



Tomografia sonica e digitalizzazione tridimensionale per l'analisi dell'architettura radicale: verifica dei dati su piante di olivo

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Seminario STRUMENTI PER LA VERIFICA DI STABILITÀ DEGLI APPARATI RADICALI DEGLI ALBERI
24 novembre 2016, Fondazione Minoprio



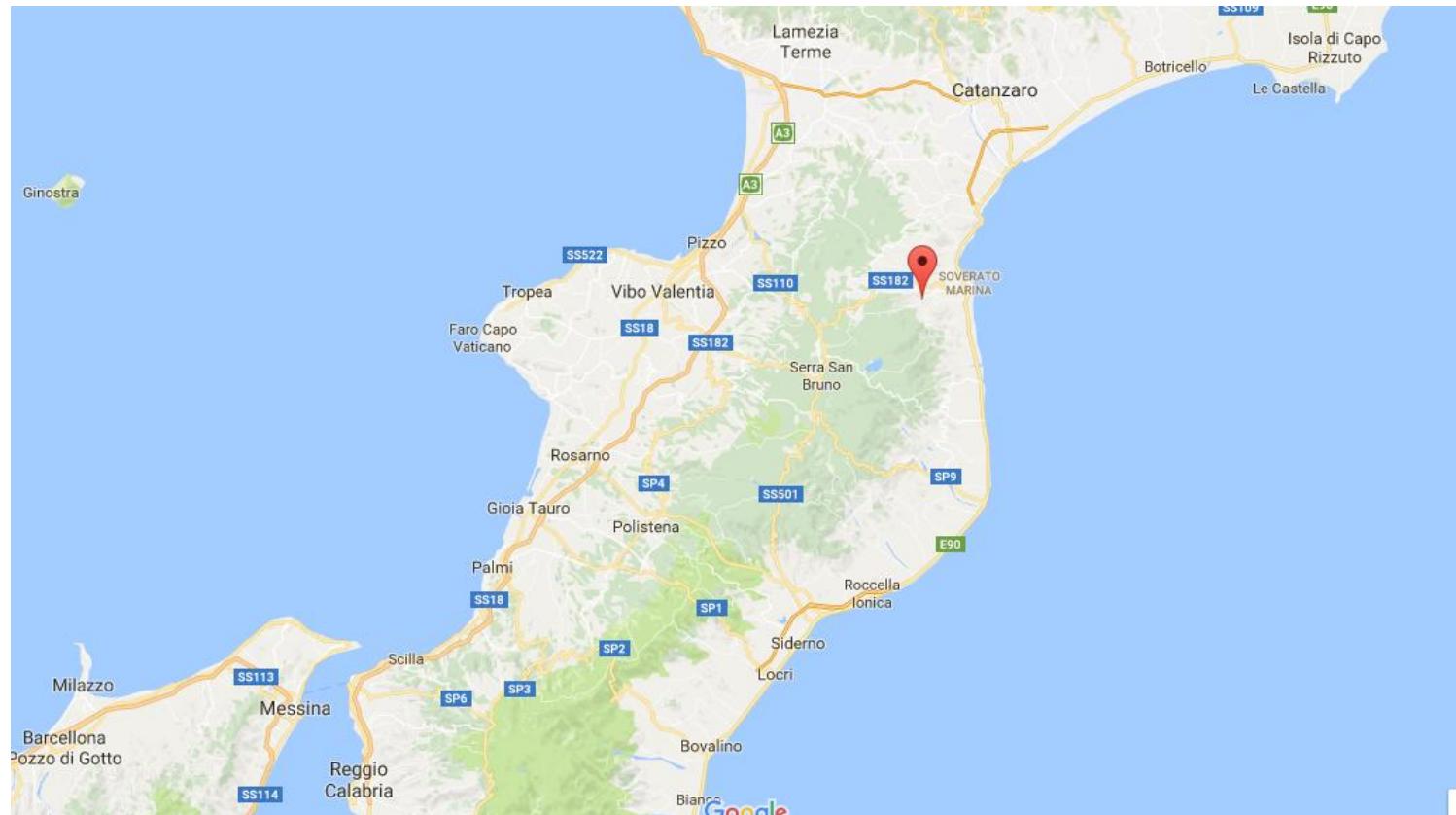
- Introduzione generale
- 3D Digitizer (Polhemus) - Acquisizione tramite Digitalizzatore in 3D dell'architettura di un apparato radicale
- Tomografia sonica mediante ArboSonic 3D + Root detector (Fakopp) - Analisi della distribuzione della biomassa radicale mediante la velocità di propagazione delle onde sonore nel terreno
- Risultati
 - Analisi delle correlazioni tra la distribuzione radiale della velocità di propagazione delle onde e la biomassa radicale per diversi ordini di ramificazione... e Discussione
- Conclusioni

Study site

Satriano (CZ), Calabria (Italy).

The site is located on a south-west facing slope (300 m altitude, 38°39'N, 16°28'E, mean slope of 20°)

Olive trees tested were 22 year-old, (cv. Carolea grafted on wild relative, *Olea europaea* subsp. *europaea*, var. *sylvestris*) 6 x 5 m spacing , equal to 334 tree/ha density.



Study site



Root detection analysis



Excavation



Air Spade method for root excavation







from Nadezhdina and Cermak, 2003

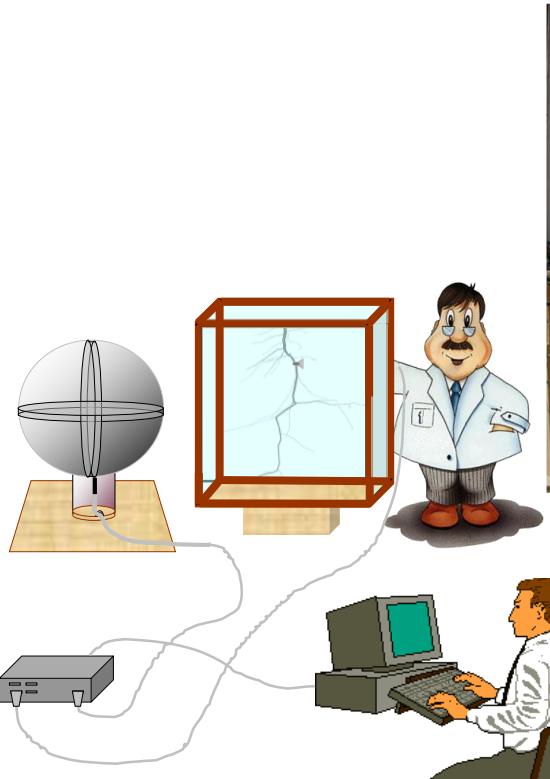
3D Digitizer

**Acquisizione tramite
Digitalizzatore in 3D
dell'architettura di un
apparato radicale**

Polhemus 3D digitiser for Root architecture measurement



Trasmitter
LONG-RANGER



3D DIGITISER
(Fastrak, Polhemus; Long Ranger option)



FASTRAK + RECEIVER



Software “**DIPLAMI**” or
“**3A**” or “**PiafDigit**”





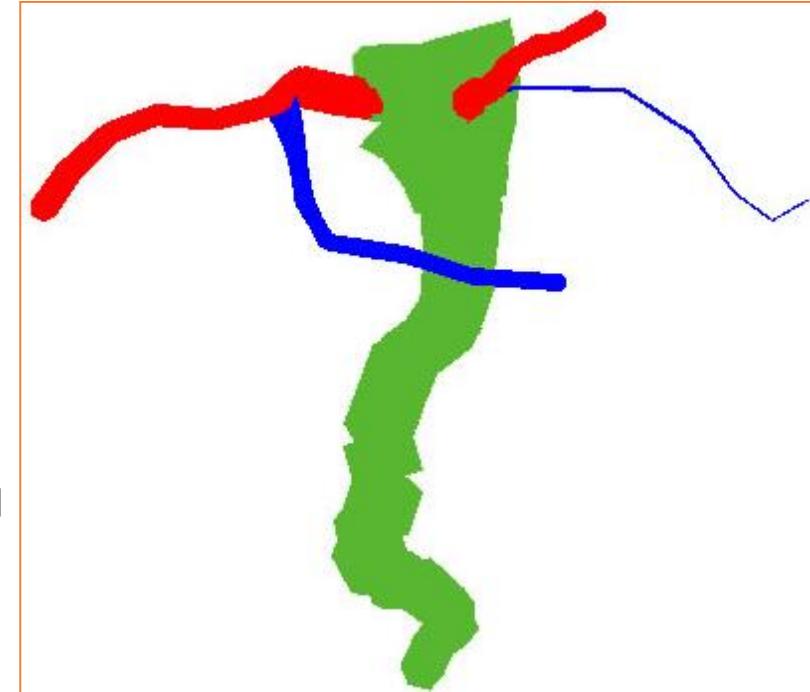


/P1	Taproot	1st	2nd	X	Y	Z	Diam	dist
				0	0	0	14	0
				0.053169	1.4488	3.890745	13.5	5.2
				-7.09327	-1.44153	6.306702	5	5.2
				-10.2988	-3.27074	6.797848	3	3
				-15.2635	-6.685	5.698591	3	6
				-21.0295	-9.33117	4.11622	3	6.8
				-33.6871	-4.11165	4.747135	2.2	13.6
				-34.1467	-3.66695	4.958002	2.4	2.4
				-34.927	-1.99128	7.368606	2	3.3
				-37.3858	0.767982	10.43925	1.5	4.9
				-41.6427	4.224183	12.94992	1.3	6.2
				-48.4361	9.367351	15.08494	1.3	8.9
				-56.9427	16.54223	15.84847	1	11.2
				-65.8812	24.07009	16.32958	1	11.7
				-71.0915	31.53381	15.44369	1	9.2
				-72.9039	38.7068	15.36192	1	7.3
				-75.3381	47.91939	16.36816	0.9	9.6
				-76.4302	58.92202	15.84297	0.9	11.2
				-38.0639	-2.17172	4.465936	1.6	4.8
				-48.0466	2.05764	4.089159	1.5	10.9
				-59.4438	4.008854	4.124006	1.3	11.6
				-72.8271	5.79552	2.050331	1.3	13.7
				-83.0365	7.326677	2.965378	1.3	10.5
				-102.166	18.10991	3.896297	1.3	22
				-112.019	23.44853	5.736001	1.3	11.3
				0.053169	1.4488	3.890745	13.5	0
				0.053169	1.4488	3.890745	13.5	0
				-0.05797	1.383359	10.01115	13	6.9
				-0.05797	1.383359	10.01115	13	0
				-0.6002	2.920903	12.11436	11	2
				-0.6002	2.920903	12.11436	11	0
				-0.6002	2.920903	12.11436	11	0
				-2.35262	5.400248	18.11261	8	6
				-2.35262	5.400248	18.11261	8	0
				-2.35262	5.400248	18.11261	8	0

VISUALIZATION OF TOPOLOGICAL RECONSTRUCTION OF A ROOT SYSTEM

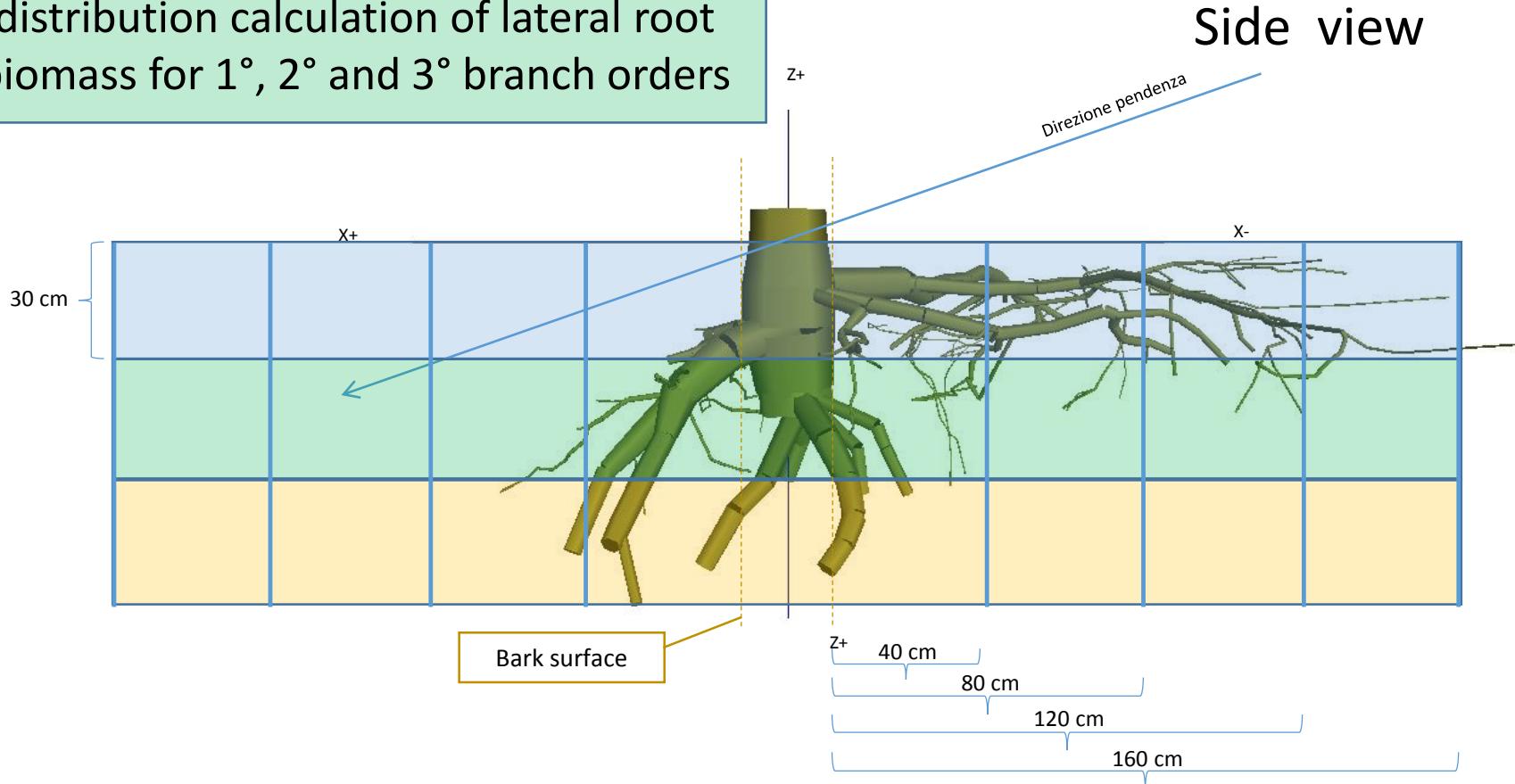
TOPOLOGICAL ORGANISATION OF 3D COORDINATES.

Different colours indicate different branching orders. The Topology description uses AMAPmod codes



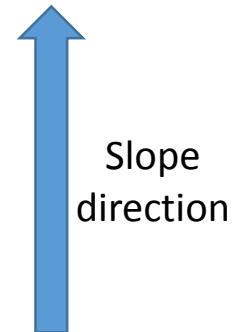
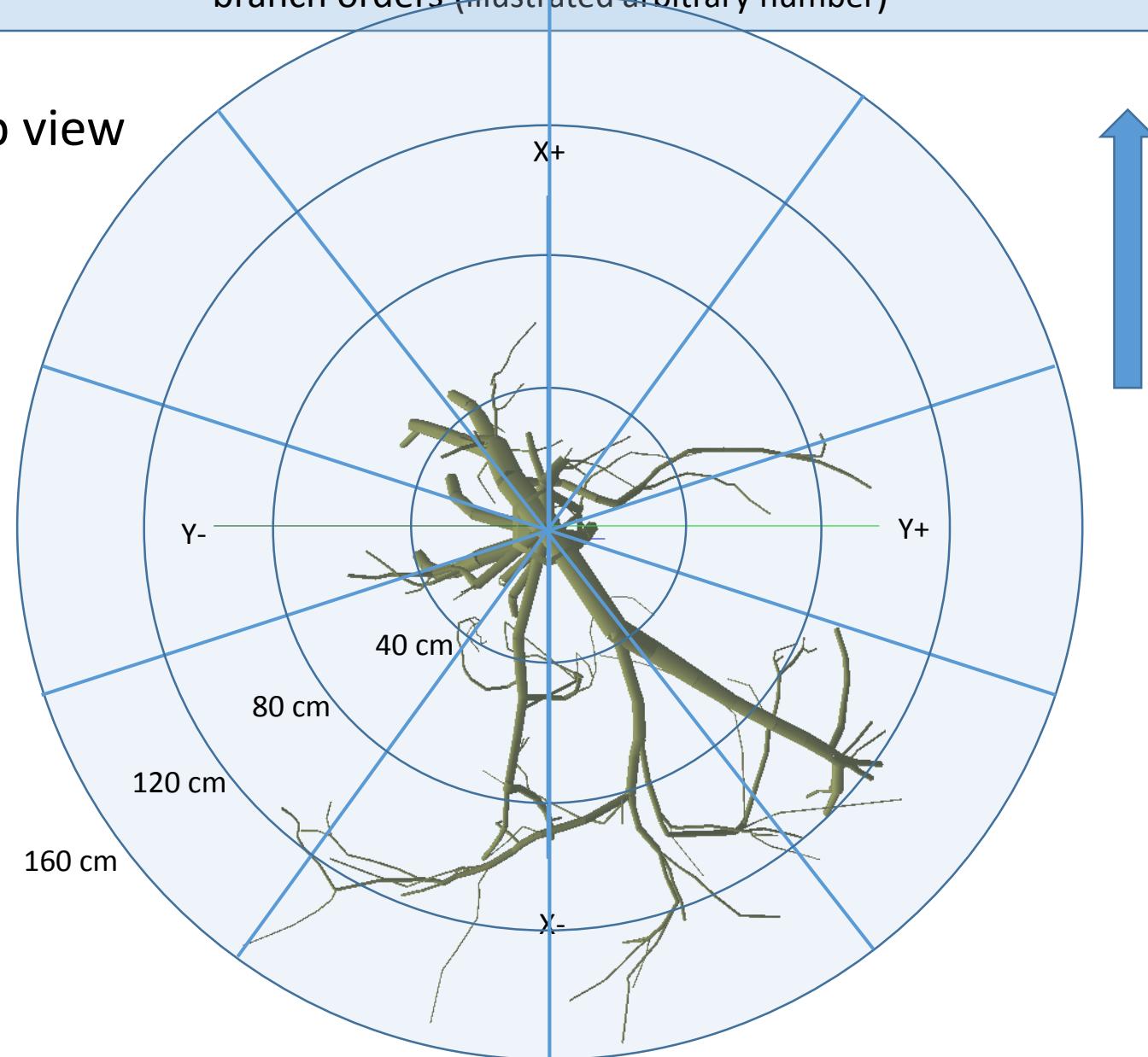
Calculation method adopted in this study

Reference soil volumes for depth distribution calculation of lateral root biomass for 1°, 2° and 3° branch orders



Reference sectors for radial distribution calculation of lateral root biomass for 1°, 2° and 3° branch orders (illustrated arbitrary number)

Top view



ArborSonic 3D

+

Root detector (Fakopp)

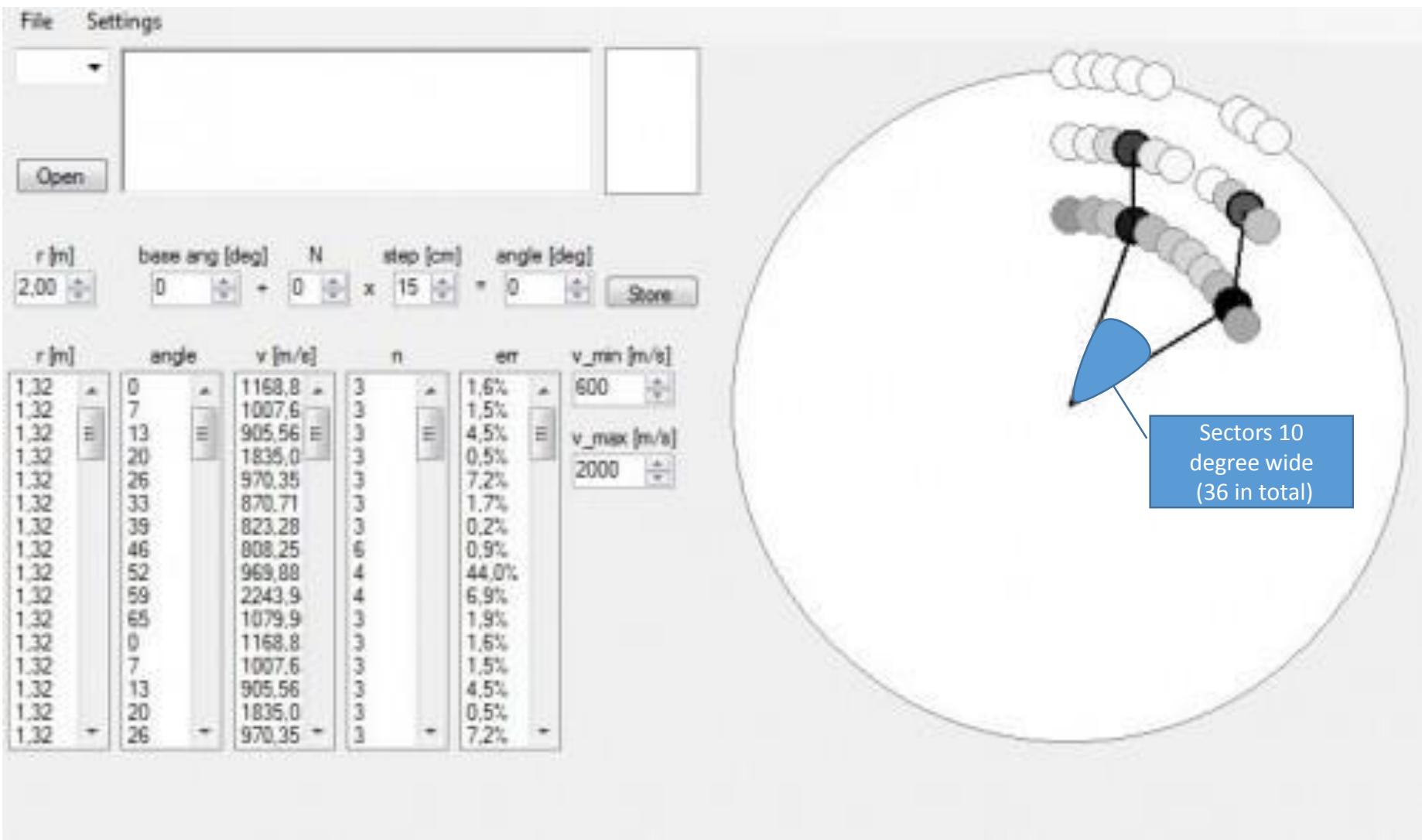
Analisi della distribuzione della biomassa radicale mediante la velocità di propagazione delle onde sonore nel terreno



ArborSonic 3D and Root detector



Root detector2 software

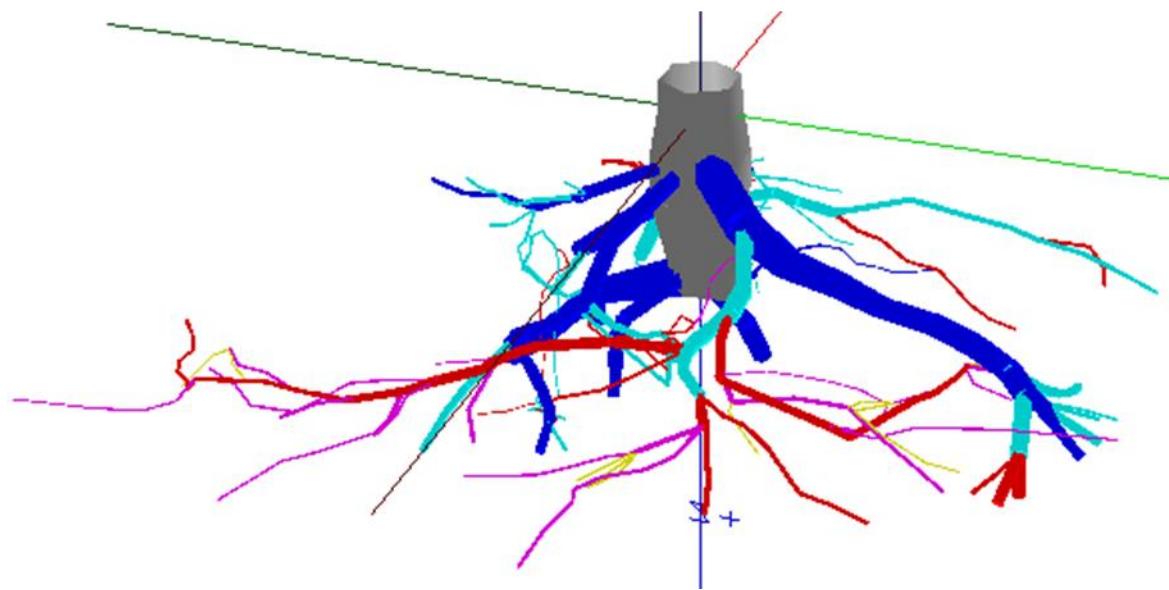




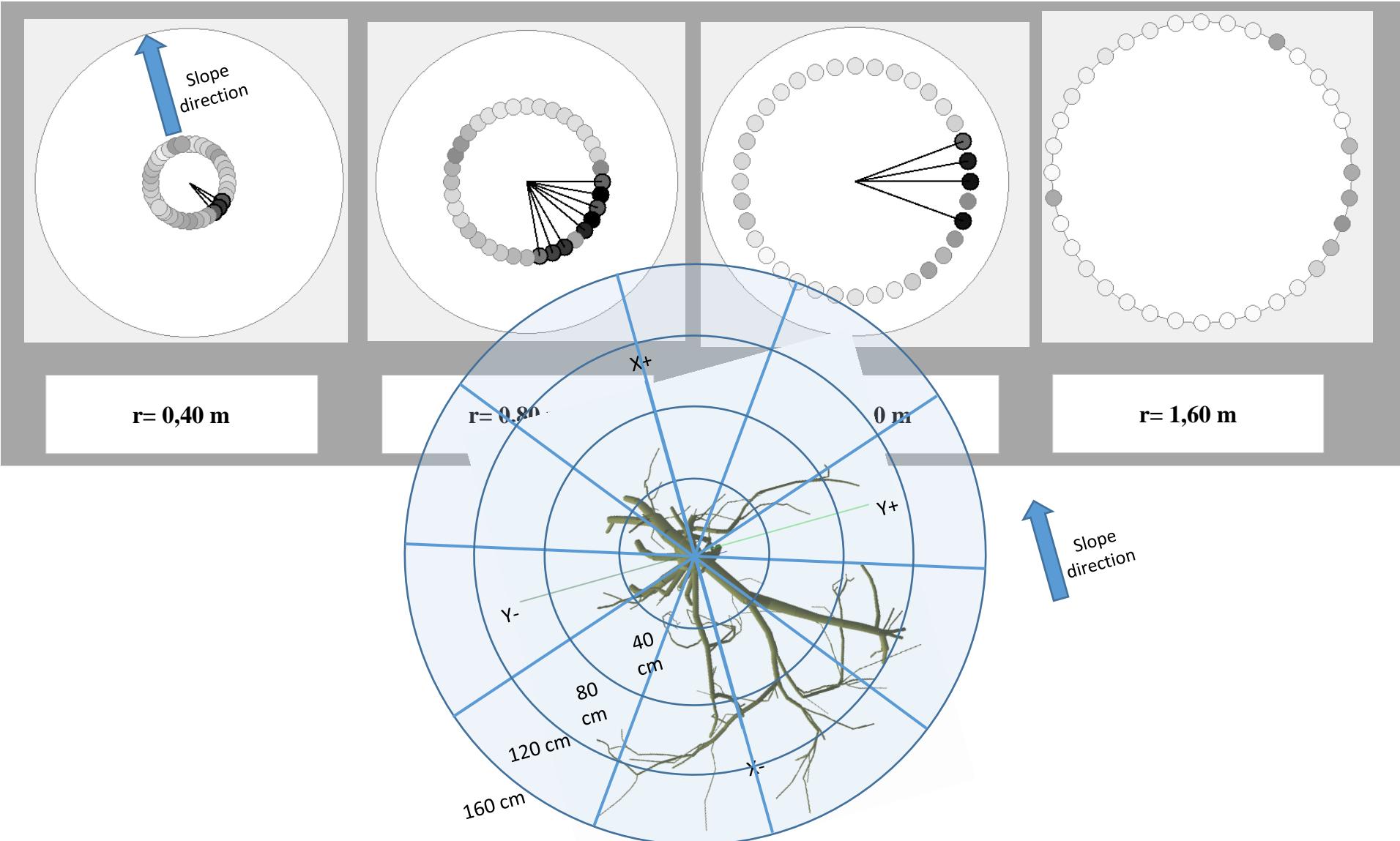


RESULTS and DISCUSSION

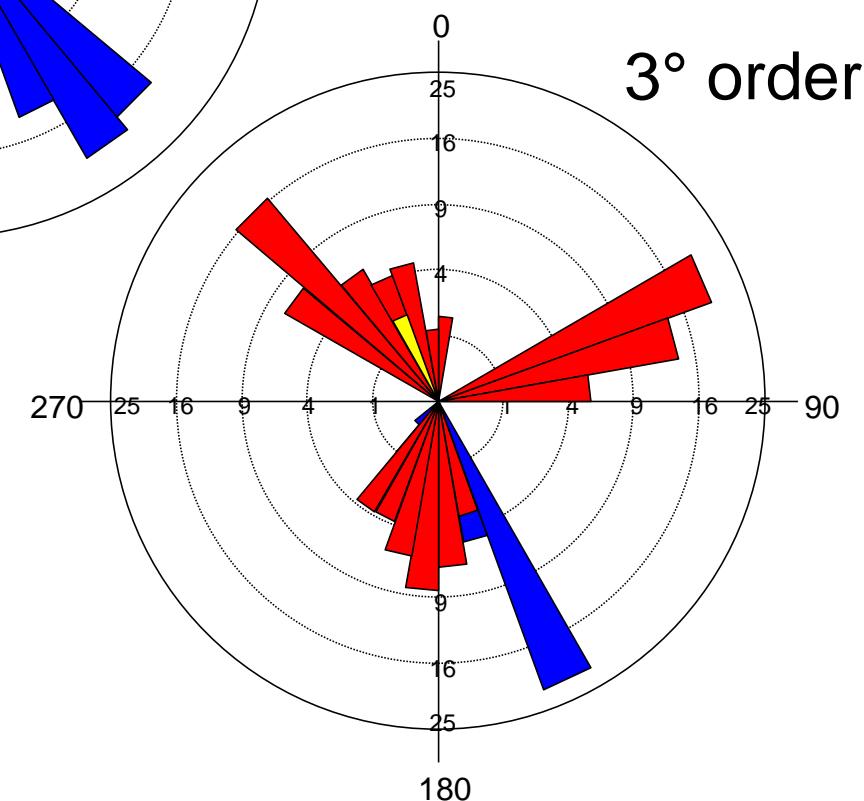
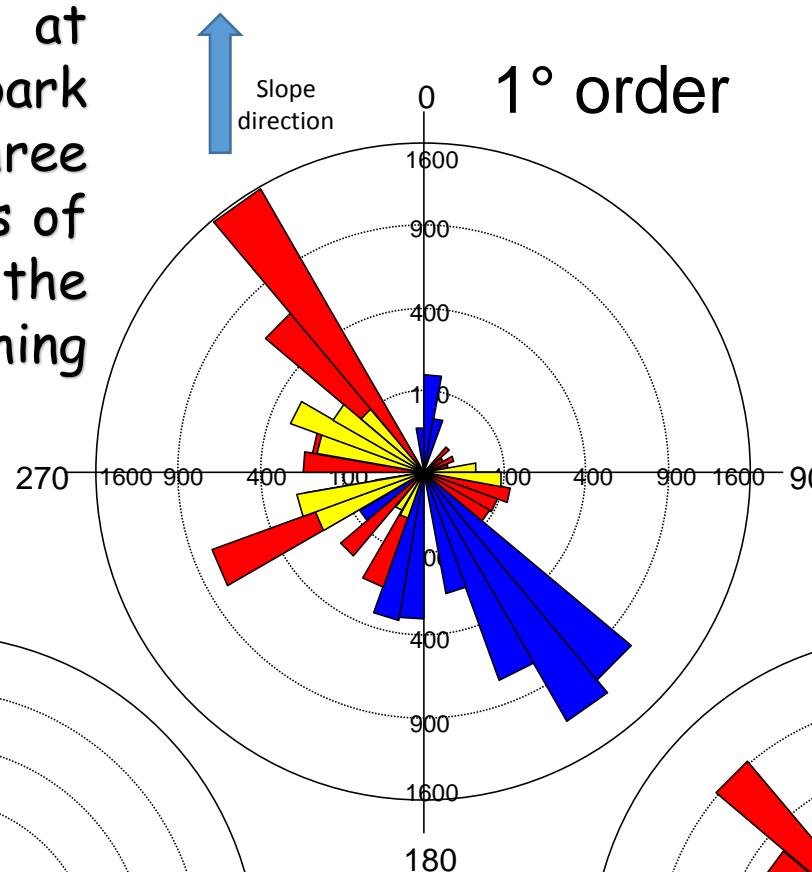
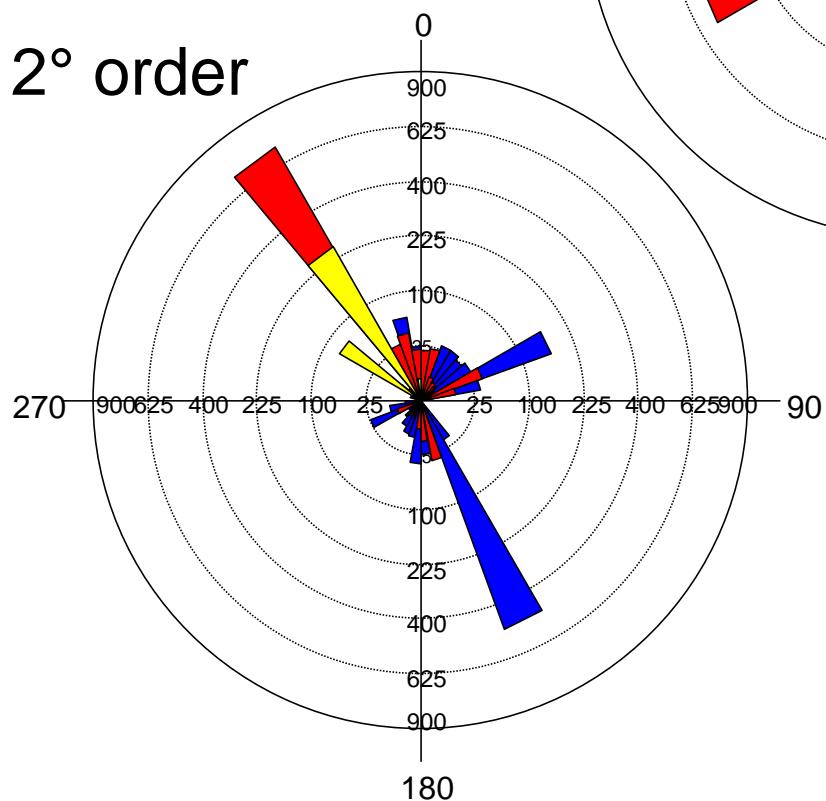
Image of olive root system obtained a) by camera, and b) by 3D digitizer with AMAPmod software. The different colors showed different root branching order.



Sonic image from ArborSonic 3D for the olive tree root system



Radial distribution at 80 cm from the bark surface and at three different soil depths of root dry mass for the first three branching orders (g m^{-2})



Soil depth

- 0-30 cm
- 30-60 cm
- 60-90 cm

Slope direction

Correlation matrix between Sound wave speed and Lateral roots dry mass calculated to 40 cm incremental distance from the bark surface

Soil depth 0-30cm

	40v	80v	120v	160v
40 tot 30	0.612			
80 tot 30	0.472	0.718		
120 tot 30	0.454	0.827	0.484	
160 tot 30	0.432	0.828	0.499	0.436
40 1st 30	0.634			
80 1st 30	0.380	0.707		
120 1st 30	0.288	0.763	0.509	
160 1st 30	0.283	0.769	0.518	0.489
40 2nd 30	-0.237			
80 2nd 30	0.502	0.336		
120 2nd 30	0.633	0.484	0.139	
160 2nd 30	0.595	0.565	0.233	0.138
3rd40 0-30	0.126			
3rd80 0-30	0.660	0.438		
3rd120 0-30	0.752	0.773	0.224	
3rd160 0-30	0.747	0.802	0.272	0.083

Correlation matrix between Sound wave speed and Lateral roots dry mass calculated to 40 cm incremental distance from the bark surface

Soil depth 30-60cm

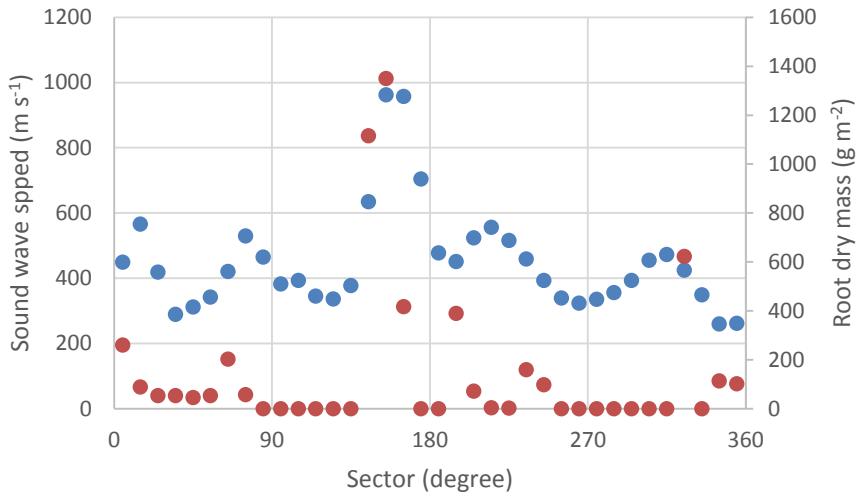
	40v	80v	120v	160v
40 tot 30	-0.095			
80 tot 30	-0.068	0.019		
120 tot 30	-0.067	0.018	-0.091	
160 tot 30	-0.067	0.018	-0.091	-0.028
1st40 30-60	-0.095			
1st80 30-60	-0.085	0.007		
1st120 30-60	-0.085	0.007	-0.095	
1st160 30-60	-0.085	0.007	-0.095	-0.008
2nd40 30-60	-0.078			
2nd80 30-60	-0.020	0.048		
2nd120 30-60	-0.020	0.046	-0.057	
2nd160 30-60	-0.020	0.046	-0.057	-0.056
3rd40 30-60	-0.025			
3rd80 30-60	0.122	-0.013		
3rd120 30-60	0.128	-0.057	-0.212	
3rd160 30-60	0.128	-0.057	-0.212	-0.309

Soil depth 60-90cm

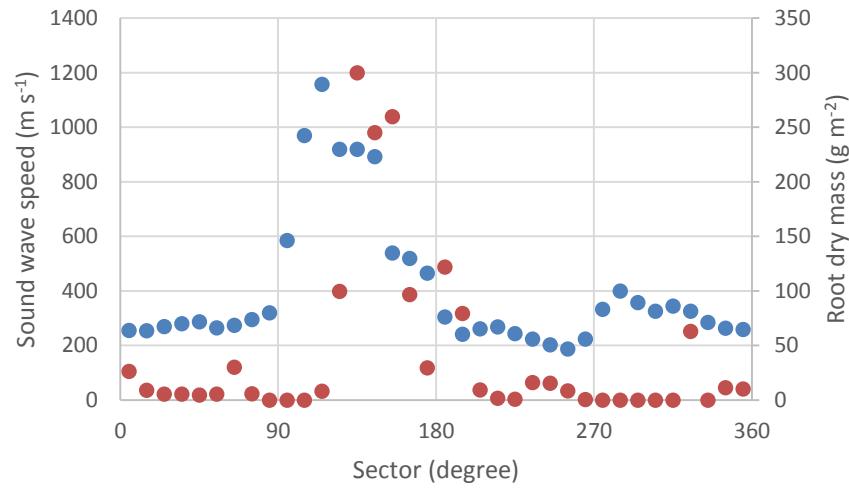
	40v	80v	120v	160v
40 tot 30	-0.114			
80 tot 30	-0.153	-0.161		
120 tot 30	-0.153	-0.161	-0.188	
160 tot 30	-0.153	-0.161	-0.188	-0.131
1st40 60-90	-0.114			
1st80 60-90	-0.159	-0.215		
1st120 60-90	-0.159	-0.215	-0.177	
1st160 60-90	-0.159	-0.215	-0.177	-0.113
2nd40 60-90	#DIV/0!			
2nd80 60-90	-0.029	0.052		
2nd120 60-90	-0.029	0.052	-0.067	
2nd160 60-90	-0.029	0.052	-0.067	-0.066
3rd40 60-90	-0.109			
3rd80 60-90	-0.109	0.008		
3rd120 60-90	-0.109	0.008	-0.081	
3rd160 60-90	-0.109	0.008	-0.081	-0.027

Radial distribution of Sound wave speed (Tomograph and Lateral roots dry mass (1° , 2° , 3° branch orders) to 30 cm soil depth, at different distances from the bark surface.

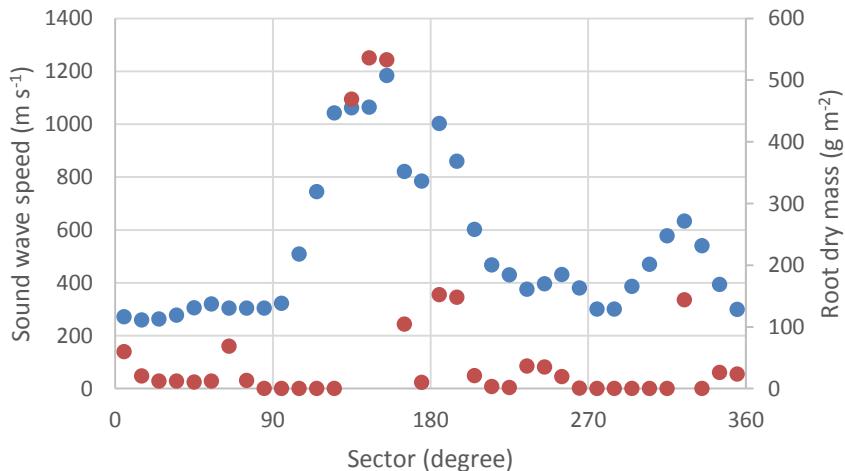
Radial distance 40 cm



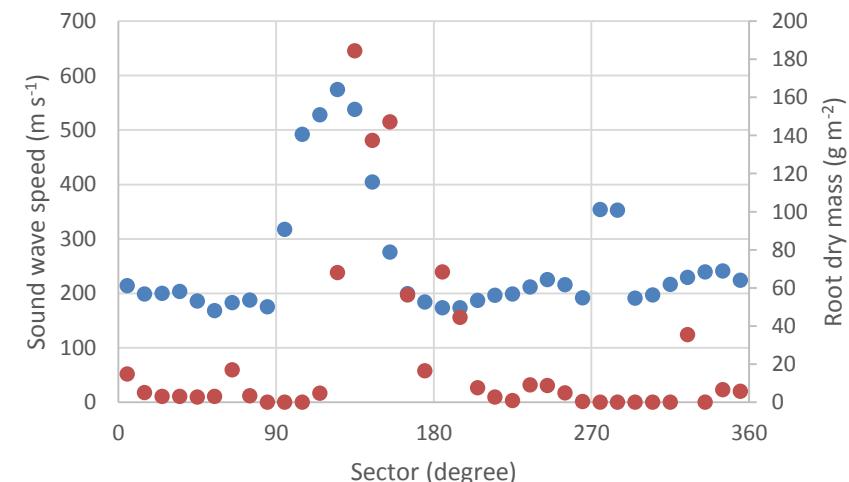
Radial distance 120 cm



Radial distance 80 cm

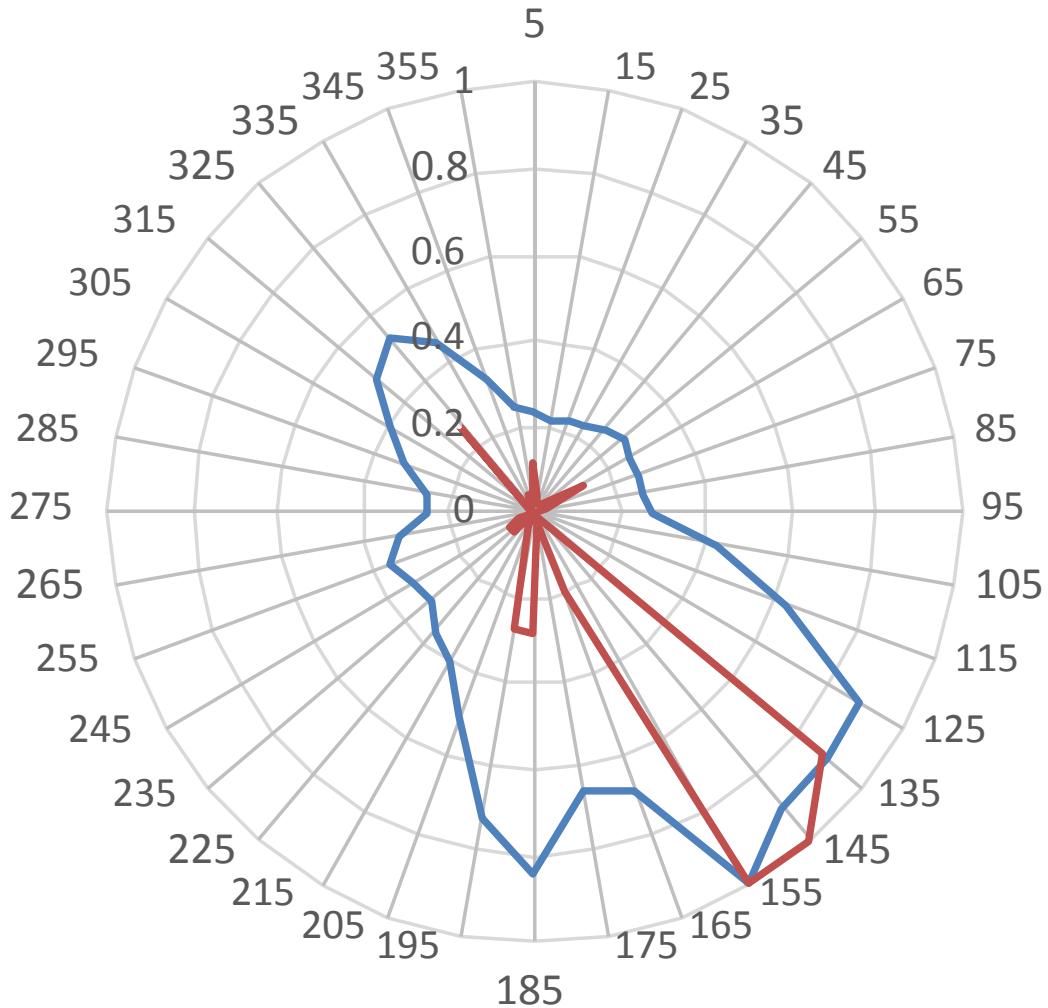


Radial distance 160 cm



Radial distance 80 cm (to 30 cm soil depth)

(normalized to the max value)



— Sound wave speed

— Total lateral root dry mass (to 30 cm depth)

Conclusioni

La tomografia sonica si rivela un valido strumento di indagine non invasivo per le sole radici strutturali (prox.diam. \approx 6 cm) superficiali, limitando la sua risoluzione a circa 30 cm di profondità

Specifiche relazioni allometriche (relazione con il DBH) possono essere testate ai fini di una migliore accuratezza nella stima dell'estensione della biomassa strutturale di un apparato radicale

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