CocoaSoils

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Title: Influence of Soil Physicochemical Properties and Cocoa Growth characteristics on Cocoa yield components in the Central Region of Cameroon

Authors: Onana, A.A ., H. M. Giweta, L. Rusinamhodzi, A. Tchouga, A. Kemga, C. Masso

Correspondance e-mail: A.Onana@cgiar.org

Background

Cocoa requires nutrient-rich soils and good management practices to achieve and maintain high productivity.

We investigated, in this study, the relationships between soil properties, cocoa growth characteristics, and yield parameters in Cameroon, the sixth larger cocoa producer in the world, with an annual production of approximately 290 000 tons.

Methodology

Study Zone: Three localities in the Center region of Cameroon viz. Ntui (1600 mm ; 26-29°C, 573 m), (Ayos (1570 mm ; 21-29°C, 700 m), and Makenene (1980 mm ; 27-29°C, 760 m), with Ferralsols and Acrisols.

Data collection and analysis: In 64 farms, aged from 8 to 22 years old, representative soil samples were collected at 0-30 cm depth of each 2000 m^2 delineated experimental plot. Soil samples were analysed for physicochemical according to the IITA standard soil analysis manual (IITA 1979). Allometric properties and yield components were determined using the protocol described by Rusinamhodzi et al. (2020). Data were analysed using principal component analysis (PCA), Spearman correlations and stepwise regression using backward method for years 2020 and 2021 (R software).

Results and Impacts

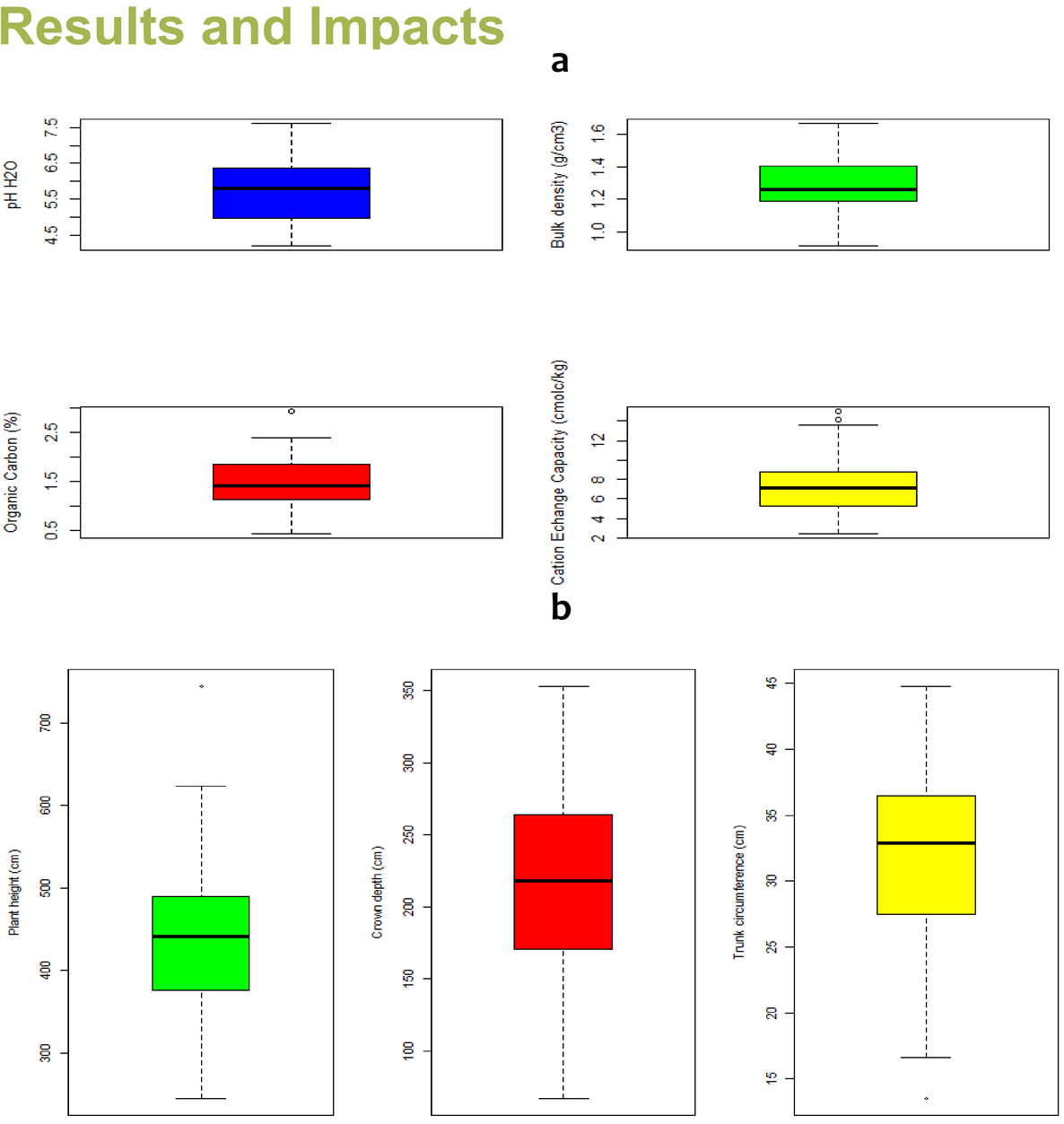

Figure 1. Boxplot of soil properties (a), allometric parameters of cocoa (b)

Dry beans yield was ranged from 260 to 5800 with a median of 413 kg/ha. They are in the range of values reported by Goenaga et al.(2015), Hartemink (2005), and Jagoret et al. (2020).

PCA revealed that actual and exchangeable acidities, exchangeable bases, bulk density, cation exchange capacity, and micronutrients exerted the most influence on cocoa yield components (number of pods, pod yield, and bean yields), while among the allometric properties, crown depth (Crownd), tree height (Theight), tree density (Pden) and trunk circumference (Tcirc) did.

Table 1: **Relationship between selected soil properties, growth and yield components of cocoa**

properties	Theight	Height1	Den	Tcirc	Crownd	Npod	Pody	Dbeany
pH	0.37***	0.22**	0.15*	0.50***	0.29***	0.36***	0.32***	0.29***
EC	0.14·	0.15*	0.06^{NS}	0.22**	0.08^{NS}	0.17*	0.17*	0.14·
Ca	0.14·	-0.04^{NS}	-0.12^{NS}	0.08^{NS}	0.21**	0.39***	0.32***	0.34***
Mg	-0.04^{NS}	0.14·	0.22**	0.07^{NS}	-0.13^{NS}	0.25***	0.22**	0.18**
K	-0.29***	-0.23**	0.06^{NS}	-0.21**	-0.10^{NS}	0.25***	0.31***	0.24***
SEB	0.07^{NS}	0.10^{NS}	0.08^{NS}	0.17*	0.05^{NS}	0.38***	0.32***	0.32***
CEC	-0.29***	0.04^{NS}	0.17*	0.21**	-0.34**	0.25***	0.24***	0.20***
BS	0.46***	0.17*	-0.06^{NS}	0.52***	0.45***	0.28***	0.22**	0.26***
ECEC	-0.14·	-0.07^{NS}	-0.003^{NS}	-0.11^{NS}	-0.07^{NS}	0.25***	0.23***	0.19**
EA	-0.33***	-0.26***	-0.26***	-0.46***	-0.17*	-0.42***	-0.39***	-0.41***
TotN	-0.24***	-0.09^{NS}	-0.03^{NS}	-0.33***	-0.17*	0.16*	0.12^{NS}	0.09^{NS}
OC	-0.30***	-0.14^{NS}	0.003^{NS}	-0.40***	-0.18*	0.15·	0.12^{NS}	0.08^{NS}
CNR	-0.19*	-0.05^{NS}	-0.16*	-0.23**	-0.19*	0.15·	-0.05^{NS}	-0.12^{NS}
BD	0.46***	0.36**	0.17*	0.51***	0.23***	0.25***	0.22***	0.25***
Sand	0.47***	0.46***	0.33***	0.38***	0.19*	-0.02^{NS}	0.10^{NS}	0.06^{NS}
Silt	-0.03^{NS}	0.03^{NS}	0.21**	-0.08^{NS}	-0.09^{NS}	0.27***	0.29***	0.19***
Clay	-0.46***	-0.47***	-0.41***	-0.38***	-0.16*	-0.08^{NS}	0.21*	0.17*

Correlation coefficients are given with level of significance
NS Non significant - .Statistically significant at 0.1 level - *Statistically significant at the 0.05 level.
**Statistically significant at the 0.01 level. - ***Statistically significant at the 0.001 level.

Stepwise regressions equations relating yield components (number of pods, pod yield and dry bean yield) growth and soil properties:

Npod= $4.10x10^5$- $4.51x10^5$ **pH**- $4.64x10^5$ **Ca**- $4.69x10^5$ **Mg**- $4.55x10^5$ **K**+ $1.01x10^6$ **ECEC**- $5.48x10^5$ **SEB** – 180.5 **BS**- $1.01x10^6$ **EA** - $7.48x10^5$ **TotN** + $1.90x10^4$ **BD**- $4.42x10^3$ **Sand**- $4.00x10^3$ **Silt**- $4.38x10^3$ **Clay**- 72.21 **Theight**- 59.61 **TrunkH**+ 9.50 **Pden**+ 101.6 **Crownd**+ 732.7 **Tcirc**. (**R^2=0.62** and **P-value < $2.2x10^{-16}$**)

Pody= $3.20x10^4$- $1.60x10^3$ **pH**- $3.19x10^5$ **Ca**- $3.22x10^5$ **Mg**- $3.10x10^5$ **K**+ $3.21x10^5$ **ECEC**- 8.99 **EC** – 55.33 **BS**- $3.20x10^5$ **EA** - $2.59x10^3$ **OC**- 381.7 **Sand**- 372.9 **Clay**+ 4.89 **Pden**+ 34.72 **Crownd**+ 321.9 **Tcirc**. (**R^2=0.65** and **P-value < $2.2x10^{-16}$**)

Dbeany= $3.82x10^5$- 250.8 **pH**- $3.51x10^4$ **Ca**- $3.58x10^4$ **Mg**- $3.36x10^4$ **K**+ $3.53x10^4$ **ECEC**- 1.64 **EC**- $3.52x10^4$ **EA**- $2.29x10^4$ **TotN**- 200.3 **CNR**- 3.62 **Sand**- 302.9 **Silt**- 358.4 **Clay**- 0.71 **Pden**+ 31.26 **Tcirc**. (**R^2=0.73** and **P-value < $2.2x10^{-16}$**)

Conclusion

Single soil and cocoa characteristics can barely explain cocoa yield performance, while a combination of properties does.

Maintenance of adequate soil fertility (e.g., integrated soil fertility management) and good crop management for healthy cocoa plants could improve cocoa productivity in Central region of Cameroon and beyond.

Acknowledgement

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