ZINC FERTILIZATION EFFECTS ON BIOMASS PRODUCTION AND SOME MORPHOMETRIC PARAMETERS FOR WHEAT

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Abstract. *Zinc is an important micronutrient in plant nutrition due to the fact that it has many physiological functions in biological systems. It is cofactor for a wide range of enzymes, nearly 3000 proteins being zinc dependent. Wheat's nutrition relation with zinc is controlled through physiological and molecular mechanisms, which can be classified into root or shoot based. The cultivation on deficient soils is the main reason of the low zinc concentration in grains. Due to these fact, low biodisponibility appears. Zinc deficiency could often be observed in arid and semiarid environments, on saline soils. Moreover, the soils which are naturally rich or poor in organic carbon, or those water imbibed present the same feature. The aim of this study was to determine zinc effects on some physiological indices. Wheat, Triticum aestivum ssp. vulgare, Ciprian cv. was cultivated on Didactic Station of BUASVM Timişoara, Romania. Wheat plants were fertilized only on leaves during spring. Zinc was part of a liquid fertilizer and five experimental concentrations were used. The probes were sampled in May 2018. The investigated indices were dry biomass and leaves lengths and widths. Biomass production was estimated using linear regression analysis. Only the aboveground parts of the wheat plants were studied, due to the fact that belowground biomass production on wheat is harder to estimate because of the morphology of the radicular system. Dry aboveground biomass increased proportionally with the amount of zinc used. The lowest values of the investigated parameters were obtained for Zn 0 samples, and the highest values were obtained for Zn 4 samples. The aboveground biomass is important because it is the base of wheat straw, which can be used in industry. The adequacy for the production of biofuels had been demonstrated. Same trends were also noticed for the others investigated indices, leaves lengths and widths, respectively and a higher zinc dose results in physiological benefits for wheat plants.*

Keywords: *dry biomass, wheat, zinc, fertilization*

INTRODUCTION

Nowadays, obvious increases in world population can be observed and these will result in a major pressure on the existing agricultural land, because of urbanization and intensive cultivation (BYRNES and BUMB, 1998). Worldwide wheat yields need to increase until 2050 by 38% to meet the projected request (FISCHER et al., 2014). Thus, a good mineral supply for wheat crop becomes important (RAWASHDEH and SALA, 2013, 2014). The deficiencies can be seen at a macroscopic scale, but also in microscopic analysis and, therefore, using an optimum fertilizer, in a sufficient amount, is of interest (SALA et al., 2015, 2016).

Zinc is a necessary micronutrient for flora, fauna, but also for human beings (BROADLEY et al., 2007; ZHAO, 2014; WANG et al., 2019) and its deficiency is a serious worldwide challenge (ALLOWAY, 2004; CAKMAK, 2008; VELU et al., 2014). Its importance can be easy demonstrated through the fact that near 10% of all body proteins are known to be zinc dependent (KREZEL and MARET, 2016; CAKMAK and KUTMAN, 2017). Zinc is able to directly attach to proteins, in the so called zinc-finger structures (BALK et al., 2019).

Wheat zinc nutrition relation is modelled by many ecophysiological and molecular mechanisms, which can be categorized intro shoot and root based (REHMAN et al., 2017). It also has been demonstrated that increased CO_2 ameliorated the effect of low Zn as well as terminal drought on wheat yield (ASIF et al., 2017, 2019). Establishing a wheat crop on zinc deficient soils is the main reason for the reduced concentration of this mineral in grains (ALLOWAY, 2009).

Zinc deficiency can generally be observed on saline soils or in arid and semiarid environments (REHMAN et al., 2017). Moreover, the soils which naturally are rich or poor in organic carbon, or those water imbibed, present the same feature (AHMAD et al., 2012). Almost a half of the world cereal-growing zones contain reduced quantities of plant-available zinc in the soil, and therefore, a zinc stress appears (GRAHAM and WELCH, 1996; CAKMAK et al., 1999).

In the wheat seed, this microelement is concentrated in the embryo and the aleurone layer, but in endosperm zinc concentration is considerably reduced (OZTURK et al, 2006). Grains are regularly consumed after the milling, process which leads to the removal of the parts with a substantial quantity of zinc (CAKMAK and KUTMAN, 2017). The highest zinc gain was noticed during seed development, suggesting the fact that foliar application during late growth periods is a good way to maximize seed zinc amount (OZTURK et al., 2006).

Zn deficiency is the world most widespread micronutrient deficiency in crop plants, but also in humans (ALLOWAY, 2004; HOTZ and BROWN, 2004). Many people who live in pour regions of the world use mainly cereal-based food (BOUIS, 2003; BOUIS and WELCH, 2010). Thus, a necessity to enrich the wheat with vitamins and minerals appears (VASCONCELOS et al. 2017).

This research purpose is to assess the effects of zinc application dose on the production of dry aboveground biomass. Moreover, zinc dose effect on morphometric indices is also of interest.

MATERIALS AND METHODS

For this research *Triticum aestivum* (L.) ssp *vulgare* species was used, Ciprian cv. The crop was establish within Didactic Station of Banat’s University of Agricultural Sciences and Veterinary Medicine from Timișoara, western Romania. A cambic chernozem, gleized in a small degree, is the representative soil (PÂSLEA and SALA, 2012).

The preliminary study was done using five zinc doses, from a complex fertilizer, applied once, in the spring.

The sampling was done during May 2018, when wheat was 59 on BBCH code. The probes were vigorous and not damaged. The wheat leaves were collected and analyzed in the laboratory. Measurements using a ruler for length and calipers for width were realized. For dry biomass determination, aerial organs were placed in an oven (Sauter Model) for a day, at 100 ^{o}C.

Using an analytical balance, weightings were performed and dry biomass (DB) values were determined (IANOVICI, 2016; DATCU and SALA, 2018). Data was processed using MS Excel 2013 and was extrapolated for 1 ha. Statistical tests, including linear regression, was realized using PAST software v 3.20 (HAMMER et al., 2001) and values below 0.05 were considered significant.

RESULTS AND DISCUSSION

This research aim was to investigate dry biomass production and some morphometric parameters in the case of wheat, Ciprian cv. Regarding dry aboveground biomass, a proportionally increase was noticed when the amount of applied zinc was bigger (R^2 = 0.968) (Figure 1). The minimum values were obtained in the case of Zn 0 samples, with a mean of 3682.6933 kg ha^{-1}, and the biggest values were obtained for Zn 4 samples, with a mean of 6500.2933 kg ha^{-1}. This variation of the DB depending on the zinc dose application is described by relation (1), within statistical limits (p= 0.2254, R^2=0.968, F=10.191).

$$DB = -138.1x^3 + 837.7x^2 + 437.1x + 3738 \quad (1)$$

x – Zn doses

This parameter, supraterranean biomass, has importance due to the fact that is the base of wheat straw, which can be used in industry (DATCU AND SALA, 2018). The glucids release from wheat straw after a hydrothermal pretreatment were successfully utilized for biofuels production (biogas, biohydrogen and bioethanol) based biorefinery (KAPARAJU et al., 2009).

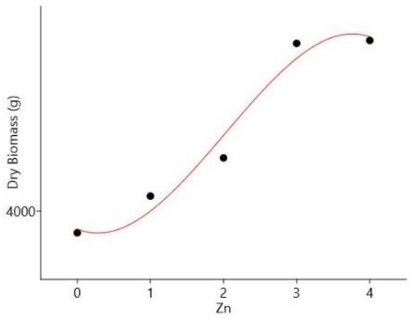

Figure 1. Zinc dose influence on dry aboveground biomass production

Zinc concentration effect on leaves lengths can be observed in Figure 2, where a polynomial model was obtained. Zn 0 samples had the lowest mean values in the case of this parameter and the highest mean values were obtained for the leaves belonging to Zn 4 set.

Minimum leaf length was 7.7 cm (Table 1) and maximum leaf length was 17.3 cm.

The leaves lengths variation depending on the increasing Zn dose is described by relation (2), with accepted statistical parameters values (p= 0.0709, R^2=0.996, F=106.91).

$$LL = 0.03875x^3 + 0.07214x^2 + 0.1123x + 10.37 \quad (2)$$

x - Zn dose

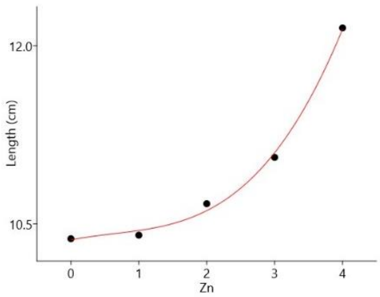

Figure 2. Zn dose influence on leaves length

Regarding wheat leaves widths, a polynomial increasing trend was also noticed (Figure 3). Minimum values of this index was obtained for Zn 0 leaves and maximum values were reached by the plants from Zn 4 set. Width lowest value was 0.5 cm, and the highest leaf width was 1.2 cm (Table 1).

Leaves widths modification due to increasing zinc concentration is described by relation (3) and statistical parameters which give the accuracy had the fallowing values: p= 0.0501, R^2=0.949, F=18.957.

$$LW = 0.0125x^2 - 0.0055x + 0.726 \quad (3)$$

x - Zn dose

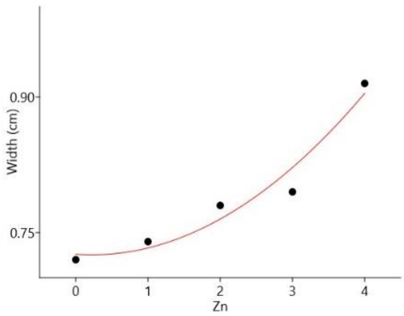

Figure 3. Zn dose influence on leaves widths

The analysis of variance revealed interesting results which can be observed in Table 1. Both leaves length and width data were heterogeneous. For this situation, Welch F test was the appropriate approach. In the case of these indices, Welch F test din not resulted in significant differences.

Table 1

Analysis of variance for wheat leaves lengths and widths analyzed in all the five experimental variants

Parameter		Zn 0	Zn 1	Zn 2	Zn 3	Zn 4	Levene's Test	Welch F test
Length (cm)	Min	7.7	8.7	8.65	9.6	9	0.02954	F= 1.007, df=21.75, p=0.4256
	Max	14	12.1	13.9	12.55	17.3		
Width (cm)	Min	0.5	0.6	0.6	0.65	0.65	0.01065	F= 2.347, df=22.07, p=0.08597
	Max	0.9	0.9	1	0.9	1.2		

CONCLUSIONS

This investigation was conducted in order to determine the Zn liquid fertilizer influence on morphometric and physiological indices on wheat.

In the case of dry aboveground biomass, a really strong interdependency between Zn amount and biomass production was noticed and a clear, polynomial increase was observed.

Moreover, both lengths and widths of the leaves presented same tendencies. Minimum values were observed at the lowest fertilization concentration and maximum at higher doses.

Thus, zinc fertilization resulted in bigger surfaces for investment in wheat plants, for Ciprian cv. and this affirmation was supported by the values of the investigated parameters.

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