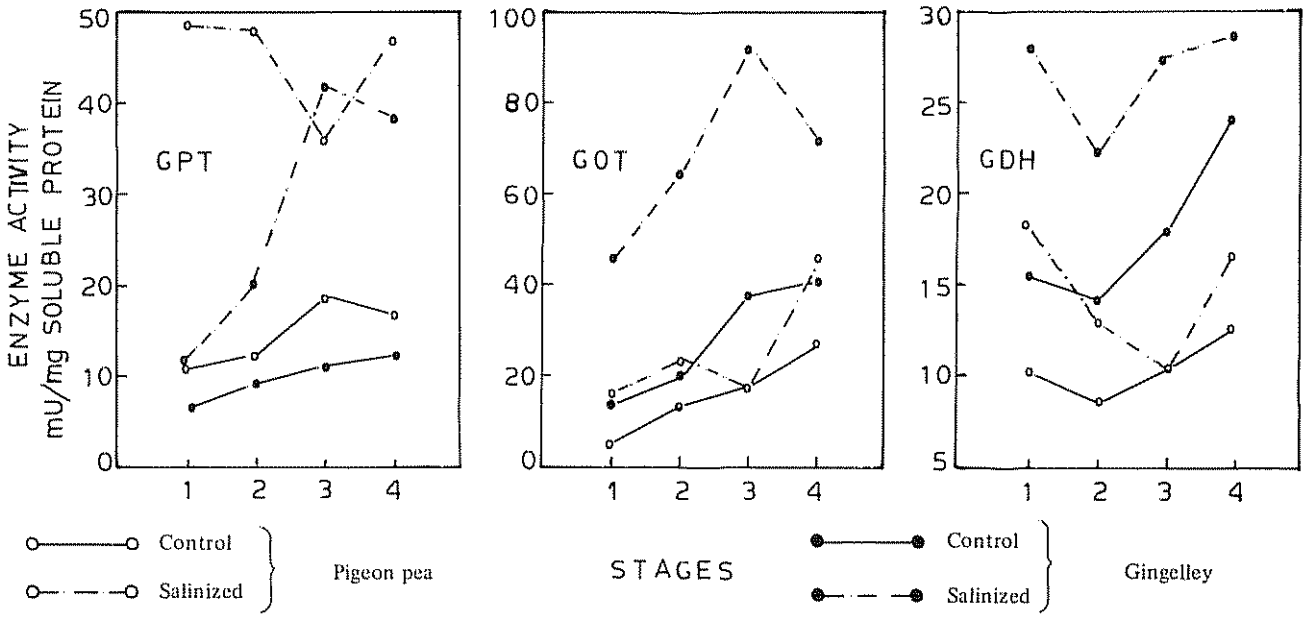

Fig 1. Activities of the enzymes Alanine amino transferase (GPT), aspartate amino transferase (GOT) and glutamate dehydrogenase (GDH) in pigeon pea and gingelley leaves under NaCl salinity.

GPT, GDH and GOT which results in the conversion of pyruvate, α-ketoglutarate and oxaloacetate to amino acids in the presence of accumulated ammonia (20) may possibly play a protective role under saline conditions. The results of the present study are in conformity with those of Joshi (12) and Gururaja Rao and Rajeswara Rao (9), who observed high GPT, GDH and GOT activities in marine algaem mangroves and a C_3 plant, wild rice (*Oryza sativa* L. Var. Kala Rata) and peanut leaves, respectively. The low amounts of PEP and high amounts of OAA in the initial stages of leaf growth indicate that PEP → OAA pathway was actively operating during the early stages. In control plants as the leaves mature the transamination reactions utilizing the keto acids for the synthesis of amino acids is affected and become sluggish.

The keto acids like OAA and PEP are formed during respiration as well as photosynthesis. But plants like pigeon pea and gingelley, which fix carbon by C_3 pathway, do not synthesise them under normal conditions during photosynthesis. The accumulation of these acids in salinized plants envisages that these metabolites are synthesised during an altered pathway of photosynthesis. Salinity induced shift from C_3 to C_4 pathway (aspartate type) was reported by Joshi (12) in marine algae, mangroves and a C_3 plant, *Oryza sativa* Var. Kala Rata. The conversion of OAA to aspartate was found to be stimulated by NaCl salinity in these plants. Both, pigeon pea and gingelley also showed high rates of $^{14}CO_2$ incorporation into OAA, aspartate, and less incorporation into sugars and sugar phosphates (8). Generally in a low salt environment the plants show C_3 metabolism and with the increase in salinity the assimilation shifts to C_4 dicarboxylic acid pathway as in the case of *Aleuropus litoralis*, a halophytic grass (4) and *Cakile maritima* (1). But in *Mesembryanthemum crystallinum* (24) and *Portulacaria afra* (21), the shift is towards crassulacean acid metabolism (CAM) and thus increasing the organic acid content for osmoregulation. It was also shown that watering of *M. crystallinum* plants with NaCl solutions resulted in high Na^+ than Cl^- in the leaves, which indicates that Na^+ should facilitate in changing the metabolism. The occurrence of low amounts of OAA and PEP at stage 4 in the salinized plants may be due to the reduced rates of synthesis as the leaves showed the initiation of senescence. In the present study the occurrence of C_4 cycle acids under NaCl salinity was unaccompanied by Kranz type of leaf anatomy. On the other hand the leaves of salt-stressed plants developed succulence (6). Salinity induced succulence of leaves was shown in *Phaseolus vulgaris* (23) and in *Cajanus indicus* and *Cyamopsis tetragonoloba* (10). Thus, the succulent nature of the leaves and the occurrence of PEP and OAA in higher amounts in salinized pigeon pea and gingelley leaves can be interpreted in terms of a shift from C_3 to weak CAM type, as reported earlier (7).

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UN APLICADOR MANUAL DE INSECTICIDAS GRANULADOS; SU EFICACIA PARA EL CONTROL DE *Spodoptera frugiperda** (J. E. Smith) y *Diatraea* sp.** CON PHOXIM EN EL SORGO, *Sorgum bicolor* EN EL SALVADOR, C. A.[1] /

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Summary

Late instar fall armyworm larvae, Spodoptera frugiperda, *were effectively controlled in sorghum by application to the whorl of 0.04 to 0.07 g of phoxim 2.5G, which is a lower dosage than that currently recommended and used by farmers. Control was unsatisfactory when the granules were applied only to those whorls which showed symptoms of recent attack. Application to all whorls resulted in satisfactory control of* Diatraea *spp. The use of a simple, inexpensive hand held bamboo aplicator prevented direct contact with the insecticide, and permitted rapid, precise and economical application of low dosages of the granules. Directions and illustrations for construction are given.*

Introducción

Para el combate químico del gusano cogollero, *Spodoptera frugiperda* (J. E. Smith), en Centro América son comunes las aplicaciones de insecticidas al cogollo del sorgo con formulaciones granulares, las cuales se aplican usando la cantidad de producto que cabe en 3 ó 4 dedos de la mano (4). A menudo se recomienda el uso de phoxim granulado (1, 3). Los agricultores de pocos recursos sólo aplican a los cogollos afectados y casi siempre contra larvas de estados avanzados ya que éstas causan daño notorio. Cualquier tendencia a utilizar dosis mayores que la mínima necesaria es antieconómica y favorece la fitotoxidad y la contaminación del ambiente. Esta práctica manual es peligrosa, ya que permite el contacto dermal con el veneno, pero es difícil aplicar dosis bajas cuando se usan guantes y otra protección. Para los minifundistas es importante proveer tecnologías que maximizan el uso de mano de obra y minimizan el gasto de otros insumos (2).

El ensayo que aquí se informa tuvo como objetivos: 1) determinar la dosis de phoxim 2.5G, para el combate eficaz de larvas del cogollero y 2) probar la utilidad de un aplicador de bambú sencillo y económico de construcción casera para la aplicación de los gránulos.

Materiales y métodos

Se construyeron 3 prototipos del aplicador de bambú presentado en la Figura 1, con las especifica-

* Lepidoptera: Noctuidae

** Lepidoptera: Pyralidae

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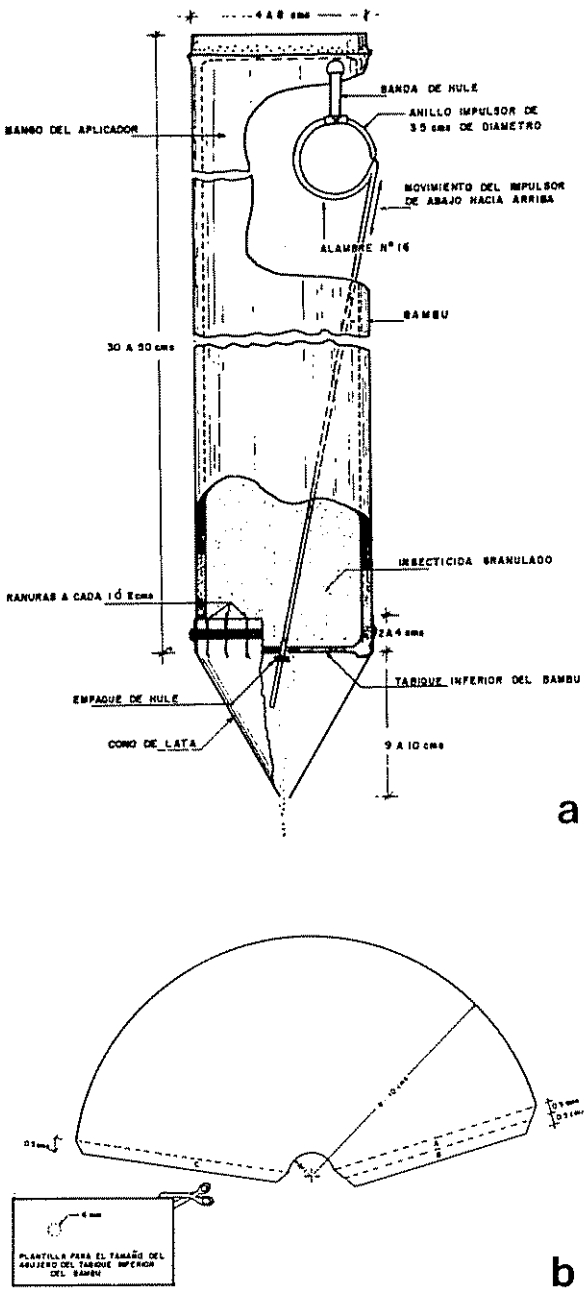

Fig. 1. Especificaciones para la construcción de un aplicador de bambú para insecticidas granulados. a) Vista lateral del aparato, b) plantilla para la construcción del cono del aplicador.

ciones presentadas en el Cuadro 1. Los materiales necesarios para la construcción del aparato son los siguientes: una vara de bambú de 4 – 8 cm de diámetro por 30 – 50 cm de longitud, un metro de alambre de amarre número 14, una banda de hule corriente de 20 cm, un recipiente de lata para leche de una libra o lámina número 34 de 15 x 25 cm, un corvo o machete, un martillo, una tenaza y un serrucho.

Los pasos a seguir en la construcción son los siguientes:

1. Se corta la vara de bambú entre dos entrenudos, teniendo cuidado de no tocar en ambos lados los tabiques de los entrenudos.

2. Se labra la parte superior del aplicador en forma de mango de corvo.

3. Se perfora un agujero en el extremo superior del aplicador, para amarrar la banda de hule.

4. El tabique inferior se perfora con un diámetro apropiado equivalente al grosor de una varilla de 0.64 cm. Para mejorar la eficiencia de aplicación puede sustituirse el tabique inferior por lata.

5. Se construye con alambre el impulsor del granulado, formando en su parte superior un anillo de 3.5 cm de diámetro para manejarlo con el dedo.

6. Se amarra el impulsor con una banda de hule en el extremo superior del bambú y al extremo inferior del impulsor se le amarra otro pedazo de hule que sirve como empaque al impulsor, el cual asegura que no salga el veneno cuando no está en uso.

7. Para la construcción del cono de aplicación se dibuja primero una plantilla (Fig. 1B). Luego, de una lata de leche se corta la lámina y se deja completamente plana. Se sobrepone la plantilla sobre la lámina para marcar el cono y los lados de unión "A", "B" y "C". Luego se recorta la lámina. La cara "C" se dobla hacia la parte externa del cono en el borde de una troza o una mesa, dejando el doblez con un ángulo a más de 90°. Posteriormente se dobla la cara "B" hacia la parte interna del cono dejando el doblez más cerrado que el anterior.

   Con la mano se empieza a darle forma al cono hasta que el lado "C" se mete entre los lados "B" y "A". Haciendo descansar el cono en la parte interna, se golpea los lados "C" y "B" sobre el lado "A" hasta remochar completamente los lados, quedando de esta forma terminado el cono.

8. Se introduce el cilindro de bambú en el cono. Se hace girar hasta dejar una marca en el interior del cono.

9. Se procede a cortar varias líneas, hasta la marca mencionada a partir de la abertura mayor del cono, dejando 1 a 2 cm de separación entre líneas.

10. Se ajusta el cono al bambú por las partes rajadas

Cuadro 1. Datos sobre los diferentes tratamientos usados por el combate con phoxim 2.5G de *Spodoptera frugiperda* y *Diatraea* spp. en sorgo. San Andrés, El Salvador. 1979.

Tratamiento	Diámetro de agujero en mm.	$\bar{X}$ gramos/planta	$\bar{X}$ kg/ha*	$\bar{X}$ horas/ha*
Aplicador 1 total	5 5	0 04	7 6	25.8
Aplicador 1 parcial	5.5	0 04	2 3	–
Aplicador 2 total	6 0	0.07	12 0	21 9
Aplicador 2 parcial	6 0	0.07	3 5	–
Aplicador 3 total	6.4	0 13	23 8	24 9
Aplicador 3 parcial	6 4	0 13	6.2	–
Con 3 dedos total	–	0 15	26.9	19 0
Sin tratamiento	–	0	0	0

* 182 000 plantas/ha.

y luego se amarra con alambre de tal forma que quede bien sujeto.

Con el objeto de probar la eficacia de este aparato, se sembró un ensayo el 5 de setiembre de 1979 en San Andrés, La Libertad, El Salvador, empleándose la variedad de sorgo CENTA S–1. Se utilizó un diseño de seis bloques al azar con ocho parcelas cada uno. Cada parcela consistió de un surco sencillo con 150 plantas, todas ellas libres a los 30 días de síntomas de daño de *Diatraea* spp. Treinta días después de la siembra se examinaron todas las plantas para determinar si estaban infestadas por cogollero, desenvolviendo el cogollo en caso necesario. La presencia de heces frescas o larvas fue el criterio usado para determinar las plantas infestadas. A los 31 días se hicieron las aplicaciones

Las dosis de phoxim 2.5G aplicadas con los aplicadores fueron promedios de 0 04, 0.07 y 0.13 gramos/planta. Se trataron todas las plantas en tres surcos de cada bloque y en tres solamente las plantas con síntomas de infestación. De los dos surcos restantes uno sirvió de testigo sin tratar y el otro recibió una aplicación hecha con tres dedos y con gasto promedio de 0.15g/planta.

A los 4 y 11 días después de la aplicación del insecticida, se determinaron los porcentajes de plantas nuevamente infestadas por cogollero en cada parcela. Para determinar el efecto sobre *Diatraea* spp. se realizó un recuento de plantas con cogollos muertos a los 34 días de la aplicación.

Resultados y discusión

Las diferencias entre tratamientos se determinaron por el ANDEVA y la prueba de Duncan ($P = 0.05$). Al momento de la aplicación de phoxim, las larvas medían un promedio de 2 cm de largo. Las infestaciones iniciales de *S. frugiperda* con un promedio de 21.9 por ciento de las plantas no fueron significativamente diferentes en los diversos tratamientos (Fig. 2). A los 4 días después de la aplicación los surcos con aplicaciones parciales tuvieron infestaciones significativamente más altas que los surcos que recibieron las aplicaciones totales. También las dosis más altas resultaron en infestaciones levemente más bajas en ambos tipos de aplicaciones, pero no hubo ninguna diferencia estadísticamente significativa entre estos tratamientos. A los 11 días los tratamientos generales continuaban superando a los tratamientos parciales y la protección dada fue igualmente buena con todas las dosis. En ambas fechas los tratamientos en los que se utilizaron los aplicadores de bambú fueron tan efectivos como el aplicado con la mano.

La infestación de *Diatraea* spp. se redujo significativamente con las aplicaciones totales (Fig. 3), existiendo una ligera relación de dosis-respuesta. Con las aplicaciones parciales no se obtuvo una reducción apreciable.

En el Cuadro 1 se presentan los datos más relevantes respecto a los aplicadores. Con tres dedos se gastó más insecticida que con los aplicadores. En los aplicadores 1 y 2 las cantidades de gránulos gastados se re-

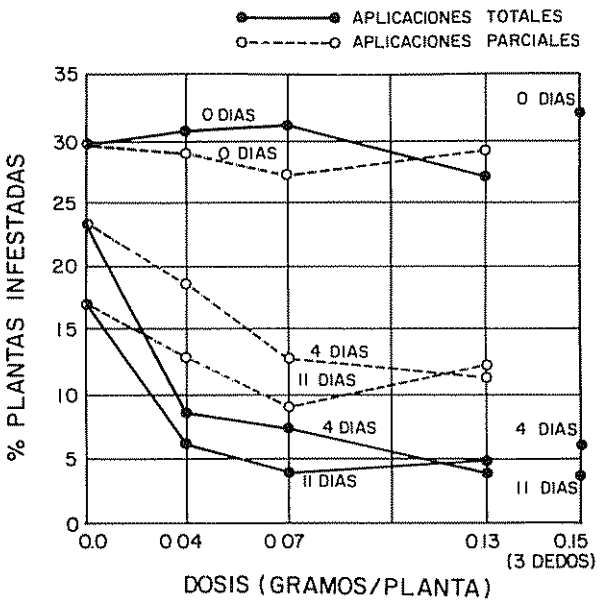

Fig. 2. Porcentaje de plantas de sorgo infestados por *Spodoptera frugiperda* a los 0, 4 y 11 días después de aplicar varias dosis de phoxim 2.5G con el aplicador de bambú y con 3 dedos. San Andrés, El Salvador. 1979.

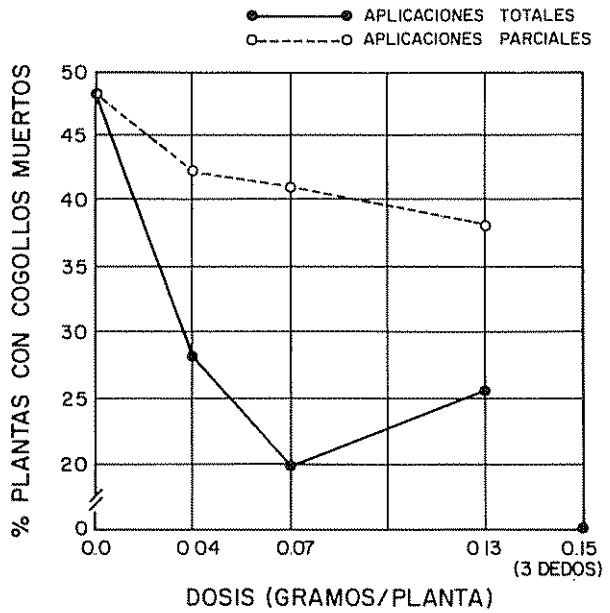

Fig 3. Porcentaje de plantas con cogollos muertos por *Diatraea* spp a los 34 días depués de aplicar varias dosis de phoxim 2.5G con el aplicador de bambú y con 3 dedos. San Andrés, El Salvador. 1979.

dujeron a 28 y 48 por ciento respectivamente, comparada con la aplicación con tres dedos. Fue un 21 por ciento más rápido aplicar con los tres dedos que con los aplicadores (19 versus un promedio de 24.2 horas/ha). En el Cuadro 2 se presentan los rendimientos por tratamiento.

Cuadro 2. Rendimiento de grano seco de sorgo tratado con diferentes dosis y en diferentes maneras con phoxim 2.5G. San Andrés, El Salvador. 1979.

Tratamiento	Rendimiento en toneladas métricas/ha
Sin tratar	1.57
Aplicador 1 parcial	1.61
Aplicador 3 parcial	2.02
Aplicador 2 parcial	2.12
Aplicador 2 total	2.36
Aplicador 1 total	2.45
Aplicador 3 total	2.96
Con 3 dedos total	3.29

Conclusiones

La práctica común de tratar solamente los cogollos obviamente dañados por cogollero no parece ser eficaz ya que el control se incrementó entre 2 a 2.5 veces con aplicaciones a todas las plantas. Con aplicaciones parciales el hábito errante de las larvas resultó en un control incompleto e insatisfactorio. La falta de una alta relación dosis-respuesta tanto a los 4 dias, como a los 11 dias indicó que las dosis más bajas de phoxim son aconsejables. Se considera que las diferencias en rendimiento se deben más a los ataques del barrenador que del cogollero.

La reducción del daño del barrenador obtenido con aplicaciones totales de phoxim sobre cogollos y la mortalidad dramática de plantas observada en las parcelas no bien protegidas, confirmaron que aplicaciones totales podrían ser una práctica económicamente recomendable para los minifundistas cuando no se ha aplicado oportunamente contra huevos y larvas de los primeros estadíos.

En cuanto a los costos de aplicación de insecticida, se observaron diferencias importantes. Los costos fueron similares para la aplicación de insecticidas con tres dedos y con el aplicador 3 ya que la pequeña reducción en costo del insecticida gastado en el primero es compensado por el aumento de tiempo gastado en el segundo. Con los aplicadores 1 y 2 se registraron reducciones sustanciales en gasto de insecticidas resultando estos tratamientos más económicos que los otros 2.

El uso del aplicador de bambú es promisorio ya que su uso es fácil y rápido. El aparato minimiza el contacto dermal con el producto y permite medir con exactitud dosis bajas. La persona que aplica sufre menos fatiga debido a que puede mantener una posición más erecta. El aplicador es fácil de fabricar, los materiales empleados son de bajo costo y están al alcance del pequeño agricultor.

Resumen

Las larvas de estadío tardío del gusano cogollero *Spodoptera frugiperda*, fueron controladas efectivamente en el sorgo, aplicando al cogollo de 0.04 a 0.07 g de phoxim 2.5G. Esta es una dosis más baja que la recomendada y es menor a la usada normalmente por los agricultores. Cuando los gránulos son aplicados sólo a los cogollos que muestran síntomas de ataque reciente, el control no es bueno; es mejor hacer la aplicación a todos los cogollos y así se controla mejor la *Diatraea* spp. El uso de un sencillo aplicador manual de bambú evita el contacto directo con el insecticida a la vez que permite una aplicación rápida, precisa y económica de dosis pequeñas de gránulos. Se dan las explicaciones e ilustraciones para su construcción.

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Reseña de libros

VAN GOOR, C. P., JUNUS, K. Indonesian Forestry Abstracts Dutch literature until about 1960. Pudoc, P. O. Box 4, 6700 AA Wageningen, The Netherlands. 1982. 688 p.

En setiembre de 1976 se firmó un acuerdo cooperativo entre los servicios forestales de Indonesia y Holanda, con el objeto de hacer accesible para los técnicos forestales indonesios, toda la literatura forestal de Indonesia producida hasta aproximadamente 1960; que en su mayor parte está escrita en holandés y no accesible para los nuevos forestales. La implementación del acuerdo fue encomendada a Perum Perhutani (Forest State Corporation) por parte del gobierno de Indonesia y a Dorschkamp Research Institute for Forestry and Landscape Planning por parte del gobierno de Holanda.

Como resultado del esfuerzo conjunto fueron recopilados y resumidos 6 026 trabajos, la mayoría libros y artículos publicados en revistas periódicas, también información no publicada. Los resúmenes se presentan en inglés en un documento de 658 páginas, clasificados según el sistema decimal "Oxford", y complementados con índices de autores, especies y temas.

La obra se considera de gran valor ya que en forma resumida logra poner a disposición de las nuevas generaciones de forestales el resultado de una gran cantidad de investigación forestal de difícil acceso. La mayoría de los trabajos recopilados son el producto de la investigación realizada entre los años 1920 y 1950, tanto con especies nativas como exóticas. Entre los géneros y especies más ampliamente citados están: *Acacia* spp, *Agathis* spp, *Cassia* spp, *Eucalyptus* spp, *Leucaena* spp, *Leucaena leucocephala, Pinus* spp, *Pinus merkusii, Shorea* spp, *Swietenia* spp, y *Tectona grandis*. A través de este período los temas más ampliamente investigados han sido explotación, transporte, aserrío y comercialización de la madera, regulaciones y política forestal, planes de manejo, uso de la tierra, plagas forestales, manglares e investigación forestal. La mayor parte de esta investigación ha sido realizada en Aceh; Irian Jaya; Java Central, Este y Oeste; Kalimatan Central, Este, Oeste y Sur; Lumpur, Timor, Riau, Sulawsi Central, Norte, Sur y Este; Sumatra Este, Oeste, Sur y Norte.

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CHEMICAL COMPOSITION AND POTENTIAL USES OF PROCESSING WASTES FROM SOME NIGERIAN CASH CROPS[1] /

*E. O. AWOLUMATE**

Resumen

Se incluye la composición aproximada de proteína cruda, fibra cruda, ceniza, sodio, potasio, fósforo y otros elementos menores de pulpa y pergamino de café, cáscara de cola, mucílago de la nuez de cola, pulpa del pseudofruto de marañón, pulpa de nues de cacao y cáscara de cacao. El alto contenido de humedad y fibra cruda pueden limitar el consumo directo por los animales de estos productos aunque el ensilaje de los mismos podría mejorar su valor alimenticio. Las cenizas son pobres en Mn, Cu y Zn pero ricas en Ca, N, K, Na, P, Fe y Mg, por esta razón, podrían utilizarse en la industria local de jabones o como fuente de fertilizante orgánico. Se sugiere su posible utilización como materia bruta para la producción de pectinas, jaleas y colorantes de alimentos.

Introduction

Cocoa, coffee, cashew and kola represent agricultural crops of significant economic importance to Nigeria. The income obtainable by the farmers from the sale of cocoa and coffee beans, cashew and kola nuts is still the main reason for cultivating the crops. However, large quantities of field processing wastes, such as pod husks and apple pulp are usually discarded and left to rot in farms and plantations all over the country. In addition, substantial amounts of coffee pulp with parchment and cocoa bean testa are left to waste in Nigeria Coffee Mills and Cocoa Processing Industries respectively. Cashew apple pulp is as yet not available as a distinct waste in Nigeria because the processing of cashew apple on commercial basis has not started. Some of the apples are only picked and sold to individuals who suck the juice and throw away the pulps. Certainly, large quantities of apples are still left behind to rot under the trees in the cashew farms. This observation supports the claim by Ohler (12) who reported that annually the greater part of about 2.5 to 5 million tons of cashew apples is left unused under the trees, and that this volume will increase sharply in the coming years with the increased area planted to cashew. The availability of these by-products in such quantities warrants efforts to develop profitable uses for them in order to provide extra income to the farmers.

Apart from the traditional use of alkaline ash from cocoa pod husk for the manufacture of crude soap (3), it has already been used to a limited extent for feeding farm animals (1, 2, 9), and as fertilizer and nematicide (6). Similarly, coffee pulp has been used as organic fertilizer or animal feed (5). The possibility exists however, that other available field or industrial wastes could be similarly used.

The chemical compositions of cocoa pod husk (3, 13), coffee pulp and parchment (5), kola pod husk and kola nut testa (14) and cashew apple (12) have been reported. However, very little information is available on the elemental composition of some of these processing wastes.

The objective of the present study, therefore, was to investigate the proximate and elemental composition of field or industrial processing wastes from cocoa, coffee, kola and cashew with the hope that the results would suggest ways in which they could be utilized profitably.

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Permission by the Director, Cocoa Research Institute of Nigeria to publish this paper is appreciated.

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Materials and methods

The cocoa pod husks used in this study were obtained from fresh cocoa pods of F_3 Amazon after the pulps and beans were removed. The bean testa were obtained after fermentation of the beans. The fresh coffee berries of *Coffea canephora* (robusta) were depulped manually immediately after harvest. The coffee beans were air-dried until the parchment (endocarp) could be removed. The kola fruits of *Cola nitida*, Vent. (Schott and Endlicer) were harvested and the pods opened with a knife. The husk, testa and nuts were separated. These samples were obtained from experimental plots in Onigambari Headquarters and Owena Sub-station of Cocoa Research Institute of Nigeria. Cashew-apples (pseudo-fruit) were obtained from Iwo and Eruwa plantations. The juice was extracted with a Zyliss juice squeezer and the residual pulp air-dried. Except otherwise stated, all the analyses reported in this work were carried out on ground, oven-dried (65°C for 24 h) samples.

Proximate analysis for moisture, ether extract, crude protein, crude fibre, ash, nitrogen-free-extract were done according to the methods described in the official methods of Analysis of the Association of official Analytical Chemists (4).

Elemental analysis was donde by ashing 0.5 g portion of sample at 550°C in a muffle furnace. The ash was dissolved in 5 cm^3 of 4N-HCl and made up with distilled, deionized water to 100 cm^3. Sodium and potassium were measured on portions of this solution using a Corning 400 Flame photometer. The other elements were measured on a Perkin-Elmer Atomic Absorption Spectrophotometer (Model 703) using appropriate hollow – cathode lamps. Phosphorus was determined by an automated version of the molybdophosphate/ascorbic acid method using the Technicon Auto-analyzer modular equipment. The molybdophosphate was reduced with ascorbic acid and the absorbance measured with a Technicon Colorimeter equipment with a continuous flow cell and filter with a nominal wavelength of 660 nm.

Results and discussion

The quantities of the by-products expressed on a fresh weight basis as obtained in the laboratory are shown in Table 1. From 498.33 g of fresh cocoa fruit, 385.65 g of cocoa pod husk were obtained after removing the beans, placenta and the mucilage, which on a wet-weight basis represented 77.39% of the weight of the whole fruit. The beans were fermented and the testa removed immediately after fermentation. From 81.54 g of beans obtained after fermentation, 20.92 g constituted the bean testa which represented on wet-weight basis about 25.66% of the total bean weight and 4.33% of the whole fruit. The proportion of by-products of coffee, cashew, and kola in relation to the whole fruit were obtained as described for cocoa. It must be emphasized that although coffee pulp and parchment were separately removed from the fruit for analyses in the present study, *Coffea canephora* (robusta) is processed by the dry method in Nigeria. Consequently, both the pulp, parchment and dry matter from the mucilage come off together in the course of shelling and are available as such in the premises of the Coffee Mills. Furthermore, cocoa bean testa is not a field processing waste because it is not removed until after the beans have been roasted in the Cocoa Processing Industries.

Table 1. Percentage content of various components in freshly harvested fruits; the percentage moisture and dry matter of each component.

Component*	Proportion (%)	Moisture (%)	Dry Matter (%)
Coffee pulp (*C. canephora* Pierre)	44.30	75.45	24.55
Coffee parchment (*C. canephora* Pierre)	10.80**	5.66**	94.34
Kola pod husk (*C. nitida*)	46.80	82.90	17.10
Kola-nut testa (*C. nitida*)	14.98	89.20	10.80
Cashew-apple pulp (red)	77.60	85.40	14.60
Cashew-apple pulp (yellow)	77.80	84.20	15.80
Cocoa-bean testa (F_3 Amazon)	4.38	78.48	21.52
Cocoa pod husk (F_3 Amazon)	77.39	82.62	17.38

* Each value represents the mean of six determinations.

** Value expressed as g/100 g of dry sample.

The data in Table 1 show that fairly large proportions of each fruit constitute undesirable waste products in the economy of production of the fruits. The problems of disposal and contamination of the environment coupled with scarcity of fertilizers and animal feed in the country make it necessary to give more attention to these field and industrial processing wastes.

All the samples were high in moisture ranging from 75.5 g/100 g of fresh sample of coffee pulp to 89.2 g/100 g fresh sample of kola nut testa. The high moisture content may necessitate the drying of some of these materials, particularly cashew apple, at the farms before being transported for use.

Representative values of the proximate chemical composition of each processing waste are given in Table 2. The values for crude protein ranged between 5.6% in cocoa pod husk to 15.0% in coffee pulp

The crude fibre content of most materials were high and this coupled with the high moisture content may be the main drawback in direct use of these materials as animal feeds. However, some of these processing wastes have been successfully fed to farm animals with significant savings in feed cost per unit body weight gain, milk or egg production. Adeyanju *et al.* (12) and Hutagalung *et al.* (10) found that cocoa pod husk could economically make up to 25% of maintenance rations for sheep and goats, about 30% in the growing/finishing diets for pigs and 20% in poultry layer's mash without any serious deleterious effects. The results of various studies reported by Cabezas, Jarquin and Braham (5) suggest that coffee pulp could be a useful feedstuff for ruminants, swine and poultry. Coffee pulp could be profitably incorporated at levels between 20% and 30% of the ration of beef cattle, 20-40% of the concentrate for dairy cattle and 16% in swine ration without any detrimetal effect on weight gain, milk production and feed conversion. To obtain better results, one study recommends the gradual introduction of coffee pulp into the rations. Ogutuga (14) has suggested that the protein in kola pod husk or kola nut testa can be extracted and used as protein concentrate for animal consumption. Furthermore, Olubaja (personal communication) has observed that beef cattle were fed with fresh cashew apple at Upper Ogun cashew plantation without any significant deleterious effect. In view of these various feeding trials, the processing wastes could find some use as cheap substitutes for some ingredients in compounded feeds. However, because of the relatively low crude protein and high crude fibre content, they seem to be more suited for feeding ruminants (1, 2, 4). It has been suggested that breeding or specialized processing methods could be used to reduce the crude fibre content of the waste products and thus improve their feeding value. Furthermore, the processing wastes may be rendered more suitable for animal feeding by ensiling in pit silos. The use of coffee pulp silage as an animal feed has been discussed by Murillo (11). It was established that coffee pulp silage is not nutritionally worse than fresh coffee pulp, and that when coffee-pulp silage has been found wanting, it is probably due to the drying of the silage by sun exposure. The results of various feeding trials led Murillo (11) to conclude that ensiled coffee pulp produces better performance than

Table 2. Chemical composition of the processing wastes.

Component*	Average composition (dry matter %)**				
	Total Ash	Crude Protein (% Nx 6.25)	Crude Fibre	Ether Extract	Nitrogen free Extract
Coffee pulp	5 70	15.00	23.8	3.75	42.71
Coffee parchment	1 74	10 05	24.69	0.48	51.78
Kola pod husk	5 97	6.25	12 24	0 95	68 01
Kola nut testa	7.63	10 31	10 20	0 87	62 47
Cashew-apple pulp (red)	2.45	9 69	13.25	4.65	59 35
Cashew-apple pulp (yellow)	4.70	8.44	11 90	6 35	56.96
Cocoa-bean testa***	7.77	13 13	14 84	2 28	53 56
Cocoa pod husk	10.97	5 63	28 2	3 54	39.82

* The varieties analyzed were those indicated in Table 1

** Each value represents the mean of six determinations

*** Not a field processing waste (see text)

dehydrated pulp, due possibly to its better palatability, better digestibility, and lower content of caffeine and tannins. The ensiling process involves simple technology and can be effectively used by both farmers and processors. This means that these processing by-products could be stored during the harvesting season and used later as fresh or dehydrated silage.

Some compounds such as tannins, caffeine, theobromine and other polyphenols present in these processing wastes could adversely affect the voluntary feed intake, digestion and metabolism of the animals. Furthermore, the different pesticides applied during the development of the fruits may also have similar adverse effects on perfomance of the animals. The effects of caffeine and tannins, as well as their interaction on farm animals fed with coffee pulp have been reported by Bressani (5) and shown to decrease palatability, reduce digestibility of coffee pulp protein and increase urine output. Chlorogenic acid has also been shown to cause increased motor activity in ruminants and rats with the ultimate effect of decreasing weight gain and feed conversion efficiency. It has been reported however, that the distribution of these polyphenols in the fruit varies and there are more in the beans, nuts and testa than in the husks or pulps (8, 9, 16). The possible effects of these polyphenols and pesticides should be taken into consideration in the use of these processing wastes as animal feed. Murillo (11) has reported that, tannis and caffeine decreased significantly during ensiling in pit silos. Both compounds are water soluble hence, they could be lost in the draining liquid. Thus, ensiling could prove to be of some benefit in reducing the adverse effects of these polyphenols on animals fed with the processing wastes.

Table 3 shows the elemental composition of the different field and industrial processing wastes.

Coffee pulp contained the lowest amount of potassium being 1.2 g/100 g of dry sample while kola pod husk contained the highest (5.1 g/100 g of dry sample). Ankrah (3) has discussed the use of cocoa pod husk as an ingredient in traditional soap making in Ghana. This is due to the high potassium content of other processing wastes reported in this paper suggests that they could be similarly utilised for soap making.

The ashes of the processing wastes were poor sources of manganese, copper and zinc but rich in calcium, phosphorus, sodium, iron and magnesium.

It should be expected, however, that the compositional values reported in this paper will change according to variety of crop, location, season and agricultural practices. The organic matter of these waste products contains high amounts of nitrogen and potassium (Table 3).

Since the organic matter content of tropical soils is rapidly depleted because of high year-round bacteriological activity, the possible use of these processing wastes as organic fertilizer could be an invaluable gain to Nigerian farming.

Greenwood-Barton (8) had earlier suggested the use of cocoa pod husk as fertilizer in cocoa planta-

Table 3. Elemental composition of the processing wastes.

Component*	Average Composition (mg/100 g of dry sample)**									
	Nitrogen	Na^+	K^+	Ca	P	Fe	Mg	Mn	Cu	Zn
Coffee pulp	2.4	98.0	1.2	286.0	120.0	18.0	65.0	0.0	2.8	3.4
Coffee parchment	1.5	86.0	1.3	172.0	72.0	7.0	39.4	0.0	12.0	13.5
Kola pod husk	1.0	58.3	5.1	500.0	170.0	14.0	21.6	4.0	0.0	3.2
Kola-nut testa	1.7	29.2	4.7	650.0	180.0	38.0	23.6	4.0	3.2	7.0
Cashew-apple pulp (red)	1.6	858.0	2.7	412.8	160.0	16.4	568.0	1.3	3.7	5.1
Cashew-apple pulp (yellow)	1.4	741.3	2.5	362.7	158.0	14.7	567.2	1.5	3.3	3.3
Cocoa-bean testa***	2.1	47.1	4.4	600.0	320.0	10.0	16.8	8.0	0.0	2.4
Cocoa pod husk	0.9	131.7	4.8	164.0	90.0	4.0	5.6	2.0	3.0	3.4

* The varieties analysed were those indicated in Table 1.

** All values were expressed as mg/100 g of dry sample except values for nitrogen and potassium which were expressed as g/100 g of dry sample.

*** Not a field processing waste (see text). Each value represents the mean of six determinations.

tions, but feared that it might serve as a reservoir for the fungus *P. palmivora* the causal agent of black pod disease of cocoa. However, Egunjobi (6) has shown, that the use of cocoa pod husk as soil amendment resulted in an increase of 122% in maize yield, 59% reduction in soil population of the nematode, *Pratylenchus brachyurus* and tolerance by maize to other diseases like leaf streak. The increase in growth and yield of maize, as well as, reduction in soil population of *Pratylenchus brachyurus* were directly correlated with the levels of cocoa pod husk amendment. The effects of cocoa pod husk in the soil persisted beyond the first maize cropping and probably beyond the second one. The results of Egunjobi (6) suggest that besides controlling certain nematodes and improving nutrient status of the soils, cocoa pod husk probably aslo improves the soil structure.

The value of cocoa pod husk as an organic fertilizer for maize has been further established recently by Oladokun and Olukotun (personal communication) who obtained bumper harvest after application of dried and powdered cocoa pod husk to maize plots. Suárez de Castro (14) has indicated that 45 kg of dried coffee pulp is equivalent, on the basis of its chemical composition, to 4.5 kg of an inorganic fertilizer 14-3-37 or to 9 kg of 7-1.5-18.5. This reflects the high potassium content of coffee pulp. Various other experiments have indicated that coffee pulp is a valuable organic fertilizer particularly for the coffee tree. The present work has similarly shown that, on the basis of the elemental composition of these processing wastes, they may be useful as organic fertilizers. This is particularly important in the case of cocoa bean testa and kola nut testa in which high amounts of theobromine and caffeine respectively may drastically limit their use as animal feed. Handling could be a problem in the use of some of these waste products as fertilizer because of the high moisture content. In cases where transportation costs permit, the fresh material could be applied directly to the soil. Alternatively, they may be dried and milled before application.

Ogutuga (14) has indicated that kola pod husk and also kola nut testa contain high amount of pectin which can be extracted and used in jam and jelly production. The preparation of pectin and jam from cocoa pod husk has also been reported (15). Furthermore, Awolumate (CRIN Annual Report, 1981) has studied the chemical composition of a greyish-brown mucilage extracted from cocoa pod husk. The characteristic sugar composition of the mucilage suggests a strong similarity to pectin, and consequently, may provide an alternative source of industrial raw materials for the production of jams, jellies, and similar types of foods. Bressani (5) has also reported that coffee-berry mucilage is very rich in pectic substances, which could yield pectins. However, recovery is made difficult by the large volumes of water involved in pulping and washing operations and recycling or use of coffee pulp as the raw material was therefore suggested. It seems therefore, that the possibilities of obtaining pectin from these sources are promising.

In another study, Awolumate (unpublished data) has successfully extracted a colouring matter from the outer pericarp of fresh cocoa pod husk. Although the major anthocyanin pigments and flavonoids have not been identified, the compound is readily soluble in water/acetone to form a golden yellow solution. Furthermore, Ogutuga (14) has also obtained a reddish extract from red kola nuts. It was observed that the colour became deeper when the compound was extracted with 1% HCl in methanol. Both coffee pulp (5) and cashew apple skin (7) are known to contain a considerable amount of polyphenols. Since most food colours currently being used in the country are imported, further investigation into the colouring matters of these field and industrial processing wastes appears economically justifiable.

This paper has .shown the relative richness of coffee, kola cashew and cocoa processing wastes in both crude protein, nitrogen-free-extract, major cations and trace elements. Therefore, these materials may have useful industrial applications. However, because of the relatively high price paid for beans and nuts, there has been little interest in the industrial utilization of these field and industrial processing wastes. The present studies have further indicated possibilities that these processing wastes could be used as a relatively cheap source of organic fertilizer, animal feed or as raw materials for the isolation of specific substances.

Abstract

The proximate composition of crude protein, crude fibre, ash, sodium, potassium, phosphorus and other trace elements of coffee pulp and parchment, kola pod husk, kola nut testa, cashew-apple pulp, cocoa-bean testa and cocoa pod husk are reported. The samples are high in moisture and crude fibre hence they may be of limited use for direct animal feeding but ensiling could improve their feeding value. The ashes are poor sources of Mn, Cu, and Zn but rich in Ca, N, K, Na, P, Fe and Mg. Therefore, they could be useful in the local soap industry or as sources of organic fertilizer. Possible uses as raw materials for the production of pectin, jam and food colours are suggested.

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CONTROL DE LA MANCHA AZUL EN MADERA DE *Pinus caribaea* var. *hondurensis* BARR. ET GOLF. EN TURRIALBA–COSTA RICA[1] */

N. REYNA R. **

Summary

This paper was designed to study the control of blue stain in Pinus caribaea *var.* hondurensis *at Turrialba, Costa Rica.*

The mixture of pentaclorophenol and diesel was not effective to avoid neither control blue stain in logs stacked 45 to 90 days in the woods.

Sodium pentaclorophenate was proved effective to prevent and control blue stain in sawn lumber during an observation period of 52 days. This lumber reached the saturation point of the fiber in 38 days of air drying under a roof.

Introducción

El *Pinus caribaea* var. *hondurensis* crece en forma natural en Belice, Guatemala, Honduras, El Salvador y Nicaragua, entre 27°15' y 12°13' de latitud Norte (6). Esta especie forestal ha sido difundida ampliamente en países como Australia, Indonesia, Malasia, Africa del Sur, Brasil, Venezuela, México y otros, en donde ha mostrado un crecimiento rápido (6).

Debido al crecimiento acelerado en plantaciones, la producción maderera se ha destinado preferentemente para la fabricación de pulpa y papel. Sin embargo por causas del aumento constante en los precios de la madera aserrada, se considera probable que la especie mencionada se use más en aserrío, a fin de posibilitar la sustitución gradual de algunas especies tradicionalmente empleadas.

La madera de *P. caribaea* var *hondurensis* es susceptible al daño de la "mancha azul" (deterioro de la madera causado por una o varias especies de hongos que pueden corresponder a varios géneros, entre los cuales el más comùn es *Ceratortomella* spp.), el que ocasiona el deterioro en su apariencia y disminuye la calidad de la madera. El presente trabajo, tiene por objeto el estudio de la prevención y el control de la "mancha azul" en *Pinus caribaea* var. *hondurensis*, de 11 años de edad, en Turrialba, Costa Rica.

Materiales y métodos

El estudio se llevó a cabo en el Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) Turrialba, Costa Rica, que se encuentra ubicado a una altitud de 600 msnm aproximadamente. Las características climáticas son: de 2 674 mm de precipitación anual, de 22.2°C de temperatura media anual y 87.4 por ciento de humedad relativa (2). El área de estudio corresponde a la zona de vida bosque muy húmedo premontano, según el sistema de clasificación de zonas de vida de Holdridge (3).

Para el ensayo, las trozas fueron extraídas de una plantación de *Pinus caribaea* var. *hondurensis*, del sector Florencia Norte, en el CATIE. Se utilizó un total de 52 trozas provenientes de árboles, de la base del

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fuste hasta un diámetro mínimo de 20 cm con corteza. Las dimensiones de cada troza fueron de 1.50 m de largo. En el bosque, a 26 trozas se aplicó el producto pentaclorofenol al cinco por ciento en aceite diesel (PD), usando una brocha. El tratamiento se hizo en ambos extremos de las trozas, en los nudos y, en las áreas accidentalmente descortezadas. Las trozas restantes no fueron preservadas. Después de tres días de la aplicación (Figura 1), 36 trozas, 18 de ambos tratamientos fueron trasladadas al patio del aserradero "Saida" en Turrialba, en donde permanecieron otros tres días, propiciando de esta manera un manejo de trozas bajo condiciones prácticas normales en dicha actividad. Luego, se procedió al aserrío de las trozas obteniendo 302 tablas de 2.5 cm de espesor. Seguidamente, la mitad del número de tabla obtenidas fueron sometidas al preservado en baño por inmersión con pentaclorofenato de sodio al 5% en solución con agua (PCN). La inmersión de cada tabla tuvo una duración 10 segundos aproximadamente. Las tablas restantes no fueron preservadas con PCN. Finalmente, se obtuvieron cuatro tratamientos: a) tablas preservadas con PCN procedente de trozas preservadas con PD, b) tablas preservadas con PCN procedente de trozas testigo, c) tablas testigo procedente de trozas preservadas con PD y, d) tablas sin ningún tratamiento.

A continuación todos los tratamientos fueron sometidos a secado al aire libre y bajo techo, usando el sistema de apilado horizontal. Con este objeto, se usaron separadores de madera de la misma especie, con un espesor de 2.50 cm. Estos separadores fueron previamente preservados con PCN y, debidamente secados al aire libre.

En el apilado horizontal, se armaron cuatro pilas sobre bases de ladrillo de 25 cm de altura. Sobre

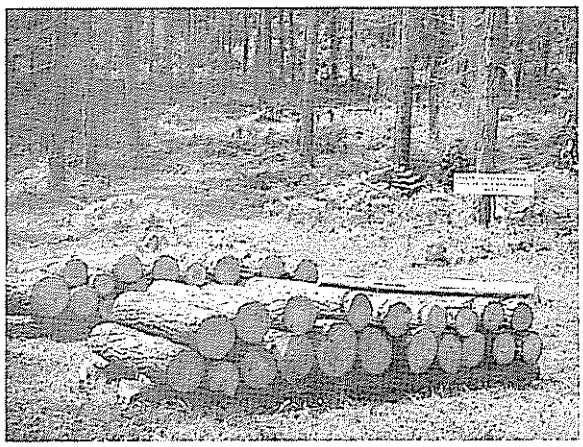

Fig 1. Trozas de *Pinus caribaea* var. *hondurensis*, de 11 años de edad, apiladas en el bosque después de los tratamientos.

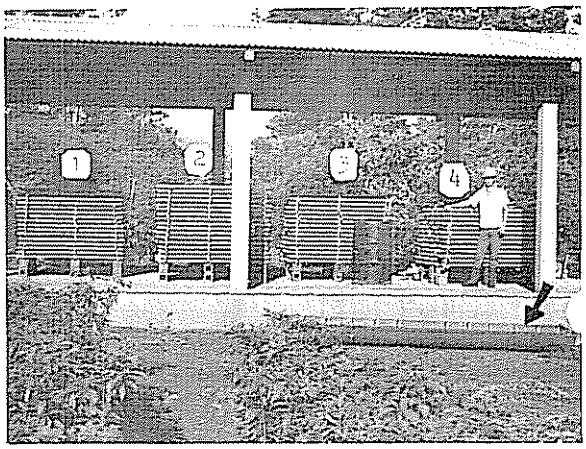

Fig 2. La madera aserrada expuesta a secado al aire libre en 4 pilas por el sistema de apilado horizontal durante un período de 52 días. Se observa además, el cilindro (estañón) para el preparado de la solución y el recipiente indicado con la flecha, para el baño por inmersión.

estas bases se colocaron tres separadores paralelos entre sí y sobre estos separadores, se ubicó cinco tablas por cada piso en sentido transversal hasta completar los cuatro tratamientos por cada pila.

Cada pila estaba representada por los cuatro tratamientos. No hubo selección de tablas al momento del apilado, solamente fueron agrupadas en cantidades similares por cada tratamiento y distribuidas en forma tal, de estar expuestas a las mismas condiciones ambientales (Figura 2).

La evaluación del efecto de la "mancha azul" en las tablas, se efectuó después de 52 días de secado al aire libre. Las diferencias entre los tratamientos A y B con C y D, se calcularon por medio de la prueba de t de Student entre pares de tratamientos. Para obtener las probables diferencias significativas entre los tratamientos C y D se realizó el respectivo análisis de varianza del diseño de bloques completamente randomizado. Todos los tratamientos fueron diseñados con cuatro repeticiones.

Para el caso de las 16 trozas que se dejaron apiladas en el bosque, la evaluación del desarrollo de la "mancha azul" se realizó a los 45 y 90 días. Con dicho objeto, en cada período, ocho trozas se aserraron en tablas de cinco centímetros de espesor.

Con los resultados de la evaluación de la "mancha azúl" en trozas para 45 días, se realizó el análisis de varianza del diseño estadístico de bloques al azar con muestreo con base en el promedio de daño por troza. Para la evaluación de la "mancha azul" en trozas para 90 días, se realizó el análisis de varianza del diseño estadístico arreglo factorial, con base en el promedio del daño de cada terminal por troza.

Para determinar el contenido de humedad de la madera en los diversos estados de árboles, trozas y tablas, se procedió de la manera siguiente.

De los árboles recién tumbados se extrajeron discos de madera de cinco centímetros de grosor a 1.50 m de altura del suelo. Seguidamente estas muestras fueron pesadas y luego secadas al horno a 105°C de temperatura hasta peso constante. El contenido de humedad (%) se calculó con base en el peso seco según la fórmula (peso verde – peso seco)/peso seco x 100.

El contenido de humedad de tablas provenientes de trozas almacenadas en el bosque por 45 y 90 días se obtuvo extrayendo una muestra de 10 cm de ancho por 25 cm de largo.

El contenido de humedad de las tablas previas al tratamiento con y sin pentaclorofenato, se determinó en muestras de 15 cm de ancho por 25 cm de largo, extraídas a 50 cm del extremo terminal de cada tabla. Estas muestras también se secaron al horno, para determinar el peso seco. Las tablas residuales de 0.85 m de largo que quedaron luego de obtener las muestras, fueron colocadas en la parte central baja de cada pila. Estas tablas se usaron para determinar la disminución del contenido de humedad de la pila, a través del período de secado.

Resultados y discusión

Trozas

La aplicación de pentaclorofenol más diesel en trozas no fue efectiva para prevenir ni controlar la "mancha azul", en períodos de 45 y 90 días. Esto, confirma lo mencionado por Pawsey (7, 8), quien atribuye dicho fenómeno a la excesiva secreción resinosa que actúa como eliminador del producto. No se encontró diferencia de susceptibilidad a la "mancha azul" entre terminales de la troza, para períodos de 90 días. Pawsey (7, 8) encontró una mayor susceptibilidad del terminal distal al desarrollo de la "mancha azul", aunque en otro estudio halló resultados similares a los diferentes obtenidos en el presente ensayo.

En trozas de 1.50 m de largo, el daño de la "mancha azul" en promedio fue de 3.4 mm/día de avance para 45 días y 2.5 mm/día para 90 días. En porcentaje fue de 20 y 30 por ciento para cada período, respectivamente. Pawsey (7) informa incidencias de daños del 20 por ciento pero, para un período de 110 días en trozas de 2.10 m de largo. Las diferencias encontradas se pueden atribuir preferentemente, a los diferentes métodos de evaluación utilizados en los ensayos.

El contenido promedio de humedad de los árboles tumbados fue de 166.9 por ciento; la humedad de las trozas para el período de 45 días fue de 194.2 por ciento de 139 por ciento para aquellas de 90 días. Estos resultados se atribuyen en especial, al origen de muestras procedentes de trozas de diferentes posiciones del árbol, tanto en altura como en sentido transversal. Según Koch (5) el contenido de humedad en el árbol aumenta en dirección longitudinal de la base al ápice y, transversalmente de la periferia hacia el centro de la madera.

Madera aserrada

El pentaclorofenato de sodio aplicado en baño por inmersión en madera aserrada, fue efectivo en la prevención y el control de la "mancha azul". En cambio, las maderas que no habían recibido el preservado, presentaron el daño de "mancha azul" en forma casi total.

En Inglaterra, Finlandia, Estados Unidos y Chile, se han obtenido resultados similares pero, a una concentración menor del producto (1, 4, 9). La mayor dosificación en el presente ensayo se estableció considerando las condiciones climáticas tropicales (Figura 3). Sin embargo, la dosis relativamente elevada no incidió mayormente en la economía. El costo del producto en la aplicación fue de ₡ 0.05 (US$ 1.00 = ₡ 8.54 en diciembre 1981) por pie tablar de madera aserrada y, sin tomar en cuenta la posibilidad de usar la solución varias veces.

La "mancha azul" se detectó en tablas aproximadamente después de 12 días de apilado y su apariencia en intensidad fue gradual, hasta los 25 días. Se observó además, que la "mancha azul" en la madera no progresó cuando el contenido de humedad descendió a menos de 40 por ciento aproximadamente.

La pérdida del contenido de humedad en la madera apilada fue acelerada en los primeros 25 días para luego reducirse cada vez más, hasta su estabilización. En general, las maderas habían alcanzado el punto de saturación de la fibra en el período de 38 días después de apilados (Figura 4).

En el proceso de aserrío, algunas maderas detectaban prematuramente el daño de la "mancha azul" y se comprobó que la misma, estuvo relacionada con la presencia de nudos en la madera. Se estima que esta infestación se origina en el árbol en pie y en estado de trozas. Las ramas al secarse, quebrarse, o cuando ocurren en forma simultánea, se contraen y se agrietan en tal forma que ofrecen condiciones apropiadas para el ingreso y desarrollo de hongos, provocando el daño en la madera. Como forma de prevenir estos

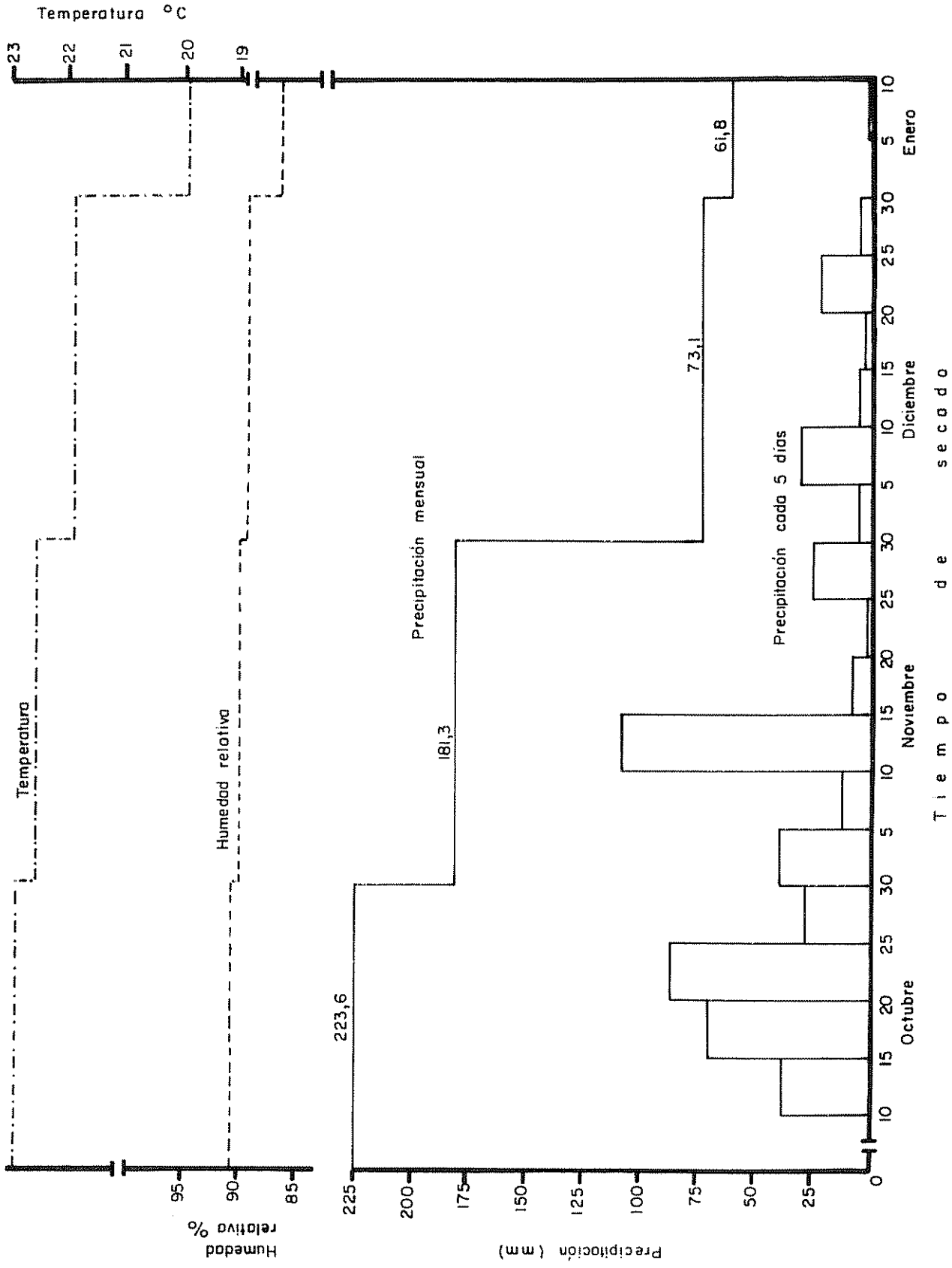

Fig. 3. Datos registrados en la estación meteorológica del CATIE durante el ensayo sobre prevención y control de la "mancha azul" en *Pinus caribaea* var *hondurensis*.

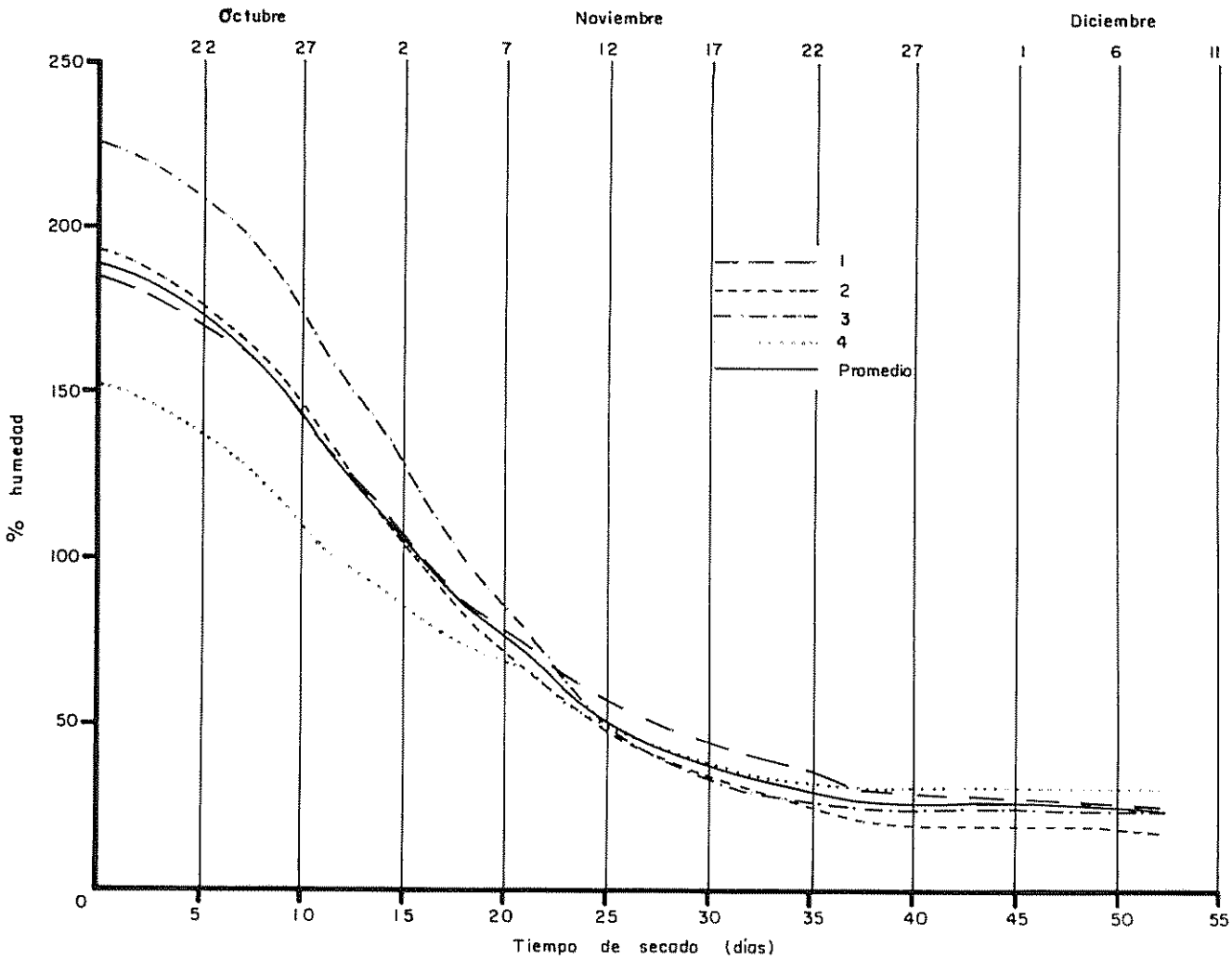

Fig 4. Contenido de humedad de las maderas aserradas (pilas 1, 2, 3, 4) secadas al aire libre bajo techo, mediante el sistema de apilado horizontal, para un período de 52 días *Pinus caribaea* var. *hondurensis*, Turrialba – Costa Rica.

daños prematuros, conviene efectuar en el árbol, prácticas de podas de ramas delgadas de la parte media e inferior del fuste.

Conclusiones

La aplicación de pentaclorofenol al cinco por ciento en aceite diesel, no tuvo efecto positivo para controlar la "mancha azul" en trozas de *Pinus caribaea* var. *hondurensis*, para períodos de 45 y 90 días de apilado en el bosque.

El avance de la "mancha azul" en trozas con o sin tratamiento previo fue de 3.4 mm/día y de 2.5 mm/día para períodos de 45 y 90 días, respectivamente.

El tratamiento por inmersión de pentaclorofenato de sodio al cinco por ciento en solución con agua, fue efectivo para prevenir y controlar la "mancha azul" en madera aserrada. En cambio, las maderas sin preservado fueron afectados por el daño en casi el 100 por ciento.

La acción y progresión de la "mancha azul", estuvo relacionada en forma directa a un contenido de humedad en la madera entre el 40 y 140 por ciento aproximadamente.

El punto de saturación de la fibra de las maderas aserradas que fueron secadas al aire libre bajo techo, se alcanzó en un lapso estimado de 38 días

Resumen

El presente trabajo, tuvo por objeto el estudio de la "mancha azul" en madera de *Pinus caribaea* var

hondurensis, de 11 años de edad, en Turrialba – Costa Rica.

Se obtuvo que el pentaclorofenol más diesel no fue efectivo para prevenir ni controlar la "mancha azul" de la madera en trozas, para periodos de 45 y 90 días de apilado en el bosque.

En cambio, el pentaclorofenato de sodio tuvo acción efectiva en la prevención y el control de la "mancha azul" en madera aserrada. Estas maderas alcanzaron el punto de saturación de la fibra a los 38 días de secados al aire libre y bajo techo.

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ALFALFA YIELD ON AN ANDOSOL IN SOUTHERN CHILE: EFFECTS OF TIMING AND RATE OF LIMING AND LIME-PELLETING OF SEED[1] */

*W. M. MURPHY***
*O. ROMERO Y.***
*L. E. BARBER***

Resumen

Problemas edáficos afectan la nodulación y el establecimiento de la alfalfa forrajera, de manera que sólo 2 500 ha de 2 7 millones de tierra cultivable en seis provincias del sur de Chile se siembran con este cultivo. Los suelos alofánicos Tremao (Andosol) podrían ser excelentes para el crecimiento de la alfalfa, excepto por su alto contenido en óxidos hidratados de hierro y aluminio y el alto contenido de aluminio libre. La fertilización con fósforo y el encalado no han dado resultados económicos. Este ensayo se efectuó para determinar si el recubrimiento de la semilla con cal o el enalamiento antes de la siembra mejoran la producción de alfalfa en un suelo alofánico.

Los rendimientos de forraje del tratamiento de recubrir la semilla con cal fueron iguales a las obtenidas con la aplicación de 2, 4, 6 y 8 t/cal/ha cuatro meses antes de la siembra. Los resultados indican que la alfalfa puede crecer bien en suelos alofánicos usando semilla recubierta con cal.

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We wish to express our sincere appreciation to those who made this study possible, in particular to the administrators, researchers, and support personnel of the Instituto Nacional de Investigaciones Agropecuarias, especially at the Carillanca Experiment Station; to J. Burton and the Nitragin Company; and J. R. Davis and M. J. Johnson of Oregon State University; A. M. Smith and S. C. Wiggans of the University of Vermont; and L. R. Frederick of USAID for facilitating the research effort.
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Introduction

Use of alfalfa (*Medicago sativa* L.) for forage is limited to only 2 500 of the 2.7 million hectares of arable land in six provinces of southern Chile because of soil problems (6). Consequently, livestock production is below potential.

The major soil groups in southern Chile are Red Clays and Trumaos, both Andosols. Red Clays are older, highly weathered, and usually fertile, but have poor physical properties because of their density and extreme expansion-contraction characteristics. Trumaos, in contrast, have problems characteristic of soils derived from volcanic ash (8). They are younger and composed of allophanes having good physical properties; however, they contain large amounts of iron and aluminum (Al) hydrous oxides and free Al, which result in a considerable ability to fix anions (nitrates, phosphates, sulfates) and in toxic effects on plants and soil bacteria. They are capable of fixing 17 400 to 19 400 kg P_2O_5/ha. The pH of cultivated Trumaos varies between 5.0 and 6.0 (1, 2, 9).

Several studies have been done in Chile to determine if liming and phosphorus (P) fertilization would improve nodulation and yield of legumes grown on Trumaos (4, 10). Although P fertilization reduced Al toxicity to forage legumes and increased the amount of available P in soils, yield increases were not great enough to offset costs of required fertilizer (7, 14). In one study with alfalfa, red clover (*Trifolium pratense* L.), subterranean clover (*Trifolium subterraneum* L.), and birdsfoot trefoil (*Lotus corniculatus* L.), 1 000 kg P_2O_5/ha were needed to obtain significant yield responses, which continued to increase up to maximum applications of 10 000 kg P_2O_5/ha (5). Liming also increased legume yield somewhat, but economic analyses of trials showed that liming resulted in net losses for all rates applied (13).

One common aspect of these studies was that lime was applied only 1 to 2 weeks before seeding legumes. However, because lime reacts slowly in soils, it should be applied several months before seeding. This research was done to study the effects of liming at different rates and times, and of using lime-pelleted seed on yield of alfalfa grown on an Andosol.

Materials and methods

Rates of 2, 4, 6, and 8 tons lime/ha were rototilled into a Trumao-Red Clay transition soil on 9 January 1978 at the Carillanca Experiment Station, near Temuco (a strictly Trumao soil was unavailable on the Station). Just before seeding on 15 April 1978, treatments of 0.5 and 1 ton lime/ha were applied to previously unlimed plots and rototilled into the soil; the 0.5 ton lime/ha was applied to plots that would receive the lime-pelleted seed treatment. All plots were fertilized with 16 kg N/ha, 125 kg P_2O_5/ha, 50 kg K/ha, and 20 kg Borax/ha before seeding. A preemergence herbicide, Plenavin, was applied before seeding at 1.5 kg a.i./ha. All plots, including the 0-lime treatment, were rototilled twice.

Plots were 2 x 6 m, arranged in a randomized complete block design replicated three times. Nitragin peat inoculant, containing the Balsac strain of *Rhizobium meliloti*, was used to inoculate seed of Alta Franconia alfalfa. Seeding rate was 15 kg/ha. A 4 m^2 (5 x 0.8 m) sample was taken from the middle of each plot to measure yield.

Seeds were pelleted by the following steps:

1. Dissolve 0.45 g Tilose (methyl cellulose) in 7.2 ml of hot water.
2. Add 3.6 ml cold water; mix.
3. Stir in 3.1 g peat inoculant.
4. Mix in 54 g of seed.
5. Add 26.6 g $CaCO_3$; mix.
6. Add 7.2 g more $CaCO_3$ to completely coat and dry pellets.

The soil was analyzed by standard methods (4) in the Soil Testing Laboratory of the Carillanca Experiment Station. Soil pH was determined on 1:2.5, soil: water suspensions. Aluminum was extracted with ammonium acetate (pH 4.8).

Results and discussion

Table 1 presents the results of annual analyses for soil pH and extractable Al for each treatment plot. The December 1978 analysis shows that soil pH rose only slightly on the plots that had received 6 or 8 tons lime/ha, 11 months before the soils were sampled for analysis. Soil pH of plots receiving 2 or 4 tons lime/ha had not changed. Compared to the 0-lime at planting in April, extractable Al decreased on plots that were limed in January.

Results of the December 1979 soil analyses were very disconcerting. Although extractable Al had decreased in expected amounts, soil pH had also decreased 0.3 – 0.4 units on all treatments during the year.

The uniform decreases in soil pH across all treatments may simply have been caused by variation in the water method used to determine Ph. Or it may have resulted from acidity produced by nitrogen (N) fixation of the alfalfa. The N fixation from an alfalfa yield of 10 t/ha may produce acidity in the soil equivalent to 600 kg $CaCO_3$/ha (12). Andosols in southern Chile likely are poorly buffered against a drop in soil pH, but well buffered against an increase in soil pH. The buffering against a rise in soil pH was well illustrated by the lack of response to the high rates of lime applied in this experiment.

The decreases in extractable Al on all treatments observed in December 1979 probably occurred for two reasons. First, rototilling aerated the soil, resulting in organic matter decomposition. Small molecular-weight, Al-organic matter complexes released by decomposition could have been leached from the surface horizon. This could explain the decrease on the 0-lime treatment. Similar amounts of Al-organic matter complexes probably were leached from the other treatments. Second, the additional decrease in

Table 1. Effects of liming rate, time of liming before seeding, and lime pelleting of seed on pH and aluminum (Al) levels of soil in alfalfa field plots at the Carillanca Experiment Station, Temuco, Chile.

	Sample date			
	December 1978		December 1979	
Treatment	pH	Al	pH	Al
0 lime	5.4	598	5.1	522
1 t lime/ha at seedling[1]	5.5	602	5.2	448
Lime–pelleted seed + 0.5 t lime/ha at seeding	5.5	606	5.2	462
2 t lime/ha[2]	5.4	580	5.0	352
4 t lime/ha	5.4	558	5.0	378
6 t lime/ha	5.8	527	5.4	347
8 t lime/ha	5.7	531	5.4	338

1 Seeded 15 April 1978.

2 Liming rates of 2, 4, 6, and 8 t/ha were applied on 9 January 1978.

Table 2. Effects of liming rate, time of liming before seeding, and lime pelleting of seed on dry forage (DF) yields of Alta Franconia alfalfa grown in field plots at the Carillanca Experiment Station, Temuco, Chile. Seeded 15 April 1978.

	Sample date						
Treatment	19/12/78	1/2/79	5/4/79	11/12/79	18/1/80	24/3/80	Total
	DF, kg/ha						
0 lime	486	942	680	3 944	2 030	1 937	10 019 c[2]
1 t lime/ha at seeding	171	886	940	4 335	2 968	2 234	11 534 c
Lime-pelleted seed + 0.5 t lime/ha at seeding	1 085	2 280	1 356	4 572	4 289	2 926	16 568 ab
2 t lime/ha[1]	269	1 420	1 325	4 372	3 372	2 682	13 440 bc
4 t lime/ha	1 061	1 653	1 352	4 452	3 684	3 037	15 239 ab
6 t lime/ha	463	2 230	1 696	4 700	4 178	3 330	16 597 ab
8 t lime/ha	497	1 999	2 075	4 213	4 774	3 401	16 959 ab

1 2, 4, 6, and 8 t lime/ha were applied 9 January 1978.

2 Means within the total yield column not followed by the same letter are significantly different at the 5 percent level by Duncan's New Multiple Range Test.

extractable Al on the limed treatments could be accounted for by the amounts of Al displaced from exchange sites by calcium in the lime and leached from the surface horizon.

Table 2 shows that total forage yield of alfalfa grown from lime-pelleted seed, plus 0.5 ton lime/ha at seeding, equalled those of alfalfa grown on soil receiving 2, 4, 6, or 8 ton lime/ha 4 months before seeding. Although the soil pH was much lower than what usually is thought adequate for alfalfa growth, the alfalfa grew well under these treatments. Unlimed plots or those that received 1 ton lime/ha at seeding, however, had sparse, weedy stands of alfalfa.

Positive effects of the lime pelleting treatment were consistent throughout the experiment. Nodulation of plants observed 15 November 1978 and 17 January 1979 (not shown) indicated that seed pelleted with lime resulted in more effective nodulation during the establishment year than did lime applied to the soil. These results agreed with Norris' (11) conclusions in Australia that small amounts of lime near seedlings may achieve the same results as heavy applications of lime on some soils.

Summary

Soil problems affecting alfalfa nodulation and establishment limit alfalfa's use for forage production to only 2 500 of the 2 7 million hectares of arable land in six provinces of southern Chile. Trumao (Andosol) allophane soils would be excellent for growing alfalfa except for the large amounts of iron and aluminum (Al) hydrous oxides and free Al that they contain. Fertilizing with phosphorus and liming have not given economical results. This research was done to determine if lime pelleting seed or liming well before seeding would enable alfalfa to be produced on an allophane soil. Forage yields from the lime-pelleted seed treatment equalled those from plots receiving 2, 4, 6, or 8 tons lime/ha, 4 months before seeding. The results indicate that alfalfa can grow well on an allophane soil by using lime-pelleted seed.

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Notas y comentarios

Premio Nobel de Economía de 1983

El ganador este año del Premio Nobel de Economía, el Profesor Gerard Debreu, de la Universidad de California, difiere de tales ganadores anteriores como los profesores Milton Friedman y James Tobin. Ellos debaten vigorosamente la política económica. Debreu ha permanecido fiel a la teoría pura, dedicado a explorar las propiedades lógicas de los modelos económicos abstractos.

Su preeminente trabajo, "Teoría del valor: un análisis axiomático del equilibrio económico", fue publicado hace ya más de un cuarto de siglo. Con sólo 102 páginas, es una de las más cortas y grandes obras sobre economía . . y una de las de más difícil lectura.

Antes de "Teoría del Valor", una de las presunciones más vitales de la teoría económica tenía que aceptarse con fe: que un mercado en el que los bienes son cambiados entre productores y consumidores se consolida en un estado de equilibrio estable de precios y cantidades; en una palabra, que la oferta y demanda funcionan. Observaciones superficiales sugerían que así era. Pero antes del trabajo de Debreu (y de Kenneth Darrow y Frank Hahn), este resultado no podía deducirse de la teoría económica.

¿Importa mucho que no pudiese ser deducido? Para los hombres prácticos, probablemente no. El exceso de matemáticas, que domina actualmente las principales revistas académicas de economía, ha sido criticado por varios prominentes economistas. Wassily Leontief (Nobel 1973), en una carta a **Science**, a mediados de 1982, habla de la enfermedad matemática que ha atrofiado a muchos economistas académicos "Página tras página de las revistas académicas de economía están llenas de fórmulas matemáticas que conducen al lector, desde un conjunto de suposiciones más o menos plausibles pero enteramente arbitrarias, hasta conclusiones presentadas con precisión pero no pertinentes". Leontief clasificó los artículos publicados por **American Economic Review** en la década pasada y comprobó, entre otras cosas, que en 1977-81, el 54 por ciento de los trabajos publicados trataban de modelos matemáticos sin ningún dato real. En este tipo de trabajo, como lo expone bien Leontief, las suposiciones determinan los resultados. Los artículos de este tipo predominante son producidos por economistas académicos con la mirada puesta en su promoción y posición social (**status**) y no nos dicen nada sobre los economistas en servicios públicos y en empresas privadas.

Los personeros del premio Nobel dicen que los modelos de predicción económica usados por organismos como el Banco Mundial están basados en el trabajo de Debreu. Esto, según **The Economist** (22-X-83, p. 77), es un poco traído de los cabellos. Los modelos de equilibrio que usa el Banco Mundial están basados en técnicas desarrolladas por León Walras en el siglo pasado. Sus pronosticadores no necesitaron pruebas de existencia y estabilidad para aplicarlos. La revolución Keynesiana antecedió a "Teoría del Valor", y las teorías clásicas que están ahora de moda son todavía más antiguas.

El gran logro de Debreu fue de desarrollar un conjunto de condiciones bajo las cuales podría existir un mercado perfecto. La falla está en que estas condiciones no se encuentran en la realidad. Todavía no se ha derivado un conjunto razonablemente realista. Como manifiesta en su carta mencionada, Leontief trabaja ahora más con ingenieros, sicólogos y otros científicos que con economistas, "porque ellos saben cómo funciona el mundo real". Mientras tanto, en el mundo real, el monetarismo sigue marchando.

Quizás el premio a Debreu estimule más trabajos en este campo. La investigación pura puede dar resultados inesperados mucho tiempo después de realizada. La teoría económica no describe la realidad. Su propósito es iluminar la realidad y esto involucra abstraerse de los detalles de casos particulares para intentar establecer principios básicos. El razonamiento matemático es más preciso y significativo que el razonamiento verbal, particularmente cuando hay preocupación sobre cuáles suposiciones de la realidad son necesarias y cuáles son suficientes. Adalberto Gorbitz

Reseña de libros

VAN DEN BOSCH, R., MESSENGER, P. S. y GUTIERREZ, A. P. An introduction to biological control. Nueva York, Plenum Press. 1982. 247 p.

Aunque Gutiérrez propone incluir los hallazgos de investigaciones posteriores a 1973, en el texto que apareció por primera vez en dicho año y cuyos autores, los fallecidos Drs van den Bosch y Messenger, se habían escritos, con la adición de secciones de control microbial, la dinámica de poblaciones, el manejo integrado de plagas, y la economía, no resulta más que una reseña de proyectos clásicos del control biológico, mayormente con ejemplos de California.

El libro trata de la naturaleza, las bases ecológicas, y la historia del control biológico; los enemigos naturales; el control microbial; los procedimientos; análisis de tablas de vida; factores que restrinjan el éxito del control biológico; control biológico natural y control integrado; análisis del control biológico clásico; otros tipos de plagas y métodos de control; economía; y el futuro. El texto contiene un índice, y una lista útil de las especies citadas en el texto. El glosario es el mismo de la edición de 1973, a pesar de que el texto incluye material nuevo.

Con la excepción de los capítulos nuevos, el libro es prácticamente el mismo que salió en 1973. Por ejemplo, una tabla que compara el control integrado y el control tradicional de las plagas del algodón no indica ningún cambio desde 1973, así como otra tabla de los éxitos de control biológico clásico que no registra ningún ejemplo posterior a 1973.

En el capítulo sobre el control biológico natural, la discusión acerca del control integrado no cabe, al igual que una descripción de tres páginas sobre la optimización económica. El capítulo sobre el análisis de las tablas de vida no da explicación suficiente sobre los factores claves, las acciones dependientes de densidad, y los modelos de poblaciones. Tampoco incluye citaciones a la literatura explícita que pueda orientar un alumno. Las fotografías son, generalmente, de una calidad inferior, y a menudo es imposible observar lo señalado en la capción. Algunas figuras tampoco demuestran lo que los autores sugieren.

Aunque el libro tiene como propósito proveer los elementos básicos del control biológico de las plagas a estudiantes post-secundarios de agronomía, manejo de plagas y entomología, el libro es demasiado elemental para usar como un texto a tal nivel. Otros textos, por ejemplo **Theory and practice of biological control** por Huffaker y Messenger, son superiores al lograr este propósito. Por lo general, las secciones nuevas carecen de la claridad de la edición anterior. El libro puede servir como lectura suplementaria, o más bien, para informar personas ajenas del campo del control de las plagas, pero su utilidad a profesionales y estudiantes en el campo de control biológico es muy limitado.

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JOHRI, B. M. Experimental embriology of vascular plants. Springer Verlag. New York. 1982. 685 p.

Tal y como lo especifica el prefacio el libro tiene un nivel adecuado para estudiantes graduados. Se nota en muchos de los capítulos una influencia muy marcada de la escuela hindú que se iniciara con Maheshwari.

Hay omisión de experiencias importantes realizadas en Europa y en los Estados Unidos y Canadá.

El hecho de que cada autor desarrolló libremente un tema, tiene como resultado el que haya duplicaciones en el texto e incluso contradicciones respecto a determinados puntos de vista.

No comparto algunos de los puntos de vista expuestos en determinados capítulos, aunque comprendo que los autores simplemente transcribieron lo obtenido de distintas referencias. En general es un texto introductorio que puede utilizarse acompañado de lecturas complementarias en un curso de nivel graduado.

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SEED AND SEEDLING ECOLOGY OF *Carapa guianensis*[1] /

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Resumen

Carapa guianensis *(Meliaceae) es una especie arbórea sub-dominante del bosque superhúmedo maduro del noreste de Costa Rica. Los árboles florecen en setiembre y producen frutos maduros el siguiente mes de mayo. La nizaciòn fenológica de la población produce marcadas diferencias anuales en la producciòn de semillas.*

La semilla producida por árboles individuales varió desde 754 hasta 3 944 semillas, con un peso seco promedio de 15.6 g. La mejor germinación se obtuvo cuando la semilla estuvo en contacto directo con suelo húmedo. En suelos drenados, las semillas hundidas hasta la mitad o sobre la superficie germinaron mejor. En suelos mal drenados (suampos), las semillas sobre la superficie o enterradas hasta la mitad presentaron un 90 por ciento de germinación. Las semillas completamente enterradas en suelos mal drenados y las colocadas sobre la superficie de suelos bien drenados no germinaron.

Los frutos caen debajo de la copa del árbol y de ahí del 54 al 98 por ciento de las semillas son transportadas a otros sitios. Es probablemente un factor importante en la dispersión de las semillas y en germinación. Las larvas de Hypsipyla ferrealis *se alimentaron de las semillas de* C. guianensis. *La remoción experimental de diferentes proporciones de endosperma de las semillas, simulando el daño causado por los insectos a los roedores, causó una reducción del número de plántulas y un aumento en la mortalidad*

Se postula que una ventaja de las semillas grandes en especies del mango tropical es la producción de un talluelo largo, lo que le permite colocar sus hojas sobre las aguas caídas en forma estacional durante todo el año.

Introduction

Carapa guianensis Aubl. (Meliaceae) is an important timber tree in the lowland wet Neotropics from Belize to Amazonian Brazil and in the Antilles (18). It is predominantly a species of swampy or periodically inundated land, occasionally forming nearly pure stands (4, 6, 12, 14, 15). As part of a demographic study of a *C. guianensis* population in Costa Rica, the authors have gathered information on its seed and seedling ecology.

This study was conducted during July – September 1974 and 1975, and in August 1976 at La Selva, the Organization for Tropical Studies' field station in northeastern Costa Rica, near Puerto Viejo de Sarapiqui, Heredia Province. The vegetation is premontane wet forest, warm transition in the Holdridge life zone system (11). Elevation ranges from 35 m above sea level along the Rio Puerto Viejo to 150 m above sea level about 3 km from the river. Mean annual temperature and rainfall are 24.1°C and 3 930 mm, respectively, without an effective dry season (9)

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In the undisturbed primary forest at La Selva, *C. guianensis* is a canopy tree which attains 2 m in diameter and 45 m in height. It is a sub-dominant of the 2 ha swamp forest in Study Area II, but also occurs in much lower densities on the higher and better drained slopes and ridges (Table 1). The occurrence of swamp species on better drained sites at La Selva is probably related to the very high rainfall throughout the year (9). The swamp soils in Study Area II are poorly drained old alluvium with high organic matter and nutrient levels (3). The Study Area II swamp has a microrelief of less than one meter consisting of interspersed hammocks and sloughs.

Fecundity

Carapa guianensis at La Selva flowers in September and produces mature fruit the following May (7). The annual production of seeds is variable; in some years (e.g., 1973, 1975) very few members of the population produced seeds, whereas in other years (e.g., 1971, 1974, 1976) virtually all mature trees bore heavy fruit crops. The fruit of *C. guianensis* is a four-valved dehiscent capsule 10 – 14 cm in diameter that falls from the tree when ripe, breaking into four segments and liberating the seeds. Impressions in the valve wall indicate the number of seeds contained in that segment. Based on a sample of 2 948 valves on the ground beneath four reproductive trees, the mean number of seeds/valve was 1.67 ± 0.06 (one S.D.) or 6 – 7 seeds/fruit. This compares well with Smith's (16) report of 7 – 8 seeds/fruit for Central American trees. Estimates for populations in northern South America, however, are considerably higher with up to 16 seeds/fruit having been reported (1, 6, 15). Marshall (12) estimated that 12 seeds/fruit was average for trees in Trinidad.

We obtained a mean fresh seed weight for *C. guianensis* of 32.1 ± 10.6 g (n = 25) and have found viable seeds from the same tree ranging from 19.0 to 62.2 g fresh weight. A mean of 15.6 ± 5.0 g (n = 76) was obtained for seeds dried at 24°C for 72 h. Fanshawe (6) reported a dry seed weight of 10 – 12 g.

Fecundity estimates were obtained for three trees in August 1976 by counting the number of seed impressions in all valves collected under each tree (Table 2). Estimates for two trees were obtained in August 1974 by counting the number of valves in a 45° area out from the base of the tree, multiplying by eight for extrapolation to 360°, and multiplying by 1.67 seeds/valve for total seed production estimates (Table 2). The crowns and valve distribution under these trees were fairly uniform. All trees sampled were located in swampy areas.

Germination

The requirements for germination of *C. guianensis* seeds were determined in July and August 1974 by planting seeds in each of three habitats: (1) heavily shaded swamp, (2) moderately shaded cacao plantation, and (3) open ground. The swamp soil was wet and occasionally covered with standing water; the latter two sites were on well-drained old alluvium. Within the three habitats, 10 seeds were sown in each of three ways: (a) on the soil surface, (b) embedded in the soil to one-half the seed's diameter, and (c) buried 20 cm beneath the soil surface. Planting occurred immediately following collection of seeds from under a fruiting tree. The majority of the seeds germinated within two to four weeks after planting. In 10 weeks high germination percentages were found for the surface-sowed and embedded seeds in the

Table 1. Dominance values based on individual ≥ 10 cm dbh for the five most important tree species in the 2 ha swamp of Study Area II, La Selva. Dominance values for *C. guianensis* on slopes and ridges (Study Area III, 4 ha) are presented parenthetically for comparison.

Species	Density (stems/ha)	Frequency (% 20 m X 20 m quadrats with species)	Basal area (m^2/ha)	Importance value (%)
Pentaclethra macroloba	122	42	19.82	56
Carapa guianensis	62 (9)	27 (9)	13.16 (1.1)	34 (2)
Pterocarpus officinalis	25	18	11.27	24
Astrocaryum alatum	61	29	0.85	16
Iriartea gigantea	35	23	0.90	11
Others	401	325	21.91	159
Total (115 species)	706	464	67.91	300

Table 2. Fecundity estimates for *C. guianensis* trees in the La Selva forest. * denotes estimate obtained in August 1974 by valve counts in a 45° area out from the base of the tree extrapolated to 360°. All other trees censused in August 1976.

Tree no.	dbh (cm)	Estimated no. of seeds
4 268	19.7	754
7 154	41.5	2 171
5	64.0	2 108*
1	90.0	3 522
4	95.0	3 944*

swamp, for the embedded seeds in the cacao, and for the buried seeds in the exposed site (Table 3). It is clear that *C. guianensis* seeds will not germinate when buried in the swamp, or if they become too dry, as on the surface of the ground in full sun. These observations accord with Marshall's (12) report that poor germination is often the result of water-logging or dessication. In the course of this study we found that newly collected seeds lost their viability rapidly, and had to be protected from drying if stored for any length of time before planting.

Seed dispersal and predation

Carapa guianensis seeds float, which enhances dispersal in a swamp or riparian species. We found *C. guianensis* seeds as an occasional component of debris deposited on the Atlantic beach at Tortuguero, and in Corcovado National Park on the Pacific coast, especially near the mouths of water courses. Fanshawe (6) reported that the seeds float until they rot.

From the distribution of valves in contiguous 2 m^2 quadrats along 11 haphazardly chosen 18 m radii from the bases of 5 reproductive trees in 1974, we constructed an average expected valve shadow transect (Figure 1). A very strong concentration of seeds occurs on the ground beneath the crown because the unopened fruits fall when mature. Such a high concentration of large seeds beneath a reproductive tree, as well as in a larger area such as the swamp forest of Study Area II, should be a prime temporal food source for seed eaters. Fifty-four to 96 percent of the expected number of seeds in the 11 sampled transects had been removed from the area at the time the valve count was made.

The major vertebrate predators of *C. guianensis* are collared peccaries (*Tayassu tajacu*), white-lipped peccaries (*Tayassu pecari*), and large rodents such as agoutis (*Dasyprocta punctata*) and pacas (*Agouti paca*). On Barro Colorado Island, Panama, Smythe (17) cited the agouti as the principal dispersal agent of large seeds through its scatter hoarding behavior, the transport and burial of seeds in various sites away from the fruiting tree (see also 13). Although utilizing *C. guianensis* seeds as food, agoutis probably enhance the germination of seeds that are buried and subsequently not retrieved. Agoutis, pacas, and collared peccaries are resident components of the La Selva forest fauna, but the gregarious white-lipped peccary has been rarely seen at La Selva. According to knowledgeable local people, white-lipped peccaries are usually found in swamps feeding on *Carapa* seeds. We did not observe any sign of white-lipped peccaries in Study Area II during the summers of 1974, 1975, and 1976.

Rate and quantity of seeds transported (presumably by agoutis, as evidenced by many tracks at the study sites) were determined in 1974 by placing different quantities of freshly collected seeds at varying distances under a reproductive *C. guianenesis* and under a control tree (*Virola koschnyi* Warb.) of approximately the same size. The experimental tree was within 200 m of other reproductive *C. guianensis*, whereas the control tree was over 200 m from the nearest reproductive *C. guianensis*. There were fresh valves under the *C. guianensis* at the time, but very

Table 3. Germination percentages of *C. guianensis* seeds 10 weeks after planting under different sowing and site conditions. n = 10 for each treatment.

Sowing position	Site conditions		
	Dense shade, poorly-drained soil	Partial shade, well-drained soil	Full sun, well-drained soil
Seed buried 20 cm	0	30	90
Seed half-embedded	90	70	30
Seed on soil surface	90	10	0

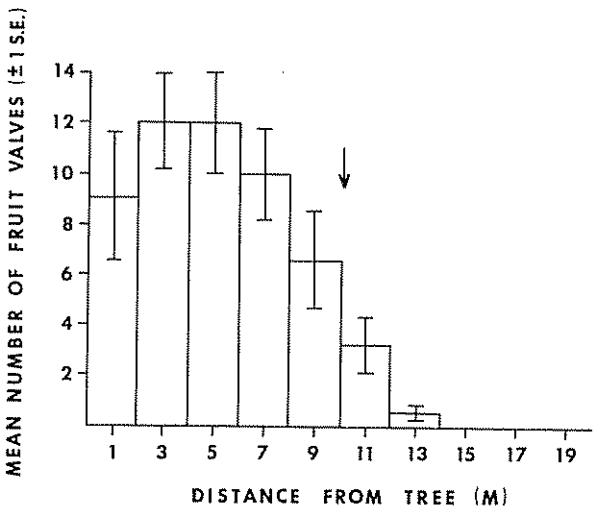

Fig 1 Average transect valve distribution based on valve counts in contiguous 2 m² quadrats from a total of 11 transects beneath five *C. guianensis*. Arrow indicates the average extent of the crowns above the transects. Bars indicate ± one S.E.

few seeds; these were removed. There were no fruits or seeds under the control tree. No precautions were taken to prevent contamination of seeds with human scent. All piles of seeds were checked daily for the first six days, then intermittently to record the number of seeds removed. The data (Table 4) show that some piles were discovered within 24 h of placement, and that seed removal was rapid. Of the piles of seeds beneath the *C. guianensis*, 45 percent of the seeds was removed in three days; 94 percent of the seeds beneath the control tree was removed in the same amount of time. Fewer sources of additional *C. guianensis* seeds near the control tree may have influenced the rapid and thorough removal of seeds. Seeds were removed from all piles except one with 5 seeds and one with 2 seeds.

In the forest we frequently found germinating *C. guianensis* seeds with the radicle missing and part of the seed chewed away through the opening made by the emerging root. Live traps baited with germinating seeds captured a porcupine rat (*Haplomys gymnurus*) that ate the radicles of the seeds in the traps and damaged them similarly to seeds we had observed.

The larvae of *Hypsipyla ferrealis* Hampson (Lepidoptera, Pyralidae, Phycitinae) are commonly found in seeds of *C. guianensis* at La Selva. Becker (2) found 36 percent of the seeds (n = 4 328) collected near Siquirres (65 km southeast of La Selva) infested with 9.3 ± 7.7 larvae/seed (n = 45). In freshly fallen seeds at La Selva we found up to 46 larvae/seed with an average of 5.1 ± 7.6 larvae/infested seed (n = 37). *Hypsipyla ferrealis* usually completes its life cycle

Table 4. Number of *C. guianensis* seeds removed between census days from different sized piles beneath a *C. guianensis* tree and a control tree (*Virola koschnyi*) in the La Selva forest. Seed removal between census days summed for all piles of the same size.

No. of piles & seeds	Time in days after seed pile placement									Total # of seeds removed	Percent seeds removed
	1	2	3	4	5	6	10	13	15		
2 piles of 25 seeds											
Carapa	2	25	0	3	0	2	5	13	0	50	100
Control	0	29	19	0	0	0	1	0	0	49	98
4 piles of 10 seeds											
Carapa	0	13	1	2	0	0	12	4	1	33	83
Control	0	26	12	0	0	0	0	0	0	38	95
6 piles of 5 seeds											
Carapa	7	8	0	4	5	0	0	0	0	24	80
Control	0	26	2	0	1	0	0	0	0	29	97
5 piles of 2 seeds											
Carapa	3	0	0	0	1	3	1	0	0	8	80
Control	0	6	2	0	0	0	0	0	0	8	80
Cumulative % removed											
Carapa	9	45	45	52	57	61	75	88	88	–	88
Control	0	67	94	94	95	95	95	95	95	–	95

within 40 days, but some larvae go into diapause for as long as five months (2). Although it is possible that the larval diapause is sufficient to delay the life cycle until the following year's young fruits are available for oviposition as suggested by Becker (2), the fact that the *Carapa* population at La Selva produces very few fruits in certain years must seriously reduce the *H. ferrealis* population if alternative food sources are not available or utilized. Entwistle (5) indicated that *Spondias mombin* L. (Anacardiaceae) and a *Rheedia* sp (Clusiaceae) in Trinidad are attacked by *H. ferrealis*. Both of these taxa occur in the Atlantic lowlands of Costa Rica, but neither has been found to host *H. ferrealis*. It is likely that other host plants occur in Costa Rica because Becker (2) reported that adult moths can be found at Turrialba throughout the year. Predation by larvae could be a selection pressure in the evolution of the phenological pattern of "good" and "bad" seed years.

We observed no shoot-borer activity on *C. guianensis* seedlings or saplings even though the genus *Hypsipyla* is well-known for the damage it causes other members of the Meliaceae (see 8).

To simulate insect or rodent damage to a seed we removed either 50 percent, 75 percent, or nearly 100 percent (by weight) of endosperm from three groups of 25 seeds each. All treated seeds and 10 whole seeds were partially embedded in the same swamp site as that for the germination investigation. There was a significant negative correlation ($r = -.76$, $P < 0.01$) between the amount of seed removed and seedling height at six weeks (Figure 2) at which time almost all seedlings had ceased growing. By the eleventh week all plants from treated seeds were dead, whereas five of the whole-seeded seedlings still survived. The difference in seedling survival at 11 weeks between the untreated and any treated group was significant by a binomial distribution test ($P < 0.002$). Endosperm removal from the treated seeds may have exposed them to fungi, bacteria, and other soil organisms whose action could further diminish seed reserves and reduce seedling survival. One cause of mortality for several of the treated seedlings was apical meristem damage. We have observed seedlings in the forest respond with up to three successive shoots after the previous meristem was damaged. A reduction in seed reserves, however, not only reduces seedling growth, by may also lessen the seedling's ability to resprout following destruction of the growing shoot.

The large seed with its store of endosperm should be important with respect to withstanding or recuperating from herbivory, in addition to enhancing seedling establishment in other ways. For a species of

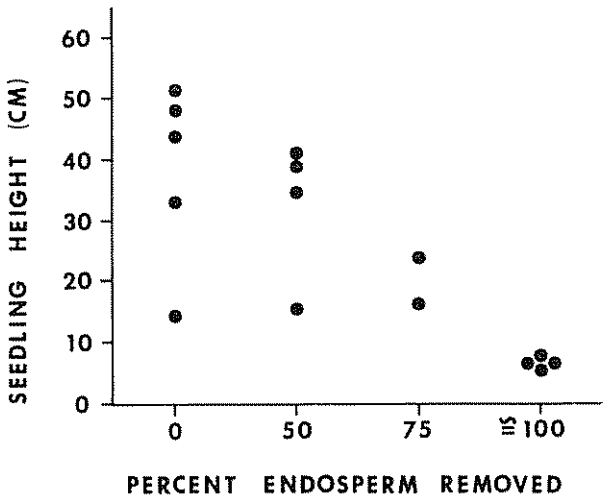

Fig 2. Heights of surviving seedlings 6 weeks after treatment and planting from seeds with different amounts of endosperm removed. n = 25 for each treated group of seeds; n = 10 for control seeds

swamp and seasonally or occasionally inundated forests such as *Carapa guianensis*, the large seed reserves may serve to establish an extensive root system for physical support, or may be important in getting the seedling's leaves above the normal level of standing water. Flood waters have probably been a strong selective force in the evolution of very large seeds in several swamp species, e.g., *Mora oleifera* (Triana) Ducke, *Pachira aquatica* Aubl., *Prioria copaifera* Griseb. *Carapa* seedlings put up a 50 – 60 cm tall shoot before leaves are produced and upward growth slows, while producing a very limited root system. These observations suggest that for *C. guianensis* the large seed may be especially important in producing a tall shoot to raise the leaves above flood water level.

Summary

Carapa Guianensis (Meliaceae) is a sub-dominant tree species in mature swamp forest in northeastern Costa Rica. The trees flower in September and produce mature fruit the following May. Phenological synchrony of the population produces marked differences in year to year quantities of seed produced.

Seed production of individual trees ranged from 754 to 3 944 seeds having an average dry weight of 15 6 g. Seeds germinated best in contact with moist soil. In well-drained soils, half-embedded and completely buried seeds germinated best. In poorly-drained swamp soils, seeds on the surface or half-embedded had 90 percent germination. Neither buried seeds in the swamp soils nor surface-sowed seeds in the well-drained soils germinated

Fruits fall to the ground beneath the tree's crown where 54 to 98 percent of the seeds are removed. Scatter hoarding by agoutis is probably an important factor in seed dispersal and in promoting germination. Larvae of the moth *Hypsipyla ferrealis* feed on *C. guianensis* seeds. Experimental removal of different proportions of endosperm from seeds, simulating insect or rodent damage, produced smaller seedlings and increased mortality.

It is theorized that one advantage of large seeds to tropical swamp species is the ability to produce a tall shoot to raise the leaves above the normal seasonal or annual flood waters.

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COMPORTAMIENTO DE 20 GENOTIPOS DE FRIJOL (*Phaseolus vulgaris* L.) A INFECCIONES DE LA MUSTIA HILACHOSA EN EL ESTADO DE TABASCO, MEXICO[1] /

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Summary

*A field experiment was carried out to evaluate the effect of the web bligh disease (*Thanatephorus cucumeris = Rhizoctonia microesclerotia*) on twenty lines of* Phaseolus vulgaris *in Tabasco, México. The index of infection was scored two weeks after the flowering stage by using a scale based on the percentage of infected foliar tissue. The plant yields were recorded at the harvest. The Jamapa-4, Arriaga TB 2-1, Medellin 2-4, Acatlan 3-6-1, Cosver 2, Bocas 1 and Medellin-4 lines, showed yields over 1 000 kg/ha. Six other genotypes yielded between 800 and 1 000 kg/ha. The rest of the lines showed poor growth and were destroyed by the disease. The scale of severity used to measure the index of infection was not useful for detecting statistical differences among the genotypes tested, therefore it was not possible to regress the yield and the percentage of infected foliar tissue. Despite this limitation, this study demostrates that several genotypes with relatively high yield are available, even under the attack of the pathogen and also using the traditional cropping system. The yield recorded in some of the lines evaluated was nearly twince as high as that shown by other cultivars grown in this region. The assumed source of resistence present in some of the lines tested remains to be determined.*

Introducción

La mustia hilachosa, cuyo agente causal es el hongo *Thanatephorus cucumeris* (Frank) Donk (= *Rhizoctonia microesclerotia* Matz) es una de las principales enfermedades que afectan al cultivo del frijol común (*Phaseolus vulgaris* L.) en las regiones bajas tropicales del Continente Americano (6, 8). Los mayores daños ocurren cuando prevalecen condiciones de alta temperatura y alta humedad relativa, combinadas con períodos prolongados de lluvia (3, 6, 8).

En México, esta enfermedad también se conoce con los nombres de Rhizoctonia del follaje, soyáme, pega-pega y quemazón, y ha sido encontrada en los Estados de Veracruz (4), Yucatán, Campeche, Tamulipas (5) y Tabasco (13) donde causa frecuentemente pérdidas de consideración en los meses cálidos y lluviosos del año.

En el Estado de Tabasco, las siembras de frijol se realizan con variedades de grano de color negro, con hábito de crecimiento en semi-guía, predominando los materiales de tipo criollo (7). Los ataques de la mustia hilachosa ocurren generalmente en las siembras tempranas de octubre y noviembre, produciendo en ocasiones la pérdida total del cultivo (3, 7, 13). En 1979, se estudió el efecto de *T. cucumeris* en diversas variedades de frijol bajo condiciones de infección natural en el campo; de los 5 materiales evaluados, el criollo regional "Nacajuca" fue el único que sobrevivió al ataque del patógeno, indicando al parecer tolerancia hacia la enfermedad (2).

En el presente escrito se proporcionan los resultados obtenidos en un experimento de evaluación de

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20 líneas de frijol negro a infecciones producidas por *T. cucumeris*, efectuado con el propósito de buscar posibles fuentes de resistencia que en un futuro pudieran ser incorporadas a los materiales criollos de la región.

Materiales y métodos

El ensayo se realizó en el Poblado Benito Juárez del municipio de Huimanguillo, Tabasco, durante los meses de noviembre de 1980 a febrero de 1981. Los genotipos a evaluar se distribuyeron en forma aleatoria en un diseño de bloques al azar con 4 repeticiones; cada parcela constó de 4 surcos de 6 m de largo, con 0.60 m entre surcos y 0.30 m entre matas. Quince días después de la siembra el experimento se uniformizó a 3 plantas por mata, lo que resultó en una población teórica de 165 000 plantas por hectárea. Como parcela útil se utilizaron los 2 surcos centrales.

Para el control de plagas, se efectuó una aplicación de paratión metílico a los 30 días después de la siembra. Las demás prácticas culturales se efectuaron de acuerdo al sistema agrícola tradicional acostumbrado en la zona (7).

Cinco días antes de la siembra se colectaron al azar 10 muestras de suelo con el propósito de cuantificar la cantidad de inóculo promedio de *T. cucumeris* en el terreno. Para aislar al patógeno se utilizó el medio selectivo de Ko y Hora (10) y su patogenicidad se probó en hojas de frijol sueltas mantenidas en cámara húmeda.

Los parámetros a evaluar fueron el índice de infección por *T. cucumeris* y la producción de grano en cada genotipo. Para estimar el índice de infección se estableció una escala de severidad con base en el porcentaje de tejido foliar infectado (Cuadro 1) en el 10% de las plantas contenidas por parcela útil. Se efectuó una lectura de severidad a los 15 días después de la floración. Al final del experimento se cosechó en forma manual y los cálculos de rendimiento se efectuaron cuando la semilla tuvo un 12% de humedad.

Cuadro 1. Escala de severidad establecida para estimar el índice de infección por *Thanatephorus cucumeris* (Frank) Donk, en 20 líneas de frijol (*Phaseolus vulgaris* L.).

Grado de severidad	% de tejido foliar infectado
1	0 – 25
2	25 – 50
3	50 – 75
4	75 – 100

Resultados y discusión

Durante el periodo en que se efectuó el ensayo, se presentaron altas temperaturas (media $\geqslant 26^{\circ}C$) y abundantes lluvias (humedad relativa $\geqslant 85\%$), condiciones que favorecen el desarrollo de la mustia hilachosa en esta zona (3). Adicionalmente, se encontró un promedio de 6 a 9 propágulos de *T. cucumeris* por cada 10 gramos de suelo. Esta densidad de inóculo es la que frecuentemente se detecta en el suelo de plantaciones de frijol afectadas por la enfermedad en esta zona (G. A. Frías, comunicación personal).

En rendimiento, se obtuvo diferencias altamente significativas ($P = 0.01$) entre tratamientos. De las 20 líneas evaluadas (Cuadro 2), la Jamapa 4, Arriaga TB 2-1, Medellín 2-1, Acatlán 3-6-1, Cosver 2, Bocas 1 y Medellín 4, fueron las que mostraron mayor producción de grano, con rendimientos arriba de los 1 000 kg/ha. Otros seis genotipos presentaron producción entre los 800 y 1 000 kg/ha. Los ocho materiales restantes mostraron un pobre crecimiento y fueron devastados por la enfermedad.

Los valores de tejido foliar infectado, mostraron en general que las líneas menos productoras presentaron mayores índices de daño foliar y viceversa. Sin embargo, los genotipos Arriaga TB 2-1, Medellín 2-1 y Medellín 4, tuvieron rendimientos relativamente altos, aún con valores arriba del 42% de daño foliar. Los materiales más afectados por la enfermedad, presentaron entre el 50 y 73.4% de daño foliar (Cuadro 2). No obstante esta obvia diferencia entre tratamientos, no fue posible aplicar un análisis de regresión estadístico entre el rendimiento y el grado de ataque del patógeno, que indicara de una manera más precisa el efecto de la enfermedad en los diversos genotipos evaluados.

El alto coeficiente de variación (C.V. = 52%) obtenido del análisis de varianza del rendimiento, era de esperarse debido a la marcada diferencia en la producción entre el mayor y menor tratamiento (Cuadro 2).

Otras enfermedades que se presentaron en el experimento, aunque con baja incidencia fueron: roya (*Uromyces phaseoli* var. typica Arth.), mancha angular (*Isariopsis griseola* Sacc.), antracnosis (*Colletotrichum lindemuthianum* (Sacc. & Magn.) Scrib.) y algunas virosis no identificadas.

En el Estado de Tabasco, es frecuente observar plantaciones de frijol completamente destruidas por

Cuadro 2. Comportamiento de 20 líneas de frijol (*Phaseolus vulgaris* L.) al ataque de la mustia hilachosa *Thanatephorus cucumeris* (Frank) Donk en el Estado de Tabasco, México.

Genotipo	Rendimiento	% de tejido foliar infectado
Jamapa 4	1 705 a*	35 9**
Arriaga TB 2-1	1 580 a	42.1
Medellín 2-1	1 275 ab	48.4
Acatlán 3-6-1	1 218 ab	39 0
Cosver 2 Bocas 1	1 173 abc	39 0
Medellín 4	1 034 bc	51 5
Medellín 3-1	977 bcd	50.0
P. Papaloapan 3	956 bcd	45 3
Tepehua 1-1	888 bcde	59 3
Remolino 6-7-1	880 bcde	46 8
Pino 3-D-1	840 bcdef	45 3
Arriaga TB 2-1-1	836 bcdefg	42 1
Arroyo 6-3	656 cdefgh	57 8
Jamapa 1	629 defgh	57 8
Arroyo 3-1-1	609 defgh	53 1
Tierra Blanca 7-2	575 defgh	50.0
Remolino	506 defgh	50.0
Tierra Blanca 7-2-4	476 defgh	72 5
Cocuite 9-7	253 h	73 4

C V. = 52%

* Según la prueba de comparación múltiple de Duncan, los números marcados con letra diferente son estadísticamente diferentes al nivel de 0.01 de probabilidad.

** Media de las repeticiones por tratamiento.

la mustia hilachosa, principalmente en la siembra temprana de cada ciclo de cultivo. Los resultados obtenidos en el presente estudio, muestran la existencia de algunos materiales de frijol con un potencial relativamente alto de producción, aún utilizando el sistema agrícola tradicional y bajo condiciones favorable para el ataque de patógeno. En otros ensayos de rendimiento efectuados en esta región, evaluando diversos materiales de frijol, principalmente del tipo criollo, se han obtenido producciones inferiores a los 900 kg/ha (1, 11). Asimismo, estos resultados aparentemente indican que existen posibles fuentes de resistencia contra la mustia hilachosa en algunas de las líneas evaluadas; sin embargo, para confirmar esta hipótesis sería necesario buscar un método más adecuado para medir el índice de infección y probarlo en dos o más ciclos de cultivo, de preferencia en varios campos donde hubiera una densidad de inóculo del patógeno, relativamente más alta a la encontrada en el presente estudio.

Adicionalmente, debido a la gran importancia económica que representa la mustia hilachosa para la producción de frijol en el Estado de Tabasco, se está evaluando como método de control el efecto de algunas prácticas culturales tales como barbecho, adición de materia orgánica y otras que afecten la sobrevivencia de *T. cucumeris* en el suelo y disminuyan su diseminación a las partes aéreas de la planta (9, 12).

Resumen

El presente trabajo se realizó para evaluar en el campo el efecto de la mustia hilachosa (*Thanatephorus cucumeris* = *Rhizoctonia microesclerotia*), sobre veinte líneas de *Phaseolus vulgaris* en Tabasco, México. Dos semanas después de la floración se estimó el índice de infección empleando una escala basada en el porcentaje de área foliar infectada. Los rendimientos se midieron a la cosecha, con valores superiores a los 1 000 kg/ha para las líneas Jamapa-4, Arriaga TB 2-1, Medellín 2-4, Acatlan 3-5-1, Cosver 2, Bocas 1 y Medellín 4. Seis genotipos dieron rendimientos entre 800 y 100 kg/ha; las demás líneas presentaron rendimientos bajos y casi fueron destruidas por la enfermedad. La escala de severidad empleada (índice de infección) no sirvió para medir las diferencias estadísticas entre los genotipos, por lo que no fue posible establecer la regresión entre el rendimiento y el porcentaje de la hoja infectada.

Los rendimientos encontrados para algunas líneas estudiadas casi duplicaron la de los cultivares usados en la región.

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INSECTS ASSOCIATED WITH TOMATOES AND CUCUMBERS IN THE UPPER AGUAN VALLEY OF HONDURAS[1] /

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Resumen

Se presenta una lista comentada de los insectos asociados con tomate y pepino cohombro que se encuentran en el Valle de Aguán, Honduras. Se incluye los insectos dañinos así como las especies beneficiosas observadas en el área. Las especies más comunes se evaluan con respecto al grado de daño ocasionado y a su abundancia; también se incluye las partes de las plantas atacadas por especies fitófagas, así como las especies atacadas por insectos beneficiosos.

Introduction

The Aguan Valley is a relatively isolated valley which follows along the north coast of Honduras behind the coastal range of mountains The upper Aguan Valley is inland about 50 kilometers south of La Ceiba. The upper regions of the valley receive an average of 875 mm of rain per year which comes mostly during the months of July through November. The rest of the year is mostly dry. The vegetation is semiarid in nature consisting mostly of scrub brush and succulents. With the exception of irrigated banana farms very little agriculture is practiced, except for scattered small corn fields during the rainy season. Most of the area is grazed by cattle.

During 1975 to 1979 Standard Fruit Company conducted research and semi-commercial operations aimed at evaluating the potential of the region for commercial production of tomatoes and cucumbers during the months of October through April.

A study of the insect populations associated with the tomato and cucumber plantings was undertaken to determine the species that would affect the crops in the region and to determine the role and importance of each insect species. Nineteen species of phytophagous insects were observed associated with tomatoes and 23 species were observed from cucumbers. Six species were considered important regarding each tomato and cucumber production. Three species (*Heliothis zea, Pseudoplusia includens* and *Diabrotica balteata*) were considered potentialy serious threats to both crops. The plant part damaged by each species was recorded as well as the pest status and relative abundance. Beneficial insects were also observed during the study and their relative abundance was noted.

Methods

The vegetable production areas studied in the upper Aguan Valley were cleared from wild lands

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I wish to extend thanks to numerous persons employed in the Standard Fruit vegetable project who helped collected data and insect specimens for this study. Invaluable contributions were made by F. Céspedes, H. Parra, R. Flores and W. Montiel. The help of Dr. Low and Dr. Braden of the Standard Fruit Research group was also appreciated

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which were completely removed from agricultural crops and other vegetable production regions of the country.

The list of insects associated with tomato and cucumber plantings was obtained through collections of adult and immature specimens on routine visits to the farms. Insects were collected mostly by hand picking from plants but collections were also made by beating the foliage and from pit traps set in the rows under the plant foliage.

Collections were made both during daylight hours and after dark with the aid of a flash light from both insecticide untreated research plots and from the commercial production areas of the farm.

Observations of insect behavior, damage, and the plant parts attacked were made by the author in the field during both daylight and night hours.

Immature specimens were brought to the laboratory and reared to adults so they could be identified and adults and larvae associated. Field collected immature specimens were placed on caged plants in the laboratory and observed until they completed development to adults.

Insect populations and damage levels were monitored daily throughout the crop season from both research plots and the commercial production areas. Each day the survey data was sent to the entomology group where insect populations and damage levels were evaluated.

Table 1. List of phytophagous insects on tomato plantings:

Insects	Plant part[1] Attacked	Pest[1] Status		Relative[2] Abundance
LEPIDOPTERA				
Heliothis zea (Boddie)*	Stems, fruit	P	1	1
Spodoptera eridania (Cram)*	Leaves, shoots, young plants	P	2	1
*Spodoptera dolichos (F.)**	Leaves, shoots, fruit	P	2	2
Pseudoplusia includens (Wlk)*	Leaves	P	2	1
HEMIPTERA				
Sagotylus confluentus (Sag.)	Foliage	O	3	2
Leptoglossus zonatus (Dallas)	Foliage	P	2	2
Largus sp	Foliage	P	2	1
Staluptus marginalis (Burm.)		N	–	3
Phthia picta (Drury)	Foliage	P	2	1
Lygaeus reclivatus Say		N	–	2
Jadera haematoloma (H.–S.)		N	–	3
Chelinidea tabulata (Burm.)	Foliage	P	3	2
ORTHOPTERA				
Xyleus discoideus (Servilla)	Foliage	O	3	3
Schistocerca nitens nitens (Thunberg)	Foliage	P	2	2
Schistocerca americana americana (Drury)	Foliage	P	2	2
COLEOPTERA				
Diabrotica balteata Lec.*	Foliage, young plant	P	2	1
Diabrotica viridula Fabr.	Fruit	O	3	3
DIPTERA				
Leafimner*	Leaves			
HOMOPTERA				
Aphididae	Stems, leaves	O	2	2

1) Pest status

P – pest status
O – occasional pest
N – not a pest

1. serious pest
2. damage is secondary
3. may cause minor damage occasionally

2) Relative abundance

1 – usually abundant
2 – uncommon
3 – rare

Results

Tables 1, 2 and 3, list those insects which are phytophagous to tomato plantings and cyrcumbers, and the insects which are beneficial to both crops, respectively.

Annotated list of the more economically important insects on tomatoes

Heliothis zea (Boddie)

Common name: Tomato fruitworm

H. zea caterpillars were the most serious pest of tomatoes. Larvae were first observed boring into the main stem of plants about 2 to 3 weeks after planting. As the plants began to set fruit the caterpillars would begin boring into and damage the green fruits.

H. zea larvae were always present but generally were more difficult to control as the season progressed and various tomato plantings of progressive ages provided a continuing source of host plant material. Early in the growing season and during the first fruit formation stages of specific cycles 0.05 *Heliothis* larvae per plant was considered the economic threshold. Toward the end of production cycle *Heliothis* were allowed to reach a maximum of 0.10 larvae per plant before treatment, which would translate into 1.5 to 2% damaged fruit.

Table 2. List of phytophagous insects on cucumbers.

Insects	Plant Part[1] Attacked	Pest[1] Status		Relative[2] Abundance
LEPIDOPTERA				
Heliothis zea (Boddie)*	Flowers, scar fruit	P	1	2
Diaphania nitidalis (Stoll)*	Fruit, terminal shoots	P	1	1
Diaphania hyalinata (Linnaeus)*	Leaves, terminal bud	P	1	2
Spodoptera exigua (Hub.)	Leaves	O	2	2
Spodoptera sunia (Gn.)	Leaves	O	2	2
Pseudoplusia includens (Wlk)	Leaves, scar fruit	P	1	1
HEMIPTERA				
Largus sp	Vegetative parts	O	2	2
Oncopeltus sexmaculatus Stal	–	N	–	3
Sagotylus confluentus (Say)	–	N	–	3
Leptoglossus zonatus (Dallas)	Stems, shoots	O	2	2
Leptoglossus gonagra (Fabr.)	Stems, shoots	O	2	2
Phthia lunata (Fabr.)	Stems, shoots	O	3	3
Anasa nr *scorbutica* (F)*	Stems, shoots	O	1	1
Catorhintha sp.	–	N	–	3
Polymerus testaceipes (Stal.)	Leaves	O	2	2
HOMOPTERA				
Aphididae	Leaves, shoots	O	1	2
COLEOPTERA				
Diabrotica balteata Lec.*	Young plants, leaves, flowers	P	1	1
Diabrotica porracea (Harold)	Leaves, flowers	N	3	3
Epilachna tredecimnotata (Latreille)	Leaves	N	3	3
Epilachna discincta Wise	Leaves	N	3	3
Metrioides karli Wilcox	Flowers	N	–	1
Acalymma sp.	Leaves	O	2	2
Acmaeodera flavomarginata Gray	Flowers	N	–	3

1) Pest status

P – pest status
O – occasional pest
N – not a pest

1. serious pest
2. damage is secondary
3. may cause minor damage occasionally

2) Relative abundance

1 – usually abundant
2 – uncommon
3 – rare

Table 3. List of beneficial insects on tomatoes and cucumbers.

	Relative Abundance	
	Cucumbers	Tomatoes
HEMIPTERA		
Zelus sp.	2	2
Sinea sp.	1	2
Geocoris punctipes (Say)	1	2
Orius tristicolor (White)	1	2
Cardiastethus sp.	2	3
NEUROPTERA		
Chrysopidae	3	–
COLEOPTERA		
Cycloneda sanguinea Linn.	2	2
Megacephala ignea Bates	3	3
Cicindela ocellata Klug.	1	1
Galerita mexicana Chaud.	2	2
Cheanius aurolimbatus Laf.	1	1
Athostrictus sericatus Bates	2	2
Calleida decora (Fab.)	1	1
Pasimachus cordicollis Chaud.	2	2
	Host Attacked	
DIPTERA		
Archytas sp.	*Spodoptera* sp.	
Allograpta exotica (Wied.)	Aphidae	
Eucelatoria sp.	*Heliothis zea*	
Drino nr. *rhoeo*	*Spodoptera* sp.	
HYMENOPTERA		
Chelonus insularis (Cr.)	*Spodoptera* sp.	
Sphex dorsalis Lap.	–	
Trypoxylon sp.	Spiders	
Ectemnius sp.	–	

1) Pest status

P – pest status
O – occasional pest
N – not a pest

1 serious pest
2. damage is secondary
3 may cause minor damage occasionally

2) Relative abundance

1 – usually abundant
2 – uncommon
3 – rare

Spodoptera eridania (Cram.) and *S. dolichos* (F.)

Both species of *Spodoptera* were common on tomato plantings, feeding on the leaves and shoots of the plants. *S. eridania* usually attacked younger plants. Adults would often lay eggs on newly emerged plants in the cotyledon stage. *S. eridania* larvae were not observed to damage fruit. However, larvae of *S. dolichos* tended to be found on older plants and on occasion were observed feeding on tomato fruit. *S. eridania* was the more common of the two species.

Pseudoplusia includens (Wlk.)

Common name: Soybean looper

A common caterpillar on tomato plantings in the Coyoles region, the soybean looper was always present but rarely proved to be a serious economic problem in tomatoes. Feeding of the caterpillars was limited to the leaves. They were never observed to damage fruit.

Schistocerca sp.

Two species of grasshoppers of the genus *Schistocerca* fed on tomato plants. The most common and most important pest species was *S. americana americana*. *S. nitens nitens* was also present, but was of secondary importance. Neither species was ever present in significant numbers so as to require control.

Diabrotica balteata Lec.

Adults fed on the leaves and new shoots of tomato plants of all ages. Significant damage occurred on smaller plants. Mortality of young and emerging plants occurred in some situations. Frequently control measures had to be taken within the first 3 weeks. Newly transplanted seedlings sometimes had to be treated to protect the main stem and new shoots until they were established.

Annotated list of the more economically important insects on cucumbers

Heliothis zea (Boddie)

Early instar larvae of *Heliothis zea* were commonly observed associated with the cucumber flowers, but damage was not observed. The young larvae may have been feeding on the pollen. Late instar larvae were observed to feed on the surface of fruit producing a brown colored scar on the fruit. Feeding by *H. zea* was only superficial. Larvae were not observed to enter the fruit, which is an interesting behavior pattern because normally this species bores into the plant part attacked. Populations of *H. zea* on tomato plantings nearby exhibited the behavior of boring into the fruit and plant stems. Usually scarring damage due to *H. zea* was not of economic importance.

Diaphania nitidalis (Stoll)

Common name: Pickleworm

This was a serious pest each time that cucumbers were planted. The larvae of this pest started attacking and boring inside the terminal shoots about 3 weeks after planting. The yound fruit started forming 4 and 5 weeks after planting. At this time the caterpillars moved to the young fruit destroying much of it. Excellent control of this pest was obtained by an insecticide *application* at 42 days. Usually this controlled *Diaphania nitidalis* for the rest of the season.

Diaphania hyalinata (Linnaeus)

Common name: Melonworm

While this insect was consistently a potential danger, it seldom became a serious pest. *Diaphania hyalinata* was most serious from about 2 to 5 weeks after planting when the larvae would infest the rolled leaves in the buds as they were opening.

Pseudoplusia includens (Wlk)

This is perhaps the most common lepidopterous caterpillar in the cucumber fields. The larvae of *Pseudoplusia includens* fed on both leaves and fruit, and were responsible for most of the fruit scarring in cucumbers. Scarring usually took place near the stem end of the fruit. Often the scarring was minor and did not result in the fruit being rejected on the packing line.

Fruit scars caused by *Pseudoplusia* includens could usually be separated from those of *Heliothis zea* and *Spodoptera* sp. caterpillars by location and texture of the scar on the fruit. Scars due to larvae of *H. zea* and various *Spodoptera* were on the sides of the fruit, and were usually more superficial and wider and of a different texture.

Caterpillars of *P. includens* first appear about 1 to 3 weeks after planting. Populations of caterpillars generally begin very low in the range of .005 per plant and within 1 to 2 weeks reach population densities of 0.1 to 0.2 larvae per plant. Generally by the 4th week after planting populations are about 0.2 larvae per plant. Populations of *P. includens* caterpillars in this range and below 0.4 caterpillars per plant are below economic thresholds.

Before fruit formation there was no significant damage to the plants. After fruit set some scarring would occur, but fruit rejection levels would be below the .5% level.

Anasa nr. *scorbutica*

Feeding by these bugs on the growing tips caused deformation of the vines and in some cases death of the growing tips. During the normal commercial growing season from October to March, *Anasa* was not an important pest, but when cucumbers were grown during the wet months serious damage occurred.

Leptoglossus sp.

Two species of the genus *Leptoglossus* are commonly present on cucumbers in about equal numbers

In some plantings one or the other would be more abundant, but both were normally present. Adults were observed feeding on stems and shoots of the cucumber plants

Diabrotica balteata Lec.

This is a very common beetle throughout the Aguan Valley. Young plants were attacked shortly after emerging. The adult beetles feed heavily on the underside of the cotyledons and on the stems. Stem feeding often killed the newly emerged plants. After 1 or 2 true leaves were developed damage levels were lower. Populations of *D. balteata* were low as the plants emerged from the soil, and built up rapidly during the next 1 to 2 weeks. Populations remained at high levels for the first 5 to 6 weeks and then declined. Peak adult populations in cucumber plantings reached 1.5 beetles per plant.

Several insecticide sprays tested had little or no effect on the population density in the plantings: any effect noted was only short lived, usually less than 24 hours. The cucumber production area was so small compared to the total beetle population in the region and the insect population was so mobile that the numbers killed by the spray were insignificant to the total environmental density, so were rapidly replaced from outside with little effect on the regional population.

Metrioides Karli wilcox

This is a very abundant chrysomelid beetle commonly found in the flowers, particularly during the morning hours. The beetles did not appear to harm the flowers or vegetative parts of the plants, so they were not considered a pest. The adult beetles are very mobile about the field. They may have some importance in pollination.

Geocoris punctipes (Say)

G. punctipes was the most common predator regularly observed on cucumber plantings. Adults were observed to be active throughout the cucumber growing season. Adult densities ranged between 0.1 and 0.2 per plant based on daily insect surveys. In cucumber cycles where insect pest problems developed and insecticides had to be used, populations were significantly reduced or eliminated. Peak densities were reached about 3 weeks following planting and remained more or less stable through the growing season.

Orius tristicolor (White)

This anthocorid predator was one of the most common predators in cucumber fields. Adults and nymphs were frequently observed in the flowers and on the foliage, particularly near the terminal buds. Populations of this insect varied between plantings, ranging from near zero to 1.8 per plant. Population densities for *O. tristicolor* are low due to its small size and secretive habits such as hiding inside the opening leaves of the terminal bud. Population counts actually represent mostly the numbers in the flowers.

Cucumber insects from other regions of Honduras

Two regions besides the upper Aguan Valley were investigated for potential cucumber growing regions. One was in the Comayagua Valley and the other in the Department of Copan near the town of Florida. Surveys of the insects attacking experimental plantings of cucumbers in these regions showed many similarities in the insect fauna, but also showed some differences.

Two groups of insect pests which did not show up on cucumbers in the Aguan Valley were commonly observed in both of the above regions. One: whiteflies were present on all plantings observed and became abundant on some plantings. Two: mirid bugs were present on plants in both regions on a regular basis.

Two species of mirids have been identified as pests on cucumbers: *Halticus bractatus* (Say) and *Cyrtopeltis notatus* (Distant). *H. bractatus* is the most common on cucumbers. Damage occurs to the young plants when heavy feeding takes place on the leaves, particularly on the young plants in the first 3 to 4 weeks after emergence.

Discussion

Because of the isolation of the region, lack of any other farming (except bananas), and the relatively small size of vegetable operations compared to the total area, the insects associated with the vegetable plantings adapted from a variety of native hosts in the area. The study of the insect populations is of particular interest because it represents a transfer of insects from native plants to a commercial tomato or cucumber cultivar. Evaluation of the insect populations on the vegetable plantings provide insight into which native species in the area will affect tomato and cucumber plants, the relative importance and abundance of the various species, and may help

point out native Central American species that could be a potential pest in other parts of the world if introduced.

Lepidoptera larvae were the most damaging of the phytophagous species collected on both crops. Of the eight species collected from both crops only 2 were common to both tomatoes and cucumbers. Even though *Spodoptera* larvae attack both crops the species were different.

Eleven Hemiptera were observed from the 2 crops. Only 3 were common to both tomatoes and cucumbers. The most diverse fauna was observed on cucumbers: a total of 9 species. Only 2 species were restricted to tomatoes.

The diversity and potential impact of coleoptera was much greater on cucumber plantings. No species were unique to tomatoes, yet they were a serious pest to cucumbers. Damage due to Orthoptera appeared to be restricted to tomatoes. Of the 3 species observed in the vegetable plantings, none were recorded from cucumbers.

Cucumbers attracted the most diverse insect fauna from the region. Fifteen species were specific to cucumbers of a total of 23 species collected. Eleven species were specific to tomatoes from a total of 19 species collected.

Abstract

An annotated list of insects associated with tomato and cucumber plantings in the Aguan Valley of Honduras is presented. Insect pests as well as beneficial species are listed relative to pest status abundance, and plant parts attacked for phytophagous species and hosts attacked for beneficial species. The more common species are discussed with regard to their association with the tomato and cucumber plantings.

Reseña de libros

BUTTLER, B. E. Soil classification for soil survey. Oxford University Press, Great Britain. 1980. 129 p.

En la literatura actual, es difícil encontrar textos que al estudiarlos de cubierta a cubierta, el lector sienta que adquirió algo valioso, como en este caso. Butler, con una experiencia en el campo de la clasificación de suelos de más de 30 años, nos sorprende con esta obra en la cual cubre aspectos sobre la filosofía de los sistemas de clasificación.

El libro consta de tres grandes tópicos: el concepto de ordenamiento de la población de los suelos, el establecimiento de un sistema de clasificación de suelos con fines cartográficos y el resumen y comentario de algunos sistemas de clasificación de suelos en vigencia.

En el prefacio, aparecen dos frases que resumen los objetivos del libro; la primera de ellas "MUCHO SE DICE, POCO SE PRUEBA" y la segunda "NADIE LE ENSEÑA AL ESTUDIANTE COMO JUZGAR (la bonanza de un sistema)". El autor emplea la primera parte del libro discutiendo la base del procedimiento estadístico a emplear en el diseño y la comprobación de las clases en un sistema de clasificación. De aquí que la primera frase cobre relevancia al concluirse con la idea de sistemas jerárquicos en los que los niveles superiores se definen en términos de RACIONALIZACION (no comprobación).

La segunda parte del libro, se basa en la idea de un sistema de clasificación con un propósito doble: predecir y generalizar. Butler considera que estas dos funciones deben ser analizadas en términos estadísticos y presenta un método para probar la bonanza de las clases. Ahora se cumple con el segundo objetivo, existe un mecanismo para juzgar.

Para terminar, se discuten los fundamentos principales de doce sistemas de clasificación de suelos. Se presentan en forma resumida los principales aspectos de cada uno, discutiéndose en términos evolutivos el desarrollo de los mismos tanto en forma positiva como negativa.

El texto merece estar incluido en la biblioteca de todas aquellas personas que trabajen en clasificación de suelos. Como referencia debería emplearse en los cursos sobre este teme al tratar el capítulo sobre principios de clasificación.

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Notas y comentarios

Premio Nobel 1983 de Fisiología y Medicina

Hace cuarenta años, Bárbara McClintock propuso la presente teoría de los genes reguladores, pero es sólo en la última década que su trabajo ha sido reconocido por el mundo académico. En los novecientos cuarenta, cuando presentó evidencia que sugería la existencia de elementos controladores, además de los genes estructurales (los pedazos de DNA codificados para proteínas), no se le prestó atención y hasta fue ridiculizada. Pero no fue por esta contribución, que hace ahora elemental la existencia de genes estructurales y reguladores, sino por su posterior descrubrimiento de que algunos elementos controladores podían cambiar su posición en los cromosomas (los llamados "genes saltadores"), que Bárbara McClintock ha ganado el premio Nobel de Fisiología y Medicina de 1983.

Desde los novecientos veinte en que empezó a trabajar en Cornell, pasando en los novecientos cuarenta a trabajar y vivir en el Laboratorio de Cold Spring Harbor, en el Estado de Nueva York, McClintock ha trabajado siempre con el maíz. Los "genes saltadores" son hoy una parte familiar, aunque todavía no muy comprendida, de la biología molecular. Son segmentos de DNA que tienen la capacidad de moverse a través del genoma e insertarse en otras partes. Mucho antes de que se supiese de la doble hélice y de las claves genéticas, McClintock obtuvo resultados que podrían ser explicados mejor al suponer que habían genes que controlaban a otros genes, y que algunos de estos se podían mover por el genoma y controlar toda clase de genes diferentes. El concepto de regulación del gen era enteramente nuevo para los genetistas y cuando McClintock lo presentó, fue virtualmente desdeñado. Esto la hizo retirarse un poco en su laboratorio, aunque sus investigaciones continuaron. Desde esa época de desengaños, publicó la mayor parte de sus resultados en el informe anual del laboratorio. Esto motivó que, varias décadas después, esos volúmenes fueran buscados en las bibliotecas académicas, conforme sus investigaciones fueron poco a poco reconocidas por su trascendencia.

No fue hasta que los genes saltadores fueron claramente demostrados en bacterias por James Shapiro, que la gente del mundo científico comenzó a aceptar las ideas de Bárbara McClintock. Estos elementos eran los responsables de que la resistencia de las bacterias a los antibióticos se propagase rápidamente entre la población bacteriana como si fuera un contagio de proporciones epidémicas. Es que en el fenómeno de la conjugación, las bacterias se juntan por momentos e intercambian material genético, es decir, los genes saltadores de McClintock.

Otras investigaciones de esta mujer se reconocen también ahora como contribuciones notables. Una de ellas fue, como mencionamos al principio, su propuesta, al explicar los resultados en la herencia de la pigmentación de los granos de maíz, de que existían dos genes además del gen mismo del pigmento (gen estructural). Uno estaba bastante cerca del gen del pigmento, y parecía un verdadero interruptor, que encendía y apagaba el gen estructural. El segundo estaba localizado a alguna distancia en el cromosoma y parecía regular la actividad de apagado y encendido del primero. A estos los llamó "elementos controladores" precediendo así, por más de una década, el trabajo de Jacob y Monod sobre genea promotor y supresor.

Una segunda investigación fue la que, con su colega Harriet Creighton, establecieron inequívocamente que durante el "crossing over" los cromosomas intercambiaban material físico e información genética. Según Shapiro, este trabajo, por sí mismo, debería haber recibido un premio Nobel.

Cuando se le comunicó la noticia del premio Nobel, Bárbara McClintock emitió unas declaraciones que describían "este extraordinario honor". "Puede parecer injusto, sin embargo, premiar a una persona por haber tenido tanto placer en el transcurso de los años, pidiendo a la planta de maíz resolver problemas específicos y observando entonces su respuesta". Aunque ya ha pasado los ochenta años de edad, Bárbara McClintock sigue observando. Adalberto Gorbitz.

OCCURRENCE AND DISTRIBUTION OF VESICULAR–ARBUSCULAR MYCORRHIZAL FUNGI IN COFFEE (*Coffea arabica* L.) PLANTATIONS IN CENTRAL SAO PAULO STATE, BRAZIL[1]

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Resumen

Durante el verano se colectó muestras de suelo de la rizosfera y raíces de plantas de café en 27 fincas de la región central del Estado de Sao Paulo, para estudiar la presencia de hongos en micorriza vesicular-arbuscular (VAM). La mayoría de las fincas fueron fertilizadas anualmente, las muestras de suelo de la rizosfera presentó un pH mayor que 5.4, más 30 ppm de P y no se encontró toxicidad de Al^{3+}.

Se logró identificar un total de 22 especies de hongos VAM y se observó 20 especies no descritas. El género Acaulospora, *incluyendo especies no descritas con esporas pequeñas, de color amarillo-oro y paredes laminadas se encontró en todas las muestras,* Glomus *spp. se presentó en el 81% de los sitios y* Gigaspora *y* Sclerocystis *spp. se encontraron en el 60% y el 40% de las muestras, respectivamente.* Gigaspora margarita, *descrita como muy eficiente para el desarrollo de plántulas de café no pudo encontrarse en ninguna muestra. La colonización de raíces por hongos VAM osciló entre el 4 y el 46%.*

Introduction

The vesicular-arbuscular mycorrhizal (VAM) fungi promote an increased nutrient uptake by plants they colonize and thus benefit their growth. The majority of wild and cultivated plant species establish mycorrhizal associations (7).

As early as in 1897 Janse (5) reported that coffee plants are normally colonized by VAM fungi. It was shown recently (8) that some species of VAM fungi promote enhancement of coffee seedling growth and phosphorus uptake. *Gigaspora margarita* Becker and Hall was a very effective species, while *G. heterogama* Gerdemann & Trappe colonized the roots without stimulating growth. Coffee plants usually are grown in containers in a nursery before being introduced into the field. If artificial inoculation is confirmed to be advantageous, this could encourage the development of large scale nursery inoculation with VAM fungi. Although few inoculation experiments with VAM fungi on coffee have been carried out in the field, in most of them beneficial effects were observed.

This survey was conducted with the objectives of determining the species of VAM fungi associated with coffee roots in one important coffee region of Sao Paulo State, and to relate their distribution and percentage of root colonization with soil chemical analysis data.

Materials and methods

All samples were collected from Feb. 2 to 9, 1981, at the locations indicated in Table 1, situated in the area within 21-22°S and 47-50°W (Figure 1). They were collected at 0-15 cm depth, under the trees. For each sample there were three replicates, collected within an area of maximum 5 000 m^2. Each replicate consisted of composited soil and root subsamples from five non adjacent neighbour trees. Each replicate of composited subsamples were placed in plastic bags and maintained in a styrofoam box during transport. For each sample, crop age, management, and origin of the seedlings, where known, were recorded.

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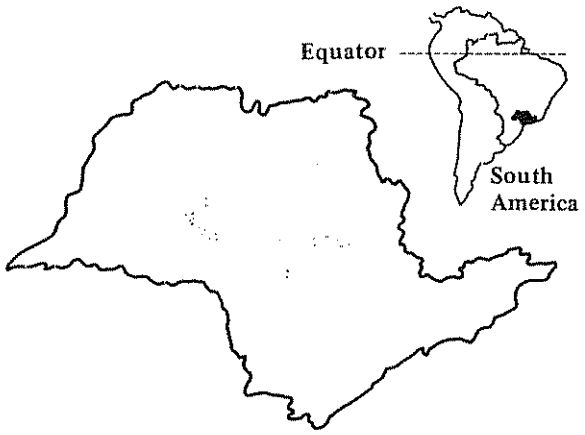

Fig. 1. Sample collecting sites for Vesicular-arbuscular Mycorrhizal fungi associated with coffee survey.

Samples were sieved on 2 mm screen, a 50 g subsample removed, and placed in a refrigerator (5°C) until spore extraction. Root samples were washed and a portion fixed in formalin acetic acid and another portion was added to sterile soil in 15-cm pots and planted with coffee and siratro (*Macroptilium atropurpureus*) to isolate VAM fungi colonizing the roots as described by Gerdemann and Trappe (3). Chemical analysis of a soil sample from each location consisting of composited subsamples from the three replicates were made at the laboratories of the Section of Soil Fertility, Instituto Agronômico. The following extractors were used: KCl 1N for Al^{+++}, Ca^{++}, and Mg^{++}; H_2SO_4 0.05 N for K and P; carbon was oxidized with $K_2Cr_2O_7$ 4N, in presence of H_2SO_4; potentiometric determination of pH was in 1:2.5 aqueous suspension.

Spore extractions were made by the wet sieving method of Gerdemann and Nicolson (2) using sieves with 720, 250, 105 and 53 μm openings. Fractions retained in each sieve were centrifuged (3 500 rpm) for 2 minutes in water, and then for 1.5 minutes in a 45% sucrose solution. Spores observed in each fraction were counted and separated for identification after mounting in lactophenol on glass slides.

Root samples of each replicate (circa 0.5 g) were cleared and stained as described by Philips and Hayman (9). Root colonization by VAM fungi was then evaluated by the grid plate method of Giovannetti and Mosse (4).

Results

Most of the soils of the studied area are classified as Podzolized (Lins and Marilia variations) great groups. They are sandy loam soils of medium fertility which were put into cultivation, starting with coffee, some 50-70 years ago. Coffee is still the major crop in the area. Results of chemical analysis of soil samples are presented in Table 1. Sample numbers 3, 4, 5, 7, 8 and 27 were from Latosolic soils. With exception of sites number 27 and 22, which had not received any fertilizer since planting (6 year old crop), all the others had received variable annual amounts of fertilizers and different management, which could explain the variation in pH and nutrient content among locations.

Spores of species of VAM fungi in the genus *Acaulospora* were recovered from all the soil samples (Table 2). Species of *Glomus* were found in 81 percent of the samples while *Gigaspora* and *Sclerocystis* were observed in 60 and 40 percent of the samples, respectively. As many as 20 types of spores, with characteristics differing from presently described species, were found in this survey. Attempts to isolate these fungi are under way. One spore type, with an unusual thick (43 μm), long subtending hyphae, and yellow-gold reticulated contents (possibly a new genus) was also observed in one sample site.

Although the genus *Glomus* was common throughout the area, the most frequently recovered species, *G. fasciculatum*, occurred only in 44 percent of the sampled sites, and thus was not as common as an undescribed *Acaulospora* sp. (A–1), recovered from 92 percent of the samples (Table 2).

Table 3 indicates the relative occurrence, and number of spores of all described and undescribed species which occurred in at least 10 percent of the sample locations. The five mostly found undescribed species indicated in Table 3 could be briefly characterized as follows:

Acaulospora sp. A–1 Small (50-150 μm), globose, golden yellow to honey colored spores, with 3-8 μm thick, 2-3 layered all, with non reticulated contents.

Acaulospora sp. A-2 Spherical or elongate small spores (50-110 x 75-150 μm) with irregular reticulate contents and a thin (0.5 - 9.0 μm) hyaline wall.

Acaulospora sp. A-3 Small (80-120 μm) red brown spherical spores, with a thick wall, having a sinous pattern on it.

Sclerocystis sp. S-1 Small elongate (20-32 x 26-38 μm) yellow-brown spores with 5-7.5 μm wall. Sporocarps are small, with peridium formed of extremely thin hyphae.

Table 1. Chemical characteristics of the soils sampled for VA mycorrhizae under coffee trees in 27 locations in Central São Paulo State, Brazil.

Sample No.	Location			e. mg/100 g soil			ppm	
		% C	pH	Al^{+3}	Ca^{+2}	Mg^{+2}	K	P
1	Rio Claro	5.5	5.4	0.1	5.6	1.1	336	180
2	Rio Claro	3.3	6.4	–	4.4	1.4	292	204
3	Rio Claro	1.7	5.9	0.1	3.3	0.5	128	91
4	Itirapina	2.2	5.3	0.4	1.0	0.3	152	30
5	Brotas	4.0	5.6	–	2.8	1.5	400	27
6	Brotas	2.2	5.6	0.7	1.1	0.4	136	37
7	Jaù	2.2	6.6	–	2.6	1.6	204	55
8	Jaú	2.5	6.2	–	5.3	1.5	132	40
9	Bauru	3.2	5.8	–	2.7	1.7	176	52
10	Bauru	1.1	5.0	0.3	0.8	0.2	68	78
11	Cafelandia	0.9	5.6	0.1	0.7	0.3	132	36
12	Lins	2.2	6.1	0.1	1.2	0.6	340	14
13	Lins	3.1	5.3	0.3	1.4	0.4	160	25
14	Marilia	1.7	5.7	–	3.6	0.4	76	217
15	Marilia	1.3	5.0	0.4	1.1	0.3	44	58
16	Marilia	1.4	5.0	0.2	2.4	0.5	44	133
17	Marilia	3.2	5.8	–	10.2	1.2	60	140
18	Marilia	2.7	6.8	–	7.6	2.4	312	122
19	Vera Cruz	1.3	6.0	–	1.6	0.6	400	81
20	Vera Cruz	1.5	6.4	–	1.8	1.1	112	18
21	Garca	1.7	4.7	1.1	0.5	0.2	52	14
22	Garca	1.2	5.5	0.1	2.5	0.4	120	12
23	Galia	2.3	6.1	–	1.9	1.1	236	37
24	Galia	2.1	6.1	–	2.2	1.3	192	34
25	Fermo Dias	1.2	5.2	0.4	0.7	0.3	72	20
26	São Manuel	2.9	4.9	1.0	0.6	0.2	764	11
27	São Manuel	1.8	5.4	0.1	1.6	0.5	102	4

Table 2. Occurrence of VA mycorrhizal fungi in coffee (*Coffea arabica* L.) plantations of the central region of São Paulo State. Data refers to average percentage of tree replicates for 27 locations.

Genus	Total species identified*	Relative occurrence of the genus (%)	Relative occurrence of most common species (%)
Acaulospora	5 (10)	100.0	92.6
Glomus	8 (4)	81.5	44.4
Gigaspora	6 (2)	59.2	29.6
Sclerocystis	3 (4)	40.7	18.5
Total	22 (20)	–	–

* Numbers in parenthesis refer to spore types which did not fit in any described species of the particular genus. Data on relative occurrence included spore types

Glomus sp. G-1 Globose or elongate small red to brown small spores (80-100 x 100-130 μm), with thick red wall (7.0-12 μm) and thick subtending hyphae.

Less frequently observed described species included *Acaulospora faveata* Trappe & Janos, *A. trappei* Ames & Linderman, *Glomus geosporum* (Nicol. and Gerd.) Walker, *Glomus trappei* James & Linder-

man, *Glomus claroideum* Schenck & Smith, and *Glomus occultum* Walker. Besides the spore types listed in Table 3, seven more in the genus *Acaulospora*, three in *Glomus*, two in *Gigaspora*, and three in *Sclerocystis* were recovered in less than 10 percent of the sites.

Counts of spores were made, but the occurrence of spore clusters or sporocarps in the genus *Glomus* and *Sclerocystis* made it difficult to obtain comparable counts within these genera. In any case, these two genera had low numbers of spores in this survey. Usually one to three spores or small clusters of those two genera were found per sample. The individualized nature of spores of *Gigaspora* spp. and *Acaulospora* spp. permitted an easier and more reliable count. However, there was great variation among replicates in those counts. The most commonly observed species of *Acaulospora* (A-1, a possible new species) also had the highest number of spores of any species, between 2 and 41 spores/50 ml of soil, with an average of 12.3 spores/50 ml of soil (Table 3). In general *Gigaspora* species had a much lower number of spores recovered. The most commonly found species of this genus, *G. pellucida*, was recovered in only 8 out of 27 locations and had an average of only 2.8 spores/50 ml of soil.

Attempts were made to relate genus and species incidence with the soil characteristics presented in Table 1, but no clear relationships were apparent. Table 4 summarizes one such attempt showing relative occurrence of the four genera, expressed as percent of locations in which they occurred, in relation to soil pH classes. The incidence of *Acaulospora*, and *Sclerocystis* was not affected by soil pH, on the range of 4.7 to 6.9. *Gigaspora* was not recovered from soils with pH higher than 6.5, and *Glomus* was less commonly found in locations with pH lower than 5.0.

Samples 14, 15, 16, and 17 were all from the same farm, and the crop had received basically the same management from planting. They differed in plant age, the younger one (No. 14) being only 6 months from transplant. In the other three sites (sample numbers 15, 16, and 17) the plants were 1, 2, and 5 years old, respectively. A tendency of decreasing root colonization with tree age was observed; the percentage of root colonization were 22.0, 23.4, 19.1, and 12.1 for samples 14, 15, 16, and 17, respectively.

Table 3. Relative incidence of species of VA mycorrhizal fungi recovered under coffee trees in Central São Paulo State, Brazil. Only species occurring at more than 10% of the sample sites are included.

Species	% Occurence	No. of spores per 50 ml of soil	
		range	average*
Acaulospora sp. (A-1)	92.3	2–41	12.3
Glomus fasciculatus (Thax.) Gerd. & Trappe	44.4	–	–
Acaulospora scrobiculata Trappe	40.7	1–15	4.7
Acaulospora laevis Gerd. & Trappe	37.0	1–5	2.0
Gigaspora pellucida Nicol. & Schenck	29.6	1–6	2.8
Acaulospora sp. (A–2)	25.9	2	2.0
Gigaspora gigantea (Nicol. & Gerd.) Gerd. & Trappe	22.2	1–3	1.8
Acaulospora spinosa Walker & Trappe	18.5	1	1.0
Acaulospora sp. (A–3)	18.5	1–8	2.8
Glomus macrocarpus Tul. & Tul.	18.5	–	–
Glomus microcarpus Tul. & Tul.	18.5	–	–
Gigaspora gilmorei Trappe & Gerd.	18.5	1–2	1.6
Sclerocystis clavisporus (Trappe)	18.5	–	–
Sclerocystis coremioides B&B	18.5	–	–
Sclerocystis sp. (S–1)	14.8	–	–
Glomus etunicatus Becker & Gerdeman	14.8	–	–
Glomus sp. (G–1)	14.8	–	–
Gigaspora heterogama (Nicol. & Gerd.) Gerd. & Trappe	14.8	1–3	1.5
Gigaspora rosea Nicol. & Schenck	11.1	1–2	1.3
Sclerocystis sinuosa Gerd. & Bakshi	11.1	–	–

* For the average value only the sites in which the species occurred were considered.

Table 4. Relative incidence of four genera of Endogonaceae in rhizosphere of coffee trees of central São Paulo State, as a function of soil pH.

Genus	Soil pH				
	4.6–5.0	5.4–5.5	5.6–6.0	6.1–6.5	6.6–7.0
	Incidence %	Incidence %	Incidence %	Incidence %	Incidence %
Acaulospora	100	100	100	100	100
Gigaspora	80	50	62	50	0
Glomus	40	100	75	100	100
Sclerocystis	60	50	12	33	50
Number of samples in each pH range	5	6	8	6	2

Spores of *Acaulospora* were found in each of the four samples, but *Gigaspora* spores were not recovered from the two samples from older plants, in this particular farm. Individual data for root colonization are not shown, but root colonization in the soils which had received no P fertilizer (samples 21 and 22) were among the highest (38 and 43 percent, respectively) in this survey.

Discussion

This represents an extensive and systematic survey on occurrence of VA mycorrhizal fungi associated with coffee. After the initial reference of Janse (5) of mycorrhizal colonization of coffee roots, only two other recent published reports were found. Cardoso (1) observed nursery plants and found only well developed seedlings to be infected. Lopes *et al.* (8) observed that growth response of coffee to mycorrhizal fungi varied with the species of endophyte.

Miller *et al.* (6) observed variable degrees of infection (4 up to 74 percent) in forage grasses and legumes, in Nova Odessa, São Paulo State. From their description of spore types, apparently no *Gigaspora* species were recovered. The absence of *Gigaspora margarita* in this survey is of interest, since this species was highly effective in promoting growth of coffee seedlings (8). A survey which is underway in Cerrado soil of São Paulo revealed that *Gigaspora* spp. is fairly common in those acid soils (Penteado, V., Instituto de Botanica, S.P., personal communication).

The occurrence of mycorrhizal species observed in this survey are much higher than the ones observed in the survey of agricultural crops in Florida (10), which involved 30 different hosts, and higher soil variations. It is not known if the widespread occurrence, and abundant sporulation of *Acaulospora* spp., particularly the undescribed (A-1) golden yellow spore type might be associated with the coffee crop. Very likely this spore type is adapted to a wide range of conditions, since it has been observed in different areas and crops in the states of Para and Minas Gerais by one of the authors (E. Oliveira).

Summary

Coffee rhizosphere soil and root samples were collected during the summer, from 27 farms in the central region of Sao Paulo State, and were assayed for presence of vesicular-arbuscular mycorrhizal (VAM) fungi. Most farms had received annual fertilizer applications. Most rhizosphere soil samples had a pH higher than 5.4, over 30 ppm P and no Al^{3+} toxicity.

A total of 22 species of VAM fungi were identified and 20 other possibly undescribed species were observed. The genus *Acaulospora,* including a nondescribed species with small, golden-yellow spores having laminated walls, was found in all sample sites. *Glomus* spp. occurred in 81 percent of the sites. *Gigaspora* and *Sclerocystis* spp. were found in 60 percent and 40 percent of the samples, respectively. *Gigaspora margarita* which has been reported as highly effective in enhancing coffee seedling development was not detected. Root colonization by VAM fungi varied from 4 to 46 percent.

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DYNAMICS OF *IN VITRO* FERMENTATION OF STRUCTURAL CARBOHYDRATES IN TROPICAL GRASSES[1] /

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Resumen

Se estudió la dinámica de la fermentación in vitro *de celulosa y hemicelulosa potencialmente digestibles en ocho gramíneas tropicales, a cuatro diferentes edades, estimadas como el número de días después del último corte. La variación observada en la tasa de fermentación de ambos carbohidratos fue pequeña y no significativa, tanto entre especies como entre edades. La tasa de fermentación varió de 4 a 10% h^{-1}. La demora para iniciar la fermentación estimada indirectamente, también fue uniforme en todas las especies y edades. Ni el porcentaje de lignina ni la edad influenciaron los parámetros de la fermentación. La edad, y en menor grado la lignina, estuvo correlacionada con la baja digestibilidad de la hemicelulosa y la celulosa.*

Introduction

A relatively large body of information is available regarding the proximal composition and digestibility of tropical grasses (2, 3). Nevertheless, current views on the nutritive value of forages for ruminants demand accurate information on the contents of specific chemical compounds, as well as estimates of the factors that influence the rate of fermentation of these entities in the rumen (11, 17). These are not readily available for tropical grasses.

It is widely recognized that the nutritive value of forages is related to the composition and digestibility of the cell wall contents. Cellulose and hemicellulose are quantitatively the main components of cell walls, and their digestibility is variable, depending upon the stage or maturity, species and lignin content, as well as on residence time in the rumen (10). To represent the dynamics of fermentation of these two carbohydrates, a two-pool model was proposed by Waldo *et al* (18), and subsequently widely used on studies of temperate forages (14, 15), and in computer simulations of rumen function (11). In that model, cellulose and hemicellulose are represented as composed of two fractions: an indigestible pool which disappears from the rumen by passage to the lower tract, and a "potentially digestible" fraction subject to passage and fermentation (18). It has been postulated that the partition of structural carbohydrates into these two pools is determined by the content of lignin, and perhaps silica (10), while the rate of fermentation of the potentially digestible pool is independent of lignin (10). The effects of age of the forage on the above parameters are not well documented.

The objective of this study was to evaluate the rate of fermentation of potentially digestible cellulose and hemicellulose in tropical grasses, in relation to age.

Materials and methods

Samples of eight grasses cut at four different stages of maturity (21, 42, 63 and 84 days respectively) were obtained from a previous experiment (13). The eight grasses were coded as follows: M = *Melinis minutiflora;* J = *Hyparrhenia rufa;* T = *Panicum maximum* var. *trichoglume* (green panic); G = *Panicum maximum* var. *gongyloides* ("coloniação); R = *Ghloris gayana;* SN = *Setaria sphacelata* cv. Nandi; SK = *Seta-*

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ria sphacelata cv. Kazungula, and N = *Pennisetum purpureum*. Chemical analyses and agronomic conditions of the samples have been described (13); lignin was determined as the organic matter residue insoluble in 72 percent H_2SO_4. To study rate of fermentation, samples were incubated for 6, 12, 24 and 48 h with the reagents of the first stage of the *in vitro* digestibility technique (16); nitrogen was not added to the incubation medium. After the filtration step, the residues were analyzed for hemicellulose and cellulose, as described previously (13). Trial runs showed that there were no significant differences in fermentation between 48 – and 72 h incubations. Due to the large number of samples and analyses, only composite samples of three field replicate were analyzed.

The amount of structural carbohydrates fermented in 48 h, expressed as percentage of that initially present in the sample, was considered "potentially digestible" (18). The amounts fermented at 6, 12 and 24 h were expressed as percentage of the potentially digestible carbohydrate, and the data was fitted to Waldo *et al* model (18) in the form of equation 1,

$$Y = b_0 \exp(-b_1 T) \qquad (1)$$

were Y is the percentage of the potentially digestible hemicellulose or cellulose, remaining at T hours, b_0 = (100 – % digestibility) and can be used to estimate the initial time lag of fermentation (10), while b_1 represents the rate of fermentation, in h^{-1}. The parameters of the regression equations thus calculated, were compared by standard analysis of covariance (5). In some opportunities, the effect of age on the value of the parameters was evaluated by linear regression.

Results and discussion

The parameters of the regression equations relating the disappearance of the potentially digestible hemicellulose or cellulose of time of fermentation, for all species and ages are included in Table 1. As an example of the small variation encountered, Table 1 shows the parameters for the disappearance of the potentially digestible cellulose of each species, in each of the two extreme ages studied. Overall, the range in rate of fermentation of hemicellulose was 4.35 to 10.53% h^{-1}, and that of cellulose was 4.89 to 8.11% h^{-1}, depending on age and species. In none of the four stages of maturity were the differences between species significant ($P > 0.05$). In every case, a single regression equation was adequate to represent the dynamics of fermentation of the potentially digestible hemicellulose and cellulose (Table 2). Comparable results for tropical grasses do not appear to have been published. Pezo and Vohnout (12) studied the *in vitro* fermentation of dry matter in six grasses, each at three ages, by application of a sigmoidal model relating extent of dry matter fermentation to time of incubation. Not having separated the dry matter into two-pools, they reported as expected, significant differences between speces and ages within species, concluding that stage of maturity is more important than species. Smith *et al* (14, 15) observed a wide range in the rate of fermentation of the poten-

Table 1. Values of the parameters in Waldo *et al* model for the disappearance of potentially digestible cellulose in relation to species and ages.

Species	21 days			84 days		
	b_0	b_1	r^2	b_0	b_1	r^2
M	103.75	0.0498 ± 0.0355	0.99	116.24	0.0681 ± 0.0492	0.96
J	115.85	0.0678 ± 0.0495	0.94	120.78	0.0714 ± 0.0526	0.93
I	112.38	0.0607 ± 0.0440	0.95	114.80	0.0594 ± 0.0430	0.96
G	112.05	0.0546 ± 0.0397	0.94	116.76	0.0622 ± 0.0453	0.95
R	120.67	0.0724 ± 0.0534	0.92	123.15	0.0707 ± 0.0521	0.92
SN	114.90	0.0608 ± 0.0445	0.93	121.53	0.0694 ± 0.0510	0.92
SK	115.67	0.0604 ± 0.0440	0.94	108.21	0.0518 ± 0.0370	0.98
N	133.69	0.0812 ± 0.0693	0.94	113.36	0.0567 ± 0.0410	0.95

Table 2. Values of the parameters in Waldo *et al* model, for the disappearance of potentially digestible hemicellulose and cellulose.

Parameter	Age, days			
	21	42	63	84
			Hemicellulose	
b_0	117 50 ± 2.452	115.74 ± 2.137	120 30 ± 2.577	117.68 ± 3 363
b_1	0.0672 ± 0 0048	0.0622 ± 0 0042	0.0711 ± 0 0050	0 0668 ± 0 0051
r^2	0.88 (P < 0 01)	0.89 (P < 0 01)	0 89 (P < 0.01)	0.88 (P < 0 01)
			Cellulose	
b_0	114 67 ± 2 043	117 543 ± 1 927	117.919 ± 1 605	116.73 ± 1.734
b_1	0 0635 ± 0.0029	0.0664 ± 0 0044	0 0656 ± 0 0040	0.0637 ± 0 0036
r^2	0 89 (P < 0 01)	0 88 (P < 0 01)	0 93 (P < 0.01)	0 95 (P < 0.01)

tially digestible neutral detergent fiber of several temperature grasses, ranging from 4 to 23%.h^{-1}, depending on stage of maturity and species. On the other hand, Mertens (10) reported a non significant correlation between rate and lignin content. A similar observation was made by Lechtenberg *et al* (8) comparing the rate of disappearance of the potentially digestible cellulose of two isogenic lines of corn differing in lignin content. The effect of maturity on rate fermentation was studied by Darcy and Belyea (4) who found no difference in the digestion rate of potentially digestible cellulose in early vs. late cut orchardgrass.

To evaluate the effect of stage of maturity on both time lag and rate of fermentation, the values of the parameters reported in Tables 1 and 2 were regressed on days of age. When this technique was applied to ages within species, only seven of the 32 possible correlations were significant ($P < 0.05$). None of the correlations between the parameters in Table 2 and ages across species were significant ($P > 0.05$). The same lack of correlation was noted when lignin content, rather than age, was related to either time lag or rate of disappearance of the digestible pools of both structural carbohydrates. Nonsignificant correlations between rate of fermentation and lignin have been noted by several authors (4, 8, 10) but there are exceptions (14, 15). The former authors, as well as McLeod and Minson (9) have suggested that the main effect of lignin is on the extent of indigestibility, and not on the rate of fermentation of the potentially digestible fiber. This hypothesis was tested by correlating indigestibility to age and lignin (Table 3). Since the latter two variables were confounded and highly correlated between themselves the data should be interpreted with caution. Nevertheless, it does suggest that lignin may not be the only factor determining indigestibility, since the correlations with age were generally larger than those involving lignin. Other factors may be involved, such as chemical entities not presently determined or morphological peculiarities not detectable by chemical analysis (1, 6).

The value of the parameter b_0 (Table 2) can be used to estimate the initial time lag of fermentation (9). In the present study, these estimates ranged from 2 h 09 min. to 2 h 36 min, and are comparable to those reported by other authors (7, 10).

Lastly, it should be noted that the model of rumen disappearance of structural carbohydrates, although fitting the present experimental data very well, could mask differences between stages of maturity, associated with changing proportions of plant tissues. Different tissues are colonized at different speeds (7), and since colonization is probably the major cause of the time lag of fermentation, the latter could be expected to increase with maturity. A similar mechanism may operate with regard to rate of fermentation, since increasing age may also increase the degree of cristallinity of cellulose (10), which has been shown to affect the rate of enzymatic hydrolysis (6).

The experimental results presented suggest that the pool of potentially digestible structural carbohydrates of tropical grasses is extremely uniform from

Table 3. Coefficients of correlation of hemicellulose and cellulose indigestibilities (%), with age and lignin content.

Species	Hemicellulose indigestibility	Cellulose indigestibility
		Correlation with age
M	0.9603 *	0.9997 **
J	0.9699 *	0.9874 *
I	0.9898 **	0.9930 **
G	0.9755 *	0.9980 **
R	0.9635 *	0.9759 *
SN	0.9623 *	0.9868 *
SK	0.9980 **	0.9924 **
N	0.9666 *	0.9584 *
		Correlation with lignin
M	0.9181	0.8620
J	0.4995	0.4746
I	0.8394	0.8403
G	0.9380	0.9384
R	0.9180	0.9158
SN	0.8706	0.9085
SK	0.9032	0.9358
N	0.8206	0.9720*

* ($P < 0.05$)

** ($P < 0.01$)

the point of view of the kinetics of anaerobic fermentation, and that the latter is unaffected either by species, age or lignin content. On the other hand, indigestibility of hemicellulose and cellulose are closely related to age.

Summary

The influence of age of the forage, expressed as number of days elapsed since previous cutting, on the rates of fermentation of the potentially digestible hemicellulose and cellulose of eight tropical grasses was studied *in vitro*. Rates of fermentation for both carbohydrates did not differ significantly between species or ages within species. The range in rate of fermentation was 4 to 10% h^{-1}. The time lag of fermentation estimated indirectly was also uniform across species and ages.

Age and lignin content did not influence significantly either parameter of fermentation. Age, and to a lesser extent lignin, was correlated to hemicellulose and cellulose indigestibilities.

Resumo

Foi estudada *in vitro*, a dinâmica da fermentação da celulose e hemicelulose potencialmente digestiveis em oito capins tropicais, em quatro diferentes idades cada. A variação observada na taxa de fermentação de ambos carboidratos foi pequena e não significativa entre espécies e idades. A taxa de fermentação variou entre 4 e 10% h^{-1}. A demora no inicio da fermentação, estimada indiretamente, também não foi afetada por espécies ou idades. A porcentagem de lignina e a idade não influenciaram significativamente os parâmetros da fermentação. Porém, a idade, e em menor grau a lignina, estiveram correlacionadas com a indigestibilidade da hemicelulose e da celulose.

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CONTENIDO

COMUNICACIONES

Effect of NAA and GA on sex expression and endogenous growth regulators in sponge gourd (*Luffa cylindrica* Poem)

Resumen. La aspersión de 100 mg/ml de ácido naftalen acético (ANA) a plantas de *Luffa cylindrica* con dos hojas verdaderas desarrolladas aumentó el número de flores con pestilo a expensas de las flores estaminadas, efecto que masculinidad, indicando que la concentración de giberalinas endógenas presentes en las plantas testigo ya se encontraba en un nivel óptimo. La aplicación conjunta de ANA y AG neutralizó el efecto del ANA. Los resultados sugieren que el balance de auxinas endógenas y giberalinas es el que regula la expresión sexual, más que sus cantidades absolutas.

The effect of applied growth regulators like auxins, gibberellins and norphactins on sex expression has been studied by several investigators. In general, it was observed that applied auxin induces femaleness in cucurbits (4, 5, 6, 7, 9, 13) while applied gibberellin favours maleness (2, 4, 10, 12, 14). Since these two growth regulators have opposing effects on sex expression it would be interesting to find their effects when both are simultaneously applied. Work on these lines seems to be meagre. Also, the present work is intended to find out whether the effect of applied auxin or gibberellin is through increasing their endogenous levels.

Materials and methods

In preliminary experiments on spraying the plants of *Luffa cylindrica* at 1, 2 and 3 – true leaf stages with aqueous solutions of naphthalene acetic acid (NAA) at 50, 100 and 150 μg/ml showed that spraying the plants at 2 – true leaf stage with NAA at 100 μg/ml till the point of run off was effective. However, spraying the plants with gibberellic acid (GA_3) at 10, 25 or 50 μg/ml had no stimulating effect on maleness.

For extraction of endogenous growth regulators, the plants (leaves and stem) one week after spraying (3-true leaf stage) with distilled water (control) or NAA at 100 μg/ml or GA at 10 μg/ml or with both of these together were used.

Extraction and bioassay of auxins and gibberellins:

The extraction of auxins from the plant material was carried out at 4°C in 70 percent ethanol containing 20 mg/100 ml sodium diethyldithiocarbamate as per the method os Mann and Jaworski (8). The concentrated extract was streaked onto Whatman no. 1 chromatography paper and developed with a solvent of isopropanol: ammonia: water (10:1:1). The chromatograms, after development, were dried and cut transversely into 10 equal strips and each strip was eluted in 3 ml 2 percent sucrose solution overnight at 0°C before the assay for growth activity using 'straight-growth' method with coleoptiles of rice (3). Length attained by the coleoptile segments both in control and the extracts at the end of 18 hours incubation at 24-25°C in darkness was measured.

Gibberellins: For extraction gibberellins, the plant material was macerated in ethanol with 5 g/100 ml solid sodium bicarbonate added as per the method employed by Radley (11). The concentrated acidic ethyl acetate extract was loaded onto Whatman no. 1 chromatography paper and developed with a solvent of isopropanol: ammonia: water (10:1:1). The chromatograms, after development were dried and cut transversely into 10 equal strips and each strip was kept in ethyl acetate overnight for elution. The eluates were evaporated to near dryness and the residues were dissolved in deionised water. The biological activity of the eluates was determined by the

cucumber hypocotyl bioassay (1) and the results are expressed as extension of hypocotyl.

Results and discussion

Spraying plants of sponge gourd with NAA resulted in (a) hastening the appearence of pistillate flowers (from node 21 to 14 bearing the first pistillate flower) while delaying that of staminate flowers and (b) increasing the number of pistillate flowers at the expense of staminate flowers thereby decreasing the sex ratio (Table 1). Similar effects of applied auxin on sex expression in cucurbits were observed previously (4, 5, 6, 7, 9, 13). GA, when applied alone, had no significant effect on sex expression in the sponge gourd although it was found to stimulate maleness in other cucurbits (2, 4, 10, 12, 14). However, when applied along with NAA it had apparently neutralised the effects of NAA on the production of pistillate and staminate flowers (Table 1).

Determination of endogenous levels of growth regulators revealed interesting points. In control plants (sprayed with distilled water) endogenous gibberellin content was high (and the auxin content was low) coinciding with maleness of the plants (i.e., appearence of staminate flowers first and a higher number of staminate flowers) (Figure 1 A). GA_3, rather than $GA_{4/7}$ is probably associated with sex expression in sponge gourd since its content was higher in the control plants.

In plants treated with NAA, endogenous auxin content increased remarkably (especially at Rf region 0.3–0.5, corresponding to IAA) while little change occurred in the content of gibberellins; this was associated with hastened appearence of pistillate flowers and their increased number (Figure 1 B). Applied GA had no significant stimulating effect on maleness, although endogenous gibberellin content increased (Figure 1 C). Apparently, the concentration of endogenous gibberellin already present (in control plants) was at the optimum level. Although endogenous levels of both auxins and gibberellins increased in plants treated with NAA and GA together (Figure 1 D), the behaviour of these plants with respect to sex expression was comparable to that of control plants (Table 1). In other words, higher auxin content (due to NAA treatment) which stimulated femaleness in the presence of low gibberellin content, failed to do so in the presence of high gibberellin content.

The results of the present investigation suggest that it is not the absolute quantity of auxin or gibberellin that decides the sex expression in *Luffa cylindrica*, but the balance between the two. Higher endogenous gibberellin content than that of auxin favours maleness while higher auxin content than gibberellin favours femaleness.

Summary

Naphthalene acetic acid at 100μg/ml sprayed on plants of *Luffa cylindrica* at 2 true leaf stage increased the number of pistillate flowers at the expense of staminate ones, which was correlated with increased endogenous auxin content. Applied gibberellic acid had no stimulating effect on maleness, indicating that the concentration of endogenous gibberellin already present in the control plants was at the optimum level. When applied along with NAA, GA neutralised the effects of NAA. Results suggest that the balance of endogenous auxin and gibberellin

Table 1. Effect of NAA and GA on Sex expression in *Luffa cylindrica*.

Observation	Control	Treatment		
		NAA 100 μg/ml	GA 10 μg/ml	NAA/GA
Position of node bearing first staminate flower	13	18	13	13
Position of node bearing first pistillate flower	21	14	21	19
Total number of staminate flowers (with buds) per 10 plants	824	496	830	820
Total number of pistillate flowers per 10 plants	68	95	67	68
Sex ratio (staminate: pistillate)	12.1:1	5.2:1	12.2:1	12:1

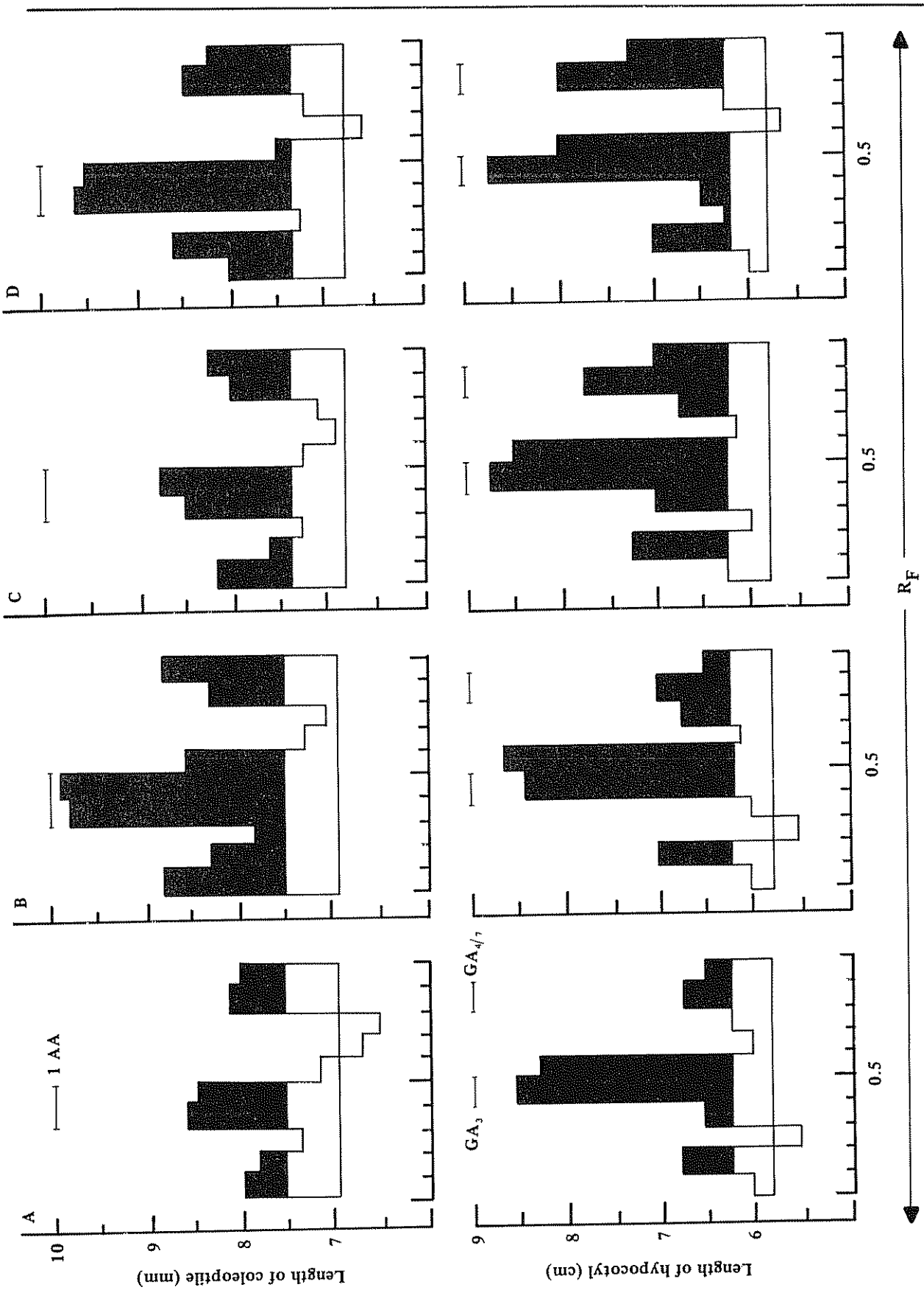

Fig. 1. Endogenous contents of auxin (as indicated by rice coleoptile bioassay) or gibberellin (as indicated by cucumber hypocotyl bioassay) in plants of *Luffa cylindrica* one week after spraying with distilled water (A), or NAA at 100μg/ml (B), or GA at 10μg/ml (C) or GA and NAA together (D). Blackened areas represent regions significantly different from controls at 5 percent probability level. Weight of plant material used for chromatography Auxins = A and C, 10g; B and D, 5g. Gibberellins = A and B, 10g; C and D, 5g.

regulates sex expression rather than their absolute quantities.

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Response of soybeans to varying planting patterns[1]

Resumen. Se investigó la respuesta de la soya sembrada bajo un sistema lineal, rectangular y triangular. El rendimiento de semilla (kg/ha) fue de 1839, 1959 y 1762 para los patrones lineal, rectangular y triangular, respectivamente.

Las relaciones entre el rendimiento de semilla en el tallo y en las ramas fueron 1.04, 1.13 y 1.17 para los tres patrones de siembra, indicando que los tallos fueron más importantes en la determinación del rendimiento para las ramas. Sin embargo, la relación número de vainas/m^2 en los tallos y en las ramas fue inferior a la unidad y osciló entre 0.97 y 0.98. El tamaño de las semillas para la relación tallo/rama varió entre 1.0 y 1.1, indicando que las semillas provenientes del tallo eran mayores que las producidas en las ramas. La relación entre el índice de área foliar (LAI) y el peso específico de la hoja (SLW) en el tallo/rama fue mayor que la unidad, ocurriendo el inverso para la relación área foliar (LAR) y el área específica de la hoja (SLA).

1 Contribution from Crop Production Department, Bunda College of Agriculture

Numerous studies have been made on the effects of planting patterns on yield of several crops. Generally narrow rows, square and narrow rectangular planting patterns have resulted in increased seed yields due to more efficient light utilization (6, 8, 9, 12, 14), less erosion and higher water infiltration rate (4) and weed supression (5, 11).

Recently, the concept of plant types (ideotypes) as a means of increasing grain legume yields have begun to receive some attention. The construction of the ideotypes has been based on mostly morphological characteristics such as the number of branches/plant, stem diameter, number and size of leaves, inflorescence/plant, pods/plant, growth habit and seed size (1, 7). One of the morphological characteristics that could conceivably influence seed yield is the number of branches/plant. Apart from the results of Lehman and Lambert (3), very little information is available on the relative importance of branches in yield determination, especially at varying planting patterns.

The experiment reported here was to evaluate the relative importance of branches in yield determination and also to determine whether planting pattern has any effect on the role of branches in seed yields.

Materials and methods

The experiment was conducted at Bunda College of Agriculture Farm (33°4' S and 14°11' E, altitude 1 118 m). Soybean seeds (*Glycine max* L. (Merill)), cultivar Geduld, inoculated with *Rhizobium japanicum* strain 63, were planted on 17th December, 1975. Each treatment which was replicated three times consisted of three gross ridges each 14 m long and 91 cm apart. All plots received 16.5 kg/ha of P and 7.5 kg/ha of K before planting and the fertilizer was banded. The sources of P and K were single superphosphate and muriate of potash, respectively. Three planting patterns were used. These were (i) single row per ridge at 5 cm between plants (linear); (ii) two rows per ridge with 10 cm between plants with seeds sown in opposite planting holes (rectangular) and (iii) two rows per ridge with 10 cm between plants and seeds sown in alternate planting holes (triangular). Dry matter distribution and accumulation were determined at three stages of growth and development from 0.91 m^2 (1 m from the middle ridge). Leaf area index (LAI) was determined using leaf area and leaf-weight relationship from discs obtained with a cork borer (10). Specific leaf weight (SLA) was leaf area (dm^2)/leaf tissue (g); leaf area ratio (LAR) was leaf area (dm^2/total plant DM above ground and specific leaf weight (SLW) was DM leaf tissue (mg)/leaf area (cm^2). Dry matter distribution, LAI, SLA, LAR and SLW were determined for branches and stems separately. Canopy height was the average "height" (including foliage tips) of the plants on 14 m ridge, while the canopy width was a measure of the spread of the plants from the center of the ridge to one edge of the ridge, an index of the rate at which plants close up the inter-row spacing. Pod clearance was the height of the plant from the transition zone to the tip of the first pod, while plant height which was determined at harvest maturity was the distance from the transition zone to the tip of the growing point. The transition zone was the constricted part of the stem-root section.

Yield and yield components were determined at harvest maturity from 4 m of the middle ridge. Seed size (g/100 seeds) was the weight of 10 whole clean seeds multiplied by 10. This was done because some of the treatments, when separated into pod frequency, had fewer than 100 seeds each. Lodging score was determined at harvest maturity on a one to five scale: 1 = upright; 5 = prostrate (12).

Results and discussion

Yield

Planting pattern had no significant effect on seed yield (Table 1). However, rectangular planting pattern yielded 6.1 and 10.1 percent higher than linear and triangular planting patterns, respectively. From the practical point of view, the yield increase of rectangular over linear and triangular planting patterns is important since it is easier to make planting holes by hand at the former than the two latter planting patterns. Data for yield and yield components for stems and branches were determined separately to evaluate their relative importance in yield contribution as suggested by Lehman and Lambert (3). Yield differences between stems and branches were significant and yields for stem/branch ratios were 1.04, 1.13 and 1.17 for linear, rectangular and triangular planting patterns, respectively, indicating that stems were more important in yield determination than branches at all planting patterns. Lehman and Lambert (3) reported that the importance of branch in yield determination varied with spacing, cultivar and location, but had no effect on the overall seed yield. The results of the present study would suggest that planting pattern should be considered when choosing an ideotype since spatial arrangement would influence the relative importance of branches, one of the important agronomic characteristics of an ideotype, since a large number of fruiting branches can increase potential sink sites and hence yield.

After harvest, pods from stems and branches were separated into empty-, one-, two-, three- and four-

Table 1. Yield (kg/ha) of one-, two-, and three-seeded pods from stems and branches of soybeans at three planting patterns.

Planting pattern	One-seeded			Two-seeded			Three-seeded			Grand total			Yield stem/branch ratio
	Stem	Branches	Total	Stem	Branches	Total	Stem	Branches	Total	Stem	Branches	Total	
Linear	117	78	195	342	419	761	477	406	883	936	903	1 839	1.04
Rectangular	95	91	186	450	439	889	493	391	884	1 038	921	1 959	1.13
Triangular	106	75	181	364	395	759	479	343	822	949	813	1 762	1.17
Mean	106	81	187	385	417	803	483	380	863	973	879	1 853	–
S.E.±	–	4.2	–	–	21.8	–	–	22.2	–	–	–	–	–

seed frequencies; but the three- and the four-seeded pods were pooled and classified as three-seeded because the four-seeded pods did not occur in all replicates and treatments. Yields from one-, two- and three-seeded pods were 187, 803 and 863 kg/ha, respectively. Stems produced significantly higher yields of one- and three- seeded pods than branches. The yield differences between stems and branches for two-seeded pods were significant in favour of the latter.

Yield components

Data for yield components are presented in Table 2. The number of seeded pods/m^2 from linear, rectangular and triangular planting patterns were 449.3, 451.6 and 428.7, respectively; and two-seeded pods occurred more frequently than any other. There were no significant differences between stems and branches in the number of empty- and three-seeded pods; while stems produced significantly higher one-seeded pods than branches. The reverse was true for two-seeded pods Planting pattern had no significant effect on pod length. Branches produced 9.8 percent significantly more two-seeded pods than stems. Seed sizes (g/100 seeds) were 19.6, 18.2 and 18.1 for the linear, rectangular and triangular planting patterns, respectively. Seed sizes for stem/branch ratios were comparable for all planting patterns and ranged from 1.0 to 1.1, indicating that seed sizes of stems were generally larger than those of branches.

Growth analysis

The results of LAI, LAR, SLW and SLA determined at three stages of growth and development are presented in Table 3. Planting pattern had no significant effect on LAI; however, LAI differences between stems and branches were significant at the first and third sampling dates. The correlation between LAI and yield from stems were 0.23, -0.48 and 0.50 at the first, second and third sampling dates compared to the correlation between LAI and yield of branches of 0.44, -0.66 and -0.49 for the respective sampling periods. Planting pattern had no significant effect on LAR; but were consistently higher in branches than in stems although the differences were not significant. The higher LAR for branches was attributed to higher DM in stems than a higher leaf area in branches. For instance, leaf area and total DM of stems and leaves on stems were 7 780.8 cm^2 and 39.2 g, respectively, compared to 1 331.2 cm^2 and 3.7 g for leaf area DM of branches and leaves on branches at the first sampling date; indicating that stems had 5.8 times greater leaf area and 10.6 times higher DM than branches. Branches had significantly higher SLA at the second and at the third sampling periods and not at the first; indicanting that leaves from branches had thinner cross-sections and probably higher midribs and veins.

Planting pattern had significant effect on petiols and leaflet weight only at the second sampling date (Table 4). However, the stem DM of petioles and leaflets were significantly higher than those of branches. Stems produced significantly higher DM than petioles (Table 5)

Other agronomic characteristics

Data for other agronomic characteristics are presented in Tables 6 and 7. Plant height, canopy height and canopy width were relatively unaffected by planting pattern; and at full flowering the distance between ridges had been covered by foliage with the rectangular and triangular planting patterns covering the inter-ridge spacing (furrow) four to five days earlier than the linear planting pattern (Table 6). While erosion and weeds were not problems at the experimental site, rapid ground cover could be an advantage in soil and water conservation (4) and in weed control (2).

The difference between planting patterns for minimum number of pods/node, plant height and the distance between the transition zone and the first branch were significant (Table 7) but the other parameters were not The correlation between the number of nodes and yield was negative ($r = 0.40$) while that between branches and yield was only 0.30. Weber, Shibles and Byth (12) reported that branching in soybean was not a critical factor in maximum seed production since treatments with the lowest branching frequency had the highest yield. However, increase in branch frequency could be an advantage provided majority of the branches bear pods and the stem is sturdy enough to bear the load of extra pods.

Summary

The response of soybeans to varying planting patterns, linear, rectangular and triangular, was investigated. Seed yields (kg/ha) were 1839, 1959 and 1762 for linear, rectangular and triangular planting patterns, respectively

Seed yields for stem/branch ratios were 1.04, 1.13 and 1.17 for the three respective planting patterns, indicating that stems were more important in yield determination than branches. However, the ratio of number of pods/m^2 for stem/branch were generally less than one and ranged from 0.97 to 0.98. But seed sizes for stem/branch ratios ranged from 1.0 to 1.1, indicating that stem produced larger seeds than

Table 2. Pods/m², pod length and seed size of empty, one-, two-, and three-seeded pods from stems and branches at three planting patterns at harvest maturity.

Planting patterns	Pod description											
	Empty			One-seeded			Two-seeded			Three-seeded		
	Stem	Branches	Total/Mean	Stem	Branches	Total/Mean	Stem	Branches	Total/Mean	Stem	Branches	Total/Mean
	Pod/m²											
Linear	7.3	5.8	13.1	58.2	38.2	96.8	85.6	111.4	197.0	78.3	77.2	155.5
Rectangular	3.6	7.1	10.7	47.5	50.0	97.5	91.1	115.5	206.6	83.5	64.0	147.5
Triangular	8.9	7.5	16.4	52.7	38.1	90.8	80.4	107.1	187.5	80.2	70.2	150.4
Mean	6.6	6.8	13.4	52.8	42.2	95.0	85.7	111.3	197.0	80.6	70.4	151.1
S.E.±	–	0.8	–	–	1.4	–	–	4.4	–	–	7.1	–
	Pod length, cm											
Linear	3.9	3.6	3.8	3.6	4.0	3.8	4.1	4.5	4.3	4.8	4.7	4.8
Rectangular	3.7	3.6	3.7	3.8	4.1	4.0	4.1	4.6	4.4	4.7	4.7	4.7
Triangular	4.0	3.4	3.7	3.8	4.1	4.0	4.1	4.5	4.3	4.7	4.6	4.7
Mean	3.8	3.5	3.7	3.7	4.0	3.9	4.1	4.5	4.3	4.7	4.6	4.7
S.E.±	–	0.11	–	–	0.10	–	–	0.10	–	–	0.05	–
	Seed size, g/100 seeds											
Linear	–	–	–	21.7	19.3	20.5	19.9	20.3	20.1	19.1	17.5	18.3
Rectangular	–	–	–	18.8	15.9	17.4	19.4	18.6	19.0	18.3	18.1	18.2
Triangular	–	–	–	19.1	17.5	18.3	18.0	17.7	17.9	17.8	18.2	18.0
Mean	–	–	–	19.8	17.5	–	19.1	18.8	–	18.4	17.9	–
S.E.±	–	0.76	–	–	0.76	–	–	0.75	–	–	0.42	–

Table 3. LAI, LAR, SLW and SLA of stems and branches at three planting patterns at three stages of growth and development.

Planting	Days from planting								
	45			59			73		
patterns	Stem	Branches	Total	Stem	Branches	Total	Stem	Branches	Total
					LAI				
Linear	0.85	0.41	1.26	1.37	0.89	2.26	1.83	0.92	2.75
Rectangular	0.99	0.23	1.22	1.47	0.94	2.41	2.50	1.64	4.14
Triangular	0.89	0.15	1.04	1.54	1.45	2.99	2.13	1.45	3.58
Mean	0.91	0.26	1.17	1.46	1.09	2.55	2.15	1.34	3.49
S.E.±	–	0.10	–	–	0.15	–	–	0.25	–
					LAR				
Linear	1.99	3.64	6.12	1.73	3.86	5.59	1.44	1.60	3.04
Rectangular	2.06	3.87	5.93	1.39	2.86	4.25	1.22	1.88	3.10
Triangular	1.93	6.22	8.15	1.28	3.51	4.79	1.14	1.89	3.10
Mean	1.99	4.58	–	1.46	3.41	–	1.26	1.79	–
S.E.±	–	0.96	–	–	0.24	–	–	0.10	–
					SLW				
Linear	2.74	1.82	4.56	3.05	3.45	6.50	3.23	2.27	5.80
Rectangular	2.83	2.27	5.10	1.41	1.81	3.22	3.11	2.27	5.38
Triangular	2.86	1.93	4.79	1.10	1.58	1.68	3.35	2.09	5.44
Mean	2.81	2.00	–	1.85	2.28	–	2.23	2.31	–
S.E.±	–	0.28	–	–	0.20	–	–	0.13	–
					SLA				
Linear	3.67	4.50	8.17	3.26	6.80	10.06	2.97	4.00	6.97
Rectangular	3.57	3.35	6.92	2.87	5.20	8.07	3.17	4.40	7.57
Triangular	3.53	4.05	7.58	2.43	6.03	8.96	3.03	4.70	7.73
Mean	3.59	3.96	7.59	3.02	6.01	9.03	3.05	4.36	–
S.E.±	–	1.40	–	–	0.44	–	–	0.16	–

Table 4. DM (g/m^2) of plant parts from stems and branches of soybeans at three planting patterns at three stages of growth and development.

Planting patterns	Days from planting								
	45			59			73		
	Stem	Branch	Total	Stem	Branch	Total	Stem	Branch	Total
					Petioles				
Linear	4.8	0.4	5.2	12.2	3.1	15.3	20.6	8.0	28.6
Rectangular	5.8	0.7	6.5	15.1	4.8	19.9	30.4	13.9	44.3
Triangular	5.3	0.5	5.8	18.1	6.4	24.5	26.4	10.7	37.1
Mean	5.3	0.5	–	15.1	4.7	–	25.8	10.8	–
S.E.±	–	0.58	–	–	0.85	–	–	2.70	–
					Leaflets				
Linear	23.4	2.6	26.0	41.8	12.5	54.3	58.3	23.7	82.4
Rectangular	29.8	3.5	33.3	50.8	17.0	67.8	77.8	37.3	115.1
Triangular	24.3	2.7	27.0	53.1	22.9	76.0	71.2	30.3	101.5
Mean	25.8	2.9	–	48.5	17.4	–	69.2	30.4	–
S.E.±	–	1.95	–	–	2.18	–	–	6.48	–

Table 5. Dry matter (DM) (g/m^2) of stems and branches at three planting patterns and three stages of growth and development.

Planting patterns	Days from planting								
	45			59			73		
	Stem	Branch	Total	Stem	Branch	Total	Stem	Branch	Total
Linear	14.9	1.0	15.9	26.6	6.4	33.0	38.6	13.9	52.5
Rectangular	16.4	1.6	18.0	39.2	8.5	17.7	78.5	19.1	97.6
Triangular	15.8	1.0	16.8	50.1	10.9	61.0	72.2	16.4	88.6
Mean	15.7	1.2	–	38.6	8.6	–	63.1	16.4	–
S.E.±	1.50	–	–	–	2.22	–	–	6.40	–

Table 6. Plant height (cm), canopy height (cm) and canopy width (cm) of soybean at three planting patterns at three stages of growth and development.

Planting patterns	Days from planting								
	45			59			73		
	Plant height	Canopy height	Canopy width	Plant height	Canopy height	Canopy width	Plant height	Canopy height	Canopy width
Linear	20 8	26.0	15.0	38.2	47.7	29.7	52.9	57 6	over 45 cm
Rectangular	22 4	23.0	22.3	38.9	39 3	32.7	48.8	60.0	over 45 cm
Triangular	20 7	22 4	14.7	40.7	41 0	30.0	51.7	54.4	over 45 cm
Mean	21.8	23.2	17.3	–	–	30.8	–	–	–
S E ±	1.5	3.5	1.9	3.0	2 6	2.6	3 8	1.6	–

Table 7. No of pods/node, nodes/plant, branches/plant, lodging and other agronomic characteristics of soybean at three planting patterns.

Planting patterns	No. pods/node		No. nodes/ plant	No. branches/ plant	Lodging score	Plant height (cm)	Distance from transition zone to first branch (cm)	Pod clearance (distance (cm) from transition zone to first pod)
	Min.	Max						
Linear	1 1	2.9	14 6	4.1	1.2	62 5	14 1	15 2
Rectangular	1.2	3 0	14.4	4 2	1.5	52.7	12.1	12.9
Triangular	1 3	2 7	15 4	3 7	1.4	57 8	13.5	14 6
Mean	1.2	2 8	14.8	4 0	1 3	57 6	13 2	14 2
S E ±	0.03	0 26	0 35	0.22	0 07	1.39	0.30	0.59

branches. LAI and SLW for stem/branch ratios were generally higher than unity while the reverse was true for LAR and SLA.

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Reseña de libros

ECOLOGIA VEGETAL FISIOLOGICA II: Relaciones hídricas y asimilación del carbono. (PHYSIOLOGICAL PLANT ECOLOGY II: Water relations and carbon assimilation) Springer Verlag. 1982. 747 p.

Esta obra, escrita en inglés, es el segundo tomo del volumen 12 de la nueva serie de "ENCYCLOPEDIA" OF PLANT PHYSIOLOGY" y fue publicado en 1982 por la casa editorial alemana Springer-Verlag. Comprende 18 capítulos, más de un centenar de ilustraciones, 3 índices (de autores, taxonómico y temas), en un texto de 747 páginas nítidamente impresas. Cabe señalar que el volumen 12 consta de 4 tomos y que en los restantes se discuten las respuestas de las plantas al ambiente físico (I) y al quimicobiológico (III); finalmente se examinan el ciclo mineral, la productividad vegetal y la influencia del Hombre, como procesos de los ecosistemas (IV).

La compleja tarea de preparar el volumen 12 le fue encomendada a 4 autoridades científicas: L. O. Lange, P. S. Nobel, C. B. Osmond y H. Ziegler, quienes, en lo que respecta al tomo II establecieron la política editorial de que la discusión de las relaciones hídricas y la asimilación del carbono tenía que hacerse con criterio ecológico. Es decir, tomando en cuenta el hecho de que esos procesos fisiológicos están íntimamente entrelazados en la planta terrestre, debido a un largo proceso evolutivo que culminó con el surgimiento de mecanismos homeoastáticos para balancear 2 tendencias opuestas pero igualmente significativas para la supervivencia vegetal: la necesidad de minimizar la pérdida de agua y la necesidad de maximizar la ganancia de carbono.

Una vez definido en aquellos términos el objetivo principal de la obra, los editores escogieron a un nutrido grupo de especialistas (26) para que desarrollaran los 18 temas principales (capítulos). Como era de esperar, los autores hicieron una magnífica labor, acorde con su vasta experiencia científica y literaria. Con la selección de tantos especialistas se amalgaron las principales escuelas de pensamiento ecofisiológico: alemana, australiana, austriaca, canadiense, estadounidense, inglesa e israelita. Pero aún así creemos que la naturaleza enciclopédica de "PHYSIOLOGICAL PLANT ECOLOGY II" pudo haberse fortalecido con la inclusión de otras escuelas "más tropicalizadas".

Después de estudiar el tomo II llegamos a la conclusión de que éste es realmente un instrumento informativo de alto valor, y que su uso como libro de consulta por diversos tipos de técnicos y científicos, e incluso por estudiantes avanzados, tiene que beneficiarlos de muchas maneras. En primer lugar, porque los temas se discuten con amplitud y profundidad; porque se revisó la literatura más reciente y en forma casi exhaustiva (en las referencias cuesta encontrar citas a trabajos hechos por científicos latinoamericanos, por ejemplo); porque los autores analizan e interpretan los tópicos en la forma novedosa y muy lógica que es la esencia del objetivo del libro; además, porque se pone énfasis en la necesidad de identificar las lagunas que aún persisten en el conocimiento ecofisiológico y se proponen maneras para corregirlas a base de nuevas investigaciones en que se combinen tecnologías reduccionistas e integrativas, y no sólo las primeras.

Una de esas áreas en que para nosotros, como fitofisiólogo, es más notoria la falta de información directa, es en el conocimiento de las propiedades del agua ligada a los metabolitos de la célula vegetal. Hasta el momento, la Biología Celular Animal (Bioquímica Aplicada) es la principal fuente al respecto; con el agravante de que aún en este campo la investigación es relativamente débil. En efecto, si consideramos que para una mejor comprensión del papel que juegan las relaciones hídricas en el desarrollo (evolutivo) de la capacidad de tolerancia a la desecación, es imprescindible saber tanto sobre las funciones del agua a nivel celular como del sistema suelo: planta:atmósfera, debemos concluir que efectivamente hay que estudiar más a fondo la Biología Celular Vegetal, pero sin restringir la investigación al ámbito de los organismos estructuralmente simples o al laboratorio.

Ahora quisiéramos referirnos a otro aspecto del valor de las obras enciclopédicas. En épocas de crisis económica como la que estamos viviendo, se sabe que la carga que representa la compra de libros y revistas científicas se vuelve más pesada a causa de la inflación y las severas restricciones en materia de comercio con moneda extranjera. Tampoco es un secreto que todavía así se debe satisfacer adecuadamente la necesidad de enriquecer los conocimientos técnicos y científicos, pues de otra manera ni estudiantes, ni profesionales, ni instituciones superiores de investigación y enseñanza, pueden ejercer sus funciones a cabalidad. En estas circunstancias creemos que el trabajo altamente encomiable de autores y editores de un libro de consulta como "PHYSIOLOGICAL PLANT ECOLOGY II", adquiere un nuevo significado al poner a nuestra disposición, en forma condensada, una cantidad de información primaria que obviamente se halla dispersa en incontables revistas de muchos países y cuya

compra está fuera de nuestra capacidad financiera. La magnitud de esta nueva calamidad (de país pobre), la ilustra perfectamente el caso de la Universidad de Costa Rica. Sólo esta institución tiene acumulada una deuda de 461 mil dólares estadounidenses por concepto de compra de revistas, en únicamente 2 años (Semanario UNIVERSIDAD , 15/21 de abril de 1983, p. 6). Esto en si es grave, pero más lo es a nuestro juicio, el descrédito que la morosidad acarrea.

A riesgo de incurrir en dos graves faltas: la pedantería y la subjetividad, trataremos de señalar los yerros del libro, animados solamente por el deseo de cumplir bien con el trabajo de reseñador y la esperanza de que se corrijan si es que ello procede. Veámoslos:

- En el último párrafo de la página 36 se repiten dos líneas completas que son del párrafo anterior.
- En el último capítulo se emplea repetidas veces el sustantivo "principle" en vez del adjetivo "principal".
- Cuatro de los 18 capítulos no tienen la sección dedicada a las conclusiones, a pesar de que éstas son las mejores lecciones para el usuario del tomo II.
- Aunque el Profesor Passioura adopta como definición de productividad fotosintética (p. 20), el aumento neto en biomasa de una planta, o una comunidad de plantas, durante una estación de crecimiento, o quizás un año, luego indica que a escala estacional es conveniente pensar en la productividad (B) de una planta, como el resultado de la multiplicación de la cantidad de agua transpirada (W) por la eficiencia con la que se usa para producir biomasa (WUE) y establece la igualdad, $B = W \times WUE$. Sin embargo, si examinamos "dimensionalmente" (en el sentido físico) esta ecuación, encontramos que es incorrecta. En efecto, si B es una medida de eficiencia fotosintética y no de transpiración, entonces debe tener unidades acordes con su naturaleza, como: kg de materia seca acumulada x m^{-3} de agua transpirada x $año^{-1}$; del mismo modo, si W es el volumen de agua transpirada durante un año, sus unidades deben ser m^3 x $año^{-1}$; finalmente, si por definición WUE es la cantidad de materia seca producida por unidad de agua transpirada por año (porque recuérdese que es a escala estacional), entonces las unidades son: kg x m^{-3} x $año^{-1}$. Sustituyendo en la ecuación anterior tenemos:

$$(kg \times m^{-3} \times año^{-1}) \stackrel{?}{=} (m^3 \times año^{-1})(kg \times m^{-3} \times año^{-1})$$

y,

$$\neq (kg \times año^{-2})$$

Por lo tanto, como no hay coherencia de unidades concluimos que B puede ser equivalente sólo a WUE, "la materia seca producida por unidad de agua transpirada" (p. 20), y nosotros agregamos, por año o estación de crecimiento. Aún admitiendo que las unidades de WUE fuese kg x m^{-3}, es obvio que $(kg \times m^{-3} \times año^{-1}) \neq (kg \times año^{-1})$, y la ecuación sigue siendo inadecuada para definir productividad fotosintética, en los términos que se plantea en el capítulo primero.

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