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PROYECTO CENTROAMERICANO
DE FERTILIDAD DE SUELOS

Soil fertility investigation in Honduras. 1977

Ronald Stryker

Anexo 7

CATIE
CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA
TURRIALBA, COSTA RICA
1978

CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA
Program of Annual Crops
CATIE

SOIL FERTILITY

INVESTIGATION IN HONDURAS

1977

BY

RONALD STRYKER

Turrialba, 1978

INTRODUCTION

It is apparent that Honduras is committed and international aid is committed to increasing yields and providing alternative management practices which will furnish sufficient food and agricultural products for the Honduran population. It is also apparent that there is a vast number of agricultural projects incorporating various disciplines dedicated to this objectives. A viable soil fertility program should also provide a service to this objective. A viable soil fertility program should also provide a service to this objective by generating reliable information which can be integrated along with other agricultural disciplines.

Soil fertility is viewed as a basic and fundamental aspect in agricultural development. It must create the capability to "backstop" the various projects and programs aimed at more diversified goals. It must be sufficiently flexible to integrate within other disciplines while at the same time generate the basic soils and crop nutrition data pertinent to agricultural management practices.

The soil fertility program in Honduras which is only one part of the Programa Nacional de Conservación y Manejo de Suelos was initiated many years ago and has received assistance from the North Carolina State University - AID sponsored program in soil Fertility Evaluation, more recently, this project has come under the auspices of CATIE. This assistance has been regionally oriented toward all countries in Central America. Although, this regional approach has certain advantages as seen by the development of concepts and methodologies which are applicable on a regional basis, there has not been sufficient man power nor

resources to support an in-country program.

The program in Honduras has had considerable difficulty in moving ahead. The internal development process has been slow and the present "research capability" is still not sufficient to investigate the soil-plant relationships appropriate to Honduran agricultural problems. The main reason for this dilemma has been the lack of a direct and long range internal committment.

If soils research is to serve Honduran needs, a committment will have to be made in terms of long range planning, as well as financing. The concept of a "research capability" and the internal "development process" are aspects which will requiere direct attention. Very often, these components are not considered in the context of people actually attempting to execute the necessary functional requirements on a daily basis.

The vast number of agricultural projects, funding agencies, receiving agencies, and changing personnel (both Honduran and foreign) often create monumental and certainly understandable problems of coordination. There is and has been almost every concievable kind of external assistance representing the latest concept in agricultural development. There are projects oriented towards small farming systems, big farming systems, specific geographic regions, the Central American region, the third world and even the planet earth. Although, such projects may be well intended, they may also fail primarily because they are insensitive to the real technical problems facing a local situation.

Considerable effort has been made by extensionists, laboratory technicians, and program leaders to improve the soil fertility program

in Honduras during the 1977 work period. Singificant improvements have, in fact been made and there is currently a momentum of interest directed toward continued internal development. There is clearly a need to provide continued external assistance matched with internal development planning and forseeable goals. In that context, this report is offered as working paper which can hopefully assist in defining and/or redefining some of the problems and objectives of a "soil fertility research program in Honduras".

With the new leadership of the Programa Nacional de Conservación y Manejo de Suelos and the creation of the new Programa de Investigación Agropecuaria as well as the new soils laboratory currently under construction, there is every reason to develop a long range comittment of an integrated research program.

SCOPE OF SOIL FERTILITY RESEARCH

The basic objective of soil fertility investigation is to develop a capability to make reliable diagnostic measurements on any given soil and thereby ascertain its nutrient supplying ability. These diagnostic techniques should first, indicate whether the soil nutrients are present in sufficient or deficient quantities for the desired crop or cropping systems. The aim, is to predict whether the crop will or will not respond to additional nutrients. If it is determined that a soil is deficient in one or more nutrients, then it becomes necessary to determine the amount or proper rate of additional nutrients required. This second aspect is determined by a knowledge of the nutrient requirements of the crop or cropping system and the nutrient supplying power of the soil on which the crop is to be grown.

In order to develop the above capability, methodology is necessary which will generate reliable data and provide a means of implementing site-specific recommendations as to the inputs required for efficient crop production systems. Methodology implies a series of integrated research, education, training and service functions. This aspect will be presented in more detail in the section titled (Functional component system).

Applying the basic principles of soil fertility investigation with appropriate methodology is only the framework of a viable program. These principles and methodologies must be flexible and, moreover, oriented toward the real agricultural problems facing Honduras.

Soil fertility investigation when viewed in the appropriate context

can be oriented toward various aspects of agricultural problems. However, it is important to understand the range of activities and interdisciplinary effort necessary for this to be accomplished.

In reality, soil fertility research implies a working knowledge of those biological and physical processes responsible for transferring sufficient quantities of the correct nutrients and in the correct balance into crops or cropping systems. It is essential to view soil fertility investigation in the context of Nutrient requirements for specific crops and/or cropping systems. Likewise, neither soil fertility nor plant nutrient requirements can be effectively studied without considering soil and water management systems. These three components are basic to the overall objective of a soil fertility program in which the goal is increasing the production of food containing the proper quantities and balance of nutrients for livestock and human consumption. There are obviously other disciplines equally important to this objectives such as disease and insect control, marketing, transportation and social economic factors. However, these components are not considered to fall within the immediate framework of soil fertility investigation.

Once a viable program begins to generate reliable data, a system of transferring this data and extrapolating information is necessary. Thus, the above research base must develop a system of soil classification whereby soils can be grouped into various management potentials.

Nutrient Requirements

The potential for diversified crops and agricultural systems

relevant to the range of soil and climatic conditions in Honduras is enormous. Intensive agricultural systems are being introduced utilizing a multitude of mixed cropping patterns, new plant species, and new varieties. These kinds of systems raize a whole realm of critical questions regarding nutrient requirements and therefore, the kinds of stress placed on the soil to obtain adequate nutrients. Although considerable knowledge is available under monoculture systems, this has only limited value in tropical multiple cropping systems.

Under systems where several different plant species may be grown on the same soil in one year, the total nutrient requirements may not only by greater than with monoculture systemsbut also vary between each species. The nutrient stress placed on the soil will be determined by the nutrient requirements of each species, these requirements as a function of space and time, and also the effects of the systems itself on nutrient availability.

Questions such as the "carry over" or "residual" effect of fertilizer nutrients must be considered in relation to the time of planting. Placement and timing of fertilizer nutrients is much more critical with multiple cropping.

A better knowledge of the soils nutrient supplying ability will provide a means to adapt specific cropping systems. At the same time, the nutrient requirements of these various cropping systems must be known in order to match them with compatible soils.

Soil and water management

The lack of water during critical periods of crop growth is still probably one of the most limiting factors in agricultural production in

Honduras. Distribution of rainfall is eratic and short term water deficits can often eliminate any benefit which might have come from fertilizer inputs.

On the other hand, high intensity rainfalls are common and much of the agricultural land is highly vulnerable to erosion. This is sometimes aggravated by the fact that much of the natural vegetative cover and crop residues are either burned or removed from the land during certain periods of the year.

Conservation practices are receiving considerably more attention in Honduras in an attempt to reduce the loss of soil and also to control water movement. Many other related practices such as irrigation, mulching, green manure crops and tillage alternatives should also be incorporated into soil and water management activities.

It is important to note that all of the above practices are concerned with the efficient utilization of soil nutrients and water by crops. Moreover, they represent the means to manipulate the availability of nutrients in the soil. Soil fertility investigation must concern itself with soil and water management practices and vice versa if real solutions are sought to agricultural production problems.

Soil Management Classification

Probably the most difficult and yet most important area of soil fertility work is the problem of extrapolating research information from one geographic to another. It is obviously impossible to do extensive soil fertility studies on all of the different soil types or even series representing potential agricultural development. It is

therefore imperative that sites be carefully selected according to a system of classification which will allow for the development of "management units" based on land capability. This component requieres a strongly coordinated effort with those agencies involved on soil classification.

A regional approach wich takes into account classification schemes and research being done in other countries should be of benefit in this context. For example, some countries have done more extensive classification work while others have done more extensive fertility work. Moreover, many of the soils and climatic factors as well as management potentials are similar from one country to another. By selecting pertinent sites for research studies and exchanging information on a regional basis, needless repetitions of data collection may be avoided.

The regional approach, however, is not meant to infer that an in-country program is of any less importance. To the contrary, the in-country approach is of vital importance to Honduras at this time and considerable effort is needed to coordinate the various disciplines and research activities within the country into a joint effort.

THE CATEGORICAL IMPERATIVE: A Functional Component System

The development of methodology appropriate to soil fertility investigation is paramount if a program is actually going to be of any benefit.

Considerable research and subsequent development of methodology has taken place over the years in conjunction with an AID-North Caroline State University agreement. Much of this work has evolved from

studies representing a wide range of tropical and sub-tropical soil-climatic conditions. Within the Central American region, the effort has been primarily directed toward a regional approach with the idea that coordination and information transfer will expedite the development process. However, the regional approach cannot have much impact unless it is matched by a coordinated country committment. Honduras is lacking this committment at present.

During the 1977 work period, the Honduran program received nearly full-time acess to a trained technician in soil fertility investigation. This technician was actually designated to work equally in two other countries but risked the consequences by attempting to stress program requirements in Honduras. Much of this activity was oriented toward methodology, training and the need for facilities to support a program. In this respect, CATIE has provided both training and methodology transfer to extensionists, laboratory technicians and program leaders from Honduras. The Pan American school at El Zamorano has also received the same training and methodology for one technician. This technician in turn has and is presently assisting the national porgram in Honduras in terms of soil analyses, laboratory and greenhouse training.

It should now be apparent that the Honduras national program must decide whether it wants a functioning program or would rather continue in the make-shift state which has existed for some time. If a functioning program is desired, an in-country committment with external assistance from AID is suggested. Without considerable emphasis on a functional system that actually generates reliable data and can transfer

these data to users (farmers), there cannot be much to expect in the way of research benefits.

The methodology, physical facilities and personel required to create a functionable program are oriented around the following components.

Site Selection, site information and sampling

Laboratory analyses

Interpretation and Correlation of Laboratory data with field data

Greenhouse Experiments

Field Experiments

Recommendations and Extension of Research Results to farmers

This component system is sufficiently flexible to orient soil fertility investigations toward almost any type of fertility problem encountered. It also can be utilized to coordinate investigations with soil classification, soil and water management and other related activities.

Each of the components include specific methodologies (see Annex) which allow for the complete investigation of a given field problem terminating with recommendations applicable to farmers. However as noted, most of these specific methodologies have been developed on a regional basis. There is now a strong need to direct and apply these methdologies to specif soil-crop management problems in Honduras. When this is done, it may be found that new or different procedures are necessary or that the system needs alteration. Nevertheless, it is important to get the system moving before such decisions can be made.

The methodologies currently being used have been designed for intermediate level technology (i.e. computers and highly sophisticated equipment are unecessary). All of this technology has been transferred to CATIE as well as Honduran technicians. Because much of this technology is also being utilized in other countries of Central America, future application of the methodology in Honduras will be greatly assited by cooperation with CATIE.

Specific Problems and Remedies

1. More effort is required to obtain and catalog accurate site information in order to follow through with experimental results and define priority problems. This will also help to coordinate the work with soil classification and other disciplines. Access to previous work in the various interdisciplinary field needs to be readily available.

2. Plant sampling procedures will be required if more work on micronutrient deficiencies, nutrient requirements and fertilizer efficiency studies are initiated.

3. Continued stress should be placed on obtaining representative soil samples and means by which these samples are efficiently transferred to the laboratory, analyzed and returned to the user with recommendations .

4. Considerable work is needed to streamline routine laboratory procedures. The purchase of multiple unit equipment would increase not only the capacity for analyses but improve precision and accuracy over the current approach.

5. The new laboratory, when ever it is finished, will require considerable planning in order to coordinate the various kinds of analyses with respect to laboratory organization. For example, there will be a need for soil fertility analyses, plant analyses, water analyses, soil classification analyses and possibly others. Each of these analyses require specific steps which may, in some cases, be common while, in other cases be different. In addition, there will be a need to consider routine analyses (procedures which are proven) and investigative analyses (procedures which are not proven) in appropriate categories.

6. A system of ordering chemicals, replacement parts and maintaince is desperately needed.

7. In general, the laboratory needs greater authority with emphasis on solving problems in items 4, 5 and 6.

8. Correlation and interpretation of laboratory results with field data needs much greater emphasis. This should be focused toward gathering specific information regarding specif crops or cropping systems in conjunction with specific soil-climatic conditions. In this way, priority agronomic problems can be delineated and investigated in order of importance. Certain sacrifies will undoubtedly be required regarding the question of attempting to correlate data over broad land areas in contrast to specific soil-crop management systems. Both approachs are needed, however, a large effort is required to do both well. Nevertheless, the latter approach needs much more attention at present.

9. Greenhouse facilities are needed and considering the low

cost ($500 - $2000) of such an item, there is no reason why one should not be built. Greenhouse studies help to delineate what are the most important nutrient porblems so that field experiments can be designed properly. Considering the time and expense of running a good field experiment, greenhouse, facilities are of minimal cost. In addition, greenhouse, studies help to define nutrient fixation problems, nutrient interactions in the soil affecting availability, and fertility relationships between soil associations.

10. Field experiments need to be designed to fit the problem of the soil and crop in question. Up to the present, most all field experiments have been standard N,P,K rate trials and until the last year, many of these were initiated without prior soil analyses. Often, the fertility problem may be something other than N,P and K. Now that the soil analyses capability is improving, field experiments can be based on site problems rather than assuming that N,P,K are always the limiting factors.

In general, field experiments represent the culmination of all information from sampling, laboratory analyses and greenhouse studies. In addition, they should receive inputs from soil classification and cropping data.

11. Fertilizer recommendation need a stronger relationship to current Honduran research activities. Soil analyses and field experiments should be designed to eventually delineate the major nutrient requirements within given regions and/or specific soil-crop management systems. More effort should be givento the extension aspects of this component, particularly in terms of training extensionistas in the

overall process of the functional component system and relating recommendations to farmers. Demonstration trials, field days and other extension activities which link the program with the farmer should receive particular emphasis.

SOIL FERTILITY PROBLEMS IN HONDURAS

Much of the fertility work done in Honduras as well as Central America has focused on N, P and K field rate studies for the different food crops such as maize, beans and rice. In many cases, these experiments have failed to show any response to fertilizer additions. For example, a summary of 240 experiments (FAO field trials in Honduras over a 10 years period) show that approximately 50% of these experiments did not respond to any combination of fertilizer N, P and K treatments. Moreover, the yield obtained with these "no response" experiments were relatively low, (ranging from 2 - 5 T/ha, for maize, beans and rice). Under these conditions it is logical to reason that some other factor was limiting production more than N,P or K.

Another problem often encountered with field experiments is the extreme variability within the experimental area. Even though the experimental sites appear uniform, individual plant growth is often highly variable. In some cases, this may be due to improper seed placement, fertilizer placement and/or faultly management of the experiment in general. However, there are numerous cases where the variation appears to be related to soil conditions.

1977 Work Program

The research program during 1977 attempted to focus attention on the above stated problems. Particular emphasis has been place on obtaining representative soil samples, conducting greenhouse studies, expanding the soil analyses capability and characterizing soil-crop management systems.

Three regions (Centro Occidental, Centro Oriental, and Occidental) were selected for primary areas of study. Soil samples were collected in each region and analyzed according to current procedures (for methodology see Annex). In addition, bulks samples were collected from selected areas for detailed greenhouse studies (for methodology, see Annex). Summaries of the soil analyses are illustrated in Tables 1-6. Example of several greenhouse studies are given in Tables 7-14.

Field experiments were installed within each of the three regions and representing the basic food crops: corn, beans, rice, wheat, potatoes and tomatoes. Unfortunately, some of these experiments did not have prior soil analyses nor greenhouse information because this capability was not available until August 1977. These experiments were therefore, standard N, P and K rate experiments utilizing the Guadalupe design (see Annex). They are still being analyzed but preliminary data suggest that approximately the same percentage (50%) will not show any response to N, P or K additions.

It is possible to make several conclusions regarding the study of soil fertility problems in Honduras based on the above studies from 1977 and also from the accumulation of previous work on N, P and K rate experiments. The following is an attempt to present some of the more important soil fertility problems in Honduras in relation to the current capability to investigate these problems. Suggestions are offered for future research effort.

Nutrient Problems

Nitrogen is still the most likely nutrient to be limiting crop production. Presently, fertilizer recommendations are based on accumulated average response data from large numbers of experiments over broad geographical regions. In general, these recommendations are reasonable as long as average data are considered. However, under site specific situations, a given recommendations may be inappropriate because of other limiting factors or special problems unique to a given site. This becomes especially important considering the fact that a small farmer cannot afford errors of this nature.

More research effort should be directed toward increasing the efficiency of fertilizer N uptake by the crop or cropping system. Nitrogen utilization is highly subject to soil and water management practices. Fertilizer sources, time of application, residual effects in conjunction with management alternatives such as rotations, mulching, different crop species and water conservation are examples of some of the considerations relevant to improving sites-specific recommendations.

Phosphorus is also of particular concern and is likely to be deficient on many agricultural soils. Unlike nitrogen, soil analyses can predict with reasonable accuracy when and where deficiencies occur. Some soils in Honduras are particularly more deficient than others. For example, many other upland soils of ignimbrite origen from the Copan region to the La Esperanza region (Table 1) can be highly deficient. Valley soils in the Danli area (Table 5), on the other hand, have somewhat better native supplies. Nevertheless, deficiencies are common in all region. It is difficult and possibly even unwise to attempt to

delineate general phosphorus deficiencies with respect to specific soils or regions because many farmers have used fertilizer in various areas which result in carry-over effects (residual). In fact, it is common to find extreme variability in phosphorus levels within small areas (less than 1 ha) and this is likely a result of past management practices.

Phosphorus deficiencies can be detected by sampling and soil analyses continued emphasis on this component will establish the variability within small areas as well as delineate predictable response. In general, the critical level is reasonably well established for P, however, there is a need to check critical levels under more precise conditions such as specific soil-crop management systems. Some crops like potatoes, for example, often have a higher critical level than other traditional food crops.

Potassium deficiencies are not a serious problem on Honduras soils (Table 1,3,5). Less than 5% of the field experiments done in Honduras show any response to potassium. Likewise, greenhouse studies done during 1977 show no response to potassium. Soil analyses and current critical levels are reasonably accurate for predicting deficiencies. However, like phosphorus future work should stress the need to refine critical levels under more precise conditions.

Potassium is included in nearly all fertilizers used in Honduras. The continuos application of potassium on certain soils may, in fact, be detrimental. For example, certain soils in the Copan and La Esperanza region are Magnesium deficient or have levels which are marginal (Tables 1 and 3). Some of these soils also are high in Calcium and

Potassium, thus, creating cation balance problems. Continual potassium fertilization on high potassium soil is likely to aggravate or increase the likelihood of magnesium deficiencies. This is illustrated in an experiment with maize in the Copan region (Table 15).

Soil analyses for Ca, Mg and K is highly beneficial in delineating where problems actually exist. Some effort is needed to discover how extensive an area is affected by Mg deficiencies and cation inbalance problems. Current fertilizer recommendations suggesting potassium applications on soils already having adequate or high quantities of this element should be discontinued, and readjusted according to soil analyses.

The cation status of many of these soils could be related to their genesis and morphological characteristics. A combination of soil fertility and soil classification work in these areas would help to delineate possible problems of Mg deficiencies and cation inbalance.

Excessive exchangeable acidity and low base status does not appear to be a serious problem except on some of the very low pH soils. These soils are normally restricted to upland conditions in the western part of the country. In any case potential problems are readily predictable by soil analyses including pH, base status and possibly organic matter determinations.

Calcium deficiencies are not a serious problem except where continuous cultivation on low pH soils have occurred with no attempt to replenish base loss. This problem was observed in the La Esperanza region at a National School where students were attempting to grow basic food crops. This soil was in the worst physical and nutrient lacking

conditions of any soil observed in Honduras. This case is pointed out to illustrate the following: In this example, soil productivity was wasted to the point where it will be difficult to recover. All bases were deficient, exchangeable aluminium was toxic, phosphorus was deficient and several micro-nutrients were deficient. The physical structure had deteriorated and little active organic matter existed. It will not only be complicated to recover the fertility status of this soil but it will take considerable time with a complex research capability. This capability does not exist nor is it likely to exist in the near future. If a minimal soil fertility input had been availalbe to assist the management of this soil, this case could have been prevented.

Sulfur deficiencies do exist in Honduras. The extent of this problem has not been well documented in the past. Studies during 1977 indicate that fairly widespread areas may be affected. Greenhouse studies (Tables 7-14) done during 1977 showed that 70% of the soils selected were deficient in sulfur. Sulfur was the third most serious limiting factor next to nitrogen and Phosphorous. Sulfur deficiency was more serious than potassium in these studies.

From a priority stand point, this means that more effort is warranted on sulfur research.

Of the soils showing sulfur deficiencies, most all were valley soils under more intensive cultivation and lower organic matter contents. Soils from the upland regions of La Esperanza, for example, with high organic matter content did not show deficiencies. Presently, there is not a reliable soil analyses which can be used to predict sulfur response.

Future work could be oriented around attempting to develop methodology to predict Sulfur response. However, a concentrated effort to continue to investigate selected soils, under greenhouse conditions is suggested. Soils responding in the greenhouse could then be further investigated in the field.

Micronutrient deficiencies occur and have been observed, however, deficiencies appear to occur sporadical and are difficult to delineate. Zinc and Magneses seem to be more commonly deficient than Cu, Fe or B.

Current methodology is useful in detect problems but considerably more work is needed in terms of defining critical levels and improving laboratory methodology. Future work should include developing a plant analyses capability. This capability would assist in the diagnosis as well as correlation of soil analyses with field data.

Conclusions

In summary, the most important fact to consider when dealing with nutrient deficiencies is to define them in terms of priority limiting factors. A secondary or micronutrient problem may be more limiting in a given situation than the major nutrients. It is important to develop the capability to diagnose the problem or problems before designing field experiments.

More effort is required to establish critical levels and fertilizer requirements with time under definable soil-crop management systems. Considerable information could be obtained by orienting future work toward the selection of specific soil-climatic sites in conjunction with specific cropping systems and studing the longer range aspects of fertility inputs.

Fertility work should be done in conjunction with soil management, water management and conservation practices. Management and conservation practices will affect nutrient availabilities and therefore, pose a means by which nutrient availabilities can be manipulated. It should be noted however, that management and conservation practices can be considered themselves as limiting factors of production. Water management is particularly important in this regard because nutrient availability is directly related to water transfer processes. Water management and conservation remain as one of the most important factors affecting crop production in Honduras.

Finally, the committment necessary to attack the above kinds of problems must be seriously considered. The functional component system must be given top priority as it is currently the most limiting factor affecting the ability to solve Honduras agricultural problems. Emphasis should be given to coordinating the various disciplines and agencies already working in related areas into a joint effort.

ACKNOWLEDGEMENTS

My thanks and appreciation go to the many extensionistas, laboratory technicians and Honduran program leaders for their enthusiasm and cooperation during 1977. Special appreciation is given to Germán Uribe, Director of the IICA Office, Honduras, for providing office space, beautiful secretaries and logistical support as well as limitless energy for action. Numerous people within the Ministerio de Recursos Naturales, the Pan American School and CATIE provided invaluable cooperation in different aspects of the work. Finally, I would like to thank Dr. J. Walker, Dr. R. Bazán, Ing. R. Díaz-Romeu, W. Bejarano, and Dr. J. Soria for their knowledge of how things work (most of the time).

LIST OF TABLES

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Table 3. Number of Soil Samples falling into four categories of nutrient availability (Ca, Mg, K Ca/K and P in Region Centro Occidental)

Table 4. Number of Soil Samples falling into four categories of nutrient availability (Cu, Fe. Mn, Zn and pH in Region Centro Occidental).

Table 5. Number of Soil Sample falling into four categories of nutrient availability (Ca, Mg, Ca/Mg, Mg/K and P in Region Centro Occidental)

Table 6. Number of Soil Samples falling into four categories of nutrient availability (Cu, Fe, Mn, Zn and pH in Region Centro Occidental).

Table 7. Greenhouse study (Region Centro Occidental, N° 4)

Table 8. Greenhouse study (Region Centro Occidental, N° 5)

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Table 10. Greenhouse study (Region Centro Occidental, N°9)

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Table 13. Greenhouse study (Region Centro Occidental, La Esperanza, N° 13)

Table 14. Greenhouse study (Region Centro Occidental, La Experanza, N° 16)

Table 15. Maíz experiment with negative potassium response (Region Occidental).

Fig. I REGION DE COPAN, HONDURAS 1977

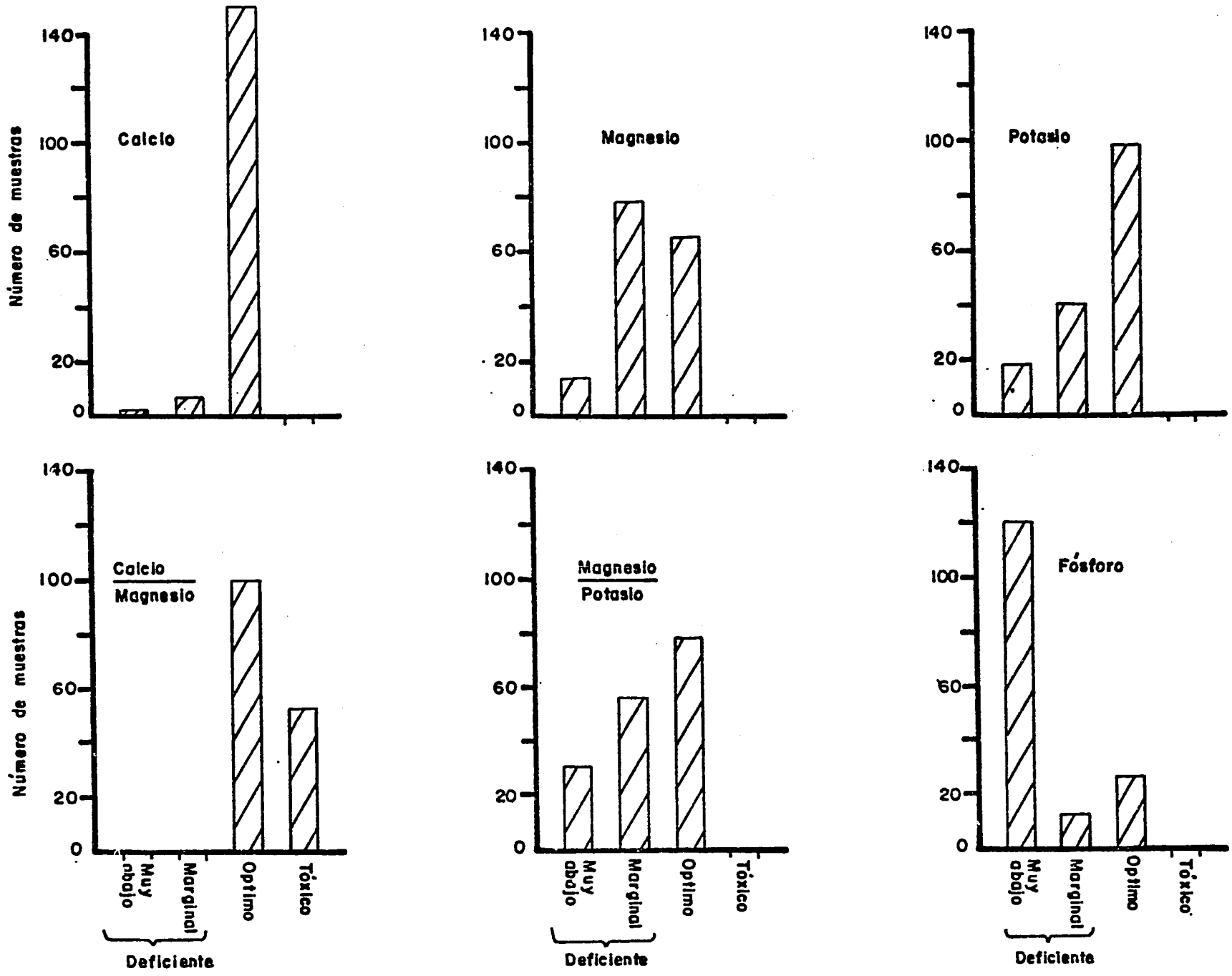


Fig. 2 REGION DE COPAN, HONDURAS 1977

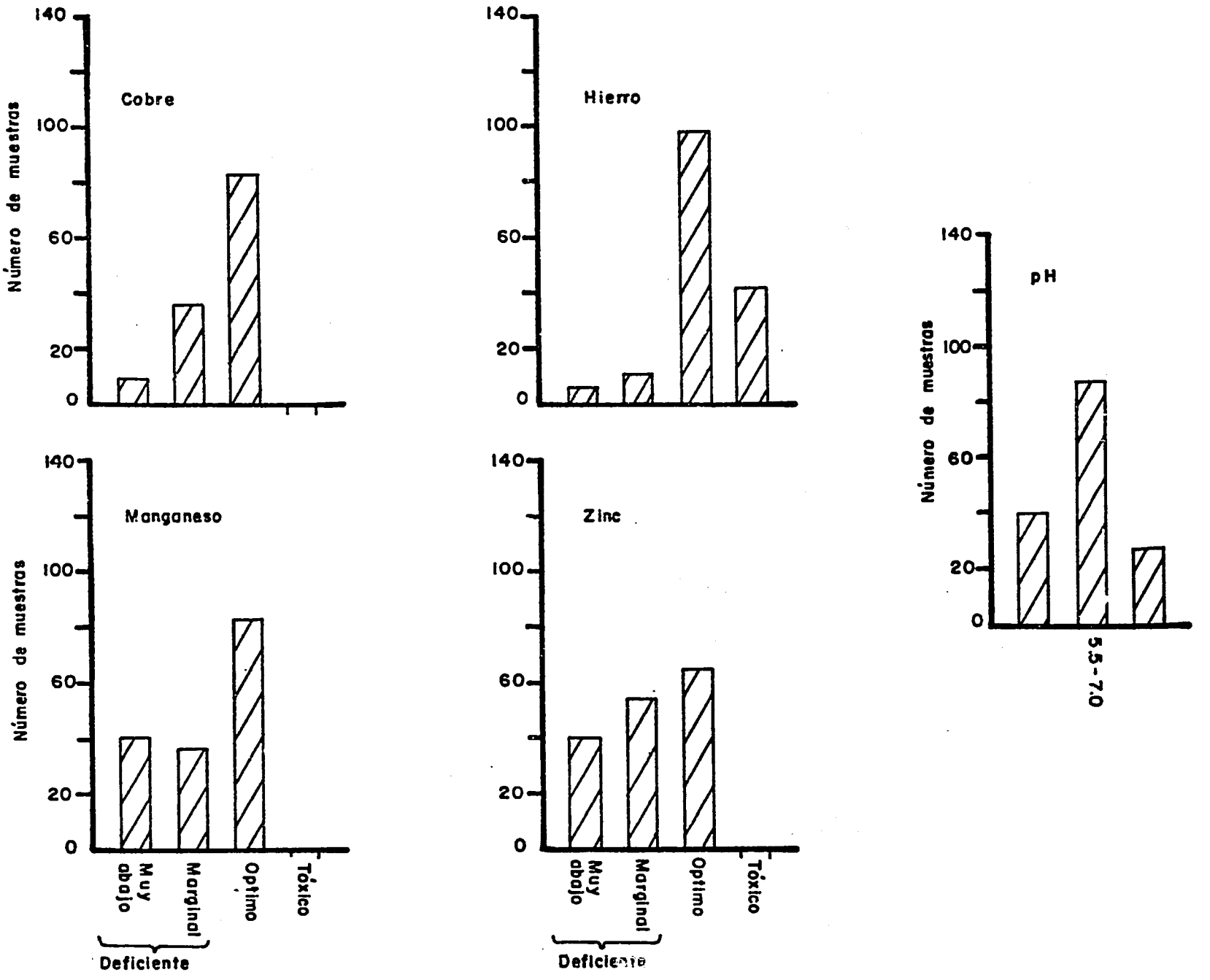


Fig. 3 REGION DE COMAYAGUA, HONDURAS 1977

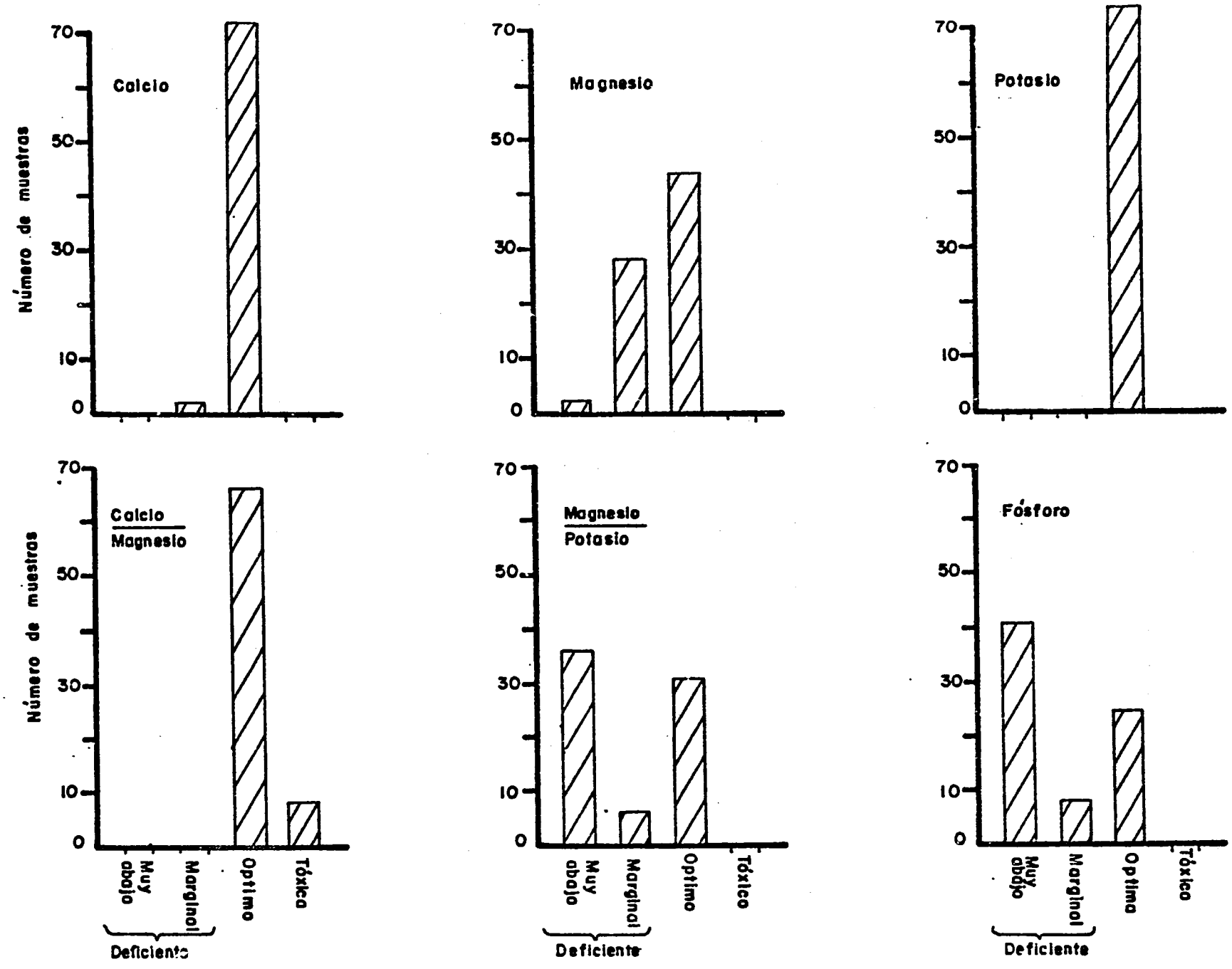


Fig. 4 REGION DE COMAYAGUCO, HONDURAS 1977

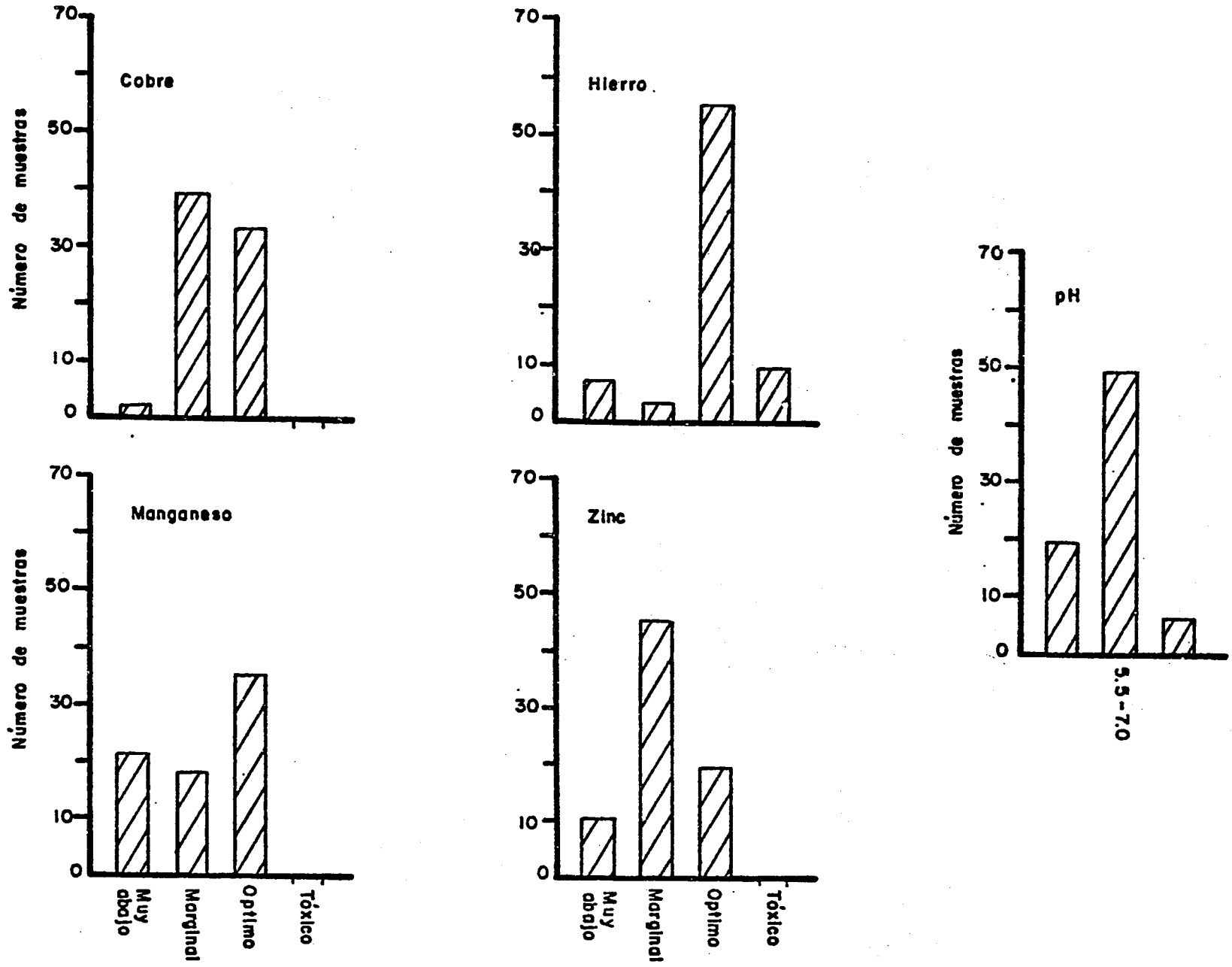


Fig. 5 REGION DE DANLI, HONDURAS 1977

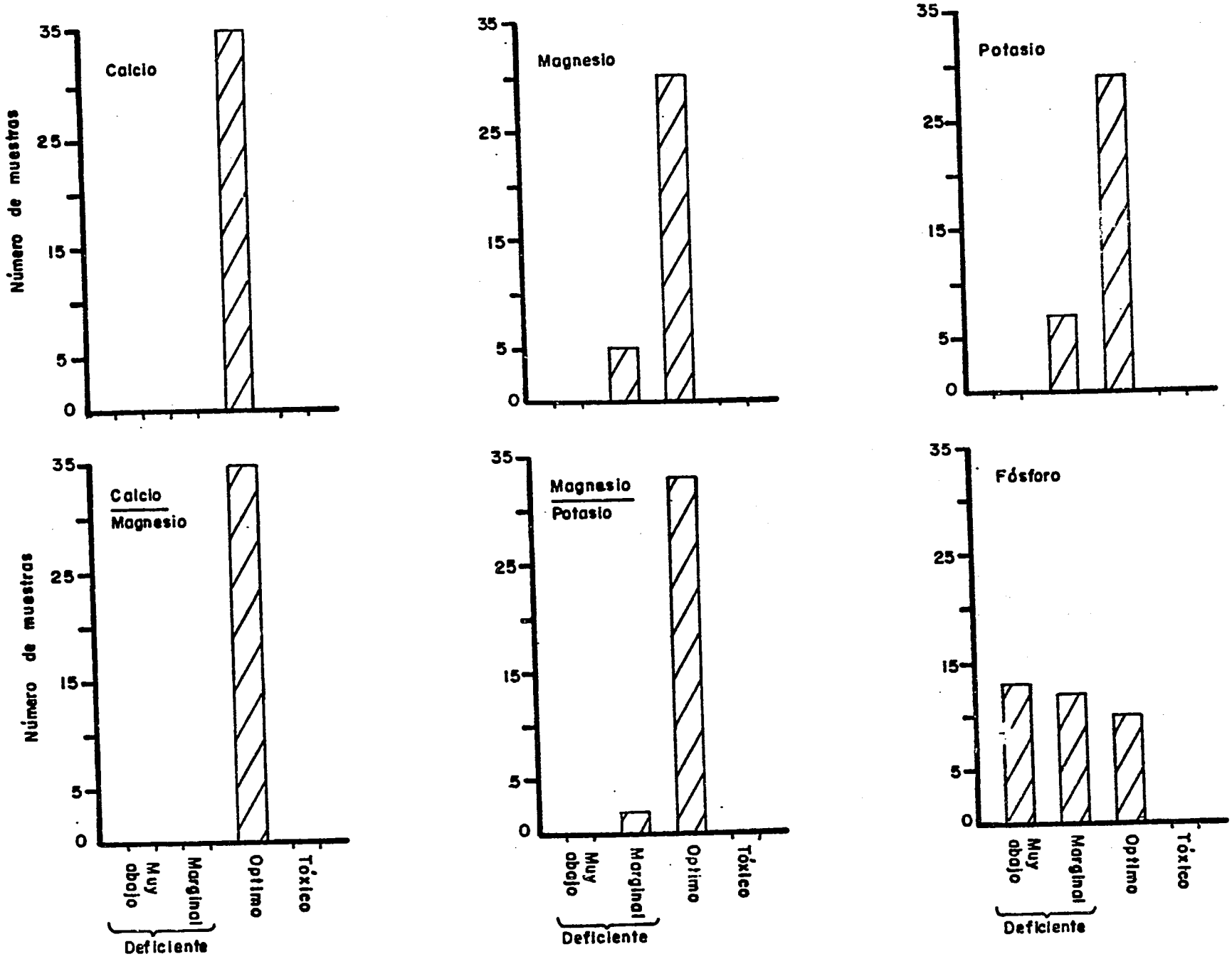


Fig. 6 REGION DE DANLI, HONDURAS 1977

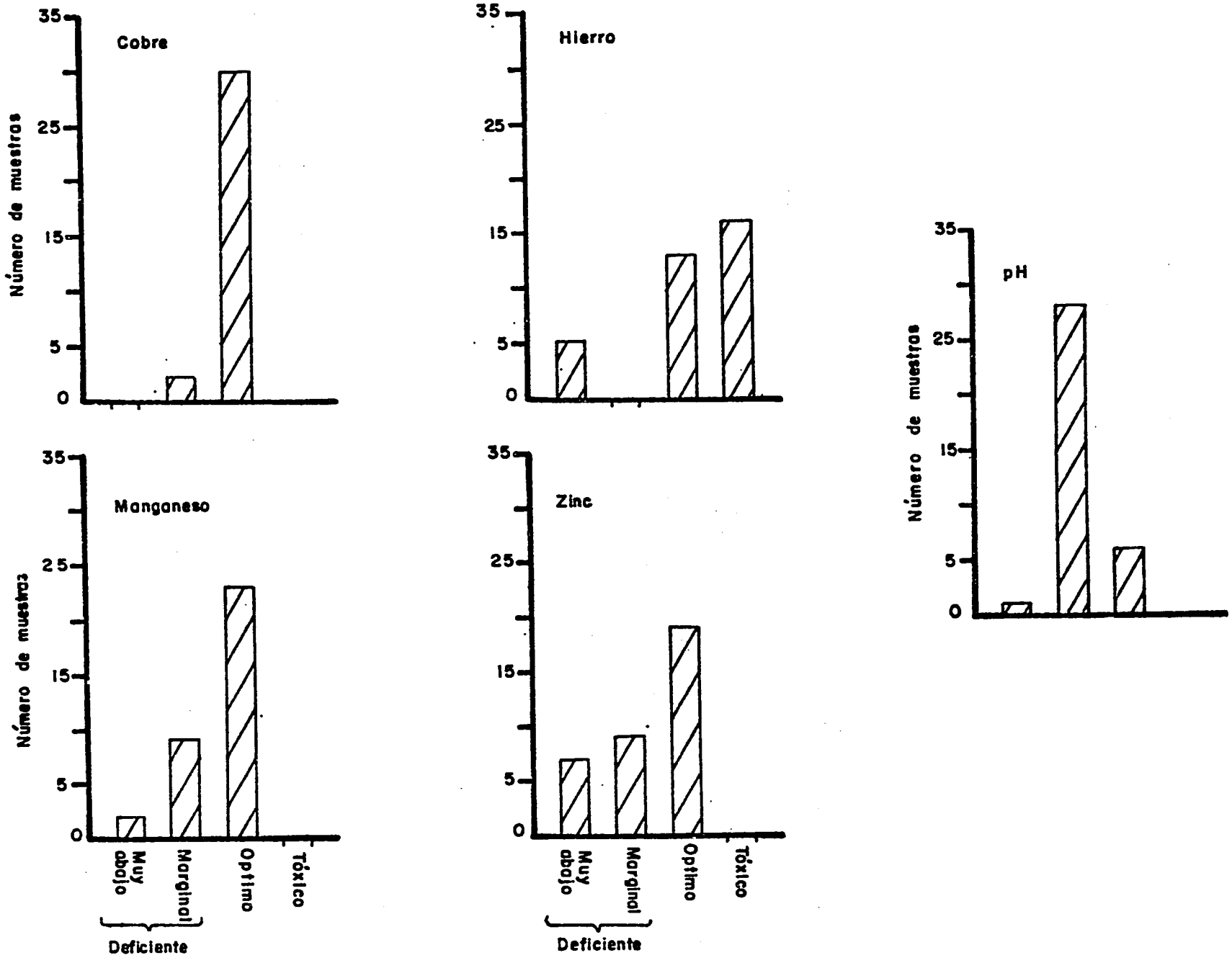


Figura 7

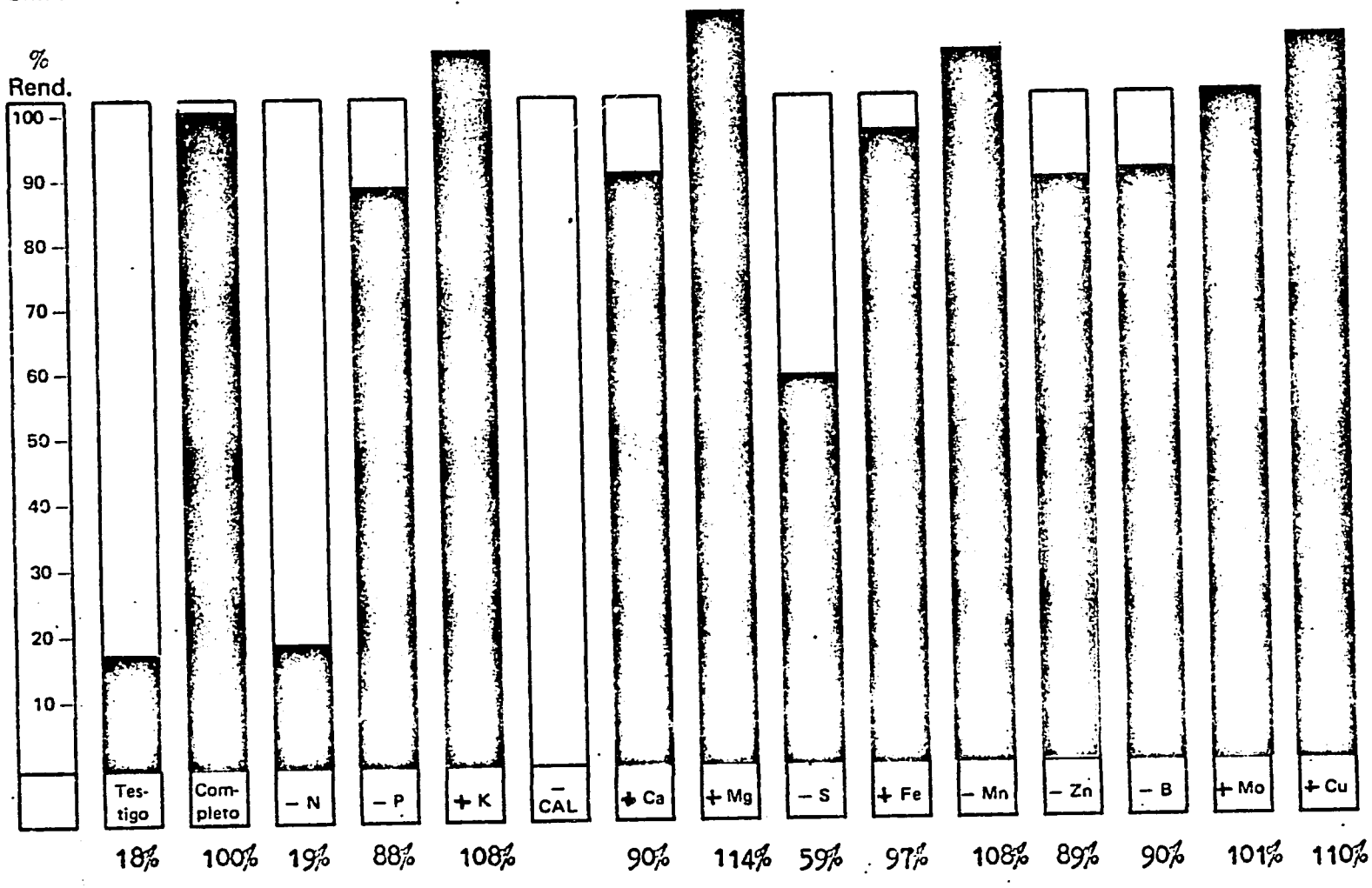
Final

28 días

Ubicación: Grupo Sifon – Ajuterique
Comayagua, Honduras

Suelo: # 4

Clima:



Análisis

NITROGENO	0.0
FOSFORO	15.0
POTASIO	0.68
CAL	0.2 acides
CALCIO	14.3
MAGNESIO	2.76
AZUFRE	12.5
HIERRO	40.5
MANGANESO	4.6
ZINC	2.7
MOLIBDENO	
BORO	0.4
COBRE	8.6
pH	7.4
textura	franco aro.
M.O.	3.15

Comentarios:

Figura 8

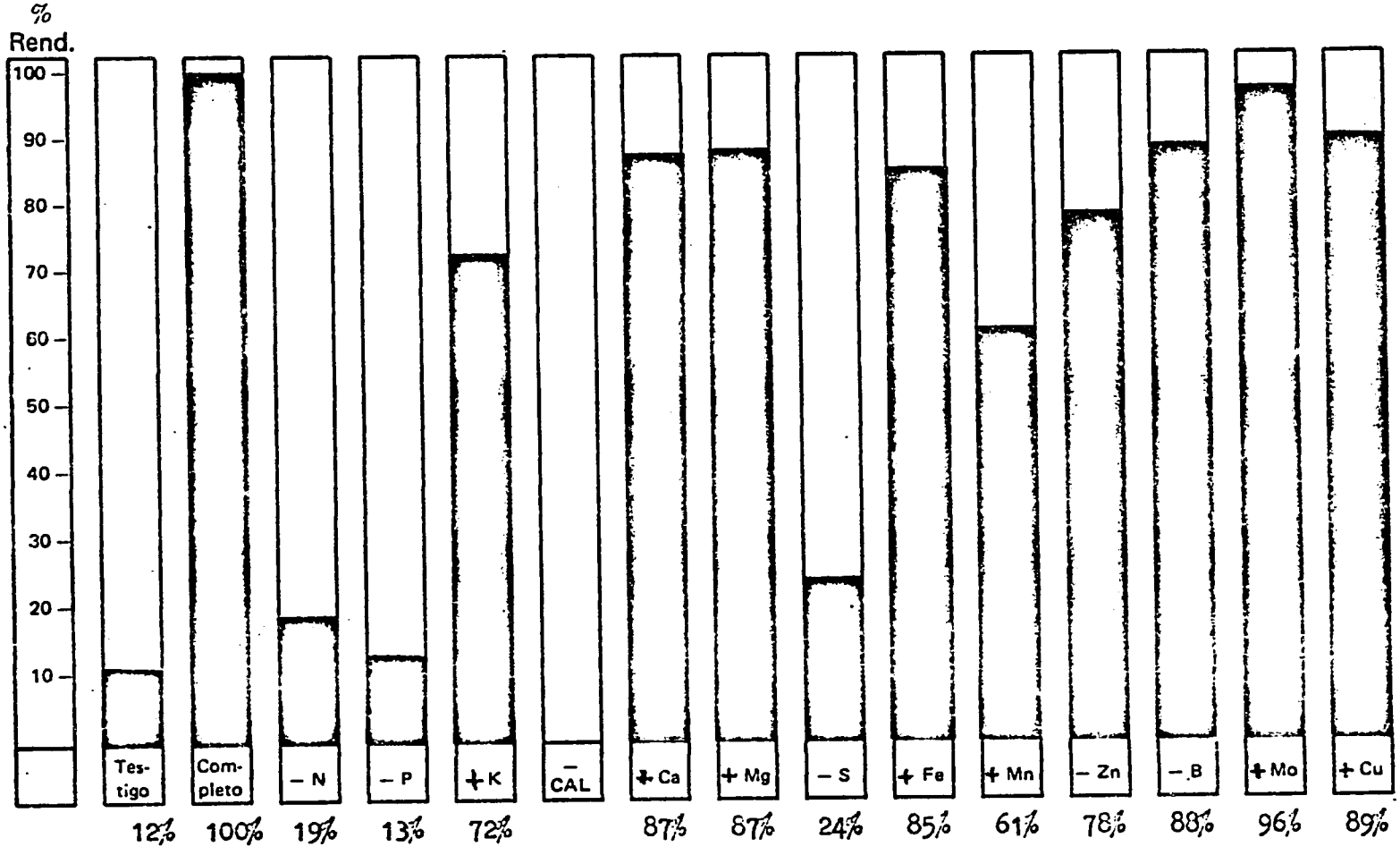
Final

28 días

Ubicación: San Antonio Savanna
El Eden, Comayagua, Honduras

Suelo: #5

Clima:



Análisis

NITROGENO	0.0
FOSFORO	6.7
POTASIO	0.8
CAL	0.2 acidez
CALCIO	6.95
MAGNESIO	1.74
AZUFRE	13.1
HIERRO	87
MANGANESO	143
ZINC	3.5
MOLIBDENO	
BORO	0.55
COBRE	4.8
pH	6.05
textura	fr arenoso mf.
M.O.	3.08

Comentarios:

CRECEGRAMA

PROGRAMA DE FERTILIDAD DE SUELOS - CATIE - TURRIALBA, COSTA RICA

Figura 9

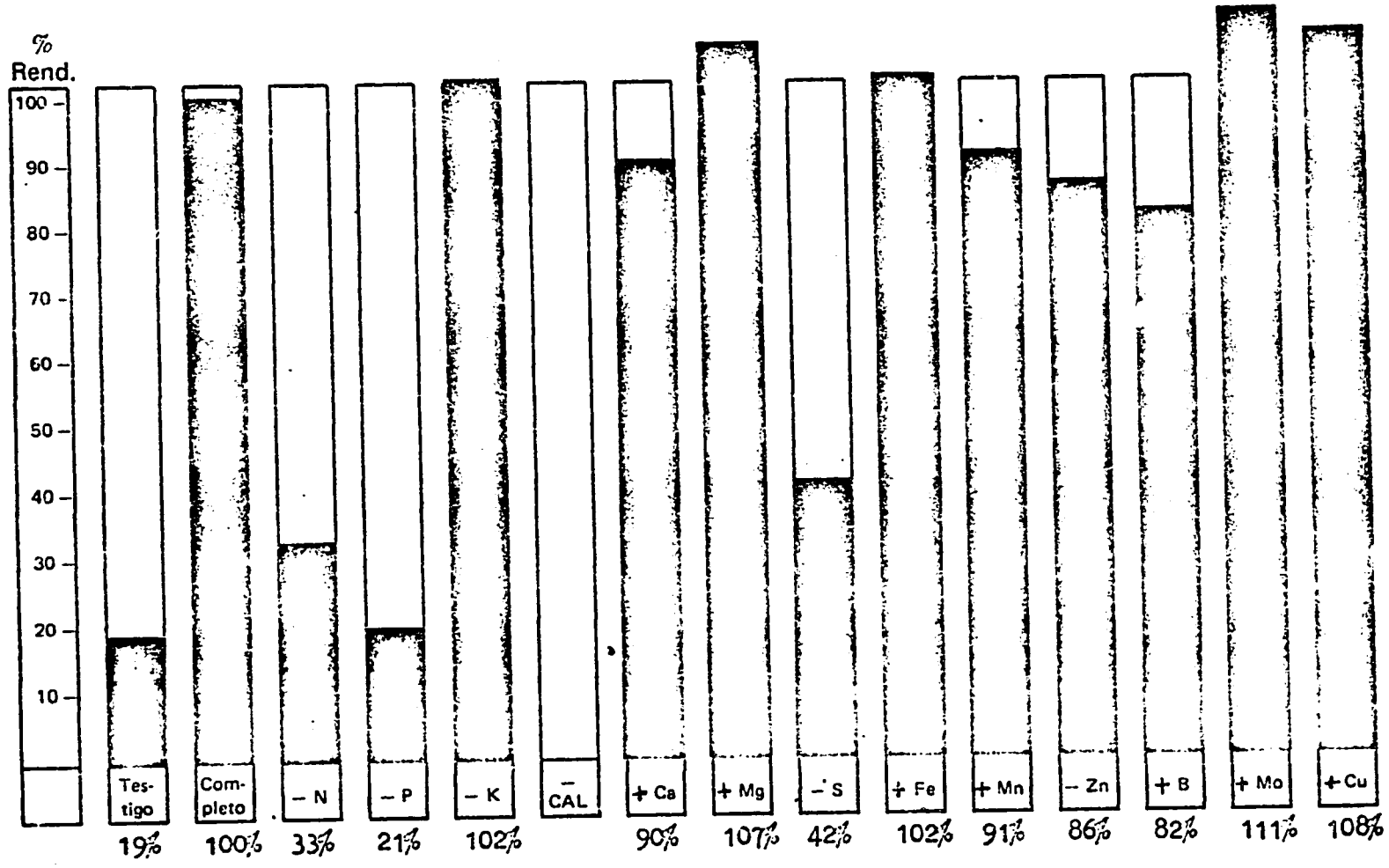
Final

28 días

Ubicación: Comunidad Ocotapeque
Cpoan Chip

Suelo: # 8

Clima:



Análisis

NITROGENO	0.0
FOSFORO	10.0
POTASIO	0.58
CAL	0.2 acidez
CALCIO	22.5
MAGNESIO	3.8
AZUFRE	12.4
HIERRO	154.0
MANGANESO	93.8
ZINC	5.7
MOLIBDENO	
BORO	0.83
COBRE	7.2
pH	5.97
textura	franco
M.O.	2.2

Comentarios:

CRECEGRAMA

PROGRAMA DE FERTILIDAD DE SUELOS – CATIE – TURRIALBA, COSTA RICA

Figura 10

Final

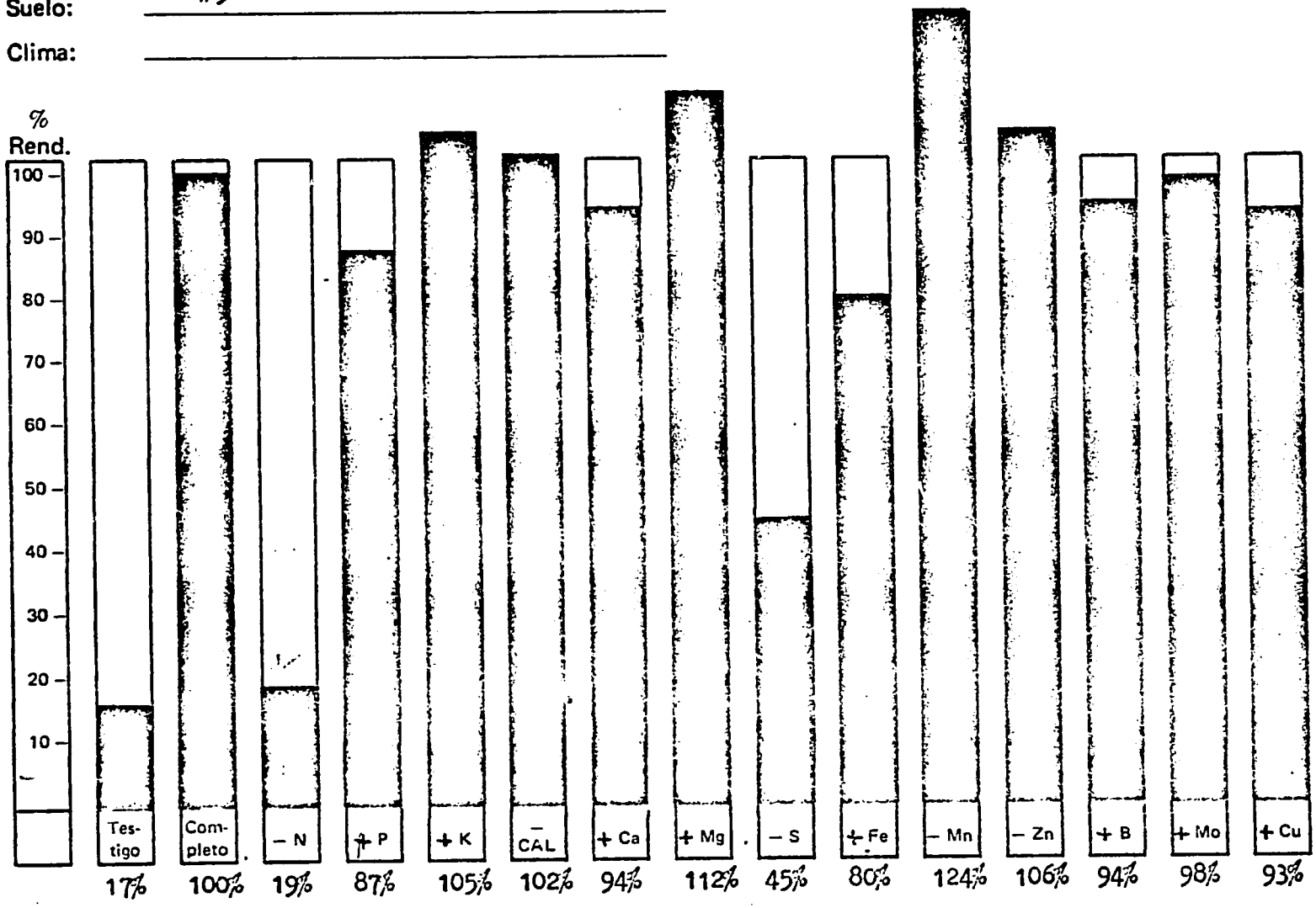
28 días

Ubicación: La Paz – Subseccional – Anach

LaPaz #1

Suelo: #9

Clima:



Análisis

NITROGENO	0.0
FOSFORO	63.0
POTASIO	1.44
CAL	0.3 acidez
CALCIO	12.7
MAGNESIO	5.67
AZUFRE	15.1
HIERRO	13.5
MANGANESO	4.0
ZINC	5.5
MOLIBDENO	
BORO	0.73
COBRE	6.2
pH	7.02
textura	franco arcill.
M.O.	2.21

Comentarios:

Figura II

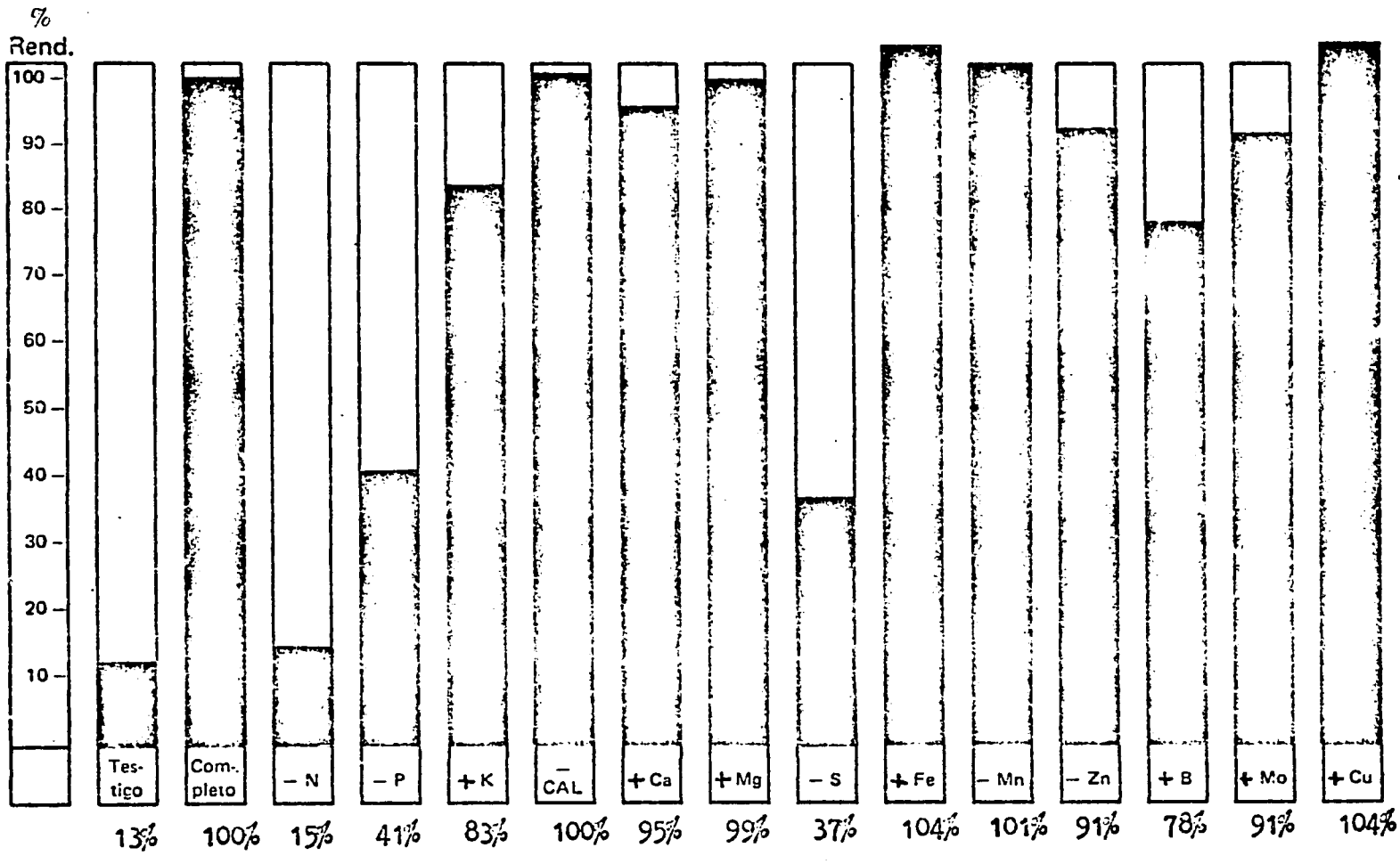
Final

28 días

Ubicación: Subseccional Anach – Legomani
Comayagua

Suelo: # 10

Clima:



Análisis

NITROGENO	0.0
FOSFORO	17.0
POTASIO	0.9
CAL	0.5 acidez
CALCIO	11.4
MAGNESIO	3.9
AZUFRE	16.0
HIERRO	26.9
MANGANESO	6.5
ZINC	4.5
MOLIBDENO	
BORO	0.73
COBRE	8.4
pH	7.44
textura	franco arcill.
M.O.	2.65

Comentarios:

Figura 12

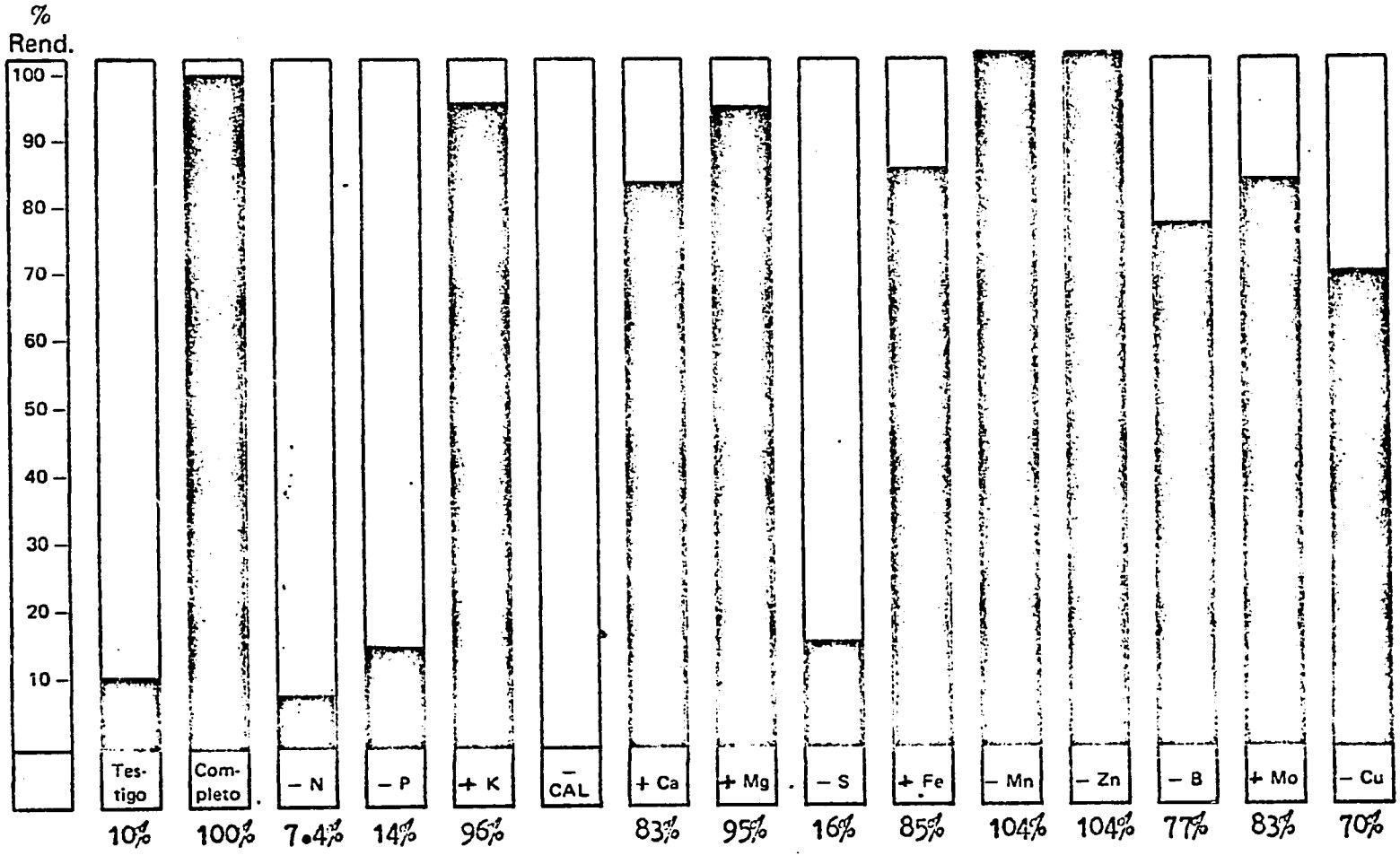
Final

28 días

Ubicación: X – 2nd lote Asentamiento "Jigua", Florida, Copan Honduras

Suelo: # 12

Clima:



Análisis

NITROGENO	34.8
FOSFORO	11.4
POTASIO	1.4
CAL	0.2 acid. ext.
CALCIO	11.5
MAGNESIO	2.34
AZUFRE	17.1
HIERRO	241
MANGANESO	10.8
ZINC	3.0
MOLIBDENO	
BORO	0.2
COBRE	2.7
pH	5.87

Comentarios:

Figura 13

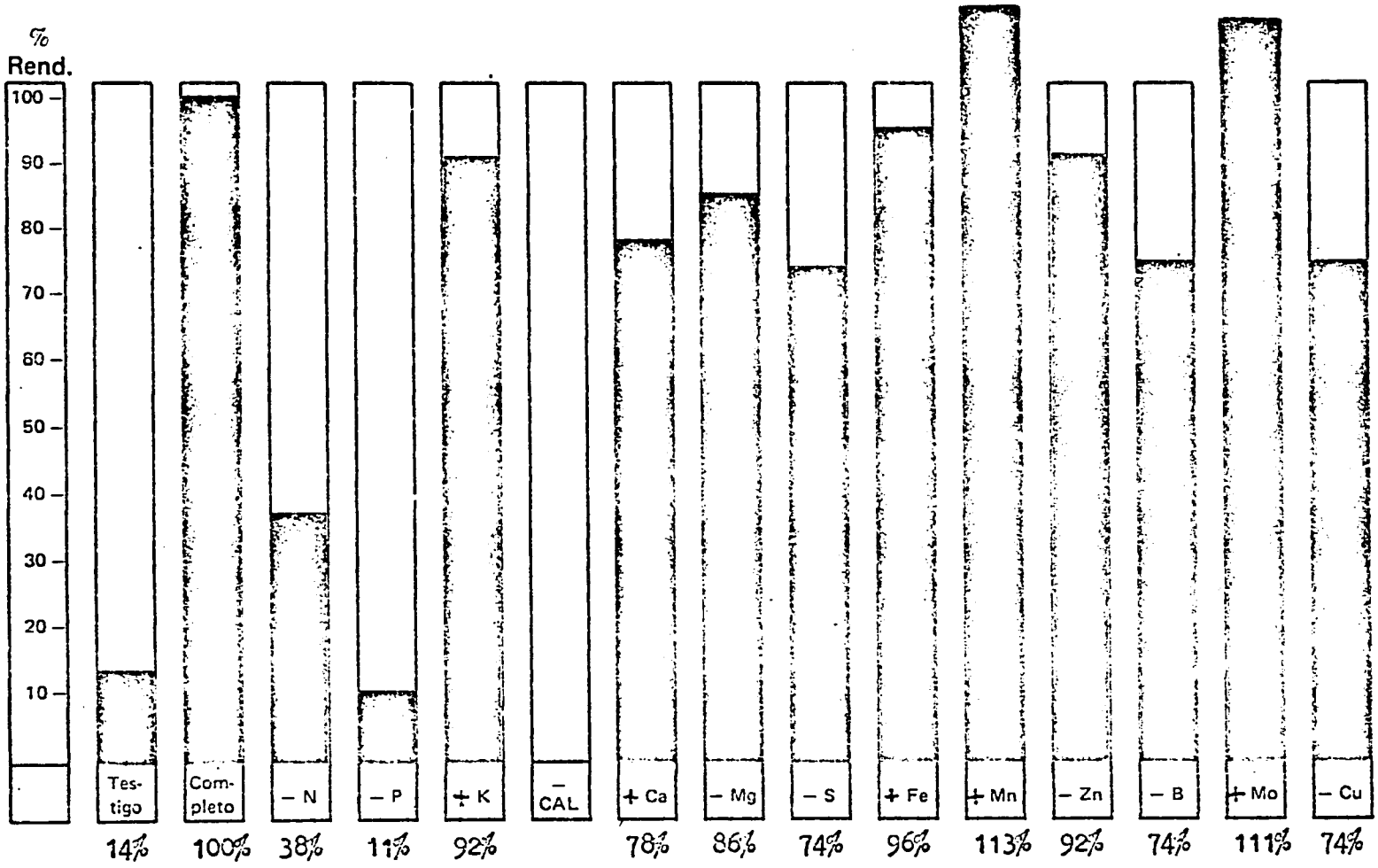
Final

28 días

Ubicación: D. Aguilar La Esperanza Honduras

Suelo: # 13

Clima:



Análisis

NITROGENO	51.2
FOSFORO	10
POTASIO	0.7 acid.
CAL	0.6 ext.
CALCIO	5.4
MAGNESIO	1.2
AZUFRE	5.2
HIERRO	48
MANGANESO	18.3
ZINC	4.6
MOLIBDENO	
BORO	0.2
COBRE	2.8
pH	5.45

Comentarios:

Figura 14

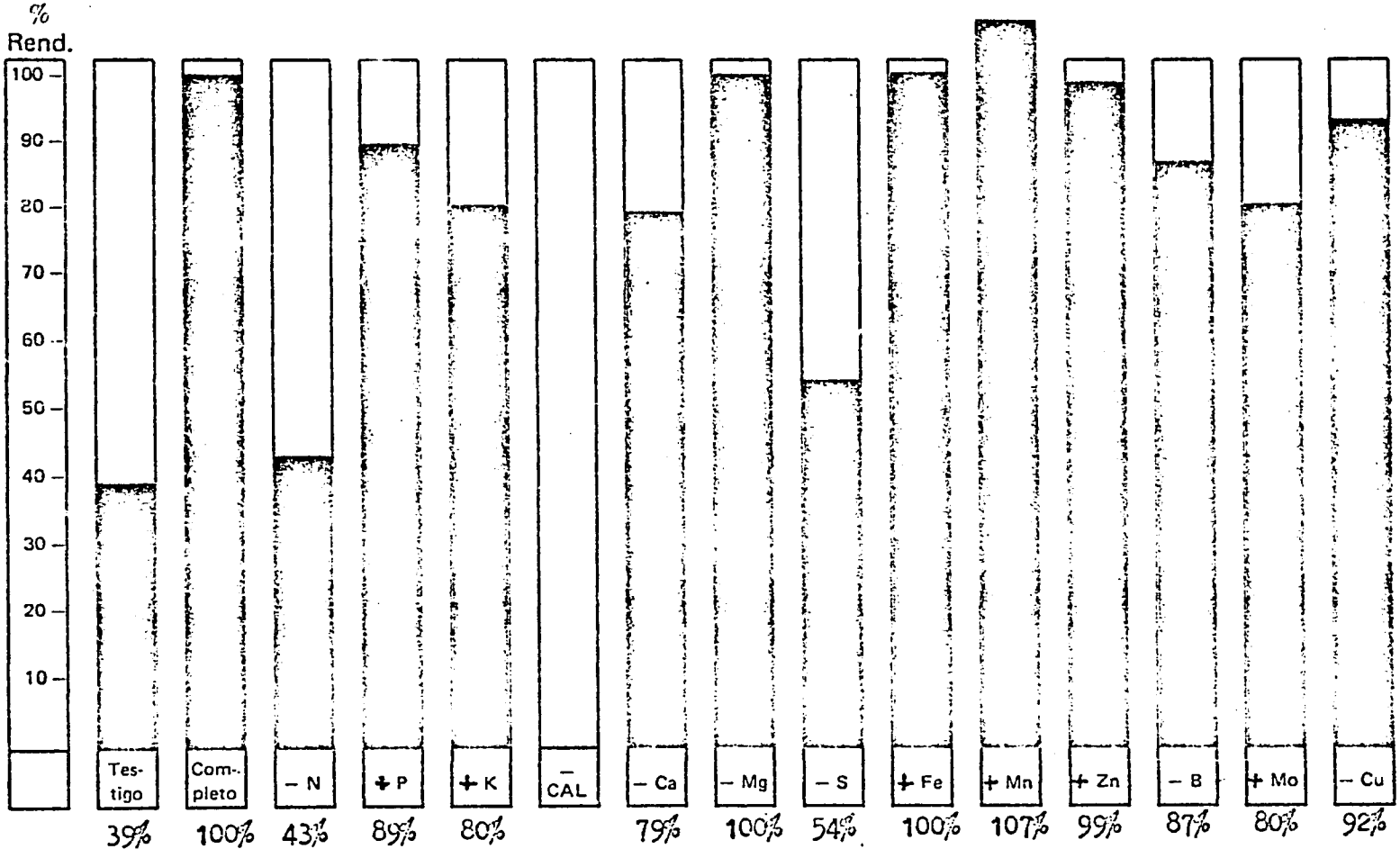
Final

28 días

Ubicación: Enrique Betencourt La Esperanza Honduras

Suelo: # 16

Clima:



Análisis

NITROGENO	65.9
FOSFORO	116.5
POTASIO	6.1 acid.
CAL	0.5 ext.
CALCIO	7.75
MAGNESIO	1.3
AZUFRE	5.2
HIERRO	396
MANGANESO	266
ZINC	20
MOLIBDENO	
BORO	0.2
COBRE	2.0
pH	4.65

Comentarios:

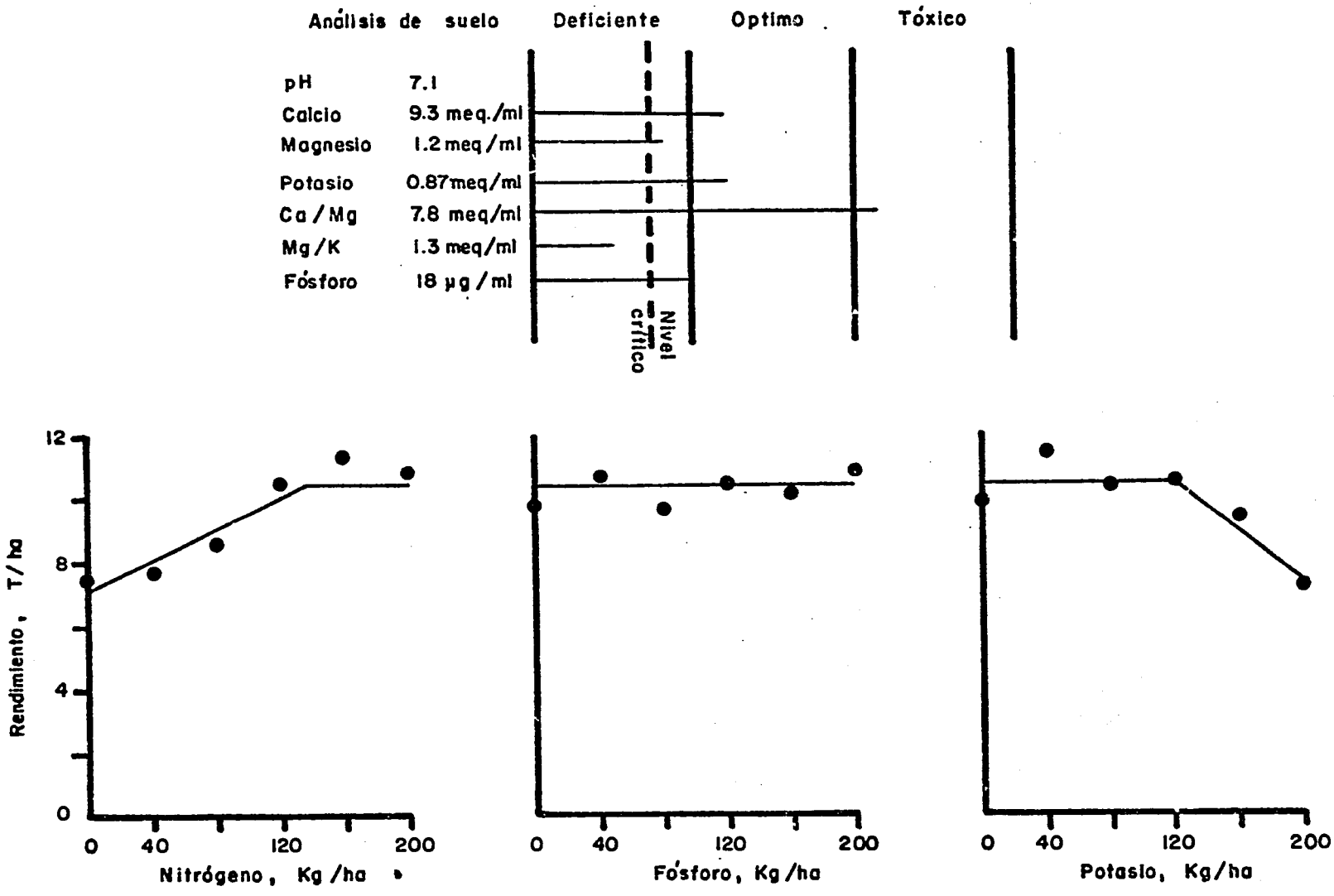


Fig. 15 MAIZ ENSAYO, COPAN, HONDURAS 1977