Efforts to develop cassava technology for the vast areas of acid infertile soils continued along the strategy outlined last year (CIAT Cassava Prog. 1979 Ann. Rept.). The screening of cassava germplasm in nutrient solution was discontinued, partly because of difficulties in reproducing results due to plant variability, and partly because nutrient solution screenings do not account for the differential ability of varieties to form mycorrhizal associations that are so essential for P uptake.

Large-scale field screenings were begun in Carimagua for P and acidity tolerance, and in CIAT-Quilichao for P tolerance. The second aspect of improving the efficiency of nutrient absorption and fertilizer application involved various fertilizer trials to determine: a) nutrient absorption and distribution within the plant during a 12-month growth cycle; b) the long-term effect of N-P-K applications on soil fertility and yield of continuously grown cassava; c) the residual effect of various sources of P; d) the lime x P interaction; and e) the effect of mycorrhizal inoculation on P absorption.

Screening for Low-P Tolerance

A small-scale screening for P tolerance in CIAT-Quilichao continued. Thirty-two cultivars from the germplasm collection were planted without P and with 44 kg P/ha (100 kg P_2O_5) applied as triple superphosphate in plots that previously had received 88 and 44 kg P/ha in two preceeding years, respectively. Leaf samples were taken at three months. At 12 months plants were harvested.

Table 1 shows P content of leaves, fresh root yields, starch content, P tolerance index and percentage

Table 1. Effect of P fertilization on leaf P content, root yield, starch content and mycorrhizal infection of the 10 most low-P-tolerant cassava cultivars, at CIAT-Quilichao.

Cultivar	P content in YFEL [1] (%)		Root yield [2] (t/ha)		Root starch (%)		Mycorrhizal infection [3] (%)		P-tolerance index [4]
	P applied (kg/ha)								
	0	44	0	44	0	44	0	44	
ICA-HMC-2	0.36	0.35	37	33	22	19	45	44	86
M Col 1226	0.39	-	48	56	26	24	25	56	85
M Mex 59	0.40	0.38	44	49	28	29	35	34	83
M Col 1879	0.28	0.32	37	36	26	27	37	30	80
M Col 1684	0.31	0.29	36	39	25	25	34	24	70
M Col 113	0.30	0.40	42	58	26	25	39	37	63
M Col 131	0.26	0.28	31	32	-	-	40	36	62
M Ven 83	0.30	0.35	36	49	30	31	40	26	57
M Col 88	0.33	0.41	32	39	-	-	22	39	55
Llanera	0.36	0.42	24	23	-	-	43	50	54

1 YFEL = youngest fully expanded leaves at three months after planting.
2 Single row yield, average of three plants, four replications.
3 % of total root observations having hyphae, vesicles or arbuscles.
4 P-tolerance index: $\frac{\text{Yield (O P)}}{\text{Yield (44 P)}} \times \frac{\text{Yield (O P)}}{\text{Max. Yield (O P)}} \times 100$

mycorrhizal infection of 10 of the most P-tolerant cultivars. The P tolerance index of the 32 cultivars ranged from 11 to 86 with an average of 43. Leaf P content at three months and the varieties' P tolerance index were not related as P content reflects both P uptake ability and plant size, which is highly variable among cultivars. Average root yields of the ten most tolerant cultivars increased only 10% by the application of P. Starch content increased in some cultivars and decreased in others by P fertilization, but differences were not significant at the 5% level for any of the seven cultivars studied; starch content varied significantly among cultivars.

Mycorrhizal infections, especially vesicle numbers, were higher in P-fertilized plants than in those without P. However, there was no correlation between percentage infection of roots at harvest, and root yield or P tolerance index. Changes in root infection during the growth cycle will have to be determined in order to establish whether early infection is essential for obtaining high yields in low-P soils.

Nutrient Absorption and Distribution

To determine the effect of fertilizers on the rate of nutrient absorption during different stages of plant development and nutrient distribution within the plant (nutrient profile), two cassava cultivars were planted in CIAT-Quilichao in large plots with and without applied fertilizer. Cultivars were M Col 22 and M Mex 59, the former a non-vigorous plant type and the latter a very vigorous one. All plots were limed with 500 kg/ha of dolomitic lime and the fertilized plots received 1 t/ha 10-30-10, 20 kg S/ha as elemental sulphur, 10 kg Zn/ha as $ZnSO_4.7H_2O$, and 1 kg B/ha as Borax, all applied broadcast and incorporated before planting; another 50 kg N/ha as urea was applied at 60 days. Two plants per plot were harvested monthly and separated into upper, middle, and lower leaf blades ("leaves"), petioles and stem, as well as roots. Samples were dried, weighed and analyzed for all macro- and micronutrients. Soil samples were also taken monthly and analyzed.

Figure 1 shows the rate of total dry matter (DM) production for the two varieties. Fertilizer had no significant effect on M Mex 59 (a variety highly tolerant to low P and not responsive to high levels of fertility—CIAT Ann. Rept. 1977, 1978 and CIAT Cassava Progr. 1979 Ann. Rept.). M Col 22, on the other hand, produced significantly more DM when fertilized, especially during the last six months. Effects were similar for dry root yields (Fig. 2). In M Mex 59 root yields were highly variable during the last three months with no apparent response to fertilization, while M Col 22 yielded similarly without fertilizer, but produced much higher yields with fertilization.

In both varieties fertilization stimulated top growth more than root growth, decreasing harvest index about 10-15%. Unfertilized M Col 22 had a final harvest index of about 0.70-0.75, which remained constant during the last five months, while the harvest index of M Mex 59 continued to increase until the 10th month, but reached only 0.55. Thus, the more vigorous M Mex 59 produced relatively more to growth, while the nonvigorous M Col 22 produced more roots and at an earlier stage. At six months, M Col 22 had produced about 50%, while M Mex 59 had produced only about 25% of its final root yield.

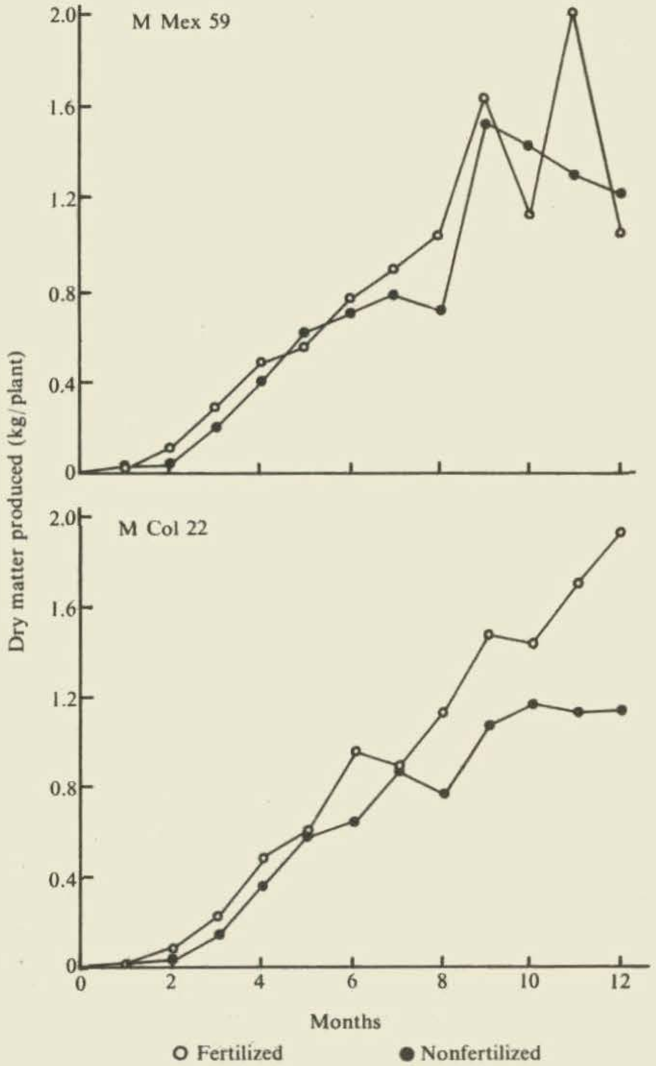

Figure 1. *Cumulative total dry matter production over 12 months for two cassava cultivars grown with and without fertilizers, at CIAT-Quilichao.*

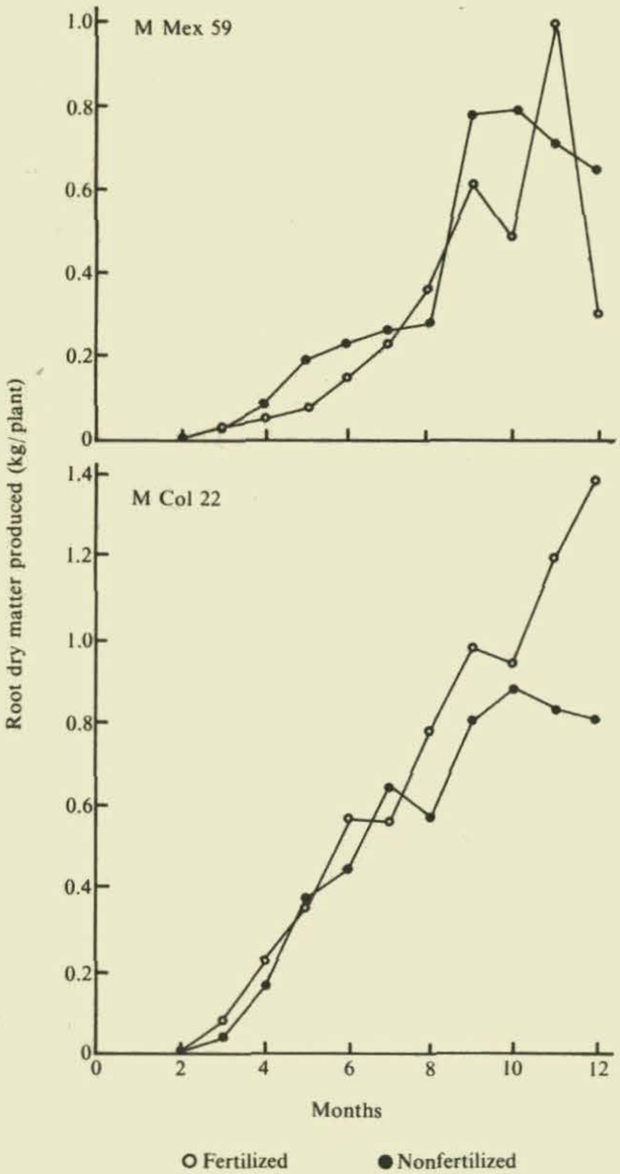

Figure 2. *Cumulative root dry matter production over 12 months for two cassava cultivars grown with and without fertilizers, at CIAT-Quilichao.*

Figure 3 shows the distribution of DM between roots, stems, leaves and petioles during the cultivars' growth cycles without fertilization. Roots started to accumulate DM after two months, and reached a maximum at 10 months in both cultivars; however, these cultivars varied markedly in their DM distribution with M Col 22 translocating most DM to roots after the third month while M Mex 59 did so only after the eighth month. The DM distribution in fertilized plants followed essentially the same pattern, except that in M Col 22 roots continued to accumulate DM up to the 12th month.

In general, N, P and K contens of the various plant parts decreased with time, especially in the upper stem tissue. Nutrient contents of upper leaves also decreased with time but not to the same extent as those of stems, petioles or roots, making this tissue more suitable for diagnostic purposes. For most elements, sampling at three months is recommended, while at a later date of sampling the critical levels should be reduced. The contents of most other nutrients also decreased with time, except Fe and Mn which remained constant in upper leaves, and Ca which increased in upper leaves and in petioles. Nutrient contents of roots decreased markedly for all elements as starch increased with time. It is clear that roots are relatively high in N and K, and these elements are removed in greatest quantities in each root harvest.

The nutrient contents of all plant parts at 2-4 months of age are shown in Table 2, both for fertilized and non-fertilized plants. Fertilization had mainly increased the nutrient content of all tissues without significantly changing the distribution pattern. Nitrogen and P contents followed similar distributional patterns and decreased in all plant parts from the top to the bottom of the plant. Potassium was highest in upper stems followed by petioles and leaves, however, the K gradient from upper to lower stem was much greater than for leaves. Leaves were more indicative of K status than the upper stem or petioles; the lower stem or the petioles might also be good indicator tissue for K although the former would destroy the plant during sampling. Data for other nutrients (Table 2) indicate Ca and Mg were both about equally high in leaves, petioles and stems, and low in roots. Unlike N, P and K, lower leaves and petioles were higher in Ca and Mg than upper leaves. Sulphur was high in leaves, extremely low in petioles and intermediate in stems; B was rather uniform throughout the plant; Cu was high in stems; Fe was high in leaves, especially lower leaves; while Mn and Zn were high in petioles especially lower petioles. The Fe, Mn and Zn contents all increased from upper to lower leaves and petioles. In this extremely acid (pH 3.9-4.1) soil, tissue concentrations of Fe and Mn were very high, probably above the critical level for toxicity.

Figure 4 shows the cumulative N, P, K profiles in M Col 22. Plants continued to accumulate nutrients throughout the growth cycle, but the greatest rate of absorption occurred from the second to the fifth month, especially for K. After the fifth month all these elements had accumulated mainly in the roots of this early root bulking cultivar. At harvest, quantities of N, P and K were greatest in roots (66% for K) followed by stems, leaves and petioles. However, Ca, Mg and Mn accumulated more in the stem than in the roots.

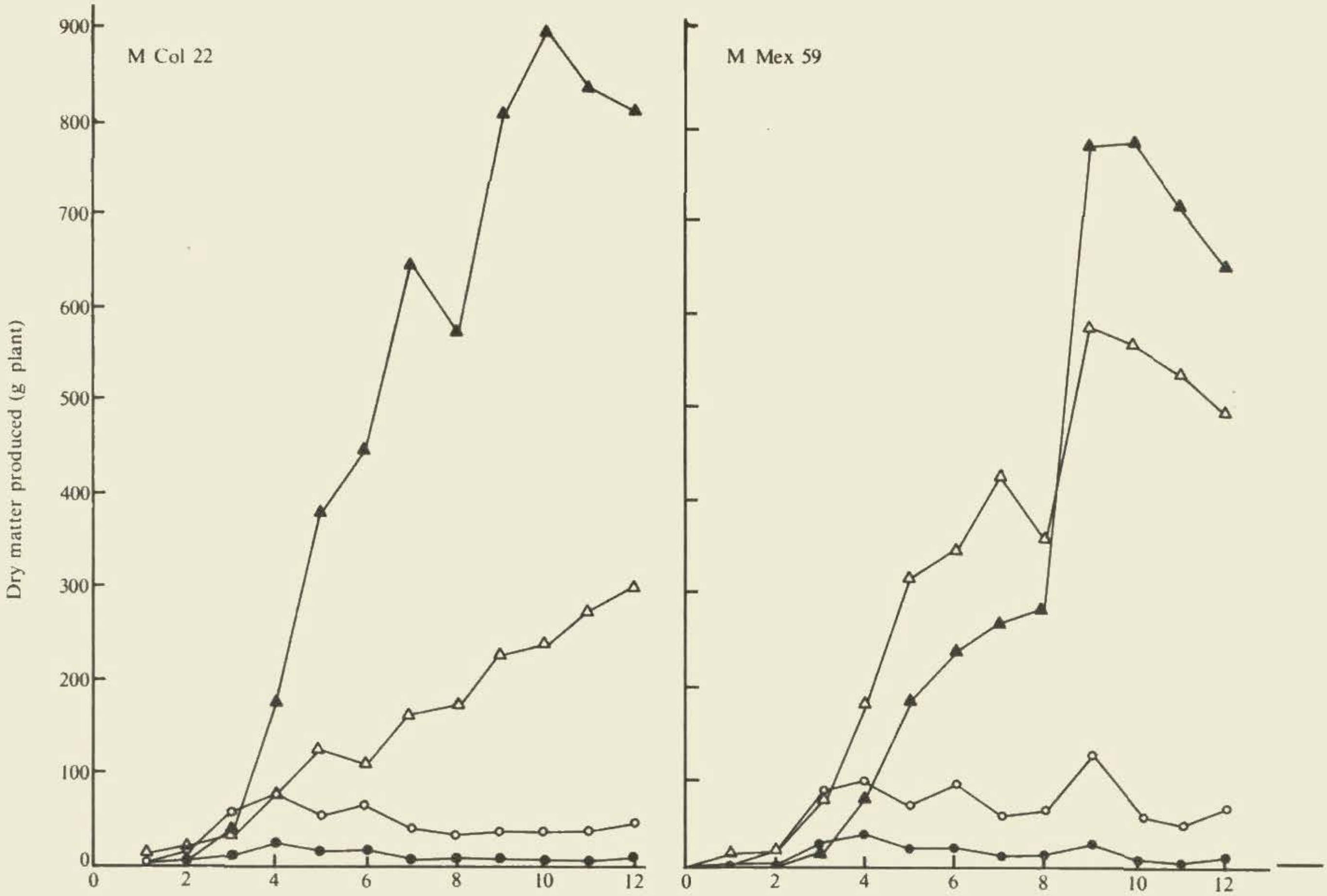

Figure 3. *Distribution of dry matter among roots, stems, leaves and petioles in two cassava cultivars grown without fertilizer over 12 months, at CIAT-Quilichao.*

Table 2. Concentration of nutrients in cassava upper, middle and lower leaves, petioles and stem, and roots[1].

Plant part		Nutrient content (%)						Nutrient content (ppm)				
		N	P	K	Ca	Mg	S	B	Cu	Fe	Mn	Zn
Leaves	upper	5.75	0.42	1.98	0.72	0.34	0.30	11.1	12.2	176	400	107
	middle	5.18	0.27	1.80	1.01	0.38	0.28	11.9	12.1	237	523	119
	lower	4.40	0.20	1.58	1.34	0.49	0.22	11.7	11.1	386	697	137
Petioles	upper	2.25	0.22	2.93	0.90	0.38	0.06	10.6	9.0	66	533	90
	middle	1.41	0.14	2.35	1.13	0.39	0.02	9.9	7.1	56	835	127
	lower	1.35	0.12	2.23	1.54	0.48	0.01	10.9	7.5	123	1470	190
Stem	upper	2.73	0.30	3.15	0.82	0.37	0.18	10.5	18.1	133	339	86
	middle	2.21	0.27	2.21	1.02	0.38	0.16	8.6	22.7	107	379	120
	lower	1.28	0.22	1.14	0.65	0.31	0.09	6.4	23.6	225	170	97
Roots		1.52	0.18	1.56	0.24	0.14	0.05	6.0	10.7	508	178	66

1 Averages of samples taken at two, three and four months, for fertilized and unfertilized cultivars M Col 22 and M Mex 59

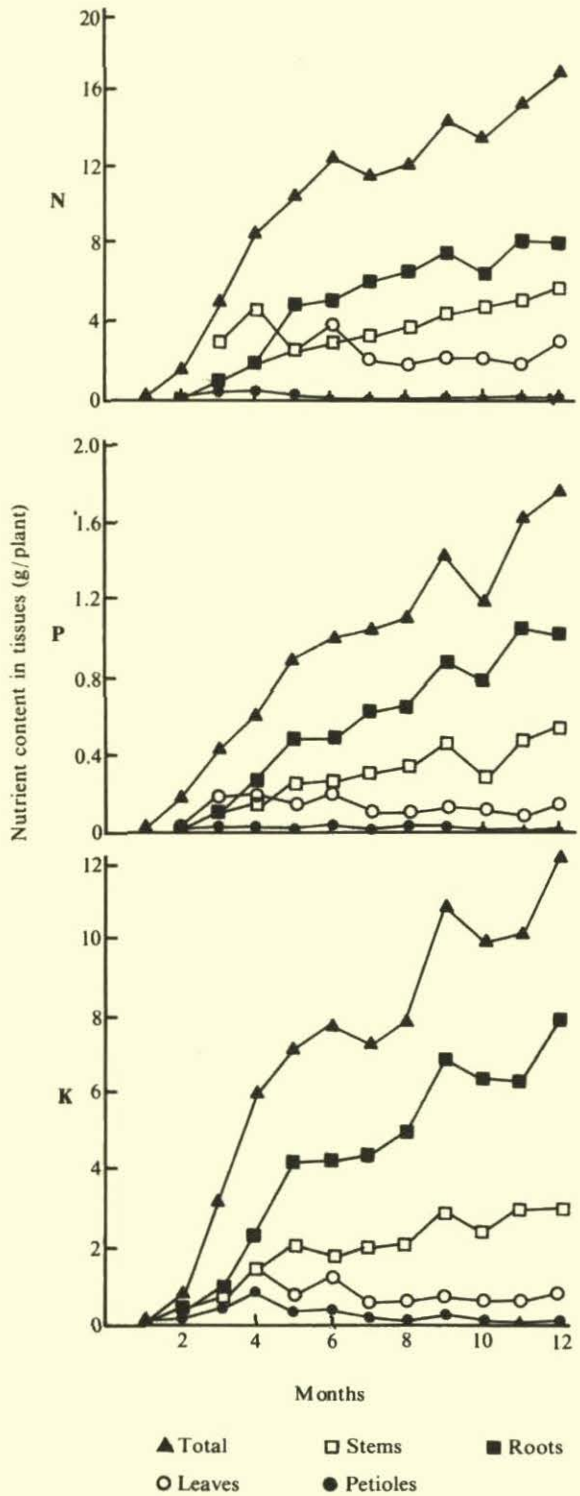

Figure 4. *Total uptake and distribution of N, P and K among plant parts of cassava cultivar M Col 22 over 12 months, at CIAT-Quilichao. (Averages from fertilized and nonfertilized plants.)*

Monthly analyses of unfertilized soils showed no significant changes in pH and Ca content, a slight increase in exchangeable Al from 2.5 to 3.5 meq/100 g; a slight increase in available P from 4 to 6 ppm, possibly due to leaf fall and decomposition; a slight decrease in exchangeable Mg; and a significant decrease in exchangeable K, from 0.4 to 0.2 meq/100 g. In fertilized plots, exchangeable K decreased from 0.60 to 0.25 meq/100 g, and increased again during the final month. The marked decrease in soil K is the cause of soil exhaustion after cassava cultivation and the reason why cassava responds more to K fertilization after several consecutive cassava crops. If each plant of a cassava crop removes about 10 g of K (see Fig. 4) and all was absorbed from the top 20 cm of soil without replacement, this decrease is as much as 0.17 meq K/100 g of soil; additional K may be lost by leaching and erosion. Thus, adequate K fertilization is essential to obtain high yields while maintaining soil fertility (see next section).

Long-Term Fertility Trial

Objetives, experimental treatments and results of the first planting with cultivar Llanera were described last year (CIAT Cassava Progr. 1979 Ann. Rept.).

In the second year, cultivar CMC 40 was planted in the same plots without additional fertilizer, except the eight additional plots receiving fertilizers annually. Figure 5 shows response to residual effects of N, P and K for root and foliage yield, harvest index, and N, P, K contents of leaves of three-month-old plants. Despite no additional application of fertilizers, root yields were very high with the lowest yield (31 t/ha) obtained with an absolute zero fertilization of N, P and K. In general, plants responded to fertilization more in terms of foliage than root yields but unlike the first year, there was no significant decrease in harvest index due to fertilization.

Figure 6 shows the root yield response to zero, medium and high fertilization both for the single and annual applications. Although there was a significant residual effect from the initially applied fertilizers, root yields increased another 5-6 t/ha from reapplication of these fertilizers. This would have been economical at the intermediate level of application, but not at the highest level.

After two years of cassava cropping the available P content of the soil had decreased from 7.8 to 2.3 ppm without applied P and from 41.8 to 6.9 ppm with 175 kg P/ha applied. Similarly, without additional K the

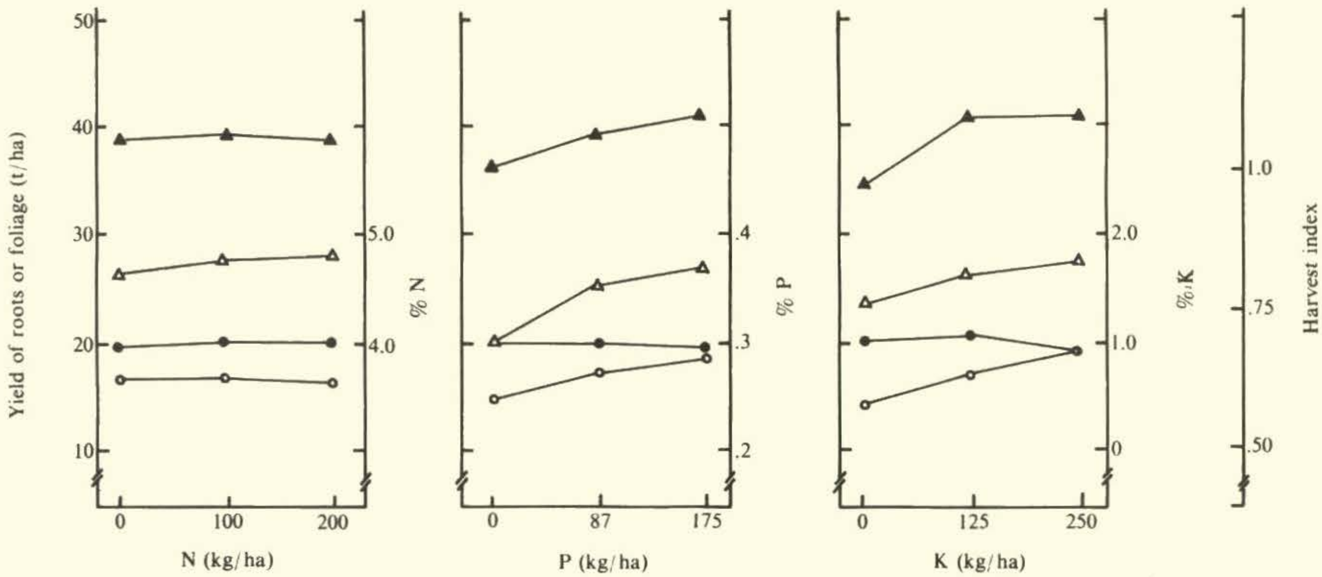

Figure 5. *Residual effects from three levels of N, P and K applied to a previous cassava crop on nutrient contents of upper leaves, at three months, and on root and foliage yields and harvest index of 12-month-old cultivar CMC 40, at CIAT-Quilichao.*

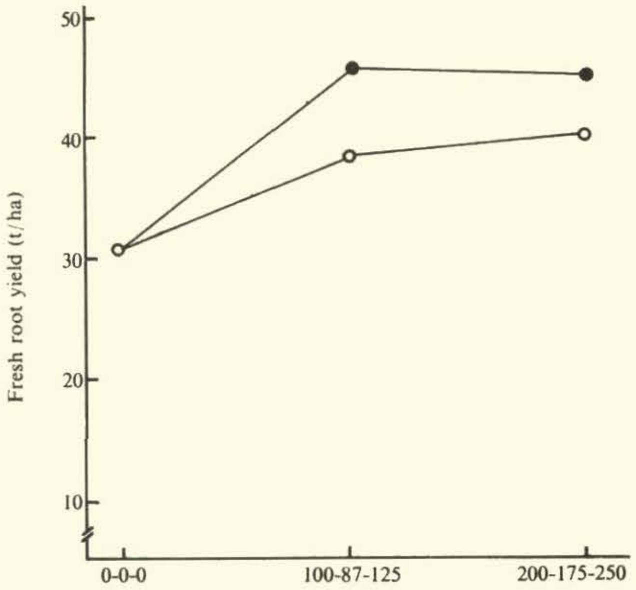

Figure 6. *Root yield response of cultivar CMC 40 to zero, medium and high levels of N, P and K applied only to the preceding crop (residual effect) or when applied annually, at CIAT-Quilichao.*

exchangeable K content of the soil decreased from 0.20 to 0.12 meq/100 g, and with the initial application of 250 kg K/ha, K content decreased from 0.48 to 0.14 meq/100 g. Only with annual reapplication of 250 kg K/ha could the soil K content be maintained at 0.21 meq/100 g after the second cropping, while an annual application of about 90-100 kg P/ha would be required to maintain an available P content of 7 ppm in the soil.

Sources of P

Two experiments to study the effect of various P sources, levels and methods of application on cassava yields in CIAT-Quilichao were initiated in 1978 (CIAT Cassava Prog. 1979 Ann. Rept.), and repeated in 1979 to study the residual effect. In the first year root yields of Llanera cassava varied from 20 to 25 t/ha, without a significant response to P application. In the second year, without additional P applied, root yields of cultivar M Col 1684 varied from 42 to 51 t/ha, again without a significant response to P. Phosphorus contents of upper leaves at three months varied from 0.38 to 0.42% in the check plots; this is at the critical level of 0.4%, indicating an adequate P status of the plants. In the P check plots the average yield was 46 t/ha.

This high yield was attained in a soil with an initial P content (Bray II) of only 3 ppm, which increased to 5-6 ppm due to organic matter mineralization even before the first planting, and had remained at that level at the second planting. Plants in all treatments were highly infected (48-83%) with mycorrhiza, resulting in an efficient uptake of P even from a very low-P soil. Mycorrhizal infection was particularly evident in plots receiving no or only small amounts of soluble P, or high amounts of rather insoluble phosphate sources; infection decreased with increasing amounts of soluble P applied. Starch content of roots varied from 26 to 28% with P application having no significant effects. These trials suffered a 30-50% defoliation at eight months due to a severe hornworm attack, followed by three months of extreme drought (total of 57 mm rainfall) without any apparent detrimental effect.

Lime x P Interaction

An experiment has been conducted for two consecutive years in Carimagua to determine the interaction between lime and P applications on an acid infertile soil (CIAT Ann. Rept. 1976).

Lime applications from zero to 4.8 t/ha increased soil pH from 4.15 to 4.75, decreased exchangeable Al from 3.5 to 1.3 meq/100 g and decreased Al saturation from 88 to 27%. Root yields of M Col 638 ranged from 7 t/ha without lime and P to 25 t/ha with a combination of 3.6 t/ha of lime and 380 kg/ha of P_2O_5.

Figure 7 shows root yield and foliage growth responses to several rates of P and lime applications. On the average, near maximum root yields were obtained with 210 kg P_2O_5 /ha (92 kg P) and 1.1 t lime/ha. While root yields showed a more or less quadratic response, foliage yields showed a nearly linear response to P, as was also reported in 1976. Harvest index was highest (0.65) with 0.3 t lime and 210 kg P_2O_5 and decreased to 0.50 at the highest lime and P rates.

In Carimagua, near maximum yields can apparently be obtained with the application of 90-100 kg P/ha and 1 t/ha of dolomitic lime, which produced a pH of 4.3 with 2.75 meq Al/100 g or 76% Al saturation. These data indicate that cassava is extremely tolerant of low pH and high Al, but also illustrate the beneficial effect of small lime applications.

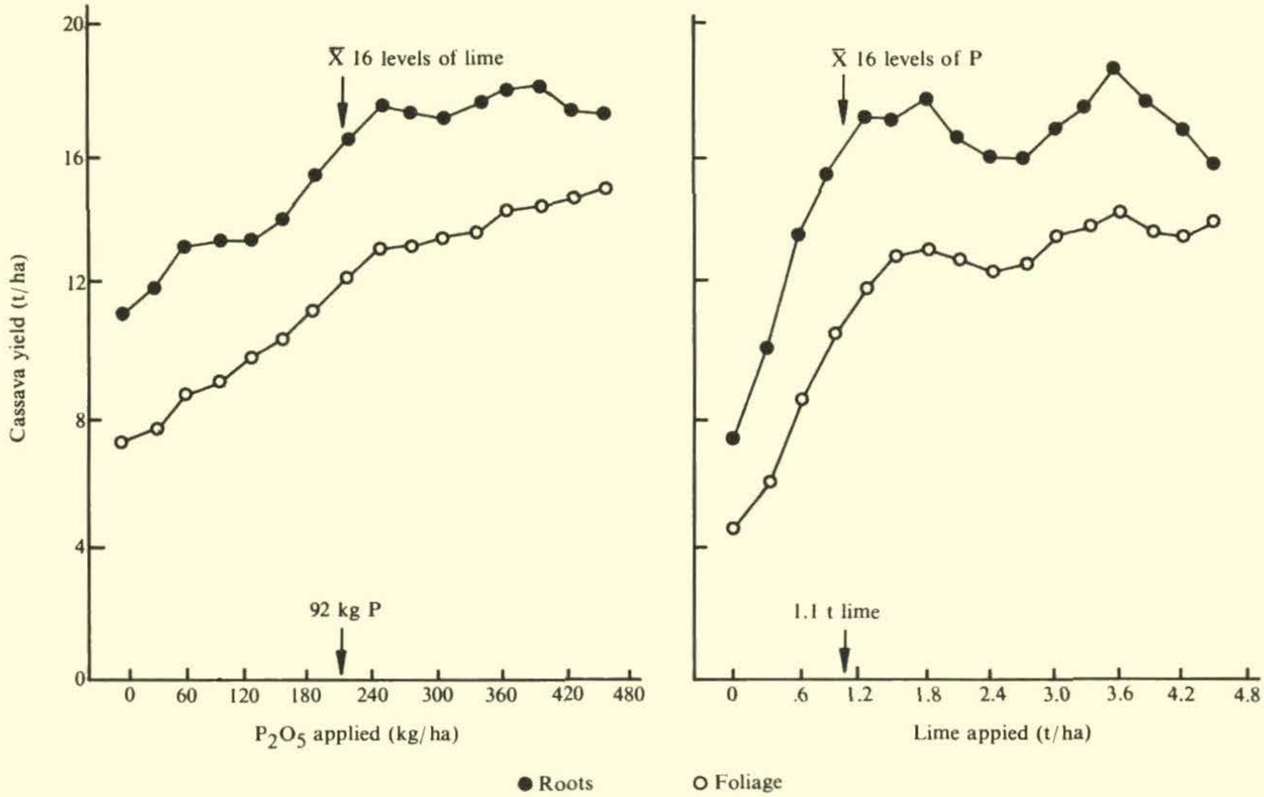

Figure 7. *Effect of increasing levels of applied P and lime on root and foliage yields of cultivar M Col 638, in Carimagua. Arrows indicate rates required for 95% of maximum yield.*

Response to Mycorrhizal Inoculation

In many cassava growing areas of Latin America, P deficiency is the main limiting nutritional factor. Inoculation with mycorrhizal fungi has been shown to improve cassava's ability to absorb P from low P concentrations in both soils and nutrient solutions (CIAT Cassava Prog. 1979 Ann. Rept.). Cassava plantlets produced in a misting chamber were planted in pots with sterilized soil from CIAT-Quilichao to which nine levels of P had been applied. Plantlets were either noninoculated or inoculated with mycorrhizal spores or infected roots. A clear P response could be observed after two weeks and a response to root inoculation after three weeks, the latter becoming more pronounced with time. The dramatic response to inoculation can be seen in Figure 8.

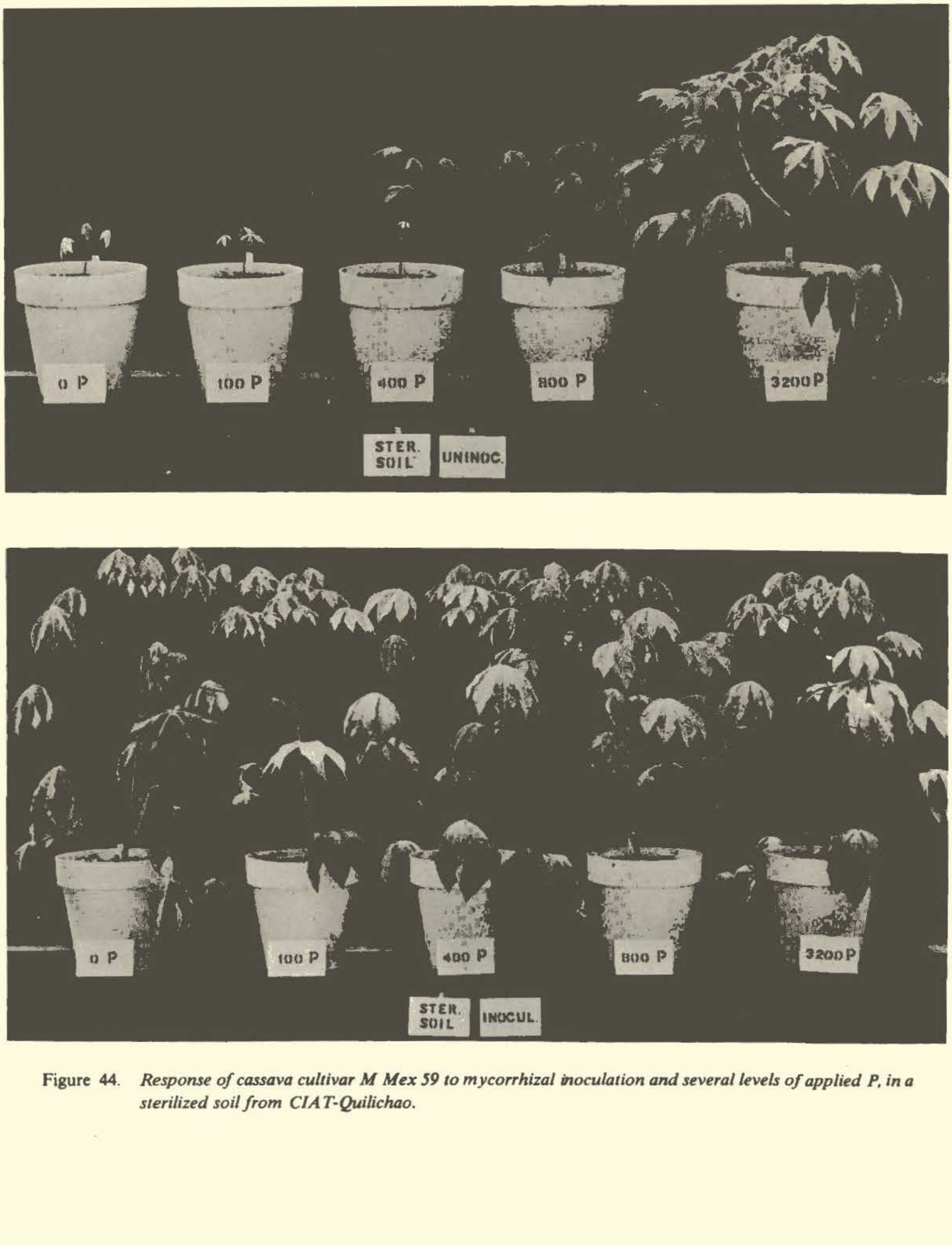

Figure 44. *Response of cassava cultivar M Mex 59 to mycorrhizal inoculation and several levels of applied P, in a sterilized soil from CIAT-Quilichao.*

Without inoculation plants remained P-deficient even with 800 kg P/ha applied, and reached near-maximum growth only with 1600 and 3200 kg P/ha. With root inoculation, plant growth was very good even without applied P; response to P-application was small initially and had nearly disappeared by harvest. The response to spore inoculation was essentially zero.

Inoculation with 2 g of infected roots in the P check increased top growth over 80 fold compared with the noninoculated treatment, and was about equally effective as the application of 1600 kg P/ha (Fig. 9). Without mycorrhizal infection, plants absorbed very little P from a soil to which 800 kg P/ha had been applied.

In the CIAT-Quilichao soil, mycrorrhizal inoculation was highly effective even without any P applied, althouth infection and the P concentration of the tops were relatively low at this level (Table 3). Maximum infection occurred at intermediate P levels corresponding to 50 and 100 kg P/ha applied (levels used in field-grown cassava). Without P applied, total uptake was over 100-fold higher in mycorrhizal than in non-mycorrhizal plants; even at the highest levels of applied P, mycorrhizal plants had higher P concentrations and absorbed more P than non-mycorrhizal plants.

Figure 10 shows the relation between DM production and available P content (Bray II) of the soil after harvest, both for inoculated and noninoculated treatments. Curves were drawn visually through the points and arrows indicate "critical" P contents, defined as 95% of maximum yield. Although inoculated and non-inoculated plants reached the same maximum yield, it is clear that the presence of mycorrhiza markedly reduced the "critical" soil P-content. The critical level of 15 ppm for mycorrhizal plants is only slightly above the level of 8-10 ppm obtained from field experiments, while the level of 190 ppm for non-mycorrhizal plants is unrealistically high.

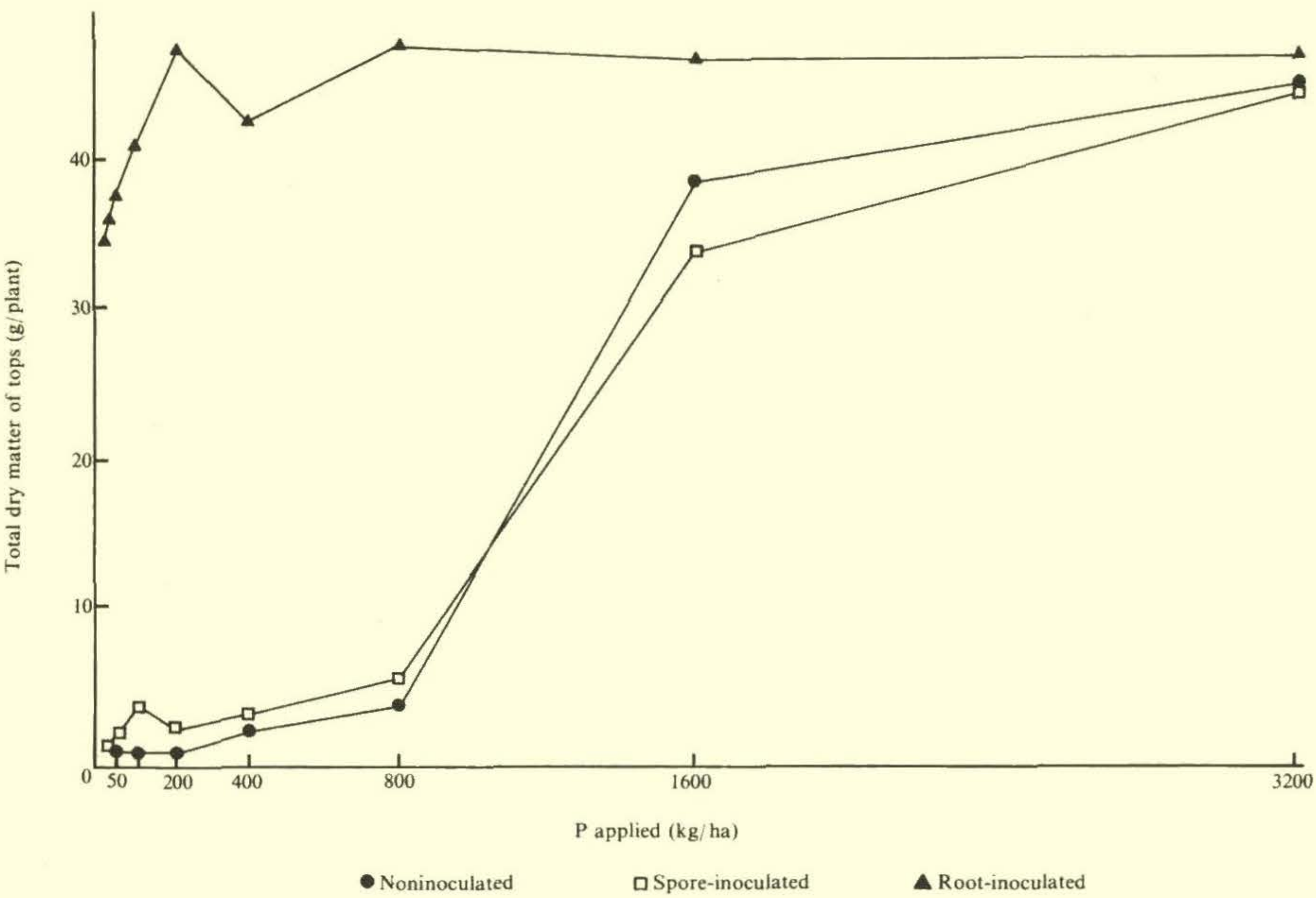

Figure 9. *Effect of mycorrhizal inoculation and several levels of applied P on dry matter production in tops of cultivar M Mex 59, in a sterilized soil from CIAT-Quilichao.*

Table 3. Effect of mycorrhizal inoculation and P levels applied on mycorrhizal infection of cassava roots, P concentration of tops and total P uptake by tops[1].

P applied	Degree of infection [2]			P concentration in tops (%)			P uptake by tops (mg/plant)		
(kg/ha)	NI[3]	RI	SI	NI	RI	SI	NI	RI	SI
0	0	1.7	0	0.05	0.08	0.05	0.2	27.7	0.3
25	0	2.2	0	0.07	0.07	0.05	0.5	25.5	0.6
50	0	2.6	0	0.04	0.11	0.08	0.3	41.3	1.5
100	0	2.6	0	0.05	0.12	-	0.3	49.4	-
200	0	2.4	0	-	0.17	0.09	-	81.0	2.0
400	0	2.0	0	0.06	0.17	0.09	1.2	73.0	2.8
800	0	1.5	0	0.09	0.18	0.06	3.4	86.0	3.4
1600	0	1.0	0	0.15	0.16	0.08	58.3	75.3	27.5
3200	0	1.0	0	0.20	0.25	0.21	90.5	118.3	93.5

1 Cultivar M Mex 59 grown on sterilized soil from CIAT-Quilichao, in the greenhouse.
2 Degree of infection: 0 = none, 3 = high number of hyphae and vesicles in roots.
3 NI = noninoculated, RI = root-inoculated, SI = spore-inoculated.

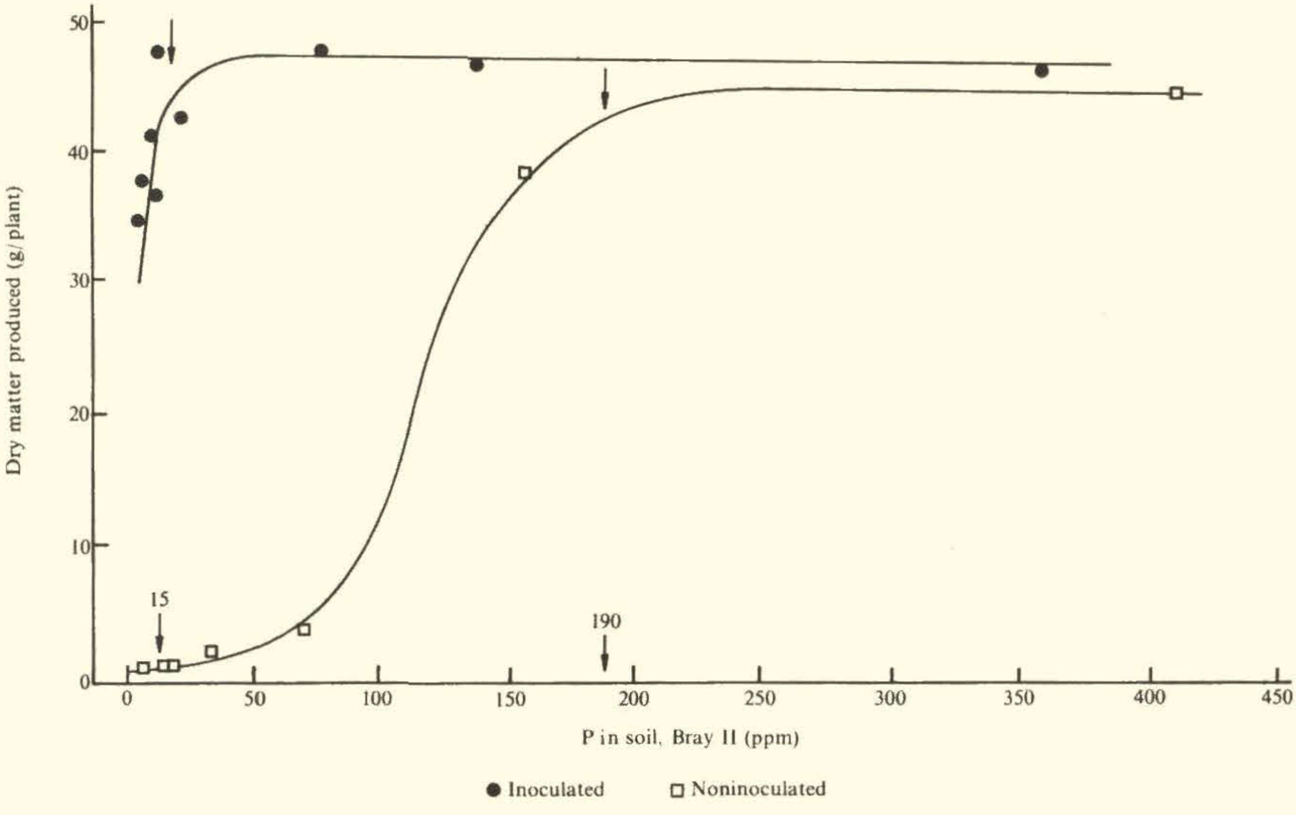

Figure 10. *Relation between dry matter yields of three-month-old inoculated and noninoculated cassava cultivar M Mex 59, and soil P content after harvest. (Arrows indicate critical P levels for 95% of maximum yield.)*

Spore inoculation did not result in an apparent root infection, nor in an improvement in plant growth, but inspection of the soil after harvest revealed a large spore population. Replanting cassava in these pots resulted in a marked improvement of growth at intermediate P levels. While infection from spore inoculation was much slower than from root inoculation, with time these methods will probably be equally effective.

The results of this experiment corroborate the conclusion (CIAT Cassava Progr. 1979 Ann. Rep.) that without a mycorrhizal association cassava roots are extremely inefficient in P uptake, and indicate the great dependence of the crop on mycorrhiza when grown on low-P soils. Practical implications of these findings are, however, not yet clear. First, in a nonsterilized soil the native mycorrhizal population may be highly efficient, reducing the beneficial effect of inoculation unless more efficient species and strains can be identified. Secondly, cassava is normally grown from stakes with a considerable reserve of nutrients (25-50 mg P/stake but less than 1 mg in rooted cuttings), which it can utilize to grow an efficient root system before having to rely on that system for P uptake. Initial responses to inoculation in cassava grown from stakes were small compared with those in cassava from rooted cuttings. It remains to be seen what the long-term effect of inoculation is once the stake reserves are exhausted.

Host specifity. To determine the degree of host specificity, mycorrhizal-infected cassava roots were used to inoculate seven species: maize, beans, cowpeas, rice, *Andropogon gayanus, Stylosanthes guyanensis* and cassava hybrid CM 91-3, all grown in sterilized soil from CIAT-Quilichao with 0, 100, and 500 kg P/ha applied.

Table 4 shows the response to inoculation and P application of these species. All species except rice benefited markedly from inoculation at the levels of 0 and 100 kg P/ha, while cassava, beans, cowpeas and *Stylosanthes* sp. also responded at 500 kg P/ha. The lack of response in rice may indicate some host specificity, but is more likely due to the extremely fine and highly branched root system of this species. The lack of response to inoculation of *Andropogon* sp., and maize at 500 kg P/ha also reflects a well developed, highly branched and dense root system.

As was observed in nutrient solutions (CIAT Cassava Progr. 1979 Ann. Rept.), without mycorrhizal infection cassava required much higher rates of P to attain normal growth than even such P-demanding species as beans. Using the ratio of DM obtained without inoculation over that obtained with inoculation as a measure of mycorrhizal dependence (Table 4), considering all P levels, cassava was the most mycorrhizal-dependent species, followed by *Stylosanthes guyanensis*. Without applied P, these two species again were most mycorrhizal dependent, although in reverse order; at 100 kg P/ha, *Stylosanthes, Andropogon* and cowpeas were even more mycorrhizal-dependent than cassava. On the other hand, with a mycorrhizal association, cassava was more P-tolerant ($DM_{P_0}/DM_{P_{500}}$) than any of the species including rice. Thus, cassava's well-known ability to grow on low-P soils is due to a large P reserve in its planting piece as well as to an effective mycorrhizal association in many (but not necessarily all) low-P soils.

Table 4. Effect of mycorrhizal inoculation and P application on dry matter in tops of seven crop species[1].

Species	Dry matter in tops (g/pot)						Mycorrhizal dependence ratio [2]			
	Noninoculated			Inoculated						
	P-0	P-100	P-500	P-0	P-100	P-500	P-0	P-100	P-500	Mean
Cassava	0.34	0.72	0.54	4.33	14.21	16.36	0.08	0.05	0.03	0.05
Beans	1.11	3.44	8.29	3.08	18.79	25.01	0.36	0.18	0.33	0.29
Cowpea	0.96	0.64	13.65	2.60	20.68	36.32	0.37	0.03	0.38	0.26
Stylosanthes sp.	0.08	0.08	2.74	1.25	9.33	12.20	0.06	0.01	0.22	0.10
Andropogon sp.	0.15	0.39	34.24	1.26	16.67	32.18	0.12	0.02	1.06	0.40
Maize	1.19	8.74	59.35	4.84	34.75	53.57	0.25	0.25	1.11	0.54
Rice	3.79	26.63	30.60	3.83	22.36	31.23	0.99	1.19	0.98	1.05

[1] Crops grown in sterilized soil from CIAT-Quilichao, in the greenhouse. Fertilized with either 100 or 500 kg P/ha.

[2] Mycorrhizal dependence is in terms of the ratio: $\frac{\text{Dry matter produced without inoculation}}{\text{Dry matter produced with inoculation}}$

Errata

Page	Columm	Element	Printed:	Should be:
6	1	Figure 2	M Col 59	M Mex 59
6	2	Figure 3	M Col 59	M Mex 59
6	2	Figure 3	LSD (P<0.05)	LSD (P<0.05)
7	1	Figure 4	M Col 59	M Mex 59
60	2	Second para., line 8	more to growth	more top growth
61	2	Line 1	and K contents	and K concentrations
20	1	Figure 1	I - Tolerant III - Tolerant V - Tolerant	I - Intermediate-resistant III - Intermediate-resistant V - Intermediate-resistant
62	1	Figure 3	Stems □	Stems △
64	1	Figure 5	5.0 4.0 % N	5.0 4.0 % N 3.0
66	1	Figure 8	Figure 44	Figure 8
93	2	Footnote	*Left during 1979.	*Left during 1980.