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Critical Level of Iron for Bean (*Phaseolus vulgaris* L.) Cultivation in Markazi Province

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Introduction: Soil test has an important role in plant nutrition management to obtain the economical agriculture system. The nutrient concentration in soils that indicates the division between responsive and non-responsive conditions is termed the critical level. Before any fertilizer recommendation, we should be aware of the amount of nutrient critical levels in each region. Soil test results in an area, is not applicable for other agricultural areas. Therefore, these tests should be carried out in the soils of a desired area, so that the soil test could be the base for fertilizer recommendation. Iron is an essential micro element in the soil that mainly was found as insoluble (Ferric or Fe^{3+}) form. Solubility of total inorganic iron decreases between pH 7.4 to 8.5. Bean (*Phaseolus vulgaris* L.) crop is one of the most widely grown throughout the Markazi province in Iran and has high nutritional value for human. Knowing that bean is a sensitive plant to iron, and because of lack of any information about iron critical level and regional calibration, this study was conducted in Markazi province.

Materials and Methods: Eighteen soil surface samples (0-30 cm) selected with a wide range of soil properties and iron concentration (extracted with DTPA method) from different zone of province and prepared for greenhouse cultivation. Soil physical and chemical properties such as: (texture, pH, calcium carbonate, organic matter, cation exchange capacity, and electrical conductivity) of soil were determined by routine laboratory methods. In this study, bean plant responses were investigated by application of two levels of iron (0 and 10 mg kg^{-1}) in soil as iron sulfate in the greenhouse experiment. All of soil samples received nitrogen, potassium, phosphorus, manganese, copper and zinc as; (150, 100, 25, 5, 5, 5) mg kg^{-1} as solution in each pot respectively. The greenhouse study was conducted in a factorial experiment with three replications as complete randomized design. Six bean seeds were planted in pots. After the second week three plants of these six seeds were kept.

Soil moisture was maintained at field capacity. At the end of vegetative phase, the shoot bean and iron concentrations were determined in plant samples. At the end of the vegetation period, the shoot parts of plants cut, and plant responses including; (dry matter weight, Fe concentration, total Fe uptake and relative yield) ($DM_{control.}/DM_{Fe\ fertilizer}*100$) were determined.

Results and Discussion: The results showed that available iron content in the soil varied from 1.5 to 20 mg kg^{-1} of soil with a mean value of 7.75 mg kg^{-1}. The bean plant responded to Fe application and their relationships with physical and chemical properties of soils, which were investigated were effected too. Analysis of variance showed that the effects of soil and Fe fertilizer application were separately significant at 1% level for (weight dry matter, Fe concentration and Fe uptake). The effects of the (soil and fertilizer) interaction were significant at 1% level for the Fe concentration and Fe uptake. The mean comparison test of plant responses was significant as affected by Fe fertilizer consumption. By using Cate-Nelson graphic method, the critical level of iron in soils was five mg kg^{-1}. Amounts of percent relative frequency indicated that eight percent of the soils were less than five mg kg^{-1} Fe, 63% of soils between 5 to 10 mg kg^{-1}, 16% of soil between 10 to 15 mg kg^{-1} and 13% of soil above 15 mg kg^{-1} Fe. Plant Fe concentration in the control treatment (without Fe application) was 439.4 (mg kg^{-1}), but at the Fe treatment (10mg kg^{-1}) increased to (534.4mg kg^{-1}).

The Fe uptake significantly increased from 1.54 to 2.16 mg Fe pot^{-1} with the application of 10 mg-Fe kg^{-1}. The Fe uptake differences between treatments was due to increase of dry matter weight, and the plant Fe concentration, and this was due to the fertilizer application. Relative yield and dry matter weight showed positive and significant correlation with (clay, CEC and Fe available), but sand revealed negative correlation with the plant's response. The Fe uptake showed positive and significant correlation with Fe available but negative and significant correlation with the sand. The regression equation showed that Fe uptake to be related with CEC

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significantly.

Conclusion: By using Cate-Nelson graphic method, the critical level of iron in soils was five mg kg^{-1}. The plant parameters were predictable significantly by soil properties such as (clay, sand, silt, soil organic carbon and Fe concentration).

Keywords: Available Fe, Bean, Soil Test

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