# Effectiveness of Different Iron Treatments in Enhancing Dry Edible Bean Yield and Quality


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## 01. Introduction

- Dry edible beans (*Phaseolus vulgaris* L.) are extensively grown throughout the Western Great Plains (WGP).
- Iron deficiency chlorosis (IDC) is common in calcareous (high $CaCO_3$) soil which is the dominant soil type in WGP.
- IDC usually limits the yield and quality of crops and fruits due to the decrease in leaf photosynthetic pigment concentrations, especially chlorophyll.
- Soil management can help increase Fe uptake, reduce IDC and increase bean yield and quality.

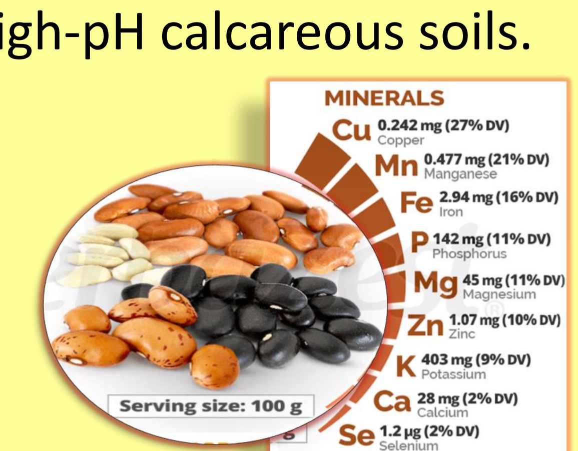
$Fe^{2+}$ —calcareous soil/high pH→ $Fe^{3+}$

Available to plants → Unavailable to plants

Iron chlorosis in dry bean

## 02. Objectives

- To determine the effects of application of granular Fe (Ferrous Sulfate; $FeSO_4$) and foliar Fe (Ferrichel Ninety®, YARA, Norway) on yield and quality (measurable digestibility, peptide content, bioavailability, bio accessibility and solubility) of dry edible bean grown on high-pH calcareous soils.




Bean minerals

## 03. Methodology

- The experiment was conducted at the University of Nebraska-Lincoln Panhandle Research and Extension Center in Scottsbluff, NE.
- The field area that had beans with IDC symptom in the spring was selected.
- Design is a randomized complete block design (RCBD) and with four replicates.
- Treatment includes the control (T1), $FeSO_4$ (T2) and Ferrichel Ninety® (T3).
- Each treatment plot is 4 rows (0.56 m) by 6.1 m long.
- $FeSO_4$ and Ferrichel Ninety® application rate is equivalent to 4.5 kg Fe $ha^{-1}$
- $FeSO_4$ (20.4 g $plot^{-1}$) - granules form, Ferrichel Ninety® (67.8 g $plot^{-1}$) - liquid form.
- Middle two rows of the plot each 3.05 m long were harvested at maturity.
- Subsamples of harvest bean samples were analyzed for crude protein and minerals (Fe, Ca, P, K, Mg, S, Na, Mo, Zn, Mn, Cu).
- Analysis of measurable digestibility, peptide content, bioavailability, bio accessibility and solubility will gateway.

**Data Analysis**

- Descriptive statistics were calculated in Excel (office 365).
- Statistical analysis was performed in SAS 9.0.
- One way analysis of variance (ANOVA) was conducted using function PROC ANOVA in SAS to test treatment effect on yield and quality parameters.
- When the main effect was significant, means were separated by the LSD test.
- Statistical significance was evaluated at significance level $p<0.05$.

## 04. Results

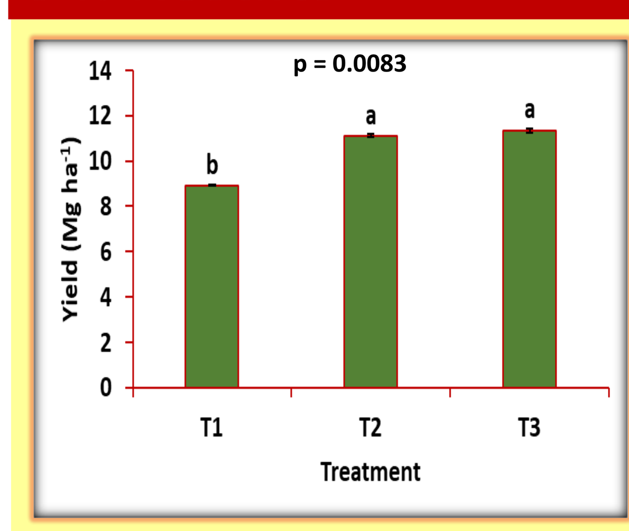



Fig 01: Bean yield under different treatments

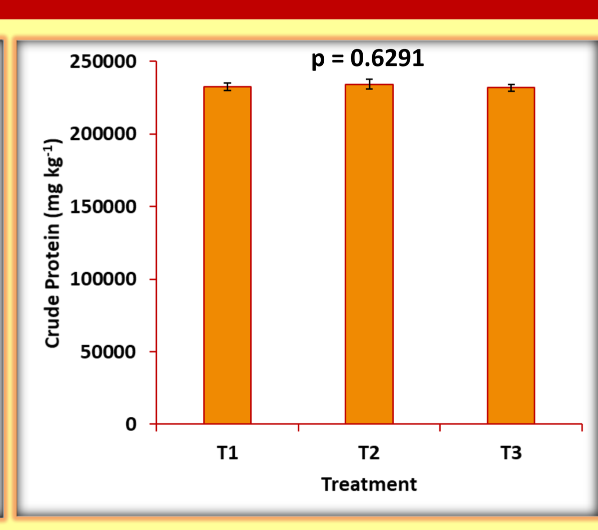



Fig 02: Crude protein concentration in bean seeds under different treatments

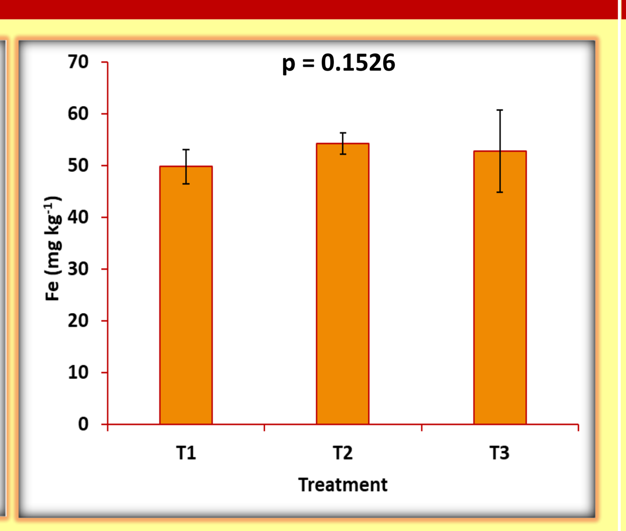



Fig 03: Fe concentration in been seeds under different treatments

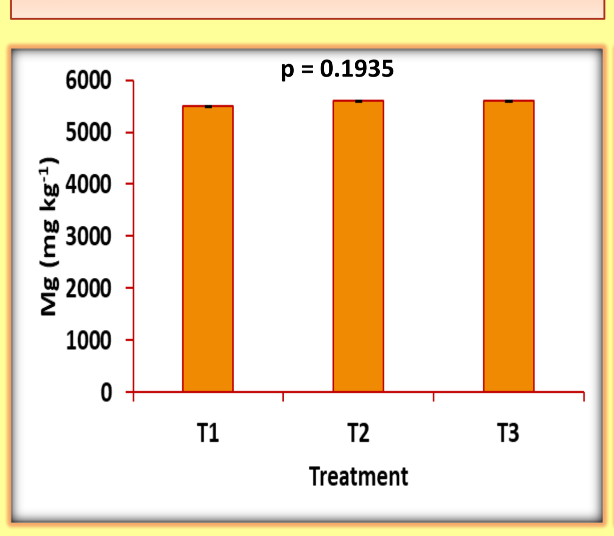



Fig 04: Mg concentration in bean seeds under different treatments

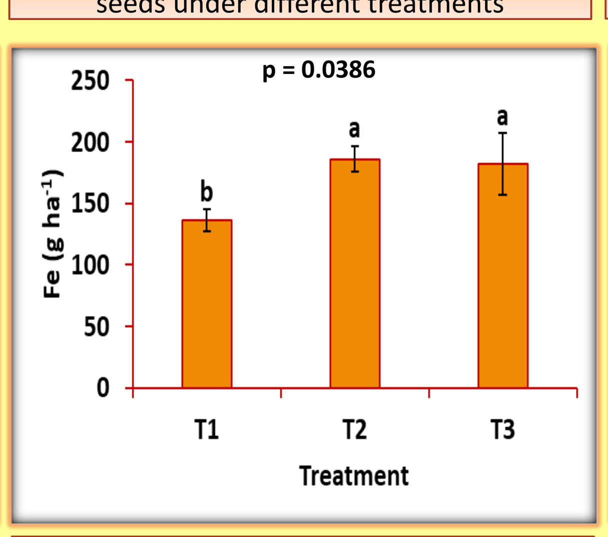



Fig 05: Fe content in harvested bean under different treatments

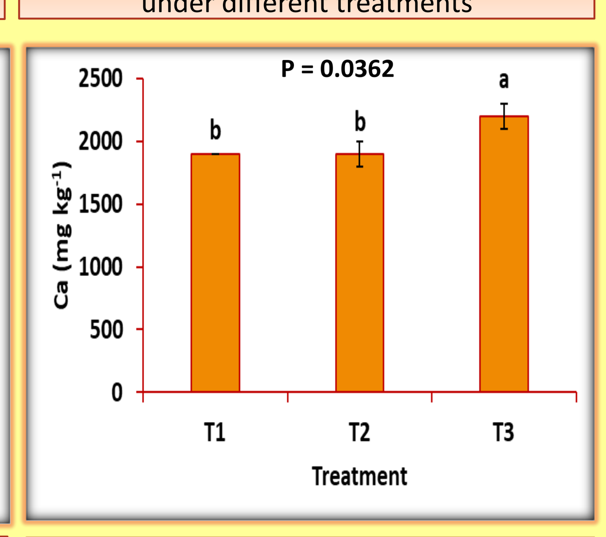



Fig 06: Ca concentration in bean seeds under different treatments

## 05. Discussion

- Bean yield gain with Fe treatments (foliar and granular) observed in this study (Fig. 01) aligned with other studies that reported yield gain with foliar and soil application of Fe on soybean (Moosavi & Ronaghi, 2011) and chelate Fe application on dry bean (Hergert et al., 2019) in high pH soils.
- Bean crude protein (Fig.02) and minerals such as Fe (Fig.03), N, P, K, Mg (Fig.04), Zn, Mn, Cu, etc. did not vary by treatments in this study. The Fe content (Fig. 05) in the beans (calculated as the product of bean yield and bean Fe concentration) was greater in the Fe-applied treatment plots than in the control. Application of Ferrichel Ninety® significantly increased bean Ca concentration compared to the control and $FeSO_4$ treatments (Fig. 06).
- In contrast to our findings, there are other reports that showed Fe application significantly improved the crude protein and mineral contents in beans (Márquez-Quiroz et al., 2015).
- The Fe treatments are generally recommended to apply soon after IDC is observed. The treatments were applied mid-Jul in this study. The late application could have decreased the potential benefits of adding Fe to IDC affected beans.

## 06. Summary and Conclusion

- Application of $FeSO_4$ and Ferrichel Ninety® increased the bean yield by 24.61% and 26.20% respectively. The Fe application also increased Fe content in harvested bean. Foliar Fe application (Ferrichel Ninety®) increased Ca content in harvested beans than the control or soil applied Fe ($FeSO_4$).
- The Fe application can prevent the bean yield loss due to IDC. Foliar-applied Fe may produce higher quality bean than soil-applied but it needs further investigation.

## 07. Bibliography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