Accuracy and efficiency of root biomass estimation methods in oil palm (*Elaeis guineensis* Jacq.) plantations

Olivier **Dassou**[1,2*], Léifi **Nodichao**[1], Hervé **Aholoukpè**[1], Dansou **Kossou**[2], Yves **Cakpo**[1] and Christophe **Jourdan**[3,4]

[1]INRAB, National Agricultural Research Institute of Bénin / *Corresponding author:mandas.oliver@gmail.com; [2]UAC, Faculté des Sciences Agronomiques (FSA); [3]CIRAD, UMR Eco&Sols & [4]SupAgro, France.

Context and justification

Root biomass is one of the most used parameter to characterize root development and distribution within soil. However, different methods exist with regards to plant root system architecture, soil sampling volume and planting design. But no standard protocol was set up for Monocotyledonous trees in an equilateral triangle planting design and comparing different ages of plantation. The purpose of this work was to identify the most efficient method to estimate root biomass for young and adult oil palm trees *in situ*.

Materials and method

⇒ Three methods of root biomass sampling have been tested on two oil palm plantations having contrasted ages (2 and 16 year-old):
- *(M1): total excavation method called « complete voronoi» method (reference method) inside the voronoi space (Fig 1, 2, 3; Pict 1).*
- *(M2): partial excavation method of 0.7m of wide on the rectangular base, called « simplified voronoi» method (Fig 4; Pict 2).*
- *(M3): auger method (15 auger cores at the rate of 3 by compartment without sampling the Z0 zone) of the voronoi triangle (Fig 5; Pict 3).*
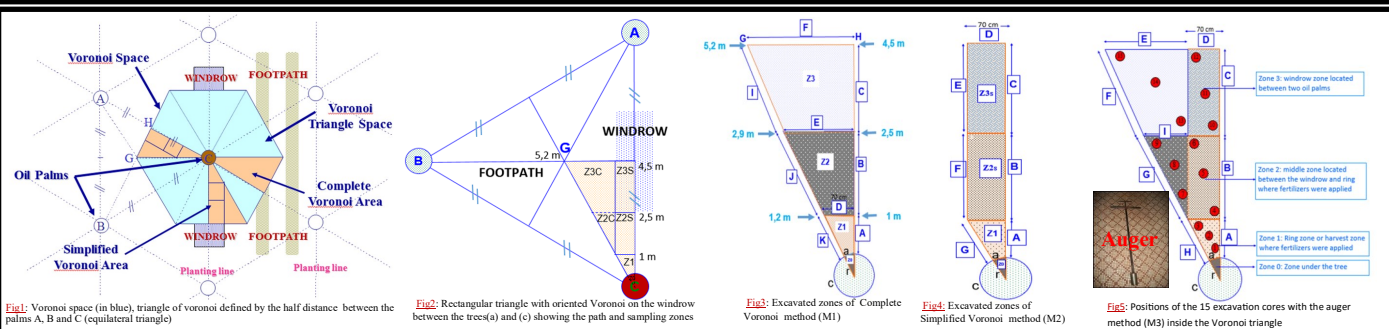
⇒ Six representative palms were chosen in each plot, each sampled tree having 6 neighbours of comparable size.
⇒ The roots were sampled until 1m deep, washed and heated with an oven to 65°C during 48h to get the dry biomass weight.
⇒ The times used for every step of each method in the field have been recorded in manday.
⇒ While considering the M1 method as reference method (1/12 sample of the elementary volume of the palm), the acuracy of the M2 and M3 method have been calculated by the relative difference of biomass data between each of the two methods and the M1 method.
⇒ The efficiency of M2 and M3 method have been calculated by the ratio between the error made by each of them and the time (*in manday*) used to set up and performed in situ the method, while considering that one worker was supposed to work 6 hours per days.

Fig1: Voronoi space (in blue), triangle of voronoi defined by the half distance between the palms A, B and C (equilateral triangle).

Fig2: Rectangular triangle with oriented Voronoi on the windrow between the trees(a) and (c) showing the path and sampling zones

Fig3: Excavated zones of Complete Voronoi method (M1)

Fig4: Excavated zones of Simplified Voronoi method (M2)

Fig5: Positions of the 15 excavation cores with the auger method (M3) inside the Voronoi triangle
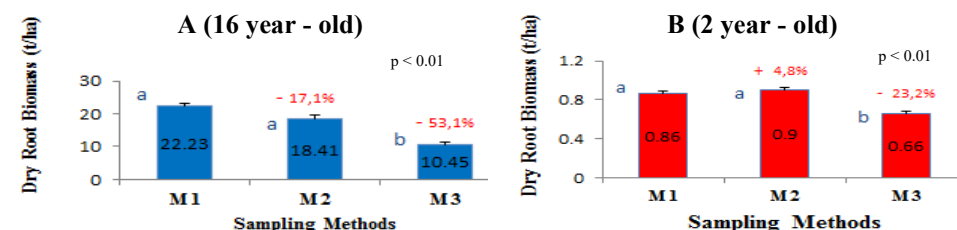
Results and discussion

Fig6: Compared survey of three methods of root biomass estimation: complete Voronoi method (M1), simplified Voronoi method (M2) and the auger method (M3) for oil palms aged of 16 years (A) and 2 years (B).

Auger method underestimated by 23,2% of the total dry root matter compared to reference method in 2 year-old oil palms. In 16 year-old plantation, it reached 53,1% of underestimation. By contrast, simplified Voronoi method overestimated by 4.8% the root biomass compare to complete Voronoi method in 2 year-old plantation, but underestimated by 17.1% the root biomass in 16 year-old oil palm plantations (Fig6).

Table1: Errors made, time elapsed and efficiency of the root sampling methods for 2 and 16 year-old oil palm plantations

Olds	Parameters Methods	M 1	M 2	M 3
2 years	**Errors (%)**	0	+ 4.65	- 23.27
	Times (Manday)	42.1 ± 8.8 a	19.6 ± 9.9 b	6.8 ± 1.1 c
	Efficiency	-	0.24	3.42
16 years	**Error (%)**	0	- 17.18	- 53.1
	Times (Manday)	113.6 ± 16.9 a	37.7 ± 10 b	13.4 ± 6.1 c
	Efficiency	-	0.46	3.96

Picture 1: Pit of Complete Voronoi method after root excavation (M1)

Picture 2: Pit of Simplified Voronoi method after root excavation (M2)

Picture 3: Holes of auger method inside the Voronoi triangle after root sampling (M3)

Conclusion

Simplified Voronoi method was the most efficient and less heavy method to manage oil palm root biomass estimation. Auger method is the fastest root sampling method but it's poorly efficient and inacurate, particularly on mature palm. The simplified Voronoi method can be kept as standard root sampling method in the studies aiming root biomass estimation.

To know more

O. Dassou (2011): Impact of the root sampling method on the determination of the oil palm (*Elaeis guineensis* Jacq.) root development parameters in Benin. *Agronomist engineer Thesis. 74p.*