Marked advantages of POTASSIUM NITRATE under water scarcity & salinity

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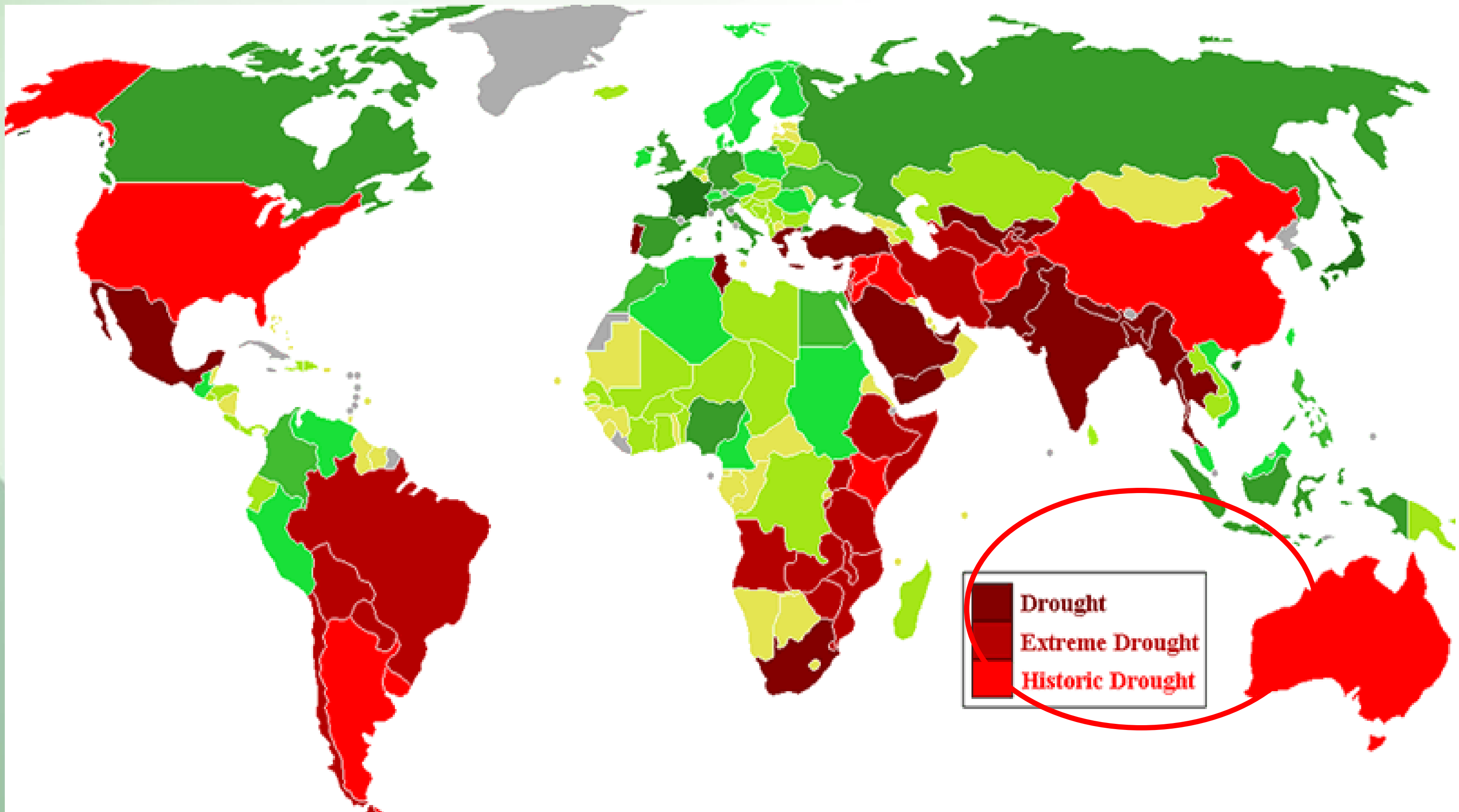
Worldwide water scarcity – supply aspect



Source: "Catastrophic Fall in 2009 Global Food Production"by Eric deCarbonnel , 2009

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Worldwide water scarcity – demand aspect

Since 1950

*** World population increased by 100%**

*** Water consumption increased by <u>600%</u>**

University of Oklahoma, Health Sciences Center (2005)

Two cardinal conclusions

- **Irrigation must be made more efficient and more sustainable**

- **Nutrition techniques must be harnessed to increase WUE**

Worldwide water scarcity –

Let's join efforts

Water Use Efficiency

$$\text{Water use efficiency} = \frac{\text{Dry (or fresh) matter produced}}{\text{Water transpired}}$$

Two independent plant functions are involved:

- **Biomass production**
- **Water management**

Water Use Efficiency

The Roles of Potassium

K & Biomass management

Potassium is a pre-requisite for normal building process of plant structure

Potassium is a pre-requisite for normal functioning of all plant biochemical and physiological systems **60 enzymes!**

K & Biomass management

K maintains <u>turgor</u>, thus reducing lodging and enhancing harvesting efficiency

K & Biomass management

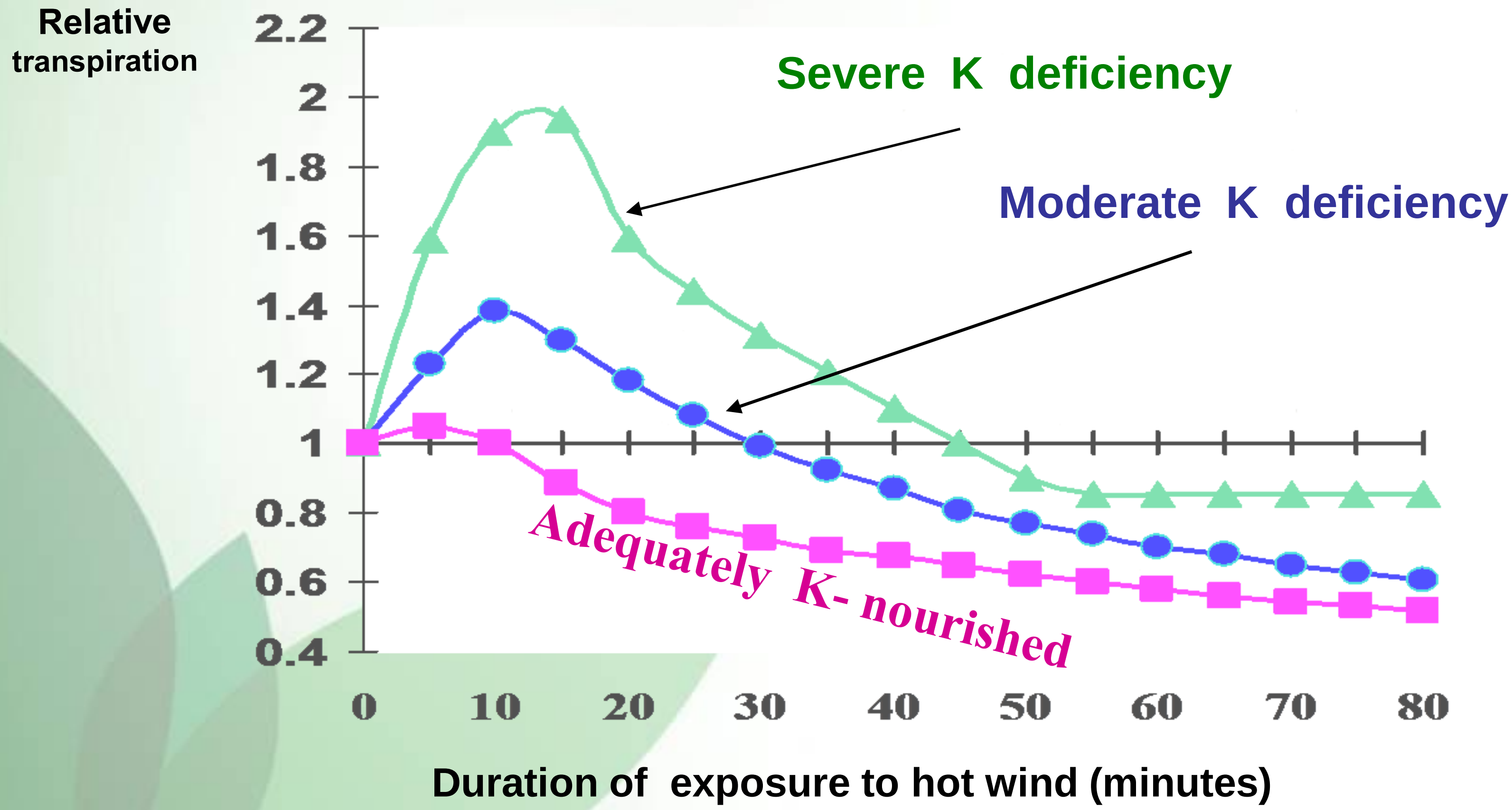
Conclusion:

Under normal growing conditions –

The higher the K, the higher biomass production

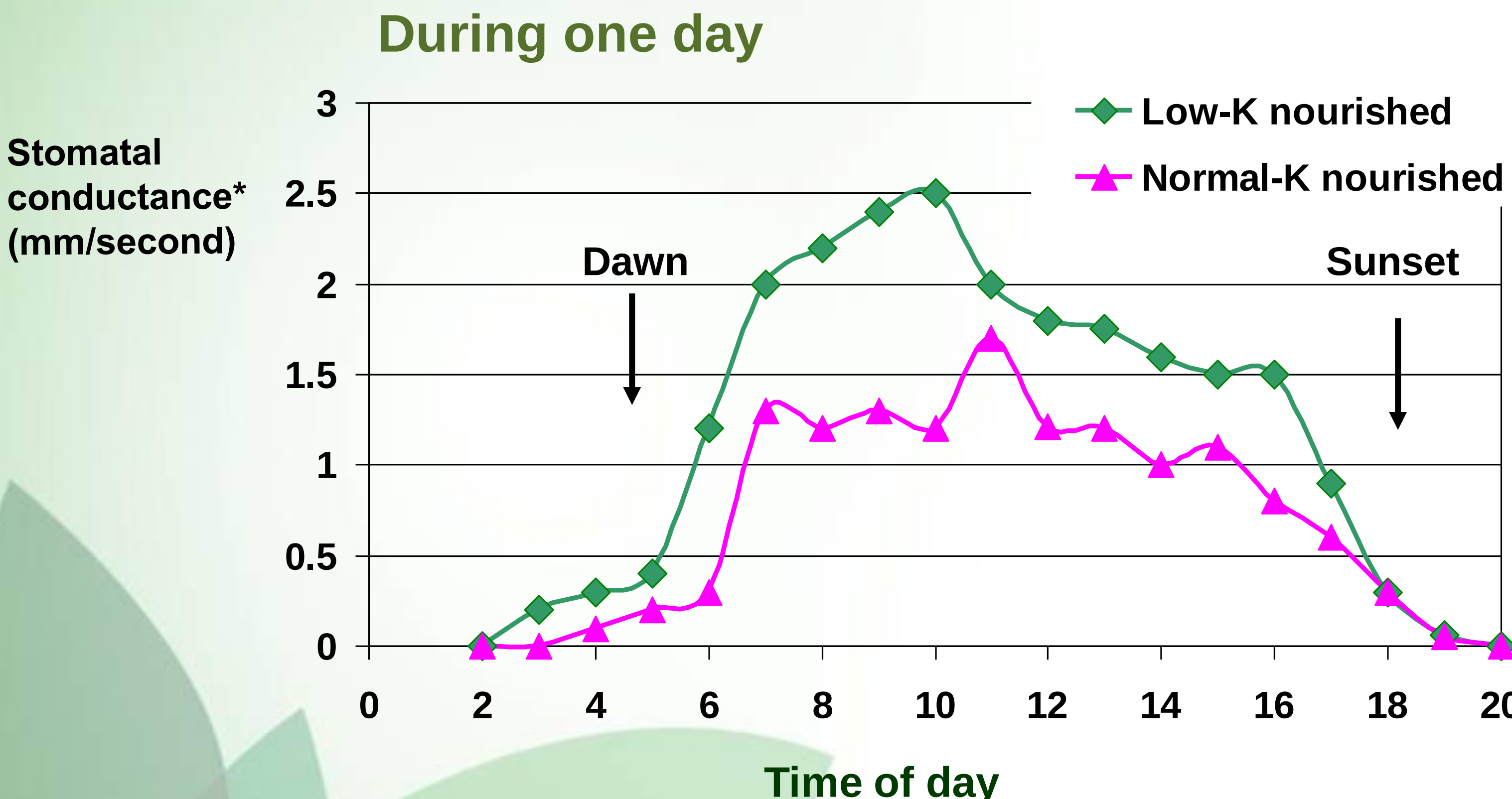
K & Water management

Potassium status of the plant determines the recovery rate from a drought stress



Skogley, 1976

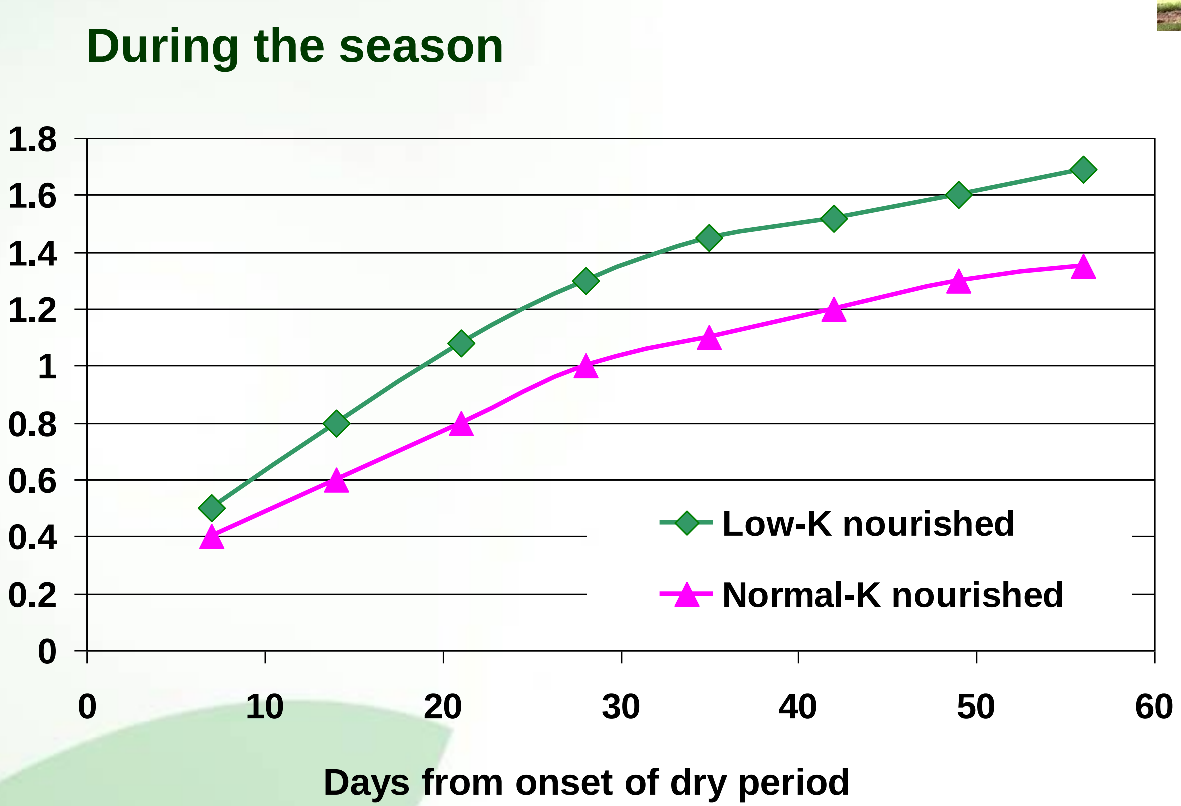
Potassium deficiency
increases stomatal conductance in olive trees



* At a typical summer day during the experiment period (93d.); Plants under drought regime; Cultivar: *'Chemalali de Sfax'*

Arqero, Barranco & Benlloch (2006)

Potassium deficiency –
increases transpiration rate in olive trees



Cultivar: '*Lechin de Granada*'

Benlloch-Gonzalez, Arqero, Fournier, Barranco & Benlloch (2008)

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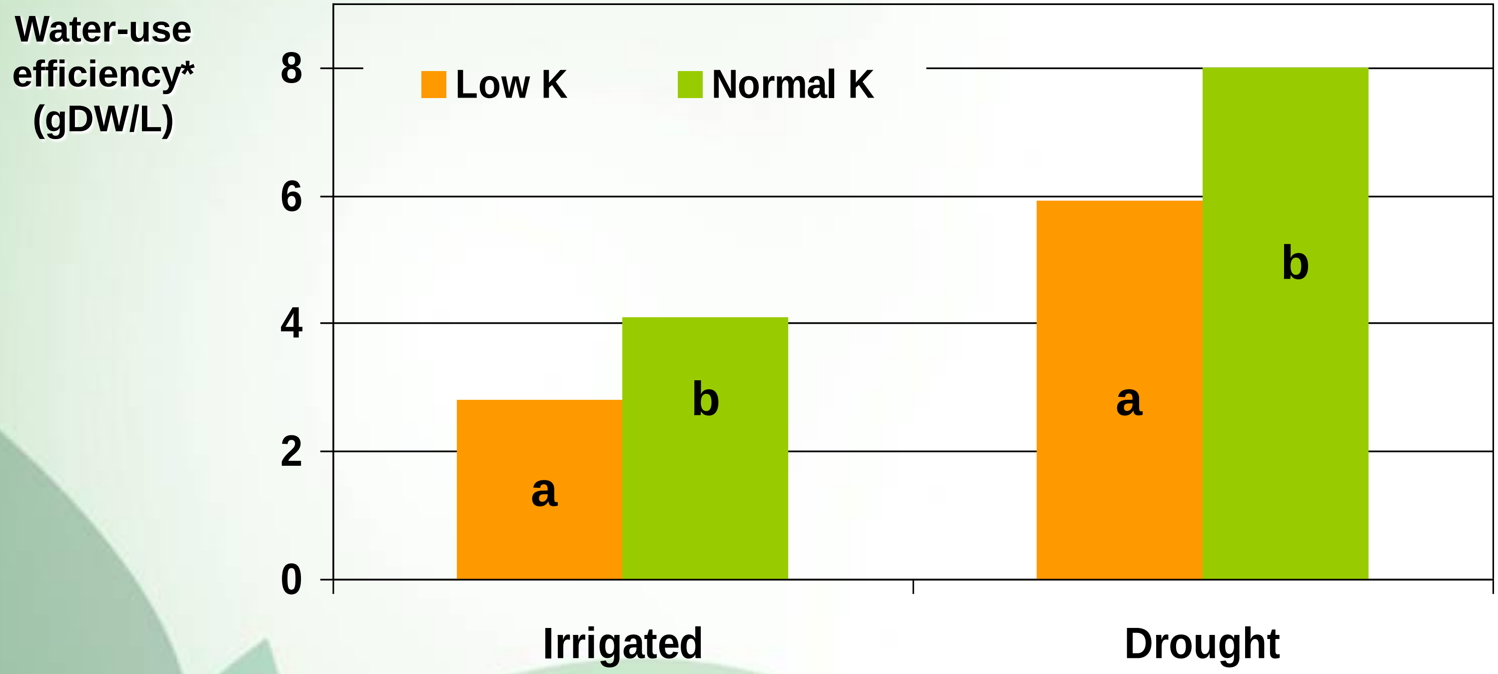
Potassium deficiency –
reduces Water Use Efficiency in olive trees



*** An integration of entire experiment period (93d.);**
Cultivar: *'Chemalali de Sfax'*

Arqero, Barranco & Benlloch (2006)

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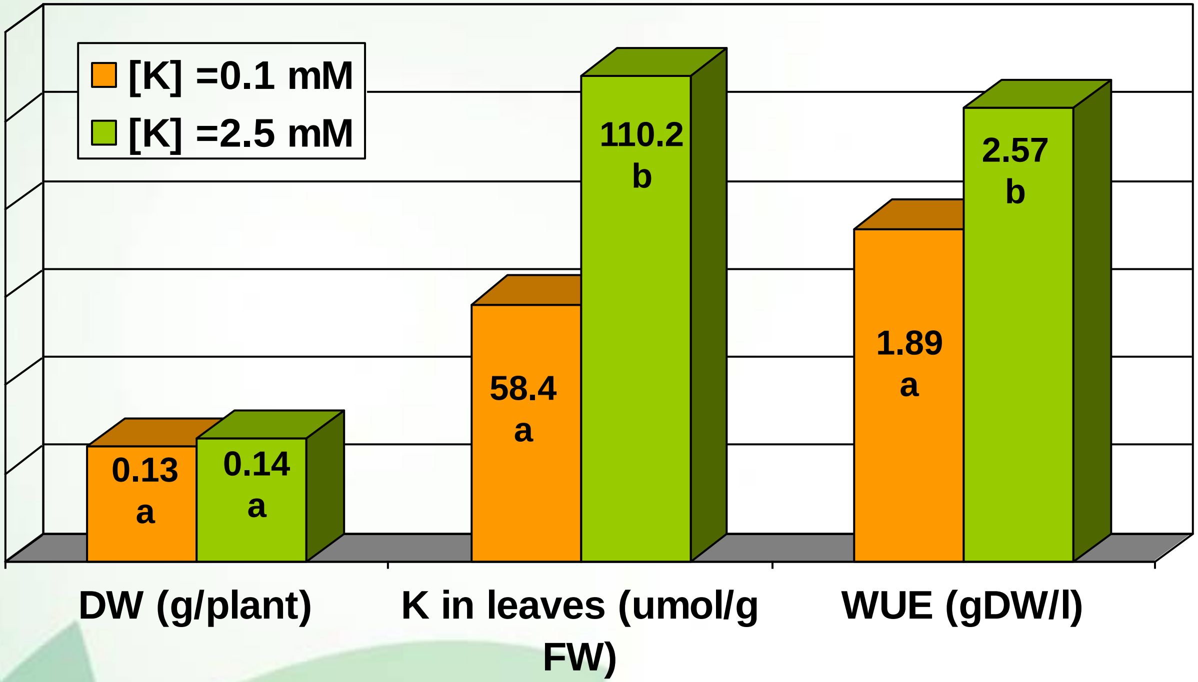
Potassium deficiency –
decrease Water Use Efficiency in sunflower plants



Plants were grown for 6 days in nutrient solution with 0.1 or 2.5 mM K^+

Fournier, Roldan, Sanches, Alexandre & Benlloch (2005)

Potassium deficiency decrease Water Use Efficiency

A similar pattern governs both crops

Olive trees (perennial, slow growing species) and in **Sunflower** (annual, fast growing species)

And other crops too:

- ✓ **Faba beans (Abdel-Wahab & Abd-Alla, 1995)**
- ✓ **Sugar cane (Sudama & al., 1998)**
- ✓ **Rice (Tiwari et al., 1998)**

PGR's are involved too in potassium management and stomatal functioning

Abscisic acid (ABA) has a special role in plant stress management.

- ❖ Increased ABA levels stimulate the release of K from the guard cells, resulting in stomatal closure.

- ❖ Ethylene is involved too.

Benlloch-Gonzalez, Arqero, Fournier, Barranco & Benlloch (2008)

Conclusion:

Under normal growing conditions –

The higher the K, the higher the WUE

The roles of Nitrate

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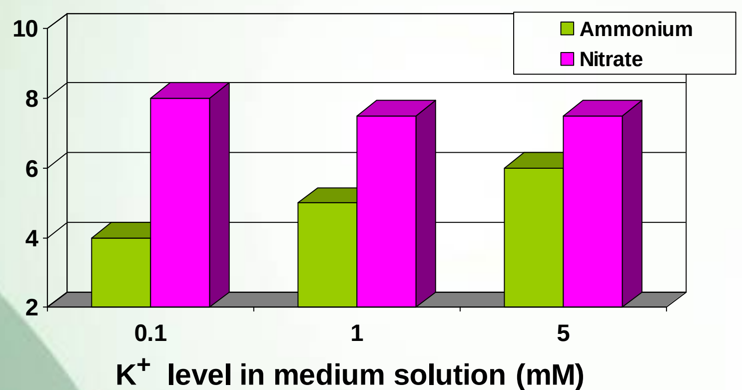
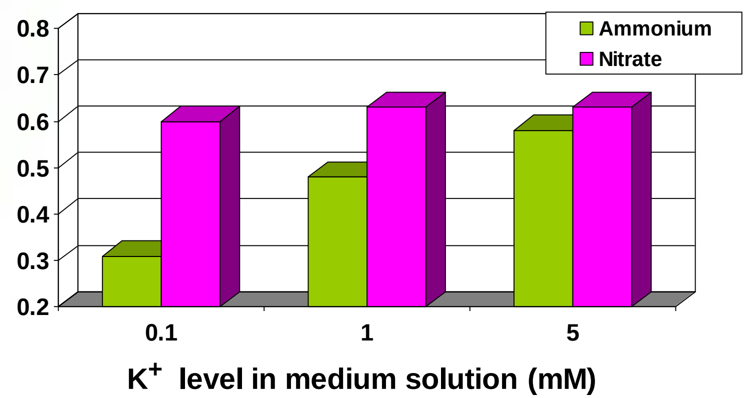
Nitrate & biomass management

Comparative effects of Nitrate and Ammonium on photosynthesis & biomass production in wheat

Photosynthesis
(mg CO2 / shoot / h)



Biomass
(g_{DM} / plant)



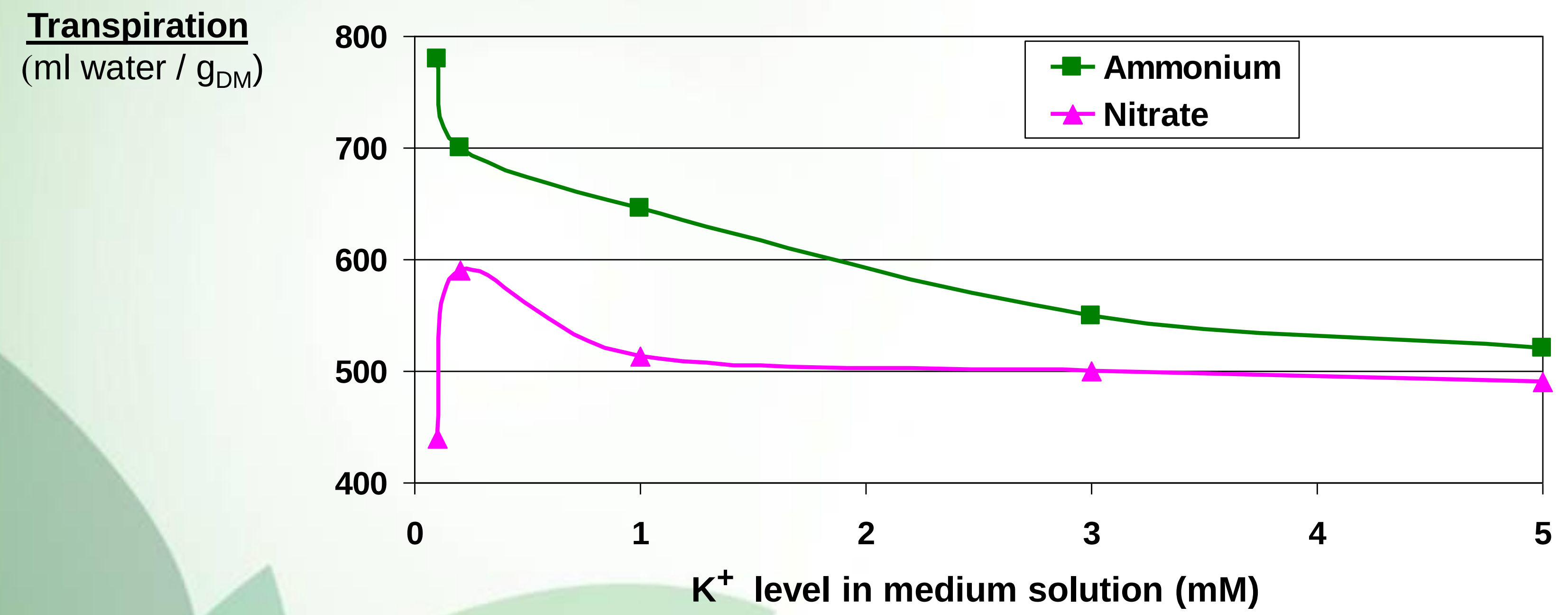
Conclusion:

Nitrate-nitrogen is markedly more efficient than ammonium-nitrogen, regarding production of dry matter, especially under K deficiency

Lips, Leidi, Silberbush, Soaresh & Lewis, 1990

Nitrate & water management

Comparative effects of Nitrate and Ammonium
on transpiration rate of wheat

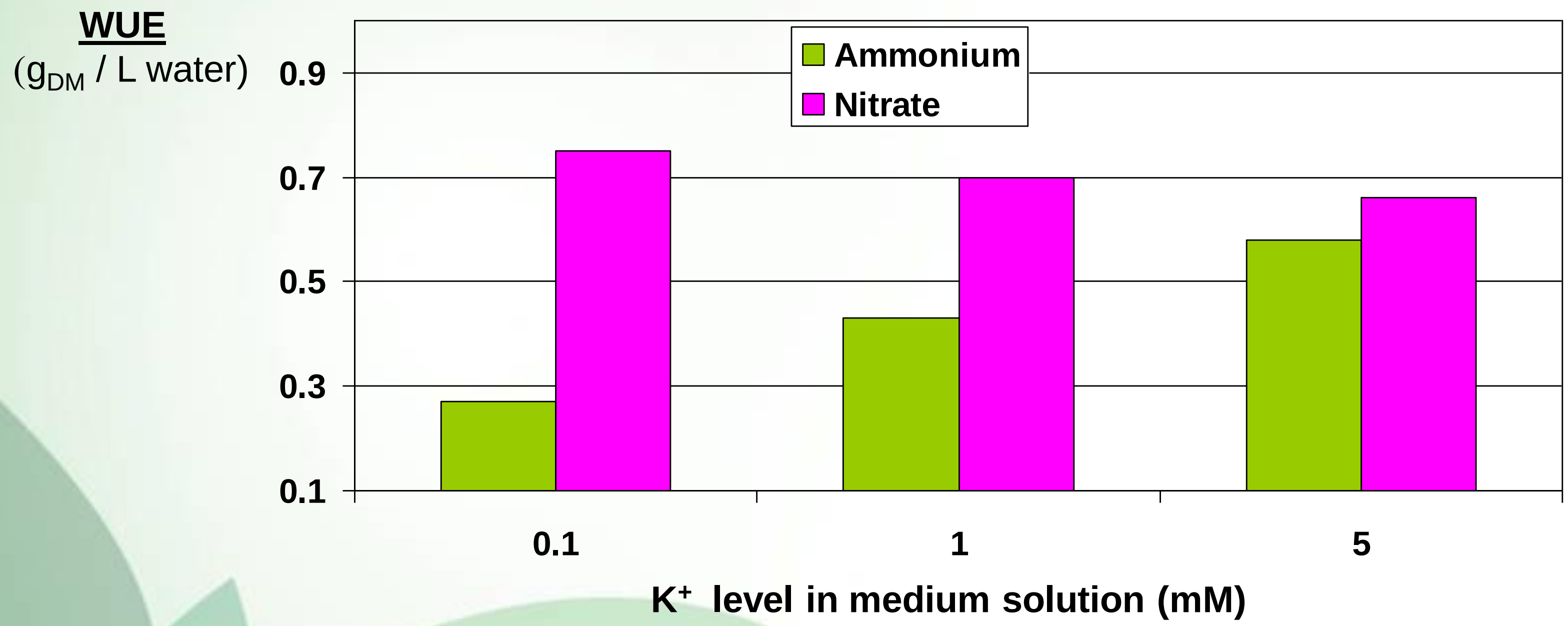


Nitrogen was applied as calcium-Nitrate or Ammonium-sulfate, @: 4 mM of N,
at various rates of K, as potassium sulfate. Wheat seedlings were grown for 21 days.

Lips, Leidi, Silberbush, Soaresh & Lewis, 1990

Nitrate & WUE

Effects of Nitrate and Ammonium on WUE in wheat



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Lips, Leidi, Silberbush, Soaresh & Lewis, 1990

Conclusion:

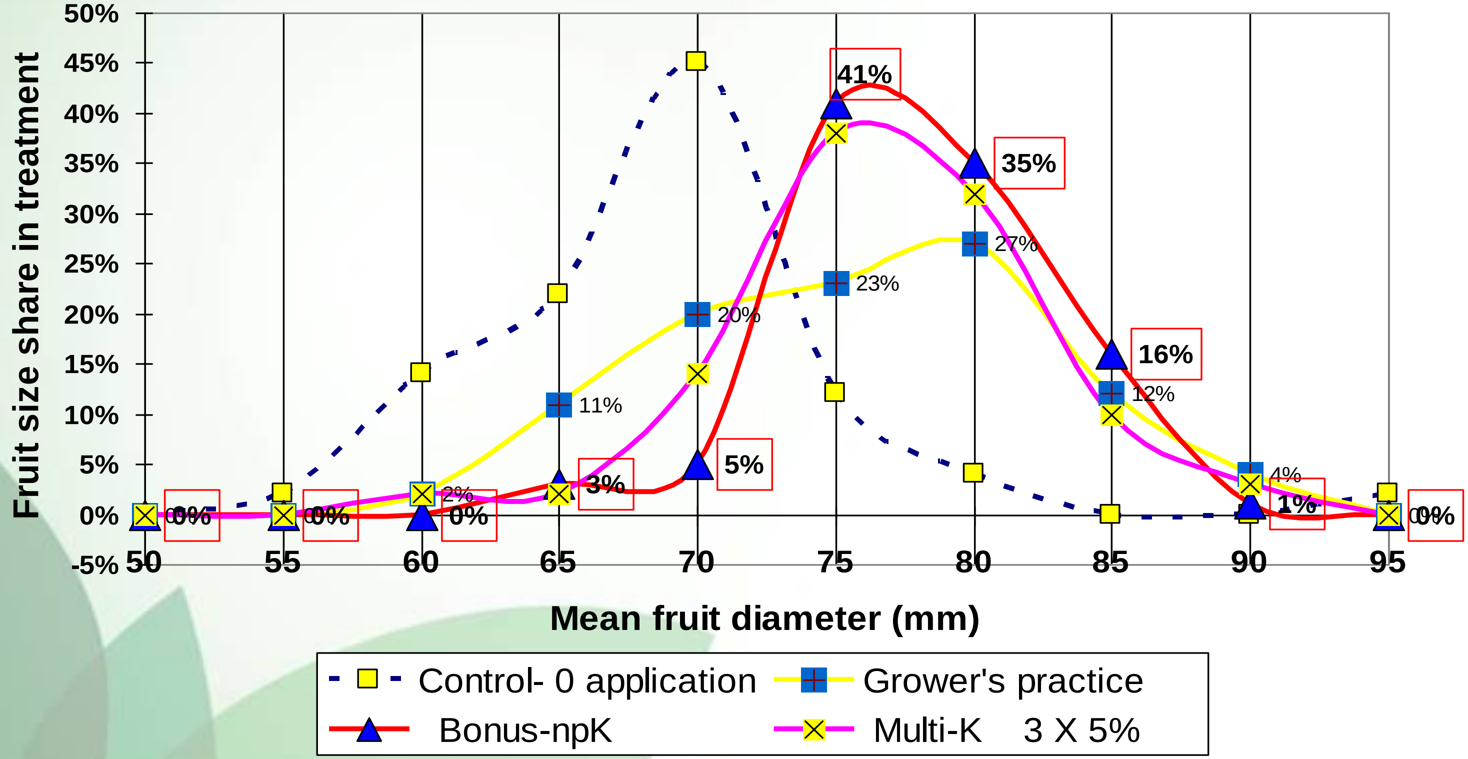
Under normal growing conditions –

The higher the Nitrate, the higher the WUE

The effect of

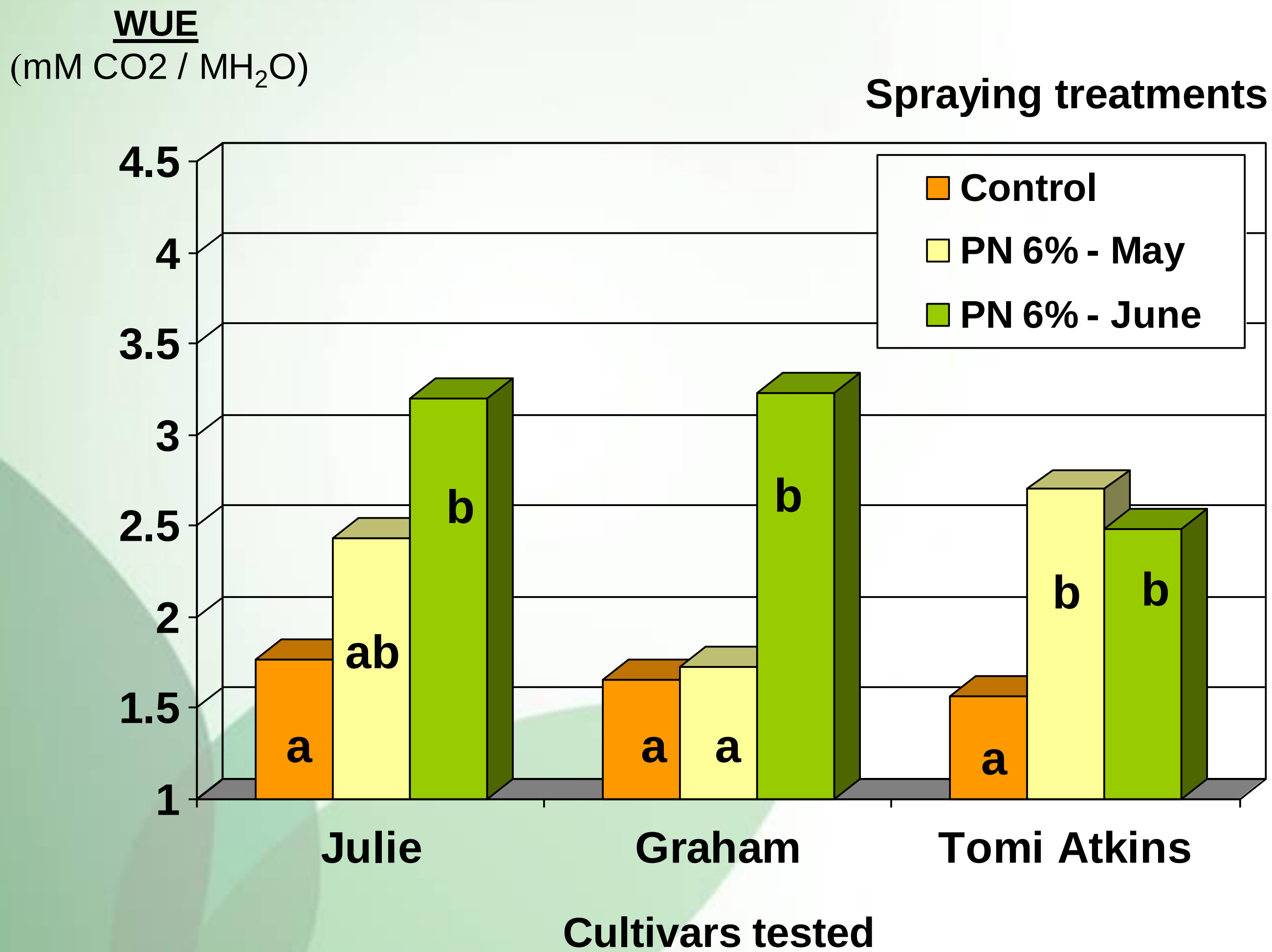
POTASSIUM NITRATE

The effect of potassium nitrate on size distribution of orange fruits



'*Jaffa'* oranges, in Israel, 2002

Increasing Mango trees productivity by spraying Potassium Nitrate, via the increase in WUE



Shongwe & Roberts-Nkrumah, Trinidad, 1996

Increased of WUE by nutrigation of Potassium Nitrate, in Tomatoes

N form (%) $(NO_3^- : NH_4^+)$	N (g/plant) Multi-K	N (g/plant) Amm. Nitrate	Yield (g/plant)	WUE mL water / g fresh fruit
100 : 0	6.3	0	2550*	23**
70 : 30	6.3	4.4	1980*	28**
63 : 37	6.3	8.7	1200*	29**
59 : 41	6.3	13.2	1000*	34**
100 : 0	12.6	0	3430*	23**

*** Significance at 0.1% probability; ** At 1% probability**

Kafkafi, Walerstein & Feigenbaum, 1971

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Potassium Nitrate
increases WUE

Hence:

Every m^3 of water
can produce more if combined with

Potassium Nitrate

The problem of man-made salinization

Severely salinated fields in central California

Irrigation-induced salinization

Country	Badly salinized as % of irrigated area
India	37 – 60
Iraq	50
Egypt	30
Pakistan	25
U.S.	23
Australia	20
China	15
Pakistan	14
Israel	13

Washington State University (2001)

The mechanism of salinity damage

Most frequent ions involved in salinity situations are:

- **Anions**: **Cl^-** , **SO_4^{-2}**, **B^-**
- **Cations**: **Na^+**

- **Elevated EC**
- **Specific toxicity**

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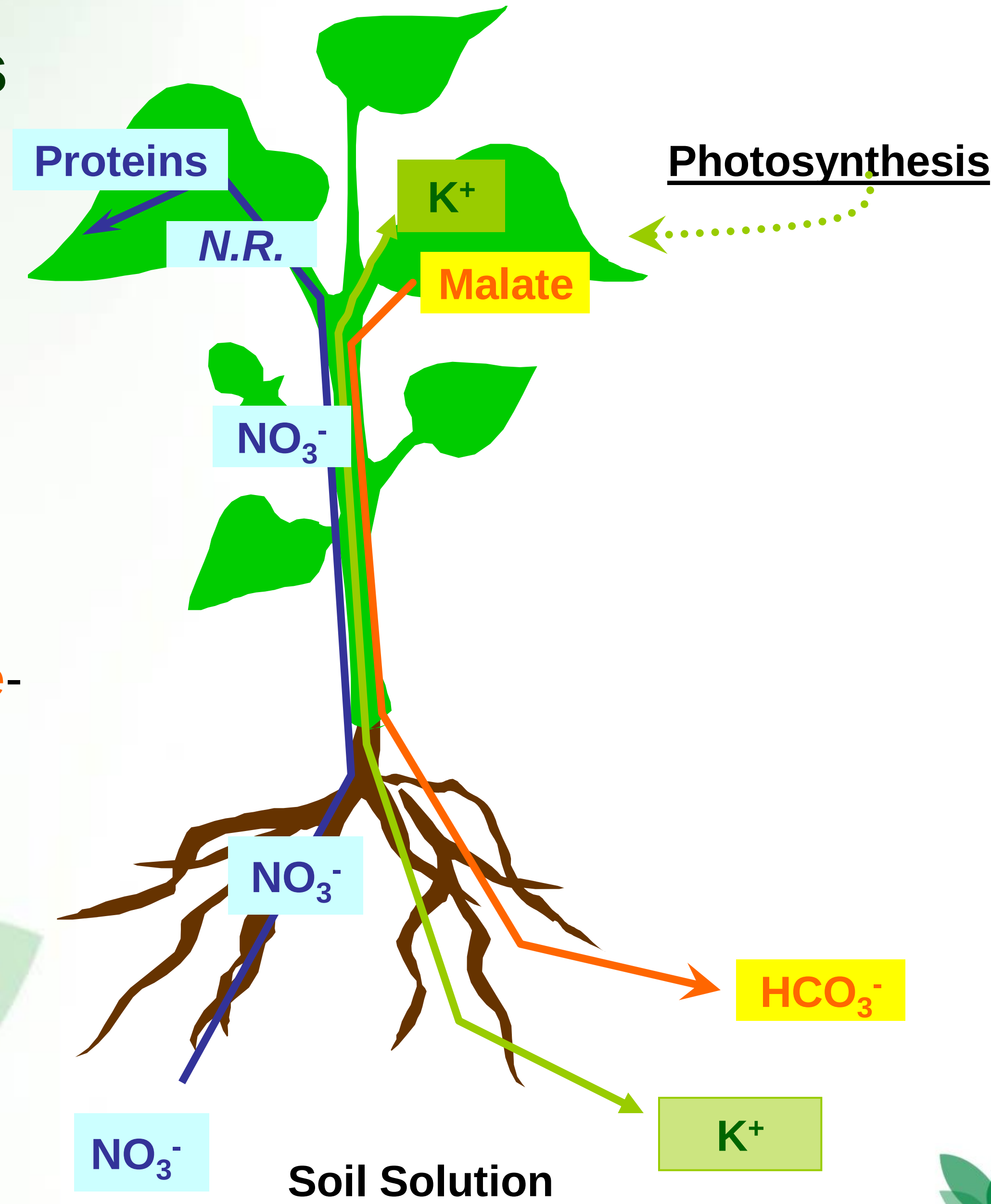
Normal metabolism at non-saline conditions in soil

A simplified model

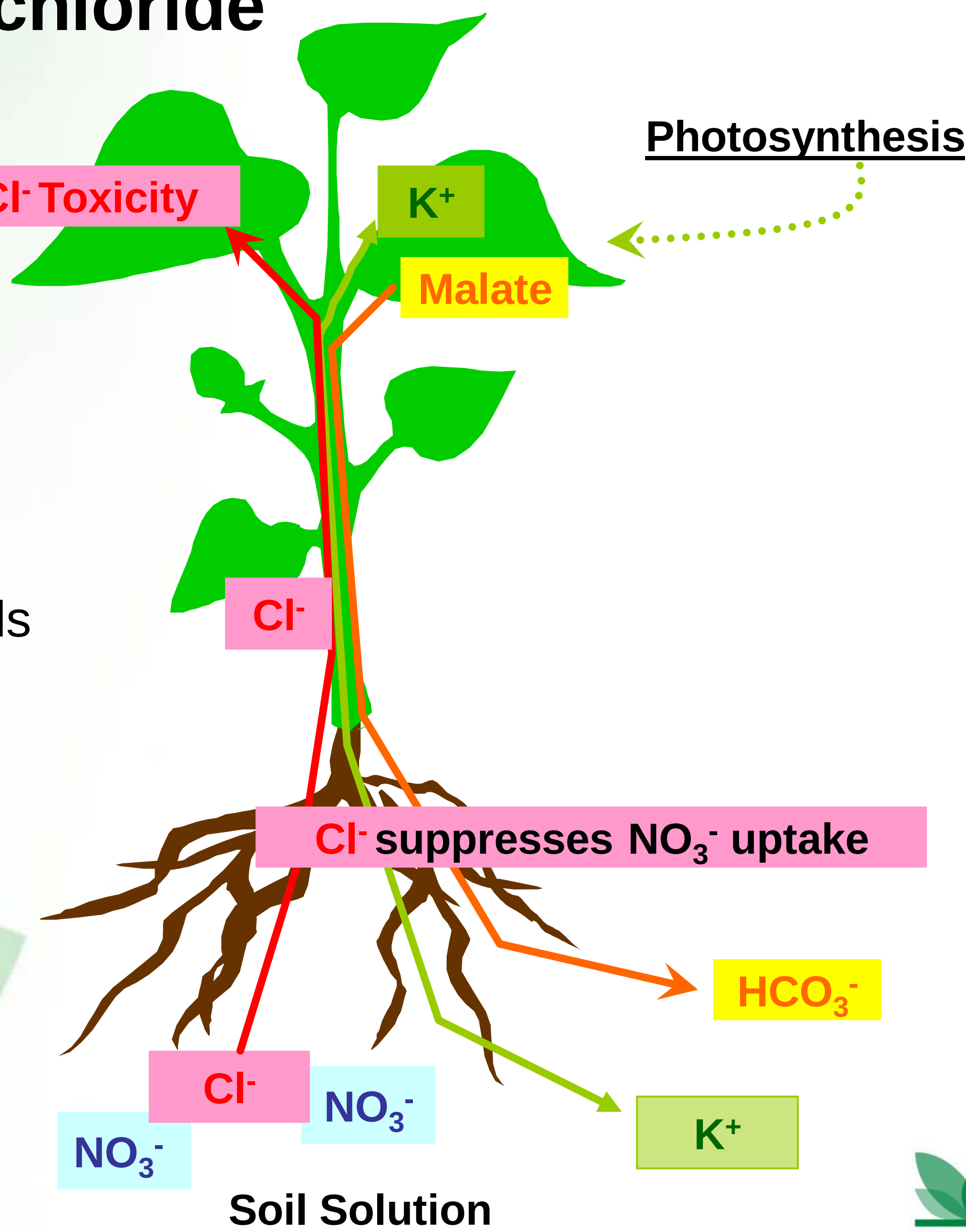
The K^+ shuttle facilitates NO_3^- movement upwards, and malate-downwards.
Proteins are produced.
Roots are well nourished



After Ben-Asher and Pacardo, 1997

A simplified model of chloride accumulation

in leaf-tips at excessive Cl^- in soil



The K^+ shuttle moves Cl- upwards and malate downwards.

Protein production is halted

After Ben-Asher and Pacardo, 1997

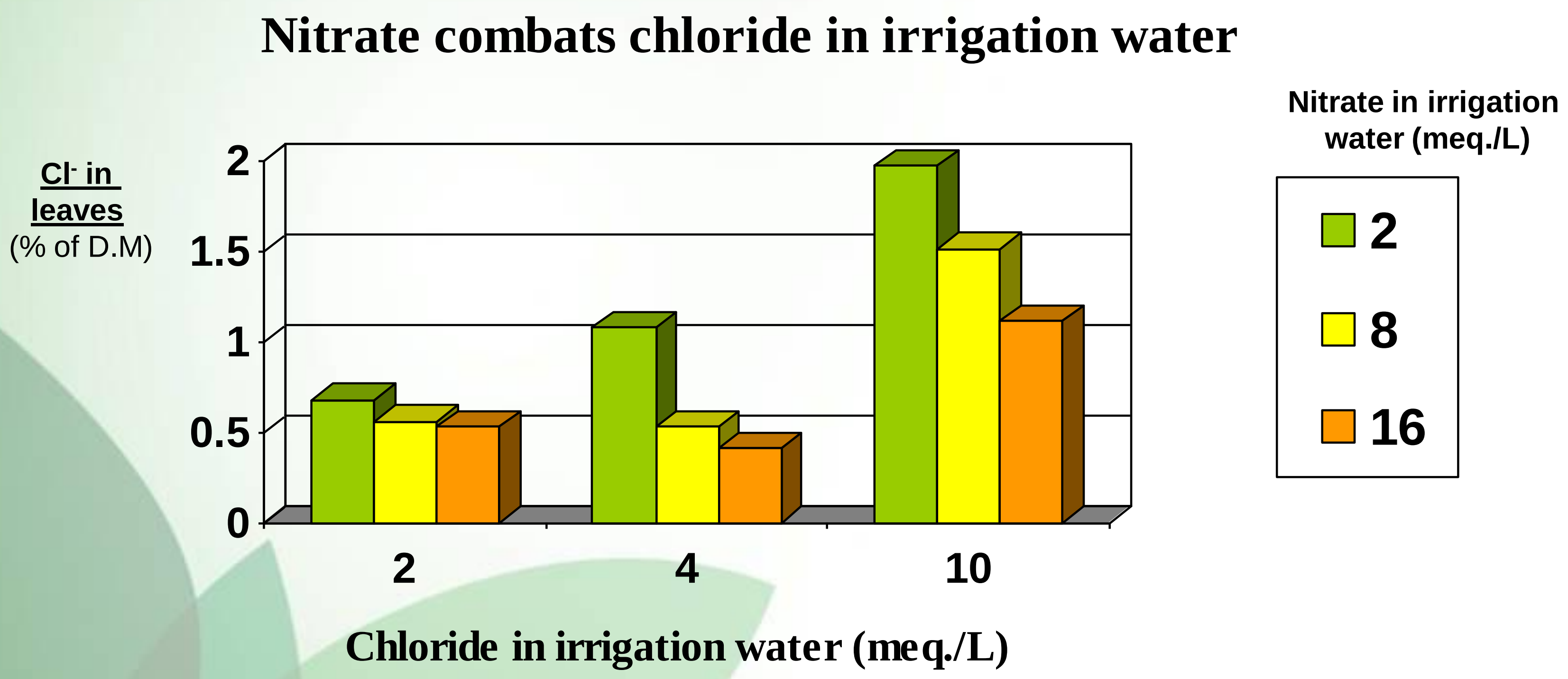
The effect of <u>Nitrate</u> in reducing Cl^- absorption

Antagonistic effect of Nitrate on chloride in AVOCADO

Relieving chloride toxicity in avocado by increasing nitrate concentration in irrigation water containing 16 mM Cl

Bar, Kafkafi & Lahav, 1987

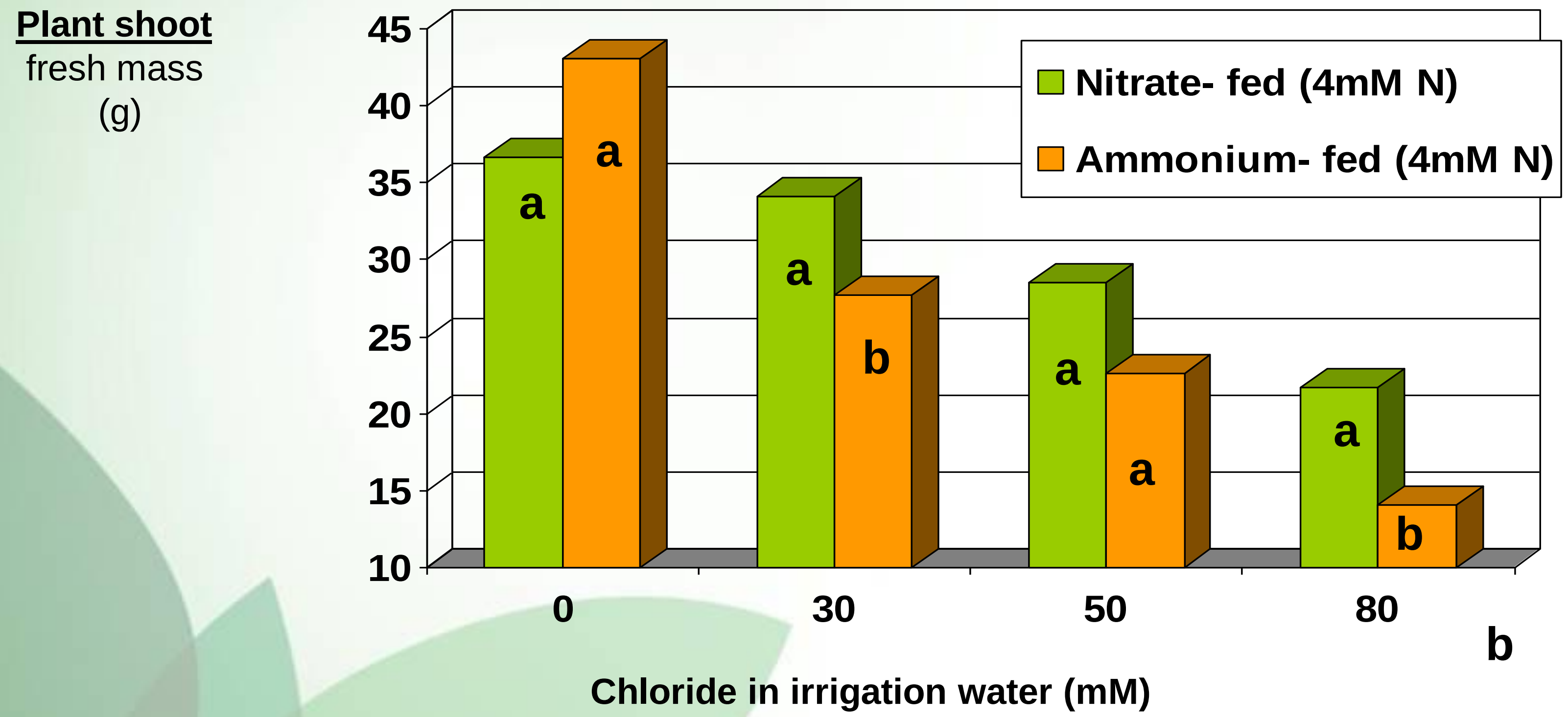
Antagonistic effect of <u>Nitrate</u> on chloride in AVOCADO



Avocado, ('*Schmidt*' Mex. salinity-sensitive) rootstock, Israel

Bar, Kafkafi & Lahav, 1987

Antagonistic effect of Nitrate on chloride in MAIZE



Lewis, Leidi & Lips, 1989

The importance of K / Na ratio in plant metabolism

The importance of K / Na

Na's toxicity **stems from its competition with K**

for enzymatic binding sites ***(60 of them, remember?)***

High K / Na ratio **in the plant**

is more important than maintaining

low Na concentration

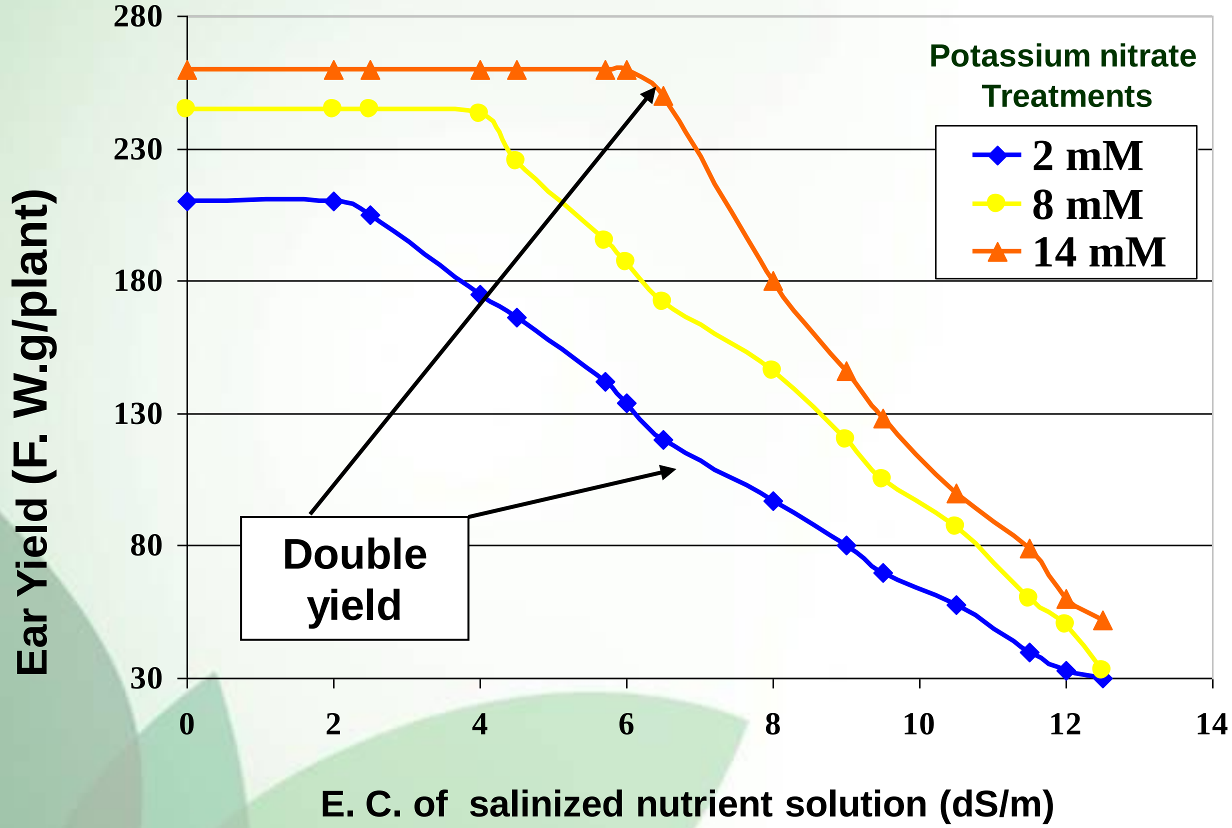
The effect of

Potassium Nitrate

in increasing biomass production

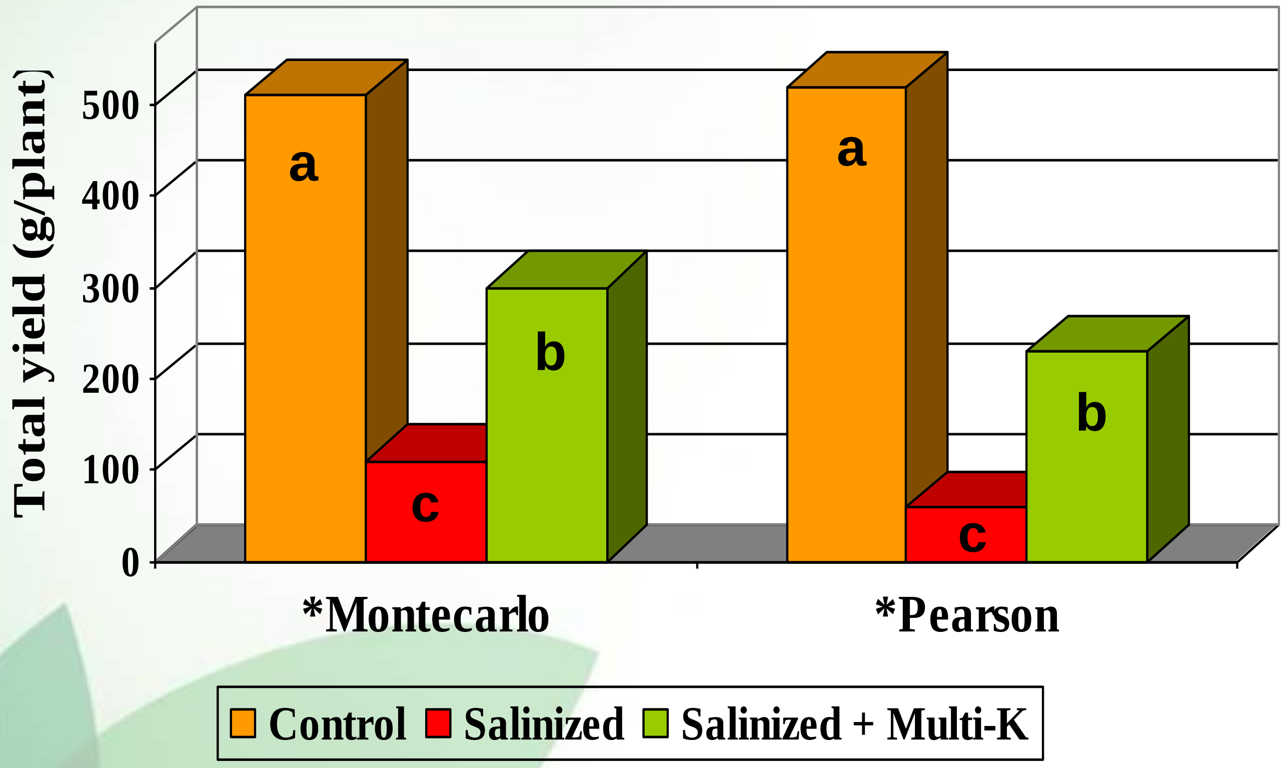
under salinity conditions

Effect of salinity and Potassium Nitrate on yield of Sweet Corn *(cv. Jubilee)*



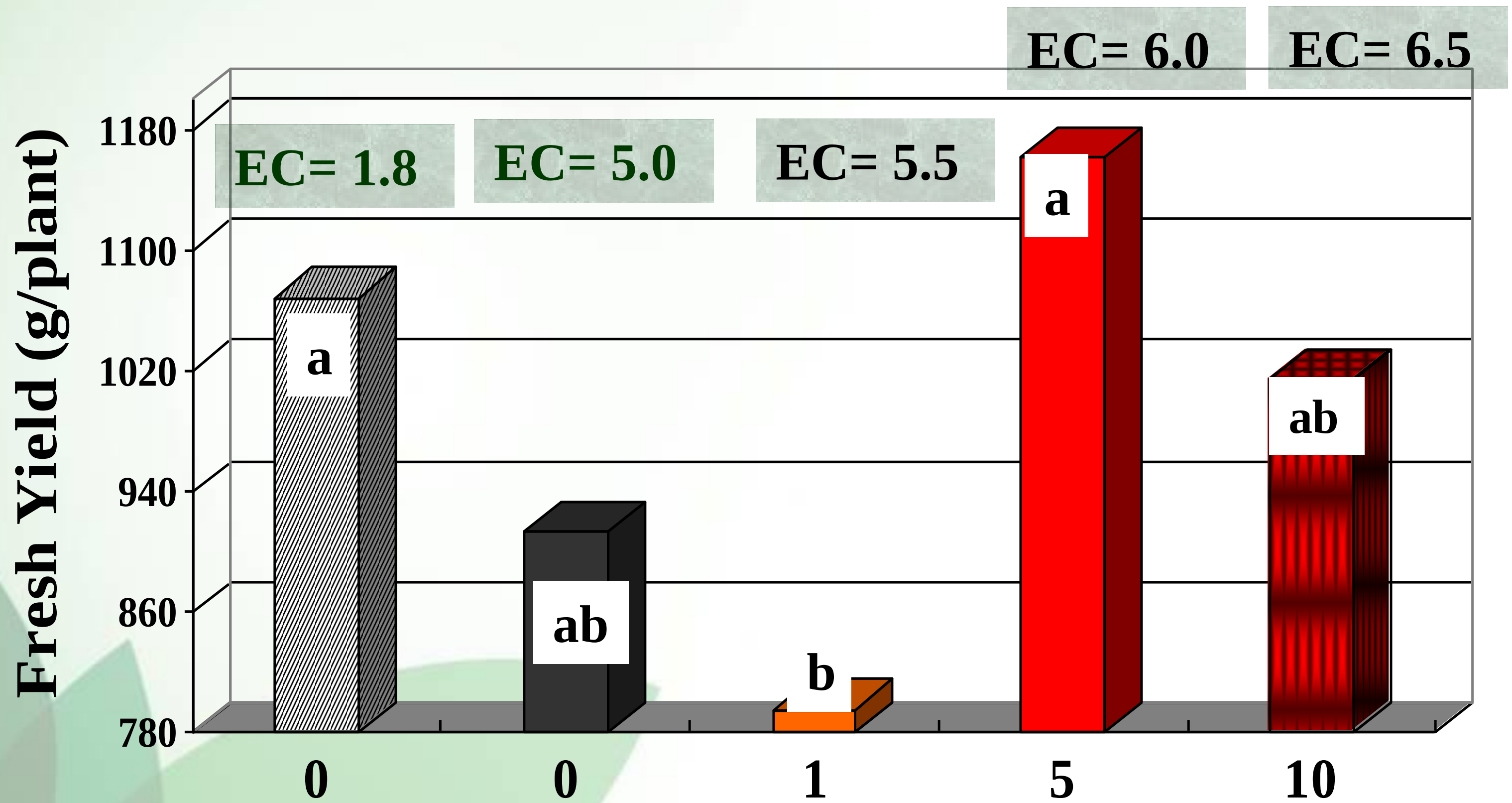
Imas & Feigin, 1995. Israel

Potassium Nitrate reverses the adverse effects of salinity on Greenhouse TOMATOES



Satti et Al. 1994

Potassium Nitrate increases fresh yield in greenhouse
CHINESE CABBAGE *(cv. Kazumi)* under salinity



PN rate (mM)

Data collected at 55 D.A.T

Feigin et Al., 1990, Israel

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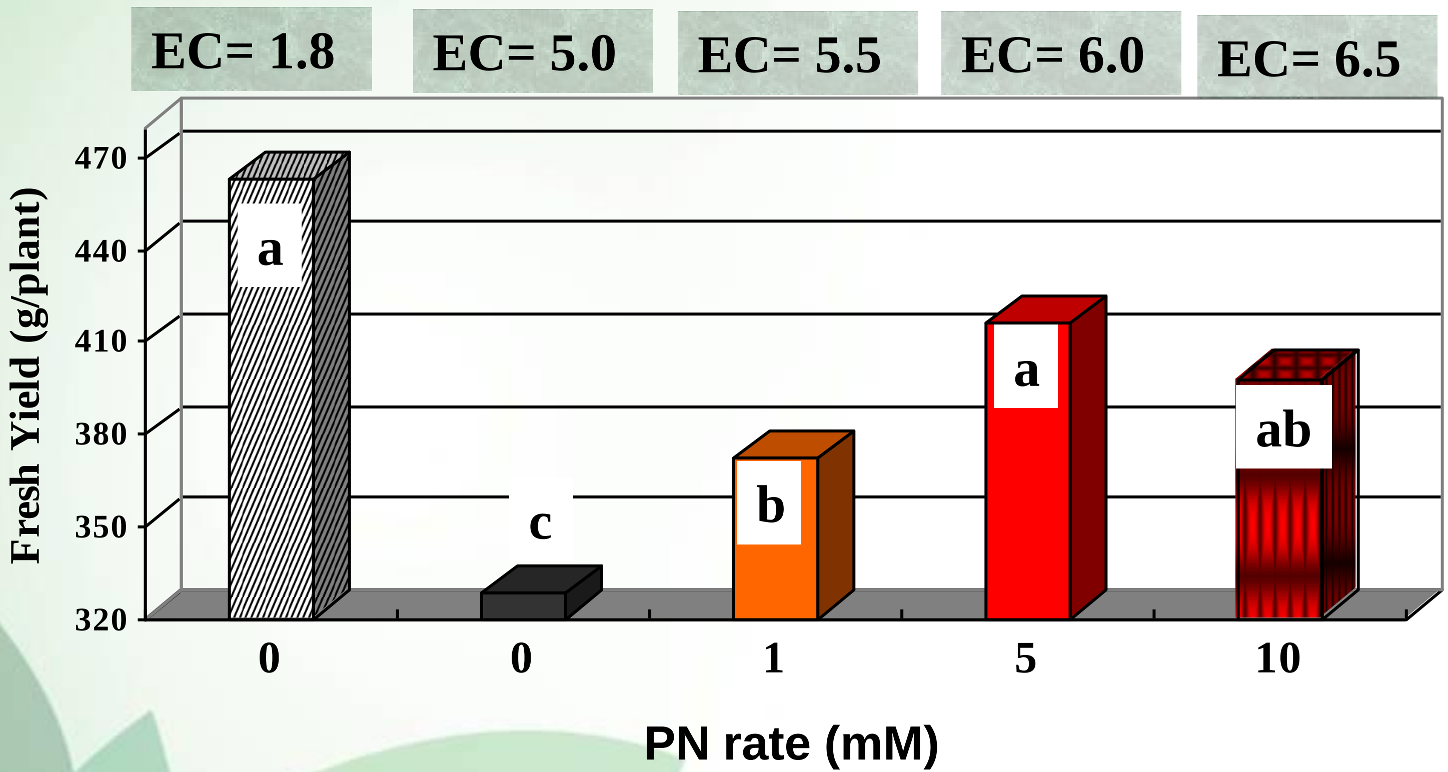
Potassium Nitrate increases salinity resistance in greenhouse LETTUCE (cv. *Salinas*) under salinity



Data collected at 63 D.A.T

Feigin et Al., 1990, Israel

Under normal growing conditions
a modest application of Potassium Nitrate,
enables 10-35% higher harvested produce
from a given water quota

Under salinity conditions
a modest application of Potassium Nitrate
enables maintaining harvested produce
in spite of elevated EC values

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