



## **The Influence of Iron Chelates on Chlorophyll Content and Yield of Bajra Napier**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. Authors SSS, DJ, TC, CB and LL designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors CB and LL aided in conducting of the experiment, managed the analyses of data and supported in overall conduct of research. All authors read and approved the final manuscript.*

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### **ABSTRACT**

Bajra Napier is an important forage crop. Numerous studies have reported a direct relationship between ferrite levels and physiological function of plants. The present study investigates the impact of iron sources and its levels on yield and chlorophyll content of Bajra Napier. The experiment was carried out in a Factorial CRD with 3 factors namely seven sources of Iron (Fe glycinate, Fe citrate, Fe tartrate, Fe glutamate, FeSO<sub>4</sub>, Fe-EDDHA, Fe malate) four levels (FeSO<sub>4</sub> - 0, 25, 37.5 and 50 kg ha<sup>-1</sup> and Fe chelates - 0, 1, 2.5 and 5 kg ha<sup>-1</sup>) and two different soils (Calcareous and Non-calcareous). The results revealed that the iron application increased the chlorophyll concentration and yield, and it was also seen that as the level increased there was an increase in both the characteristics. These results indicated that applying Fe chelates have significantly improved the quality of produce and it was seen that there was an improvement in the iron uptake and the fodder yield showed a greater increase when compared to ferrous sulphate.

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## 1. INTRODUCTION

Bajra Napier grass is a valuable, high biomass producing tropical grass and is well recognized throughout our country for its palatability and good fodder quality. Manure can be a valuable source of nutrients for grass. A number of factors, including soil type, rate and method of application, forage management and environmental conditions can impact the effectiveness of different fertilizer sources to crops.

In India, the deficiencies of some micronutrients in have been observed in calcareous soils and highly alkaline or acid leached soils. Serious deficiency of micronutrients, particularly, iron and zinc have focusing the attention of soil scientists in recent years. Iron, an important micronutrient is present in abundant quantity in soils; but its availability to crops and its utilization is limited by several factors. Iron is essential for chlorophyll synthesis, protein formation, photosynthesis, electron transfer, oxidation and reduction of nitrates and sulphates and enzymatic activities. Iron exists in soil as oxides, carbonates, hydroxides and organic compounds. Among the various forms, ferrous iron (reduced form) is available to crops whereas ferric (oxidized) form is not available. Presence of adequate amount of biologically active iron ( $Fe^{2+}$ ) is very important for optimum photosynthesis. Iron deficiency causes interveinal chlorosis in newly emerged leaves due to reduced chlorophyll synthesis resulting in reduced photosynthesis, poor growth, yield and quality. Iron chlorosis cause severe yield reduction in the crop yield as reported by Singh [1] and it will be not useful for fodder purpose. The solubility and availability of iron to plants is strongly depended on the chemical properties and plant mechanism for iron acquisition from soil. To date, different agronomic approaches have been applied for alleviation of Fe-deficiency by increasing the availability of Fe ions with protonation, chelation, and reduction. In the past six decades, iron chelates, such as the ethylenediamine tetraacetic acid (EDTA) and the ethylenediamine-N-N'-bis(o-hydroxyphenylacetic) acid (EDDHA) have been recognized as the most widely supplements for improving Fe availability to plants. Synthetic Fe-chelate fertilizers are expensive and have direct or indirect effects in the environment. Moreover, ligands such as EDTA have been shown to exhibit toxic effects on cellular division, chlorophyll synthesis, and

biomass production of photosynthetic organisms [2]. This study was taken up to see the effect of iron amino acid chelates on the yield and chlorophyll content of the crop which indicates the utilization of iron by plants.

## 2. MATERIALS AND METHODS

The study was carried out at pot house in the department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore. The aim of the study was to evaluate the effect of using iron amino acid chelates on active iron, chlorophyll content and yield. The experiment was carried out in Factorial CRD with two replications and 3 factors. First factor was seven sources of Iron (Fe glycinate, Fe citrate, Fe tartrate, Fe glutamate,  $FeSO_4$ , Fe-EDDHA, Fe malate) second factor was four levels ( $FeSO_4$  - 0, 25, 37.5 and 50 kg ha<sup>-1</sup> and Fe chelates - 0, 1, 2.5 and 5 kg ha<sup>-1</sup>) and the third factor was two different soils (calcareous and non-calcareous). Initial soil sample was collected and analysed for various physico-chemical properties using standard procedures. The chlorophyll meter readings were taken in the first fully expanded leaf from the top at maturity stage by using SPAD 502 (Minolta, Japan) chlorophyll meter. SPAD readings were taken around the midpoint of each leaf and averaged its values. The same randomly selected leaves were collected from individual plots and the midribs were removed. The mid portions were cut into small pieces with stainless steel scissors and the leaf samples were taken for chlorophyll analysis [3] and active iron content [4]. The crop was harvested at maturity and the yield was recorded. The results were subjected to analysis of variance. Differences among treatment means were determined using the LSD test at a significance level of 0.05.

## 3. RESULTS AND DISCUSSION

### 3.1 Active Iron

The active iron concentration of leaves was seen increasing with increase in levels of iron sources in both soils. The increase in the levels of iron treatment marked an increase in the active iron concentration. The highest active iron was noted in treatment applied with Fe citrate and lowest was with  $FeSO_4$ . The active iron content in all treatments applied with iron were higher when compared to the control (Fig. 1).

Extraction of leaves with dilute acids to characterize the so called “active iron” often improved the correlation between iron and chlorophyll content in leaves of plants grown in field. The promoting effect of application of different iron sources on leaves content of chlorophyll and active iron might be attributed to their important role in chlorophyll formation and encouraging respiration and photosynthesis processes as well as producing more carbohydrates and amino acids which aid in the formation of new cells. Reflected on stimulation effect on cell division as well as the acceleration on the formation of organic foods and the movement of IAA could explain the present results [5].

### 3.2 Chlorophyll Content of Bajra Napier

SPAD readings (chlorophyll index) taken at the end of the treatment period showed that leaves with higher SPAD readings are those applied with Fe citrate whereas, those applied with FeSO<sub>4</sub> had lesser SPAD readings. The zero-iron treatment produced the lowest chlorophyll index. There was an increase in the chlorophyll content as the level of iron source increased and all the treatments were significantly different from the control. The chlorophyll content varied depending on iron fertilization levels in both the soils (Figs. 2 and 3). The most evident effect of Fe deficiency is a decreased content of photosynthetic

pigments, which results in the relative enrichment of carotenoids over chlorophyll and leads to the yellow colour that is characteristic of lower. It is reported that iron is an essential element for plant growth. Lack of Iron causes young leaves to yellow photosynthesis activity to reduced significantly and consequently biomass is produced [6]. Iron fertilizer uptake and chlorophyll synthesis is relative to iron fertilization rates. Soil iron primarily exists in insoluble forms [7]. Iron is transported to points of growth and expanding leaves mainly via the phloem subsequent to spray applications, whereas iron is immobile in lower and upper leaves [8]. During rapid growth during establishment requires comparatively large amounts of iron and new leaves were likely to suffer etiolation due to iron deficiency. Thus, application of iron chelates during this period promoted iron uptake and led to a significant increase in chlorophyll concentration.

### 3.3 Fodder Yield

Results depicted in Figs. 2 and 3 indicated that application of different iron sources markedly produced higher yield (kg /ha). Fe citrate treatment recorded the highest significant values of these parameters followed by that of Fe glycinate and Fe tartrate treatments in both calcareous and non-calcareous soils. For example, these superior treatments increased

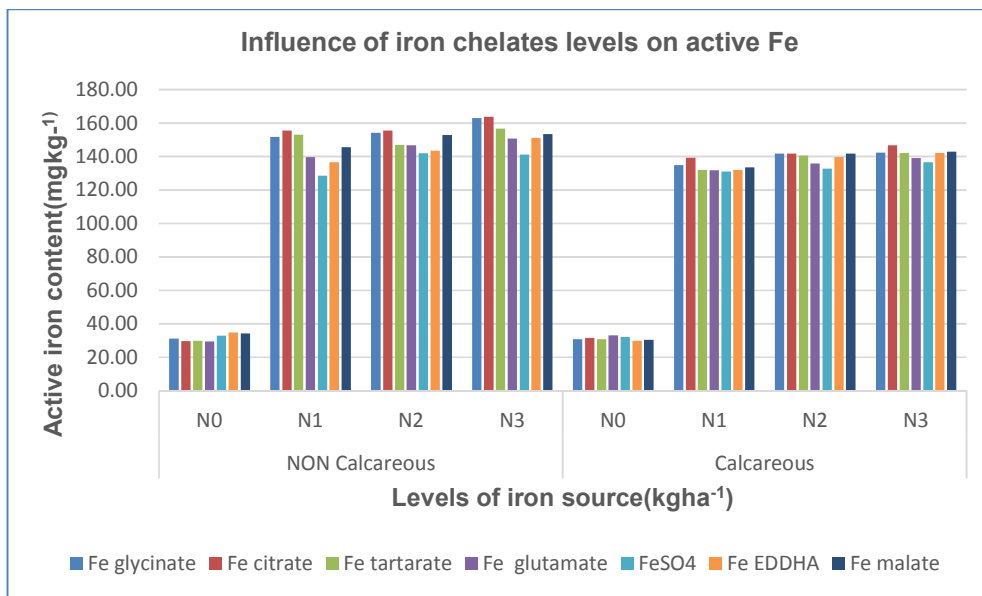


Fig. 1. The influence of iron chelates on active iron concentration

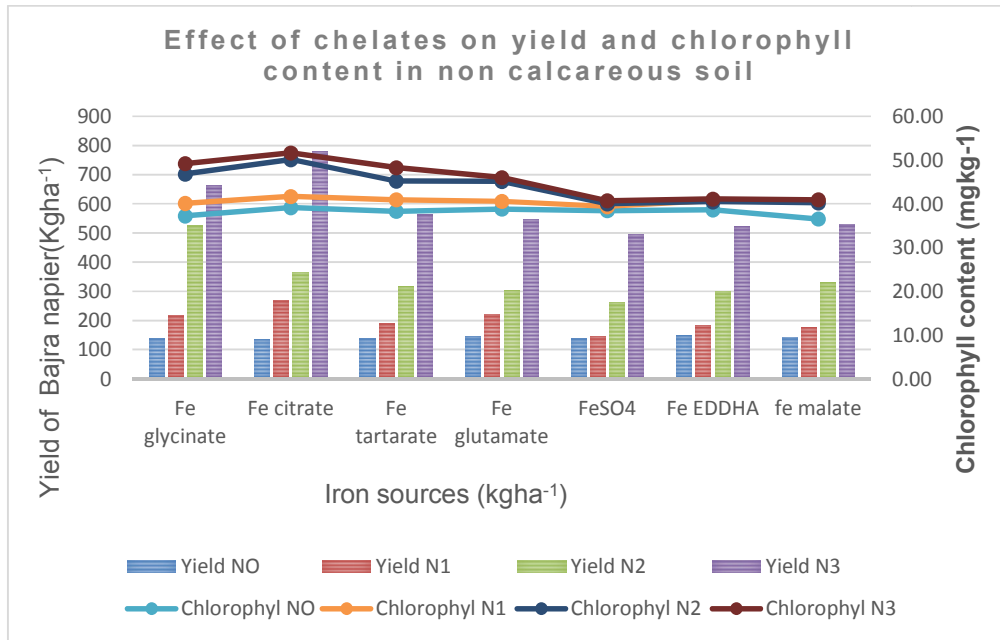


Fig. 2. Effect of chelates on yield and chlorophyll content of Bajra Napier in non-calcareous soil

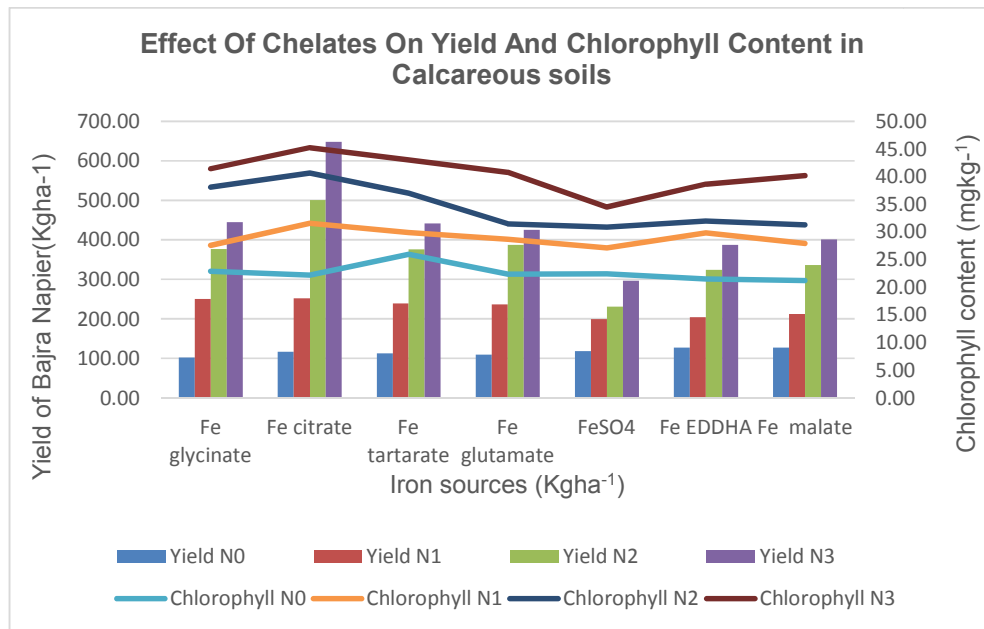


Fig. 3. Effect of chelates on yield and chlorophyll content in Bajra Napier in calcareous soil

the yield (kg) than control treatment. On the contrary, the lowest statistical values were recorded with the untreated (control). The stimulation on nutritional status of the Bajra Napier is a response to application of Fe chelates surely reflected on improving the yield

and yield components (Figs. 2 and 3). The study is in accordance with that conducted by Alvarez-Fernandez [9] and Mansour et al. [10].

A reduction in photosynthetic efficiency typically accompanies nutrient limitation, causing reduced

production due to impairment of synthesis of fully functional macromolecular assemblages. Several studies [11,12] indicate that iron fertilizer is effective in correcting iron chlorosis even in fruit trees. Mostaghimi & Matocha [13] reported that iron fertilizer improved plant growth or yield. It was found that, when iron fertilizer applied at appropriate concentration, yields significantly higher. Iron fertilization influenced chlorophyll synthesis, light capture capacity, light energy conversion efficiency and potential chemical activity of photosystem reaction center. This consequently increased the apparent photosynthetic transport rate and total photosystem photochemical quantum yield, and reduced the non-irradiative energy dissipation. Thus, leaves had a reduced capability of photosynthesis through full utilization of captured light energy via maximizing photosynthetic rate and yield. For a particular nutrient, there exists a relationship between its concentration in soil as well as in plants, which eventually reflects in its yield as well as quality attributes. This serves as a guide to obtain maximum productivity of quality produce [14].

#### 4. CONCLUSION

Generally, it could be concluded that different iron sources enhanced leaf chlorophyll, active iron and nutrition status of leaves and yield, and also controlled iron deficient chlorosis. The highest yield with best quality was obtained by application of Fe citrate. The photosynthetic capacities and the productivity of Bajra Napier was effectively enhanced with application of iron chelates. In iron deficient regions, application of iron chelates enables an effective increase of active iron and chlorophyll concentrations, enhances maximum yield. It was also seen that as the chlorophyll concentration increased the improvement was also reflected in the yield in a linear manner.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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