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# Yield of Spring Wheat with the Combined Use of Sodium Selenite and Growth Regulators Depending on the Conditions of Water Supply

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## ABSTRACT

**Background:** Currently, technologies that provide the energy and nutritional value of agricultural crops under extreme growing condishions have the greatest advantage. Much research is devoted to the study of the effect of brassinosteroids and their analogs, as well as zircon, which have a multifunctional effect on the yield and the formation of elements of productivity of various agricultural plants. Also many studies have been carried out to study the effect of microelements on the formation of yield and adaptive ability of grain crops. However, some aspects of increasing the efficiency of growth regulation and microelements require further study. In this regard, studies were carried out to study the effect of the combined use of growth regulators and sodium selenite on the yield and the formation of productivity elements of spring wheat, depending on the conditions of water supply. The efficiency of the action of plants growth epin and zircon, introduced together with sodium selenit, on the yield and production process of spring wheat plants under conditions of optimal irrigation and short-term soil drought has been studies.

**Methods:** The research was carried out in 2018-2019. In a vegetation experiment at the Russian State Agarian University-Moscow Agricultural Academy. The object of research was spring soft wheat of the Ivolga variety. The plants were grown in vessels with a capacity of 5 kg of soil. For the experiments, a soddy-podzolic medium loamy soil was used. The optimal conditions for water supply were created watering the vessels during the entire growing season. A short-trem drought was created by stopping irrigation duting the steming phase. The duration of the drought is 5-6 days. In experiments, growth regulations epin, zircon and sodium selenite were studied, which were used by treating seeds before sowing wich 0,01% solutions of preparations. In the studies, the yield of spring wheat ang the formation of productivity elements were determined.

**Result:** Analysis of variance results for differences in the action of sodium selenite, zircon and epin, as well as their combination on various aspects of the production process of forming wheat yield. The stimulating effect of the combined use of sodium selenite and zircon on the reproductive organs of wheat was established, as a result of cariopses in an ear increased by 1.43 time. The activation of the attracting ability of the ear established when using the conscientious use of sodium selenite and epin. As a result, the wheat yield increased by 20% with optimal water supply and drought.

**Key words:** Growth regulators, Short-term drought, Sodium selenite, Spring wheat.

## INTRODUCTION

Growth regulators, as a rule, have certain properties that affect the physiological and biochemical activity of plants. Currently, in crop production, considerable attention is paid to the use of plant growth regulators, which, being environmentally friendly physiologically active substances, increase not only the yield, but also improve the quality of products. The positive effect of natural phytohormones on the ripening activity and the yield of various crops, including cereals, is due to an increase in seed germination, stimulation of the growth and development of roots, the processes of flowering, pollination and maturation of seeds (Plechov *et al*., 2015; Sasaki *et al*., 2005). Currently, use of growth regulators for agricultural crops under extreme growing conditions have the greatest advantage (Sadegh *et al*., 2020). The mechanism of action of growth regulators of biogenic or chemical origin manifests itself as inductive and stimulating. The inductive effect of growth regulators is caused by the launch of a specific cascade of reactions that implement plant resistance. While the stimulating effect is manifested in the form of activation of already ongoing processes. At the same time, it should be noted that under a number of conditions, these mechanisms include a number of reactions following one after another or

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simultaneously. In this case, the action of growth regulators is manifested as polyvalent, since their use activates the processes of cell division and growth, synthesis and transport of assimilates and the processes of realizing the adaptive abilities of plants (Filippov, 1998). Studies show that the use of phytohormones for seed treatment stimulates the processes of germination and fruiting, increasing plant resistance to drought (Mangena, 2020). In the assortment of new growth regulators with high biological activity, growth regulators are isolated that have an anti-stress effect and increase the resistance of agricultural crops to the effects of oxidative stress caused by biotic stresses (Mironova, 2009). Much research is devoted to the study of the effect of brassinosteroids and their analogues, as well as zircon, which have a multifunctional effect on the yield and the formation of elements of productivity of various agricultural plants (Seregina *et al*., 2003; Malevannaya, 2004). However, some aspects of the search for ways to improve the efficiency of growth regulators require further study. In this regard, the purpose of our research was to study the effect of the combined action of growth regulators and sodium selenite on the production processes of spring wheat, depending on the conditions of water supply.

## MATERIALS AND METHODS

The research was carried out in 2018-2019 in the vegetation experiment at the Department of Agronomic, Biological Chemistry and Radiology of the Russian State Agrarian University-Moscow Agricultural Academy. Spring wheat plants (*Triticum aestivum* L.) variety Ivolga were grown in soil culture in Wagner vessels with a capacity of 5 kg of dry soil. Sod-podzolic medium loamy soil was used for research. In the experiments, the growth regulators epin, zircon and sodium selenite were studied, which were used by treating the seeds before sowing with a 0,01% solution of the preparation. Variants without seed treatment served as control. Sowing was carried out with swollen seeds, 30 seeds each vessel into each vessel. In the tillering phase, thinning was carried out and 15 plants were left in vessels. The level of mineral nutrition by adding $NH_4NO_3$, $KH_2PO_4$ and KCl, at the rate of N150, P100, K100 per 1 kg of soil. In the experiments, the conditions of water supply were varied: optimal moistening (watering), which was carried out by watering the vessels by weight up to 60% of the total moisture capacity and insufficient moisture (drought). Drought was modeled by stopping watering of plants at stage VI of organogenesis. The duration of the drought was 5-6 days, after which watering was resumed. After harvesting, the weight of grain and straw (in grams/vessel), the number of grains and spikelets per spikelet (pieces per plant) and the weight of 1000 grains (grams) were determined. Statistical analysis of the results was carried out using the analysis of variance (Kobzarenko *et al*., 2015).

## RESULTS AND DISCUSSION

Under optimal condition of water supply, the use of sodium selenite, zircon and epin led to an increase in the yield of spring wheat (Fig 1). The use of sodium selenite led to an increase in the grain weight by 1.4 times, the use of zircon led to an increase in the grain weight by 1.23 times, the use of epin led to an increase in the drain weight by 1.27 times. The studied factors have differently influenced the formation of elements of productivity of wheat plants. The use of sodium selenite contributed to an increase in wheat yield as a result of an increase in the number of spikelets by 11% and the number of caryopses by 25% per spike on average per plant. When using zircon, the grain weight increased by 23%, which occurred as a result of the effect of the number of spikelets by 7% and the number of grain by 25% per spike on average per plant. When using epin, an increase in the weight of wheat grain occurred as a result of the effect of the growth regulator on the number of grains by 27% and the weight of 1000 grains by times (Fig 2). The combined application of growth regulators and sodium selenite with optimal water supply also revealed a positive effect on the formation of wheat yield. The combination of zircon and sodium selenite resulted in the highest wheat yield. In this variant, an increase in grain weight by 39% was obtained, due to an increase in the number of spikelets in an spike by 7% and a grain size of an spike by 1.43 times. The combination of an epin with sodium selenite led to a 1.2 times increase in grain weight due to a 1.4 times increase in the weight of 1000 grains, compared to that of without seed treatment.

It can be concluded that the action of individual studied factors contributed to the regulation of various aspects of the production process. It was found that the action of sodium selenite and zircon, introduced separately and the combination of zircon+sodium selenite, had a stimulating effect on the laying of reproductive organs, activating the processes of realization of of rudimentary flowers into grains. The use of epin and a combination of epin+sodium selenite revealed a positive effect on the increase in the weight of 1000 grains. The increase in the weight of 1000 grains indicates the activation of the processes of the outflow of assimilates from the vegetative mass into the spike.

The studies carried out made it possible to study the effect of growth regulators and their combination with sodium selenite on the formation of productivity with a deficit of water supply at the VI stage of organogenesis. It was shown that under conditions of a lack of water supply, there was a decrease in wheat yield in all variants of the experiment by an average of 10-35% compared to the variants where the plants were grown with optimal water supply (Fig 1). The use of sodium selenite, zircon and epin under drought conditions contributed to an increase in grain weight by an average of 1.4, 1.3, 1.2 times, respectively, compared with the control option without seed treatment. In these variants, the effect of the studied factors was manifested as a result of an increase in the number of caryopses in an ear by 30%,

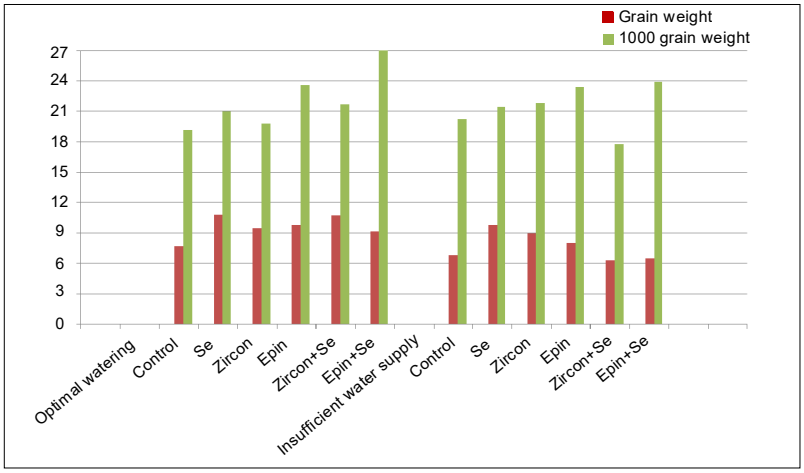


**Fig 1:** Influence of growth regulators and selenium on grain weight (g/vessel) and 1000 grain weight (g).

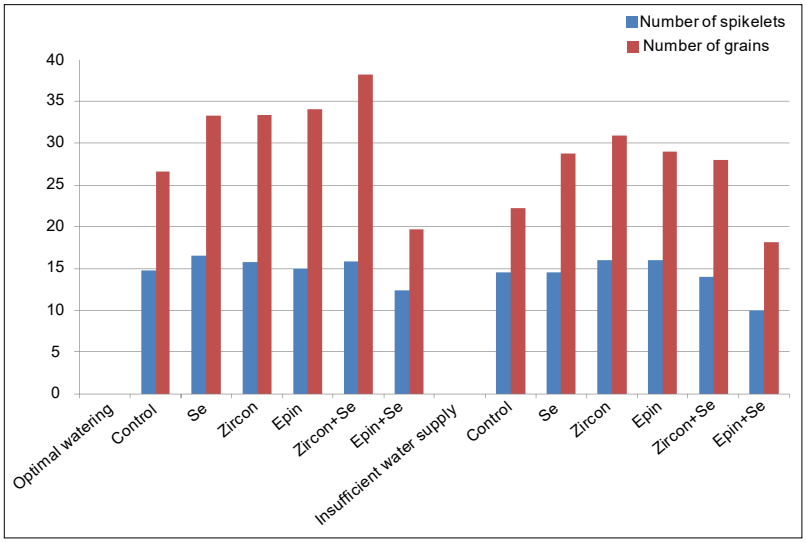


**Fig 2:** Influence of growth regulators and selenium on the number of spikelets and grains per plant, depending on the conditions of water supply (pcs).

39%, 27%, respectively (Fig 2). Previous studies revealed that the effect of sodium selenite and zircon on plant productivity is due to the participation of their active substance in the regulation of hormonal metabolism in plants, as a result of which the processes of flower formation are activated, as well as the processes of cell division and cytomorphogenesis of cells (Seregina, 2007). The action of epin is due to the activation of the protein-synthesizing system at the transcriptional level, as a result of which the active substance of the growth regulator regulates the synthesis and redistribution of proteins (Kotolovkina, 2004) and promotes the growth of the weight of 1000 grains. The active substance of epin has an auxinic nature, as a result of which the ratio of abscisic acid and indoleacetic acid changes towards an increase in indoleacetic acid, which activates not only the synthesis of protein compounds, but also the maturation processes (Kotolovkina, 2004).

The use of a combination of zircon+sodium selenite contributed to an increase in the number of grains in an ear by 26%, the combination of epin+sodium selenite contributed to an increase in the mass of 1000 grains by 17%. However, the change in the intensity of the development of the reproductive sphere of plants did not lead to a high grain yield in these variants. Apparently, the limitation of the processes of the formation of the yield of wheat plants was limited by a combination of a number of factors.

## CONCLUSION

The results of the studies made it possible to reveal the positive effect of sodium selenite, growth regulators, as well as their combinations on individual stages of the production process, which led to better yield of wheat under varying water application regimes. Under optimal water supply conditions, the effective effect of seed treatment before sowing with zircon and combined seed treatment with zircon + sodium selenite on the formation of reproductive organs was revealed due to changes in the hormonal balance of plants, which determined a high increase in grain yield in

these options. Under the same conditions, the positive effect of epin and the combination of epin + sodium selenite was manifested as a result of the activation of the attracting ability of the ear, as well as the outflow of assimilates into the forming caryopses, as a result of stimulation of the synthesis and redistribution of protein compounds. This led to an increase in the mass of 1000 grains and a high increase in grain productivity. Under drought conditions, the resistance of wheat plants to drought was stimulated in variants where the seeds were treated with sodium selenite, zircon and epin. In variants with the use of sodium selenite and zircon, an increase in the yield of wheat grain was obtained as a result of the activation of the development of rudimentary flowers and a decrease in the depression of the formation of caryopses. In the variant where the seeds were treated with epin, as a result of stimulating the outflow of assimilates from the vegetative organs to the reproductive organs, the weight of 1000-grains increased and this contributed to a decrease in the depression of plant productivity.

The research result revealed the possibility of using growth regulators epin, zircon, sodium selenite, as well as combinations of epin + sodium selenite and zircon + sodium selenite for seed treatment before revealed to increase wheat resistence to drought. An increase in wheat yield was revealed under optimal growing conditions and under drought conditions. The maximum effect was obtained when using a combination of zircon+sodium selenite. This is due to the most optimal combination of growth regulators.

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