Root Distribution of Plantains Growing on Five Soil Types[1, 2]

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ABSTRACT

Plantain roots decreased sharply with depth and distance from the pseudostem on 5 soils typical of vast areas in the tropics. Primary roots in the upper 15 cm of all soils decreased from an average of 111 cm/1,000 cm^3 of soil at 0-30 cm from the pseudostem, to 29 cm/1,000 cm^3 of soil at 60-90 cm from the pseudostem. At 0-30 cm from the pseudostem, roots decreased from 111 cm/1,000 cm^3 of soil in the upper 15 cm of soil to 11 cm/1,000 cm^3 of soil at the 30-45 cm depth. No roots were present below 45 cm in any soil.

INTRODUCTION

Information on the distribution of plantain roots in different soil types is important as a basis for developing effective cultural practices such as irrigation and fertilization. The root system of bananas (*Musa acuminata*, AAA) has been studied by Sumerville[4], but we found no reference to such studies with plantains (*Musa acuminata* × M. *balbisiana*, AAB).

This paper describes the distribution of plantain primary roots in five different soil types typical of large areas in the humid tropics.

MATERIALS AND METHODS

Following is a brief description of the sites and soils where the studies were conducted.

1. Corozal clay at Corozal

This site is located at an elevation of about 200 m and receives an annual rainfall of about 1,650 mm. Average annual temperature is about 25° C with mean monthly variations of about 5° C.

The Corozal (Ultisols) is a clayey, mixed isohyperthermic Aquic Tropudults, derived from early tertiary volcanic conglomerates. The surface soil is well drained but the subsoil is only moderately so. The surface soil (0-30 cm) is clayey with a fine, subangular, very strong blocky structure. The subsoil has brown streaks, and thick continuous clay films cover the aggregates. The predominant clay minerals are kaolinite and vermiculite.

[1] Manuscript submitted to Editorial Board July 9, 1979.

[2] This paper covers work carried out cooperatively between Agricultural Research, Science and Education Administration, USDA and the Agricultural Experiment Station, Mayagüez Campus, University of Puerto Rico.

[3] Horticulturist, Soil Scientist and Research Technician, Science and Education Administration, USDA, Río Piedras, PR, respectively.

[4] Sumerville, W. A. T., 1939. Root Distribution of the bananas, Queens. Agri. J. (52):376–92.

The Corozal clay is on a 15% slope, has 3% organic matter and a pH of 5.3. Cation exchange capacity is 16 me/100 g of soil and exchangeable bases are 11 me/100 g of soil. Bulk density is 1.2 g/cm^3 in the surface 15 cm and 1.3 g/cm^3 at all other depths. This soil has a moisture content of 45% at field capacity.

2. Coloso clay at Gurabo

This site is adjacent to that described below for Mabí and has the same climatic characteristics.

The Coloso (Entisols) is a fine, mixed, nonacid, isohyperthermic Aeric Tropic Fluvaquents. The surface soil is dark-brown, silty clay. It is firm, slightly sticky and slightly plastic. The subsoil is firm, and more plastic and sticky than the surface soil. It forms dense clods when plowed. This soil is derived from moderately fine textured sediments from surrounding hills. The predominant clay mineral is kaolinite with some 2:1 clays.

The soil is on a 2% slope, has 4% organic matter and a pH of 6.0. Cation exchange capacity is 28 me/100 g of soil and exchangeable bases are 26 me/100 g of soil. Bulk density is 1.2 g/cm^3 in the surface soil and 1.3 g/cm^3 in the subsoil. At field capacity this soil has a moisture content of 34%.

3. Cayaguá soil at San Lorenzo

This site is located at an elevation of about 200 m. Annual rainfall is about 2,000 mm, and temperatures are similar to those at Corozal.

Cayaguá (Inceptisols) is a fine, mixed, isohyperthermic Aeric Tropaqualfs derived from quartz diorite. It has a moderately permeable surface layer but restricted internal drainage. The surface (0-30 cm) is sandy loam, fine granular, and nonsticky. The subsoil is brownish-gray clay with brown mottling. It is very firm when moist and somewhat sticky and plastic when wet. The predominant clay mineral is kaolinite.

The Cayaguá soil is on a 30% slope, has 4.5% organic matter and a pH of 6.0. Cation exchange capacity is 10 me/100 g soil and exchangeable bases are 8 me/100 g of soil. Bulk density is 1.4 g/cm^3 in the surface layer and 1.3 g/cm^3 in the subsoil. This soil has a moisture content of 31% at field capacity.

4. Humatas clay at Aguas Buenas

This site, located at an elevation of about 400 m, receives about 1,800 mm annual rainfall. Average annual temperature is about 24° C with mean monthly variations of about 5° C.

Humatas (Ultisol) is a clayey, mixed, isohyperthermic Typic Tropohumults, derived from volcanic rocks, mainly andesitic tuffs. The surface soil has a fine to medium subangular blocky structure and is slightly plastic when wet. The subsoil (35 cm) has a weak fine subangular blocky structure and is slightly plastic. The predominant clay mineral is kaolinite.

The Humatas clay is on a 25% slope, has 3.5% organic matter and a pH of 5.5. Cation exchange capacity is 13 me/100 g of soil and exchangeable bases are 10 me/100 g of soil. Bulk density of the soil ranges from 1.0 in the surface layer to 1.1 g/cm^3 at the 30-45 cm depth. At field capacity this soil contains 42% moisture.

5. Mabí soil at Gurabo

This location is at an elevation of about 80 m. Annual rainfall is 1,500 mm, and there is a well-defined winter dry season. Average annual temperature is 26° C with monthly variations of about 5° C.

Mabí (Inceptisols) is a montmorillonitic isohyperthermic Vertic Eutropepts. It is rather poorly drained and has slow permeability. The surface soil is a dark-grayish-brown clay with yellow, brown and red mottles. It has a fine granular structure. The subsoil is yellowish brown with many distinct gray mottles. It has a weak, fine, angular, blocky structure and is very firm and plastic when wet. Clay minerals are predominantly montmorillonite with moderate amounts of kaolinite and small quantities of mica.

The Mabí soil is on about a 4% slope, has 4% organic matter and a pH of 6.0. Cation exchange capacity is 24 me/100 g of soil and exchangeable bases are 21 me/100 g of soil. Bulk density is 1.5 g/cm^3 in the surface soil and 1.6 g/cm^3 at lower depths. At field capacity the soil has a moisture content of 40%.

The plantain fields at all locations were at least 2 ha and were planted to a high-yielding clone of the Maricongo cultivar. The soil was limed to about pH 5.5 where necessary and the soil at all sites was plowed several times before planting. Plant spacing was 1.8 × 1.8 m, which is equivalent to about 3,100 plants/ha, and close to optimum for this crop.[5]

The suckers used for planting were peeled and dipped in an insecticide-nematicide solution before planting. These pesticides were later applied in granular form around each plant every 4 months. Fertilizer was applied at the rate of 700 kg of 10-5-20/ha every 3 months.

The plantains at Gurabo and Corozal were irrigated whenever 50% of the available moisture in the soil was depleted. At the other locations, rainfall was generally abundant and the plantains were not irrigated.

The root systems were studied about 10 months after planting, just

[5] Irizarry, H., Rivera, E., Rodríguez, J. A., and Green, J. J., 1978. Effect of planting pattern and population density on yield of the horn type Maricongo plantain (*Musa acuminata* × *M. balbisiana*, AAB) in North-Central Puerto Rico, J. Agri. Univ. P.R. 62(3): 214–23.

before the plantains started to flower. Soil samples (30 × 30 cm and 15 cm deep) were taken at 0 to 30, 30 to 60 and 60 to 90 cm from the plantain pseudostems, and at the 0 to 15, 15 to 30, 30 to 45 and 45 to 60-cm depths on two sides of each of four plants at each location. By hand, the roots were carefully removed from each sample and their lengths determined.

RESULTS AND DISCUSSIONS

The accompanying figures show the distribution of plantain primary roots at different depths and distances from the plantain pseudostem in

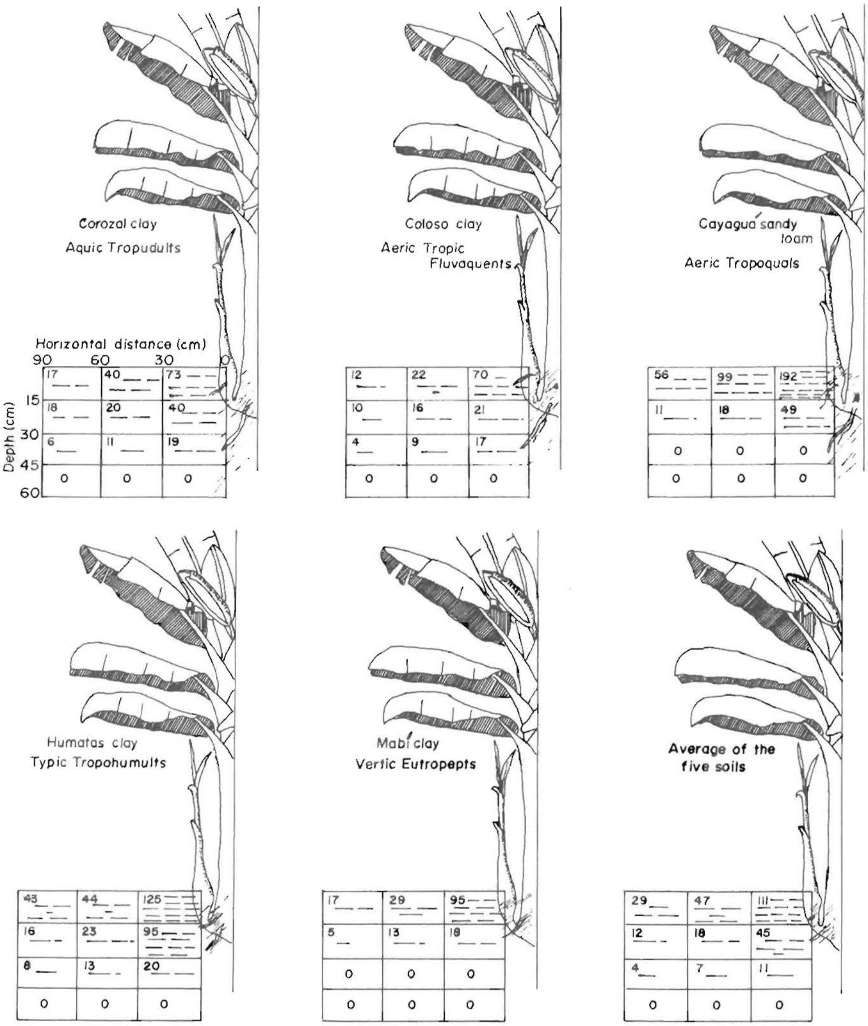

FIG. 1.—Distribution of primary roots of 10-month-old plantains growing on five soil types typical of large areas in the tropics. Numbers show cm of roots/1,000 cm^3 of soil.

the different soil types. All values are averages for samples on both sides of each of four plants at each location.

In all soils, and at all depths, plantain roots decreased sharply with distance from the pseudostem (fig. 1). Averages for all soils show that in the upper 15 cm of soil, the cm of roots/1,000 cm^3 of soil decreased from 111 at 0 to 30 cm from the pseudostem, to 29 cm at 60 to 90 cm from the pseudostem.

In all soils, and at all distances from the pseudostem, plantain roots decreased sharply with depth in the soil. Averages for all soils show that at 0 to 30 cm from the pseudostem the cm of roots/1,000 cm^3 of soil decreased from 111 at the 0 to 15 cm depth, to 11 cm at the 30- to 45-cm depth. No plantain roots were found in any soil at depths beyond 45 cm.

The root system of plantains was very extensive in the upper 15 cm of Cayaguá sandy loam, but there were few roots at the 15-30 cm depth and none at the relatively impermeable lower depths.

In the Humatas soil, plantain roots were also extensive in the surface layer and were more extensive in the 15 to 30 cm layer than in any other soil.

The heavier Coloso, Corozal and Mabí soils, contain fewer roots/1,000 cm^3 of soil at all depths than did the other soil types.

Due to the rather short and superficial root system of plantains, mechanical cultivation close to the pseudostem should be avoided since this practice would mutilate a large part of the root system.

This peculiar root development in plantains should also be taken into consideration when fertilizers, granular pesticides and irrigation water are applied under field conditions.

RESUMEN

Se determinó la distribución de las raíces primarias de plataneros unos 10 meses después de sembrados en 5 suelos: Humatas, Corozal, Cayaguá, Mabí y Coloso.

Se tomaron muestras de suelo de 30 × 30 cm y 15 cm de profundidad a 0-30, 30-60 y 60-90 cm del seudotallo y a profundidades de 0-15, 15-30, 30-45 y 45-60 cm en dos lados opuestos de cada una de cuatro plantas en cada suelo. Las raíces se extranjeron de las muestras a mano y se midieron determinándose el promedio de las 8 muestras tomadas a cada profundidad y distancia del seudotallo en todos los suelos. El largo de las raíces se expresó en cm/1,000 cc de suelo.

En todos los suelos y a todas las profundidades, las raíces disminuyeron marcadamente según aumentaba la distancia del seudotallo. El promedio para todos los suelos a la profundidad de 0-15 cm fue de 111 cm de raíces/1,000 cc de suelo a la distancia de 0-30 cm del seudotallo, pero de sólo 29 cm de raíces/1,000 cc de suelo a una distancia de 60-90 cm del seudotallo.

En todos los suelos y a todas las distancias del seudotallo, las raíces disminuyeron señalademente con la profundidad en el suelo. El promedio para todos los suelos a una distancia de 0-30 cm del seudotallo fue de 111 cm de raíces/1,000 cc de suelo a una profundidad de 0-15 cm pero de sólo 11 cm de raíces/1,000 cc de suelo a una profundidad de 30-45 cm. No se encontraron raíces a profundidades mayores de 45 cm en ninguno de los suelos.

Este sistema radical del platanero deberá tenerse en cuenta cuando los platanales se rieguen, se abonen o se apliquen pesticidas granulados.