Photosynthesis response as indicators of potassium use efficiency in oil palm (*Elaeis guineensis* Jacq.) progenies

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Introduction

- In oil palm, as in other C_3 plants, photosynthesis drives the synthesis of carbohydrates that support growth and yield.
- Understanding photosynthesis's response to nutrient availability is essential for enhancing potassium uptake and use efficiency and maintaining oil palm productivity under resource-limited conditions.

Pic. 1. Mature oil palm plantation *(Ra. HA)*

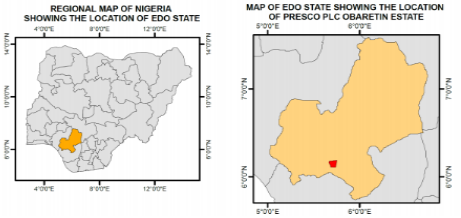


Fig. 1. Map of Nigeria and Edo state showing the localization of the Presco Plc Ologbo Estate where the trial was set up *(Ra. RI)*

Aim

Evaluate the relevance of photosynthetic measurements for screening oil palm progenies with efficient K use, and their potential application in breeding programs aimed at improving nutrient use efficiency and yield.

Materials and method

- The study was conducted as part of a larger fertilizer x progeny experiment (set up in 2011) designed as a K^3xMg^3 factorial trial with 6 replications and fertilizer whole-plots divided into four progeny split-plots
- To compare the photosynthetic responses of progenies to K fertilization only, we focused our study on palms that received an average amount of 0.75 kg Mg palm^{-1} year^{-1} (Mg1 dose), combined with the three KCl levels, in three replications, making three fertilizer treatment combinations (K0Mg1, K1Mg1, and K2Mg1).
- To examine genotype, fertilizer, and genotype x fertilizer interaction effects, 3 way ANOVAs were performed with factors "genotypes", "K" and "Mg".
- Photosynthesis measurements were performed *in situ* on the leaf of rank 9 of the central palm of each fertilizer treatment subplot (Dufrêne, 1990), using an infrared gas analyzer (GFS-3100, Walz, Germany).
- Photosynthetic photon flux density (PPFD) in the measurement cuvette was increased stepwise from 0 to 1100 µmol m^{-2} s^{-1} in increments of 200 µmol m^{-2} s^{-1}.

Table 1. Genetic characteristics, varieties, and genetic origins of the parents of the different oil palm progenies

Progenies	Dura (Female parent)	Dura origins	Pisifera (Male parent)	Pisifera origins	Genetic origins	K uptake efficiency (kg of K palm^{-1})	Mg uptake efficiency (kg of Mg palm^{-1})	Average bunch numbers produced per palm	FFB Yield (Mg ha^{-1} y^{-1})	CPO_{mill} yield (Mg ha^{-1} y^{-1})
C1	PO 2630 D	DA 10D x DA 3 D	PO 2766 P	LM 10 T AF	D x L	3.35 ± 0.71 b	0.42 ± 0.04 b	14.4 ± 6.0 a	13.10 ± 0.58 c	3.60 ± 0.15 c
C2	PO 3174 D	DA 115 D AF	PO 2973 P	LM 5 T x LM 10 T	D x L	3.81 ± 0.82 a	0.46 ± 0.03 ab	14.3 ± 5.1 a	14.20 ± 0.59 b	3.95 ± 0.16 b
C3	PO 3174 D	DA 115 D AF	PO 4747 P	LM 5 T AF	D x L	3.86 ±0.79 a	0.54 ± 0.03 a	13.6 ± 5.3 b	15.80 ± 0.79 a	4.41 ± 0.22 a
C4	PO 4953 D	Unknown	PO 4260 P	LM 238 T x LM 511 P	D x Y	3.31 ± 0.8 b	0.45 ± 0.04 ab	11.4 ± 2.5 c	12.20 ± 0.68 d	3.23 ± 0.21 d

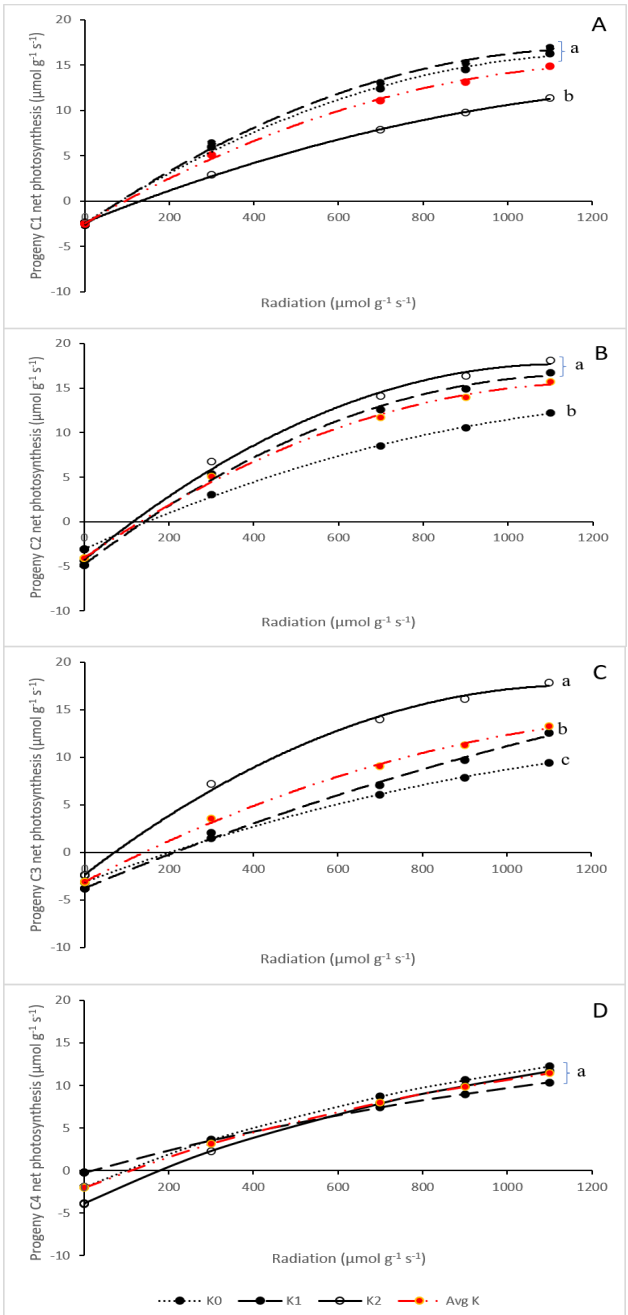
The last letter after the PO number (e.g., PO 2630 D or PO 2766 P or LM 10 T) indicates the main varietal group: P = Pisifera, D = Dura, and T = Tenera. Progenies C1, C2, C3 and C4 are all Tenera crosses (they all come from crosses between a Dura and a Pisifera variety). Data in the Dura and Pisifera columns show the genetic material from which female inflorescences and male inflorescences (pollen) were used to obtain the progenies. AF refers to self-pollinated trees (e.g. LM 10 T AF = LM 10 T x LM 10 T). D x L: Deli x La Mé, D x Y: Deli x Yangambi

Pic. 2. Fertilization on experimental palm in the weeding zone

Pic. 3. Oil palm photosynthesis measurement with the Walz

Results

Fig. 2. Oil palm progenies' photosynthesis rates with increasing radiation and according to KCl supply



Different letters (a, b and c) indicate significant differences in photosynthesis rates between KCl treatments, using Tukey's test at 1100 µmol m^{-2} s^{-1}. Tested progenies: C1, C2, C3 and C4. Tested KCl levels: K0, K1, and K2. Avgk = average photosynthetic activity according to radiation levels.

More information

Dassou SO. 2023. Interaction between oil palm (*Elaeis guineensis* Jacq.) progenies and K and Mg mineral nutrition. Ph.D. Thesis, Ghent University, 9000 Ghent, Belgium, 329pp. ISBN – Number: 978-94-6357-645-1

Pic. 4. Adult oil palm tree exhibiting Fresh Fruit Bunches (FFB) in the frond axils

Conclusion

This study demonstrated clear genotypic differences in the photosynthetic performance of oil palm progenies under varying KCl fertilization levels. These findings suggest that photosynthetic measurements can serve as an effective physiological indicator for identifying oil palm genotypes with superior nutrient-use efficiency and greater tolerance to drought stress. Breeding programs could therefore benefit from integrating photosynthetic performance screening to select cultivars capable of maintaining higher photosynthesis, and hence productivity, under limited water availability and high radiation conditions.

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