
بسم الله الرحمن الرحیم
In the neme of God

International Quinoa Conference 2016
Quinoa for Future Food and Nutrition Security in Marginal Environments

Dry Matter, Yield And Activity Of Antioxidant Enzymes In Three Quinoa Genotypes Grown At Varied Water Stress Conditions

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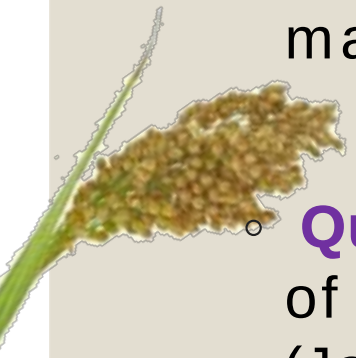
Introduction

Quinoa Conference

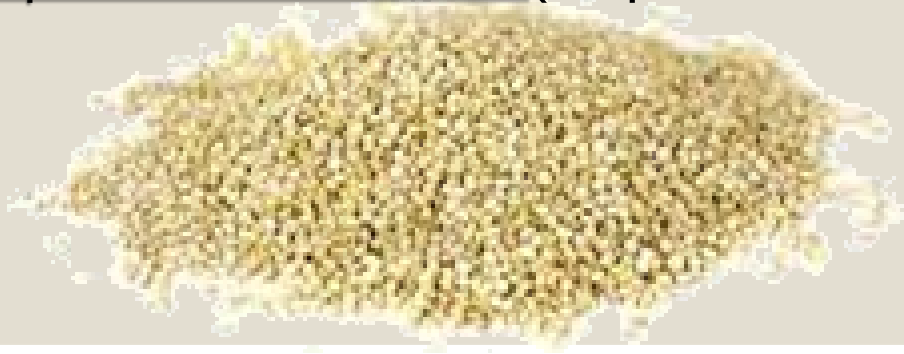
Quinoa

- Variations in environmental components are widely indicated as a major threat for global food security (Ruiz-Carrasco et al., 2011).



- **Quinoa** (*Chenopodium quinoa*) is a seed crop from the Andes region of South America grown on poorer soils at elevations up to 12.000 ft (Jacobsen et al. 2005).

- This plant is considered as one of the crops that might sustain food security in this century for its excellent nutritional features, such as unique amino acid composition and high protein content (Repo-Carrasco et al., 2003).



Quinoa response to stresses

- Quinoa exhibits remarkable tolerance against environmental stresses such as drought (Ruiz-Carrasco et al., 2011) and salt (Munns, 1993).

- The response of quinoa to water stress has not been well-studies compared to salt stress, because this plant is a halophytes with high salt stress tolerance (Munns, 1993).

- Water stress as the most important environment stress affects more than 10% of arable lands, and reduces yields of most of the crop plants over 50% worldwide (Bartels and Sunkar, 2005).

- Plant resistance to water stress varies depending on plant species and even among genotypes of the same species (Pirasteh-Anosheh et al. 2013).

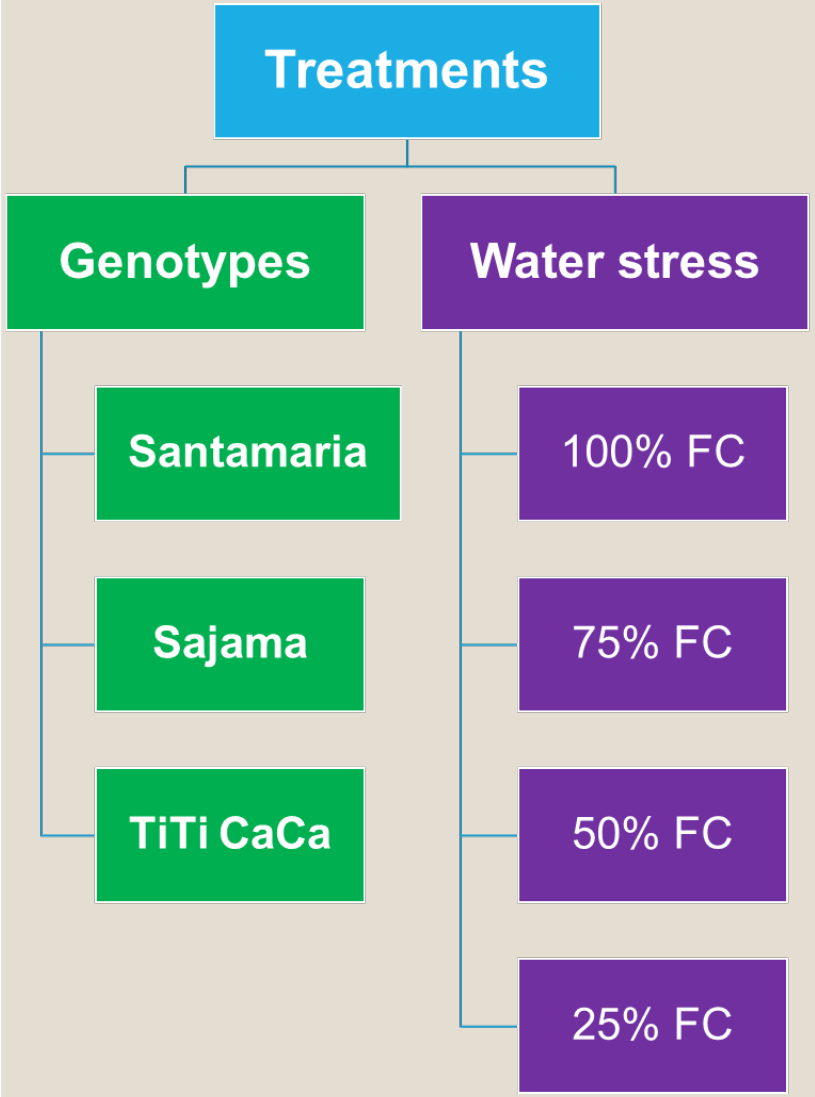
The objective

- There is little information available about growth, seed yield and antioxidant enzymes of quinoa plants grown at water deficit environments.

- However, it is important to know, not only for economic reasons, but also for understanding of the mechanisms which are responsible for the survivability of the seed, where drought influences the content of food reserves or nutrients and on the viability of the seed.

- Thus, this study was conducted to examine the effect of varied water stress on growth, seed yield and activity of antioxidant enzymes of three quinoa genotypes.

Materials & Methods



Time: **2015**
Place: **Shiraz University, Shiraz, Iran**
Design: **Completely randomized design**

Treatments:
Three genotypes: Santamaria, TiTi CaCa and Sajama
Four water stress level:100%, 75%, 50% and 25% F.C.

Measurements

❑ Growth

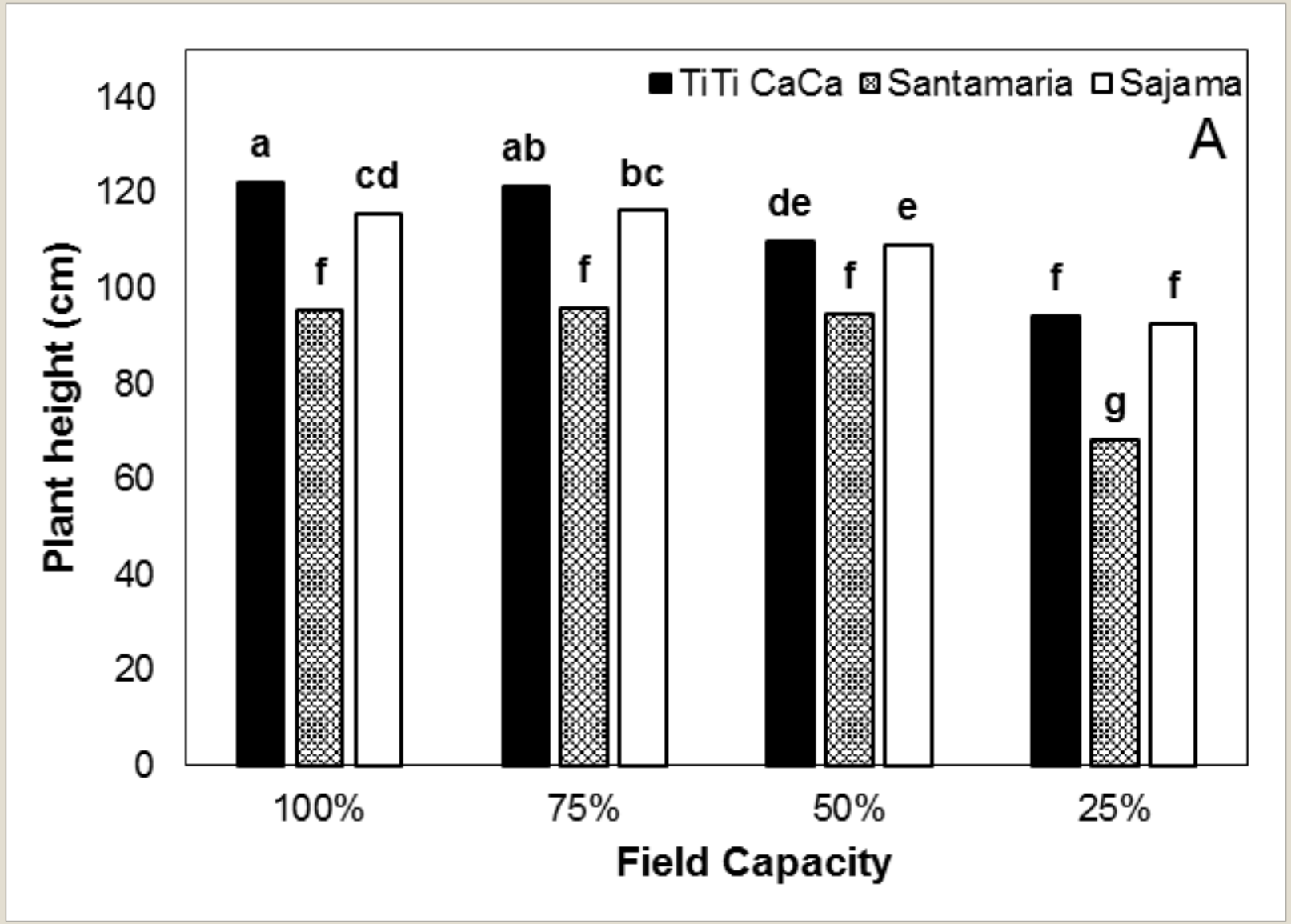
- Plant height ⟶ Ruler
- Leaf area ⟶ Leaf area meter (ΔT)
- Dry matter ⟶ 48h oven 80 °C
- Grain yield ⟶ 48h oven 80 °C

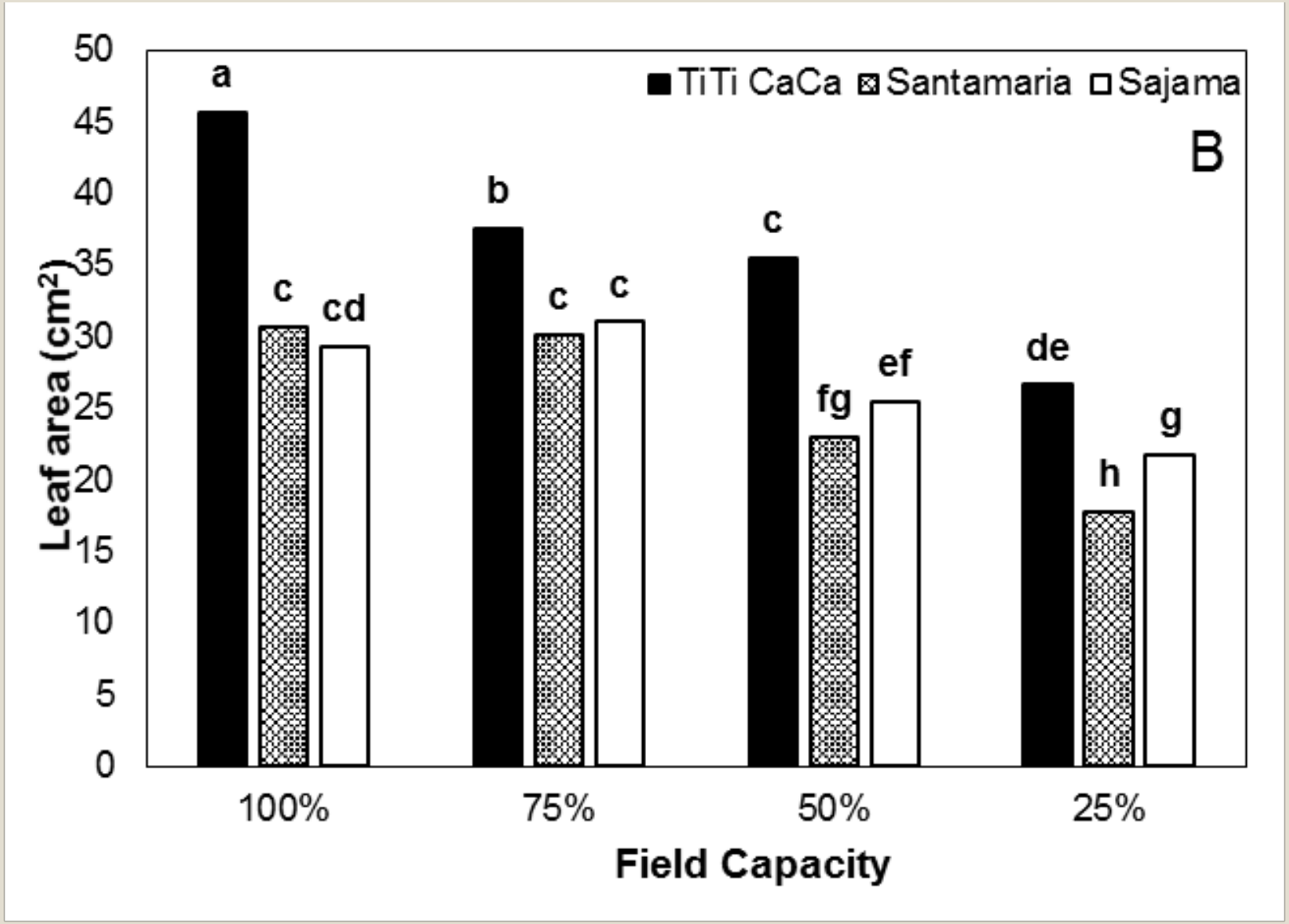
❑ Antioxidant enzymes

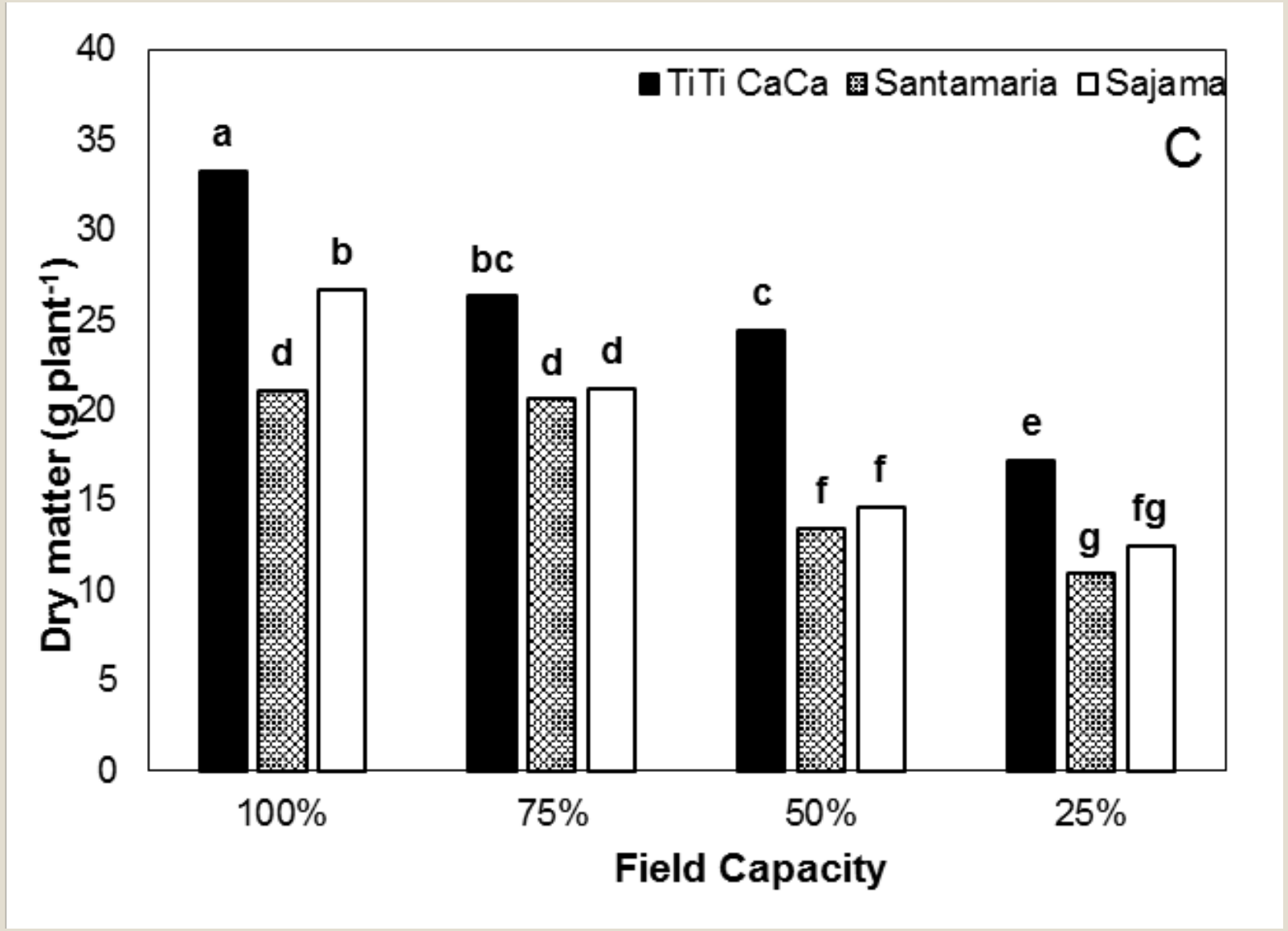
- SOD ⟶ Dhindsa et al. (1981)
- POD ⟶ Chance and Maehly (1995)
- CAT ⟶ Dhindsa et al. (1981)
- APX ⟶ Nakano and Asada (1981)

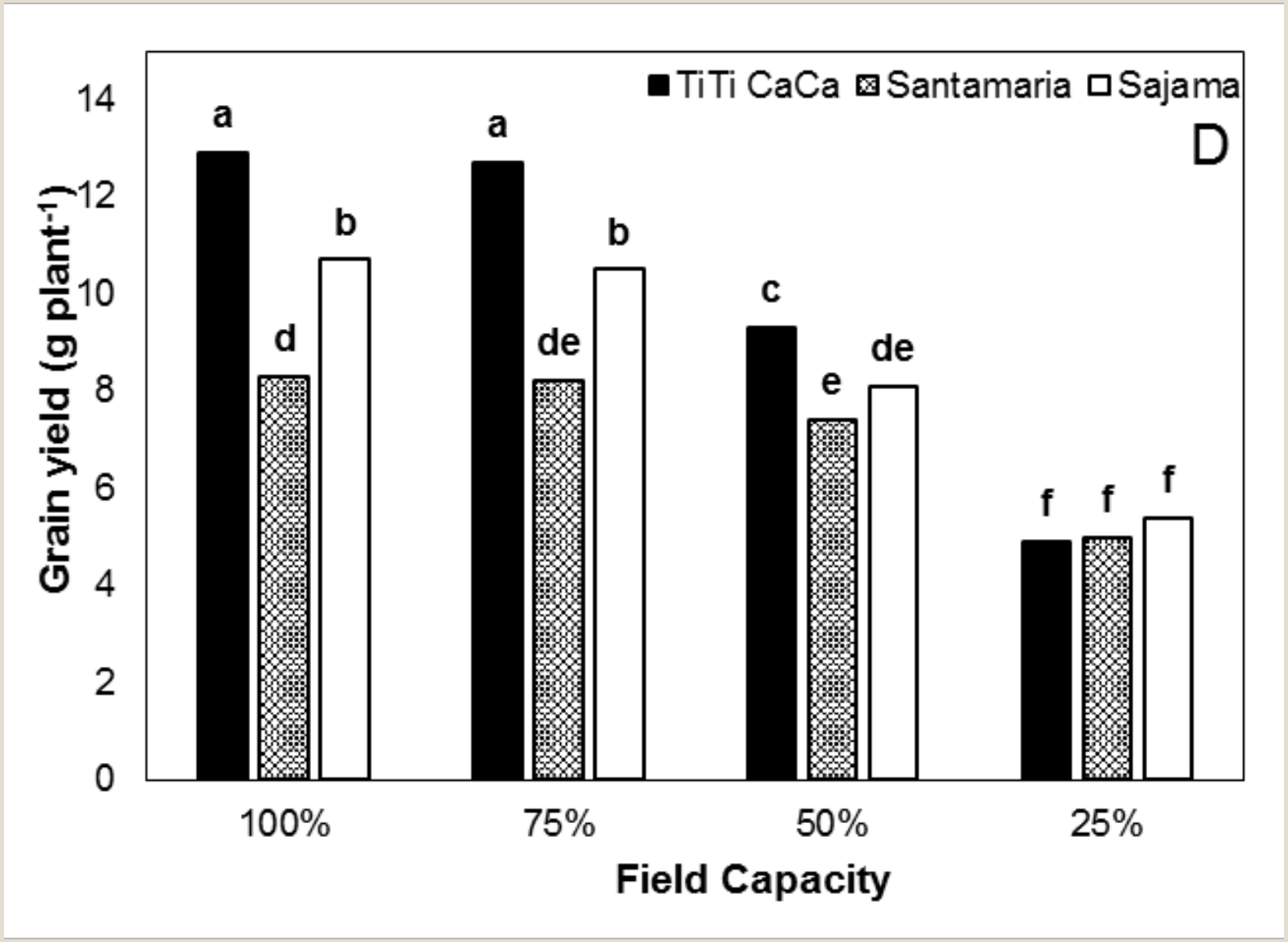
Spectrophotometer

Results & Discussion


TiTi CaCa
Santamaria
Sajama
A
Plant height (cm)
140
120
100
80
60
40
20
0
a
f
cd
ab
f
bc
de
f
e
f
g
f
100%
75%
50%
25%
Field Capacity


TiTi CaCa
Santamaria
Sajama
B
Leaf area (cm²)
50
45
40
35
30
25
20
15
10
5
0
a
c
cd
b
c
c
c
fg
ef
de
h
g
100%
75%
50%
25%
Field Capacity

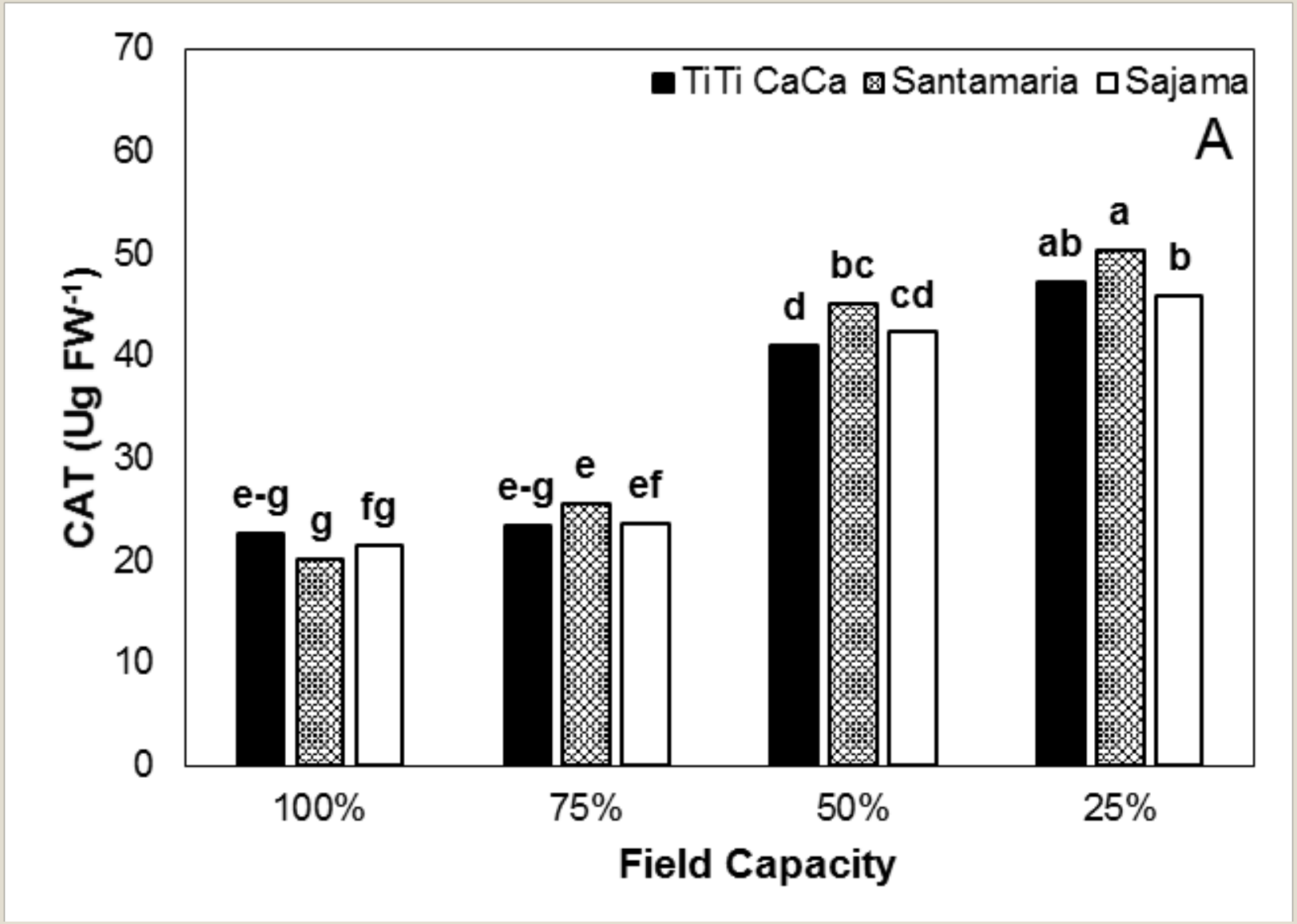

TiTi CaCa
Santamaria
Sajama
C
Dry matter (g plant-1)
40
35
30
25
20
15
10
5
0
a
d
b
bc
d
d
c
f
f
e
g
fg
100%
75%
50%
25%
Field Capacity

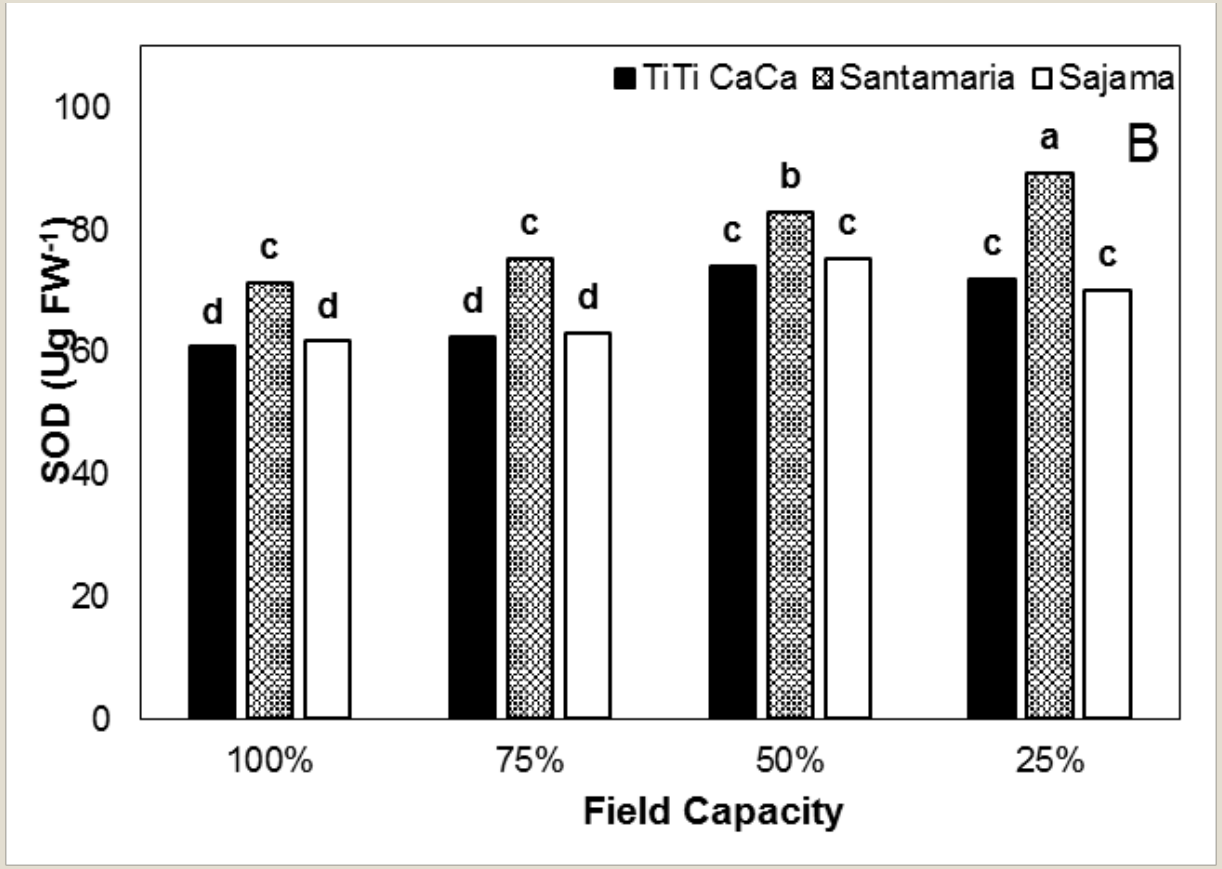

TiTi CaCa
Santamaria
Sajama
D
Grain yield (g plant-1)
14
12
10
8
6
4
2
0
a
d
b
a
de
b
c
e
de
f
f
f
100%
75%
50%
25%
Field Capacity

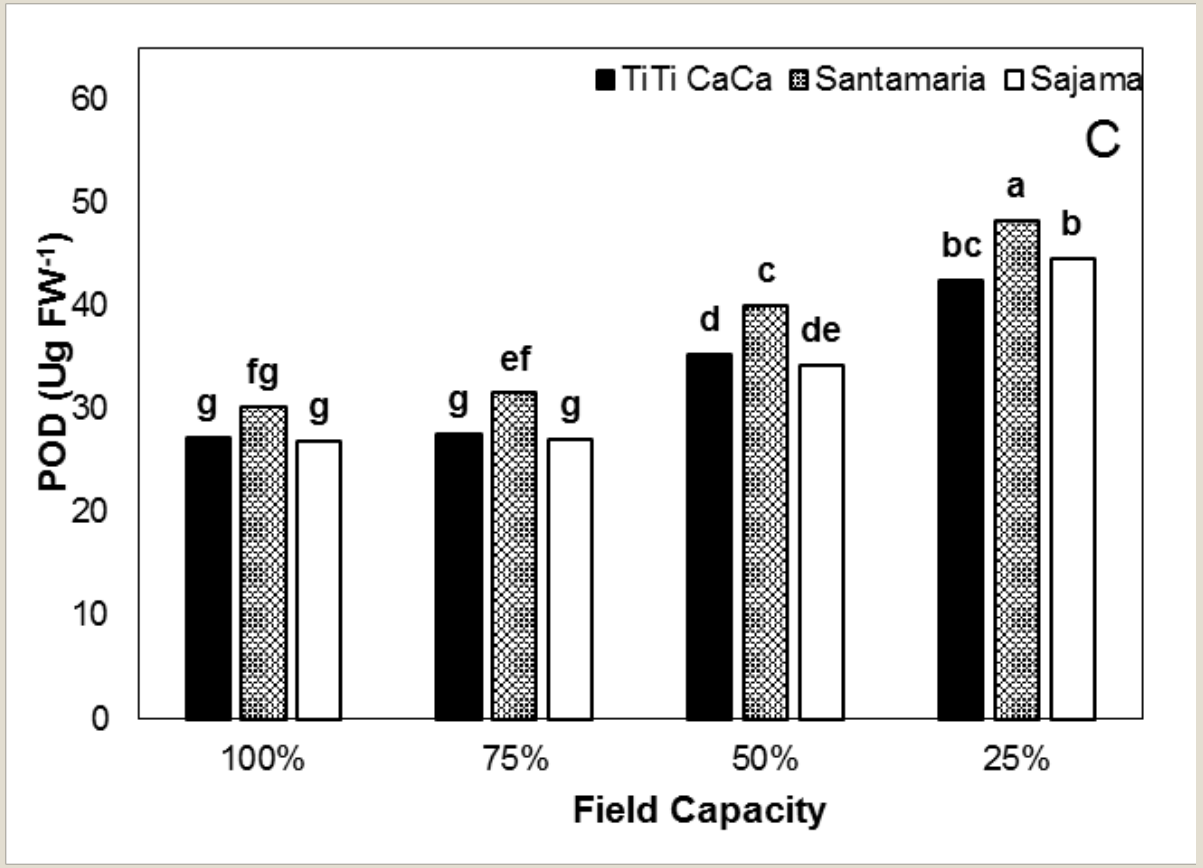
- Drought stress is considered as a major environmental factor inhibiting many metabolic processes, which eventually constrains plant growth and crop productivity (Chaves and Oliveira, 2004).

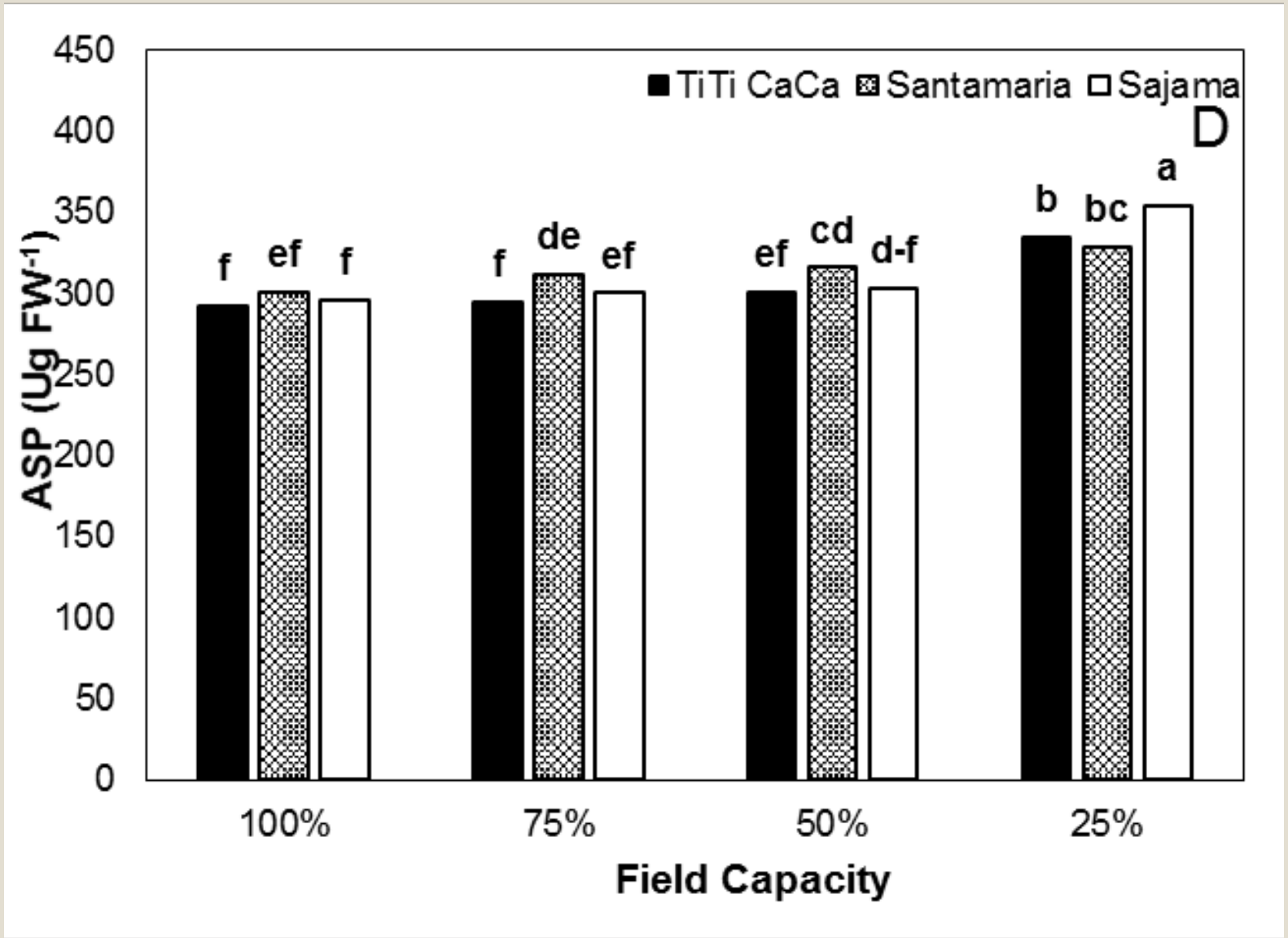
- Plant resistance to water stress varies depending on plant species and even among cultivars of the same species (Quartacci et al., 1995).

- Quinoa can grow with only 200 mm of rainfall in pure sand.
- Some lines with improved drought resistance have been identified, and several drought-mediating mechanisms have been found.


TiTi CaCa
Santamaria
Sajama
A
CAT (Ug FW-1)
70
60
50
40
30
20
10
0
e-g
g
fg
e-g
e
ef
d
bc
cd
ab
a
b
100%
75%
50%
25%
Field Capacity


TiTi CaCa
Santamaria
Sajama
B
SOD (Ug FW-1)
100
80
60
40
20
0
d
c
d
d
c
d
c
b
c
c
a
c
100%
75%
50%
25%
Field Capacity


TiTi CaCa
Santamaria
Sajama
C
POD (Ug FW-1)
60
50
40
30
20
10
0
g
fg
g
g
ef
g
d
c
de
bc
a
b
100%
75%
50%
25%
Field Capacity


TiTi CaCa
Santamaria
Sajama
D
ASP (Ug FW-1)
450
400
350
300
250
200
150
100
50
0
f
ef
f
f
de
ef
ef
cd
d-f
b
bc
a
100%
75%
50%
25%
Field Capacity

- **Water stress** elevates generation of reactive oxygen species (ROS), an effect common in plants exposed to most abiotic stresses (Saed-Mouchesi et al., 2014).

- Such ROS accumulation may lead to many negative effects, protein degradation, lipid peroxidation and pigment bleaching (Ashraf and Akram, 2009).

- To protect cells from such negative effects, plants increase activities of key antioxidant enzymes in the cytosol, including superoxide dismutase (SOD), peroxidase (POD), catalase (CAT) and ascorbic peroxdidase ,which are believed to counteract the effects of ROS (Pirasteh-Anosheh et al. 2012).

Conclusion

- The results showed that **water stress** in general reduced growth and yield of all quinoa genotypes assessed by plant height, leaf area, dry matter and grain yield, and enhanced activity of antioxidant enzymes consisted of superoxide dismutase (SOD), peroxidase (POD), catalase (CAT) and ascorbic peroxdidase (ASP).

- These impacts were closely associated with stress intensity, however even at the highest water stress level (i.e. 25% F.C.) quinoa genotypes could grow and produce grain.

- Indeed, water stress at 50% and 25% F.C. can significantly decreased average of grain yield of quinoa genotypes by 22.3% and 52.1%, respectively.

- Among the genotypes, TiTi CaCa had the greater growth and yield and Santamaria had better water stress tolerance, which might be due to higher activity of antioxidant enzymes in this genotype.

- **In general, growing quinoa genotypes, especially TiTi CaCa with lower irrigation volume by 25% was not associated with reduced growth and yield; so could be more examined as a potential practical approach in the regions with limited moisture resources such as Middle East.**


Thank you