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INFLUENCE OF IRON FOLIAR FERTILIZATION ON SOME GROWTH AND PHYSIOLOGICAL PARAMETERS OF WHEAT AT TWO GROWTH STAGES

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Abstract

A field experiment was carried out to evaluate the influence of foliar application of iron on growth and physiological parameters of wheat (Triticum aestivum L. Alex cultivar) at various growth stages, during the growing season 2012-2013 at Didactic Station, Timisoara, Romania. The experiment was laid out in a randomized complete block design with three replications. Wheat plants were exposed to four treatments: control (T1), Fe applied to plants at Feekes growth stage 2 (T2), Fe applied to plants at Feekes growth stage 9 (T3), Fe applied to plants at growth stage Feekes 2 and 9 (T4). The treatments were foliar application of Fe (1000 mg L^{-1}) using iron chelate [Fe-DTPA (6% Fe)]. Foliar solution of Fe was sprayed with a hand held pump sprayer at the rate of 1.2 L $plot^{-1}$ on plant foliage. Soil samples were collected before sowing of crop from 0-25 cm depth and analyzed for chemical and physical properties. Data analysis showed that there were significant differences among treatments on plant height, number of plants, flag leaf area and flag leaf chlorophyll content. The highest plant height (88 cm), number of plants m^{-2} (418), flag leaf area (30 cm^2) and chlorophyll (59.3 SPAD value) were obtained from the foliar application of Fe at Feekes GS 2 and Feekes GS 9 (T4), in comparison with the control. The data suggest that foliar application of Fe during vegetative growth stages can maximize plant growth and development of wheat.

Key words*: iron, growth stages, morphological and physiological parameters, wheat.*

INTRODUCTION

Micronutrients consist of six essential elements: iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B) and molybdenum (Mo). These elements present in very small amounts in both soils and plants, but their role is regularly as important as the primary or secondary nutrients (Steven, 2000). They are playing an important function in growth and development of plant. Actually, their necessary function in plant nutrition and rising soil productivity makes their significance ever greater. In an intensive cropping with high yielding varieties and application of high analysis, primary and secondary nutrient fertilizers, micronutrient deficiency have been more marked (Dewal and Pareek, 2004). Fe plays major role in many plant functions. This function includes respiration, photosynthesis processes, chlorophyll development, energy transfer within the plant, a component of at enzymes and proteins, and involved in nitrogen fixation **(**Eskandari, 2011). Wheat plant needs Fe in small quantity but many research showed that foliar spray of Fe alone or share with other micronutrients had a positive effect on growth and yield parameters of wheat crop. (Ali, 2012; Abbas,et al., 2012; Bameri et al., 2012; Safyan et al., 2012). Very little deficiency of Fe is observed in common soils but many factors can cause deficiencies of Fe including imbalance of nutrient in soil, critical physico-chemical state of soil like high pH, poor aeration, and accumulation of phosphorus (P) (Lindsay and Schwab, 1982). In Romanian Banat Region, Fe chlorosis has been noticed on plum tree grown on a pre-luvisol soil. The deficiency of Fe happened due to the momentary storage of limestone near plum trees for purpose on

nearby farmland. Rainfall leached enough limestone into the soil to cause Fe deficiency (Sala, 2012). Until now in Romania the affect of foliar application of micronutrient on growth parameters of wheat plant is not sufficient investigated and documented. The present study was undertaken to evaluate the impact of foliar application of Fe on some growth parameters of wheat plant at different growth stages.

MATERIALS AND METHODS

This research was conducted during the growing season of 2012-2013 at the Didactic Station, Banat University, Timisoara. The experimental site was located at 45°46′ N latitude, 21°25′ E longitude with an altitude of 85 m above sea level. Composite soil sample of surface soil (0-25cm depth) was taken after the site had been prepared, air dried, ground, passed through 2 mm sieve, analysed for chemical and physical properties by using standard methods at laboratory of Physical-Chemical analysis "OSPA – USAMVB" according to (SR-ISO, 1998). Available Fe was determined by ammonium oxalate 0.2 N extractions (Pouget and Juste, 1972). Soil texture was clay, pH 6.73, EC 0.41 dS m^{-1}, humus 3.22%, total N 2.21%, P 11.23, K 171.13 ppm, available Fe 25.30 ppm. The experiment was laid out in a randomized completely block design (RCBD) with three replications. Seeds were sown through drills at a 15 cm distance between rows. A seed rate 270 kg ha^{-1} of "Alex" wheat cultivar was used. The size of each plot was 10.0 m long and 3.0 m wide. A buffer zone of 2.0 m spacing was given between plots. Nitrogen was applied in two doses. First dose of nitrogen along with full dose of phosphorus and potassium were applied for all treatments at 4 weeks after sowing in the form of complex 150:100:100, respectively at the rate of 360 kg ha^{-1}. Second dose of the nitrogen in the form of urea was applied at the stem elongation stage at a rate 100 kg ha^{-1}. Weeds and insects associated with wheat were controlled by using a tractor-mounted boom sprayer. The experiment included four foliar spray treatments: control (only received distilled water) T1, 1000 mg L^{-1} Fe at Feekes GS 2 T2, 1000 mg L^{-1} Fe at Feekes GS 9 T3, T2+T3 T4. Source of iron Fe-DTPA (Fe 6%). Foliar solutions of Fe were sprayed at leaves with a hand pump sprayer at the rate of 1.2 L $plot^{-1}$ at two growth stages: beginning of tillering stage (Feekes GS 2); and early booting stage (Feekes GS 9) according to the Feeks scale as described by (Travis, 1999). At maturity stage, plants in one square meter area selected randomly, selected at three locations in each plot were harvested by manually and the following parameters were obtained:

Plant height. The height of plants from ground level to the tip of the plant excluding spike. The average height of these plants was calculated and expressed as mean plant height (cm).

Number of plants. The number of plants was counted and the average was calculated and then mean value was recorded and converted into number of plants per square meter.

Flag Leaf area. Flag leaf area was measured by taking the maximum length and width of the fully grown flag leaf of the main tiller in cm. Flag leaf area was calculated by using the formula of (Muller, 1994).

Flag leaf area (cm^2) = Maximum flag leaf length × Maximum flag leaf width × 0.74.

0.74 = Correction factor.

Measurement of Chlorophyll content (Unit SPAD). Fifty flag leaf of the main tiller samples were selected randomly from each plot one week after anthesis to determine leaf chlorophyll content by using a SPAD-502 (Model Konica-Minolta, Osaka, Japan). Data presented are total chlorophyll.

Data analysis. Data were analyzed statistically for analysis of variance following the method described by (Gomez and Gomaz, 1984). MSTAT-C computer software was used to carry out statistical analysis (Russel and Eisensmith, 1983). The mean differences among the treatments were compared by Duncan Multiple Comparison Test at 0.05 level of probability.

RESULTS AND DISCUSSIONS

Plant height. Plant height was significantly affected by foliar application of Fe (Figure. 1). The highest plant height (88 cm) was achieved

by treatment T4 followed by T3 and T2 treatment. The lowest plant height (79 cm) was obtained by T1 treatment. Compared with control, plant height increased 12%, 11% and 9%, by treatments of T4, T2 and T3 respectively. Fe plays a role in energy transfer within the plant, component of enzymes and proteins, and involved in nitrogen fixation and enters in root cells these reasons may be leads to an increase in plant height. (Abbas et al., 2009; Ali, 2012; Bameri et al., 2013). Reported that soil application and foliar spray of Fe alone or in combination with other micronutrients increase plant height of wheat.

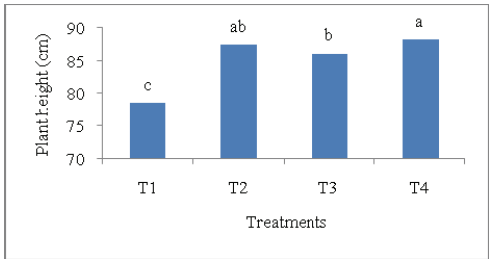

Figure 1. Effect of foliar fertilizer of iron at different growth stages on wheat plant height
(The columns sharing the same letter are not significantly different at *P*=0.05)

Number of plant m^{-2}. Number of plants was significantly increased by foliar spray of Fe as compared with the control (Figure 2). The highest number of plant was recorded with the application of Fe at two growth stages (T4). Number of plants was increased by 12.51% with T4 followed by 8.21% with T3 and 6.59% with T2 as compared with the control. There was no significantly difference between T2 and T3 for number of plant m^{-2}. Nadim et al. (2012), Abbas et al. (2009), they reported that application of Fe alone or in combination with other micronutrients significantly increased the number of tillers compared with the control.

Flag Leaf area (cm^{-2}). Flag leaf area was significantly increased by foliar application of Fe at different growth stages (Figure 3). The highest flag leaf area 30 cm^{-2} was obtained by foliar application with Fe at two growth stages (T4). The lowest flag leaf area was obtained from control (T1). Compared with control, flag leaf area was increased 37%, 28% and 19% by treatments application of T4, T2 and T3 respectively. Fe is an important element in crops, because it is necessary for synthesize chlorophyll, keeps up the structure of chloroplasts, involved in nitrogen fixation which lead to higher crop production and leaf area increase (Zayed et al., 2011).

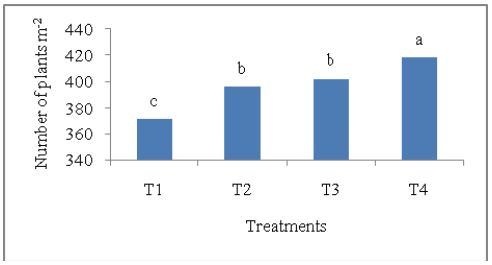

Figure 2. Effect of foliar fertilizer of iron at different growth stages on number of plant m^{-2} of wheat plant
(The columns sharing the same letter are not significantly different at *P*=0.05)

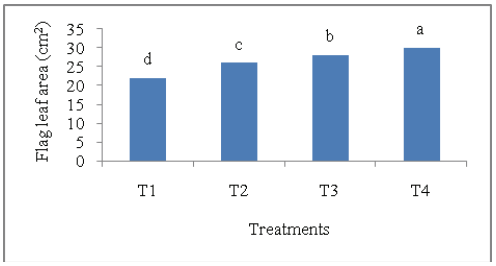

Figure 3. Effect of foliar fertilizer of iron at different growth stages on flag leaf area of wheat plant
(The columns sharing the same letter are not significantly different at *P*=0.05)

Flag leaf chlorophyll content. The effect of foliar spray with Fe on chlorophyll content (SPAD value) in the flag leaves of wheat plants at Feekes GS 2 and Feekes GS 9 are shown in (Figure. 4). Flag leaf chlorophyll content was significantly increased by foliar application of Fe at Feekes GS 2 and Feekes GS 9. The maximum value of leaf chlorophyll content (59.30) was recorded from the treated plants with T4, and followed by T3 and T2. The minimum values of chlorophyll content (51.46) was recorded when wheat plant received only distilled water (T1). Fe is important in chlorophyll formation, photosynthesis, enzyme systems, chloroplast development and respiration of plants (Miller et al., 1995; Halvin et al., 1999). This result was agreement with

(Ai - Qing et al., 2011; Mohsen, 2013 and Kobraee et al., 2011) who demonstrated that adding Fe alone or in combination with other micronutrients increased chlorophyll content of plants.

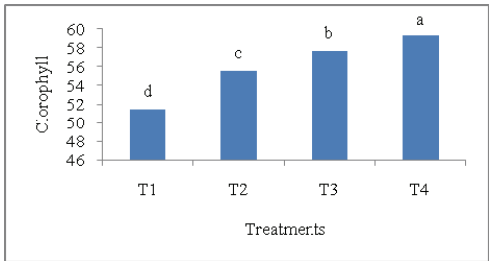

Figure 4. Effect of foliar fertilizer of iron at different growth stages on flag leaf chlorophyll content of wheat plant
(The columns sharing the same letter are not significantly different at P=0.05)

CONCLUSIONS

The current study showed that foliar spray of Fe (1000 mg L^{-1}) at different Feekes growth stage (GS 2 and GS 9) significantly increased wheat plant height, number of plants, flag leaf area and flag leaf chlorophyll content. The best result of all studied parameters was obtained from Fe sprayed at two growth stages (T4). The control (T1) gave the lowest values of all studied parameters.

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