EFFECT OF ROOTSTOCKS AND POTASSIUM FERTILIZATION TECHNIQUES ON YIELD, ANTIOXIDANT ENYZMES ACTIVITIES OF SATSUMA MANDARINS UNDER SALT STRESS

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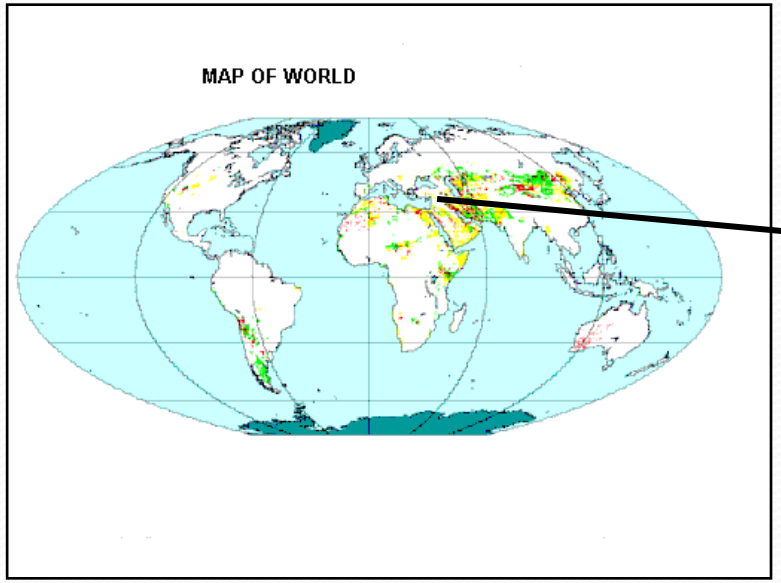
1-INTRODUCTION

- In Turkey, citrus is grown intensively along the coastal areas of the Aegean and the Mediterranean regions.



Currently,citrus is grown primarily between the latitudes 35°N to 35°S in TURKEY

Mediterranean Basin is a typical example where sea water intrusion takes place on the world.

- Under arid and semi-arid climatic zones, salination of underground waters occurs due to aridity arising from climate change and due to seawater intrusion in the coastal areas resulting from over pumping for agricultural or domestic purposes.

- **In this regard citrus trees which are generally the main crops of the M.R are very much damaged due to salination.**

The Northern (Spain , Italy, Greece and Turkey) and

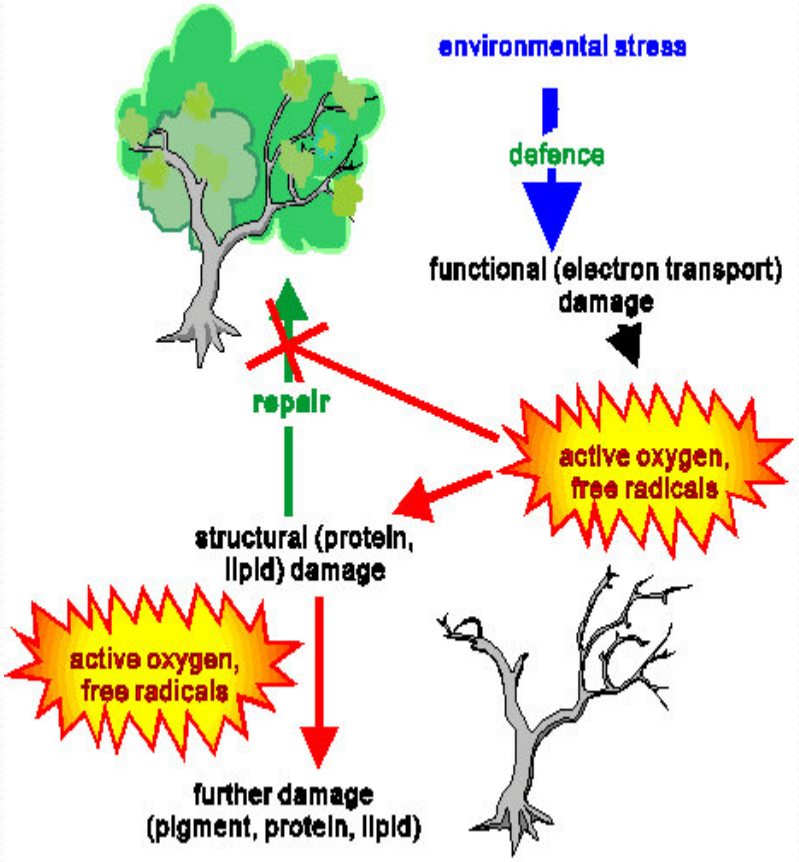
southern (Morocco, Egypt, Israel, Tunisia, Lebanon and Algeria) Mediterranean region.

Three major hazards are associated with saline habitats:

- water stress
- specific ion toxicity,
- and nutrient ion imbalance

Plants exposed to environmental stress,

- suffer from oxidative damage due to reactive oxygen species (ROS)
- like superoxide radical (O_2^-),
- hydrogen peroxide (H_2O_2) and
- hydroxyl radicals (OH^-) which are produced in the chloroplasts.



2-Objective

*The impact of salt in citrus trees that are known as highly salty sensitive may be controlled by the techniques :

1-the use of different species, cultivars, rootstocks

Poncirus trifoliata

-resistant to diurnal changes

-early harvest

Troyer citrange resistant to

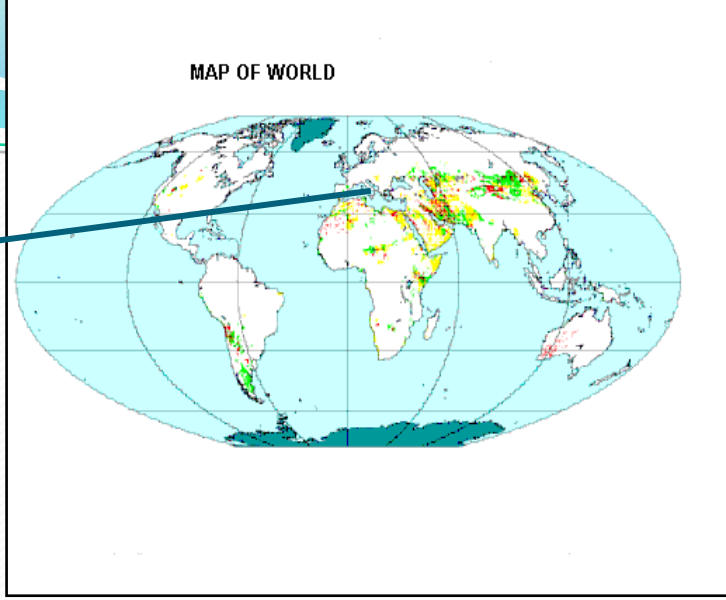
-lime and salt stress

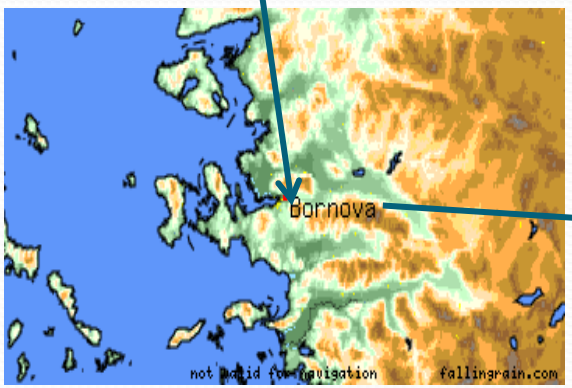
2-practiced applications

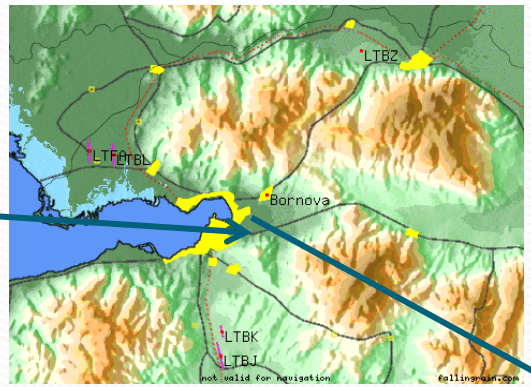
***fertilization**

***intercropping salt removing crops**

GEOGRAPHIC COORDINATES OF FIELD EXPERIMENTS







http://www.fallingrain.com/world/TU/35/Bornova.html

Field experiment

Field Experiment were conducted at Ege University Campus Bornova-IZMIR-TURKEY

Altitude (meters): 63 m (209 feet)
Latitude (DMS):38° 28' 11 N
Longitude (DMS):27° 13' 16E

The study aimed…

Examining the effect of **K fertilization** on

* the yield,
* physiological and
* enzymatic

response of satsuma mandarins budded onto different **rootstocks** under saline conditions.

Layout

The view of the field experiment

Fertilizer and Irrigation Tanks

- Field experiments were conducted two successive years in a salinized parcel of an experimental mandarin orchard of Satsuma nursery trees.

Layout

- To control salt stress, two different rootstocks,
- *Poncirus trifoliata* (P.T) and Troyer citrange (T.C).

T.citrange

P.trifoliata

Three levels of potassium fertilization
Ko (control),

K1=600 (optimum) and

K2=1200 (excess) g K_2O $tree^{-1}$] at the initiation, enhanced with development of trees.

Solu Potasse (Potassium Sulphate)

N P K Fertilizer

Three levels of salinity
control ➔ [S_0] ,

3.5 dSm^{-1} ➔ [S_1] and

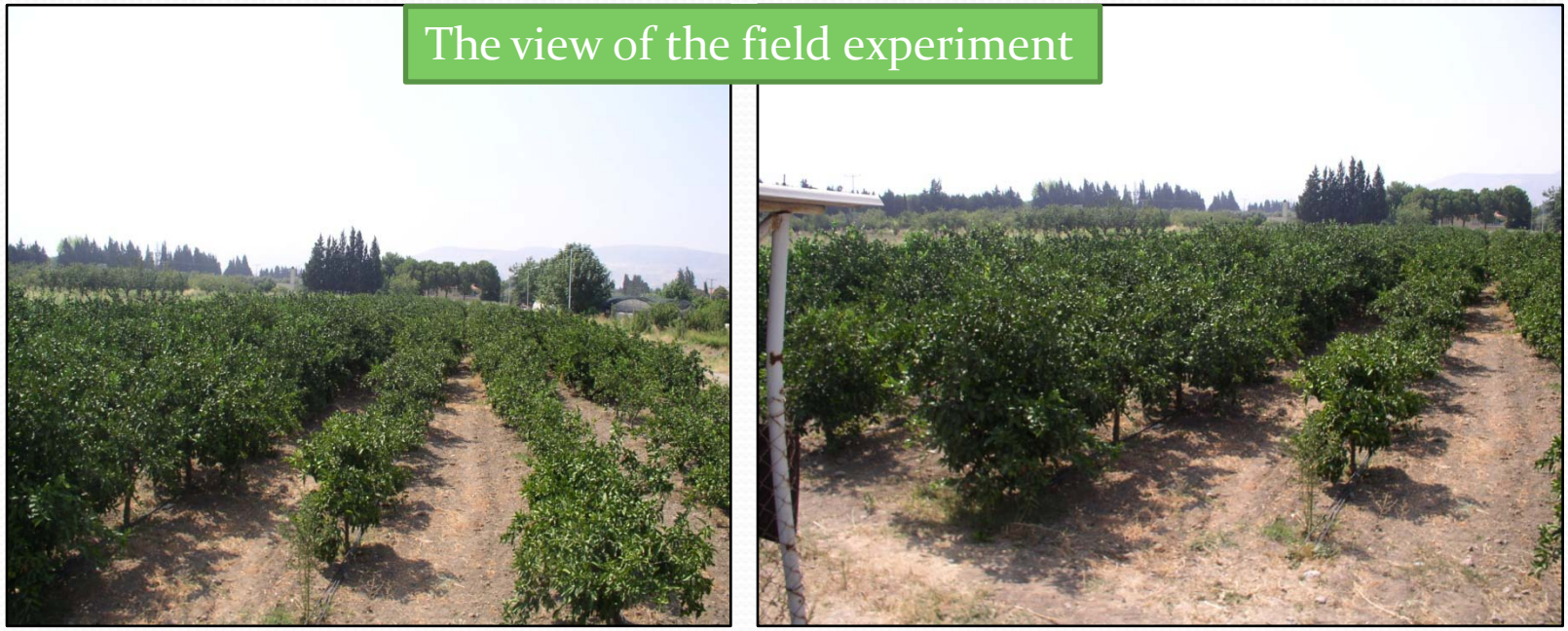
6.5dSm^{-1} ➔ [S_2]
in irrigation water.

Sea Salt

triple line source

Experimental design

The view of the field experiment



- Experimental design was randomized blocks with 4 replications.

the data obtained was subjected to analysis of variance (ANOVA) and the mean differences were compared by LSD tests.

The impact of potassium fertilization and rootstocks was analyzed by measuring,

- yield
- leaf properties

1-antioxidant enzymes (POX, SOD, CAT)

2-ions (K, Na and Cl)

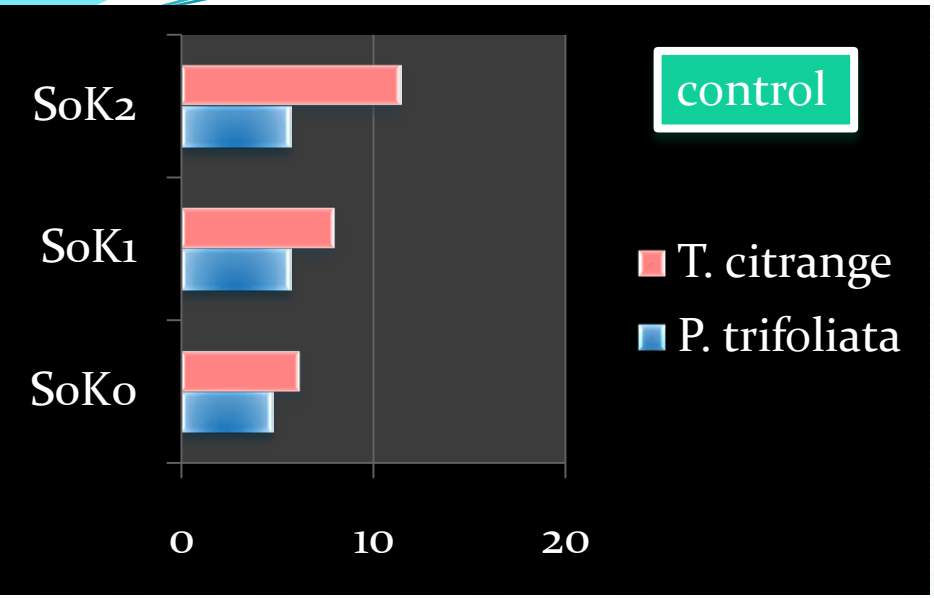
RESULTS

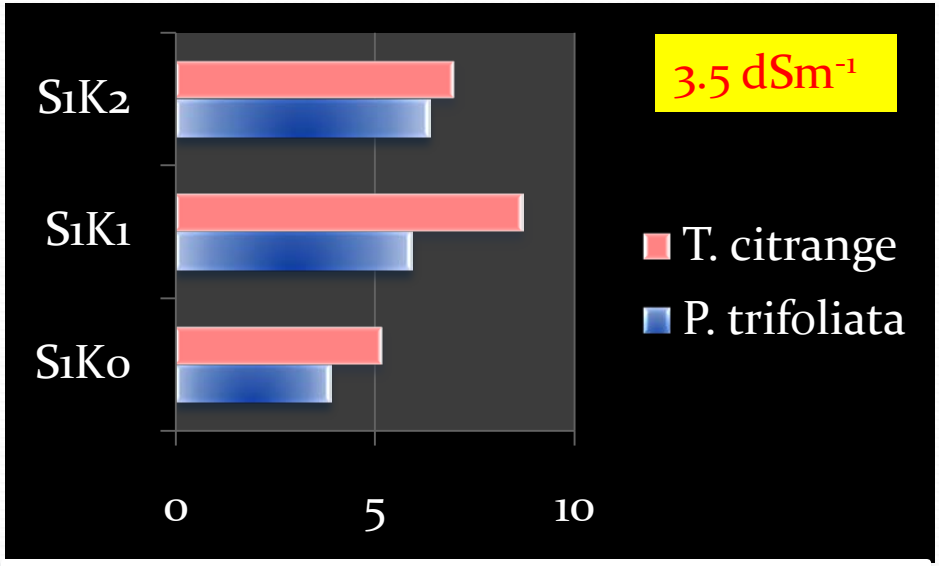
Table.1.Some physical and chemical analysis of experimental soil

Physical and Chemical Characteristic	Soil depth	
	0-30 cm	30-60 cm
pH	7.35	7.38
Total Salt (%)	0.035	0.030
$CaCO_3$ (%)	1.16	1.07
Sand (%)	66.88	62.88
Silt (%)	19.84	21.84
Clay (%)	13.28	15.28
Soil Texture	Sandy loam	Sandy loam
Organic matter %	2.61	1.52
Total-N %	0.137	0.280
Available P (mg kg^{-1})	5.34	4.25
Available K (mg kg^{-1})	280	230
Available Ca (mg kg^{-1})	3200	3000
Available Na (mg kg^{-1})	60	60
Available Mg (mg kg^{-1})	102	89

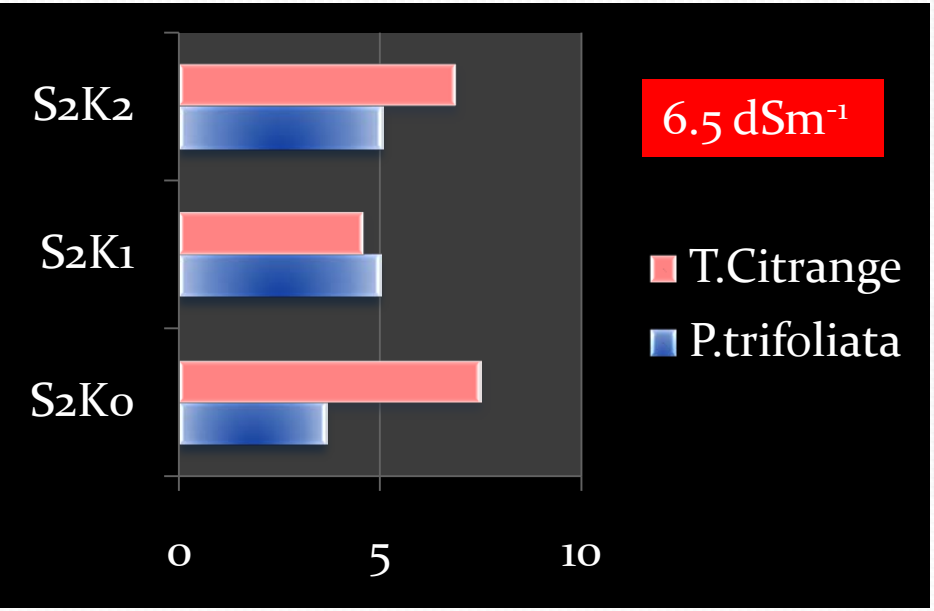
The pH of the soil is neutral, texture sandy loam,generally rich in plant nutrition with no salt problem.

YIELD(two-year average(kg tree^{-1})





Under severe salination conditions (S_2=6.5 dSm^{-1}), relative yield increases of T.C is more than P.T .



Moderate salinity condition (S_1=3.5 dSm-1) relative yield increases of T.C is more than P.T.

2- Peroxidase Activity (POX) (…stress enzyme)

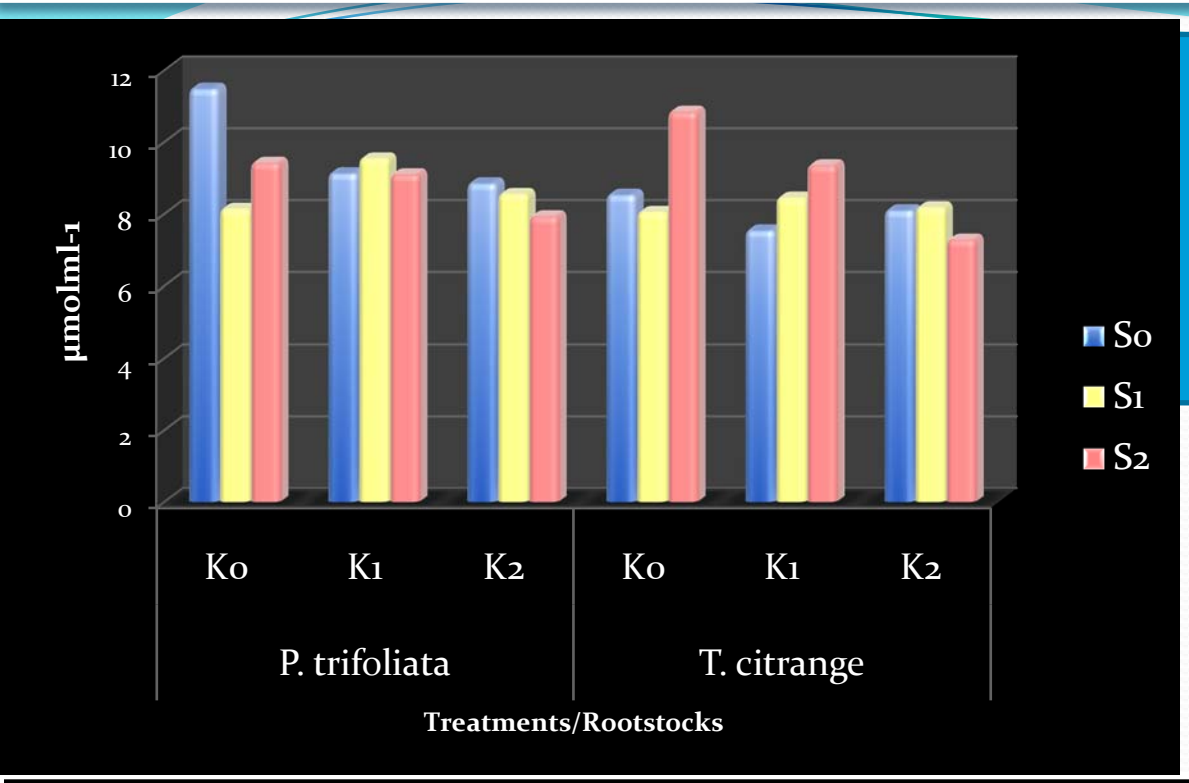
- Peroxidase (POX) is a

- **scavenging enzyme for toxic H_2O_2.**
- It is also involved in the **biosynthesis of cell wall components and lignifications.**

- **POX activity increase** parallel with the

-salinity of the environment

Peroxidase Activity (POX)



In the higher K dose (K2), the POX activity slightly decreased most probably due to the presence of K which might have had ameliorative effect on oxidative damage.

Fig.2 Leaf peroxidase activity as a function of rootstocks, salinity and K doses

POX increase due to saline treatments however when K is applied POX decline. In this case, the supplemental positive effect of K contributes to the stress mitigation.

However, the relative decrease was more in *Poncirus trifoliata* which is a rootstock that is thought to respond well to K fertilization but is also susceptible (Fig. 2).

3-Superoxide dismutase activity (SOD)

- Super oxide dismutase activity (SOD) **is responsible to** detoxifies the super oxide free radical O^-_2 by the formation of H_2o_2.
- SOD activity takes place in chloroplasts and mitochondria.
- Conflicting data is present in relation to its tendency when stress conditions prevail.

SOD (Superoxide dismutase activity)

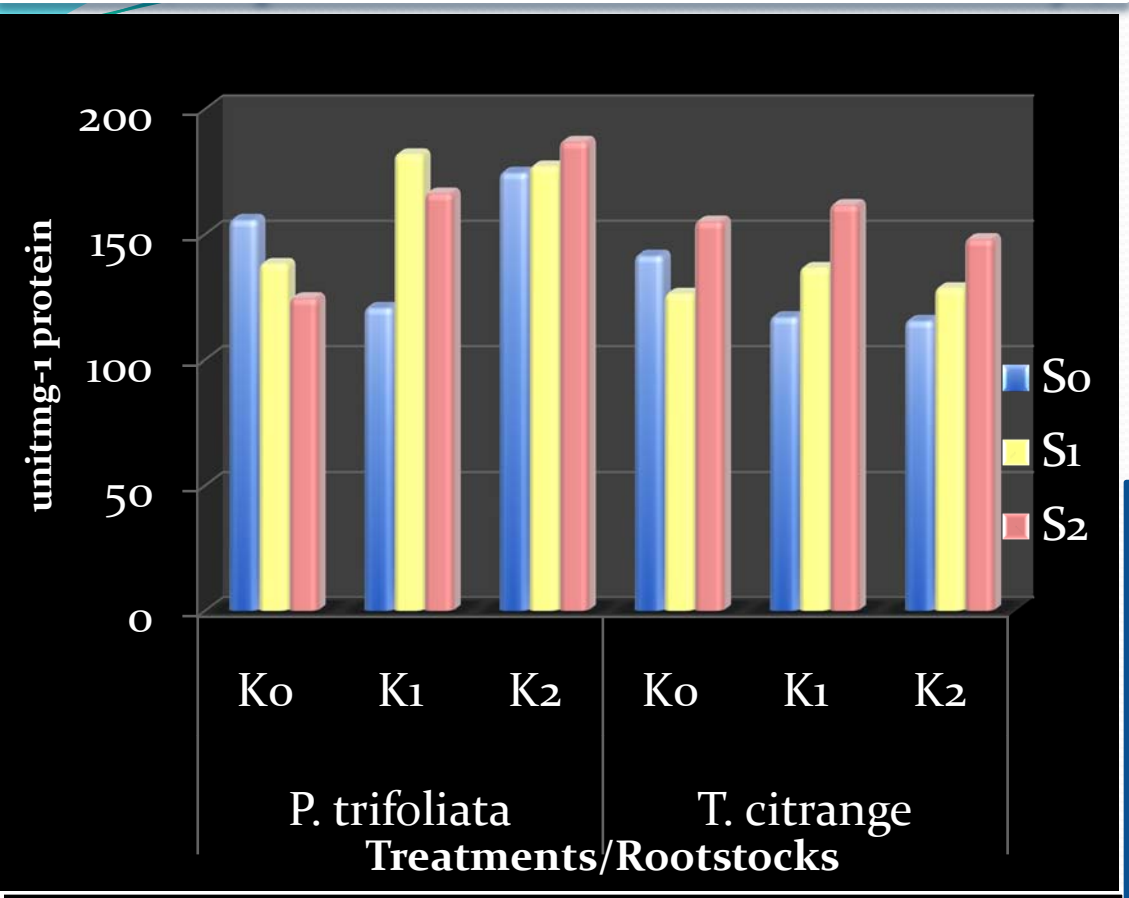


Fig.3 Leaf Superoxide Dismutase activity as a function of rootstocks, salinity and K doses

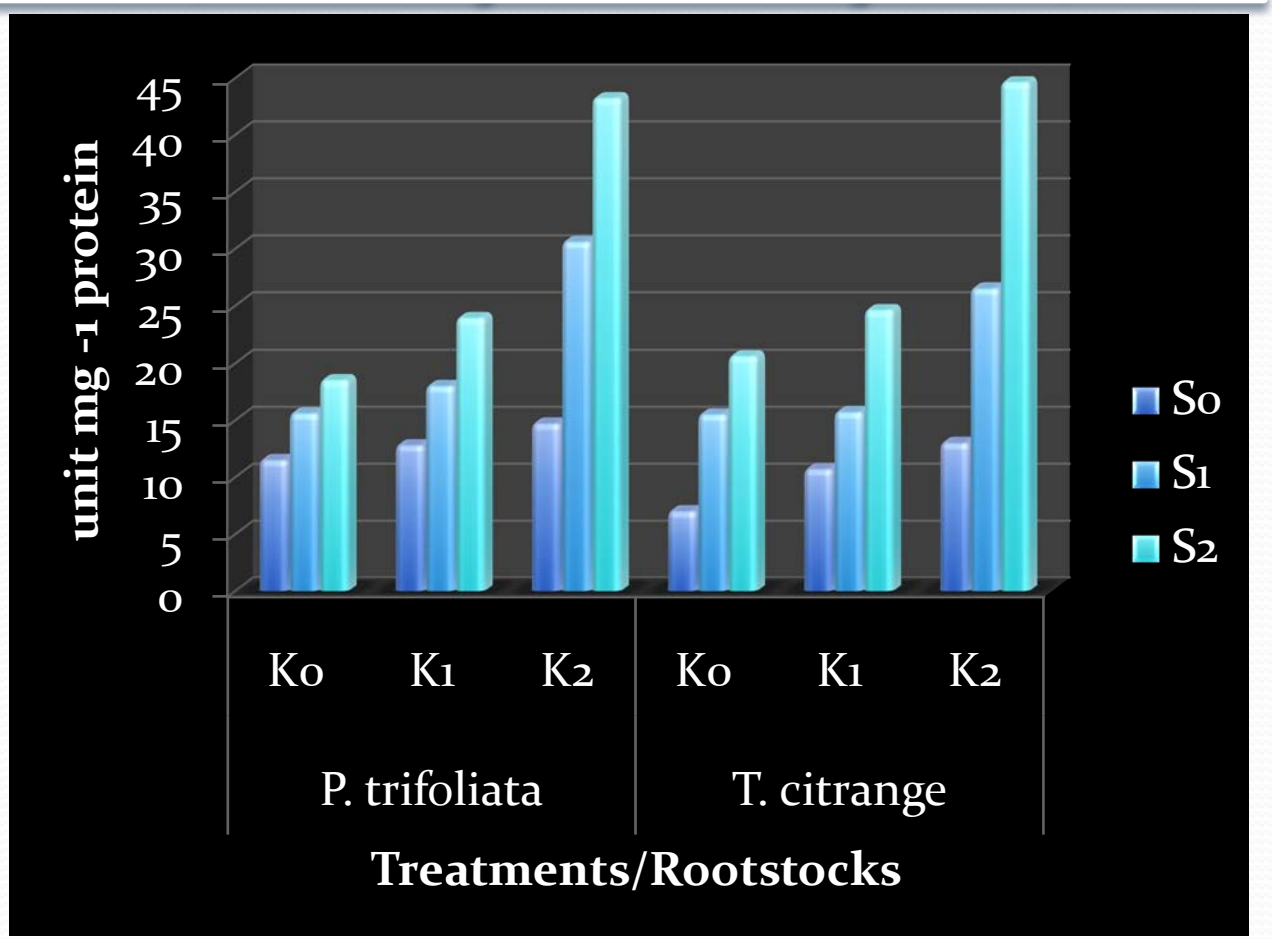
Troyer citrange had higher SOD measurements in the highest salt level (S_2) and statistically differed from the non (S_0) and low (S_1) salinity treatments

SOD measurements of *Poncirus trifoliata* increased with enhanced doses of K. This finding could be associated with the contribution of K to the anti oxidative defense system of susceptible plants (Fig.3).

4-CAT (Catalyze Enzyme)

- Catalyze (CAT) enzyme plays a significant role in eliminating H_2O_2 during its decomposition to H_2O and O_2.
- CAT do not exist in chloroplasts
- Scientists report conflicting data in relation to CAT response under stress conditions (Dhindsa and Matowe, 1981; Hurng and Kao, 1994; Türkan et al., 2004).

CAT (Catalyze Enzyme)

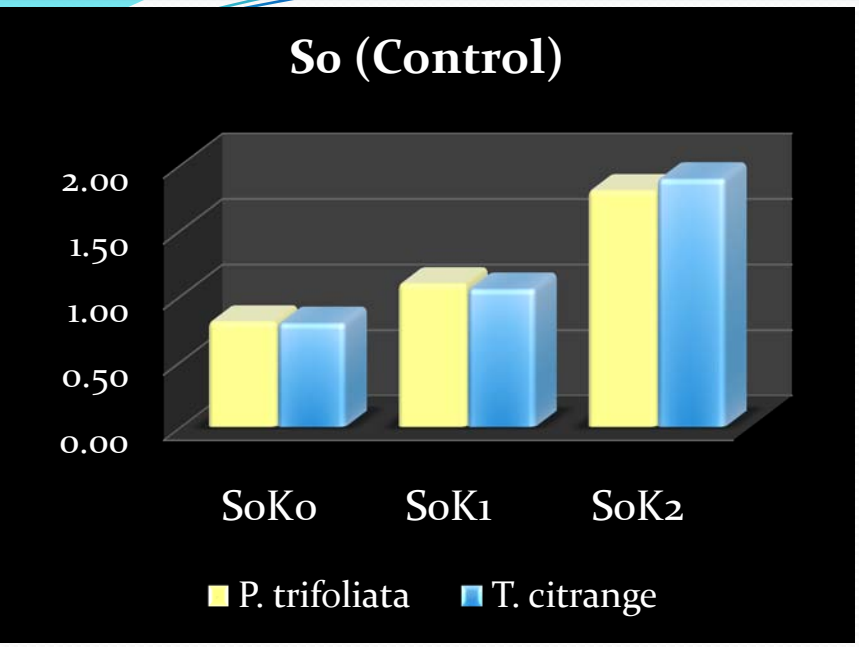


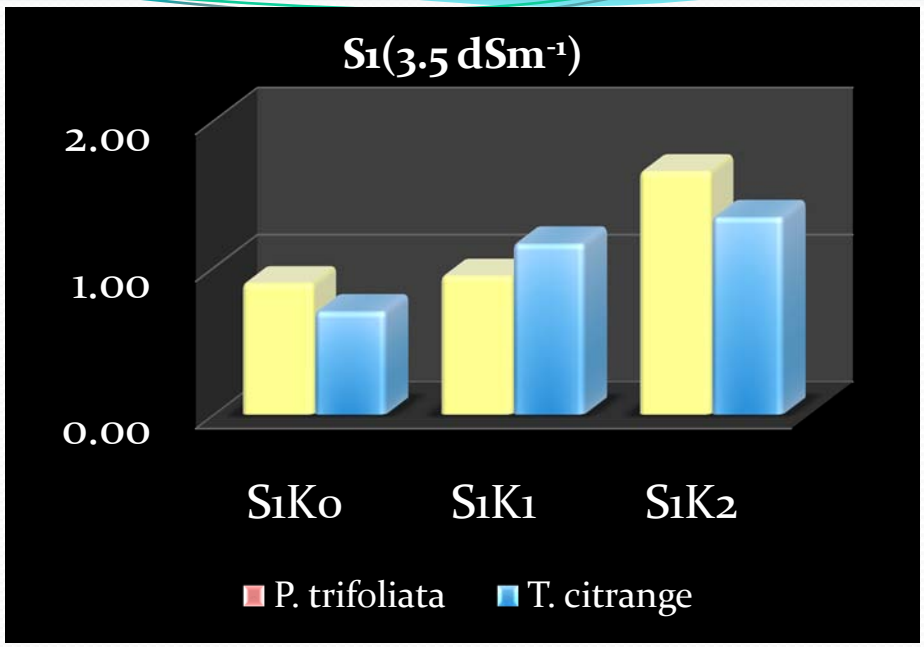
CAT activity increased as the salt applications increased.

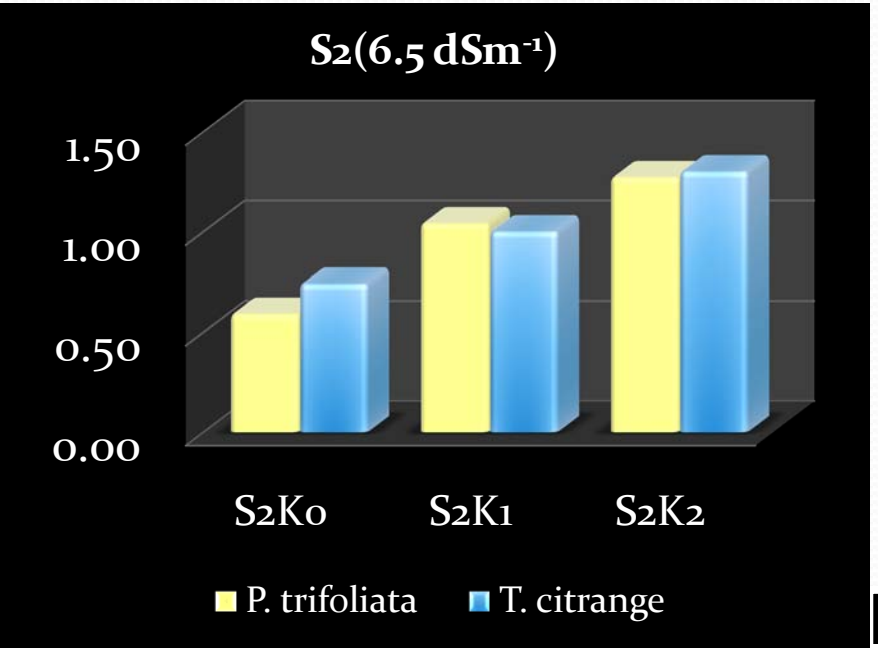
Results in relation to the effect of K fertilization showed that K has a positive impact on CAT activity;

Fig.4 Catalase activity as a function of rootstocks, salinity and K doses

5-Leaf K (two-year average)





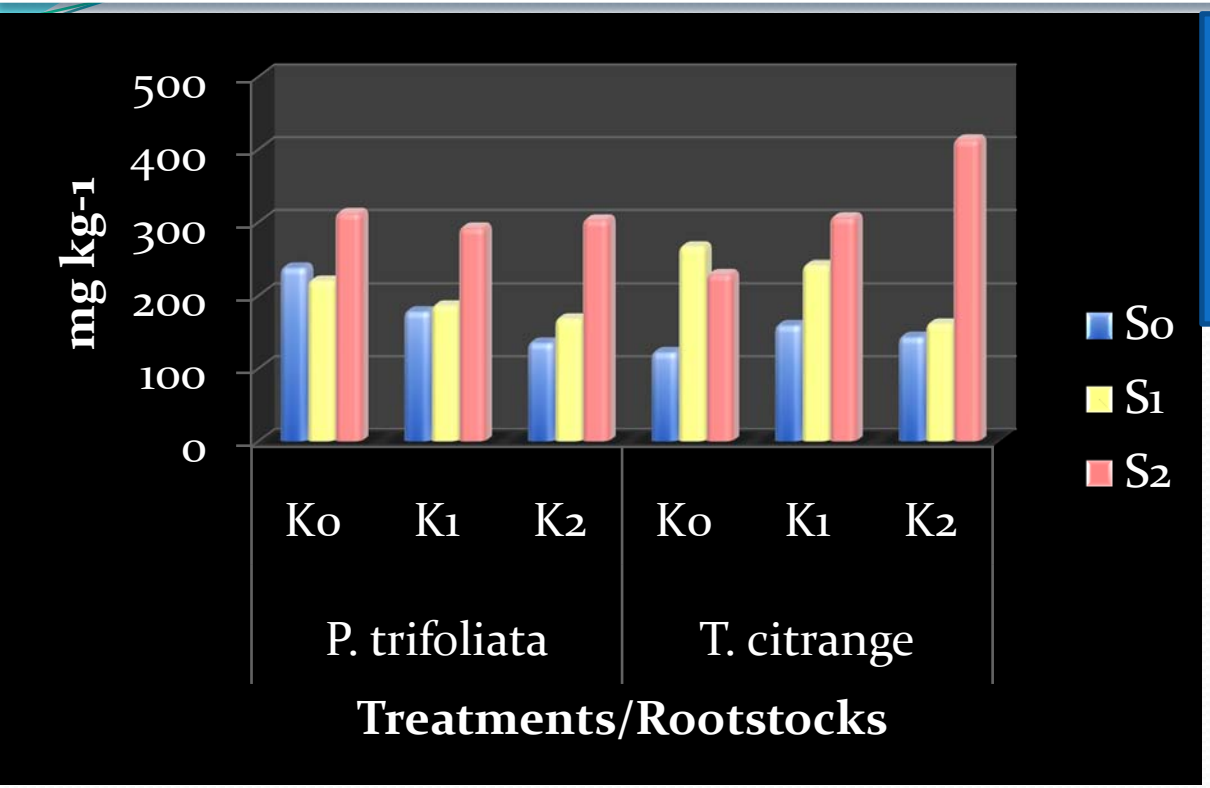


K fertilization increased leaf K of P.T more under moderately saline conditions (3.5 dSm^{-1})and T.C proved its resistant character always.

it might be concluded that Troyer citrange benefit from the applied K more than *Poncirus trifoliata* in Control (So) parcels.

Fig.6 Leaf Na as a function of rootstocks, salinity and K doses

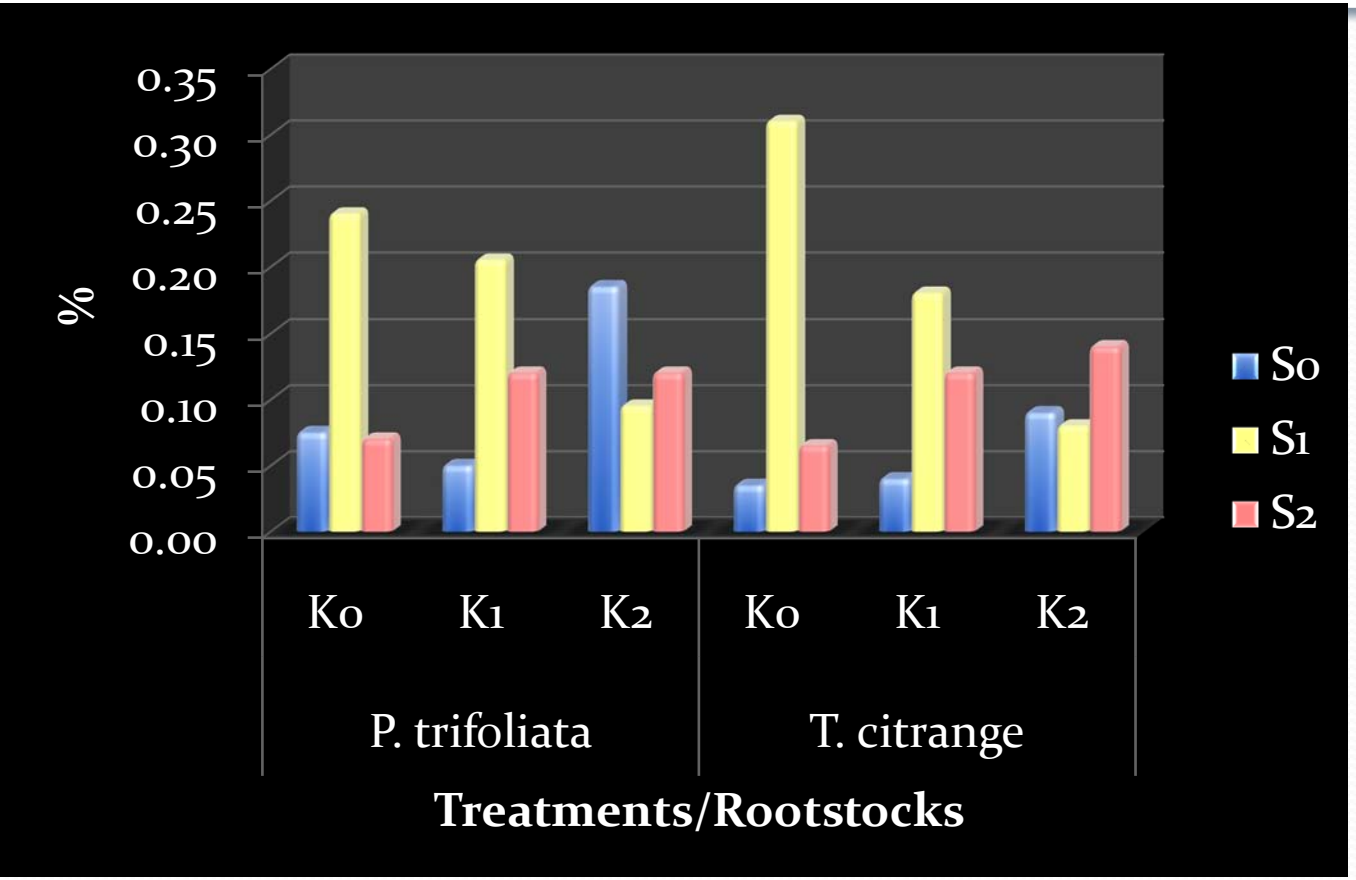
6-Leaf Na



Under moderately (S_1 =3.5dSm^{-1}) saline conditions no matter what the K application rate was, Troyer citrange always had more Na in its leaves.

In relation to the role of K in this interaction effect, results showed that particularly under moderately low salinity conditions (S_1), *Poncirus trifoliata* had taken the privilege of K and decreased the Na contents of the leaves parallel with the enhanced doses of K fertilization (Fig.6).

7-Leaf Cl



The rootstock *Poncirus trifoliata* was positively affected from the K fertilization and the leaf Cl contents of the trees that received K decreased

in the severely higher salty conditions (S_2), Troyer citrange likewise *Poncirus trifoliata* was also affected by the positive impact of K fertilization and leaf Cl decreased

Conclusion

1. Under salt stress, rootstock effect is dominating no matter what the practiced technique is.
2. TC always had higher yield and higher biochemical properties.
3. **P.T also benefited from K fertililization, some times, even under severe salination but mainly under non and moderate salinity conditions.**
4. **PT can be a logical and economical rootstock selection for the region with an efficient nutrient management..**
5. **Currently, farmers of the region are reluctant in their selections and shifting from PT to more tolerant TC.**

All of the results showed that

- **under highly saline conditions** (S2=6.5 dSm^{-1}) for *Poncirus trifoliata* which is accepted as a sensitive rootstock 1200 g K_2O $tree^{-1}$ and

for Troyer citrange which is relatively tolerant 600 g K_2O $tree^{-1}$ can be **recommended** provided that similar conditions of this experiment prevail.

THANKS FOR YOUR ATTENTION