ROOT SYSTEM SPATIAL VARIABILITY OF COFFEE PLANTS UNDER WATER DEFICIT

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Introduction

Water deficit is one of the most limiting condition to plant growth and productivity in the ecosystems, mainly to the imposed restrictions to photosynthetic carbon fixation. The study of water relations on coffee plants is a major concern, being that a small water deficit supply can drastically reduce plant growth and productivity, even when water deficit symptoms are not visible (Alves and Livramento, 2003;Alves, 2008).

However, the capability of plants to survive in limited conditions of water supply will largely depend on the uniformity and depth of its root system (Dardanelli et al. 1997; Paglis, 1999). Data in literature show that plants can leave an appreciable amount of water in the soil without being extracted even in conditions of water deficit (Passioura, 1983; Tardieu et al. 1987; Paglis, 1999). This means that plants will become dormant or die even when a supply of water still available in the soil. If roots are not present in some soil regions, these regions will not be adequately explored and an incomplete water extraction may occur.

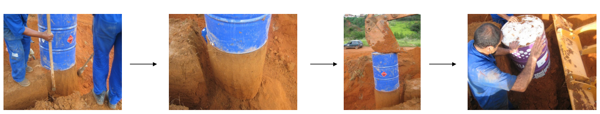
In the coffee breeding program, conducted at MAPA/Funprocafé, the so named Siriema cultivar, an inter-specific hybrid between *Coffea arabica* and *C.racemosa,* has been pointed out as a potential genetic material with high yield, even under low water supply (Matiello et al., 2003;2004). Besides of the evidences indicating the cultivar as being drought tolerant (Grisi et al., 2008) there are a few studies explaining the mechanisms involved or proving that such characteristic occurs under field conditions.

Considering that, the aim of this work was to study the root system distribution of this cultivar under water deficit conditions.

Material and Methods

1 - Soil core preparation

Twelve undisturbed soil cores were collected and cultivated with 18 months old coffee plants during 18 months. The soil was classified as Red-Yellow Latosol.



2 - Coffee plants at greenhouse

Treatments -Two water conditions supply were imposed, with and without deficit.

3 - Root sampling

Forty four soil samples were taken in a grid pattern at depths of 10, 30, 50 and 70 cm for each soil core.

Soil sampler

Grid pattern used

These soil samples were washed and sieved in order to separate the roots, which were analyzed by using the STD 1600 WhinRhizo system.

4 - Washed roots → 5 - Image analysis → 6 – Root Length maps

Results

water deficit	Min	Max	Mean	Standard deviation	CV (%)
10	84,02	385,45	219,54	70,03	31,89
30	44,85	552,60	228,96	115,50	50,14
50	56,31	371,17	176,04	77,40	43,96
70	37,36	171,47	63,64	23,28	36,58
w/o water deficit	**Min**	**Max**	**Mean**	**Standard deviation**	**CV (%)**
10	74,26	567,46	218,22	78,42	35,94
30	133,89	730,25	430,37	167,22	38,85
50	30,96	233,62	122,99	46,82	38,07
70	17,74	92,33	41,38	19,27	46,55

Tab.1. Descriptive statistics for root length (cm) under two water deficit conditions at four soil depths (cm).

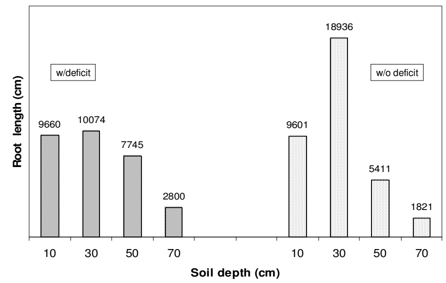


Fig.1. Total root length (cm) under two water deficit conditions at four soil depths (cm).

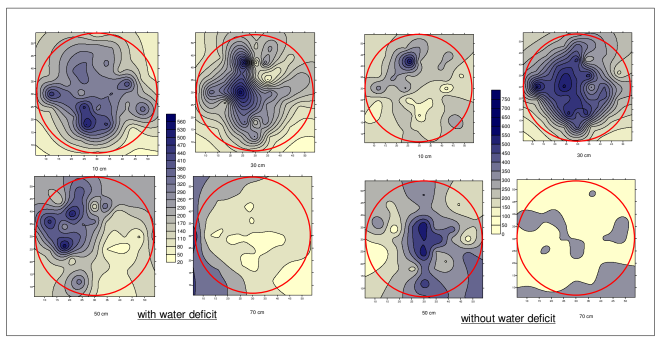


Fig.2. Contour maps for root length (cm) under two water deficit conditions at four soil depths.

Conclusions

Based on these results, one can conclude that Siriema cultivar invests on root system growth at deep soil layers under soil water deficit conditions, and leads to a more uniform root system distribution along the soil profile. Yet, in adequate soil water supply, roots will tend do be concentrated at the first top 30 cm. But in both situations root were spatially distributed.
Under water deficit conditions, Siriema cultivar alters the source-sink relation in favor to root growth, which may characterize an important survival strategy during long periods of drought, possibly explaining its water resistance in field conditions.

References

ALVES, J.D. 2008. Morfologia do cafeeiro. In. Cultivares de café: origem, características e recomendações. Carvalho CH (Org.) 01. ed. Brasília: EMBRAPA CAFÉ,. 332 p.
ALVES, J.D.; LIVRAMENTO, D.E. 2003.Morfologia e fisiologia do cafeeiro. Textos acadêmicos. Lavras FAEPE/UFLA. 46p.
DARDANELLI, J.L., O.A. BACHMEIER, R. SERENO, AND R. GIL. 1997. Rooting depth and soil water extraction patterns of different crops in a silty loam haplustoll. Field Crop Res. 54:29-38.
GRISI, F.A.; ALVES, J.D.; CASTRO, E.M.; OLIVEIRA, C.; BIAGIOTTI, G.; MELO, L.A. 2008. Avaliações anatômicas foliares em mudas de café 'catuaí' e 'siriema' submetidas ao estresse hídrico. Revista Ciência e Agrotecnologia, vol.32 no 6 Lavras Nov./Dec.
MATIELLO, J. B.; ALMEIDA, S. R.; SILVA, M. B. 2004. Maior vigor e resistência à seca em cafeeiros Siriema. Revista Brasileira de Tecnologia Cafeeira, [S.l.], v. 1, n. 2.
MATIELLO, J. B.; ALMEIDA, S. R.; SILVA, M. B.; FERREIRA, R. A. 2003. Seleção de progênies de café visando resistência à ferrugem do cafeeiro. In: Simpósio de pesquisa dos cafes do Brasil e workshop Internacional de café & saude, 3., 2003, Porto Seguro. Anais... Brasília, DF: Embrapa Café.
PASSIOURA, J.B. 1983. Roots and drought resistance. Agric. Water. Management 7:265-280.
PAGLIS, C.M. 1999. Micro scale spatial variability distribution of crop roots, water content, soil texture and their influence on soil water extraction rates. Ph.D. dissertation. Michigan State University. MI,USA, 110 p.
TARDIEU, F., AND H. MANICHON. 1987. Etat structural, enracinement et alimetation hydrique du mais. I. Modelisation d'etat structuraux de la couche labouree. Agronomie 7(2): 123-131.

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