Effect of foliar application of nano-chelated iron and manganese fertilizers on yield and yield components of wheat (*Triticum aestivum* L.) under drought stress

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Extended Abstract

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Introduction: Wheat (*Triticum aestivum* L.) is one of the most important and strategic crops in the world. At global level, wheat occupies the largest total cultivated area (217 million hectares) with a total production of 651.4 million tons and an average yield of three tons per hectare (Anonymous, 2015). Drought is a major environmental stressor throughout the world, posing severe constraints to crop productivity. Drought stress causes nutritional imbalances in crops and restricts the ability of their roots to take up the required nutrients from soil (Cakmak, 2008). To overcome the limitations imposed by drought stress, foliar nano-micro nutrients such as iron (Fe) and manganese (Mn) can be used as complementary foods to feed plants and improve their nutritional status. Given the limited availability of Fe and Mn in the soils of Iran and also acute shortage of irrigation water and the frequent occurrence of drought stress in the country, this experiment was conducted to investigate the impact of chelated form of Fe and Mn micronutrients on yield and yield components of wheat under water stress conditions.

Materials and Methods: The experiment was carried out in 2014-2015 at the Agricultural Research Farm Station of Tarbiat Modarres University, Tehran as split plot in a completely randomized blocks design with three replications. The main factor was drought stress consisted of three conditions: no cessation

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of irrigation (S_1), cessation of irrigation at vegetative state whenever 70 % of the field capacity (FC) was depleted (S_2), cessation of irrigation at reproductive stage whenever 70 % of FC was depleted (S_3). The sub-factor comprised of 11 foliar fertilizer concentration treatments including 1/1000 chelated nano iron (F_1), 3/1000 chelated nano iron (F_2), 1.5/1000 chelated nano manganese (F_3), 3/1000 chelated nano manganese (F_4), 1/1000 nano chelated iron+ 1.5/1000 nano chelated manganese (F_5), 1/1000 nano chelated iron + 3/1000 nano chelated manganese (F_6), 1.5/1000 nano chelated manganese + 3/1000 nano chelated iron (F_7), 3/1000 nano chelated iron+ 3/1000 nano chelated manganese (F_8), no foliar application of the nano fertilizers as control (F_9), foliar application of pure water (F_{10}) and micro-fertilizer complex (F_{11}). The measurements consisted of leaf area, seed yield and yield components including spike number per square meter and grain number per spike at physiological maturity, dry weights of leaf, shoot and spike, 1000-kernel weight as well as plant height.

Results & Discussion: The imposition of drought stress and the application of nano fertilizers as well as their interaction had a significant impact on wheat seed yield, spike number, kernel number per spike, leaf area and dry weights of leaf, shoot and spike at the 1% probability level. The highest spike number (322 spikes/m^2) was obtained from S_1F_8 treatment where no water stress was imposed and iron and manganese were used at 1/1000 concentration. No water stress treatment and the application of 3/1000 nano iron fertilizer plus 1.5/1000 nano manganese (S_1F_7) produced the maximum seed yield (2611 kg/ha) and the greatest number of grains per spike (52 grains/spike). The main effect of the nano fertilizer application revealed that the F_7 treatment gave the highest seed yield (1603.11 kg/ha). The highest leaf area (97.10 cm^2/plant) was achieved with S_1F_7 treatment. It was also observed that the highest dry weights of leaf, shoot and spike were respectively 135.11, 361.11 and 304.17 gr/m^2 which were respectively obtained from S_1F_7, S_1F_2 and S_1F_7 treatments. The interaction of drought stress and nano fertilizers had no impact on wheat height. Drought stress at reproductive stage limits the transfer of iron and manganese to grain (Karim *et al.,* 2012). The number of grains per spike decreased with drought stress and it was found to be more sensitive to stress at the vegetative than the reproductive stage. Our results showed that the use of nano Fe fertilizer together with nano Mn could alleviate the negative effects of drought stress on the wheat.

Conclusion: The study showed that drought stress at vegetative and reproductive stages decreased the wheat yield by 40 and 26%, respectively. Foliar spraying of 3/1000 Fe together with 1.5/1000 Mn at vegetative and reproductive stages respectively increased the wheat yield by 50 and 61% as compared to the foliar

spray of pure water

Keywords: Agronomic traits, mineral fertilizers, nanoparticles, plant nutrition.

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