The Effect Of Zinc Sulfate On Stem Growth, Root And Seed Germination At Different Concentrations In Peas

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Abstract

Many authors who researched the effect of Zn on seed germination, plant growth and development showed that zinc is reducing the rate of seed germination and inhibiting stem and root elongation in different plant species. The aim of this study is to investigate and compare the effect of different concentrations of zinc on seed germination, stem and root growth, as well as the increase in fresh and dry (dry) weight in peas which is a dicotyledonous plant.

Material for this research was pea's seeds. The substance used in the experiments is zinc sulfate ($ZnSO_4$) in the following concentrations: 10^{-5}, 10^{-4}, 10^{-3}, 10^{-2}, 2×10^{-2}, 4×10^{-2}, 5×10^{-2}, 6×10^{-2}, and 8×10^{-2} mol (M). These concentrations have been used in tests in the form of aqueous solutions prepared with distilled water. The action of the substance during the experiment was called permanent - Permanent Treatment (T.P.), and limited - Before Treatment (P. T.) for 24 h, 48 h and 72 h. In both types the treatment is the same. The seeds, before being placed in germination, are cleaned with ordinary water and then with distilled water two or three times. We placed the seeds in the soil at a temperature of 26 ^{0}C. The percentage of germinated seeds is determined after 96 hours from the moment they are placed for germination. Determination of the length of the plant organs was done 10 days after the placement of the seeds for germination. Their length is determined by measuring the buds and the main roots and is expressed as the average for a stalk, respectively root. Ten days after the seeds are planted for germination, the increase of fresh and dry weight of peas is determined, depending on the concentrations of $ZnSO_4$.

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Based on the obtained results it can be noticed that zinc sulfate in lower concentrations (10^{-5}, 10^{-4}, and 10^{-3} M) not only does not inhibit seed germination, but in many cases stimulates seed germination, when compared to high concentrations (2 x 10^{-2}, 4 x 10^{-2}, 6 x 10^{-2}, and 8 x 10^{-2} M). Zinc sulfate in small concentrations (5 x 10^{-2}, to 2 x 10^{-2} M) did not inhibit further growth of previously germinated seeds. High concentrations with 48 h and 72 h pre-treatments (4 x 10^{-2} to 8 x 10^{-} M) significantly inhibit further growth of shoots and roots. This phenomenon is more pronounced especially in peas because we do not have the development of these vegetative organs at all, while in maize we have a poor development.
Small concentrations of zinc sulfate stimulate stem and root growth. The greatest inhibitory effect of high concentrations occurs on the growth of peas root rather than corn. This is because the cell wall as well as the cell membrane in peas is thinner and more permeable to zinc sulfate.

Keywords: Peas, Germination, Stem, Root, $ZnSO_4$, Pre-treatment (PT), Permanent treatment (TP).

1. Introduction

Although zinc is known as a trace element, it is important in the development of the body as a catalyst of metabolic processes [1]. Therefore, we can say that zinc in small concentrations not only has no toxic effect, but its presence activates many biochemical-physiological processes [2]. Its lack can lead to plant chlorosis, which is a consequence of the lack of chlorophyll synthesis.

Also based on the fact that this element affects the growth and development of corn in favorable concentrations. With this paper we will observe in which concentrations it appears as positive and in which toxic. Zinc participates in the enzymatic system, which catalyzes the biosynthesis of indole of acetic acid-3, which is a typical representative of auxins [5].

2. Materials and Methods

In this work, we followed the parameters mentioned above, depending on the different concentrations of ZnSO4, in peas as a dicotyledons plant. The substance used in the experiments for this type of plant is zinc sulfate ($ZnSO_4$) in the following concentrations: 10^{-5}, 10^{-4}, 10^{-3}, 10^{-2}, 2 x 10^{-2}, 4 x 10^{-2}, 5 x 10^{-2}, 6 x 10^{-2}, and 8 x 10^{-2} M. These concentrations were used in the tests in the form of aqueous solutions prepared with distilled water. Their treatment with zinc sulphate was in two ways during the experiment: Permanent treatment - permanent (TP) and limited - pretreatment (PT) in which the seeds were kept in Petri dishes with zinc sulphate for 24 hours, 48 hours, and 72 hours. Experiment progress: In these experiments, we determined the percentage of seed germination in corn, depending on the

concentrations of zinc sulfate. The seed germination rate was determined based on the number of germinated seeds in the test of 100 peas seeds placed in special Petri dishes.

Before placing the seeds in Petri dishes for germination, they are pre-cleaned with ordinary water and then with distilled water two or three times. After that, the seeds are placed in a thermostat at a temperature of 26 ^{0}C. The percentage of germinated seeds is determined after 96 hours from the moment of setting for germination. Also, after 10 days, the percentage of grown shoots and roots is calculated.

Determination of stem and root length was done 10 days after placing the seed in the incubator for germination. Their length is determined by measuring the stalks and main roots of the corn, and obtaining the average for both vegetative organs.
Determination of the increase in fresh and dry weight of the plant - ten days after the seeds are set for germination, the increase in fresh and dry weight of the corn is determined, depending on the concentrations of $ZnSO_4$.
The increase in dry weight in peas was determined after drying the plant material for 24 hours at a temperature of 105 ^{0}C. The results are expressed in mg as the average for peas as a dicotyledons plant [8].

3. Results and Discussion

Peas (*Pisum sativum*) seeds were included in this study to investigate the effect of zinc sulphate on seed germination. The seeds were treated in two ways: a) treated with certain concentrations of zinc sulfate permanently until the end of the experiment - Permanent treatment (TP) and Pre-treatment (PT) of seeds also at 24 h, 48 h, and 72 h.
Thanks to the results obtained, we can say that zinc sulfate in lower concentrations (10^{-5}, 10^{-4}, 10^{-3}, and 10^{-2}) not only does not prevent seed germination but in many cases stimulates seed germination. Conversely, high concentrations (2 x 10^{-2}, 4 x 10^{-2}, 6 x 10^{-2}, and 8 x 10^{-2} M) of zinc sulfate significantly inhibit seed germination, especially concentrations of 4 x 10^{-2}, 6 x 10^{-2}, and 8 x 10^{-2} M before treatment of 48 and 72 hours at a value of 40% completely inhibits the germination of seeds and the growth of the stem while the root reaches full growth. High concentrations (4 x 10^{-2} - 8 x 10^{-2} M) significantly inhibit the further growth of shoots and roots in germinated seeds (Figures 1, 2, 3, and 4).

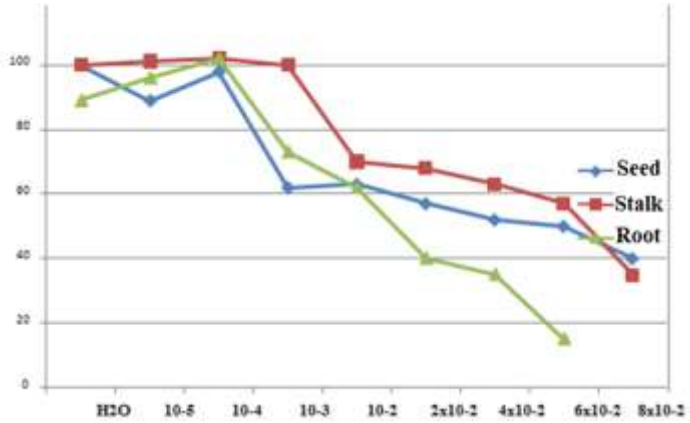

Figure 1. Concentration and permanent treatment (P.T.) in peas

In Figure 1, in which we have the permanent treatment, it is clearly seen that the small concentrations included in this study have approximately not the same effect. The stem and the germination of the seeds have a toxic sensitivity because the growth is interrupted at the value of 40% while on the side the root has continued to grow, as noted by Davis and Parker [3], and Davis *et al.*, [4] for peanuts. In corn, toxic zinc sulfate begins to appear from a concentration of 2 x 10^{-2}. At high concentrations (2 x 10^{-2}, 4 x 10^{-2}, 6 x 10^{-2}, and 8 x 10^{-2} M) a marked decline in the development of these organs begins, except for the root. While on the side the root has continued to grow and this may be due to the higher concentration of cellulose which is structural polysaccharide of the cell wall.

In the pre-treatment (P.T) 24 hours, it is clear that at the value of 60%, a horizontal extension of the growth of the vegetative organs in the same shape is visible (Figure 2). This can be an optimal influence of this solution on the development of the three vegetative organs.

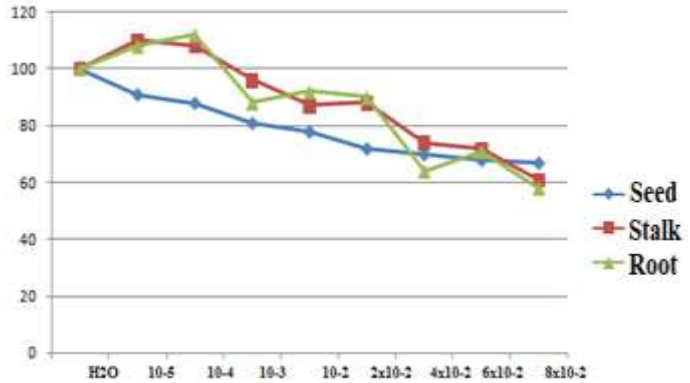

Figure 2. Concentrations and preliminary treatment (P.T.) 24 hours in peas

In the case of pre-treatment (PT) 24 and 48 hours (Figures 2 and 3) it is clear that 100% begin to decrease in the development of the three vegetative organs which end with a concentration of 8 x 10^{-2} and ends with 60%.

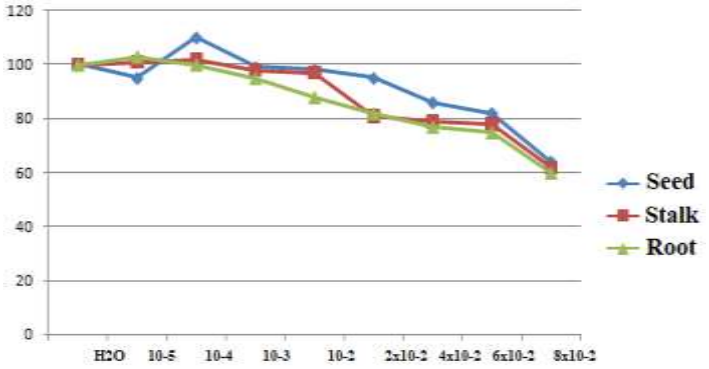

Figure 3. Concentrations and pre-treatment (P.T.) 48 hours in peas

In the 72 hours pre-treatment of corn, we have a reduction of 10^{-2} and it ends with 10% up to a concentration of 8 x 10^{-2} M, while in peas, the percentage of development ends at 60% (Figure 4).

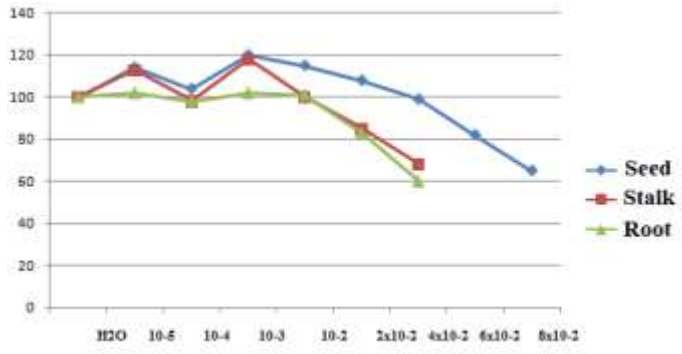

Figure 4. Concentrations and pre-treatment (P.T.) 72 hours in peas

Therefore we say that in this case the toxic effect of the first zinc sulfate is smaller in peas. Therefore, we propose that these concentrations are positive and can be applied in the field. Also from the investigation of the impact of zinc sulfate on the growth of stem and root, the results are presented in the form of histograms [6] .

Figure 5 clearly shows that zinc sulfate in small concentrations (10^{-5}, 10^{-4}, and 10^{-3} M) in the test where the permanent treatment (TP) was used stimulated stem and root growth, while on the other hand in

concentrations higher (10^{-2}, 2 x 10^{-2}, 4 x 10^{-2}, 6 x 10^{-2}, and 8 x 10^{-2} M) inhibited the growth of these organs in peas.

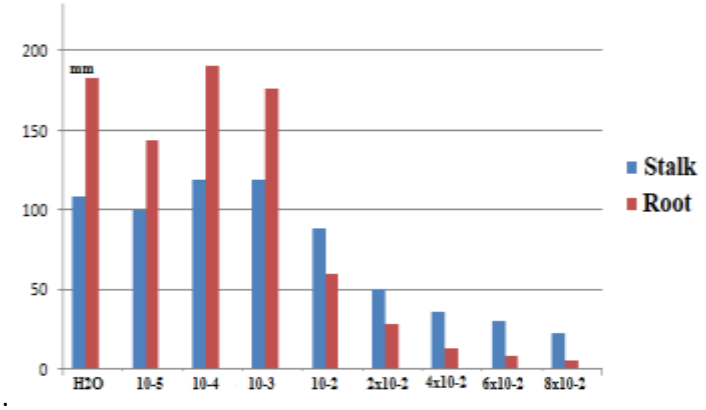

Figure 5. Permanent concentration and treatment (T.P.) in peas

So here we do not have a complete inhibition in the growth of plant organs, because the cellulose in peas creates a strong cell wall 2 x 10^{-2}, 4 x 10^{-2}, 6 x 10^{-2}, and 8 x 10^{-2} M, therefore these organs are still significantly more developed (Figure 5).

In the case where we used the temporary treatment (24 hours), the low concentrations mainly stimulate the growth of the stems and in particular the growth of the roots, while the high concentrations (4 x 10^{-2}, 6 x 10^{-2}, and 8 x 10^{-2} M) significantly inhibit the growth of these plant organisms (Figure 6).

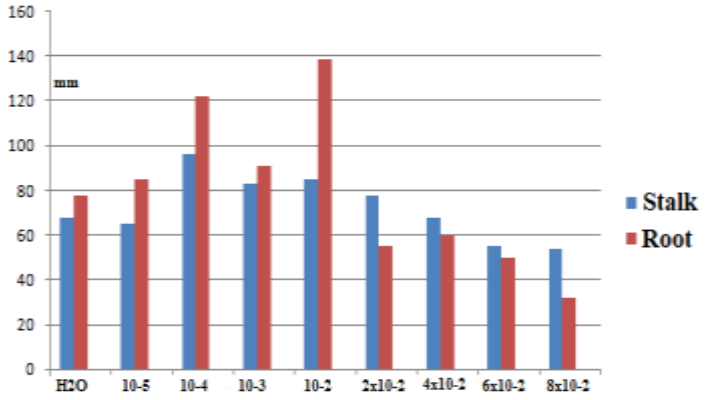

Figure 6. Concentrations and pre-treatment (P.T.) 24 hours in peas

When used before treatment 48 and 72 hours, zinc sulfate at almost all concentrations inhibited stem and root growth while water treatment is equally positive (Figures 7, 8).

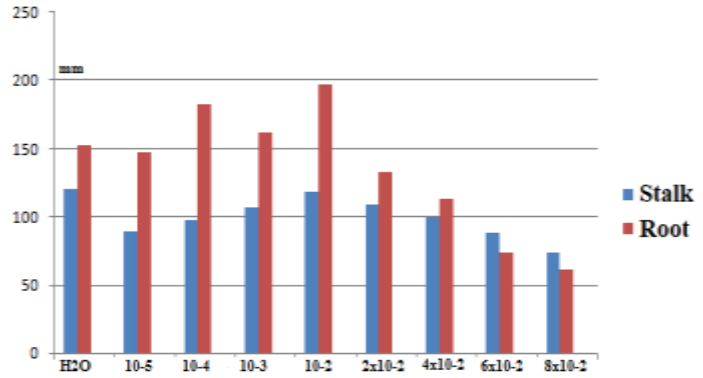

Figure 7. Concentrations and pre-treatment (P.T.) 48 hours in peas

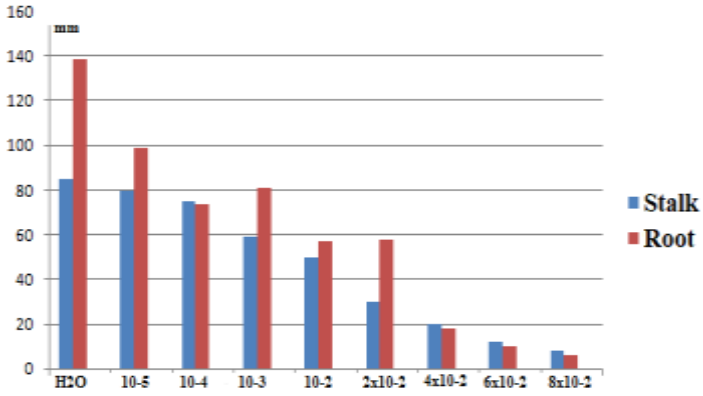

Figure 8. Concentrations and pre-treatment (P.T.) 72 hours in peas

The effect of zinc sulfate on the increase of fresh and dry weight of peas was investigated after permanent treatment (T.P.) and pretreatment (P.T.) 24, 48, and 72 hours, while corn at each concentration has a positive appearance but normally with changes based on concentrations of solutions.

The results obtained are presented in Table 1.

Table.1. Influence of zinc sulfate (ZnSO4) on the increase of fresh and dry weight of peas

Concentrations	Permanent treatment (PT)		Pre-treatment P.T. 24 hours		Pre-treatment P.T. 48 hours		Pre-treatment P.T. 72 hours	
	Fresh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry
H_2O	596.09	54.43	379.5	35.23	592.01	53.91	358.15	43.99
10^{-5}	563.97	51.81	337.33	33.18	487.08	46.03	381.34	39.3
10^{-4}	648.31	57.04	397.15	35.97	572.1	51.97	281.26	27.16
10^{-3}	661.82	54.57	368.19	33.32	593.4	53.04	245.7	27.08
10^{-2}	466.66	46.44	480.57	37.29	609.57	54.07	203.32	20.78
2×10^{-2}	264.05	33.21	453.09	49.14	559.78	51.26	210.53	16.99
4×10^{-2}	181.53	23.76	385.38	36.74	542.02	51.95	174.77	14.03
6×10^{-2}	158.88	20.52	328.5	33.41	478.56	46.01	117.03	7.68
8×10^{-2}	98.67	12.07	288.25	33.11	407.9	38.86	81.51	6.5

From Table 1, it is clear that the seeds treated with Permanent Treatment are distinguished by a higher weight of the roots and the last stems. In Pre-treatment (P.T. 48 hours) comparing the values are very close to Permanent Treatment. But on the other hand, the values of Pre-treatment (PT). 24 hours and pretreatment (PT) 72 hours we can say that the values of both together are approximately equal to Permanent Treatment (TP) or Pretreatment (PT).

4. Conclusions

- Zinc sulfate in low concentrations (10^{-5}, 10^{-4} and 10^{-3}) stimulates seed germination and stalk and root growth in peas.
- As the time before treatment increases, the stimulating effect of low concentrations of zinc sulfate gradually decreases.
- In parallel with the increase of the concentration of this substance, its inhibitory effect increases in both types.
- In the pre-treatment, the peas germinated up to a concentration of 8×10^{-2} [7].
- The greatest effect on the development of these vegetative organs has been in any concentration of peas. This may be related to the hereditary factor and the cytological structure of the cell as the cell wall which may be the barrier of zinc absorption inside the cell.
- We suggest producing fertilizers with concentrations that increase pea's productivity at these concentrations. Use Permanent Treatment (TP) and Pre-treatment in duration Before Treatment (PT 48 hours).

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5. References

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