Tropentag, September 17-19, 2018, Ghent

"Global food security and food safety:
The role of universities"

Oil Palm (Elaeis guineensis Jacq.) Root System Characteristics in a 12 Year Old Density Trial in Nigeria

[1]B. Filliers
[1,2]R. Impens
[1]P. Van Damme
[3]X. Bonneau

[1]UGent,
Faculty of Bioscience Engineering,
Dept. Of Plants and Crops,
Coupure links 653,
Ghent - Belgium

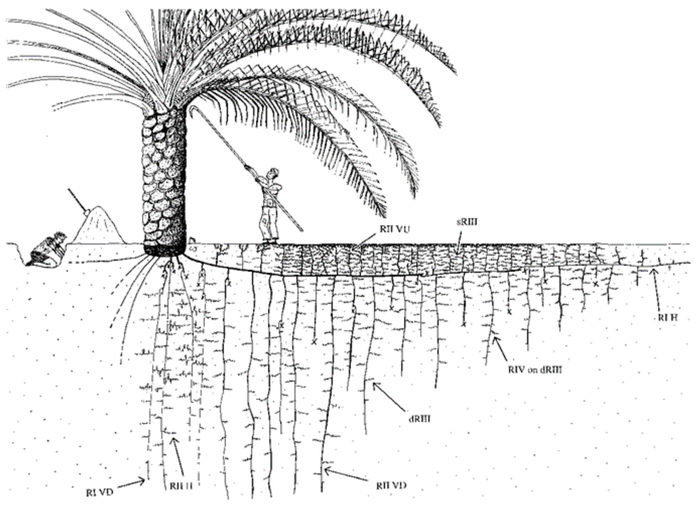
[2]Presco plc,
Benin/Sapele Road,
P.O. Box 7061, Benin City,
Edo State - Nigeria

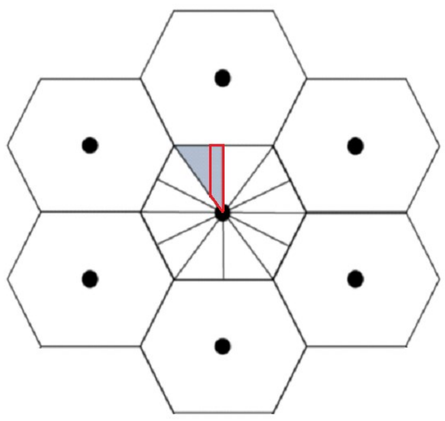
[3]CIRAD,
TAB34/02 avenue Agropolis
Montpellier - France

Context:
Several plant density trials for oil palm have been set-up and studied across the world over past decades. These usually focus on bunch production and above ground competition for light with occasionally some physiological studies but the root system is usually left un-studied.
This paper presents part of the results from a root analysis study carried out on an oil palm density trial in Nigeria. The biomass, root length and density was quantified per palm and per hectare for different soil volumes around the palm trees. This brings further understanding of how planting density affects the underground processes in oil palm plantations under the West-African environment. Characterized by a seasonal soil moisture deficit.

Methodology:
3 different planting densities were studied : 128, 160 and 205 palms/ hectare, corresponding to a spacing of 7.5, 8.5 and 9.5m respectively between the palms.
The simplified voronoi method was used with trenches of 2m deep for 4 palms per density
Volumes were divided based on 4 horizons and 4-5 zones
For each soil volume the dry biomass of roots was determined with distinction of primary, secondary and fine roots
Root samples were scanned and analysed with WinRhizo to determine root length and volume.

Figure 1: Picture from ongoing excavations for the root analysis following the simplified voronoi method





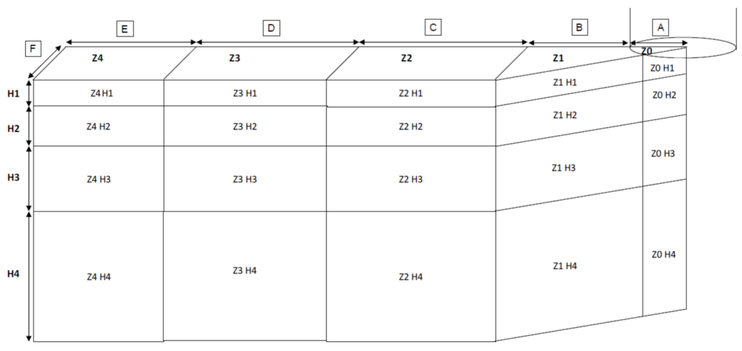
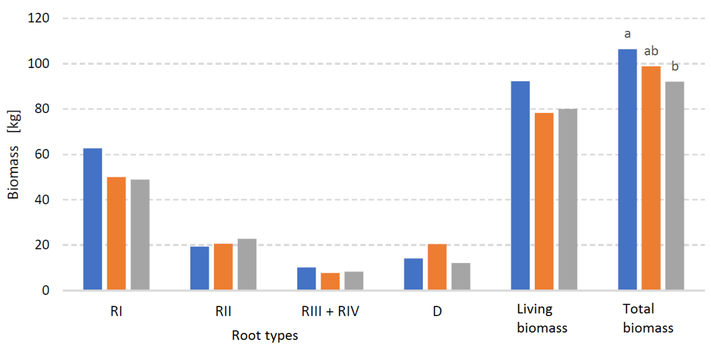


Figure 2: Methodology of root analysis study. **Left:** Oil palm root architecture (from Jourdan and Rey (1997)) . **Middle:** Equilateral triangle planting pattern of the oil palms (black dots), Thiessen polygon (hexagons) represnting the area from each palm and containing the complete vornonoi polygon (grey zone) and the simplified voronoi used for the study (red zone). **Right:** Entire excavated and studied soil volume with separation per zone and horizon

Results:

A) Average oil palm root biomass for the different root types and densities studied (kg per palm)



B) Average oil palm root biomass for the different root types and densities studied (ton per hectare)

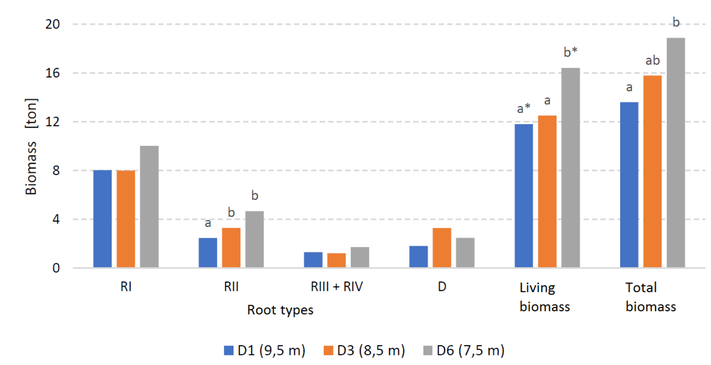


Figure 3: Average root biomass per tree (A in kg/palm) and per hectare (B in ton/hectare) for the different planting densities and root types studied

		RI				RII				RIII + RIV			
		Z0 + Z1	Z2	Z3	Z4	Z0 + Z1	Z2	Z3	Z4	Z0 + Z1	Z2	Z3	Z4
D1	H1	1777	463	390	342	474	655	479	566	1380	4642	2741	2334
	H2	1911	108	120	71	209	224	229	255	625	685	403	437
	H3	207	33	15	6	136	97	78	85	102	67	30	89
	H4	148	54	20	43	127	79	69	78	134	135	62	67
D3	H1	960	294	203	232	406	567	566	593	1501	3246	3313	3387
	H2	810	179	175	82	318	465	317	205	567	444	305	107
	H3	278	36	5	11	221	153	182	50	152	36	34	33
	H4	73	11	2	4	233	100	79	83	132	106	84	68
D6	H1	1070	213	201		634	480	704		3904	4109	2051	
	H2	756	199	144		342	406	388		575	657	230	
	H3	182	13	6		253	136	114		187	73	49	
	H4	58	7	1		200	109	107		148	100	70	

0-99	200-300	400-500	600-700	800-900	1000-1500	3000-5000		
100-200	300-400	500-600	700-800	900-1000	1500-3000	[m m^{-3}]		

Figure 4: Average root density (m/m^{-3}) in the different horizons and zones for the 3 densities studied and the 3 root types considered

- More root biomass per palm, in lowest density mainly due to more RI production
- More root biomass per hectare for highest density as a result of higher number palms/ha
- Primary roots in low planting densities are more superficial and less branched
  => Exploration, less underground competition
- Primary roots in higher densities are relatively deeper and more branches
  => Exploitation, more underground competition

Conclusion:
- Root biomass per tree and per hectare as well as their distribution differs between the planting densities
- Branching from primary roots to secundary and fine roots also differ pointing to architectural plasticity of root system that reflects competition for soil resources
- More complementary studies are ongoing to assess the turnover rates of fine roots, the role of soil moisture in root distribution and turnover patterns and the relations between root biomass, total biomass and bunch production

References
- Filliers, B. (2018) Plantdichtheid en wortelkenmerken van oliepalm - Studie op een 12 jaar oude dichtheidsproef in West-Afrika (Nigeria). Unpublished master's thesis, University of Gent, Belgium.
- Jourdan, C., H. Rey (1997). Architecture and development of the oil palm (Elaeis guineensis Jacq.) root system. Plant and Soil 189(1): 33-48

Collaborators

200 YEARS GHENT UNIVERSITY

Presco

cirad AGRICULTURAL RESEARCH FOR DEVELOPMENT

Contact:
reinout.impens@siat-group.com