

EFFECT OF BALANCED FERTILIZATION ON COCOA YIELD IN COLOMBIA

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Fertilizing cocoa growing under shadow produces only modest increments of yield, but, fertilizing plantations completely exposed to sunlight produces significant yield response of dry beans. Under sunlight, photosynthesis is more intense compared with a shadowed plantation therefore fertilizer response is high. However, if no fertilizer is used yields drop rapidly with time and the plantation enters in an early senescence. Research studying response of cocoa to fertilization has been scarce in Colombia. The present study was designed to evaluate, the response of cocoa to balanced nutrition for five consecutive years

Conditions of the experimental site

The experiment was conducted in Santander, Colombia in a 4-year old plantation of mixed commercial hybrids. The site was 900 meters above sea level, had a mean annual precipitation of 3000 mm and a mean annual temperature of 24° C. Soil chemical properties at the beginning and end of the study are presented in Table 1. Treatments used in the experiment

included three rates of nitrogen (N) (50, 100, and 150 kg/ha), one rate of phosphorus (P) (90 kg P₂O₅/ha), and three of potassium (K) (50, 100, and 200 kg K₂O/ha) and a check that received 2 kg chicken manure per tree, which is the common farmer practice. All experimental units received an annual application of 200 g/plant of dolomite. Fertilizer application was split twice a year with applications made at the beginning of each rainy season.

Results and discussion

The mean yield response to fertilizer treatments during the five-year period is shown in Table 1. The 150-90-200 NPK treatment produced the greatest response with an average yield of 1160 kg of dry bean/ha in the five year period, which was more than 100 percent check. The second best was the 100-90-200 NPK treatment. It was 87 percent greater than the check. The good response to fertilizer application was due to the nutrient requirements of the crop and the initial low nutrient content of the soil (Table 2).

Table 1. Cocoa yield response to N and K rates in Santander, Colombia. Data represent 5 years average.

Treatments, kg/ha			Yield of dry beans
N	P ₂ O ₅	K ₂ O	Kg/ha
50	90	50	560
100	90	50	574
150	90	50	572
50	90	100	601
100	90	100	650
150	90	100	943
50	90	200	819
100	90	200	1049
150	90	200	1160
Check*			562

* 2 kg of chicken manure and 200 g of dolomite per plant

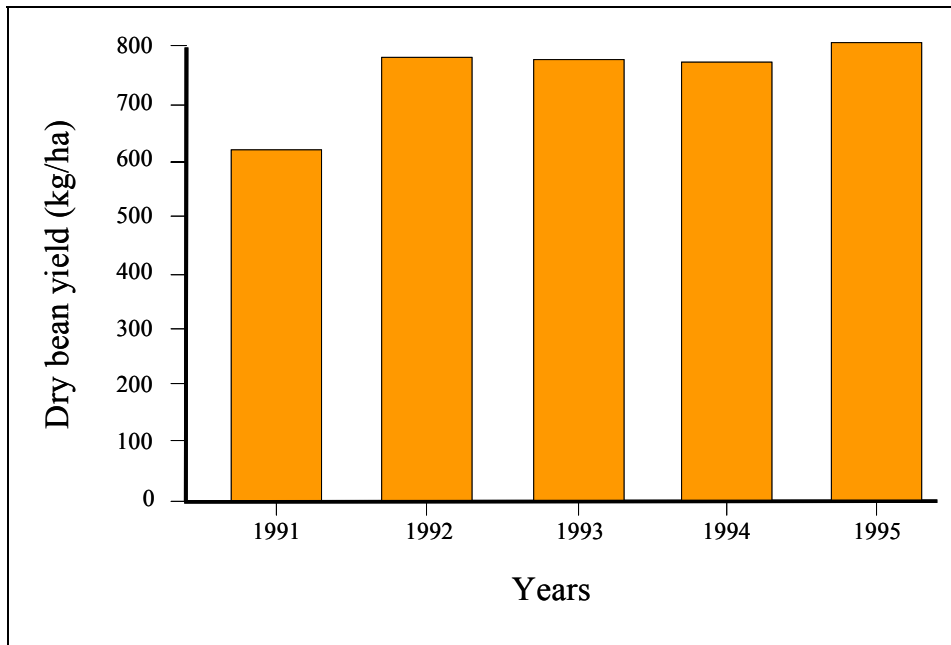


Figure 1. Mean cocoa yield response across fertilizer treatments over a five year period in Santander, Colombia.

The mean response across fertilizer treatments, over the five year period, is presented in Figure 1. Year five accumulated the greatest yield with a mean of 802 kg of dry beans/ha. Yields were slightly lower in years two, three and four and the lowest yield (620 kg) occurred in year one. This suggests that the effect of fertilizer treatments materialize in a long-term period in plantation crops as cocoa and that the greatest yield response occurred after the soil test levels were built to a higher fertility.

Most of the cocoa producing areas of Colombia have an average annual rainfall greater than 2000 mm. The area where the experimental site was located averaged 2956 mm over the last 4 years of the experiment.

Rainfall distribution pattern is important to determine the time when fertilizer applications should be made. Even though it was not a factor in this study it is worth noting that the total fertilizer rates were split to coincide with the initiation of each one of the rainy periods prevalent in the zone (Figure 2). This also contributed to the response to fertilizer application at this site.

A simple economical analysis was conducted in the treatments of the study (Table 3). The data indicates a profitable balance when inputs and outputs are computed. The best economic treatment received 150-90-200 kg/ha of N, P₂O₅, K₂O, respectively. It produced a net profit of \$479/ha.

Table 2. Average initial, intermediate and final soil test of the treatment plots where the highest yields were obtained.

Year of The study	PH	MO %	P ppm	Al	K	Ca	Mg
				-----	meq/100 g soil	-----	
1	4.6	9.2	10	2.9	0.12	0.60	0.11
3	5.0	9.7	12	2.4	0.21	0.75	0.19
5	5.6	10.8	14	2.1	0.31	1.01	0.26

Summary

Data obtained in this experiment demonstrate the need of fertilizing cocoa plantations completely exposed to sunlight. The treatment that produced the highest

yield was fertilized with 150 kg of N, 90 kg of P₂O₅ and 200 kg K₂O per hectare. This data show that adequate and balanced fertilization of cocoa can be profitable and it sustains yield through time.

Table 3. Balanced nutrition effect on cocoa yield and income in an Santander, Colombia.

Treatments			Yield	Total income	Cost of fertilizer US \$/ha	Net income
N	P ₂ O ₅	K ₂ O				
kg/ha						
50	90	50	560	288	57	231
100	90	50	574	295	74	221
150	90	50	572	294	92	201
50	90	100	601	308	65	243
100	90	100	650	334	83	251
150	90	100	943	484	100	384
50	90	200	819	421	84	337
100	90	200	1049	538	101	437
150	90	200	1160	596	117	479
Check			562	289	65	224

* 2 kg of chicken manure and 200 g of dolomite per plant

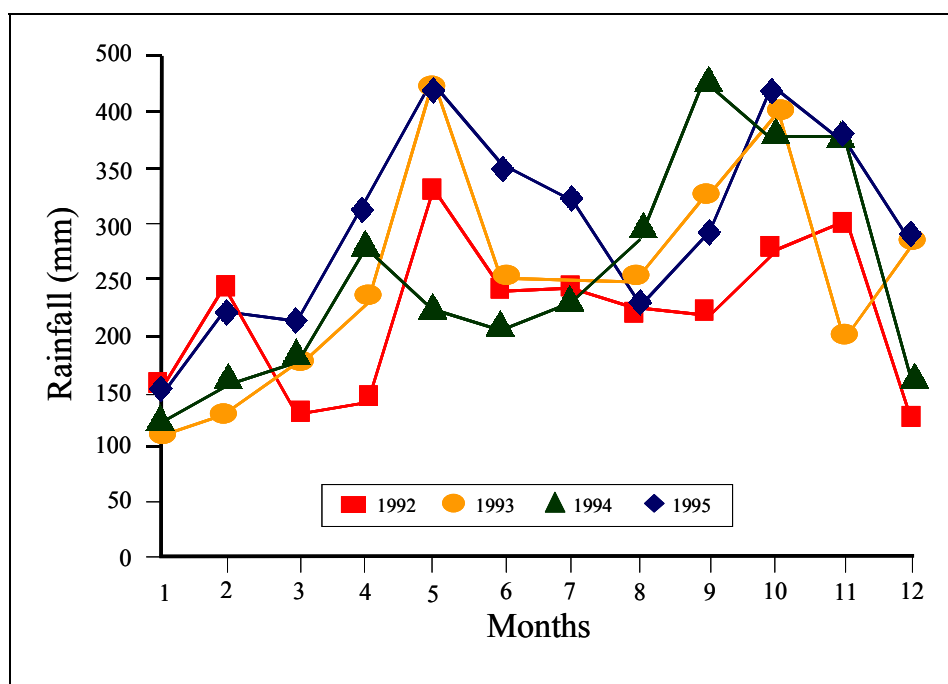


Figure 2. Rainfall distribution pattern in Santander, Colombia in a four-year period.