Communications in Plant Sciences (2237-4027)
volume 2, issues 3-4, p.163-165, Jul-Dec, 2012

Biometry and dry mass of soybean at different levels of Zn contamination

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Workshop Information

I Workshop of Plant Biology (I Workshop de Biologia Vegetal) was held in the Bioscience Institute – UNESP, campus of Rio Claro, Brazil, during August 20 and 21, 2012. Workshop was a scientific event organized by Post-graduate students from that Institute aiming to integrate Post-graduate and Graduate students from different areas related to Plant Biology (Anatomy, Ecology, Evolution, Morphology, Physiology, and transitional areas) from different Universities. Workshop Organization offered a large number of speaking activities, scientific discussions, and extra short-courses to improve the knowledge and formation of students in Plant Biology.

Received on August 14, 2012. Accepted on August 21, 2012. Online published on November 14, 2012.

INTRODUCTION

Micronutrients are chemicals elements essential for the development and maintenance of plants, as an example of some of these: iron, zinc and copper. In general, plants may absorb significant quantities of metals through the leaf and root uptake. The amount of some of these nutrients has increased in soils of some regions of Brazil, as the product of the industrialization process and soil contamination (Silva et al. 2011).

Zinc has a natural distribution in the soil, however, currently, it can be observed in a greater amount due to some human activities, such as the use of chemical pesticides, fertilizer in agriculture and more recently through the use of domestic and industrial waste. In the plant body, zinc is used by enzymes that assist in antioxidant defense system and one of its main functions is to be used as a cofactor in chemical bonds (Ferreira 2007). Zinc interference on plant development has been reported in several studies, mostly regarding changes in growth and in other cases contributing to plant growth (Eloy et al. 2010). It should be noted that the concentrations of this element on plant tissue can cause an increase in toxicity as higher amounts of zinc are metabolized.

Other micronutrients also show toxicity on plant development, such as reported by Bertoni et al. (1999), who observed the effect of sulfur and magnesium in cultured rice and Gonçalves et al. (2012) who found no changes in biometrics and dry mass of *G. max* exposed to different levels of contamination by copper. Brazil has a large role in world food production, having soybeans as a major plant in this scenario. Some farming techniques have been improved and declined due to productivity gained. Therefore, it is important to preserve and meet some ecological and physiological status of the soybean zinc toxicity.

This work aimed at evaluating the biometric and dry matter production of *G. max* exposed to different levels of zinc sulfate.

MATERIAL AND METHODS

Area of study. The experiment was conducted in an open area of experimentation in Nove de Julho University, Campus Santo Amaro, located in the southeast metropolitan region of São Paulo. The city of

São Paulo is located about 770 m above sea level, at the coordinates 23º 30' S and 46º 40' W, southeast Brazil. In this city, the climate is characterized by the dry winter during the months of June to August and wet summer, from December to March (Ferreira 2007).

Plant exposure. Four soybean seeds were planted in plastic pots of 500 ml containing 2/3 of sand. The seeds of G. max cv. BRS 282 were provided by the Brazilian Agricultural Research Corporation (Embrapa-PR), all from the same lot. When the plants had two fully expanded pairs of leaves, a thinning was performed leaving only one plant per pot, thus making the experimental plot smooth. The pots were placed in polystyrene plates in order to serve as thermal insulation against heat that comes from the ground. The nursery was covered at one meter from the ground by 30% shade screen in a frame made from PVC pipe (Almeida et al. 2005). The experimental plants were irrigated weekly with 100 ml of "Hoagland" enriched with 1x (T0), 10x (T1), 100x (T2), 1000x (T3) grams of zinc sulfate per liter as described by (Epstein, 1975) and followed by (Gonçalves et al. 2012). The plants were subjected to initial height measurements, from the cervix to the apical bud using a ruler, and for stem diameter a digital caliper was used (Mitutoyo 0-150 mm) with centesimal scale. Leaves were subjected to measurement using a steel ruler called scale, 0-300 mm. For the leaf area index, the length was multiplied by the width. The experiment occurred from February to April 2012, in which the plants were measured after the beginning of the first contamination and at the end of the experiment, which is one week after the last contamination. For the evaluation of dry root weight and biometrics, the plants were removed from pots, washed and separated by organs: leaves, stem and root. The roots were washed in running water to remove sand. The parts of the plants were placed in paper bags identified and dried in an oven with mechanical circulation at 80 °C for 48 hours. The organs were weighed separately in semi-analytic digital scale with a 320 grams capacity.

Statistical treatment. The experiment was developed by adopting a statistical design of randomized blocks. Four treatments were conducted, two replications with six plants per treatment, totalizing 60 plants. To verify the difference between treatments, a variance analysis (one way) and Tukey test at 5% of probability were applied by using SIGMA STAT.

RESULTS AND DISCUSSION

Plants have not presented any difference in root growth over the treatments (Table 1), highlighting that zinc levels have not been sufficient to cause a stress situation. Concerning the stem growth, no significant changes were observed over the four treatments, neither in height nor diameter. However, for stem and root growth, the plants under treatment two have presented the higher tendency to grow. These results were similar to the findings from Rezende et al. (2005), in which the authors showed that the height was not significantly altered, even though different from Coelho et al. (2011) who observed good soybean culture growth, over different zinc dosages. For leaf area index, only the younger leaves have shown difference in growth. The leaves four, five and six showed a slower growth when compared to the leaves of plants of other treatments, except leave six, which did not show a great development; concerning treatment zero. One possible explanation for this is that the young leaves probably suffered the action of higher levels of zinc, indicating a stress situation. Gonçalves et al. (2012) observed a greater difference in growth of young leaves of *G. max* exposed to different concentrations of zinc sulfate.

Table 1. Average values of final growth of soybean plant organs, exposed to different contamination levels by zinc sulfate.

Charac.	T0	T1	T2	T3
Root lenght	193.3	193.0	224.0	189.8
Stem diam	2.6	2.4	2.6	2.6
Stem height	178.3	188.3	219.9	209.8
F1	474.3 A	917.8 A	544.8 A	508.7 A
F2	766.6 A	1,274.7 A	904.3 A	875.7 A
F3	1,191.0 A	1,607.1 A	1,546.9 A	1,078.7 A
F4	2,067.2 A	1,749.5 A	1,854.3 A	1,010.8 B
F5	1,519.5 AB	1,443.3 AB	2,192.1 A	758.3 B
F6	496.8 B	1,654.3 A	1,653.6 A	165.3 B

OBS. Means followed by the same letter in the lines do not differ significantly by Tukey test at 5% of probability.

Regarding the values of root biomass, T1 plants showed a higher amount of dry mass than the other plants. However, there were no significant differences among treatments. Concerning the accumulation of stem dry mass, T2 plants were the most probable to accumulate dry mass. T3 leaves presented the least dry weight gain among plants from other treatments, whereas T2 leaves presented the highest quantity of dry mass. Gonçalves et al. (2012) have also observed differences in dry mass accumulation over different levels of copper contamination in soybean plants, although, they have not fond differences in dry mass accumulation on stems exposed to contamination, results that support this paper.

Table 2. Average dry weight of plant organs soybean exposed to different zinc sulfate contamination levels.

Charact.	T0	T1	T2	T3
Root	0.475 A	0.519 A	0.469 A	0.482 A
Stem	0.177 A	0.223 A	0.233 A	0.221 A
Leaves	0.672 AB	0.619 AB	0.871 A	0.476 B

OBS. Means followed by the same letter in the lines do not differ significantly by Tukey test at 5% of probability.

CONCLUSIONS

Treatment 2 presented the best development of *Glycine max* plants regarding biometrics and dry mass values. The younger leaves were most affected by the zinc sulfate contamination, highlighting the rapid effect this contaminant presents. In this paper, it was stated that higher zinc sulfate dosages can interfere in this soybean culture development.

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Review process and quality of English writing is responsibility of Workshop Scientific Committee.