Vine rootstocks under water deficit: responses in biomass, biochemical variables and gas exchange

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Introduction

Why should we use rootstocks in viticulture?

- ✓ Resistance or tolerance to soil pathogens (phylloxera, fusarium, nematodes, etc.);
- ✓ Prevent abiotic stresses in soils with low fertility, saline, sodic, alkaline, high aluminum content;
- ✓ Adapt vine growing in soils subject to flooding and water restrictions;
- ✓ Maximizing the genetic potential of vine cultivars: influence on vigor, nutrient absorption, yield, chemical and physical characteristics of grapes, juices and wines
- ✓ To face climatic changes
- ✓ Most important rootstocks in São Francisco Valley, Brazil: Paulsen 1103, SO4, IAC 313, IAC 766, IAC 572 and Ramsey (Salt Creek)

Objective

Select grapevine rootstocks tolerant to water deficit that allow irrigation management with reduced water availability

Materials and **Methods**

Local

Bebedouro Field Station, Embrapa Semiarid, Petrolina, PE (9°08’06” S 40°18’28” W), Northeastern Brazil

Period

08/25 to 12/31/2021 (four months)

Treatments & Design

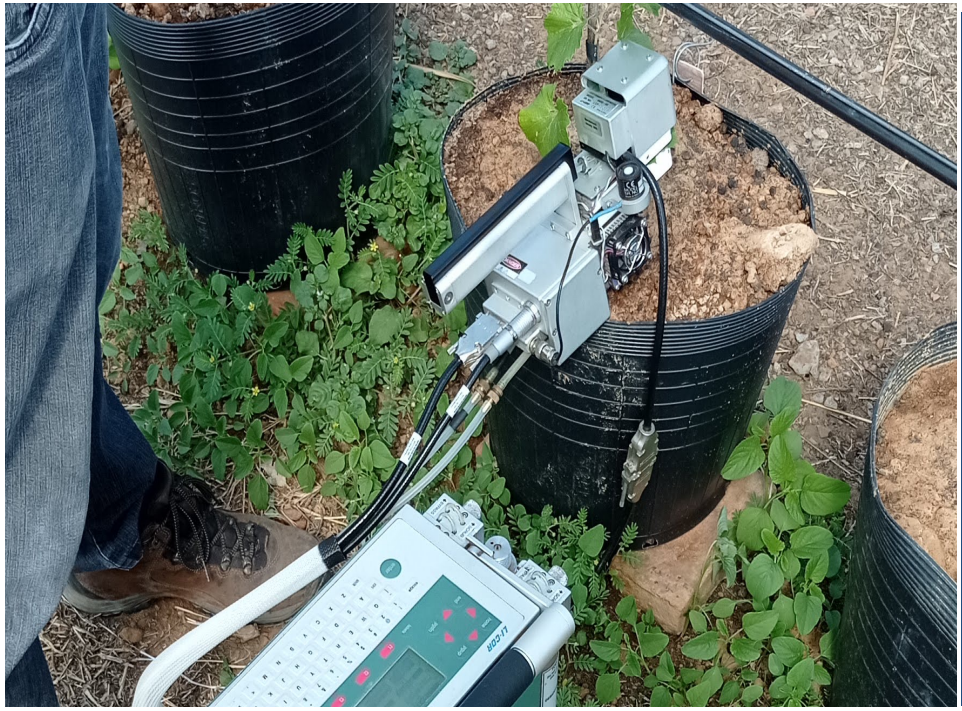
Seven rootstocks: ‘Paulsen 1103’, ‘SO4’, ‘IAC 313’, ‘IAC 572’, ‘IAC 766’, ‘Ramsey (Salt Creek)’ and ‘101-14 MgT’

Three irrigation levels (100, 50% and 20% Eto)

Randomized blocks with 4 replications in the split-plot scheme and two pots per plot

Materials and **Methods**

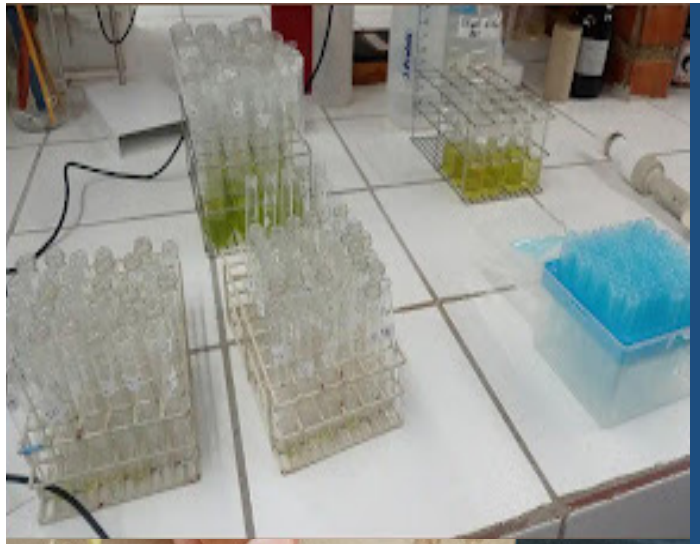
- ✓ Soil quemical and physical analysis
- ✓ Daily climatological monitoring to calculate water demand for irrigation



Gas Exchange:

1. Net photosynthesis (*A*),
2. Stomatal conductance (*gs*),
3. Transpiration rate (*E*),
4. Vapor pressure deficit between the leaf and the atmosphere (DPV),
5. Internal and external CO2 ratio (*Ci/Ca*),
6. Efficiency intrinsic water use efficiency (*A/gs* micromol CO2 mol-1 H2O),
7. Instantaneous water use efficiency (*A/E* micromol CO2 mmol-1 H2O)
8. Leaf temperature (Tf)

Materials and **Methods**



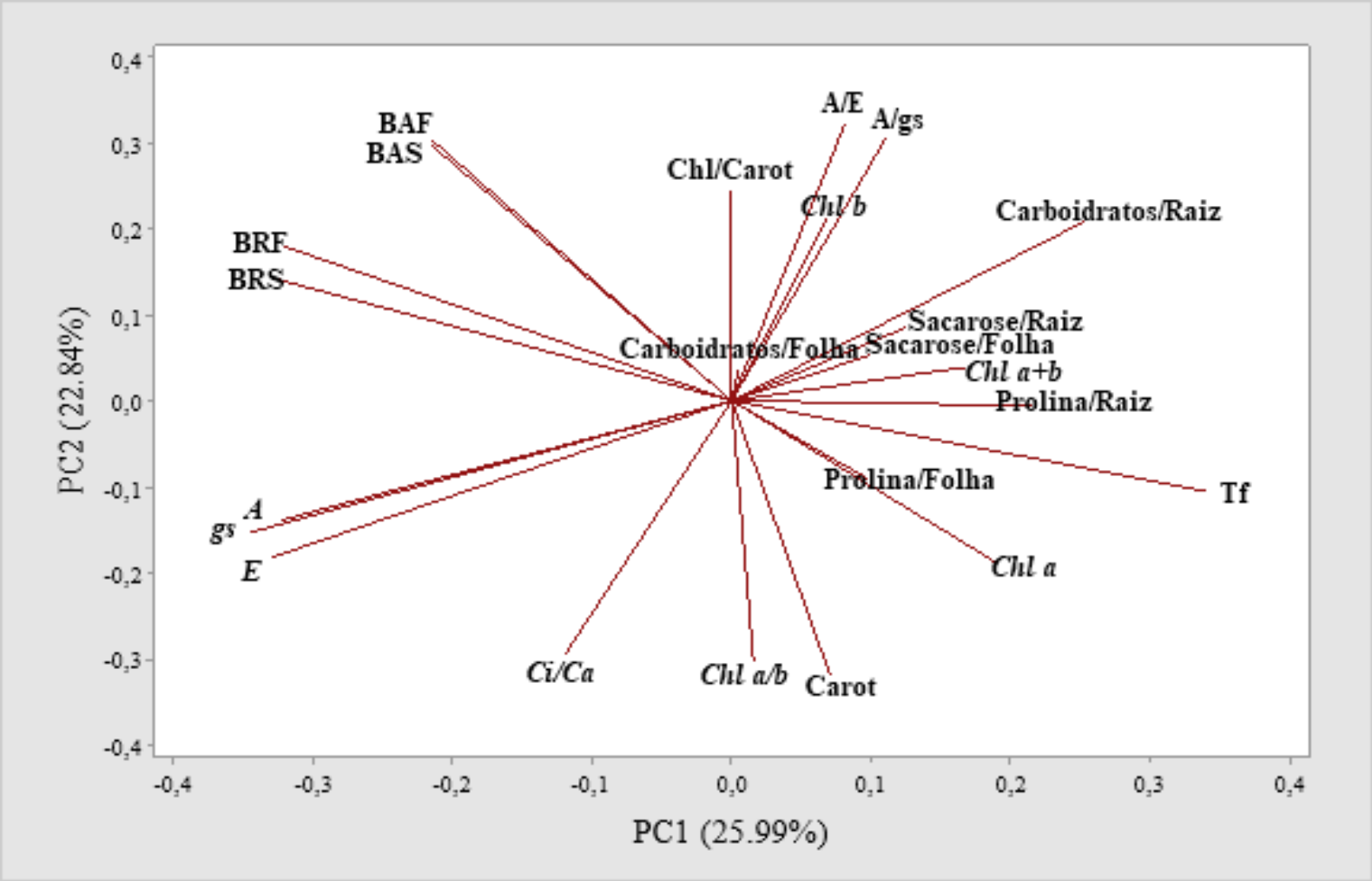
Pigment and metabolite contents:
Total chlorophyll (a and b)
Chlorophyl a; Chlorophyl b
Chl a/b – ratio chlorophyll a and b
Carotenoids,
Chl/Carot – ratio total chlorophyll and carotenoids
Total soluble carbohydrates in leaves and roots,
Sucrose
Proline in leaves and roots
Fresh matter of leaves and roots
Dry matter of leaves and roots

Statistical Analysis:
PCA; ANOVA and comparison means by Scott-Knot test ($p < 0.05$)

Total of 123 variables evaluated

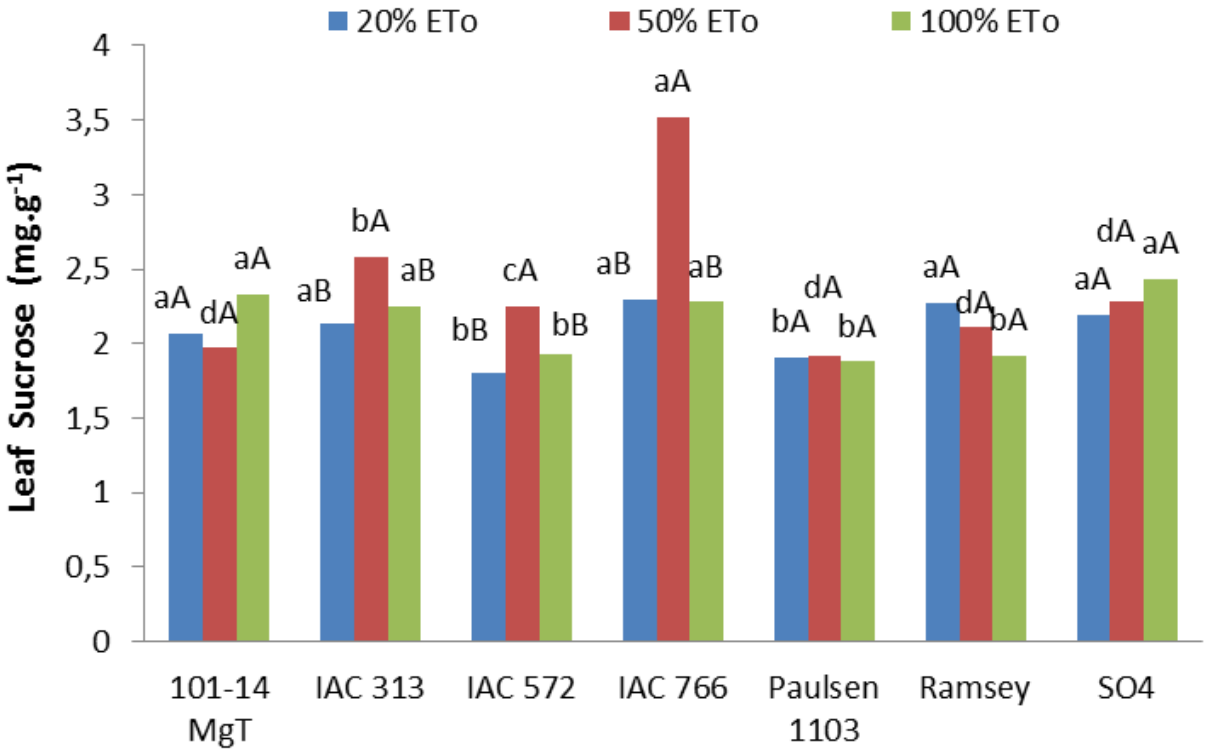
Results and **Discussion**

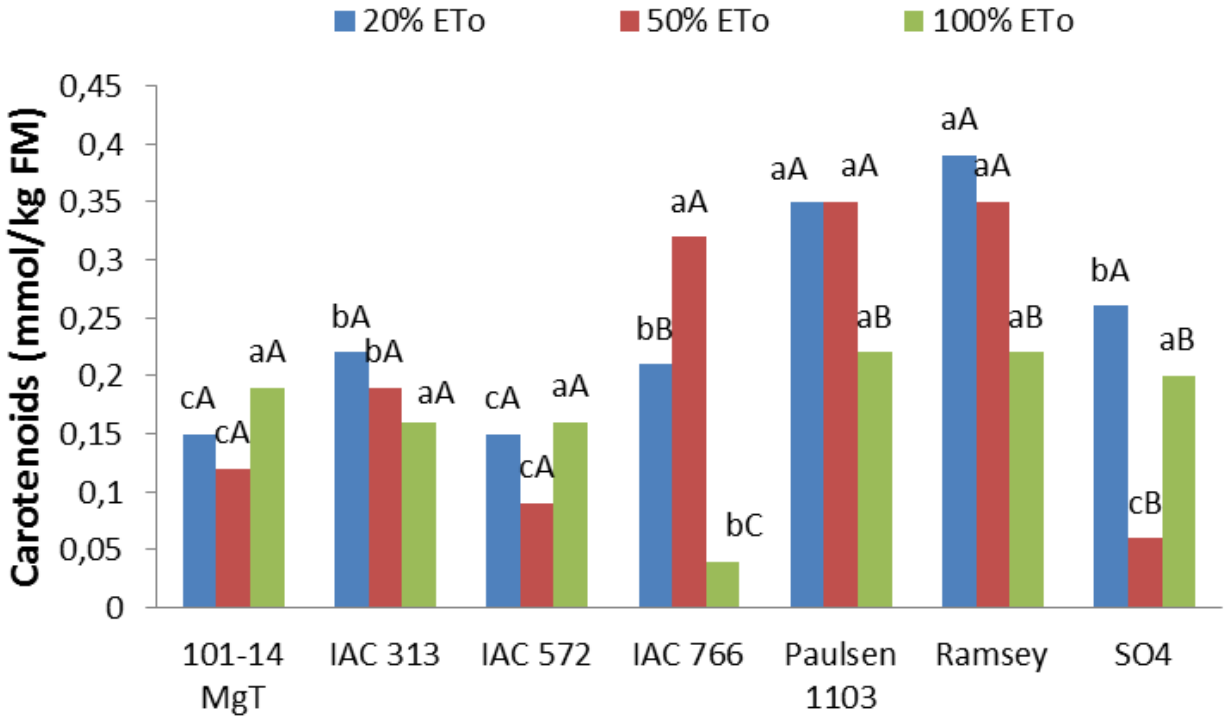
Principal component analysis (PCA) was used to determine which of the evaluated characteristics had the greatest contribution to data variation, to reduce the number of variables



- ✓ Leaf and root carbohydrate and proline concentration, A, E, gs, Tf, and BRF are highly positively correlated;
- ✓ These characteristics led to the highest factor loadings in this PCA analysis.
- ✓ The seven variables with the greatest contribution to data variation were used for analysis of variance and the Scott-Knott mean cluster test.

Influence of rootstocks x irrigation levels on leaf sucrose and carotenoids content



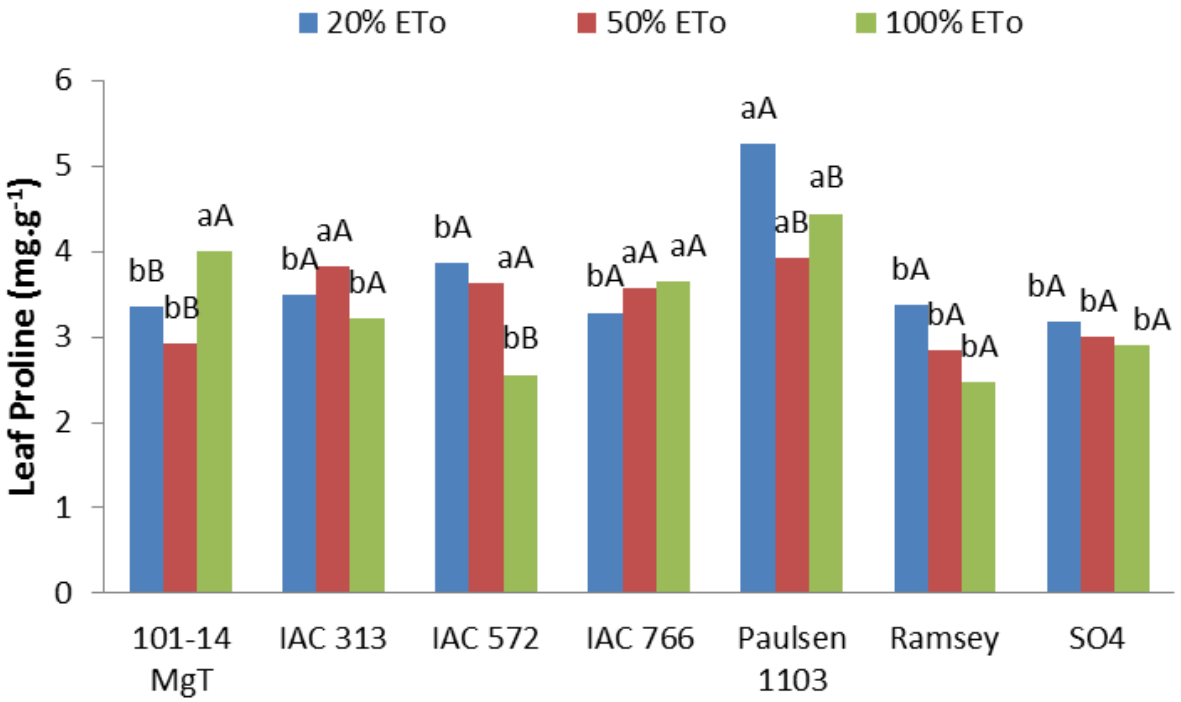


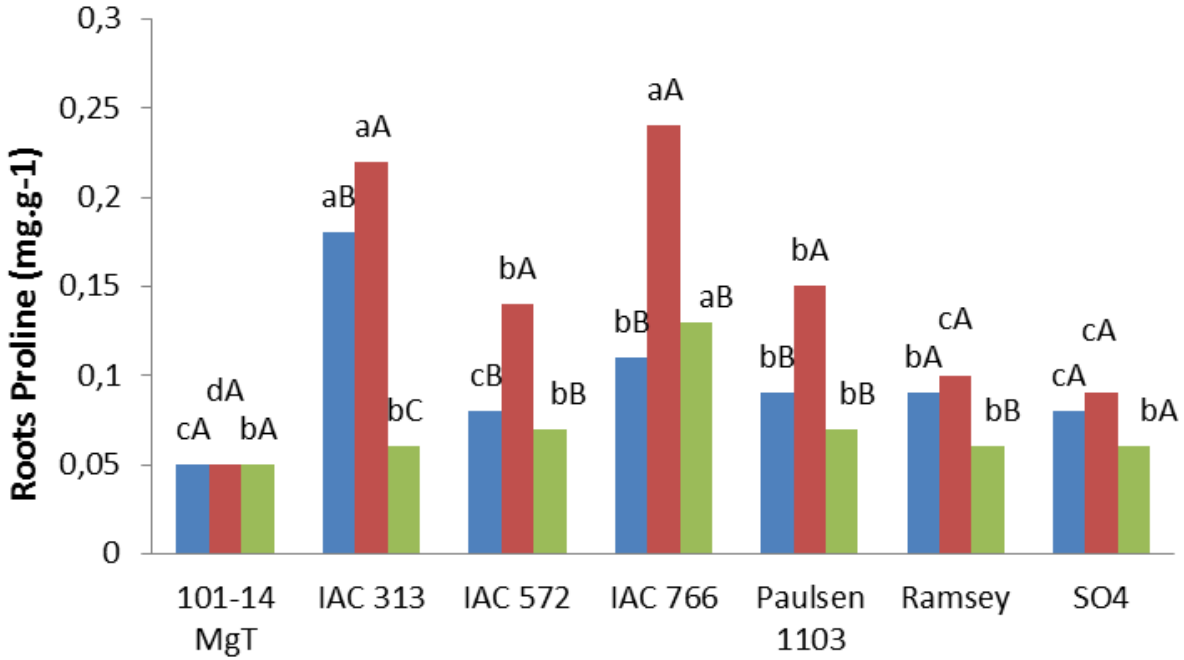
Means followed by equal lowercase letters comparing rootstocks and capital letters comparing irrigation levels do not differ according to the Scott-Knott test ($p < 0.05$).

- ✓ **'IAC 766'** showed higher sucrose content in leaves comparing to the other rootstocks in the 50% Eto irrigation level.
- ✓ Sucrose content in leaves **was not affected** by water restrictions in soil*

- ✓ 'Paulsen 1103' and 'Ramsey' had a higher content of cartenoids in the leaves under conditions of lower water availability compared to '101-14 MgT', 'IAC 313', 'IAC 572', 'IAC 766'
- ✓ There was not reduction in carotenoid content in any rootstocsk under lower (20% and 50% ETo) compared to full irrigation (100% ETo).

Influence of rootstocks x irrigation levels on proline content in leaves and roots



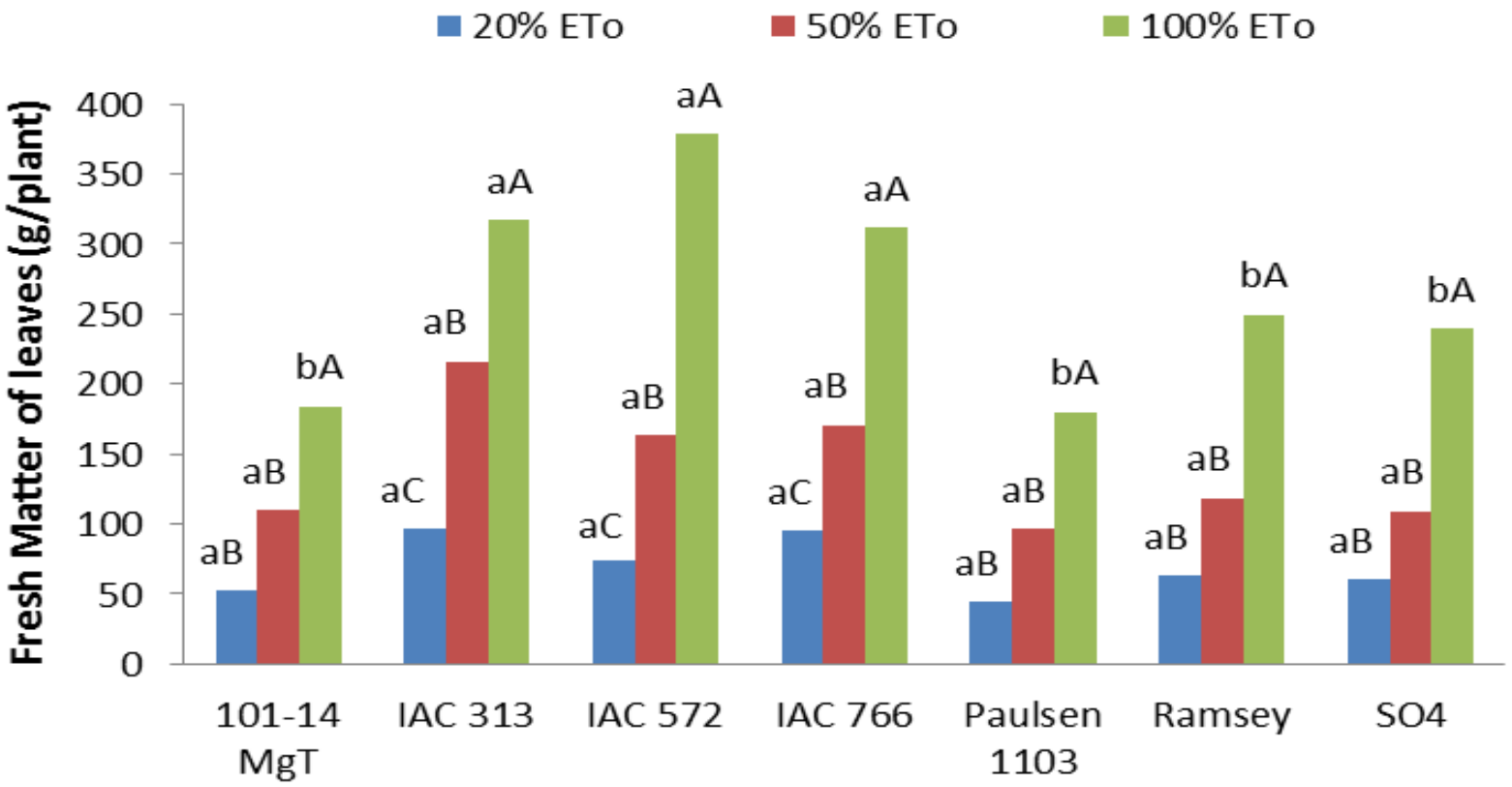


Means followed by the same lowercase letters comparing rootstocks and capital letters comparing irrigation levels do not differ according to the Scott-Knott test ($p < 0.05$).

- ✓ **'Paulsen 1103'** showed higher proline content in leaves under water deficit conditions differing of all the other rootstocks
- ✓ Proline accumulation is an osmoprotection strategy associated with tolerance to water stress

- ✓ 'IAC 313' had a higher proline content under water deficit (20% ETo) but mot differ of "IAC 766' also in 50% Eto irrigation
- ✓ Higher values of proline in the roots were observed in the intermediate irrigation (50% of ETo) for most rootstocks, except for the '101-14 MgT' and 'SO4'

Influence of rootstocks x irrigation levels on vine vigor



Means followed by equal lowercase letters comparing rootstocks and capital letters comparing irrigation management do not differ according to the Scott-Knott test ($p < 0.05$).

- ✓ Water restriction reduced the vegetative development of all rootstocks
- ✓ Under full irrigation conditions (100% ET0), the best results were for the IAC group rootstocks, especially the more vigorous ‘IAC 572’

Influence of rootstocks x irrigation levels on net photosynthesis (*A*)

Rootstocks	*A* (micromol CO2 m-2 s-1)						
	Sep 14th	Sep 30th	Oct 7th	Oct 19th	Nov 9th	Dec 8th	Dec 14th
101-14 MgT	19.38 a	17.46 b	12.18 b	13.05 a	19.72 a	12.77 a	8.17ns
IAC 313	17.26 a	15.59 b	10.38 b	10.09 b	11.58 d	12.15 a	5.04
IAC 572	14.04 b	16.50 b	11.68 b	9.79 b	11.22 d	11.34 a	4.10
IAC 766	15.76 b	16.27 b	9.79 b	10.62 b	16.95 b	11.16 a	4.68
Paulsen 1103	16.6 b	17.36 b	13.87 a	12.00 a	19.62 a	13.67 a	6.68
Ramsey	17.98 a	22.25 a	14.76 a	14.46 a	20.51 a	12.59 a	5.73
SO4	16.65 b	18.25 b	10.86 b	9.59 b	15.47 c	8.23 b	8.23
Mean	16.81	17.67	11.93	11.37	16.44	11.78	6.09
20% ETo	17.08ns	14.02 c	4.50 c	10.80ns	18.34 a	6.99 b	4.20 b
50% ETo	16.67	17.96 b	14.45 b	11.21	16.75 a	13.00 a	8.93 a
100% ETo	16.68	21.03 a	16.84 a	12.10	14.23 b	15.12 a	3.88 b

Means followed by the same letters comparing columns do not differ according to the Scott-Knott test ($p < 0.05$).

- ✓ *A* showed a trend to be reduced throughout the experiment, especially in the last evaluation dates
- ✓ Water restriction (20% ET0) promoted a significant reduction in *A* in some evaluation dates (09/30, 10/07, 12/08 and 12/14)
- ✓ Ramsey showed higher *A* on all dates evaluated, except on the last date when there were no differences between **the rootstocks**

Influence of rootstocks x irrigation levels on transpiration (*E*)

Rootstocks	*E* (micromol CO2.m-2.s-1)						
	Sep 14th	Sep 30th	Oct 7th	Oct 19th	Nov 9th	Dec 8th	Dec 14th
101-14 MgT	5.44ns	4.02 c	3.34 b	4.39 b	4.63 a	3.79 a	2.55 a
IAC 313	5.02	3.52 c	2.74 b	3.35 c	2.38 c	3.42 a	1.43 b
IAC 572	4.55	4.00 c	3.01 b	3.11 c	2.31 c	3.04 b	1.13 b
IAC 766	4.86	3.81 c	2.62 b	3.44 c	3.72 b	3.00 b	1.30 b
Paulsen 1103	5.01	4.26 b	3.78 a	4.09 b	4.83 a	3.95 a	2.10 a
Ramsey	5.35	5.21 a	4.12 a	5.06 a	4.41 a	3.38 a	1.61 b
SO4	5.23	4.53 c	3.12 b	3.50 c	3.68 b	2.25 b	1.62 b
Mean	5.07	4.19	3.25	3.85	3.71	3.28	1.68
20% ETo	5.18 a	2.91 c	1.22 c	3.72 a	4.25 a	1.82 b	1.37 b
50% ETo	4.96 a	4.25 b	3.83 b	3.76 a	3.81 a	3.57 a	2.70 a
100% ETo	5.06 a	5.43 a	4.70 a	4.06 a	3.07 b	4.40 a	0.97 b

Means followed by the same letters comparing columns do not differ according to the Scott-Knott test ($p < 0.05$).

- ✓ It was not possible identifying a trend for *E* reduction in a specific rootstock in conditions of water deficit (20% or 50% ETo), which could signal an adaptation strategy
- ✓ Water restriction (20% ET0) promoted a significant reduction in *E* in some evaluation dates(09/30, 10/07, 10/19 and 12/08)
- ✓ Ramsey showed higher *E* on the most dates evaluated, except on the first and last dates

Conclusion

- ✓ The rootstocks 'IAC 313', 'IAC 766' and 'Paulsen 1103' showed better performance for primary metabolites, pigments, vegetative development and gas exchange, which are important strategies for adaptation to water deficit.
- ✓ Studies should continue to evaluate interaction scion X rootstocks at different irrigation levels in field conditions

Thank you!

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