Response of Lentil to Zinc Fertilization at Two Sites in Saskatchewan

S. Anderson, J. Schoenau, M. Maqsood, and A. Vandenberg

Zinc

- Essential trace element
  - Vital for enzyme function
  - Growth and development
- Human zinc deficiencies affect over 30% of the world population

Fig 1. Effect of foliar applied zinc on growth of barley plants in Central Anatolia (Cakmak, 2009)

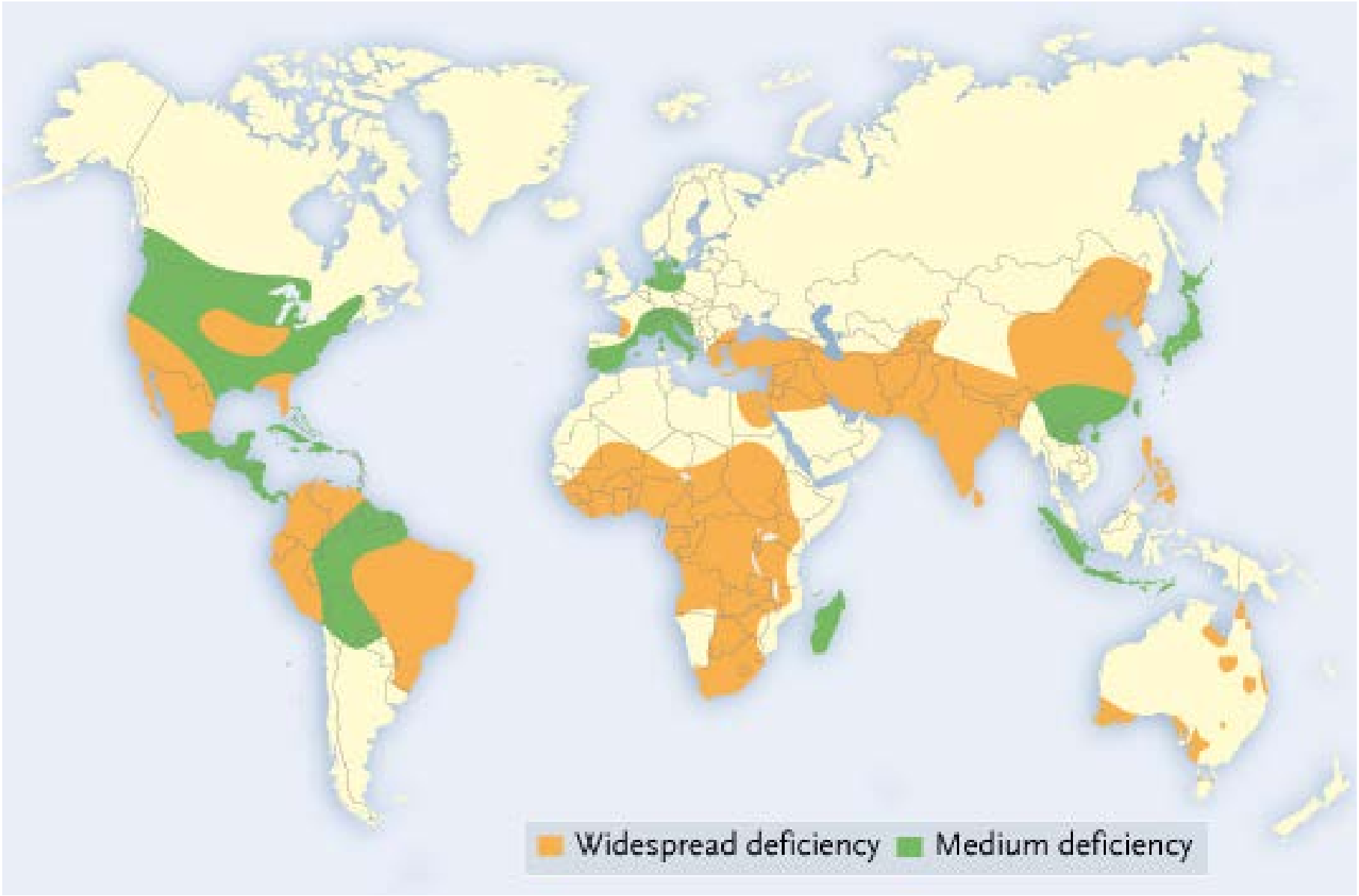


Fig 2. Regions of crop zinc deficiency as reported in international literature (Alloway, 2008)

Lentil

- Canada is world leader in lentil exports
- Economically important crop for Saskatchewan
- Increasing global lentil consumption
- Inherently low source of bioavailable Zn

Research Objectives

- Investigate lentil cultivar response to zinc fertilization, particularly in terms of an increase in yield and grain zinc concentration
- Determine what zinc fertilization rates, lentil genotypes, soil characteristics, and forms of zinc will result in the greatest response

Rate

Form

Red

CDC Maxim

Small Green

CDC Imvincible

Large Green

CDC Impower

Effects of soil applied zinc sulphate on lentil yield and grain zinc content under field conditions

Field Site Selection

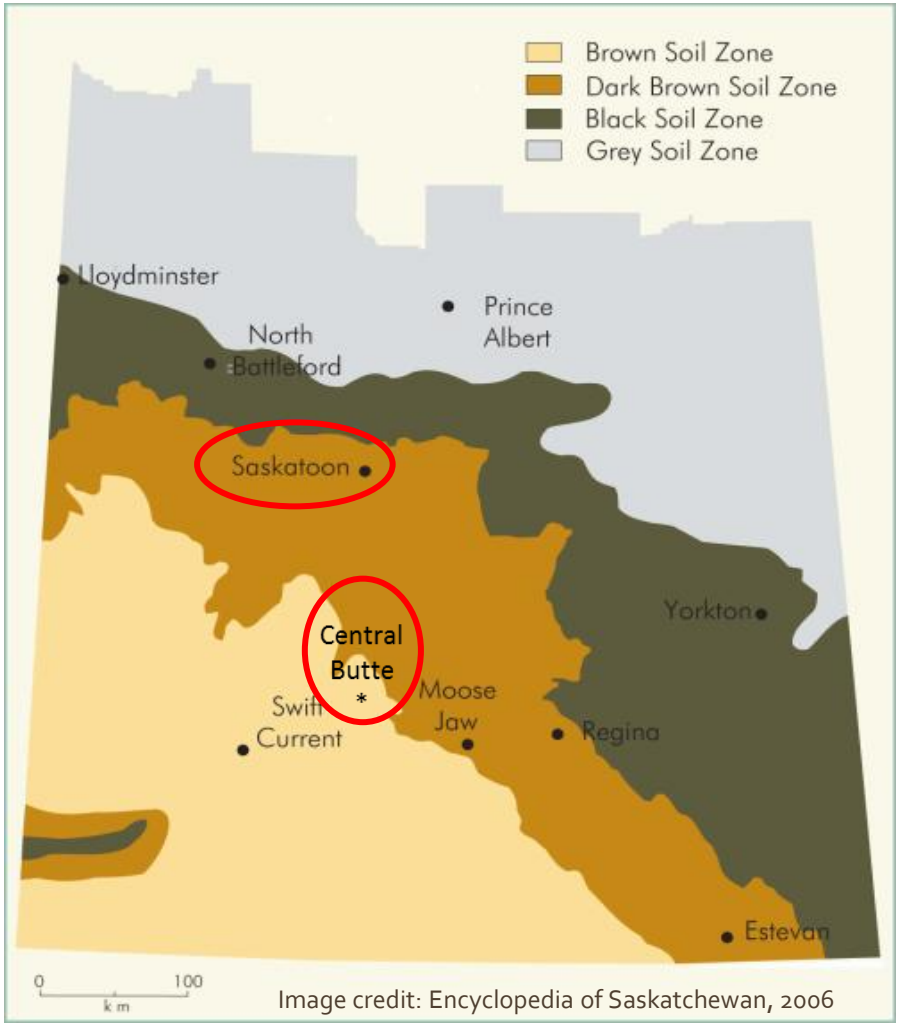


Image credit: Encyclopedia of Saskatchewan, 2006

Canadian Pulse Growing Regions

Bean Chickpea Lentil Pea

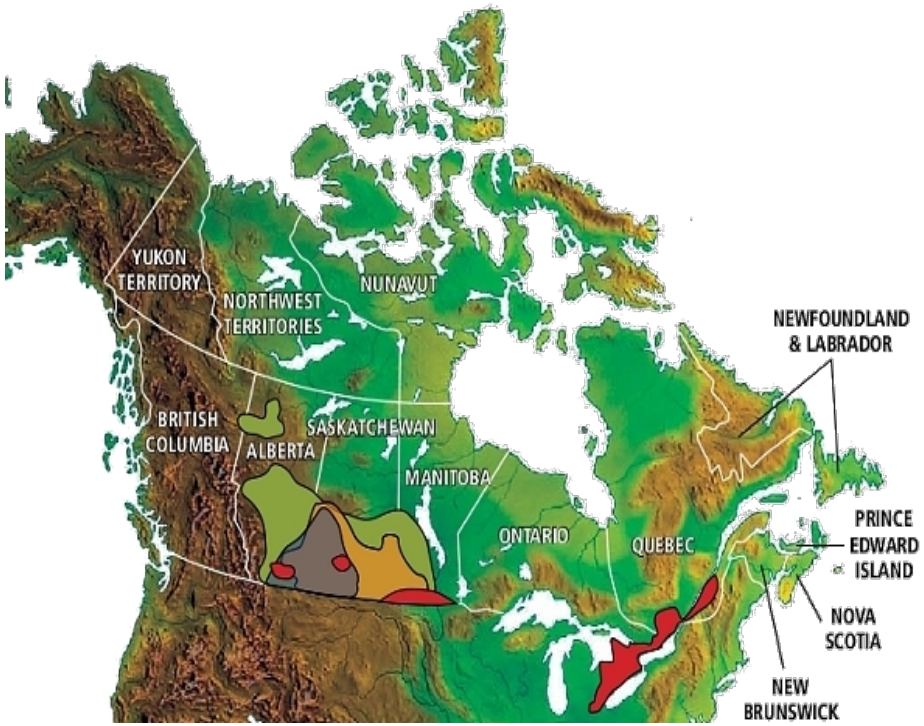


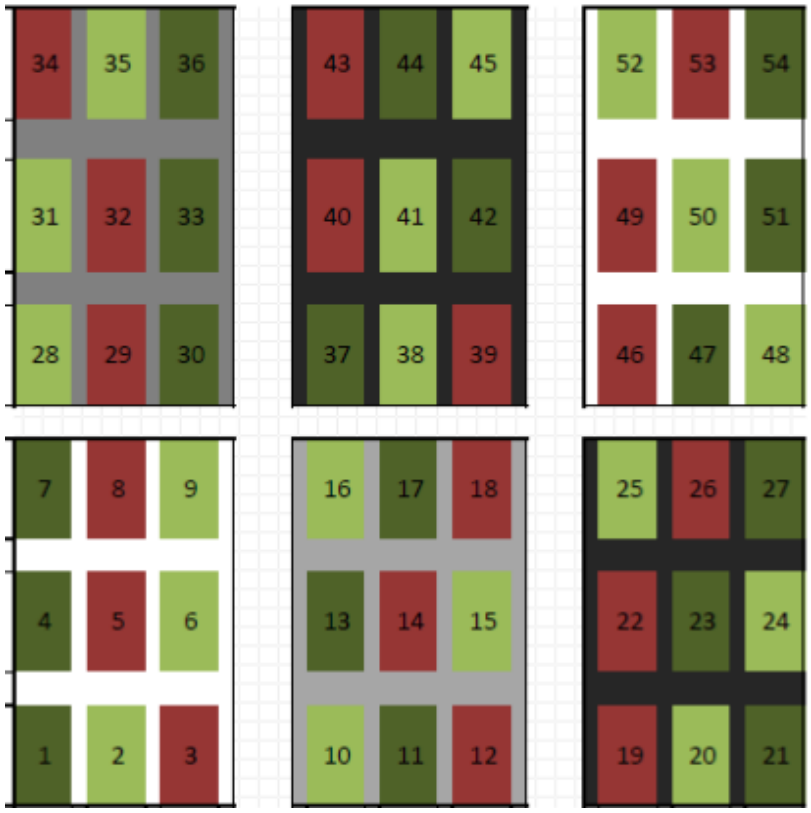
Image credit: Pulse Canada, 2014

Soil Characteristics

Table 1. Summary of baseline soil properties from Central Butte and Saskatoon field site locations (May, 2013).

Depth (cm)	Soil Property							
	pH	EC	OC	N	P	K	S	Zn
		(dSm^{-1})	(%)	($kg\ ha^{-1}$)				
	----------Central Butte----------							
0-15	8.0	0.23	1.4	8.4	17.7	535.0	14.8	0.93
15-30	8.1	0.26	-	8.5	-	-	16.9	0.54
30-60	-	-	-	10.4	-	-	645.1	-
	----------Saskatoon----------							
0-15	7.1	0.26	2.6	11.0	38.4	504.2	13.1	3.7
15-30	7.2	0.13	-	10.0	-	-	9.7	2.2
30-60	-	-	-	17.9	-	-	29.8	-

Experimental Set-Up



Main Plot: Fertilizer Rate

0 kg Zn ha^{-1} 2.5 kg Zn ha^{-1} 5 kg Zn ha^{-1}

Sub-Plot: Lentil Cultivar

CDC Maxim CDC Imvincible CDC Impower

Results- *Yield*

Table 2. Effect of three rates of $ZnSO_4$ on grain and straw yield (kg ha^{-1}) of three lentil cultivars

Site		Yield † Zn Rate (kg ha^{-1})			SEM‡	P values		
		0	2.5	5		Rate (R)	Cultivar (C)	R*C Interaction
Central Butte	Grain	2919a	2880a	2917a	359	0.994	0.554	0.925
	Straw	2597a	2502a	2508a	194	0.929	0.198	0.588

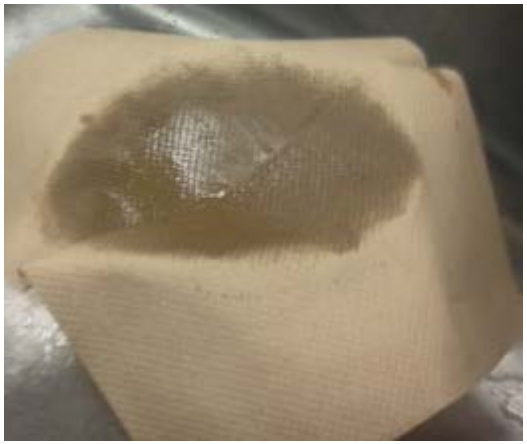
† Means with the same letter in the same row are not significantly different (P>0.05) as determined by multi-treatment comparisons using the Tukey-Kramer method.
‡ SEM= standard error of mean

Effects of zinc fertilizer amendments on yield and grain zinc content under controlled conditions

Soil Preparation and Planting

- Base Macronutrient Application
- Control Treatment
- Soil Zinc Treatments
  - $ZnSO_4$
  - 9% Zn chelated with EDTA
- Foliar Zinc Treatments
  - 9% Zn chelated with EDTA
  - 7% Zn Lignosulphonate

Foliar Fertilization



- 8th-9th node stage
- 6 sprays= 1 ml pot^{-1}= 500 L ha^{-1}

Results- *Yield*

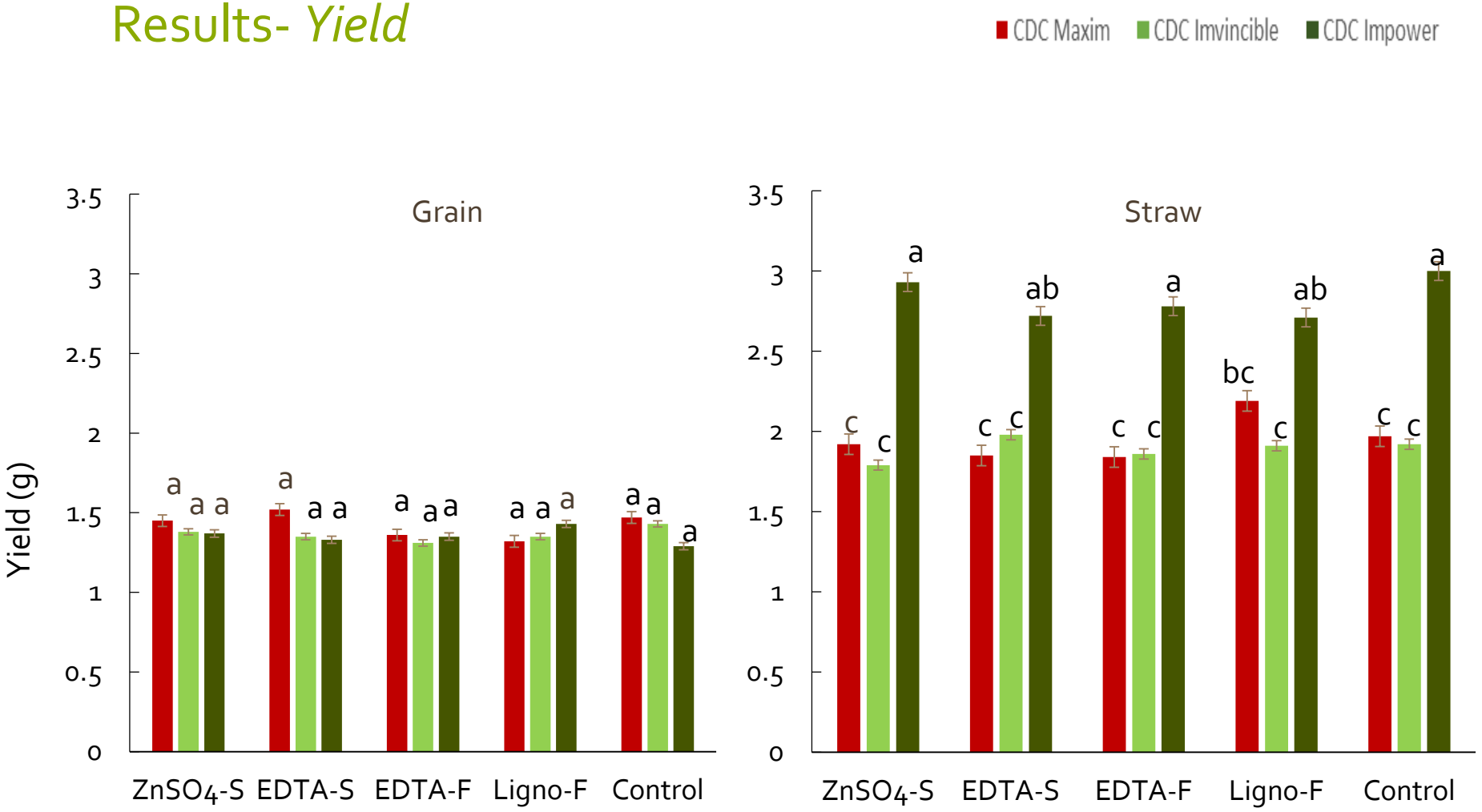


Fig.4. Yield (g) of grain (left) and straw (right) of three lentil cultivars grown in a pot study under controlled conditions. For a given plant component (grain or straw), variety, and form, means with the same letters are not significantly different (P>0.05) as determined by multi-treatment comparisons using Tukey-Kramer method.

Results- *Zinc Concentration*

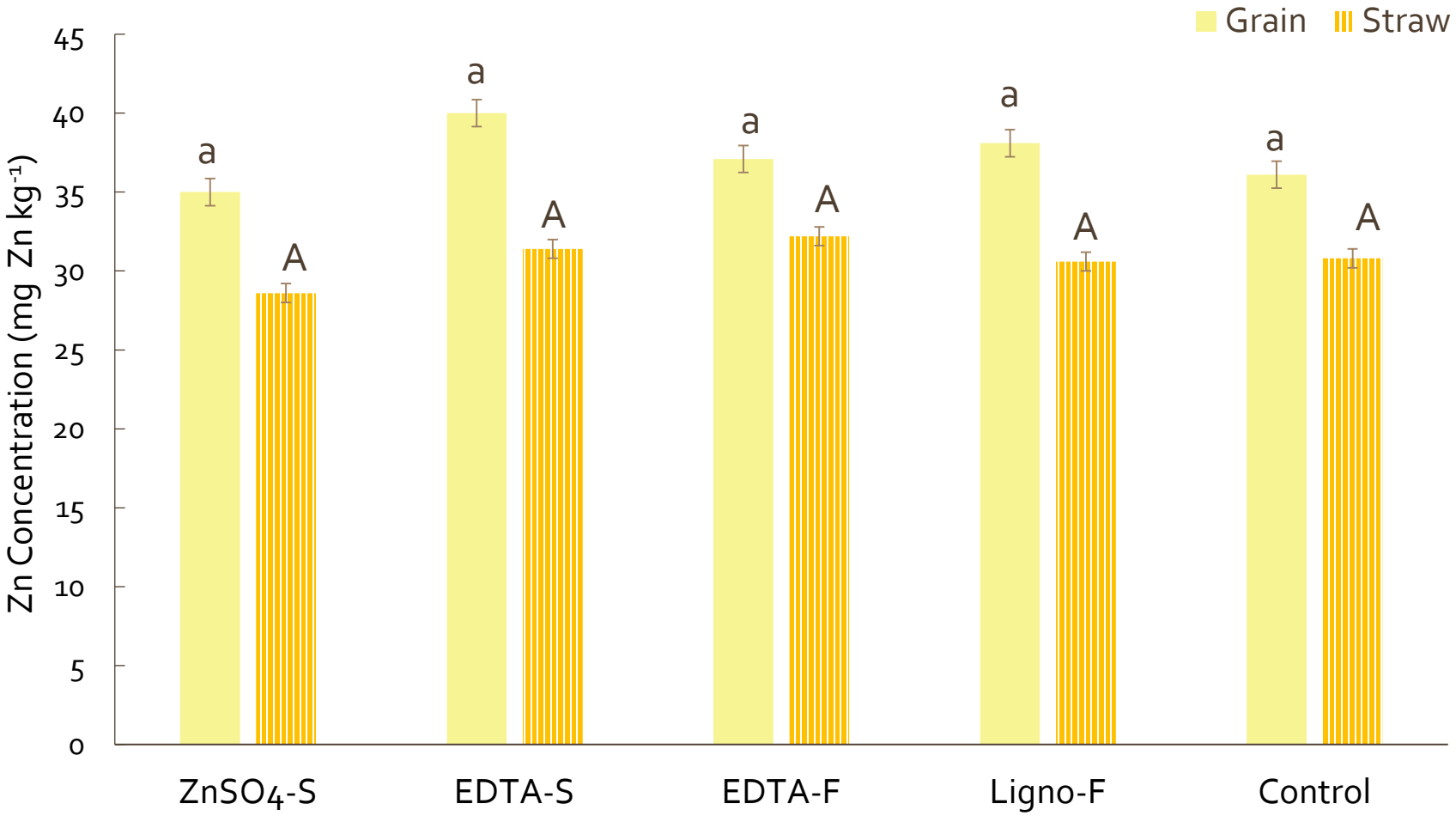


Fig.5. Zinc concentration (mg Zn kg^{-1}) of grain (solid bars) and straw (striped bars) of five fertilizer treatments. For a given plant component (grain or straw), means with the same letters are not significantly different (Tukey-Kramer, P>0.05)

Results- *Zinc Removal*

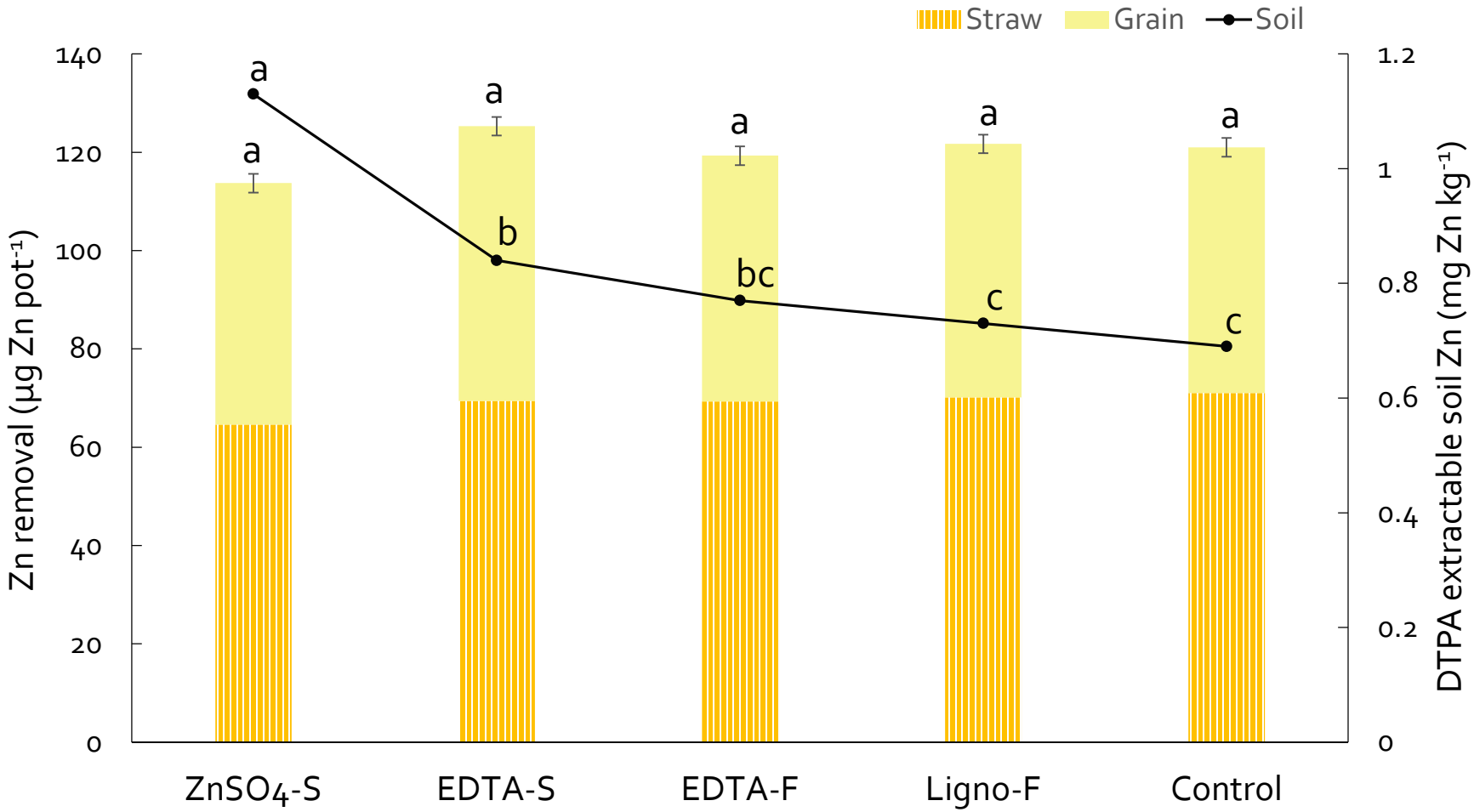


Fig.6. Comparison of Zn fertilizer treatment effects on residual DTPA extractable soil Zn (mg Zn kg^{-1}) against total Zn removal (g Zn pot^{-1}) partitioned into uptake by grain (solid bars) and uptake by straw (striped bars). For a given measurement, means with the same letter are not significantly different (P>0.05). Error bars are standard error of the mean.

Results- *Zinc Removal*

Table 2. Zn removal (µg Zn pot^{-1}) in three different lentil cultivars grown under controlled conditions and amended with five different Zn fertilizer treatments.

Cultivar	Zn Removal (µg Zn pot^{-1}) †		
	Straw	Grain	Total
CDC Maxim	58.7b	54.2a	112.9b
CDC Imvincible	58.1b	50.1a	108.2b
CDC Impower	89.9a	49.6a	139.4a
SEM‡	2.92	3.00	4.54
P-value	<.0001	0.494	<.0001

† Means with the same letter in the same column are not significantly different (P>0.05) as determined by multi-treatment comparisons using the Tukey-Kramer method.
‡ SEM= standard error of mean

Conclusions

- Soil applied $ZnSO_4$ did not improve yield or grain zinc content
- Yield differences between cultivars, but not in response to zinc
- No significant differences between soil and foliar forms of zinc
- Total zinc removal does not differ significantly between zinc forms
  - Under controlled conditions, CDC Impower removes more zinc than CDC Maxim and CDC Imvincible
- Residual soil extractable zinc is significantly greater when $ZnSO_4$ is applied compared to other forms

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SASKATCHEWAN pulse Growers

Questions?