13th IPI-CAU-ISSAS International Symposium

The role of potassium in plant biotic and abiotic stresses

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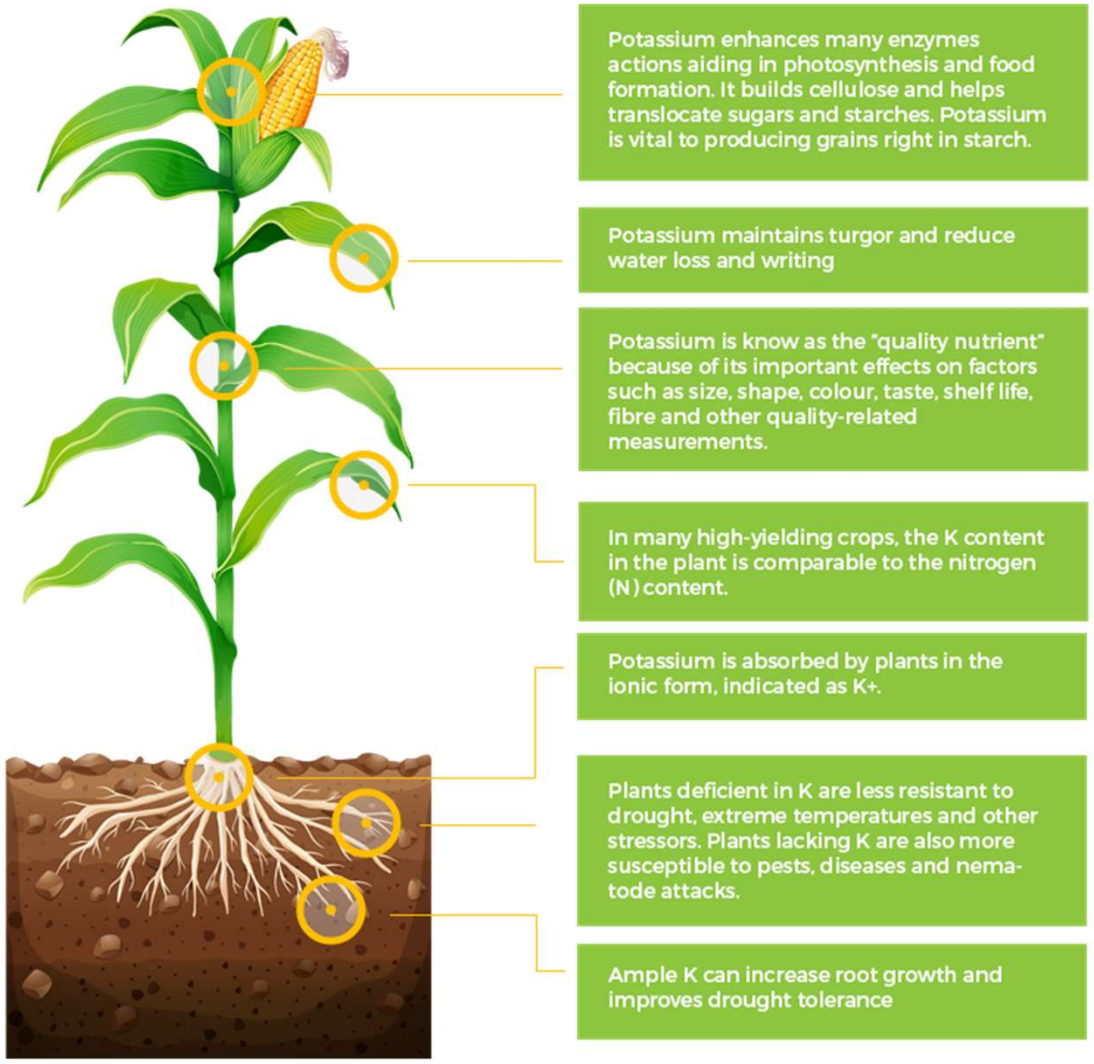
The function of K in higher plants



K supply can increase the tolerance of plants to biotic and abiotic stresses.

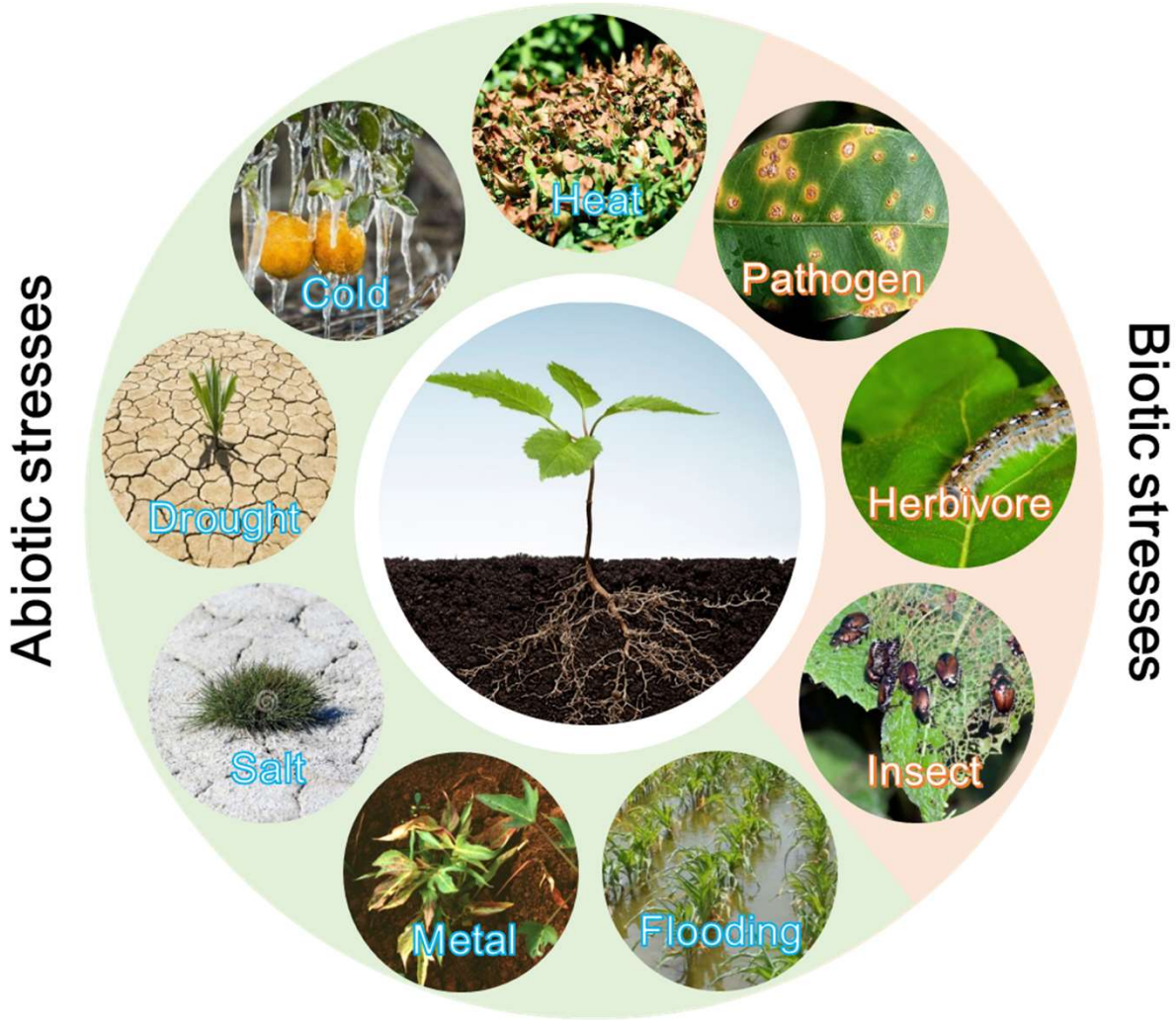
(ETE.FERT, http://www.etekin.com/en/type-product/fertilisers/why-fert/)

K deficiency symptoms in crops

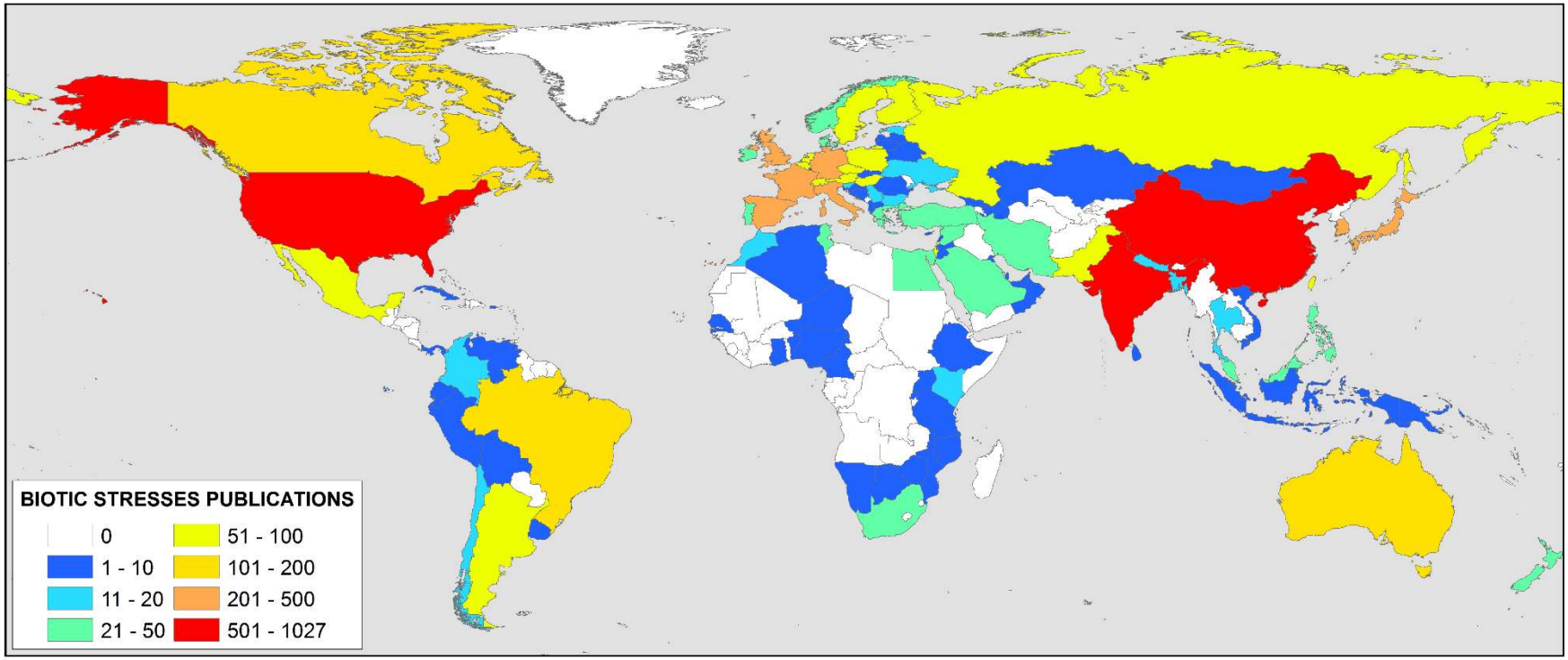
(Zörb et al., 2014, Journal of Plant Physiology)

Biotic and abiotic stresses in plants

Agricultural production continues to be constrained by a number of biotic and abiotic factors that can significantly reduce crop yield and quality.



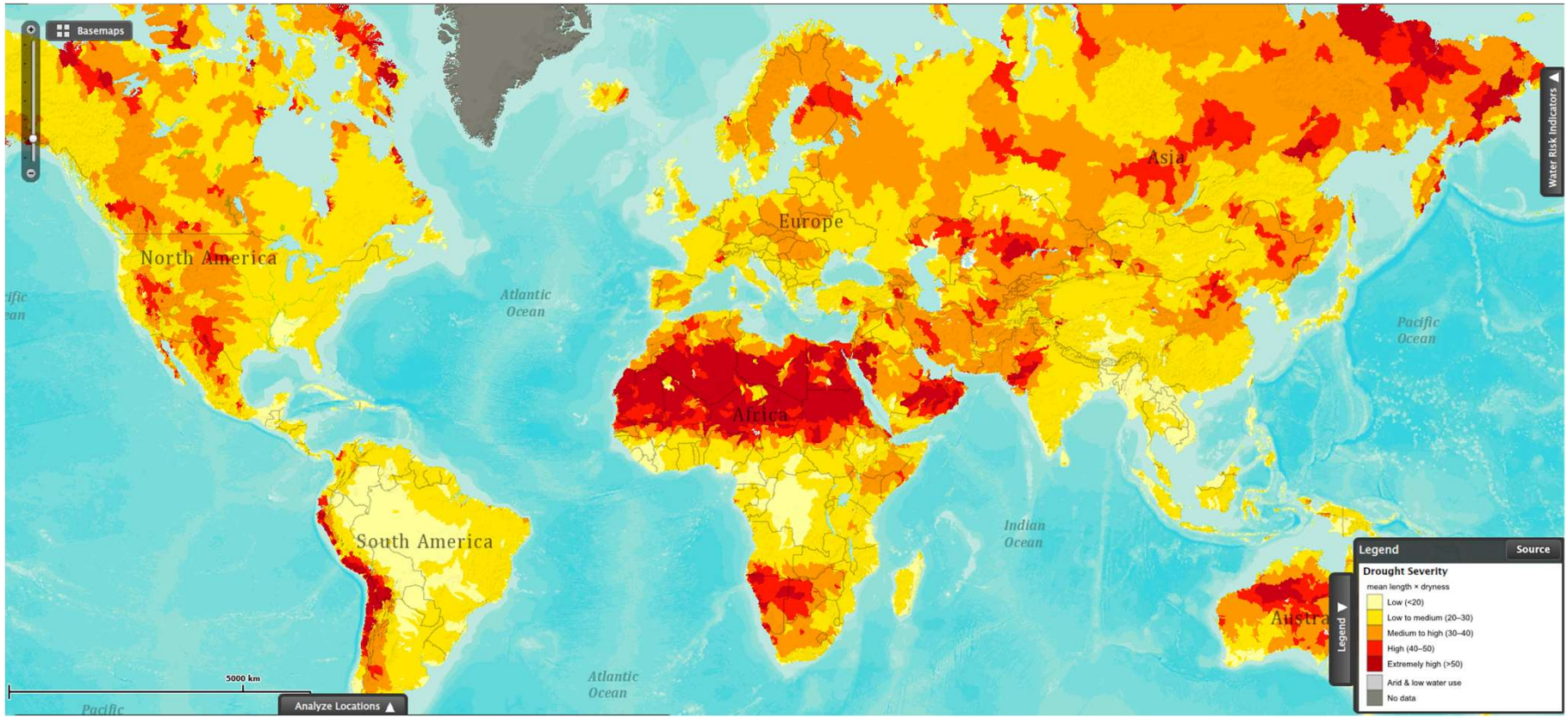
Biotic stresses in plants



(Gimenez et al., 2018, Sustainability)

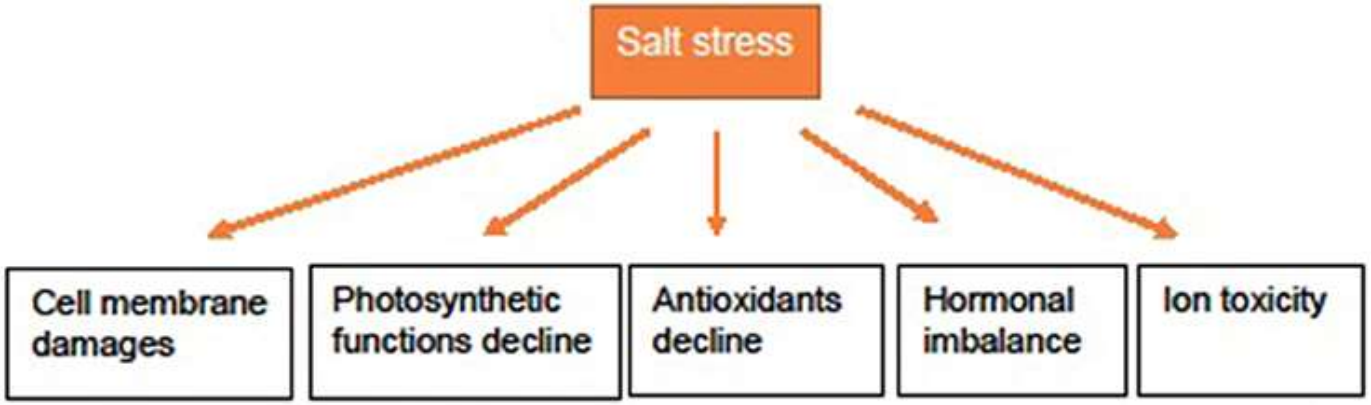
Abiotic stresses in plants Drought

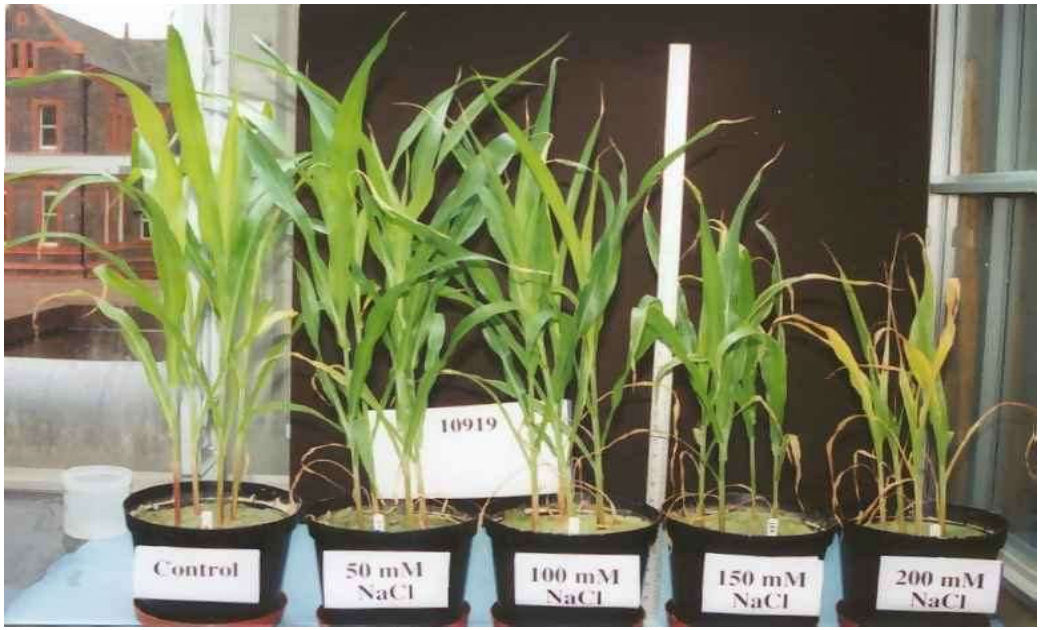
Globe drought



(Source: GLOBALIST)

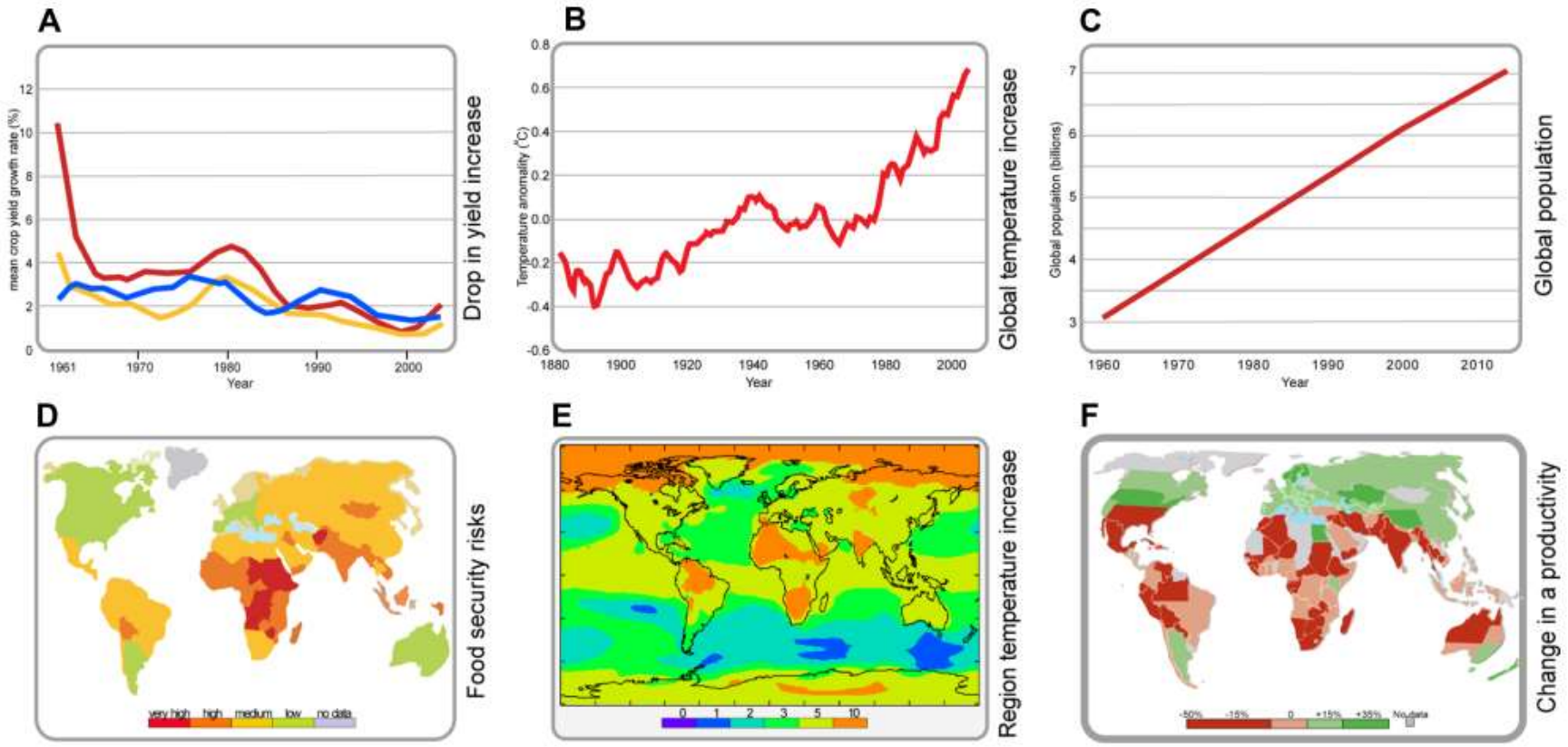
Abiotic stresses in plants Salt





https://www.liverpool.ac.uk/~sd21/stress/salt.htm

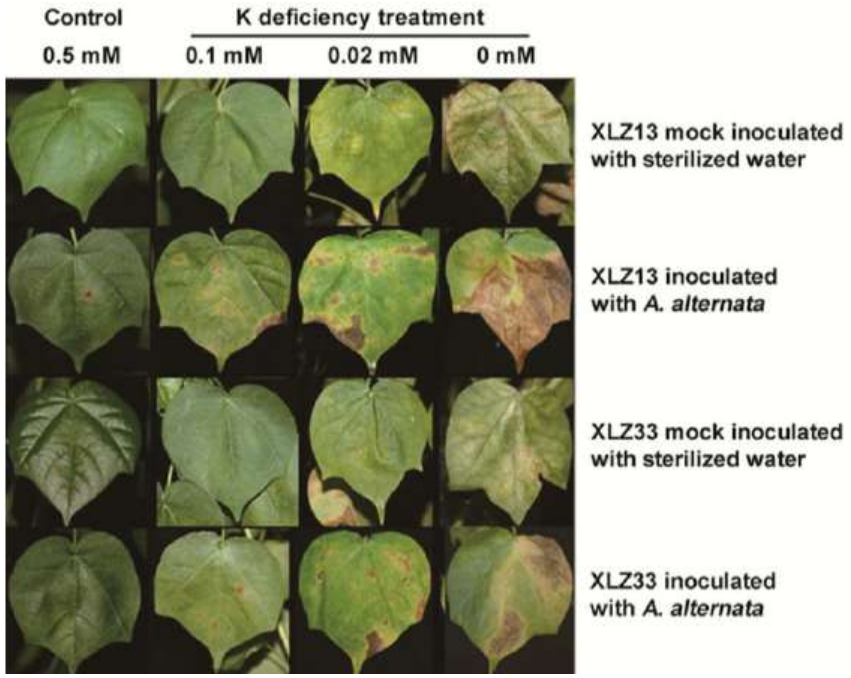
Abiotic stresses in plants Temperature



Global temperature and population trends

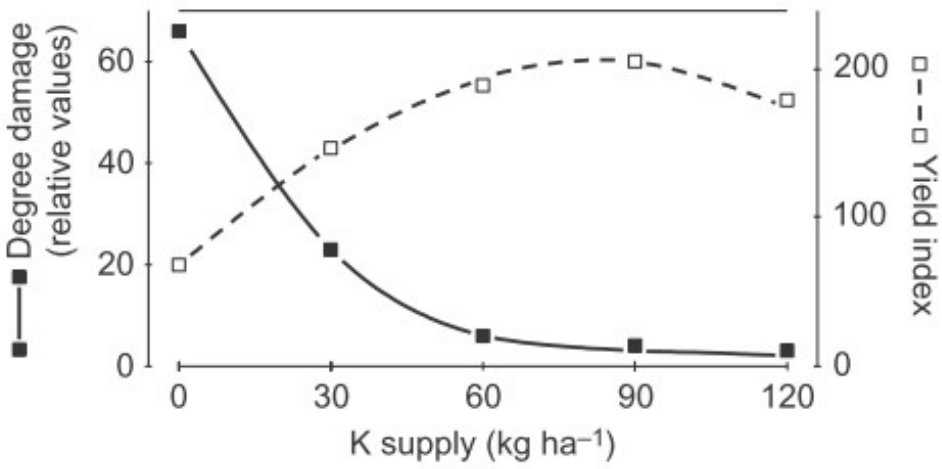
(Bita and Gerats, 2013, Frontiers in Plant Science)

K and biotic stresses



Cotton

(Zhao et al., 2013, Australian Journal of Crop Science)



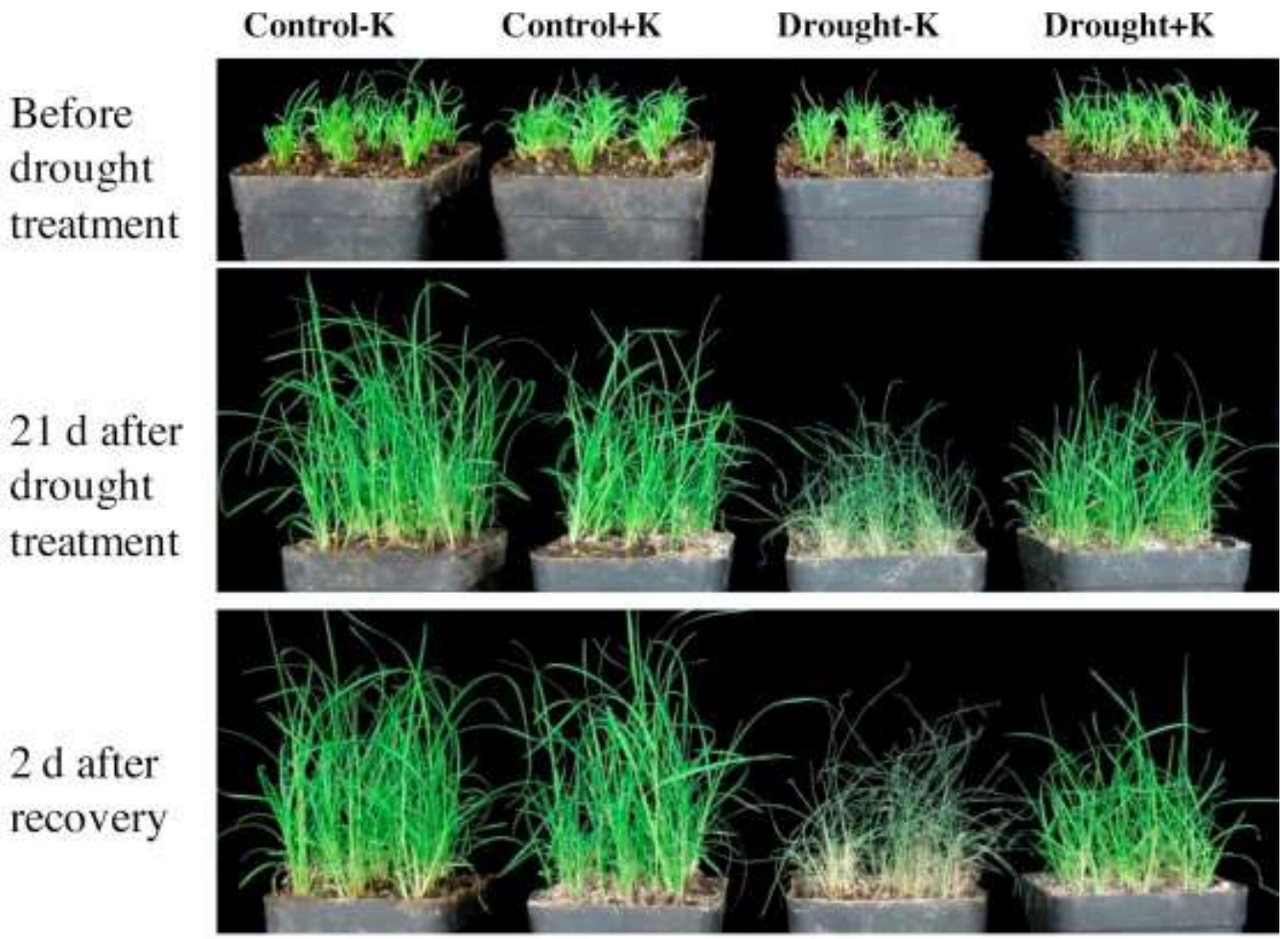
Rice

(Marschner, 2012)

Diseases	Fungi	Bacteria	Viruses
Cases	155	23	15
Increase	23	5	4
Decrease	110	18	9
No effect	22	0	2

(Prabhu et al., 2007)

K and abiotic stresses Drought

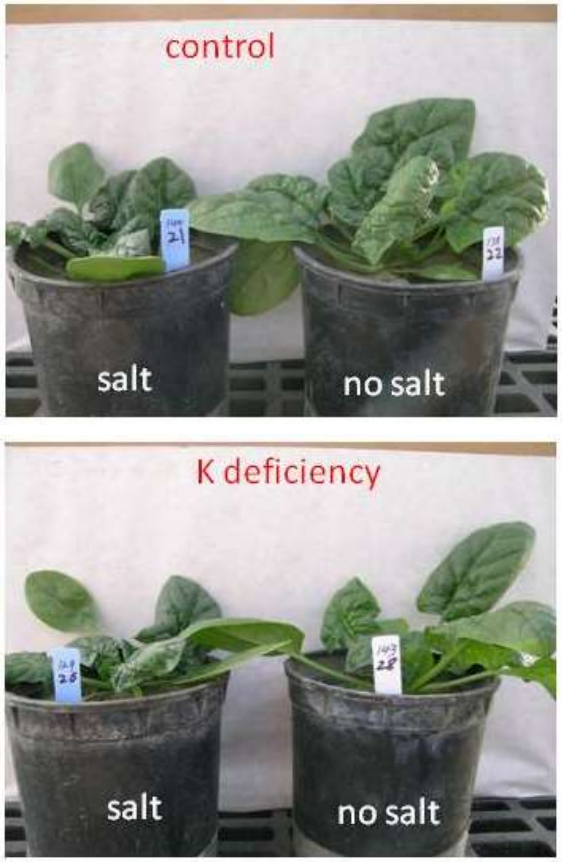


Bermudagrass

(Liu et al., 2015, Scientia Horticulturae)

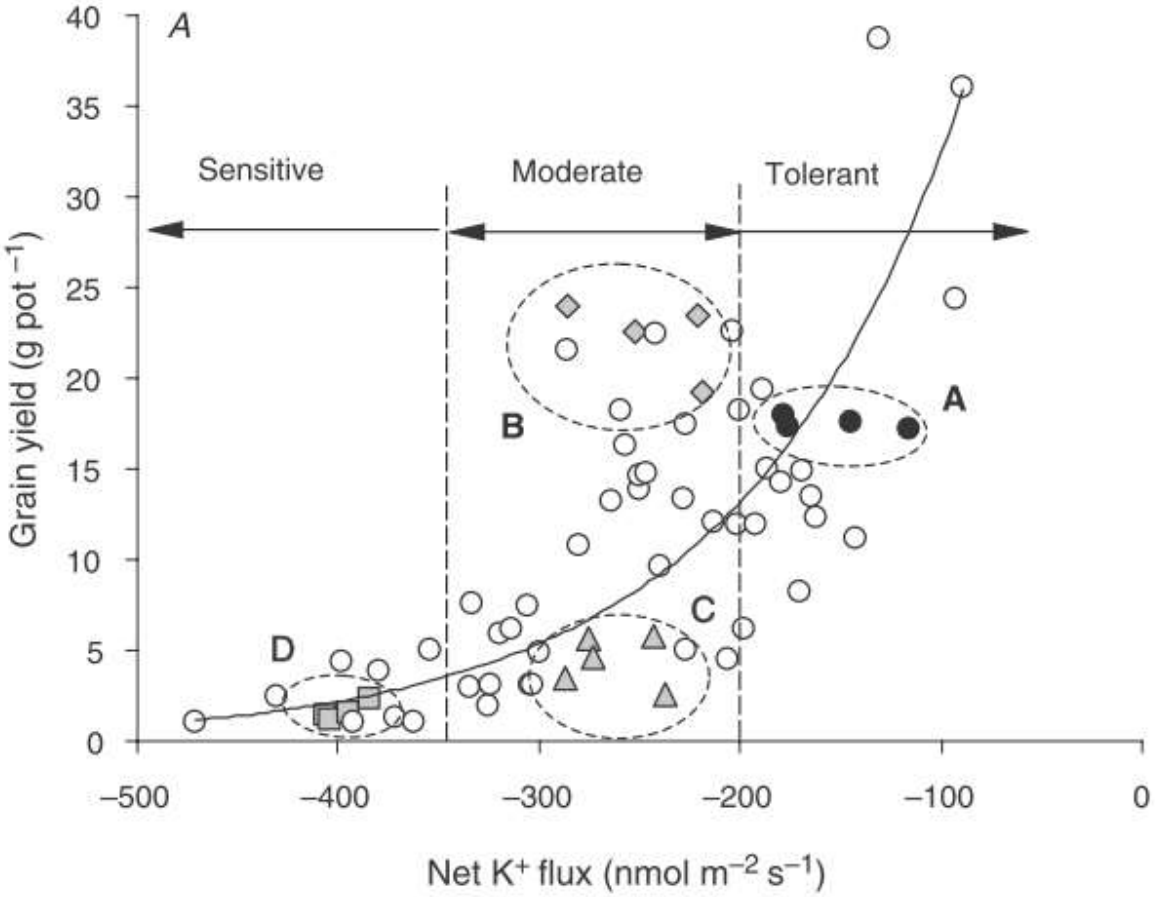
K and abiotic stresses Salt

Spinach



https://phys.org/news/2016-03-effects-salinity-nutrient-deficiency-spinach.html

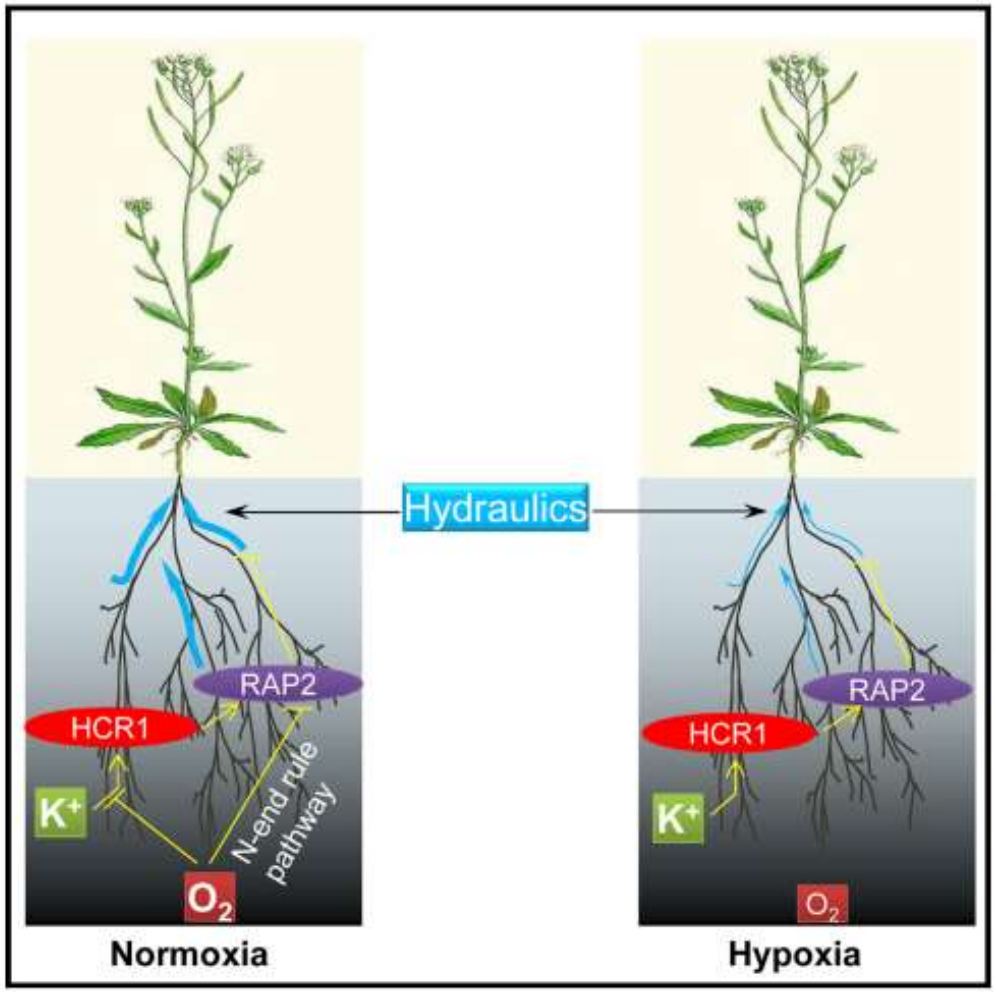
Correlation between barley grain yield and NaCl-induced net K^+ flux

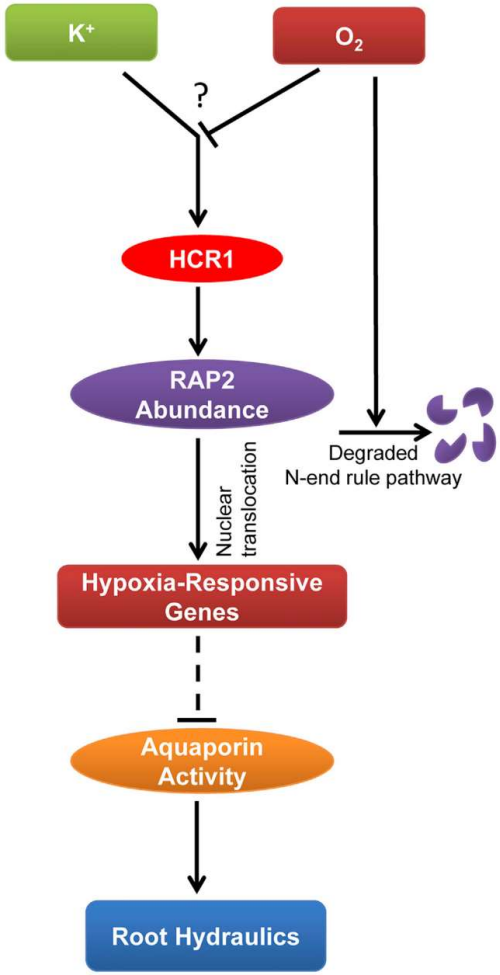


(Chen et al., 2007, Functional Plant Biology)

K and abiotic stresses Flooding

A potassium-dependent oxygen sensing pathway regulates plant root hydraulics allows plants to survive flooding.





(Shahzad et al., 2016, Cell)

Plant biotic and abiotic stresses regulated by K (meta-analysis)

Year: 2000-2019

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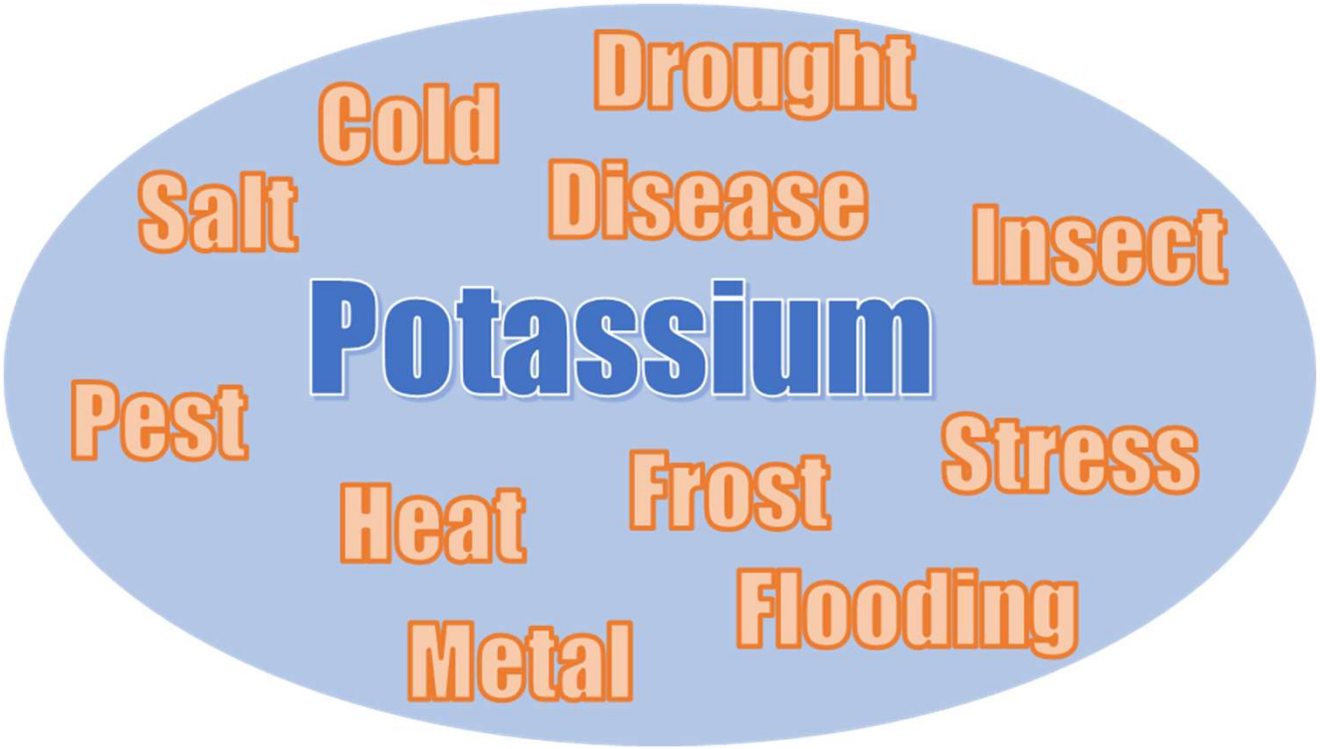


Plant biotic and abiotic stresses regulated by K (meta-analysis)

Dicot (17)


Asteraceae


Leguminosae


Cucurbitaceae


Chenopodiaceae


Oleaceae


Rubiaceae


Apiaceae


Araliaceae


Urticaceae


Rosaceae


Liliaceae


Solanaceae


Brassicaceae


Myrtaceae


Rutaceae


Malvaceae

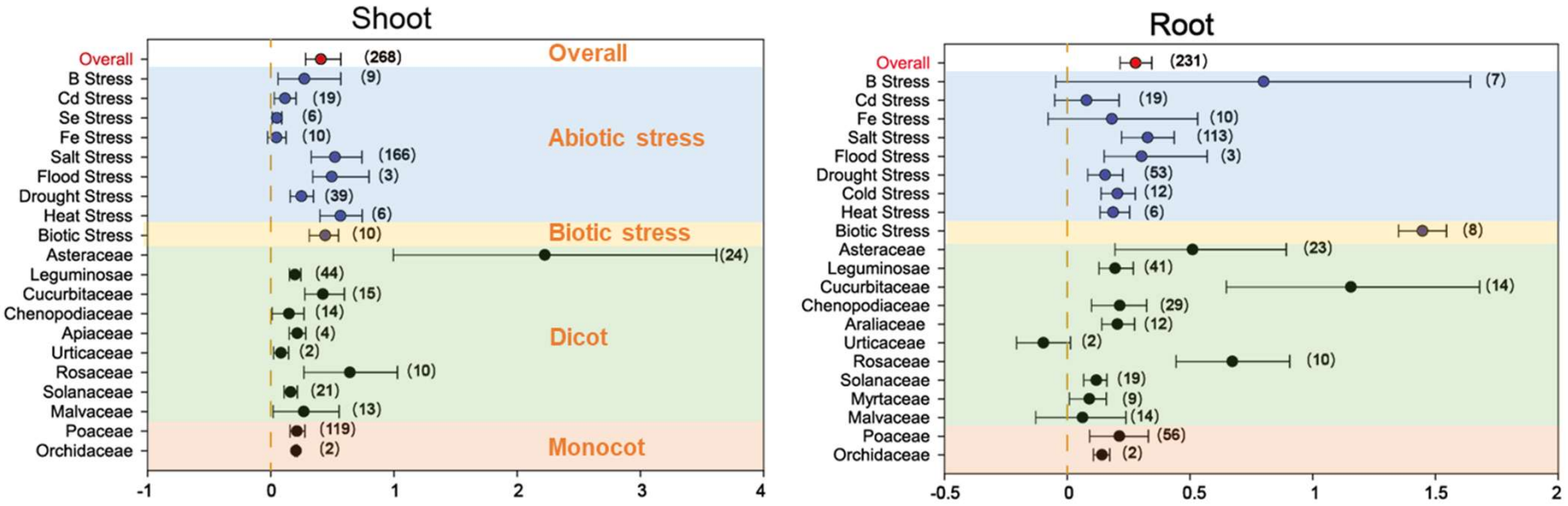

Vitaceae

Monocot (2)


Poaceae


Orchidaceae

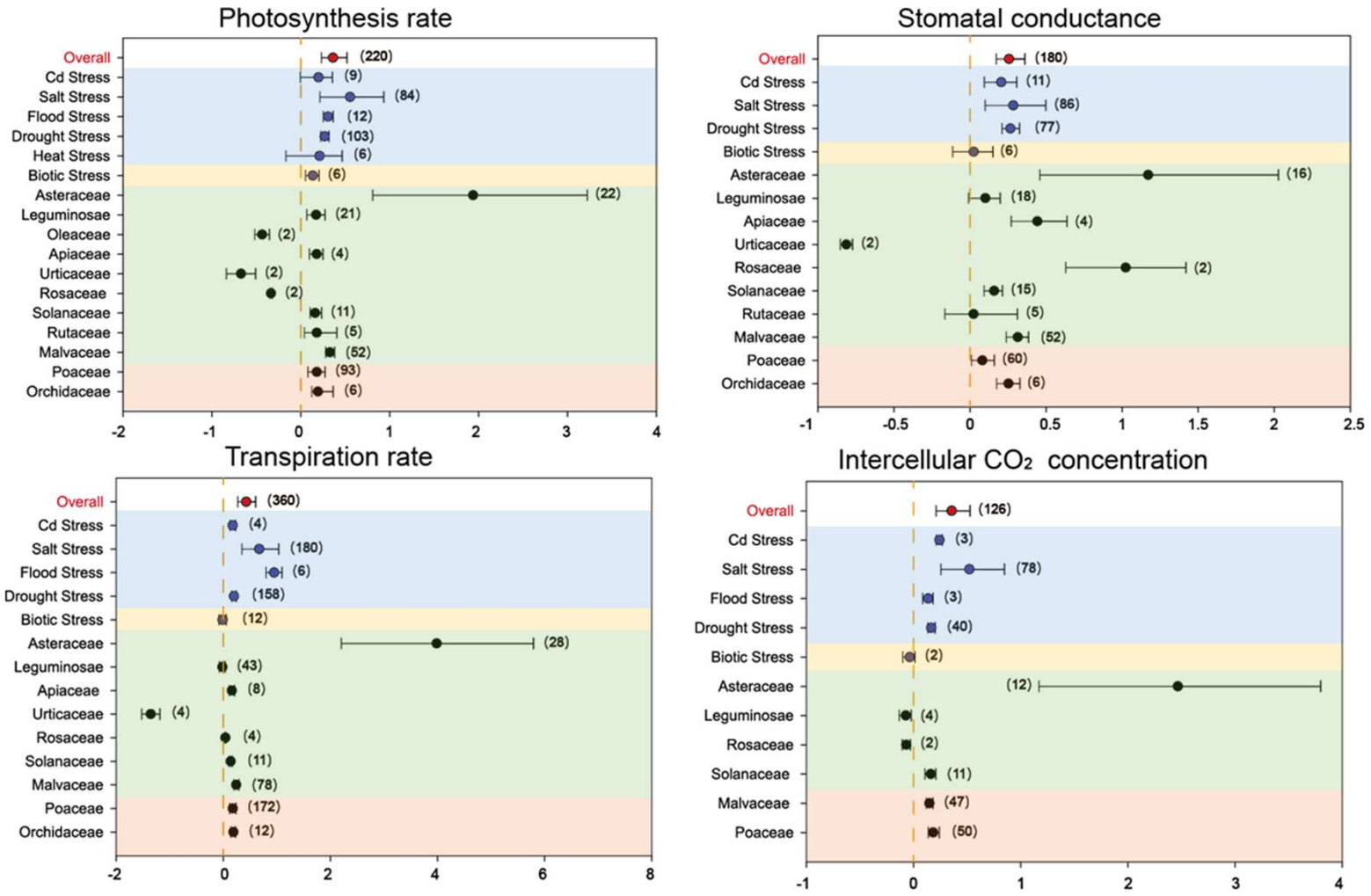
Plant growth regulated by K under stresses



- Shoot and root biomass were significantly increased by K supply under salt, flood, drought, heat and biotic stress conditions.
- Shoot and root biomass in both dicot and monocot plants were markedly increased by K application.

(Zhu et al., unpublished)

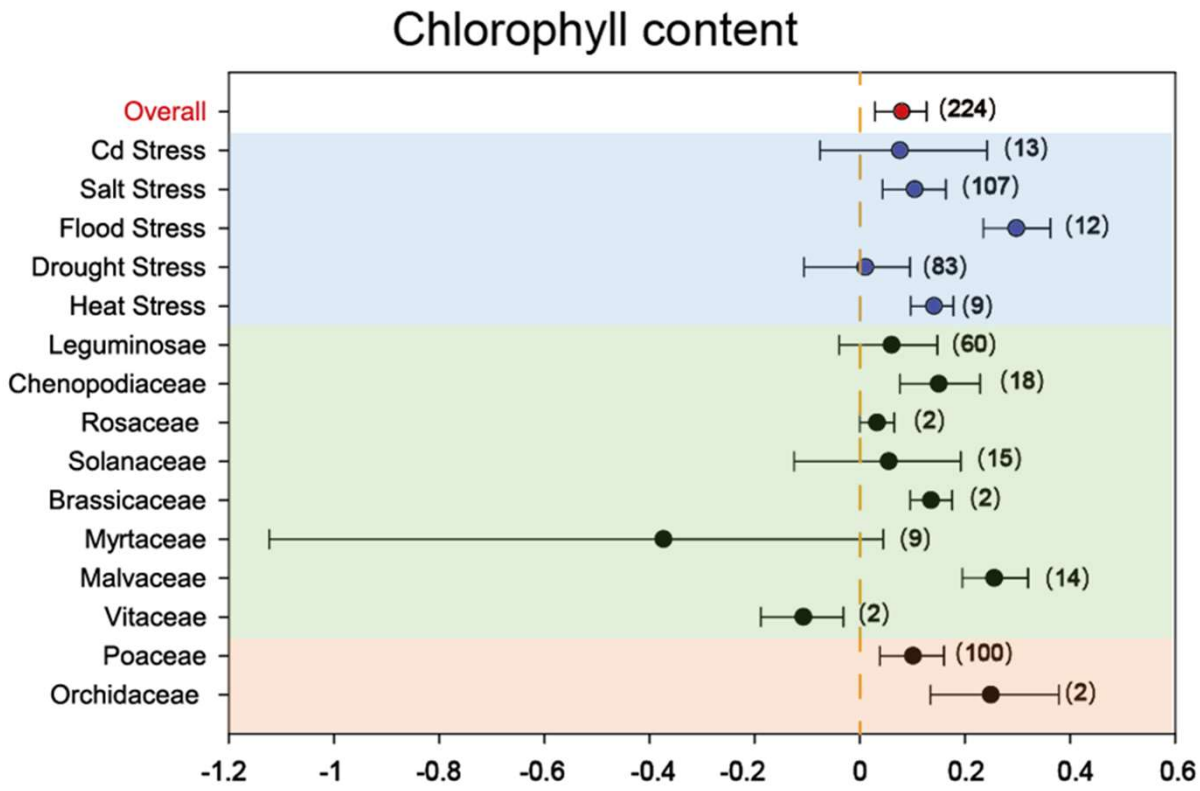
Photosynthesis regulated by K under stresses



- Photosynthesis rate was significantly increased by K supply under salt, flood stress conditions, especially for Asteraceae, corresponded with higher g_s, E and C_i.

(Zhu et al., unpublished)

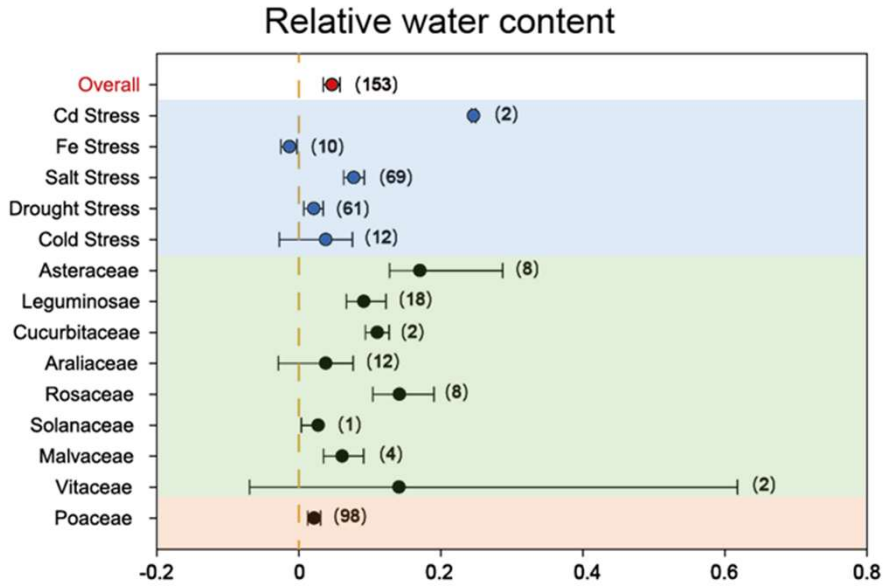
Chlorophyll content regulated by K under stresses

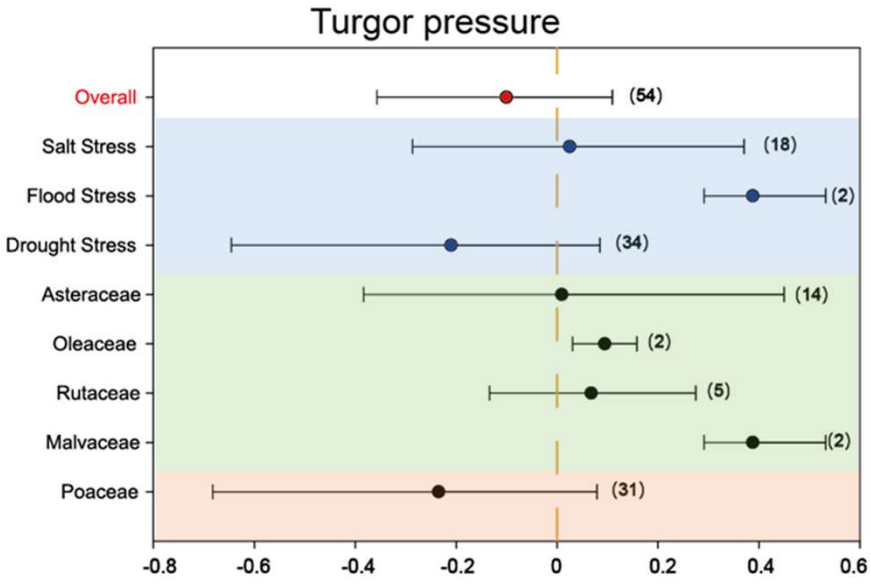


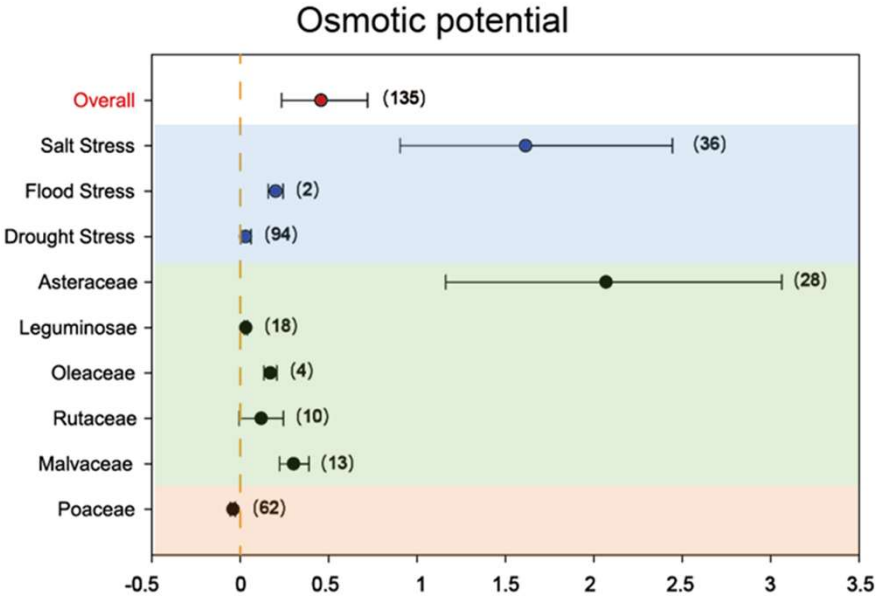
- Leaf chlorophyll content was increased by K supply under salt, flood, heat stress conditions, which may contribute to increased photosynthesis rate.
- For monocot plants, chlorophyll content was increased by K application under various stress conditions.

(Zhu et al., unpublished)

Leaf water status regulated by K under stresses



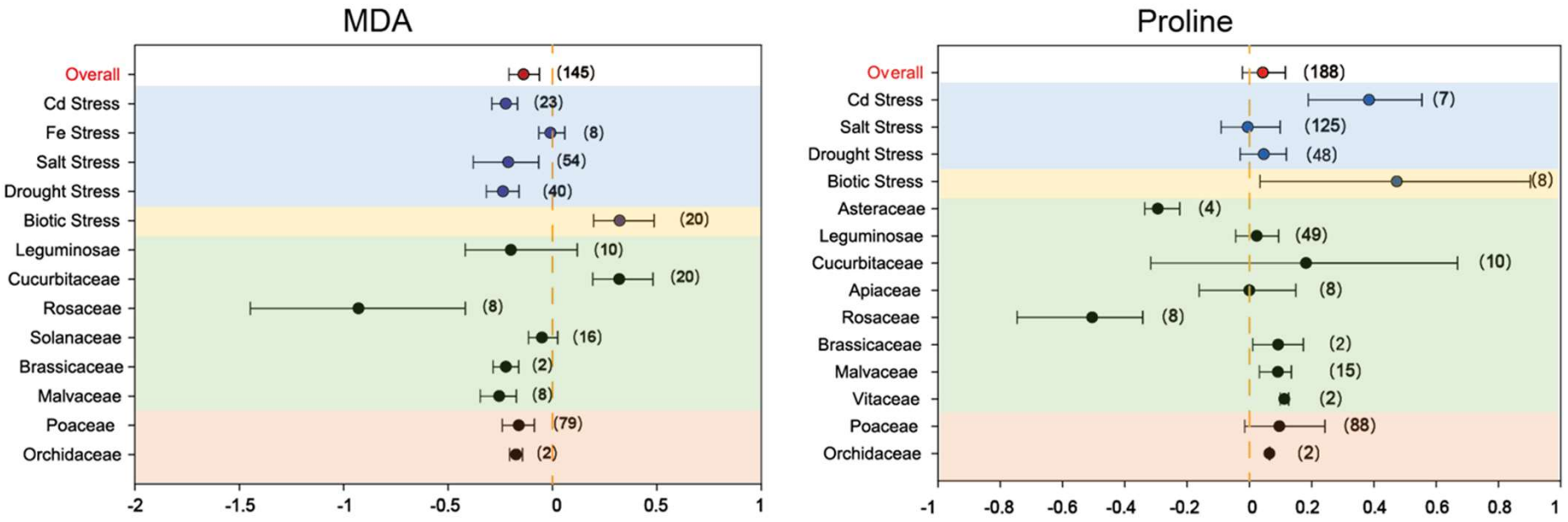




- Overall, K addition to stressed plants increased leaf relative water content and osmotic potential, especially under salt stress as well as in Asteraceae and Malvaceae.

(Zhu et al., unpublished)

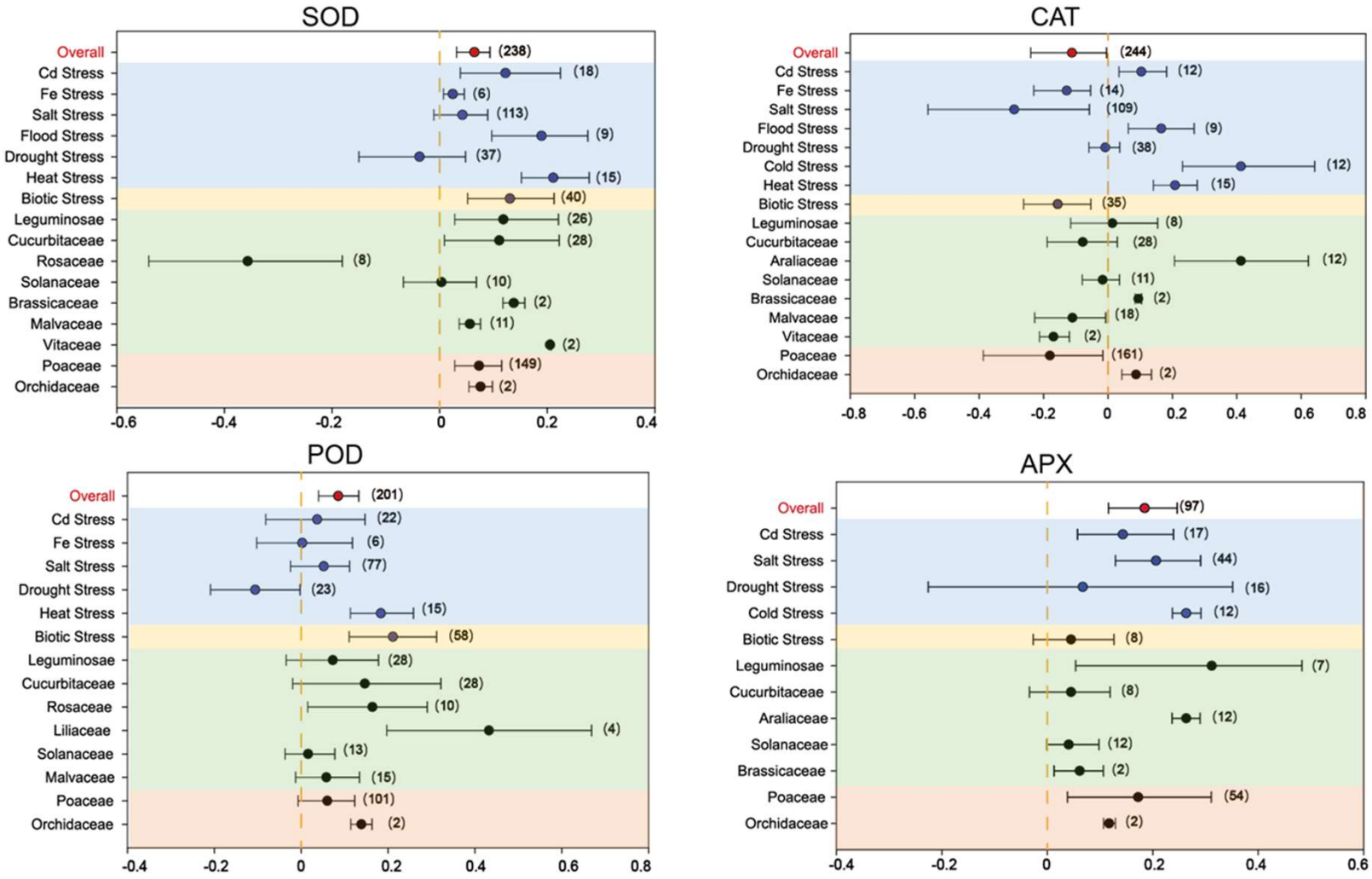
MDA and proline regulated by K under stresses



- MDA content was significantly reduced by K supply under Cd, salt and drought stresses, whereas MDA and proline were increased under biotic stress.
- In Rosaceae, Brassicaceae, Malvaceae, Orchidaceae plants, MDA content was decreased after K application, while proline content was increased.

(Zhu et al., unpublished)

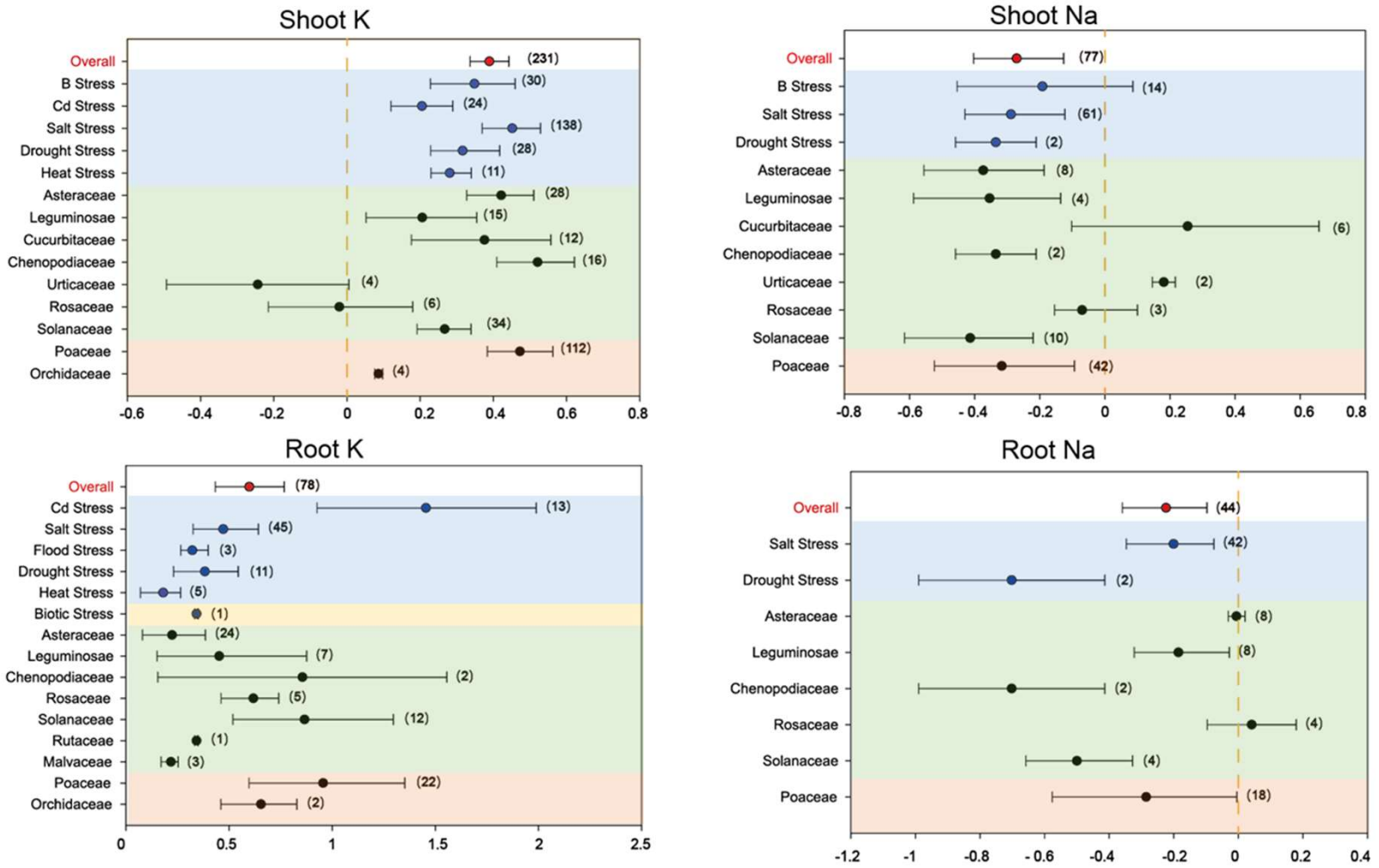
Antioxidant activity regulated by K under stresses



- Overall, K addition to stressed plants increased leaf SOD, POD and APX activity, while reduced CAT activity. Antioxidant activity of monocot was more sensitive to the K application under stress conditions.

(Zhu et al., unpublished)

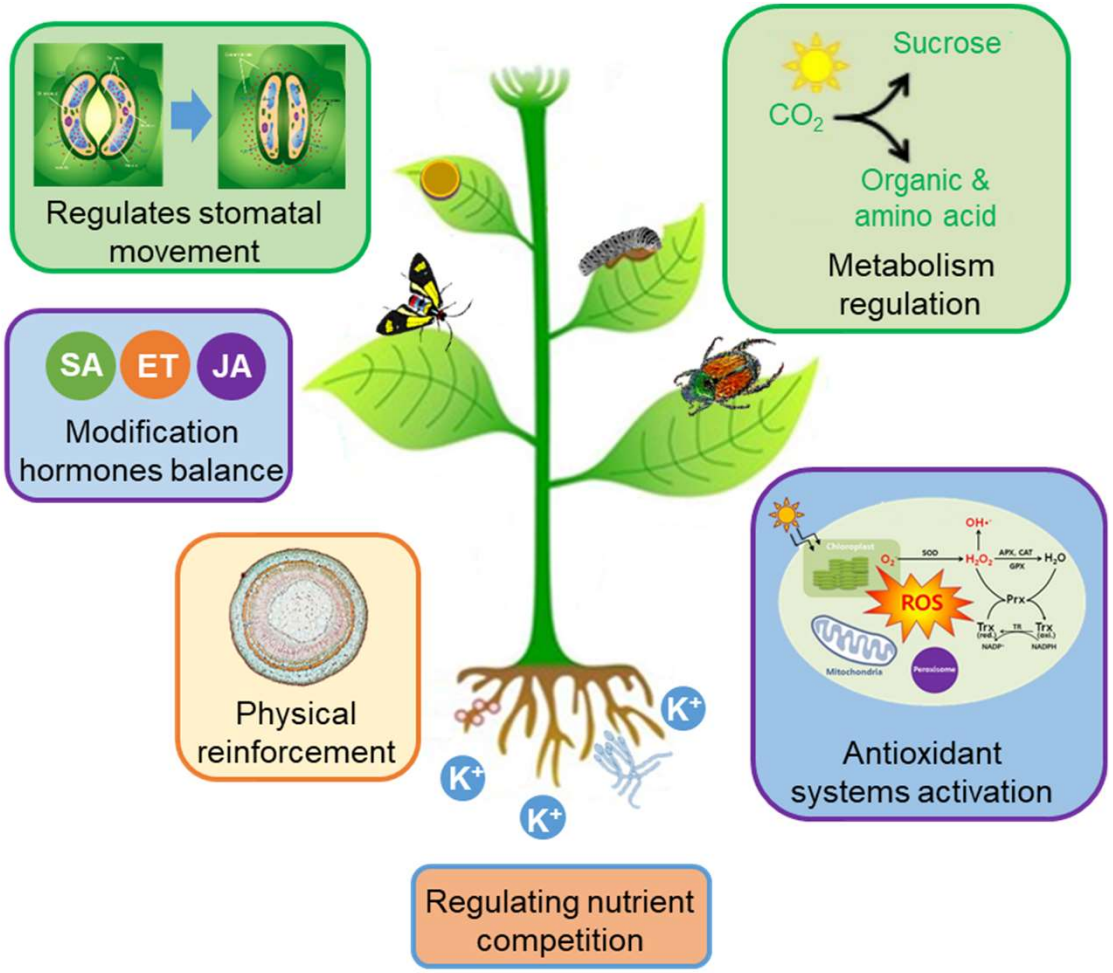
K and Na concentration regulated by K under stresses



- Overall, K application to stressed plants increased shoot and root K concentration, while decreased Na concentration, therefore increased the K^+/Na^+.

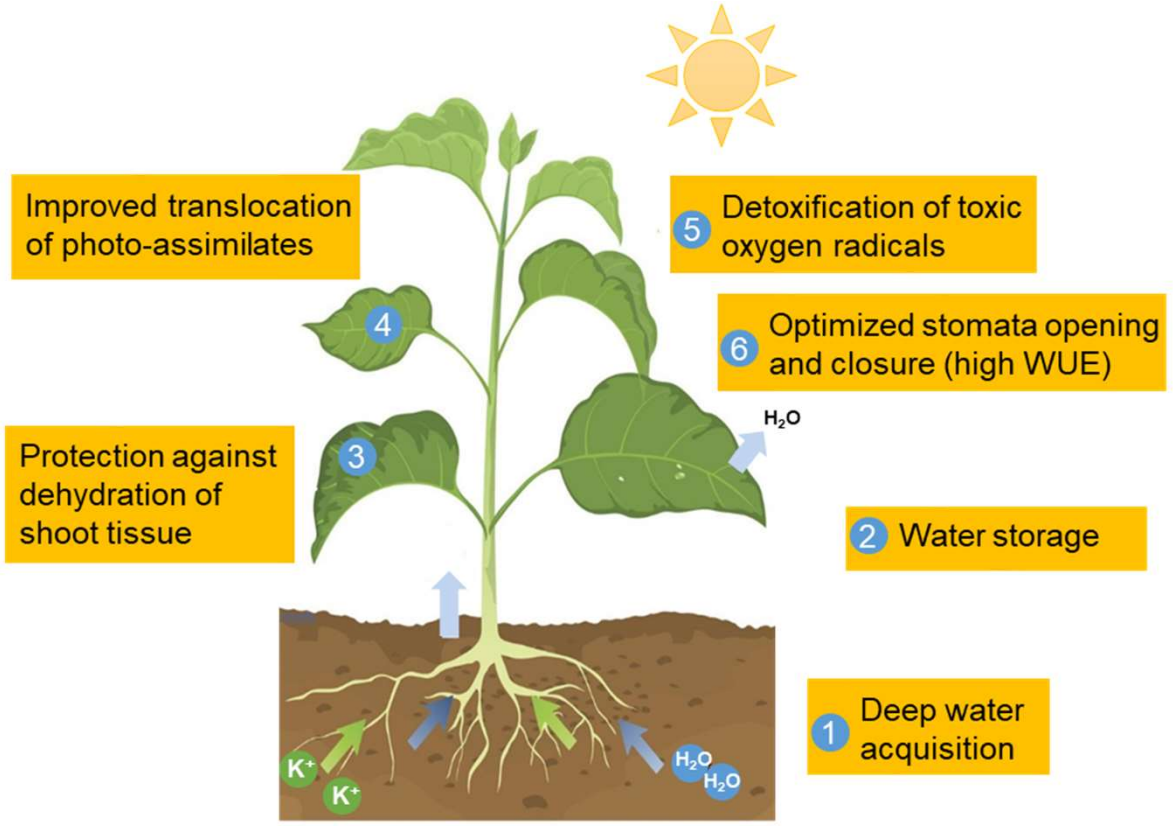
(Zhu et al., unpublished)

Role of K in biotic stresses



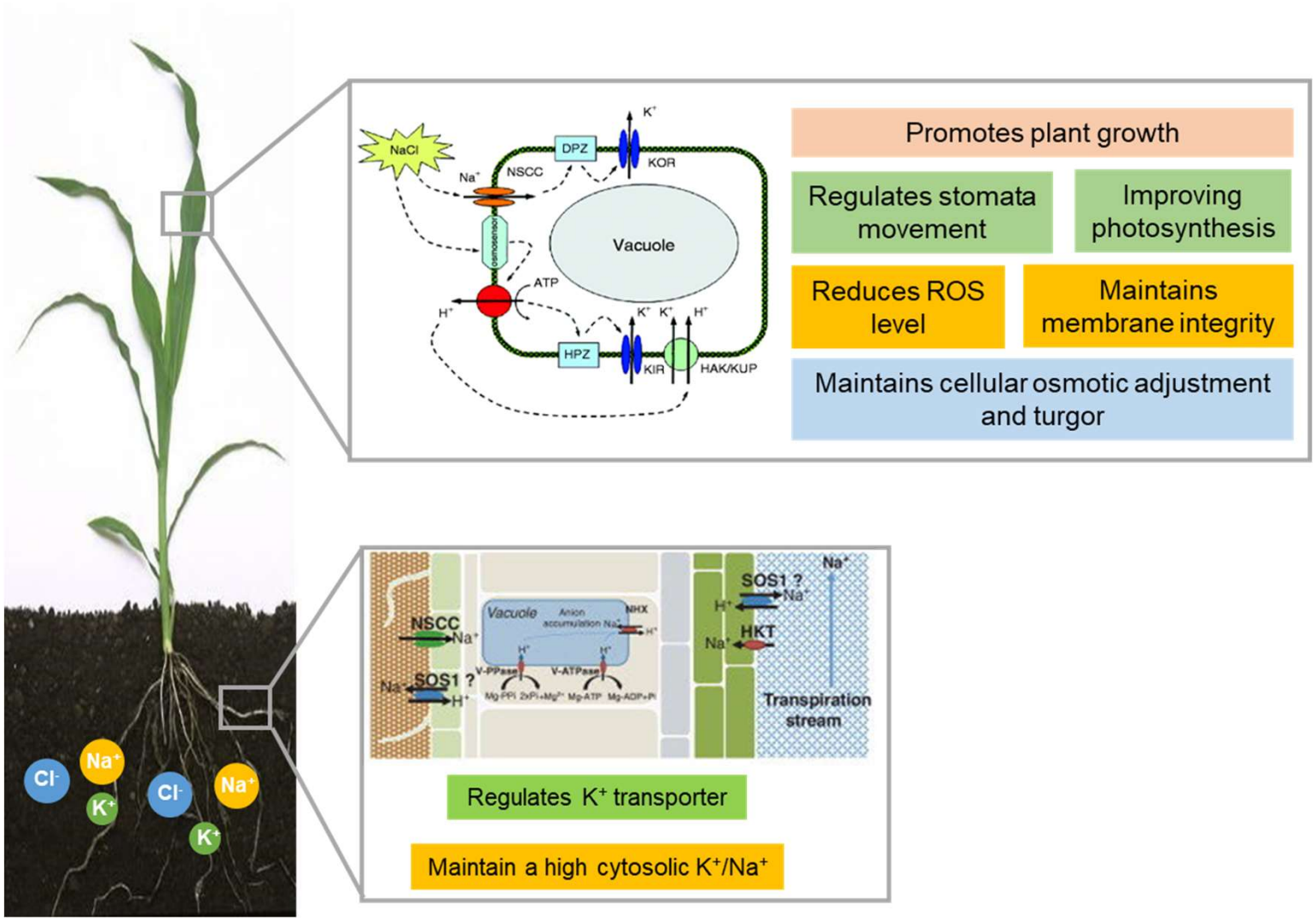
(Modified from Wang et al., 2013, International Journal of Molecular Sciences)

Role of K in drought/heat stresses



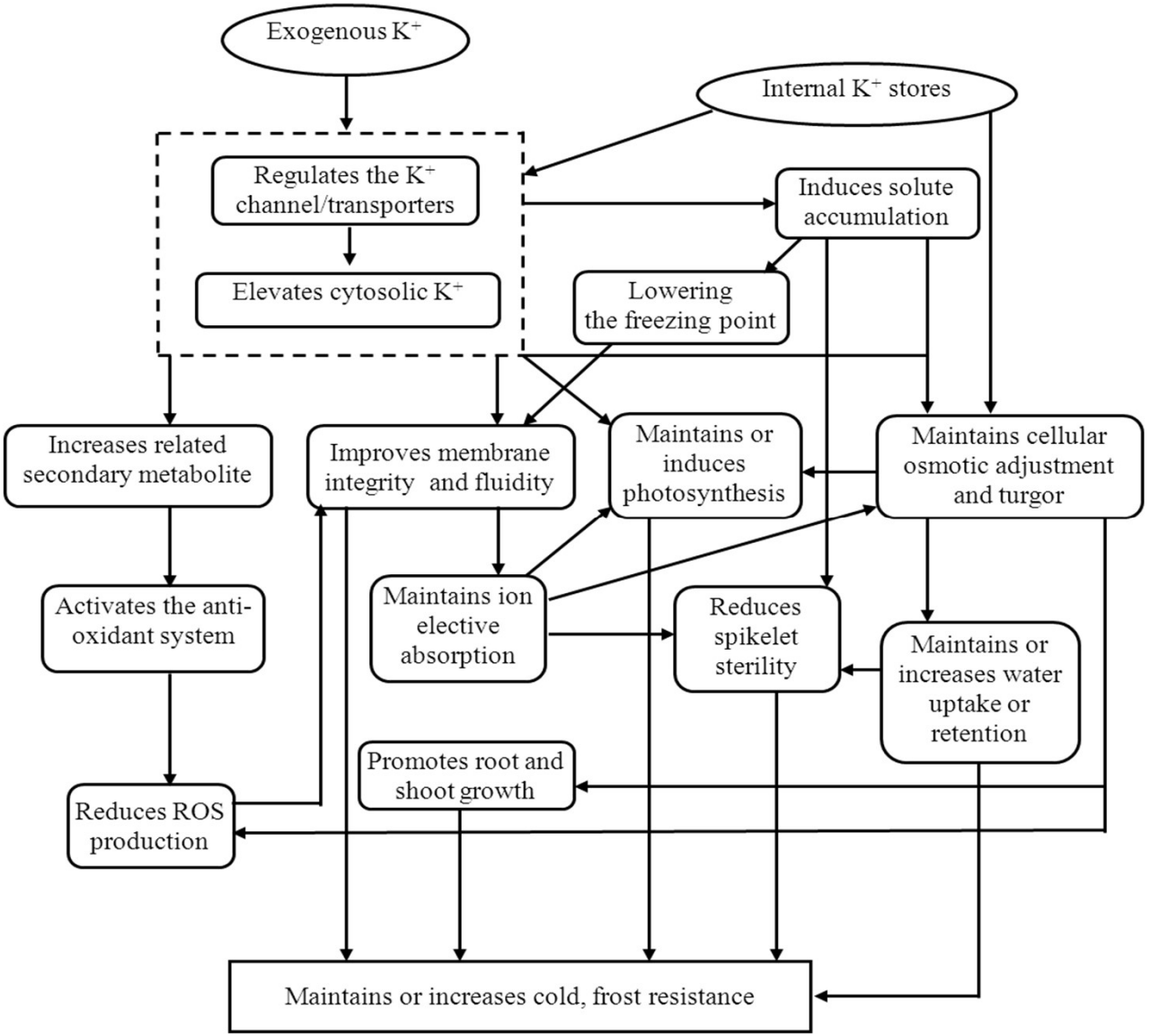
(Modified from Marschner, 2012 & Wang et al., 2013, IJMS)

Role of K in salt stress



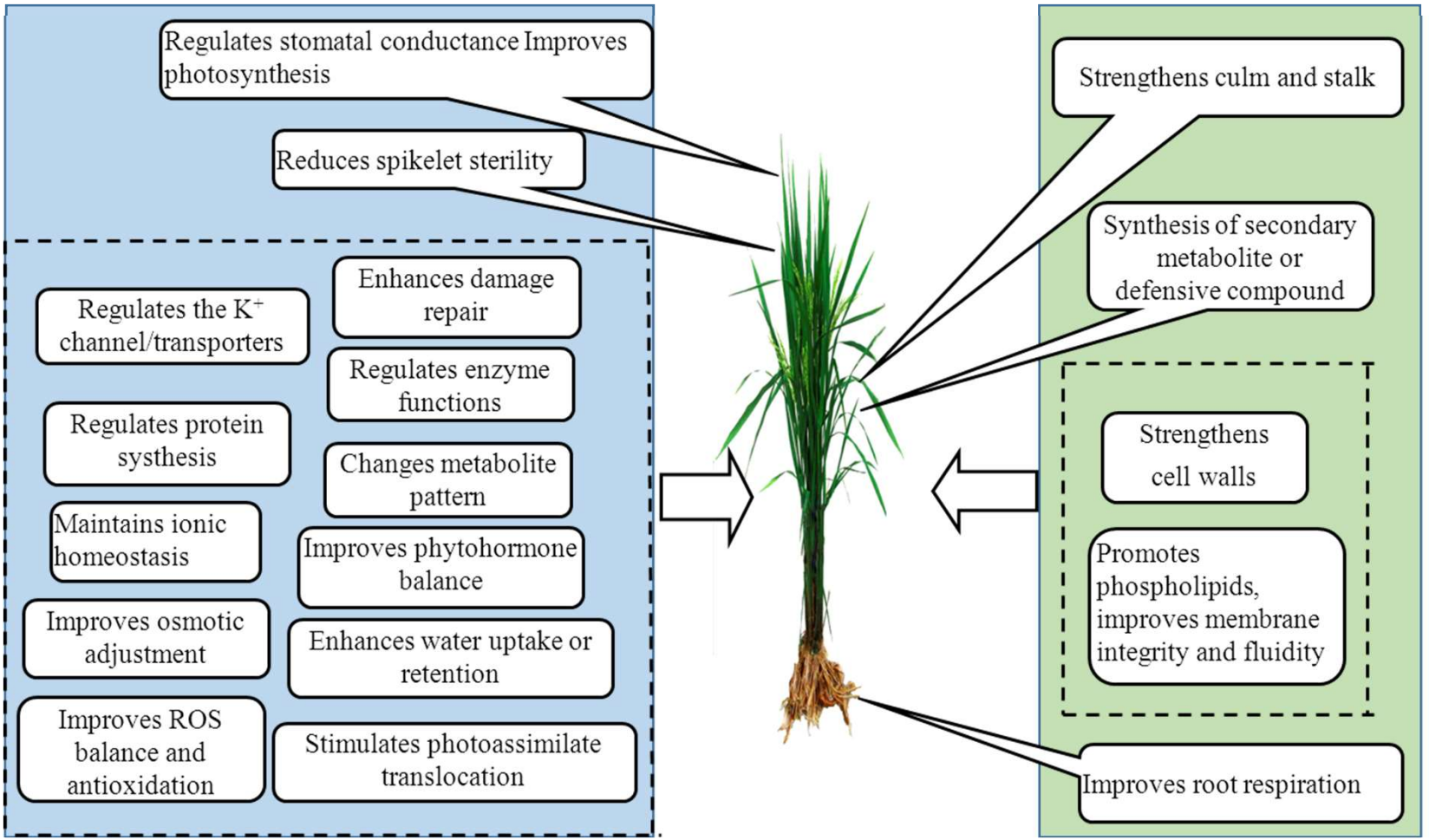
(Modified from Wang et al., 2013, International Journal of Molecular Sciences)

Role of K in cold stress



(Wang et al., 2013, International Journal of Molecular Sciences)

The role of K in biotic and abiotic stresses



(Wang et al., 2013, International Journal of Molecular Sciences)

The role of K in biotic and abiotic stresses

- Maintaining an optimum K nutritional status is essential for plant resistance to biotic and abiotic stresses.
- Balanced fertilization and efficient K usage in combination with other nutrients not only contribute to sustainable crop's growth, yield and quality, but also influence plant health and reduce the environmental risks.

The Critical Role of Potassium in Plant Stress Response

By: Wang, Min; Zheng, Qingsong; Shen, Qirong; et al.
INTERNATIONAL JOURNAL OF MOLECULAR SCIENCES Volume: 14 Issue: 4 Pages: 7370-7390 Published: APR 2013

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Review

The Critical Role of Potassium in Plant Stress Response

Min Wang, Qingsong Zheng, Qirong Shen and Shiwei Guo *

Thanks for your attention!