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Evaluation of P-uptake in *Coffea canephora* (Pierre ex Froehner) under different shade regimes

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ABSTRACT: Phosphorus uptake studies in *Coffea canephora* Pierre ex Froehner were undertaken at Idi-Ayunre, Ibadan Oyo State and Uhonmora Edo State representing the rainforest and derived savanna zones respectively between 1995-1997. One hundred and sixty five kilograms per hectare of rock phosphate were applied. The experiment was a randomized complete block design in factorial layout with 4 replicates.

The least P – uptake was 21.81 g/plant and 35.10g/plant at Idi-Ayunre and Uhonmora under 100% shade while the highest under 50% shade were 52.40g/plant and 49.45g/plant at Idi-Ayunre and Uhonmora respectively. The P – uptake under 50% shade was significantly higher ($p=0.05$) than 100% shade regime in the two ecological zones considered.

Key Words: *Coffea canephora*, P-uptake, Shade regimes; Ecological zones.

Introduction

Phosphorus is an essential nutrient element that is considered to be immobile in soils. Coffee had been found to respond to phosphorus. The best response is obtained on young coffee trees (De Geus, 1967). Under highly weathered conditions, P fertilizer application undergoes significant chemical changes within the soil profile. Soils under coffee in the open are more affected by this effect than soils under shade (Rene, 1992). As a result of high fixation, it has been reported that about 70% to 80% of applied P is unavailable to coffee seedlings (Narik *et al*, 1988).

The report on P uptake by coffee under shade is scanty but Reve (1993) and Opeke (1982) had reported that shade promotes food growth of coffee under poly culture than it was obtained under monoculture. An experiment was conducted on with degree of shade under which coffee would perform optimally and the effect of shade on P-uptake.

Materials and Methods

This study was carried out on an alfisol at Cocoa Research Institute of Nigeria (CRIN) Headquarters, Idi-Ayunre Ibadan, Oyo State (a rainforest zone) and on ultisol at CRIN subtraction Uhonmora, Edo State (Derived savanna zone) between 1995 and 1997. These locations lies between latitudes 7°25'N and longitude 3°25'E for Idi-Ayunre and latitudes 6°50'N and 3°25'E at Uhonmora. The seedlings used for the experiment were collected from CRIN nursery at Ibadan. Land preparation and plot layout were carried put between February and April 1995. Planting holes of dimention 60 x 60 x 60 cm dug and seedlings were transplanted in June at 3.1m apart. Eight plants were planted for each treatment.

Two factors were considered. Shade regimes 50, 100 and zero percent) and length of shading 3,6,12 months and permanent). Shed were constructed using bamboo at 1.5m height and fresh palm fronds were used to cover the top and sides leaving a small inlet for data collection. Light mater was used to adjust the level of light to 0, 50 and 100 percent levels throughout the trials. The shade were removed 3, 6 and 12 months living only treatment with permanent shade untouched. Rock phosphate for coffea canephora.

The experiment was a Randomized Complete Block Design (RCBD) in a factorial layout, consisting of 12 treatments and four blocks. Soil samples were collected at the beginning of the trial for routine analysis. Three months thereafter, some coffee seedlings were uprooted on treatment basis. The roots were washed, weighed and oven dried to a constant weight and weighed again. The dried plants were milled and analyze for the P content and the uptake calculated. The result was subjected to statistics and LSD was used to separate the means that were significant.

Results and Discussion

The chemical characteristics of the soil under investigation are shown in Table 1. Also the soil chemical characteristics after the experiment are shown in Table 2.

Table 1: Soil Chemical Characteristics of the experimental sites at the beginning of the experiment before application of rock phosphate.

Soil Chemical Properties	Idid - Ayunre	Uhonmora
pH (H ₂ O)	6.4	5.4
% Organic Carbon	0.85	0.90
% Total Nitrogen	0.08	0.10
Available P (mg/kg) soil	7.30	7.20
Exchangeable K (cmol/kg) soil	0.41	0.30
Exchangeable Ca (cmol/kg) soil	2.50	2.56
Exchangeable Mg (cmol/kg) soil	0.06	0.05
Exchangeable Na (cmol/kg) soil	0.01	0.02

Table 2: Soil Chemical Properties of the experimental Sites After application of rock phosphate

Soil Chemical Properties	Idid - Ayunre	Uhonmora
pH (H ₂ O)	6.4	5.4
% Organic Carbon	0.85	0.92
% Total Nitrogen	0.08	0.10
Available P (mg/kg) soil	9.45	9.30
Exchangeable K (cmol/kg) soil	0.44	0.32
Exchangeable Ca (cmol/kg) soil	2.50	2.56
Exchangeable Mg (cmol/kg) soil	0.07	0.06
Exchangeable Na (cmol/kg) soil	0.02	0.03

Available P was shown to have increased significantly compared to the initial soil P. with regard to the P uptake, coffee under 100 percent shade gave the least uptake at both ecological zones. The uptake were 21.8g/plant and 35.10g/plant at Idi-Ayunre and Uhonmora respectively (Tables 3 and 4). The 50% permanent shade gave the highest P-uptake of 52.40g/plant and 49.45g/plant at both Idi-Ayunre and Uhonmora respectively, 24 months after transplanting (Tables 3 and 4). The P – uptake was significantly higher in the 50% shade than for zero% and 100% shade regimes. This indicates that 50% shade regimes enhances P – uptake in coffee than other regimes of shade. The results obtained agrees with the earlier findings of Rene (1992) that light shade promote good growth of coffee and Opeke (1982) on growth advantage under shade than in monoculture. Leaching and erosion might have contributed to low P-uptake under the zero % shade regime than 50% shade.

Table 3: Effect of different levels of shade on P-Uptake (g/plant) of coffee canephora at Idi Ayunre from 3 MAT to 24 MAT P-Uptake (g/plant)

Treatment	3	6	9	12	15	18	21	24 (MAT)
0% Shade (O)	40.01	45.42	45.50	46.11	47.43	48.60	48.90	49.10
50% Shade (O)	43.24	48.10	48.12	48.14	50.75	51.10	51.62	52.40
100% Shade (O)	21.81	32.21	33.04	33.62	33.62	34.50	34.57	35.30
0% Shade (3)	27.28	38.21	38.24	39.30	40.21	41.30	41.50	42.34
50% Shade (3)	26.38	30.50	31.26	34.45	35.49	36.21	36.34	37.38
100% Shade (3)	20.32	25.60	26.62	27.20	26.37	27.40	27.57	28.43
0% Shade (6)	27.92	27.50	28.10	29.20	30.12	33.36	33.57	34.20
50% Shade (6)	24.88	29.60	29.93	31.25	32.42	34.45	35.00	35.38
100% Shade (12)	24.80	25.42	26.50	28.31	24.45	26.30	26.65	27.80
0% Shade (12)	20.10	26.95	27.96	30.50	32.30	33.32	33.37	34.51
50% Shade (12)	35.92	40.14	40.50	41.31	41.75	42.30	42.60	43.50
100% Shade (12)	26.25	27.55	27.60	28.14	29.15	29.33	29.37	29.38
Mean	29.08	33.15	33.61	34.79	35.38	36.51	36.76	36.85
LSD (P=0.05)	4.44	4.81	4.63	4.40	4.96	4.78	4.84	5.11

*MAT = Month after transplanting.

0 = Permanent Shade

3 = Shade removal after 3 months

6 = Shade removal after 6 months

12 = Shade removal after 12 months.

Table 4: Effect of different levels of shade on P-Uptake (g/plant) of coffee canephora at Idi Ayunre from 3 MAT to 24 MAT P-Uptake (g/plant)

Treatment	3	6	9	12	15	18	21	24 (MAT)
0% Shade (O)	38.46	39.62	40.20	42.12	43.50	44.40	44.45	44.53
50% Shade (O)	40.51	43.78	44.40	46.00	47.62	48.15	48.30	49.45
100% Shade (O)	35.10	35.44	36.00	38.00	38.19	36.17	36.20	36.50
0% Shade (3)	34.68	36.63	37.40	40.31	41.30	42.20	42.30	43.45
50% Shade (3)	34.48	38.30	39.23	42.30	48.20	44.30	44.36	45.23
100% Shade (3)	34.92	34.66	35.00	36.00	37.18	37.20	37.25	39.32
0% Shade (6)	36.38	35.96	36.10	37.62	38.41	39.52	39.55	40.20
50% Shade (6)	37.90	38.09	39.02	40.34	41.18	42.50	42.57	44.34
100% Shade (12)	36.65	37.84	38.90	39.91	40.12	40.14	40.19	42.41
0% Shade (12)	34.10	35.87	36.75	37.70	38.50	39.41	39.46	40.11
50% Shade (12)	35.76	36.38	37.40	38.98	39.20	40.74	40.78	43.52
100% Shade (12)	32.63	33.32	33.34	33.61	34.10	34.10	34.16	34.60
Mean	35.42	37.16	37.81	39.45	40.21	40.71	40.80	41.97
LSD (P=0.05)	1.32	1.64	1.73	1.34	2.13	2.37	2.39	2.47

*MAT = Month after transplanting. = Permanent Shade

3 = Shade removal after 3 months

6 = Shade removal after 6 months

12 = Shade removal after 12 months.

The highest P – uptake that was obtained at 50% permanent shade regime indicates that more photosynthetic activities and early ripening of berry would result when the seedlings reach the age of berry bearing and this would be higher than zero % and 100% shade regimes. This trend was obtained when shades were removed at 3, 6 and 12 months after transplanting.

From the results, 50% permanent shade regime has been found to be most suitable for field establishment of *Coffea canephora*. This would result to higher P – uptake than for zero % and 100% regimes of shade.

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