Effects of macronutrients on the growth and dry matter accumulation of cashew (**Anacardium occidentale** L.)*1/

J. A. FALADE**

COMPENDIO

En un experimento de cultivo en arena se investigaron los efectos de varias concentraciones de N, P, K, Ca, Mg y S sobre el crecimiento del marañón (Anacardium occidentale L.).

Tanto las deficiencias como los excesos de los nutrimientos deprimieron la tasa de crecimiento y acumulación de materia seca. Sólo en el caso del nitrógeno se observaron algunos síntomas visuales de deficiencia. Esta se caracterizó por un amarillamiento general de las hojas, particularmente las viejas, tal como se describe en la literatura para muchos cultivos. El marañón parece ser menos exigente que muchas otras plantas en sus requerimientos nutritivos. La concentración de iones en hojas de 4 meses, debajo de las cuales son probables deficiencias, son: K-0,342; Ca-0,176; Mg-0,088; N-1,24; P-0,118; y S-0,70 por ciento de la materia seca.

Introduction

CASHEW, *Anacardium occidentale* L is widely grown in the humid tropics mainly for its kernel which has been shown to have the highest protein among tree nuts (11). Its shell oil is also becoming of great economic importance as its derivatives, particularly cardol, are used in an increasing number of industrial processes

The kind of information available in the literature on the tree seems to suggest that not much attention has been paid to research into its nutritional requirements. The neglect could be due to an earlier suggestion that cashew must be modest in its nutritional demands since it was found to produce on soils too poor and dry for other crops (6, 7, 8).

Lefevre (4, 5) has since skown that the tree may be as demanding as many other crops. He showed that appli-cation of fertilizer at planting time increased the growth rate of the tree and resulted in fruiting and production starting two years earlier.

From the foregoing, it can be seen that there is need for better understanding of the nutritional demands of the tree. This will help in improving the management of the tree and achieving maximum production.

In this paper the results of the effects of the macronutrients on the rate of growth and dry mater accumulation by the plant are reported. Information is also given on leaf ion concentrations below which nutrient deficiencies may occur.

Materials and methods

It was a sand culture experiment.

The experimental procedure giving details of preparation of the sand medium and solutions, planting, care of the plants and techniques of chemical analysis of plant tissues was as earlier described by Falade (2).

Four levels (Table 1) of each of the macronutrients - N, P, K, Ca, Mg and S were involved in the study. Each solution differed from the reference solution only in its concentration of a particular macronutrient. The reference solution was prepared on the basis of the formula proposed by Hoagland and Arnon (3). There were four replicates of each treatment.

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** Cocoa Research Institute of Nigeria, P.M.B. 5244, Ibadan, Nigeria.

Table 1: Concentrations (meq/l) of various nutrients in the nutrient solutions

Level	Ca	Mg	K	N	P	S
1	0.0	0.0	0.0	0.0	0.0	0.0
2	1.6	0.8	1.2	4.0	0.6	0.8
3	8.0	4.0	6.0	20.0	3.0	4.0
4	80.0	40.0	60.0	100.0	30.0	40.0

The height of the plant from the sand level and the stem girth 1 cm above the cotyledonal node were taken at monthly intervals.

At harvest (seven months after planting) the plants were carefully removed from the sand and the roots washed in distilled water. The plants were then divided into stem, leaves and roots. The eighth and ninth leaves which were at mid-stem and about four months old were removed and washed in distilled water. All the plant sections were dried for 48 hours in an air oven at 70°C and then weighed.

The eighth and ninth leaves were ground and later analysed for the respective minerals.

Results

Growth rate

Only the graphs of stem height against days after planting are presented, since those of girth were not appreciably different in shape. It can be seen from Fig. 1 that for all treatments the curves have distinct sections. An initial period of fast growth was followed by one of relatively slower growth then by another of fast growth. Each section extended over a period of about 70 days.

Generally, the treatments had profound effect on the rate of growth.

The pattern and extent of effect depended on the nutrient considered.

Potassium

There was not much difference between the rates of growth at levels 1 - 3 at any period but that at level 4 was relatively much reduced.

Calcium

The rate of growth within the first 70 days after planting was highest at level 2, lowest at level 4 without much difference between those at levels 1 and 3. After 70 days, no appreciable difference was observed between the rates of growth at levels 1 - 3. At level 4, the plants started to grow faster than that at any other level so much so that the plants recovered from the initial relative stunted growth to be second tallest at harvest.

Magnesium

No appreciable difference was found between the rates of growth at levels 1 - 3 during the first 70 days after which the plants started to grow at different rates with those at level 1 growing faster and at level 3 slowest. The rate of growth at level 4 was lower at any time than that at any other level.

Nitrogen

The rates of growth at the various levels were consistently different except for those at levels 2 and 3 where no appreciable difference was observed until after 120 days after planting. The rate of growth was highest at level 3 and lowest at level 4.

Phosphorus

The rate of growth at level 2 within the first 70 days was highest. There was not much difference between the rates of growth at levels 1, 3, and 4 until about 140 days when the plants at level 4 started to grow faster than those at any other level. The relatively higher rate of growth at level 2 was limited to the first 70 days after which the rate was fairly the same as at levels 1 and 3.

Sulphur

There was only slight difference between the rates of growth at levels 1 - 3. The slight difference occurred in the first 70 days when plants at level 3 were growing faster than at any other level. The rate at level 4 was smallest. This depressive effect appeared to seize after about 70 days.

Deficiency and toxicity symptoms:

No visual symptoms of deficiency or toxicity of Ca, Mg, S or P were observed apart from stunted growth.

In the case of excess K, the older leaves usually developed necrosis at the tips. This quickly spread backwards and within a few days the leaves died and fell so much so that at harvest there were virtually no leaves on the plants.

It was only in the case of nitrogen that deficiency symptoms were observed. It started with old leaves (about 2 months old) which first appeared light greenish yellow. As the deficiency became severer the yellowing got more advanced until all the leaves were light yellow with the younger leaves and the veins greenish yellow. The leaves were also much smaller and the internodes shorter than those of the healthy plants. The stem was stunted and very stiff.

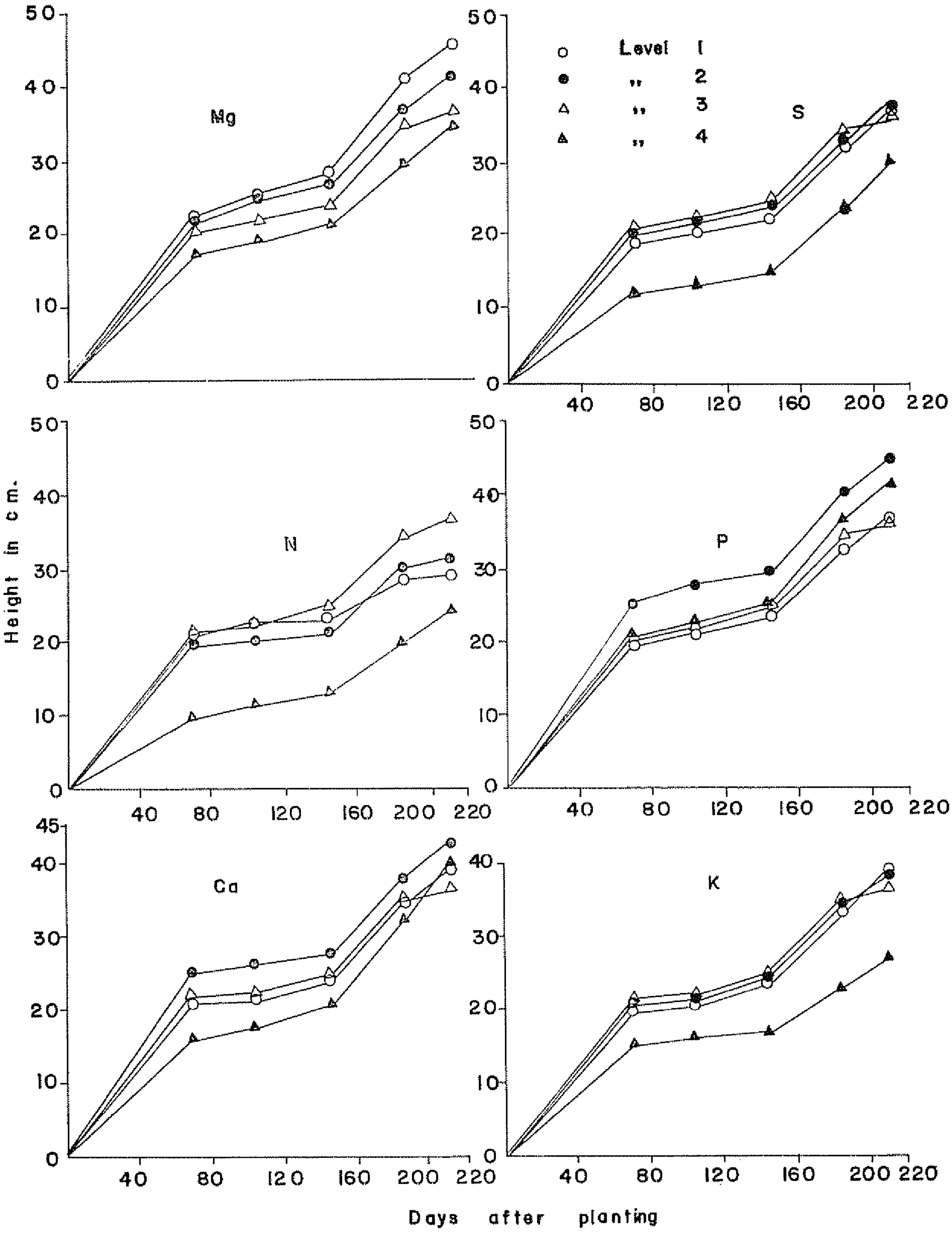

Fig. 1—*Effects of varying levels of nutrients on growth of cashew*

Excess nitrogen was characterised by stunted growth, succulent, glossy and very dark green leaves and very flexible sten which could hardly stand erect

Dry matter

The dry matter of each plant section was plotted against the concentration of each nutrient in the eighth and ninth leaves It is seen (Fig. 2) that in all cases the dry matter first increased to a maximum before falling with increasing leaf ion concentration which was found to increase with increasing concentration of the ion in the nutrient solution

For all the nutrients the maximum occurred at a leaf concentration corresponding to level 2 treatment

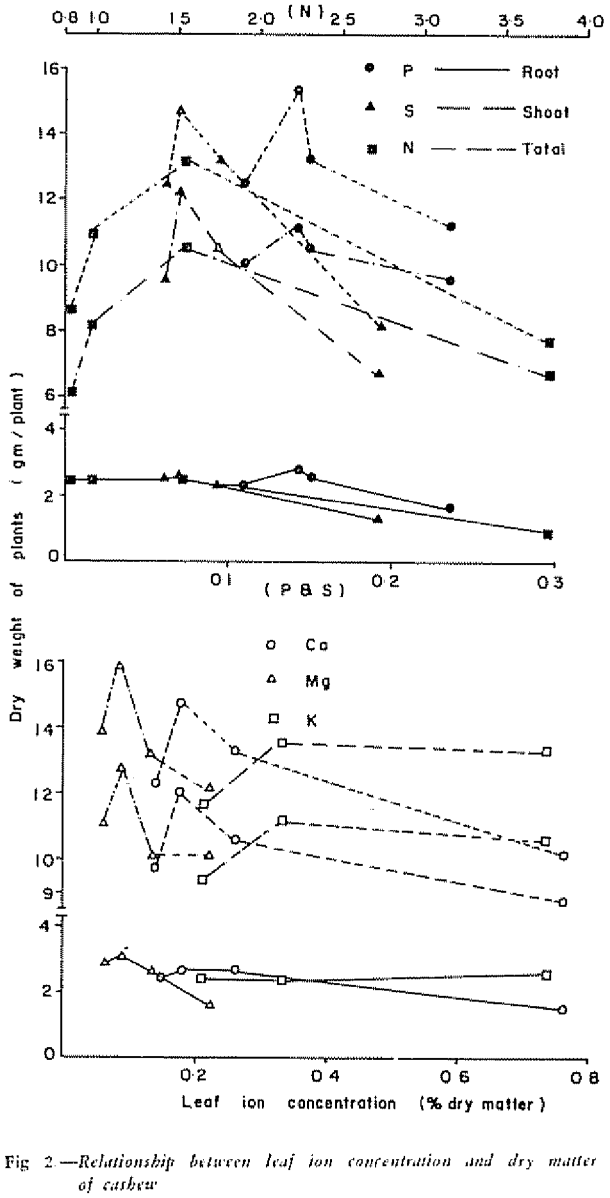

Fig 2.—*Relationship between leaf ion concentration and dry matter of cashew*

except in the case of nitrogen where it was between levels 2 and 3

The various leaf ion concentrations corresponding to maximum growth were K - 0.342; Ca - 0.176; Mg - 0.088; N - 1.24; P - 0.118 and S - 0.070 per cent of the dry matter

Discussion

The data presented show that deficiencies and excesses of macronutrients have profund depresive effect on the perfomance of cashew seedlings. The extent of effect depended on the nutrient considered

No appreciable differences were observed in the rates of growth of plants grown in deficient and adequate levels of Mg, K, N and S within the first 70 days This seems to suggest that the planted nuts hod adequate reserves of these elements to last the growing plants for between 40 - 50 days after germination. In the case of Ca and P there seemed to be insuficient reserves.

It is interesting to note that under the conditions the plants were grown they exhibited a regular growth periodicity of 70 days alternating periods of active growth and rest The reason for this is not known

The results show that cashew may be less demanding than many other crops in its nutritional demands.

The Hoagland solution composition is such that it ensures just adequate supply of nutrients to many crops (3). In the present study, it was found that best growth and maximum dry matter accumulation ocurred at level 2 treatment of any of the nutrients. The concentration of a particular element at this level was just 20 per cent of that in the Hoagland solution

Furthermore the concentration of Mg (0.88 per cent) and P. (0 118 per cent) below which deficiencies of the nutrients may occur in cashew are lower than that of 0 162 and 0.180 respectively in citrus (9, 10). That for K (0 342 per cent) was also much lower than that of 1.0 per cent found by Egbe (1) for *Cola nitida*

Because of its lower nutrient demands cashew may be much slower than other crops in showing visual deficiency symptoms under the same condition. Lack of such symptoms may not necessarily mean that the plant has adecuate supply of nutrients as shown by the results presented. It is in this respect that the use of leaf analysis and critical leaf ion concentration may be vital in detecting nutrient deficiencies in cashew

The critical concentrations of ions presented above can only serve as a guide in the field considering the fact that the plants were grown under controlled conditions and that the soil is more complex than the nutrient solution. Studies under field conditions are necessary to establish more reliable values of such critical ion concentrations.

Summary

In a sand culture experiment the effects of varying concentrations of N, P, K, Ca, Mg and S on the growth of cashew were investigated

Both deficiencies and excesses of the nutrients depressed the rate of growth and dry matter accumulaion Only in the case of nitrogen was any visual deficiency symptoms observed This was characterised by general yellowing of the leaves particulary the old ones as described in the literature for many crops. Cashew seems to be less demanding than many plants in its nutritional requiriments The concentrations of the ions in 4 months old leaves below which deficiencies may likely occur are K - 0.342; Ca - 0.176; Mg - 0.088; N - 1.24; P - 0.118 and S - 0.070 per cent of the dry matter

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Notas y Comentarios

Un medidor simple de humedad del suelo

Un medidor de humedad del suelo, muy simple, pero muy confiable es un instrumento desarrollado recientemente en Israel Puede ser utilizado por cualquier agricultor, sin que sean necesarias habilidades especiales, y proveyéndole de información vital sobre el contenido de humedad del suelo. no en la superficie sino cerca del sistema radical del cultivo (*Innovation*, August 1978).

Distribuido con el nombre de Hydratal 78, el instrumento se parece algo a un termómetro largo. En su extremo inferior hay una taza de cerámica, la que junto con el cuerpo "tensiómetro" del aparato, están llenos de agua recién hervida pero fria Un tubo capilar paralelo extrae mercurio de una taza en su fondo.

Para instalar el instrumento, se perfora un estrecho agujero en el suelo a la profundidad deseada; en muchos casos, el clavar un tubo para agua, de media pulgada de diámetro, dará un hueco satisfactorio El Hydratal 78 se instala con la taza de cerámica en el fondo, a la profundidad de las raíces; para cultivos con sistemas radicales muy pro fundos, puede ser aconsejable un instrumento cerca de la superficie, y otro cerca de las raices más profundas El suelo debe ser compacto cerca del fondo Se aconseja aporcar algo el sitio por donde se asoma el instrumento, para evitar la formación de charcos durante el riego

La altura de la columna de mercurio en el instrumento indicará las condiciones de humedad en la profundidad crítica: conforme el suelo se seca, el mercurio se eleva y de nuevo cae a las lecturas bajas después de lluvias o riegos. Lecturas regulares permitirán al agricultor planificar su programa de riegos más exactamente; lo que resultará en un consumo de aguas más bajo y rendimientos mejores en el cultivo.

Aunque *Innovation* no presenta ilustraciones del instrumento, ni precios, suponemos que se puede solicitar esta información al fabricante: Aharon Tal Eng. & Consult Ltd P O B 556, Herzlia B, Israel.

Notas y Comentarios

Micorrizas y el crecimiento del pejibaye

Una investigación llevada a cabo en Costa Rica por David P. Janos, de la Smithsomian Tropical Research Institute, ha demostrado la importancia que puede tener la micorriza vesicular-arbuscular (V-A) en la supervivencia y crecimiento del pejibaye (*Bactris gasipaes H BK*) (*Principes* 21 (1): 12-18. 1977)

El pejibaye ha sido usado por largo tiempo en América Central y del Sur por sus frutos comestibles y por su madera (para arcos y flechas principalmente). Recientemente se ha despertado interés por el uso de esta especie para la producción del palmito, el cogollo de ciertas palmeras cuyo uso en la mesa es apreciado. Las micorrizas V-A se han encontrado en numerosas especies vegetales y no hay razón para pensar que las palmeras sean una excepción a esta ocurrencia general.

El estudio se condujo en la Finca La Selva, una estación y reserva forestal que la Organización de Estudios Tropicales posee en el noreste de Costa Rica (10° 26' N), en una zona de bosque húmedo premontano tropical, según el sistema Holdridge.

Las semillas esterilizadas se plantaron en suelo aluvial, ácido, típico del trópico húmedo, esterilizado. El suelo de un grupo de 18 latas fue inoculado con raíces picadas de cacao con micorrizas. Las latas restantes recibieron también raíces picadas pero esterilizadas.

Los resultados ponen en evidencia que las micorrizas V-A pueden incrementar grandemente el crecimiento. Las plantas sin inocular crecieron muy poco después de agotadas las reservas en la semilla, y la mayoría murieron un año después de plantadas. Siete de las nueve plantas inoculadas sobrevivieron hasta el final del experimento. Fueron significativamente más altas y tenían hojas más numerosas y más grandes que las plantas no inoculadas. Las plantas inoculadas desarrollaron micorrizas V-A; las no inoculadas no desarrollaron nada.

Las plántulas a las que se les quitó el endocarpio murieron todas. También se observó una falta de respuesta a la inoculación en plántulas a las que se les eliminaron las reservas seminales. Las micorrizas cada vez más se reconocen como que ayudan a una mayor absorción en suelos de bajos niveles de disponibilidad mineral, como en el suelo usado en este experimento. Por eso no son sorprendentes los resultados registrados por Janos. Lo que caracteriza a las plantas que dependen de las micorrizas es que tienen sistemas radicales poco ramificados, compuesto por raicillas rudimentarias sin pelos radicales. Estos sistemas son probablemente uperficiales y la mayoría de las raicillas tienen micorrizas. Estas son características de muchas palmáceas, por lo que es de esperar que otras especies también participen de esta simbiosis, lo que se había comprobado en *Calamus* en Java, en *Cocus nucifera* en Trinidad, y ahora en *Bactris gasipaes* en Costa Rica.

Biblioteca Nacional de Agricultura de Brasil

En junio de 1978 fue creada la Biblioteca Nacional de Agricultura (BINAGRI) vinculada a la Secretaría General del Ministerio de Agricultura del Brasil. El nuevo organismo, responsable de la organización, orientación y coordinación de la información documental agrícola, a través del Sistema Nacional de Información y Documentación Agrícola (SNIDA), deberá recibir por depósito legal la documentación agrícola producida en el país, asegurando su procesamiento y difusión en el ámbito nacional e internacional. Cabe también a BINAGRI la responsabilidad de coordinar e implementar la Red Nacional de Bibliotecas Agrícolas.

En el momento en que el SNIDA es transferido a BINAGRI, se encuentran en franco funcionamiento diversos servicios, como el de diseminación selectiva de información, BIP/AGRI, a base de datos del AGRIS; la publicación de numerosas bibliografías por productos o zonas; reconocimiento de instituciones de investigación agrícola.

El acceso a los documentos originales está asegurado mediante la cooperación de cerca de 200 bibliotecas agrícolas brasileñas y de los componentes de la Red Mundial de Bibliotecas Agrícolas (AGLINET), de la cual la BINAGRI forma parte.

Las actividades de implantación de SNIDA, iniciadas en enero de 1974, venían siendo desarrolladas por la Empresa Brasileira de Asistencia Técnica e Extensão Rural (EMBRATER). La implantación de SNIDA, que deberá estar completada en 1980, cuenta con el apoyo y asistencia técnica del Programa de las Naciones Unidas para el desarrollo (PNUD) y de la FAO.

La BINAGRI lanzará en breve un nuevo servicio de búsqueda retrospectiva de información documental mediante el computador, utilizando varias bases de datos nacionales y extranjeras. El nuevo servicio, que será llamado AGRISEARCH, deberá estar funcionando antes de fin de año.

Con fecha 21 de julio fue nombrado Director de BINAGRI el Ing. Agr. José Carlos Pedreira de Freitas.

Publicaciones

CIDIAT 78. El Centro Interamericano de Desarrollo Integral de Aguas y Tierras (CIDIAT), con sede en Mérida, Venezuela, ha iniciado la publicación de un informativo trimestral, *CIDIAT 78*, destinado a dar a conocer las actividades de la institución, que en su mayor parte son cursos de adiestramiento y capacitación, en categoría de postgrado (Desarrollo de Recursos Hidráulicos), cursos cortos nacionales en Venezuela o en otros países (Ecuador, Nicaragua, Brasil, Honduras, Bolivia, Colombia), cursos interamericanos (en Perú y Colombia), seminarios nacionales, y seminarios internacionales. Tiene un trabajo de "comunicación directa" sobre panorama al sector riego en México, escrito por Enrique Palacios Velez. El director es Germán Uzcátegui y la dirección es Apartado 219, Mérida, Venezuela.