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The Effect of Different Fertility Levels on Yields of Intensively Managed Coffee in Puerto Rico[1]

Fernando Abruña, José Vicente-Chandler, and Servando Silva[2]

INTRODUCTION

Coffee plantations in Puerto Rico generally consist of old, unselected coffee trees growing in very dense shade provided by old shade trees. Insects and diseases are not controlled, the coffee trees are rarely pruned, and little fertilizer is applied. It is therefore not surprising that yields average only about 150 pounds of market coffee per acre, probably the lowest of any coffee-producing country.

In 1951, the authors started experimenting with a system for the intentensive management of coffee in Puerto Rico. The trees were planted close together in rows with no shade, in line with Cowgill's (*1*)[3] work in Guatemala. The high-yielding Bourbon variety was used with periodic spraying for pest control, heavy fertilization, systematic pruning, and proper soil- and water-conserving practices. These plantings produced very high yields—the oldest has produced four crops averaging almost 2,000 pounds of market coffee per acre, yearly. It immediately became apparent that information on the fertility requirements of such intensively managed, high-yielding plantings was urgently needed.

Information on the fertilizer requirements of coffee in Puerto Rico is limited. McClelland (*3*) found that shaded coffee growing on a soil not typical of the Coffee Region responded in yield to applications of potash, particularly when nitrogen was also used, but did not respond to phos-

[1] This work was carried out cooperatively between the U. S. Department of Agriculture and the Agricultural Experiment Station of the University of Puerto Rico, Río Piedras, P.R.

[2] Soil Scientist, Project Supervisor, and Physical Science Aid, respectively, Soil and Water Conservation Research Division, Agricultural Research Service, U. S. Department of Agriculture.

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[3] Italic numbers in parentheses refer to Literature Cited p. 146.

phorus applications. On the other hand Gómez, *et al.* (*2*), found that shaded trees growing on a typical soil (Catalina) responded to phosphorus applications and to a lesser extent to nitrogen, but did not respond to potash. There is no information available in Puerto Rico on the fertility requirements of coffee intensively managed as described above.

MATERIALS AND METHODS

The experiment was carried out at Castañer at an elevation of about 2,000 feet, mean monthly temperatures varying from about 70° to 80° F., and about 70 inches of annual rainfall. A severe drouth occurred in 1957, with rainfall that year of less than 50 inches.

The soil was steep (45-percent slope), eroded, Alonso clay, the upper 6 inches of which had about 3.5-percent organic matter with a pH of 4.8, an exchange capacity of 22 m.e., and 12 m.e. of exchangeable bases per 100 gm. of soil. The soil is well drained and has excellent physical condition.

Arabica coffee of the Bourbon variety was planted 3 feet apart in two rows 4 feet apart, forming hedges which are 10 feet apart, with about 2,000 trees per acre. Grass was allowed to grow between hedges to control erosion, but the ground under the trees was kept free from weeds. No stock was used. The seedlings were transplanted to the field when about 2½ feet tall, with a ball of earth surrounding the roots. The trees were encouraged to produce three to four vertical stems and old, diseased, or weak branches were removed once a year. The plantings were sprayed four times yearly with a mixture containing Parathion, Dieldrin, and Copper A, to help control insects and diseases. Two tons of limestone and 400 pounds of magnesium sulfate were applied per acre to all plots every 2 years. All plots received two light applications of nitrogen over the first 4 months, after which the specific differential treatments were initiated. Since up to the present no clear evidences of minor element deficiencies had been noted these have not been applied.

A randomized block design was used with all treatments replicated 16 times. Individual plots consisted of 12 trees, 6 trees in each of the 2 rows of a hedge, and surrounded by ditches to reduce the possibility of fertilizer washing into adjoining plots. Seven replications were planted in July 1954 and the other nine in July 1955.

The eight fertilizer treatments are listed in the first three columns of table 1. Zero, 150, and 300 pounds per acre yearly each of nitrogen (from ammonium sulfate), phosphoric acid (from 20-percent superphosphate), and potash (from potassium chloride) were tested in the presence of the highest level of the other two nutrients. In addition, a no-fertilizer treatment was included. Fertilizer was applied in three equal applications in April, July, and October of each year.

RESULTS AND DISCUSSION

The results obtained in the first three crops, starting 2½ years after planting, are summarized in table 1 and figure 1. Yields for the first two crops were more than doubled, and those of 1958 more than tripled by proper fertilization, when compared with no fertilization.

Yields of market coffee were increased by 8.7, 3.7, and 7.3 hundredweights per acre in 1956, 1957, and 1958, respectively, by the application of 150 pounds of nitrogen per acre yearly (fig. 2A). During the very dry year of 1957 there was no evidence of a response beyond this level.

In 1956, yields were increased by 5.7 hundredweights per acre by the

TABLE 1.—*The effect of 3 levels each of nitrogen, phosphorus, and potassium on yields of intensively managed coffee grown in Alonso clay at Castañer, P. R.*

Treatment[1]			Yields of market coffee		
N	P_2O_5	K_2O	1956[2]	1957	1958
Lb./A.	*Lb./A.*	*Lb./A.*	*Cwt./A.*	*Cwt./A.*	*Cwt./A.*
0	0	0	9.2	6.6	5.6
300	300	300	18.9	14.0	18.9
0	300	300	7.6	10.5	9.3
150	300	300	16.3	14.2	16.6
300	300	0	13.7	10.0	11.1
300	300	150	19.4	13.1	15.1
300	0	300	13.9	15.3	17.4
300	150	300	18.1	15.9	17.4
L.S.D. 5-percent level			5.7	3.6	3.6
1-percent level			7.7	4.8	4.8

[1] In 3 equal applications yearly.

[2] 7 replications this year—16 in successive years.

application of 150 pounds of potash per acre yearly. In 1957, yields were increased by 4 hundredweights per acre, by the application of 300 pounds of potash. In 1958, yields were increased by 4 hundredweights per acre by the application of 150 pounds of potash, and by an additional 3.8 hundredweights by the application of 300 pounds of potash per acre yearly (fig. 2B).

There was no significant response to phosphorus applications during any year, the apparent response during the first year not attaining statistical significance.

The data indicated the need for at least 150 pounds each of nitrogen and potash per acre yearly. With favorable weather somewhat more nitrogen may be required. With increasing growth of trees, applications of at least 300 pounds of potash per acre were required for maximum yields with the third crop. At least in young plantations, applications of phosphorus seem

desirable. Under some conditions, heavier applications of fertilizer than indicated above may be warranted. There can be no doubt that heavy fertilization of intensively managed coffee is very profitable considering the magnitude of the yield increases obtained and the relative prices of coffee and fertilizer.

Analysis of leaf samples taken from all plots when the 1958 crop was

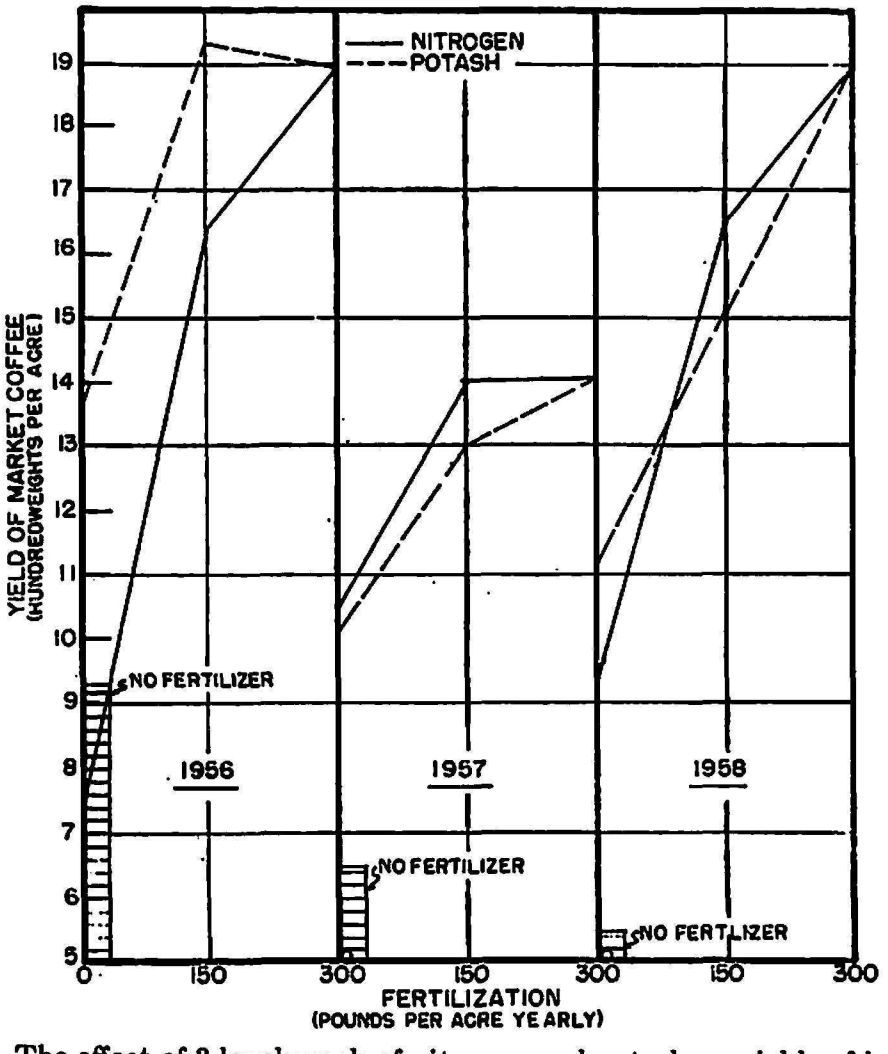

FIG. 1.—The effect of 3 levels each of nitrogen and potash on yields of intensively managed coffee, Puerto Rico, 1956–58.

maturing showed that nitrogen content of the leaves increased with nitrogen rates, averaging 2.3, 2.8, and 3.0 percent at the 0-, 150-, and 300-pound levels, respectively. Similarly, potassium content averaged 0.98, 1.67, and 2.18 percent at the 0-, 150-, and 300-pound levels of potash, respectively. Neither the phosphorus content, which ranged from 0.15 to 0.19 percent, nor the calcium content, which ranged from 0.90 to 1.2 percent, was appreciably affected by the treatments, although highest leaf contents of these nutrients occurred when no nitrogen was applied. It is of interest to note that the magnesium content of the leaves dropped from 0.85 to 0.59 and 0.45 percent, respectively, with each increase in potash level.

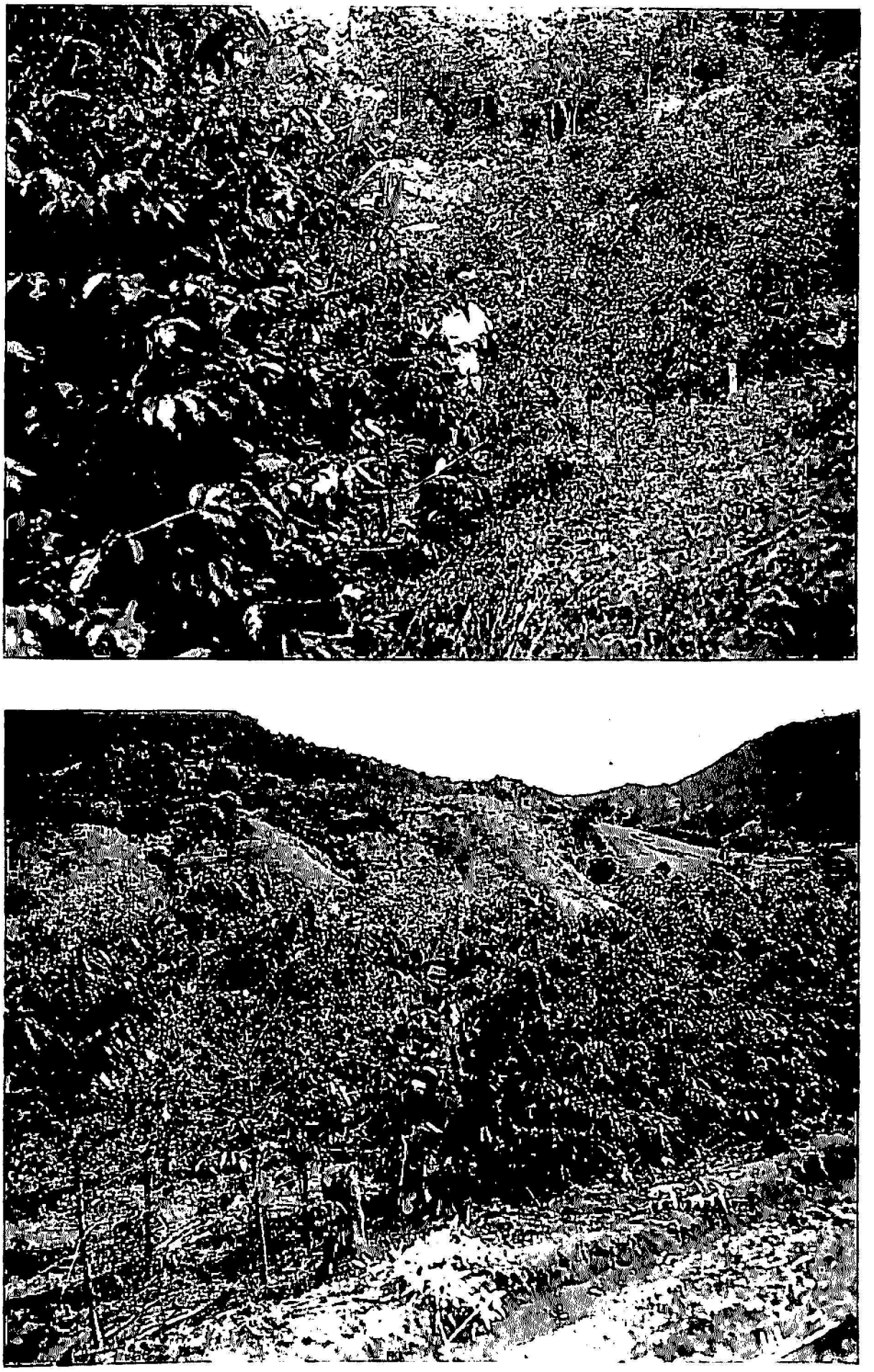

FIG. 2.—Intensively managed coffee responds strongly to fertilization with nitrogen and potash. In both cases trees received an abundance of nutrients other than those indicated: A (top), Trees on right received no nitrogen, those on left 300 pounds per acre yearly; B (bottom), trees on left received no potash, those on right 300 pounds per acre yearly.

SUMMARY

The effect of three levels each of nitrogen, phosphoric acid, and potash, on yields of intensively managed coffee grown in Alonso clay at Castañer were determined. Yields averaging in excess of 15 hundredweights of market coffee per acre were obtained over 3 successive years, compared to an Islandwide average of about 150 pounds.

A marked response to the application of 150 pounds of nitrogen per acre occurred during all 3 years, with a strong indication of a response to an additional 150 pounds of nitrogen during the 2 years of normal rainfall. A strong response to the application of 150 pounds of potash per acre occurred during the first year, a response to the 300-pound application the second year, and to the 150- and 300-pound levels the third year. There was no significant response to phosphorus in any year.

RESUMEN

Se determinó el efecto de tres niveles de nitrógeno, ácido fosfórico y potasa en el rendimiento de café cultivado intensivamente en suelo Alonso arcilloso, en Castañer. El rendimiento promedio fué de más de 15 quintales de café pilado por cuerda durante 3 años consecutivos, lo cual compara favorablemente con el promedio de 150 libras por cuerda para la Isla en general.

Hubo una reacción favorable en rendimiento a la aplicación de 150 libras de nitrógeno por cuerda durante todos los 3 años. Durante los 2 años de lluvia abundante hubo indicación fuerte de una reacción a la aplicación de 150 libras de nitrógeno adicionales. También hubo una reacción favorable en rendimiento a la aplicación de 150 libras de potasa por cuerda el primer año, y a la aplicación de 300 libras por cuerda el segundo año. Durante el tercer año hubo una reacción favorable a la aplicación de 150 y de 300 libras de potasa por cuerda. La aplicación de fósforo no afectó significativamente los rendimientos de café.

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