

The 23rd Session of the International Poplar Commission

Enhancement by Hydrogel Polymers of Salt Resistance in Poplar

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Beijing, Oct 29th, 2008

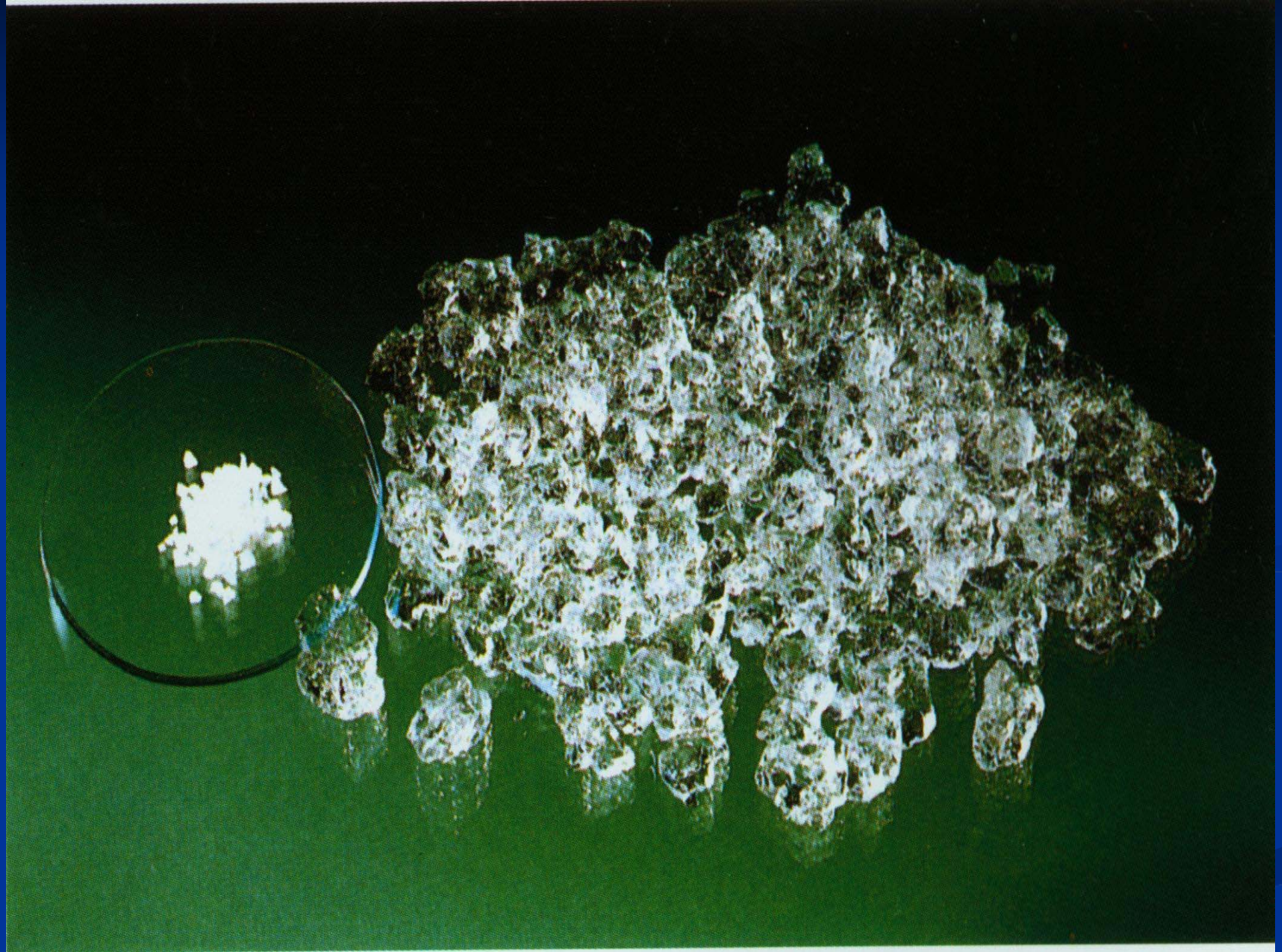
Soil salinization

- Soil salinization is severe in China and saline-alkali land is approximately 30 million hectares, which is mainly distributed in the north of Yangtze River.

China Three-North Plantation Project



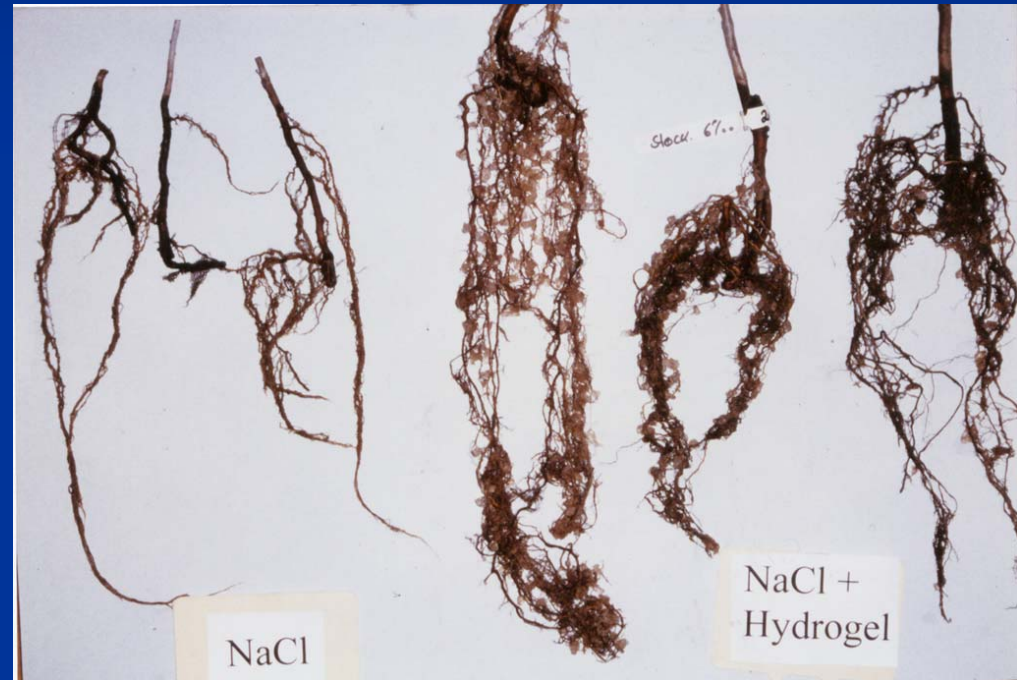
Stockosorb polymer



Stockhausen GmbH, Krefeld, Germany

Hydrogel increased salinity tolerance of *P. euphratica* —A 2-year experiment in Göttingen Univ. Germany

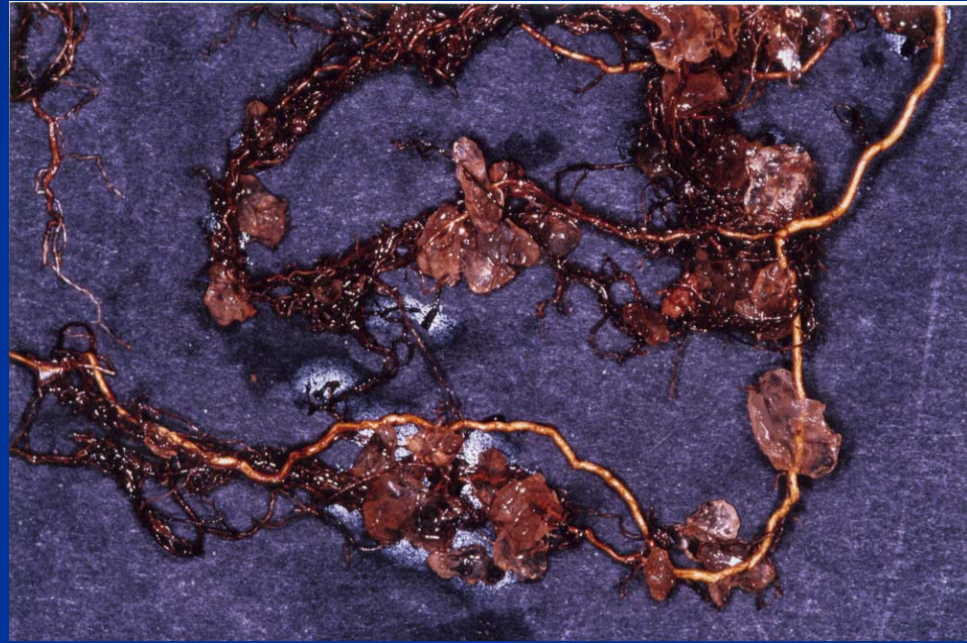
- Hydrogel amendment:
 - Potassium mine refuse in Bischofferode (Germany)/abundant with NaCl
 - 0.6% (v/v) Stockosorb K410, which is a highly crosslinked polyacrylamide with about 40% of the amide group hydrolysed to carboxylic groups.



+ 2.7-fold biomass

Hydrogel-covered roots

- Effects of hydrogel on cellular ion relations (by EDAX):
 - restricted apoplastic Na^+ in young and old roots
 - limited apoplastic and cytoplasmic Cl^- in old roots
 - increased Cl^- compartmentation in cortical vacuoles
 - enhanced uptake of Ca^{2+}



Chen S, et al. 2004. *Trees* 18, 175-183.

Objectives

- Is the polymer working in salt soil in China?
- Is the polymer able to enhance salinity tolerance of salt-sensitive poplars?

Experimental treatments

- Two species: *P. euphratica*, *P. popularis*
 - Control ± hydrogel
 - NaCl – hydrogel
 - NaCl + hydrogel

Hydrogel: Stocksorb 500 XL, 0.5% (v/v)

NaCl: Addition of 1L 250 mM NaCl to 10 L soil/per pot, reaching a final concentration of ca. 55 mM in soil solution

Plant response to salinity

处理 Treatment	胡杨 <i>P. euphratica</i>	群众杨 <i>P. popularis</i>
Control	Normal	Normal
NaCl	Normal	Injured/25d
NaCl + hydrogel	Normal	Injured/45d

Salt injury

— *P. popularis*

NaCl + hydrogel

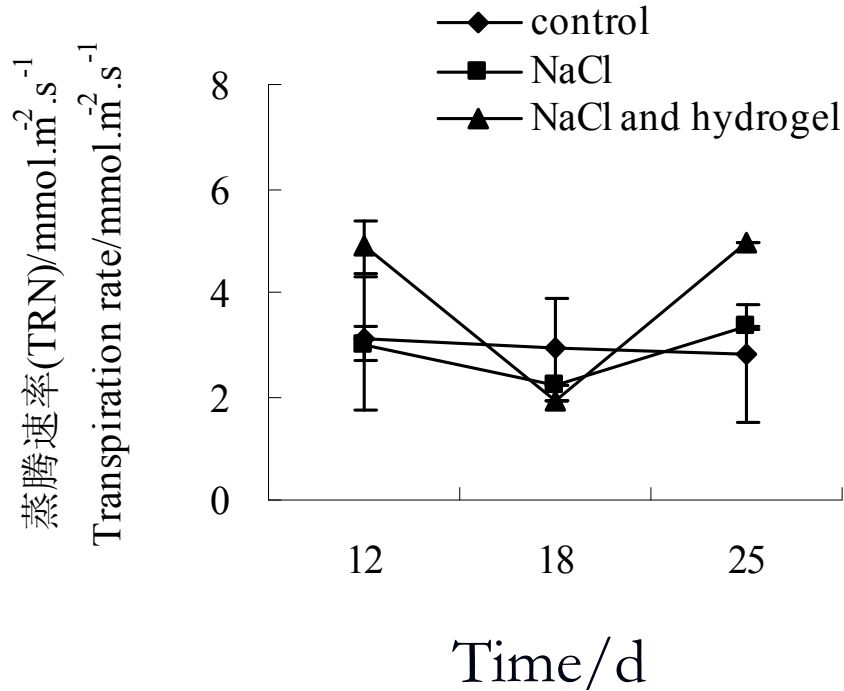
NaCl – hydrogel



Unit transpiration rate

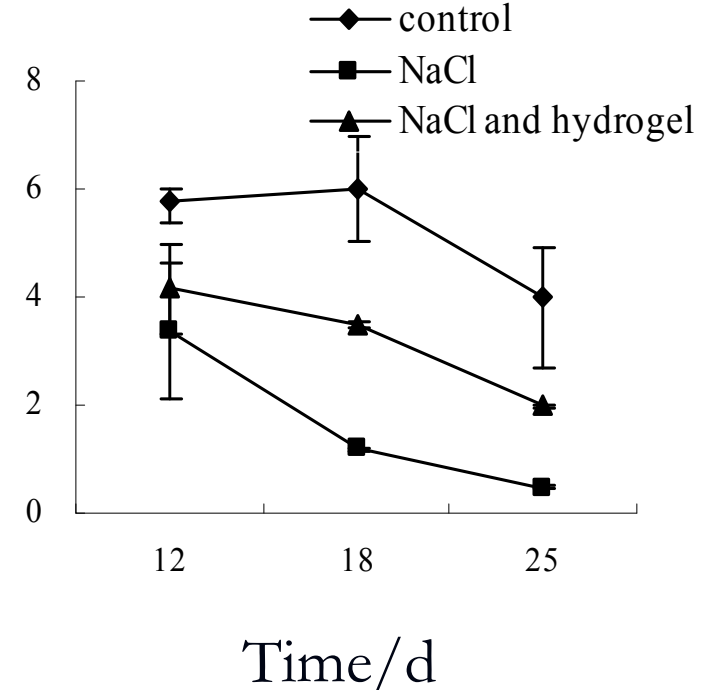
胡杨

P. euphratica



群众杨

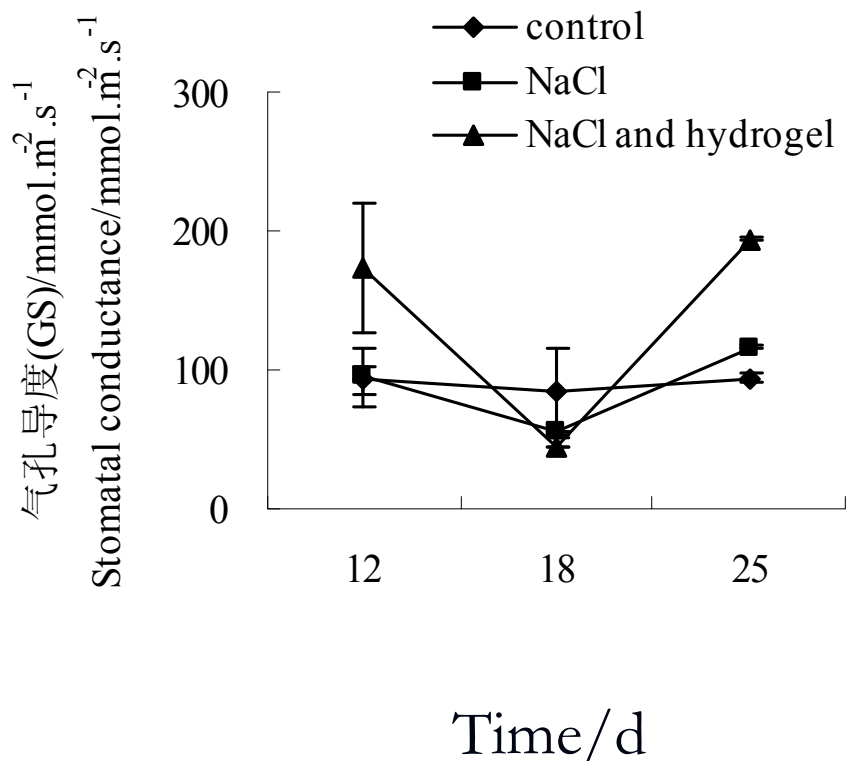
P. popularis



Stomatal conductance

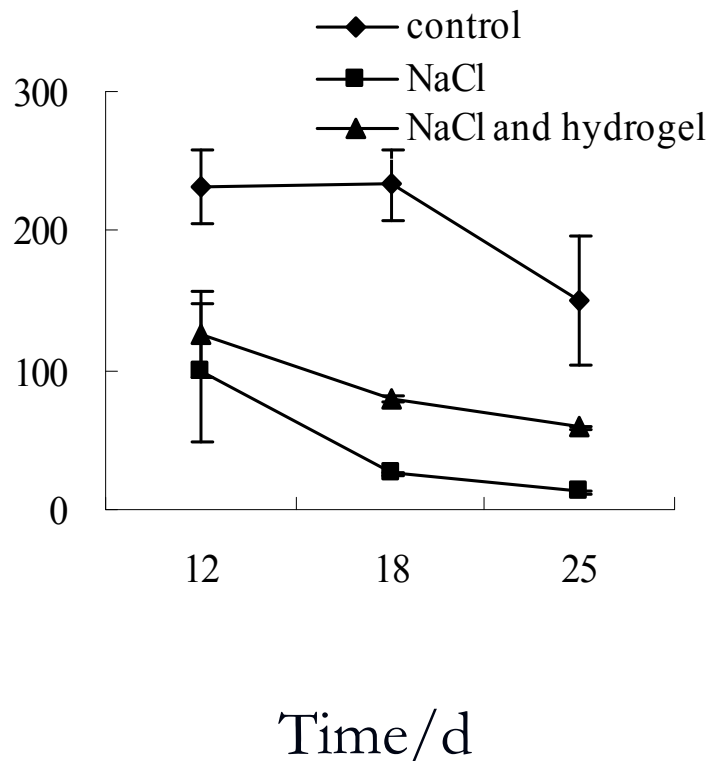
胡杨

P. euphratica



群众杨

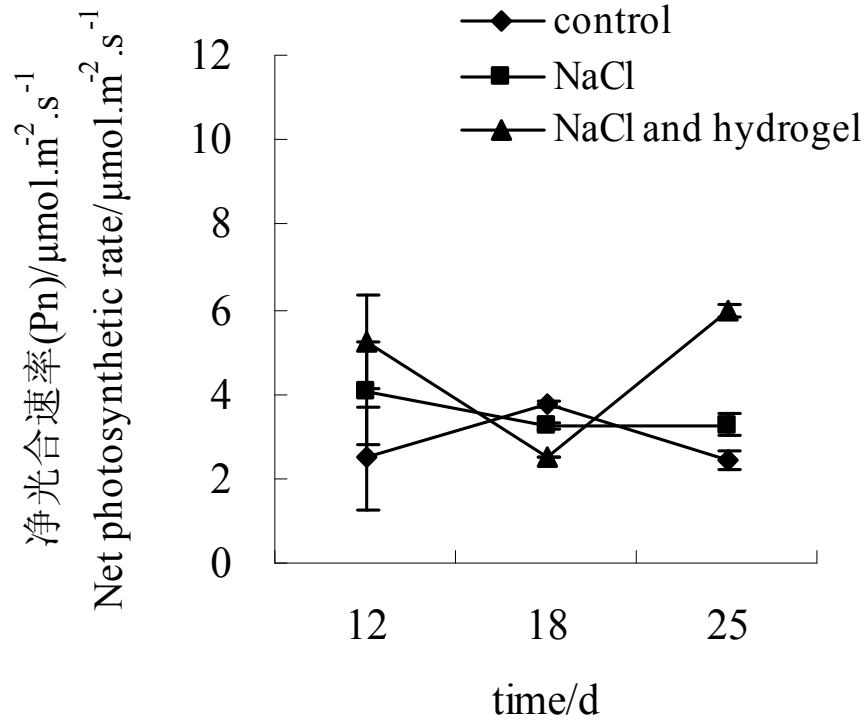
P. popularis



Net photosynthetic rate

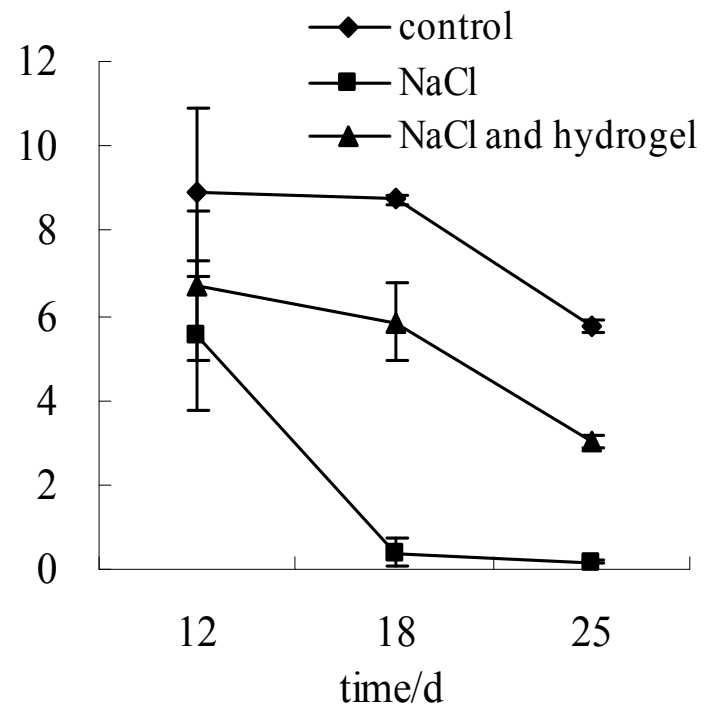
胡杨

P. euphratica



群众杨

P. popularis



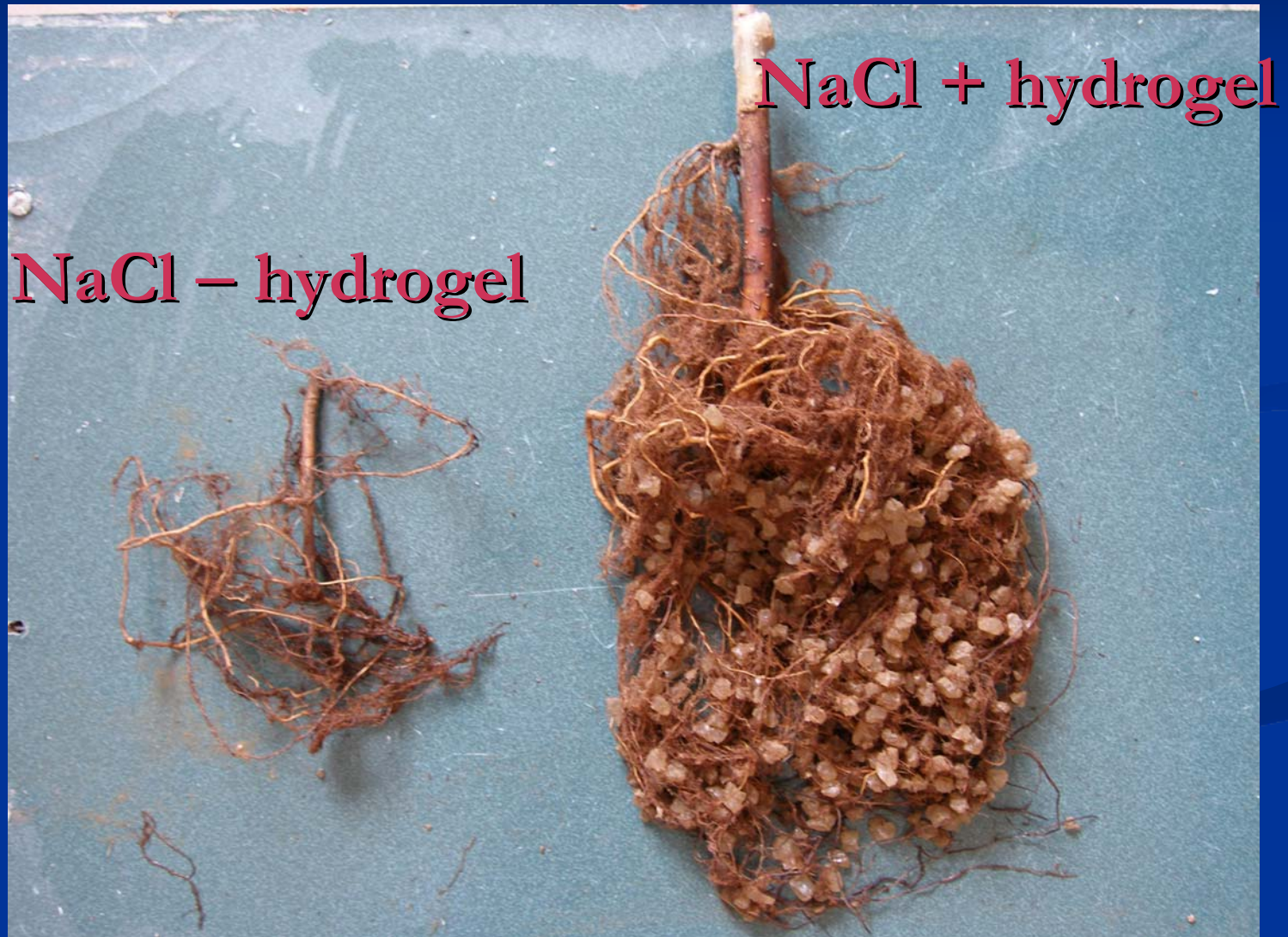
Leaf ion concentrations (mmol g⁻¹DW)

树种 species	处理 Treatment	Cl ⁻	Na ⁺	K ⁺	Ca ²⁺	Mg ²⁺
胡杨 <i>P. euphratica</i>	Control	0.22c	0.05c	0.53a	0.09a	0.17a
	NaCl	0.52a	0.23a	0.42b	0.08a	0.16a
	NaCl + hydrogel	0.38b	0.16b	0.56a	0.07a	0.15a
群众杨 <i>P. popularis</i>	Control	0.20c	0.03c	0.38b	0.10a	0.18a
	NaCl	1.16a	0.48a	0.41b	0.10a	0.18a
	NaCl + hydrogel	0.64b	0.27b	0.50a	0.10a	0.19a

Soil ion concentrations (mM)

处理 Treatment	Cl ⁻	Na ⁺	K ⁺	Ca ²⁺	Mg ²⁺
Control	14.2d	7.0c	4.4b	8.3a	12.3a
NaCl	64.1a	48.9a	1.0c	7.9a	10.5a
NaCl and hydrogel:					
— Soil	39.7b	36.6b	4.5b	7.8a	12.3a
— Hydrogel granules	29.9c	2.7d	0.8c	1.5b	2.1b
Hydrogel products	0.2e	1.7e	6.8a	0.1c	0.3c

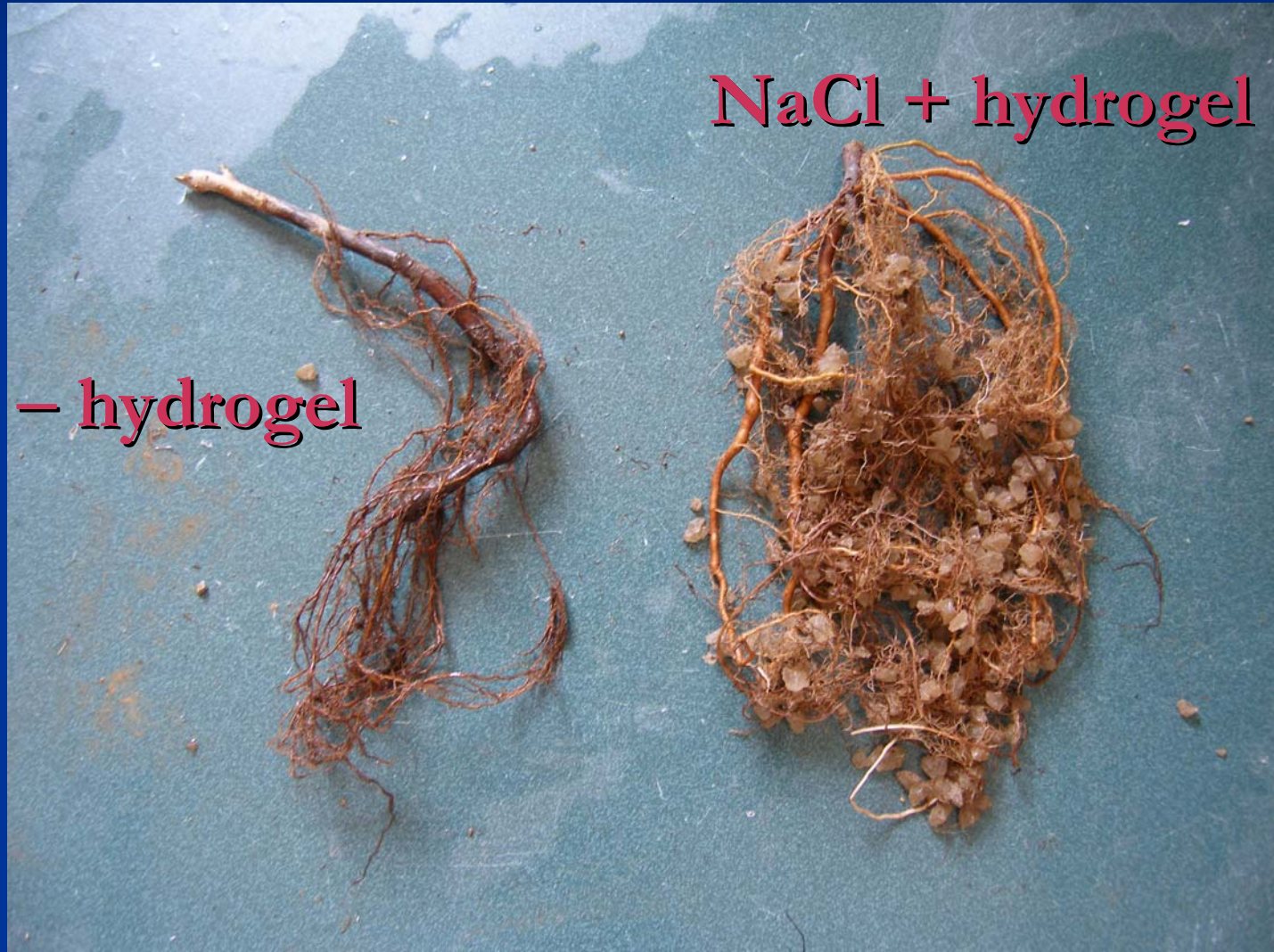
Root aggregation in hydrogel granules — *P. popularis*



Root aggregation in hydrogel granules — *P. euphratica*

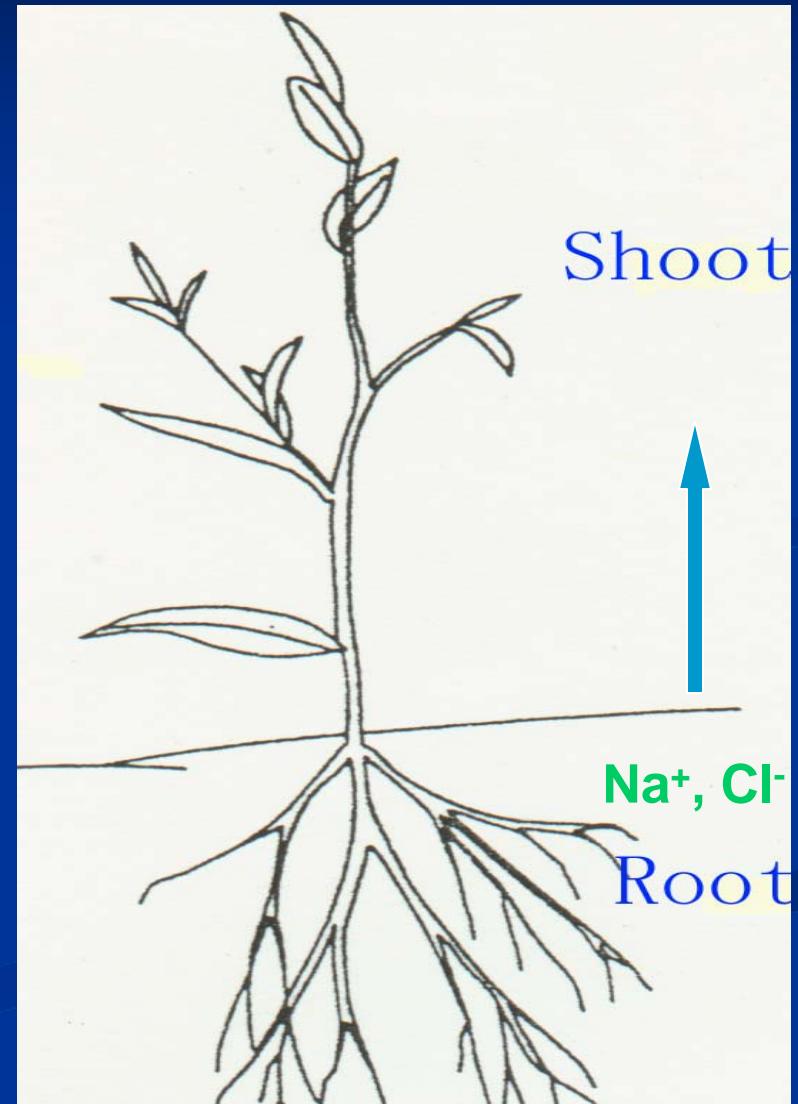
NaCl – hydrogel

NaCl + hydrogel



Root-shoot salt transport regulation

- Is the polymer working in salt soil in China?
 - —Yes.
- Is the polymer able to enhance salinity tolerance of salt-sensitive poplars?
 - —Yes.
- Hydrogel effects:
 - Salt buffering capacity
 - Nutrient source, e.g. K^+



Acknowledgements

Institut für Forstbotanik der Universität Göttingen

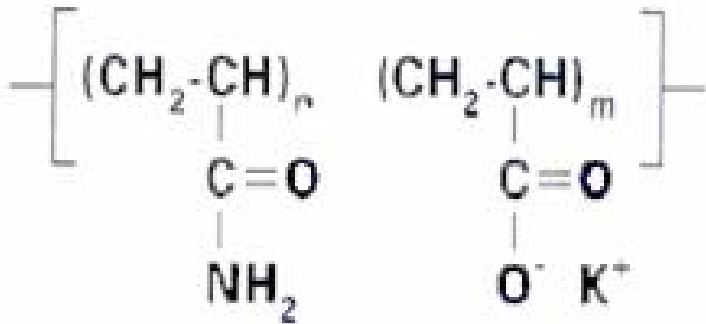
- Prof. Dr. Aloys Hüttermann
- Prof. Dr. Andrea Polle
- Dr. Eberhard Fritz
- Ms. Karin Lange
- Mr. Moitaba Zommorodi
- Mr. Konrad Wehr
- Ms. Christine Kettner

Beijing Forestry University

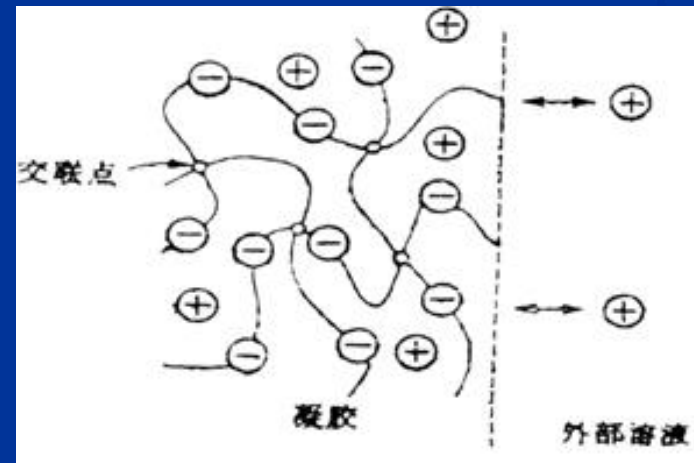
- Prof. Shasheng Wang
- Ms. Jinke Li
- Mr. Jie Shao
- Mr. Yong Shi
- Mr. Jian Sun
- Dr. Ruigang Wang

The Hebrew University of Jerusalem

- Prof. Dr. Arie Altman



Structure of acrylamide-
potassium acrylate
crosslinked polymers



Model of swelling gel

The “Silk Road” Tour



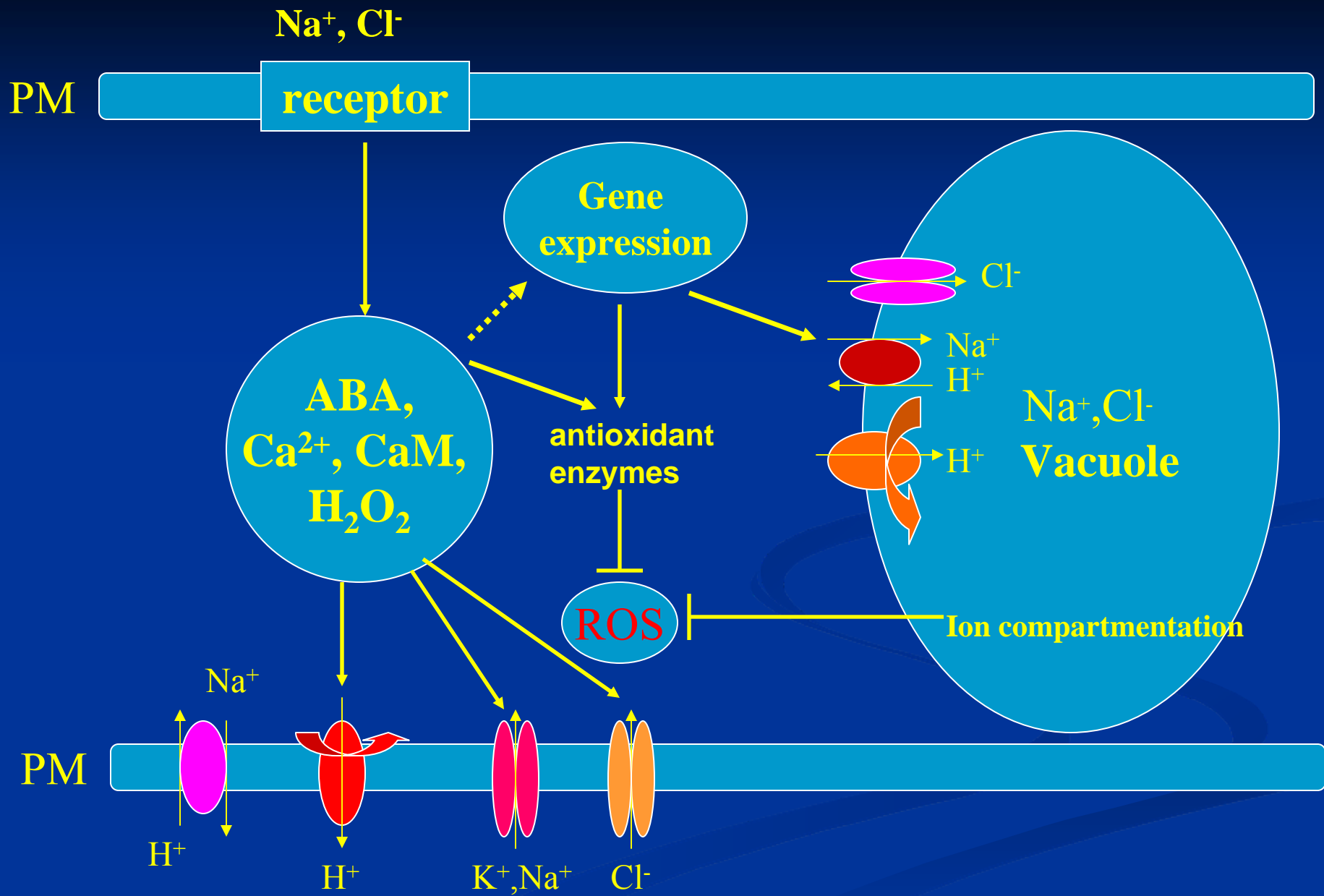
大漠胡杨

摄影：王汉冰

Populus euphratica Oliv. (胡杨)

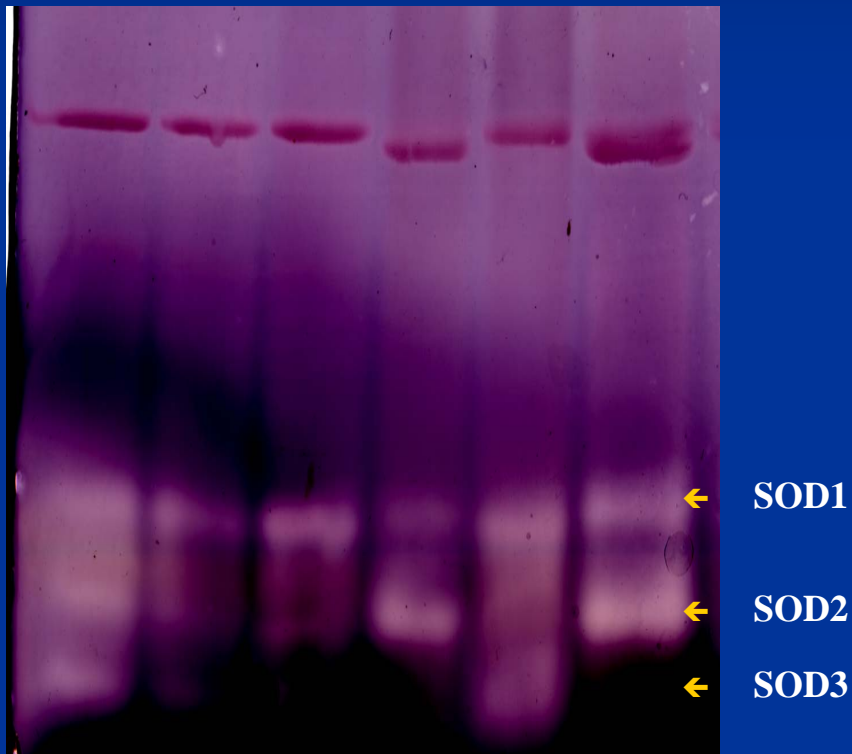


(Chen et al. 2001, 2002a, 2002b, 2003, 2004, Chang et al. 2006, Wang et al. 2007, 2008)



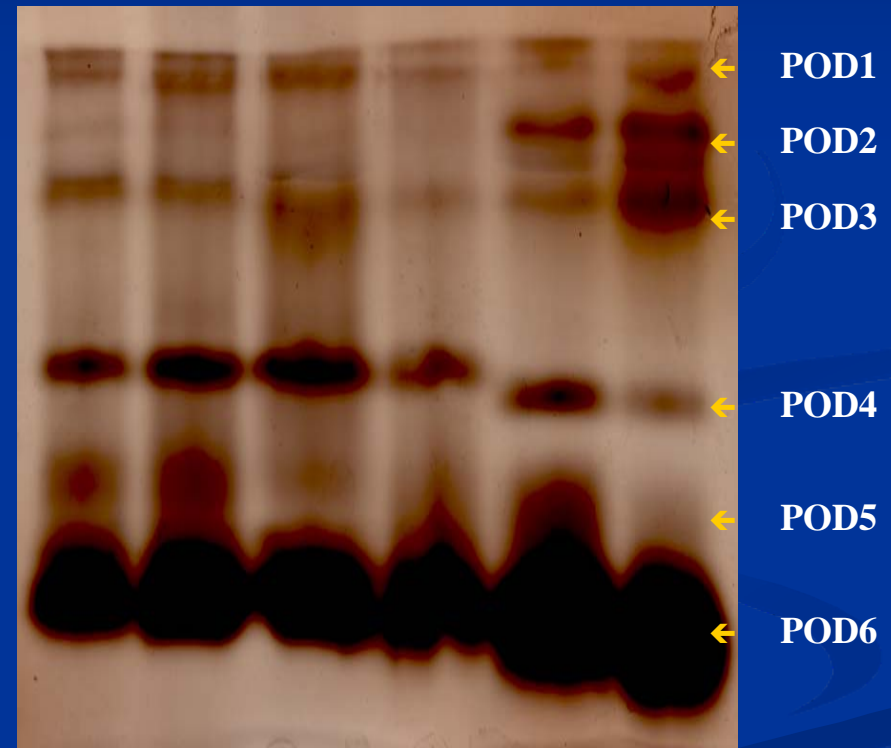
SOD (superoxide dismutase) isoenzymes

P. euphratica P. popularis
S S+H C S S+H C



POD (peroxidase) isoenzymes

P. popularis P. euphratica
C S+H S C S+H S



S: NaCl; **S+H:** NaCl+hydrogel; **C:** control