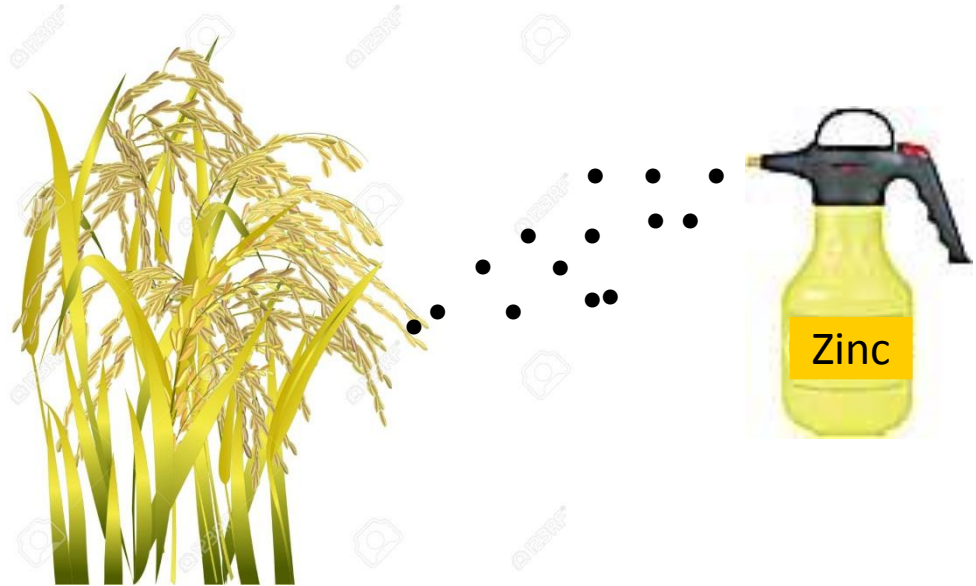


Improving zinc concentration in rice grain by foliar zinc application



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Mai University, THAILAND

Content

1

- Why foliar Zn application is required in cereal crops?

2

- The optimum stage of foliar Zn application in rice

3

- The double benefit of high seed Zn in rice by foliar application

LATEST NEWS/HEADLINES

The World Bank has called on the international community to co-ordinate its efforts in a "new deal" to **fight global hunger and malnutrition.**



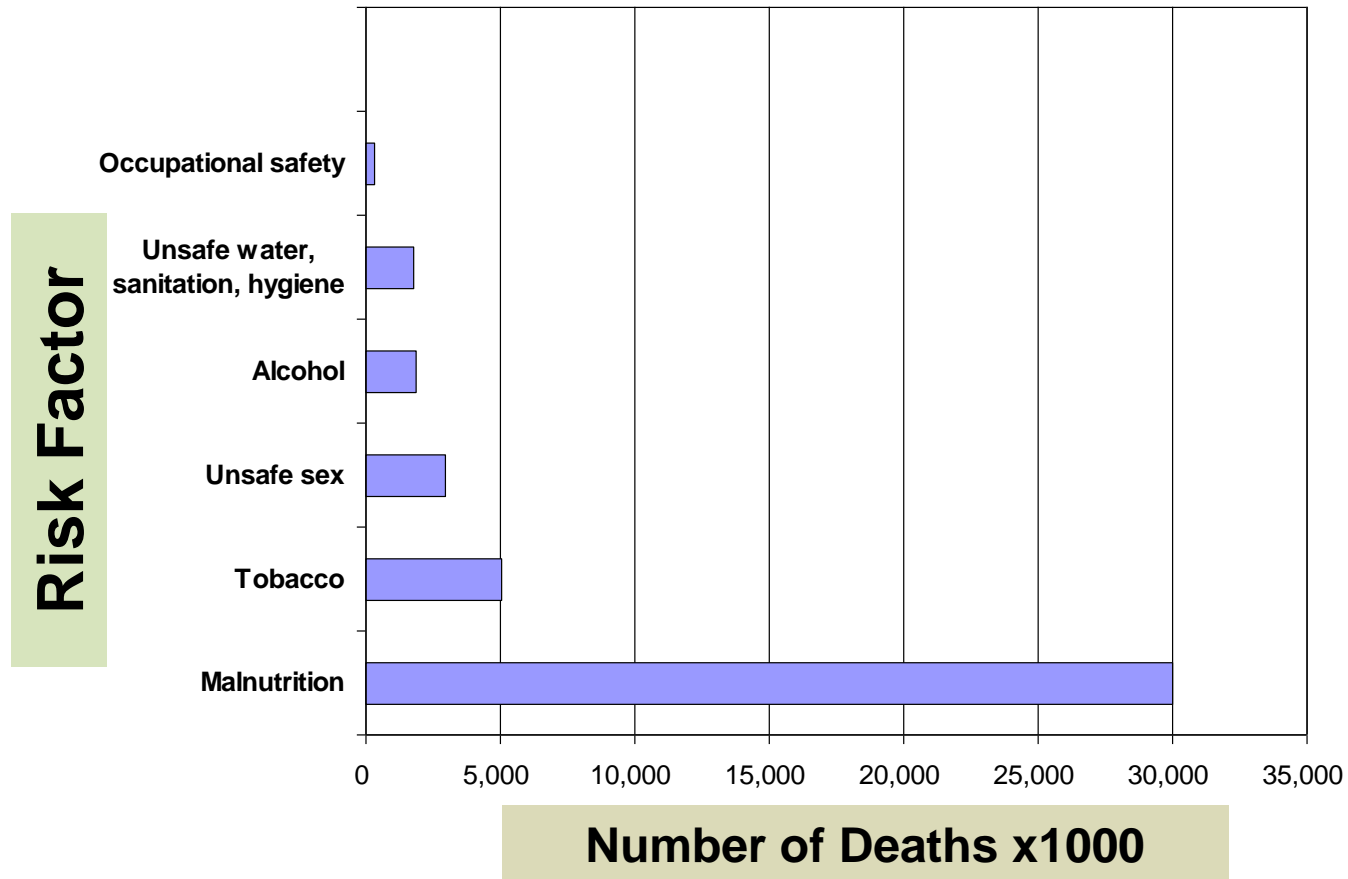
Mounting Food Prices, Rise In Violence Because Of Shortages Prompt Call For Emergency Aid



Courtesy of Dr. I. Cakmak
Sabanci University

Some Major World Risk Factors Causing Deaths

Some WHO Major Risk Factors Causing World Deaths in 2000



Malnutrition accounts of ≈ 30 million deaths per year (≈ 1 death per second) (WHO estimate)

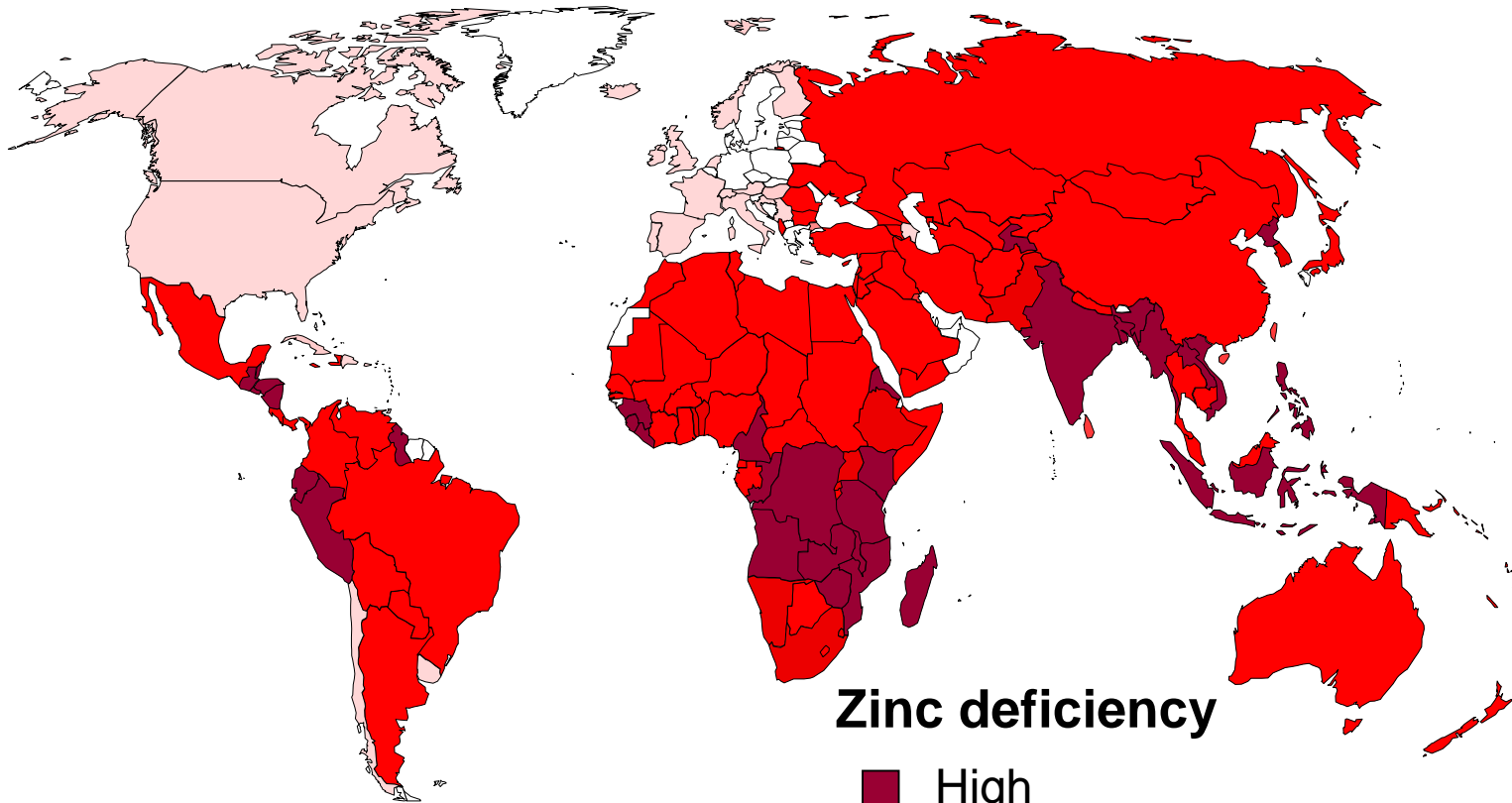
Leading 10 Risk Factors in Developing Countries

% Cause of Disease Burden (WHO, 2002)

Underweight	14.9%
Unsafe sex	10.2%
Unsafe water	5.5%
Indoor smoke	3.7%
Zinc Deficiency	3.2%
Iron deficiency	3.1%
Vitamin A deficiency	3.0%
Blood pressure	2.5%
Tobacco	2.0%
Cholesterol	1.9%



Zinc deficiency: global nutritional problem in human beings



Zinc deficiency

- High
- Moderate
- Low
- Not sufficient data available

Courtesy of Dr. J.Veenemans
Wageningen University



Zinc affects a range of functions:

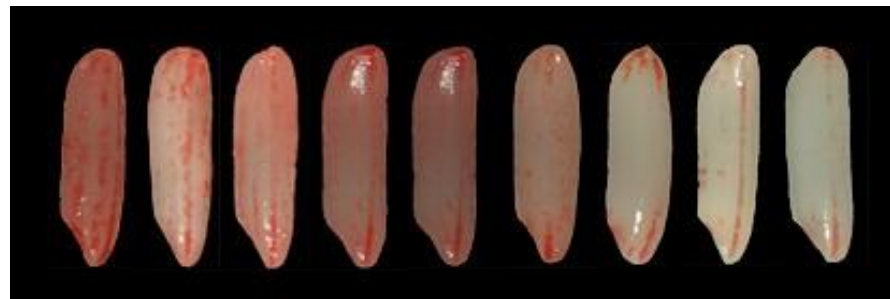
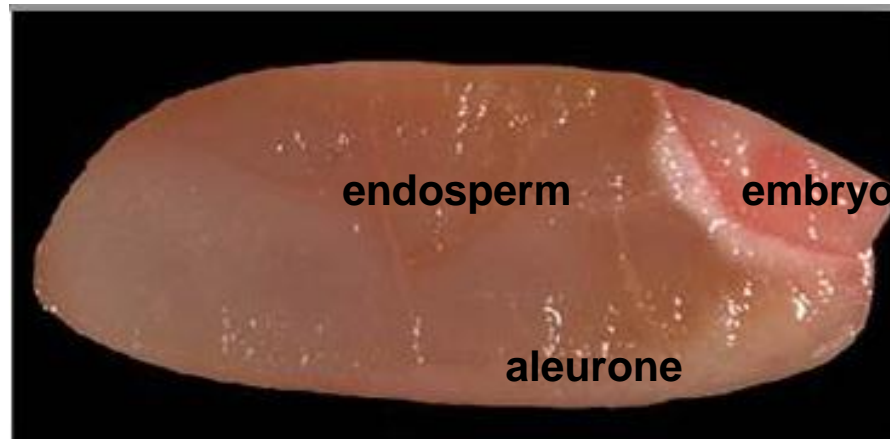
- Immunity
- Growth
- Brain development
- Reproduction
- Sexual Formation



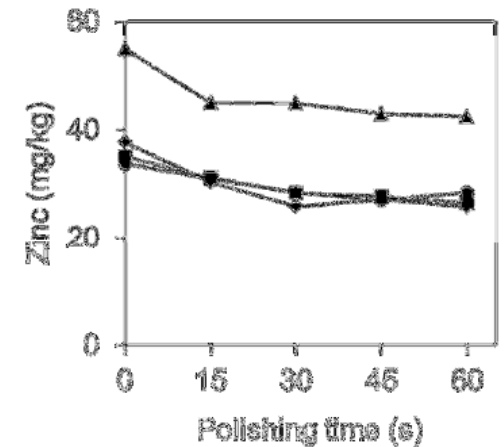
Reason: High consumption of cereal based foods with low zinc content is one major reason for widespread occurrence of Zn deficiency in humans in developing world



Localization and Staining of Zinc in Rice Seed (embryo and aleurone: Zn-rich parts)



Polishing time →



Rerkasem et al., 2015
(Int. J. Agri. Biol)

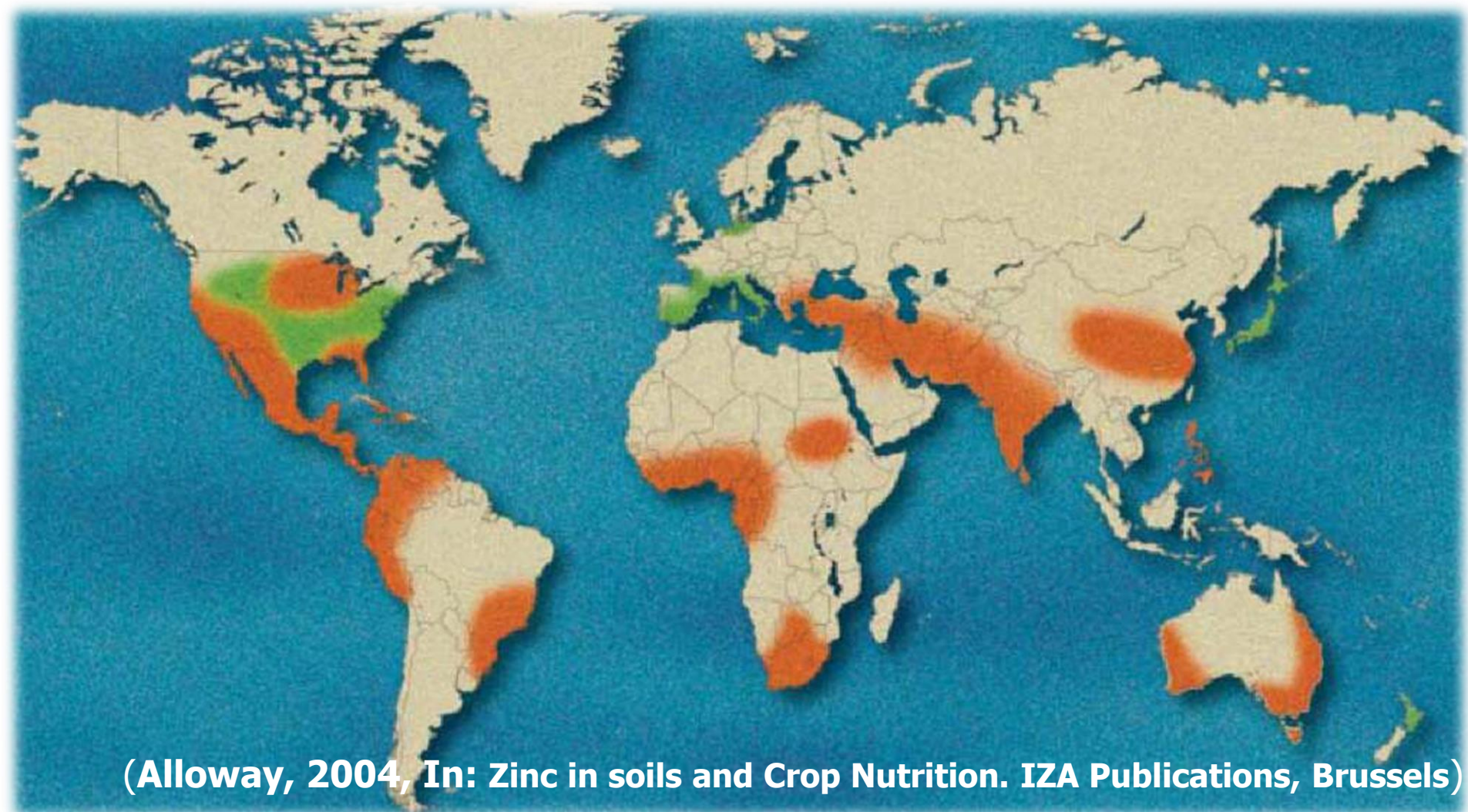
Cereals have **inherently** low concentrations of Zn in grain, particularly when grown on Zn-deficient soils



Currently, nearly 50 % of the global cereal growing regions are on soils having low levels of available soil Zn

Geographic distribution of severe (red) and moderate (green) zinc deficient soils in the world

Zn Deficiency: Global Nutritional Problem in Soils



(Alloway, 2004, In: Zinc in soils and Crop Nutrition. IZA Publications, Brussels)

When Zn is deficient in soil or wheat

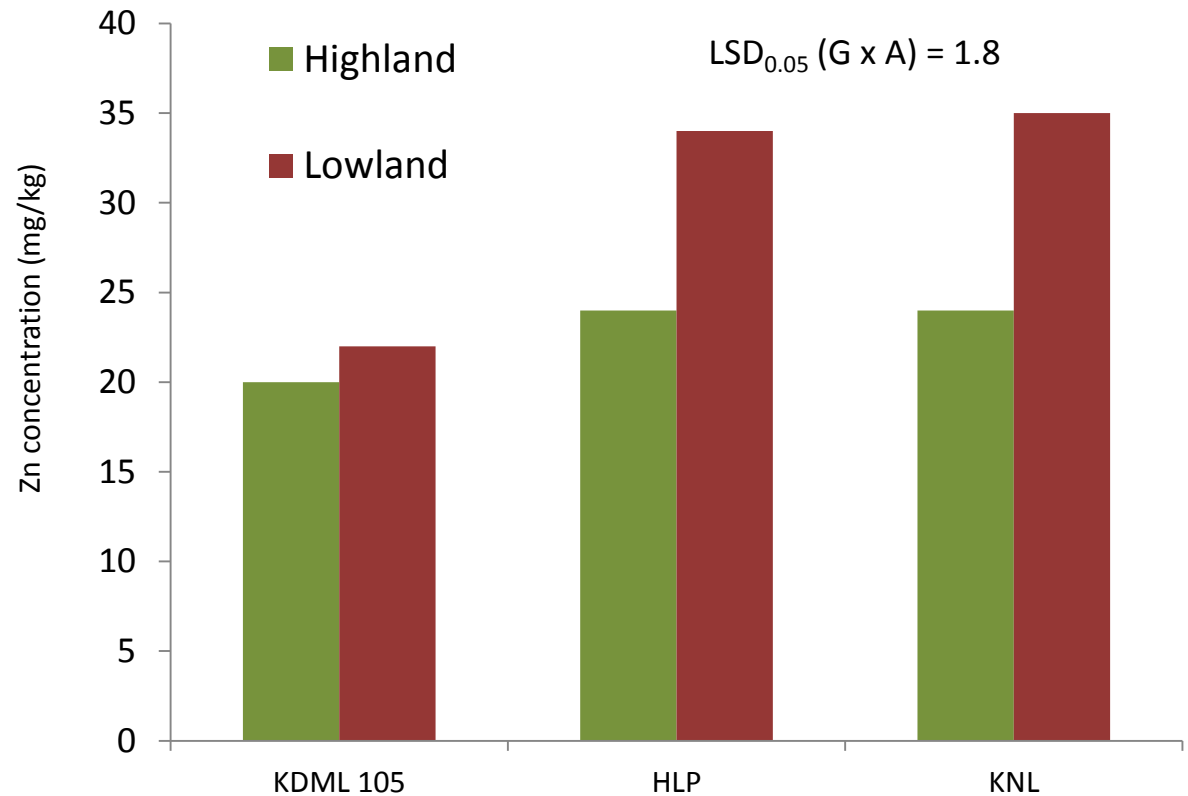
-Zn

+Zn

Grain Zn:
35 mg kg⁻¹

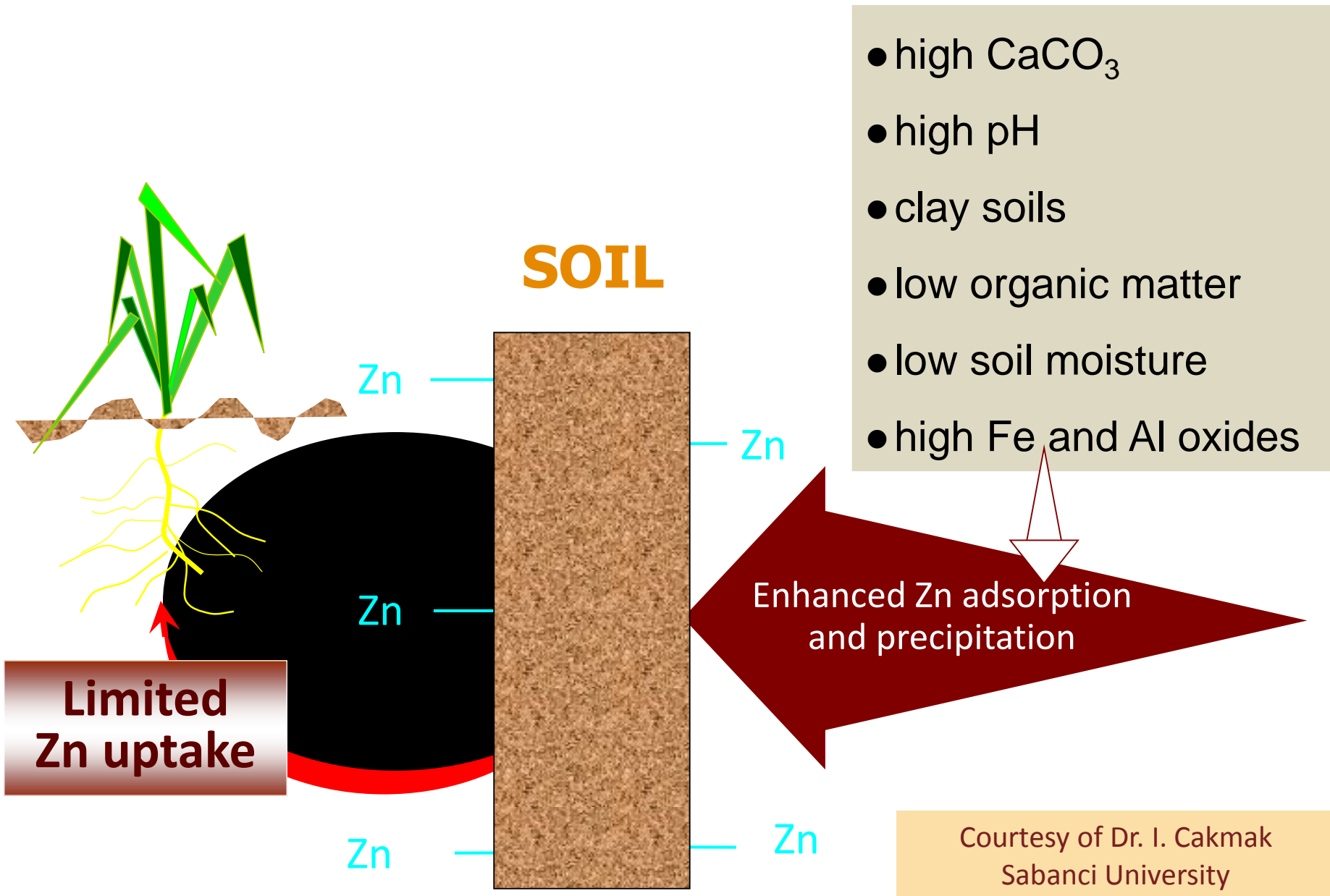
Grain Zn:
12 mg kg⁻¹

When Zn is different in soil and rice



Soil Zn concentration (mg/kg) DPTA extraction	
Highland	Lowland
0.4	1.5

Major Soil Factors Affecting Zn Uptake



Estimation:

For a better Zn nutrition of human beings, cereal grains should contain around **40-60 mg kg⁻¹ Zn**



Current Situation:
10-30 mg kg⁻¹ Zn



Solutions to Zinc Deficiencyy in Human Beings

- **Supplementation**
- **Food Fortification**
(Expensive approaches)

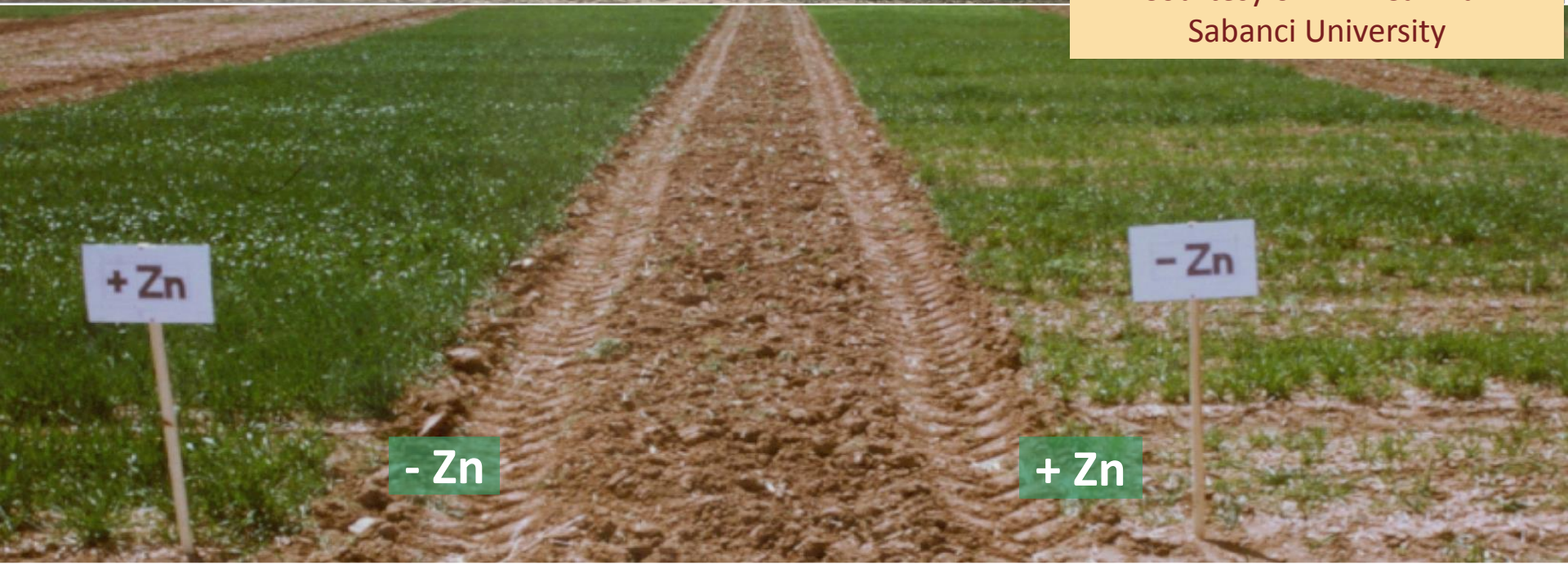


Improving Zn Density in Grain of Food Crops

Effect of Zinc Fertilization on Wheat Production in Central Anatolia



Courtesy of Dr. I. Cakmak
Sabanci University



+Zn

-Zn

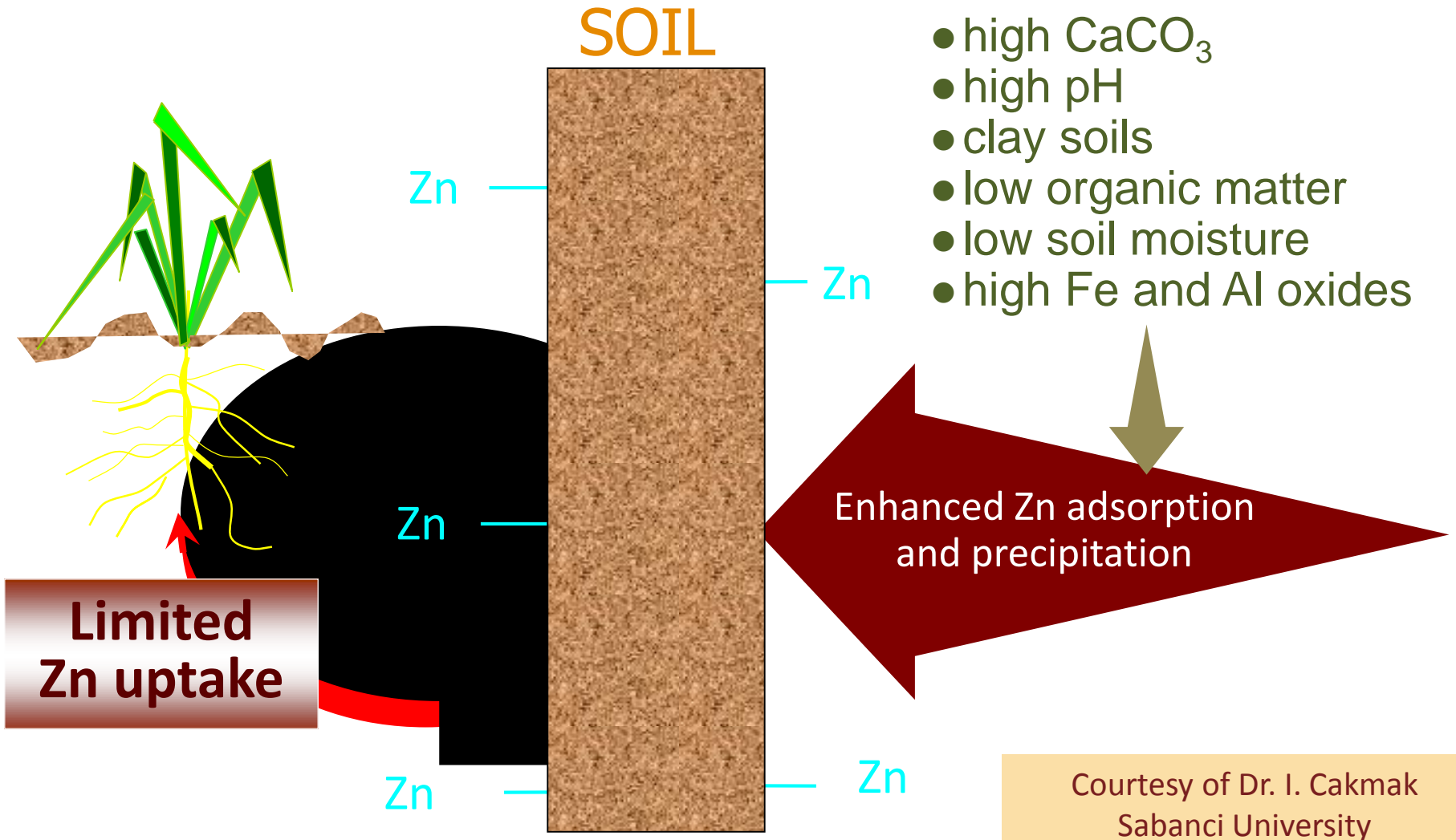
Zinc deficient fields in Konya:

+Zn

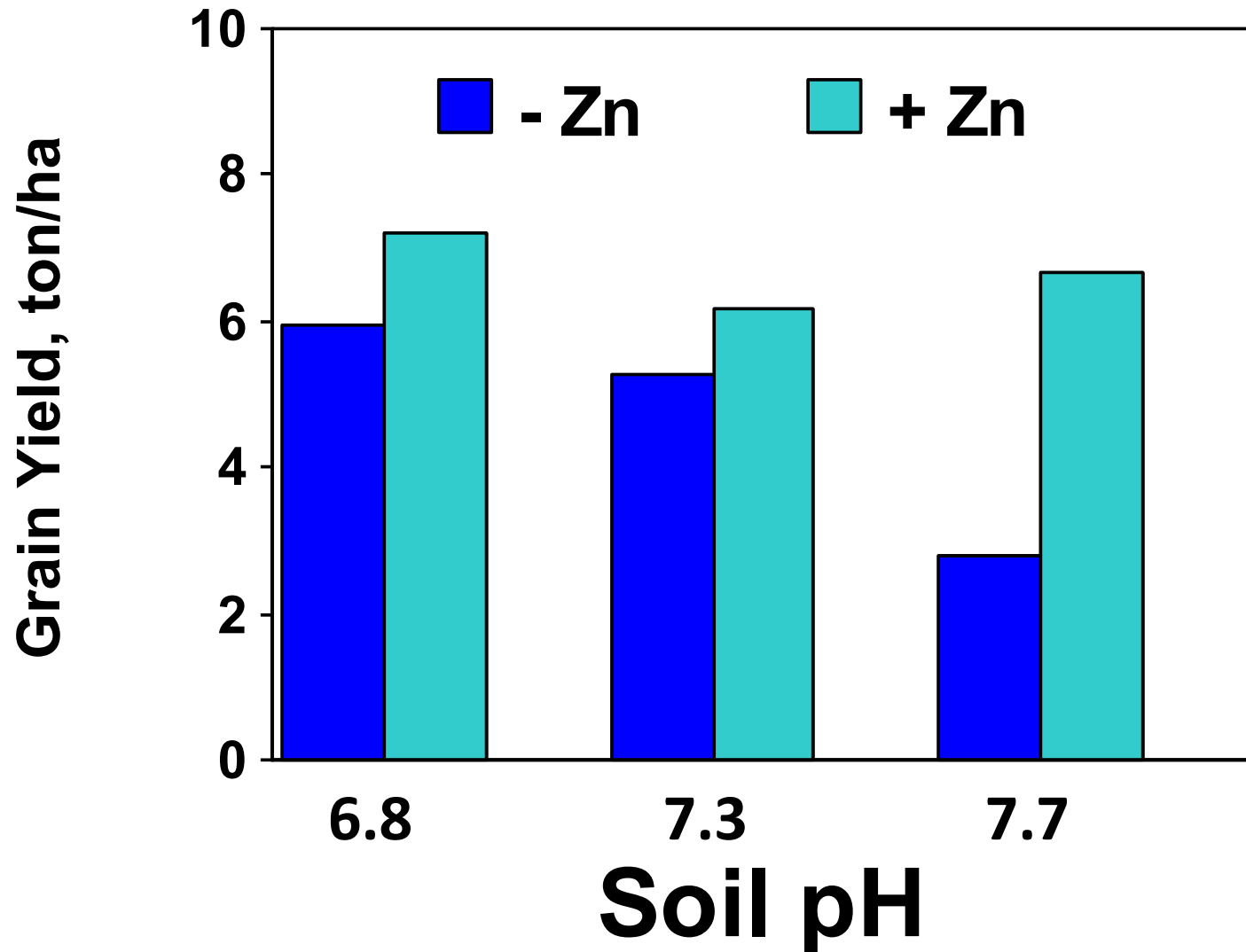
-Zn

Courtesy of Dr. I. Cakmak
Sahanci University

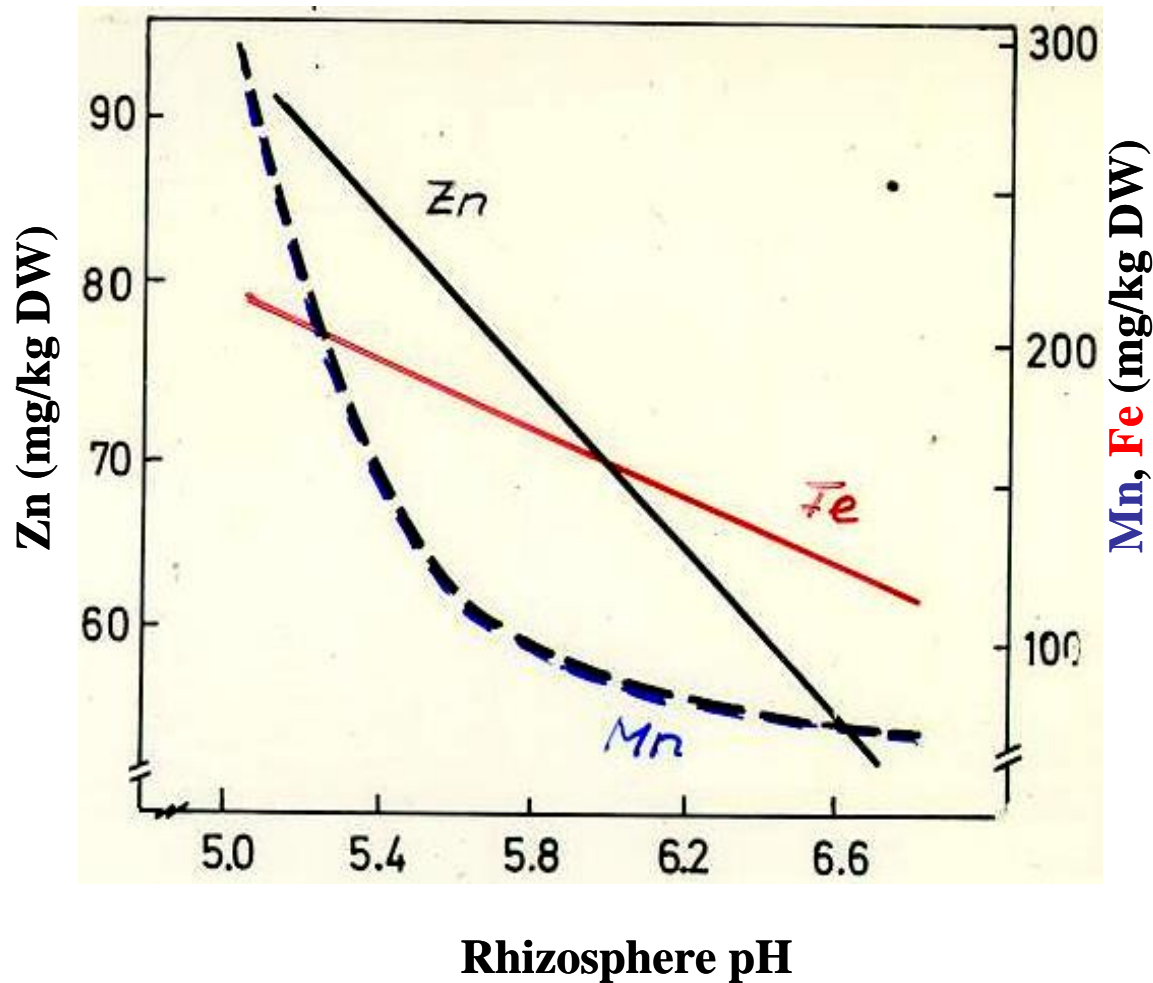
There are also several soil and plant factors that could limit the capacity of newly developed (biofortified) cultivars to absorb adequate amount of zinc from soils



Influence of soil pH and zinc supply on rice grain yield

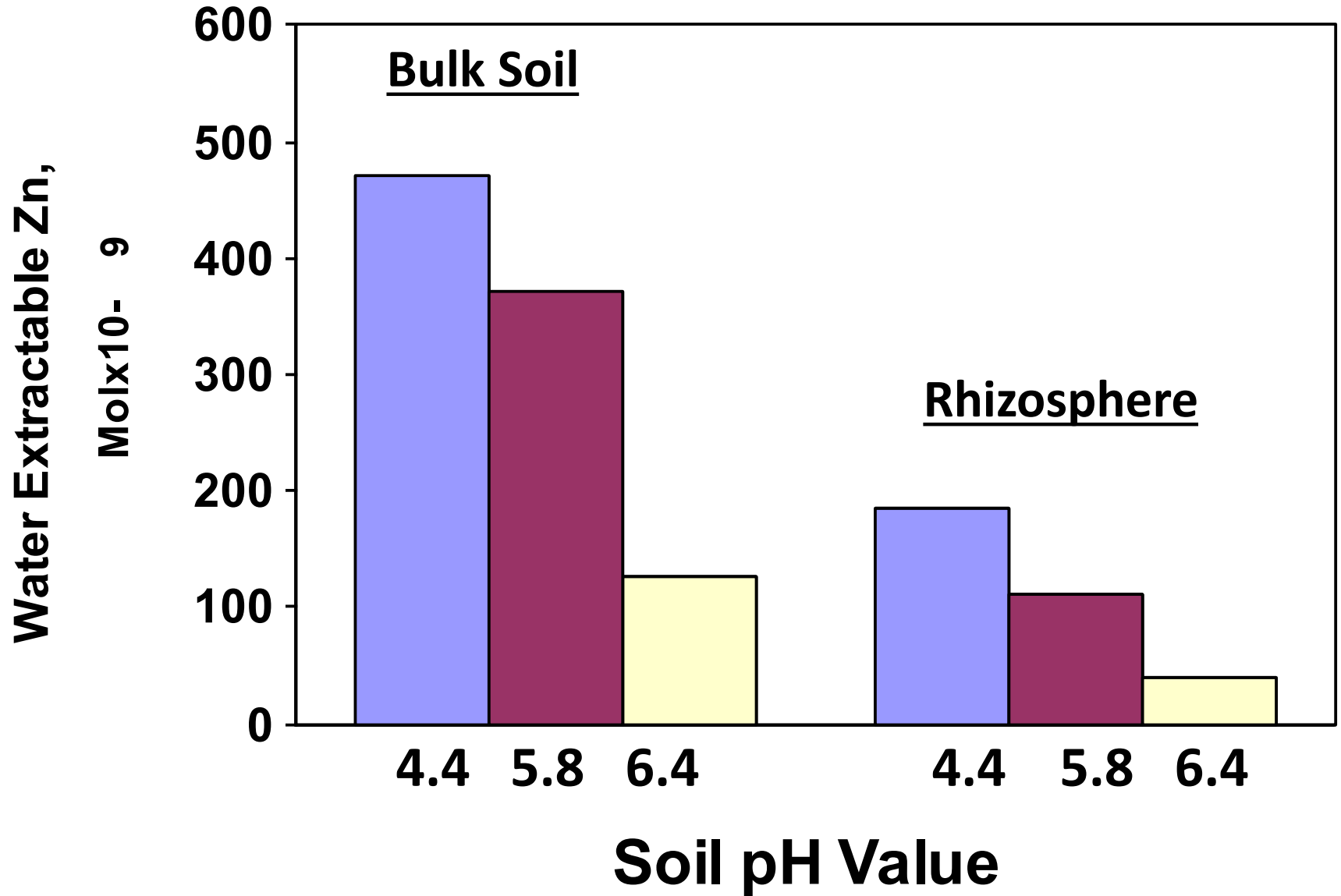


Soil pH Effect on Concentrations Of Micronutrients in Bean

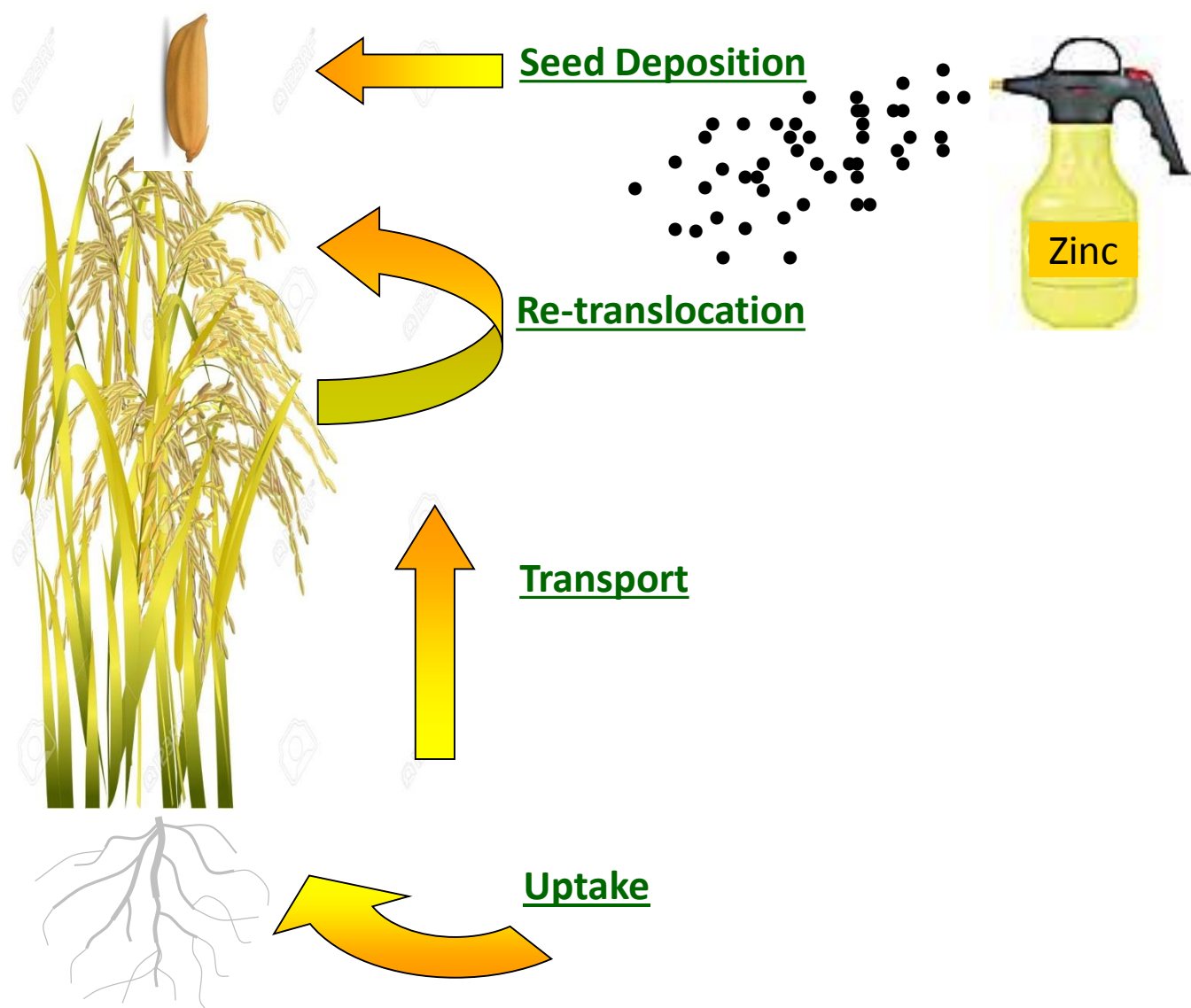


(Sarkar and Wyn Jones, Plant Soil 66, 361, 1982)

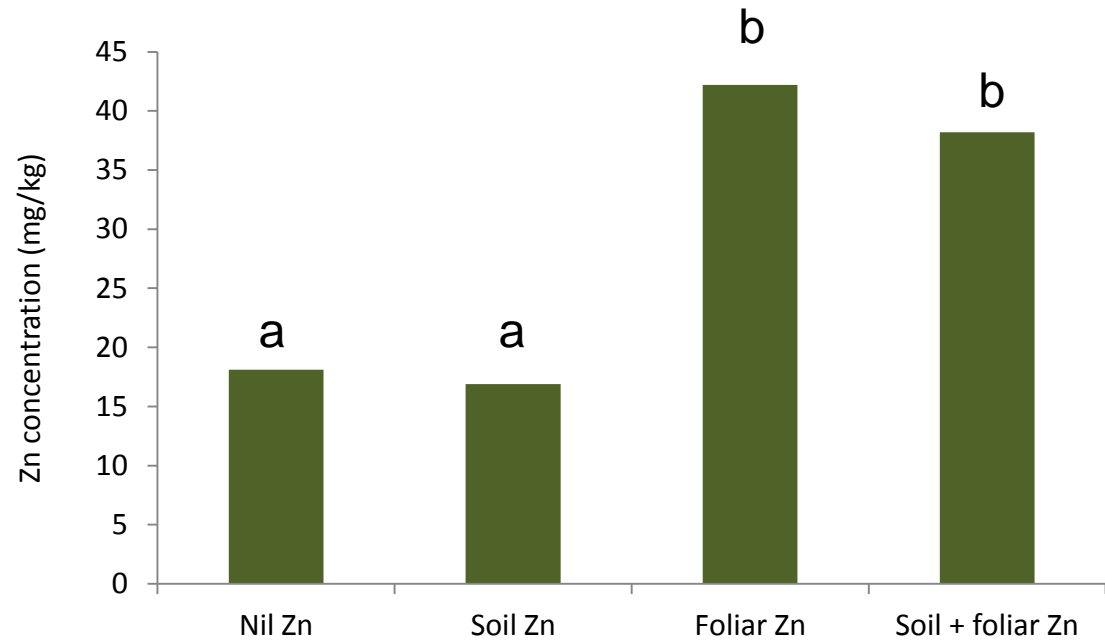
Soil pH: a critical factor reducing Zn availability



Root Zinc Uptake and Seed Deposition of Zn



Zn concentration in paddy rice of different Zn treatments



Increasing grain zinc provides double benefit



Nutritional value for human



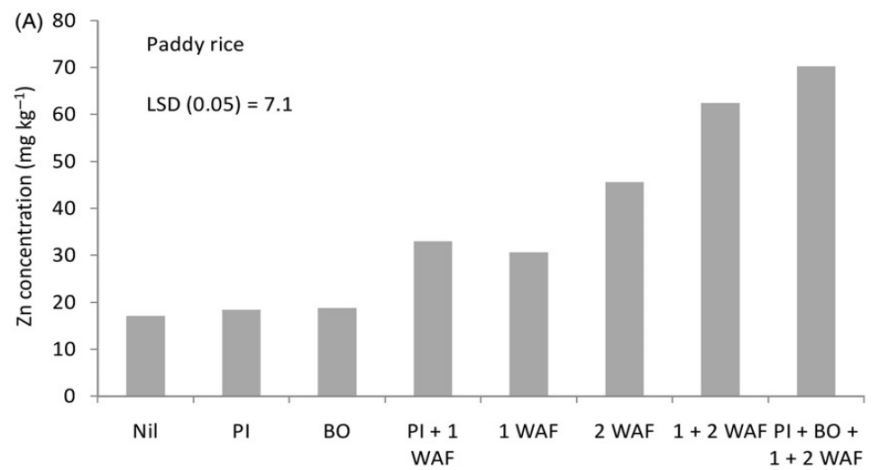
**Seedling growth and
development**

Period of foliar spray application with 0.5% zinc sulfate (ZnSO_4) cultivar CNT 1. The rate of application was 900-1000 L ha⁻¹.

Treatment	Plant growth stage when foliar spray application with 0.5% $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$	Symbol
1	Control (no foliar)	Nil
2	Panicle initiation	PI
3	Booting	BO
4	Panicle initiation and 1 week after flowering	PI + 1WAF [†]
5	1 week after flowering	1WAF
6	2 weeks after flowering	2WAF
7	1 week and 2 weeks after flowering	1 + 2WAF
8	Panicle initiation + Booting + 1 week and 2 weeks after flowering	PI + BO + 1 + 2WAF

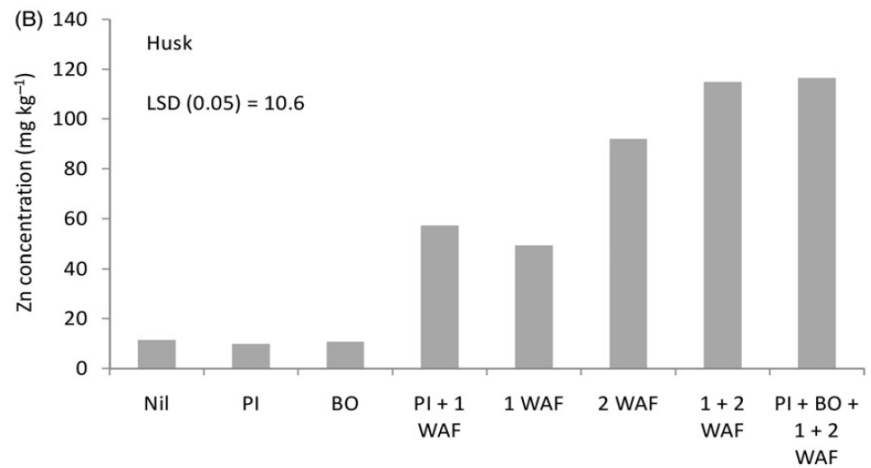
[†]WAF = Week after flowering.



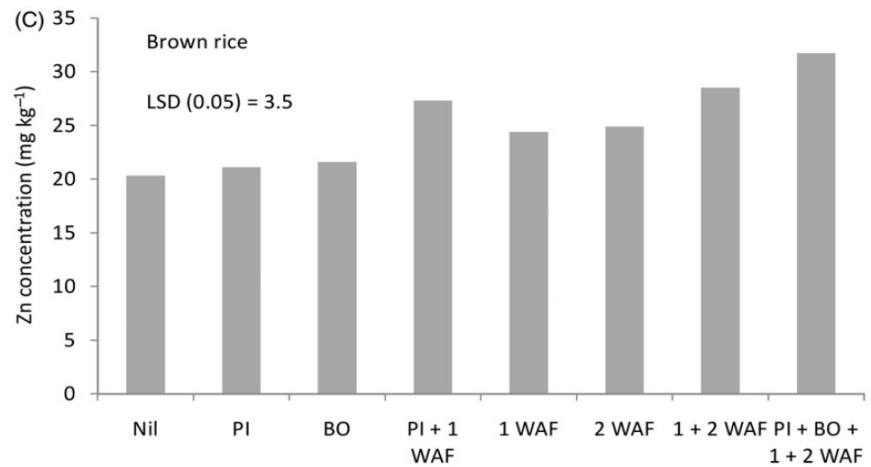


Zn concentration

Paddy rice

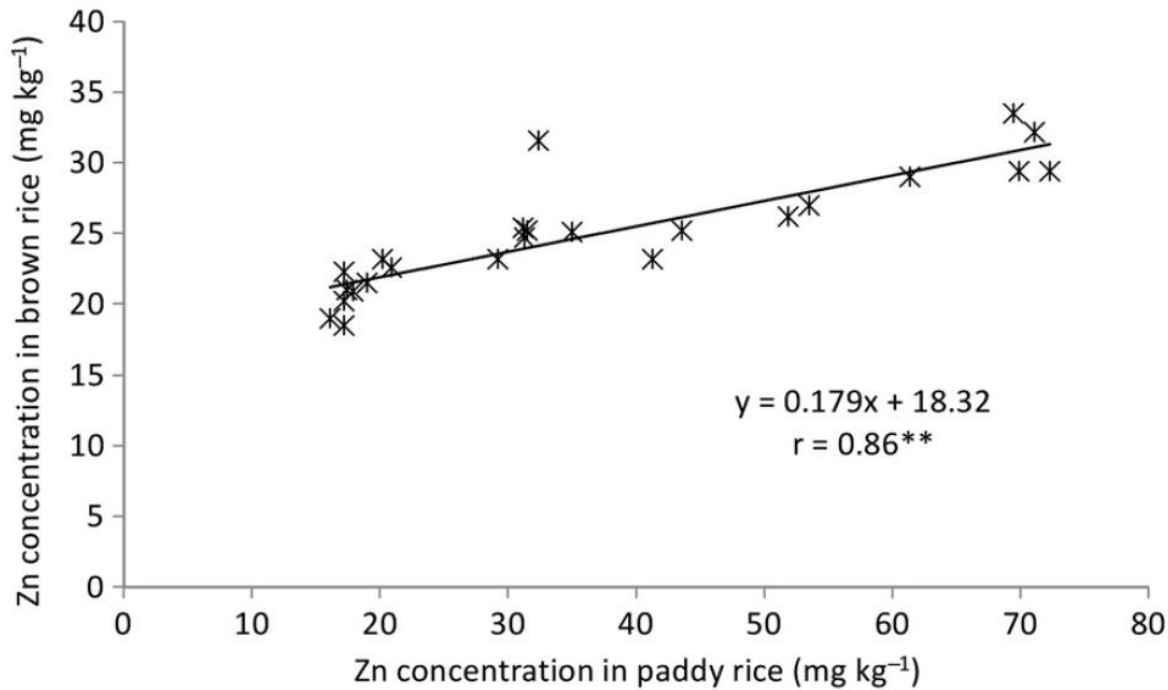


Husk



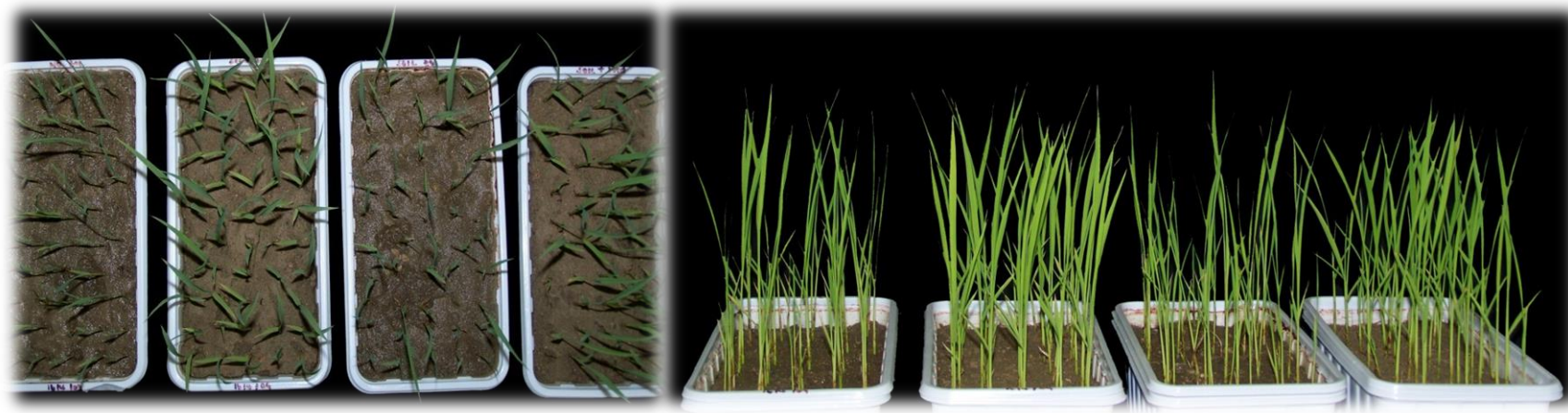
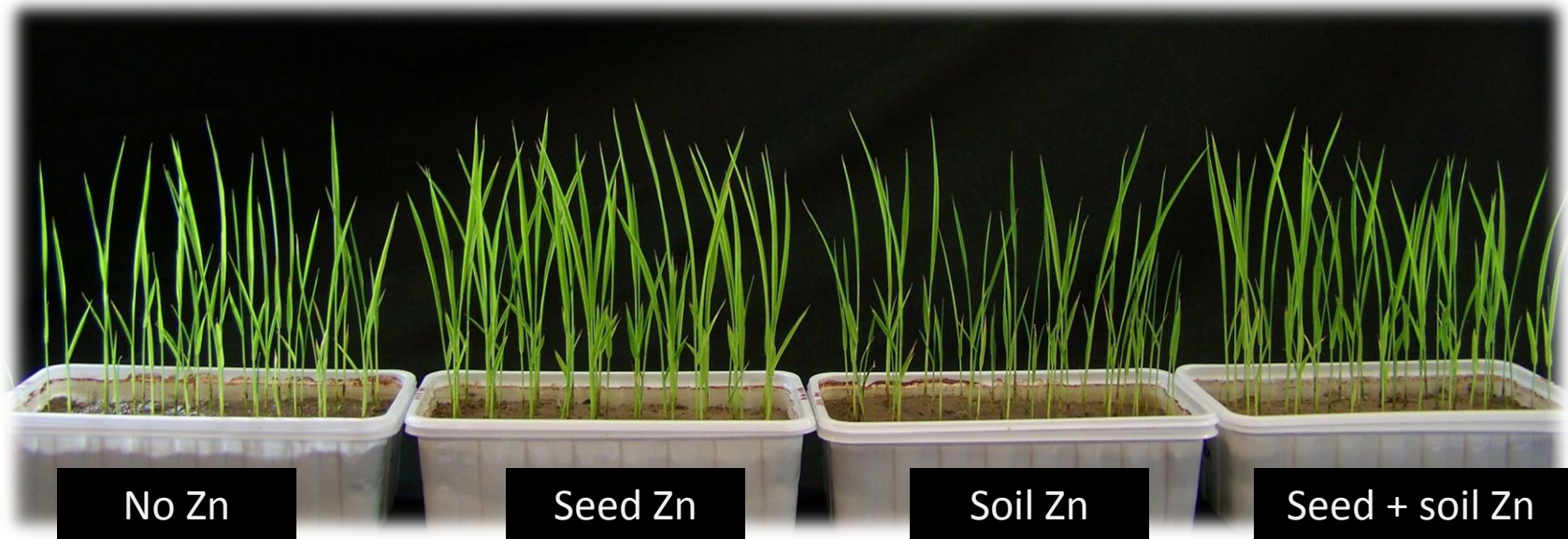
Brown rice

High Zn concentration in both paddy and brown rice after foliar Zn application



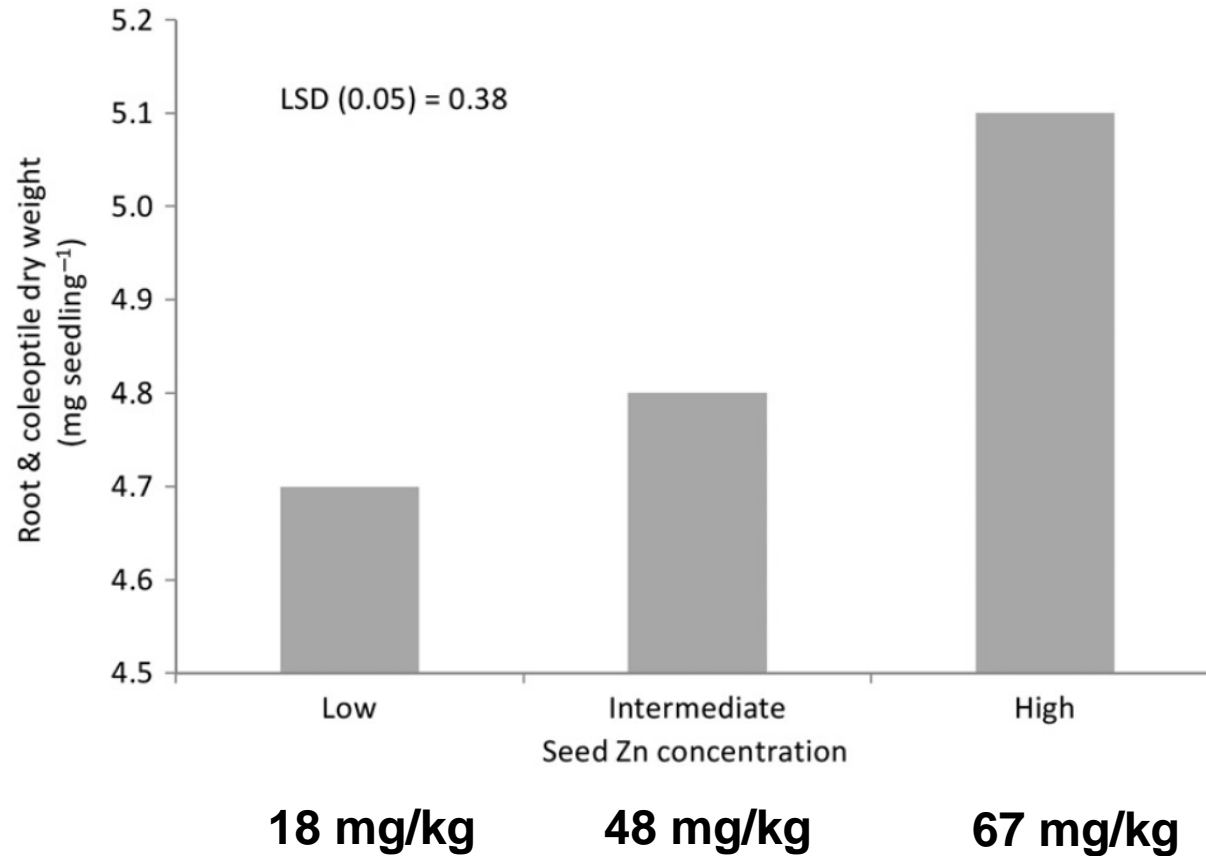
Germinated seed



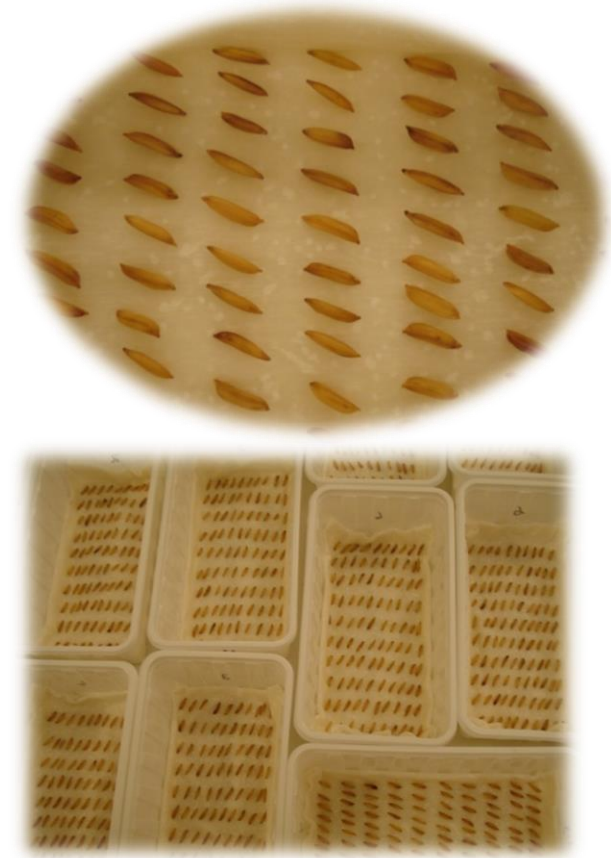
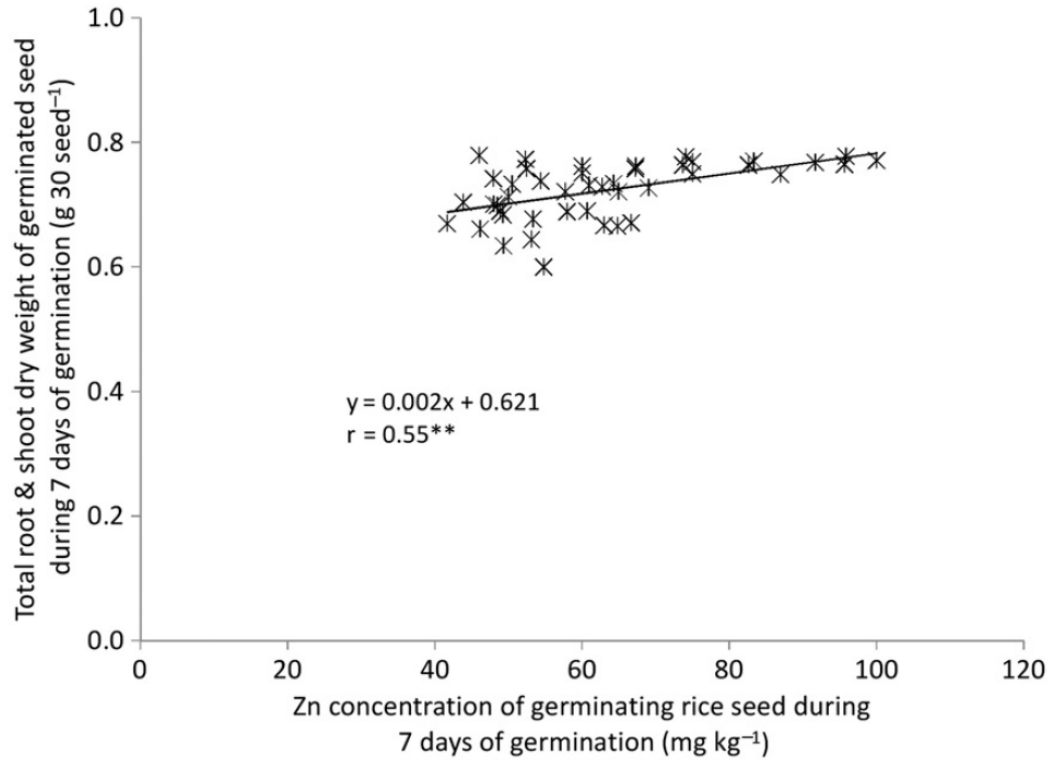


Each container contained 50 seeds

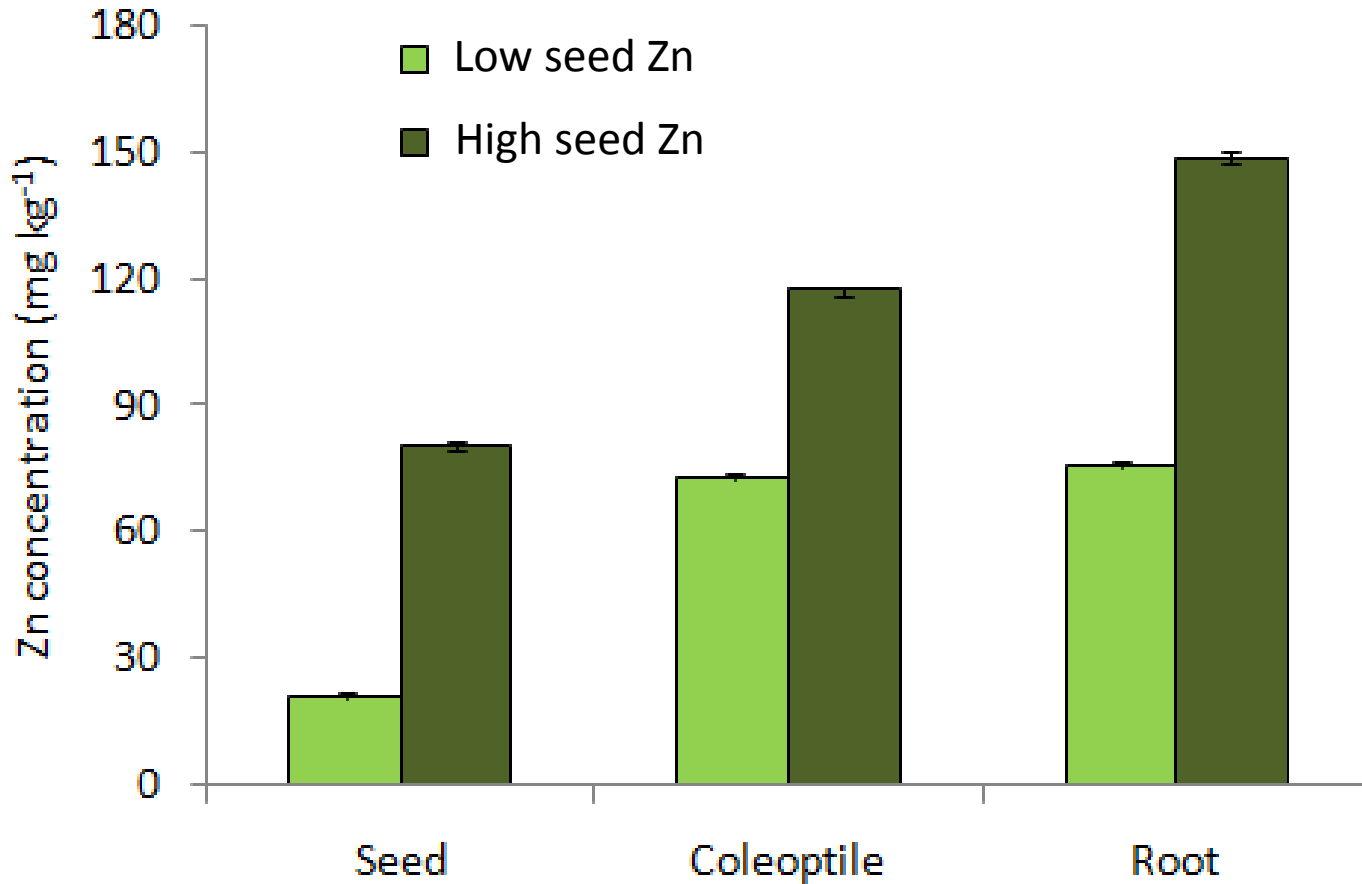
Seedling growth & development



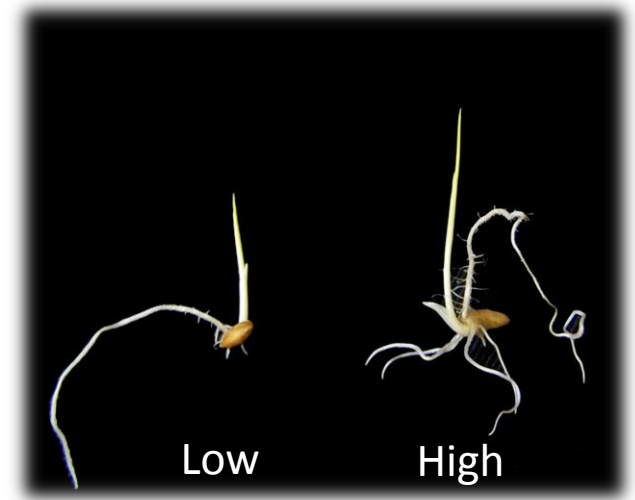
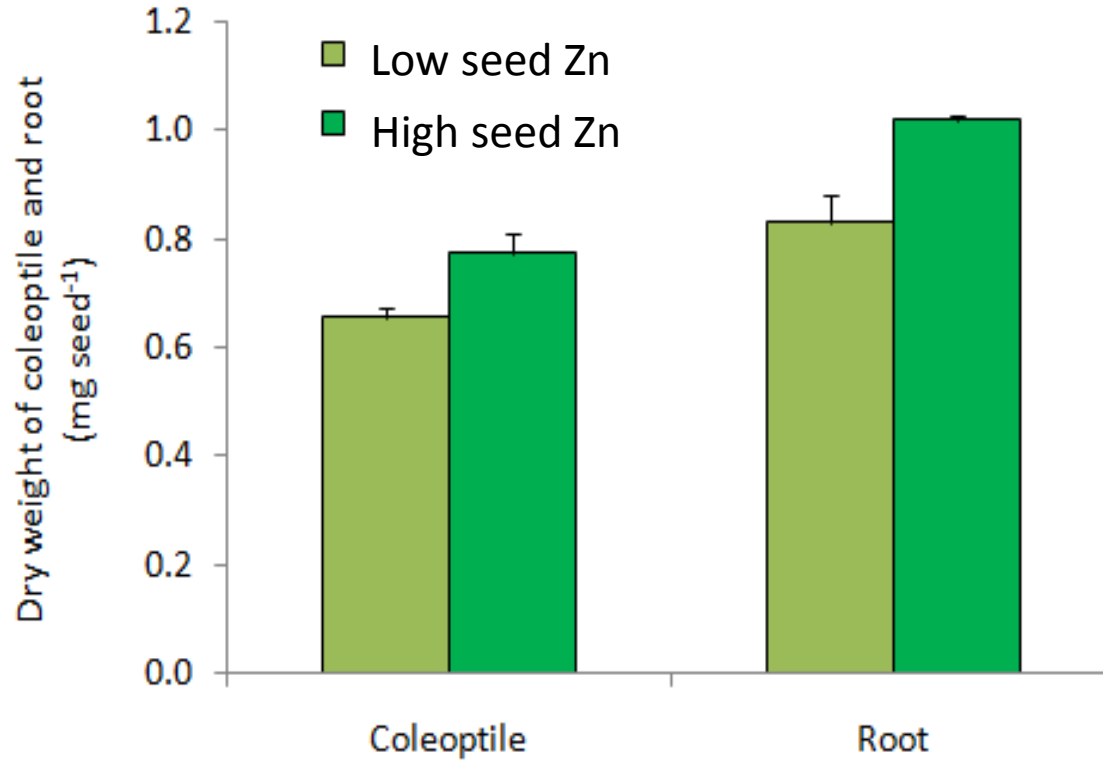
Higher seedling growth rate with high seed Zn concentration



Zn concentration in low and high seed Zn concentration after germination period



Dry weight of coleoptile and root in germinating seed



Maize, Paraguay, 1996



Plants are happy when their seeds are **“galvanized”**

Foliar Zn application



High seed Zn concentration



High nutritional value for human diets

Improve seedling growth & development

THANK YOU



CMU: University of Excellence
Where Nature Nurtures Beautiful Intelligence



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