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ORIGINAL ARTICLE

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Effects of Pre-Application with Gibberellic Acid on Germination of Soybean under Salt Stress

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This study was conducted to determine the effect of GA_3 applied on soybean seeds before germination in Sinop University Department of Biology Laboratory. Soybean seeds were treated with different doses of GA_3 (50, 100 and 150 ppm) for three different application times (6, 12 and 24 hours). After this, soybean seeds pretreated GA_3 irrigated with different doses of pure water and NaCl (50, 100 and 150 mM). Germination rate and germination time at room temperature, radicle and hypocotyl lenght, wet and dry weight of radicle, hypocotyl and cotyledon values were examined. Study, the highest germination rate was by (42.83% and 41%) and 6 hours in GA_3 pre and NaCl application (pure water) group, the highest germination time (6.80 and 6.81 days) at 6 hours with control (pure water) and at 50 ppm GA_3 pre and 150 mM NaCl. The highest radicle and hypocotyl length were obtained from 12 hours pre-application control (pure water) and 100 ppm GA_3 dose.

As a result; it has been observed that as the salt ratio increases, all the parameters decrease significantly and the soybean seed is very sensitive to salt, especially 6 hours control (pure water) and 50 ppm GA_3 pretreatment provides salinity resistance.

Key words: Glycine max. L., GA3, Radicule, Hypocotyl, Salt Stress

Most produced in the world and known as golden plant, soybean (*Glycine max* L.) is an annual cool-climatic and oil crop plant from legumes. Since it contains 36-40% protein, 18-24% fat, 26% carbon dioxide and 18% mineral matter in its seed, it has an important role in human and animal nutrition. Because it is the most produced oilseed in the world and has a wide usage area, it is widely used in almost every field of industry. Thanks to its unsaturated fatty acids, soybean oil prevents the occurrence of several health problems such as arteriosclerosis, diabetes, heart disease, breast cancer in humans and has an important place in human nutrition due to the group elements and vitamins it contains (Rahman *et al.,* 2011). Since the protein contained in soybean seed contains very important amino acids, it is used in animal feed; soybean flour is used in bread baking and baby food because it delays staling, and also used in meat products and production of several foodstuff since it is equivalent to protein in meat (Bohn *et al.,* 2014). Found in the roots of soybean plant, *Rhizobium japonicum* bacteria to absorb the free nitrogen in the air and give nitrogen to the soil thanks to the nodules formed in its roots.

Salinity is one of the major problems in arid and semi-arid agricultural areas in the world due to insufficient rainfall and high evaporation. Since the growth of plants grown in these soils is negatively affected, it causes significant reductions in yield (Promila and Kumar, 2000; Yılmaz *et al.,* 2011). Since the rate of salt in the soil prevents the water uptake of the seeds during the germination period, it leads to decrease in the germination and seedling growth of the seeds or death (Shila *et al.,* 2016; Sikdar *et al.,* 2016). Plant hormones are important chemical components that provide growth and differentiation in this region by moving to the places that affect the growth of the plant. One of the natural growth hormones, gibberellic acid (GA_3) has effects enhancing the features of the plants such as germination, vegetative development and grain yield (Rahimi *et al.,* 2011). Gibberellins increase the growth level of the embryo and the endo-β-mannanase enzyme produced in the endosperm accelerates germination by providing the breakdown of the cell wall of the endosperm. (Karakurt *et al.,* 2010). There are a number of studies indicating that the application of gibberellic acid in saline soils reduces salt stress on plants, and the effect of gibberellic acid on germination varies according to dose, time and plant species (Rout *et al.,* 2017; Zheng *et al.,* 2009).

Since plant seeds are usually exposed to salt stress in saline and arid soils, germination either slows down or stops completely. As a result, significant decreases occur in yield. It is necessary to determine the appropriate dose of the growth hormone, gibberellic acid, in order to ensure a faster and uniform germination and emergence of the seeds by preventing the plants from being exposed to salt stress. The aim of this study was to determine the effect of GA_3 plant growth regulator doses applied to seeds before germination against the germination problem that occurs in the soybean due to salinization in arid and semi-arid agricultural lands.

MATERIALS AND METHODS

This study was carried out in the "Germination Laboratory" of the Biology Department of the Faculty of Art and Science and Letters at Sinop University in 2019 with three replications according to the Randomized Blocks Experimental Design considering the application time as the main factor and the GA_3 and NaCl applications as the sub-factor. Soybean seeds (*Glycine max* L.) cv.SA88 obtained from a commercial provider (Agrova, Adana, TR) were used in the experiment. The seeds were sterilized through the treatment with 5% sodium hydrochloride solution for 10 minutes. As the seed pre-applications in germination experiments, seeds were kept in 3 different doses of GA_3 (50 ppm, 100 ppm and 150 ppm) and distilled water (H_2O) at 20 ± 1°C in dark conditions at each dose for 6, 12 and 24 hours. After the application, the seeds were passed through pure water 3 times and dried, then kept at +4 ^{0}C until being used. At the end of the waiting times, the soybean samples were placed in each petri dish with two pieces of blotter paper as 50 seeds. The NaCl solutions prepared at different doses (0, 50, 100 and 150 mM) were applied to the determined petri dishes. 10 ml of water was added to each petri dish and each was placed in sealed plastic bags to prevent evaporation.

Prepared experiments were left in completely dark germination cabinet at 25 ±1 ^{0}C for 10 days. Seeds in the dishes were checked every day during this period and were recorded as germinated with a radicle length of 2 mm (ISTA, 2007). At the end of the 8th day we defined, the total number of the germinated seeds was counted and the germination percentage (%) was found. The germination time was determined according to the formula stated by Tame (2011). Radicle wet, dry weight and length, hypocotyl wet, dry weight and length, cotyledon wet and dry weight were specified by measuring 10 germinated seeds randomly selected from each replication on the 8th day of the experiment.

Statistical Analysis:

The data obtained as a result of the research was statistically analyzed using the SPSS computer software, and the differences between the means were checked by Duncan's Multiple comparison test according to their significance levels.

RESULTS

According to the variance analysis results of the germination rate, germination time, radicle wet, dry weight and length, hypocotyl wet, dry weight and length, cotyledon wet and dry weight values of NaCl doses applied in different doses to soybean seeds that were subjected to GA_3 pre-application, time, gibberellic, salt, time x gibberellic, time x salt, gibberellic x salt and time x salt x gibberellic interactions were observed statistically significant at P<0.01 (Table 1). The mean values of the experiment parameters and Duncan groups are shown in Table 1.

Germination Rates and Germination Duration:

Table 1 states the mean values related to the germination rate and germination time of the NaCl doses in soybean seeds, which were subjected to GA_3 pre-application in different doses and defined times, and Duncan groups.

The highest mean germination rate was obtained from the 6-hour control (pure water) application of the Soybean seeds and GA_3 150 ppm pre-application with 42.83% and 39.5%, respectively. The lowest mean germination rate (13.17%) was obtained from control (pure water) application and 12-hour pre-application. The highest mean germination rate of soybean seeds in which certain doses of NaCl were applied was obtained from the control (pure water) application subjected to 6-hour pre-application with 42.83% while the lowest mean germination rate was obtained in the 150 mM NaCl dose in the 12-hour pre-application with 08.33%. It is clearly seen that NaCl has a negative effect on the development of plants and the germination rate decreases considerably due to the dose increase while it has the highest values in the control (pure water) application.

In terms of germination time, the highest mean germination time (6.80 days) in seeds was obtained from respectively 6 and 12-hour control (pure water) application and GA_3 50 ppm pre-application, and the highest germination time (6.81 days) was received from the 100 mM NaCl dose exposed to 6-hour pre-application. The lowest mean germination time of the seeds was obtained at 150 mM NaCl dose (4.84 days) in 6-hour 100 ppm (5.05 days) GA_3 pre-application. Generally, as GA_3 pre-application doses increase, the germination time decreases and this time increases in NaCl doses. It is clear that these two applications are inversely proportional to each other.

Radicula Wet, Dry Weight and Length:

Table 1 states the mean values of radicle wet, dry weight and length regarding different gibberellic acid and NaCl doses in soybean seeds subjected to GA_3 pre-application, and Duncan groups.

The highest radicle wet weight in soybean seeds was obtained in the 12-hour pre-control (pure water) application with 0.053 g and it was obtained in the same time period as 0.048 g from GA_3 150 ppm pre-application. The lowest radicle wet weight was obtained as 0.018 g from 6-hour GA_3 100 ppm pre-application. In the seeds, the highest mean radicle wet weight was obtained as 0.061 g from the 12-hour control (pure water) application while the lowest radicle wet weight was obtained as 0.016 g from the 150 mM NaCl dose in the 6-hour pre-application.

In terms of the radicle dry weight, the highest value was obtained from the soybean seed in 12-hour pre-control (pure water) application with 0.006 g while the lowest radical dry weight was obtained from the 6-hour control (pure water) application with 0.002 g and GA_3 100 ppm pre-application. Generally, the mean radicle dry weight received values as 0.003 and 0.004 g according to the 6- 12 and 24-hour pre-application results. In the seeds, the highest mean radicle dry weight was obtained as 0.006 g from the 12-hour control (pure water) application while the lowest radicle dry weight was received as 0.002 g from the 150 mM NaCl dose in the 6 and 24-hour pre-application.

The highest radicle length obtained according to GA_3 applications which were applied to soybean seeds considering certain hours was obtained from the 12-hour pre-control (pure water) application with 4.36 mm while the lowest radicle length (1.64 mm) was received from 150 GA_3 ppm pre-application within the same pre-application hour. When the effect of the salt concentrations that increased at certain doses on the radicle length was examined, the highest radicle length (4.73 mm) was obtained from 12-hour pre-control (pure water) application and the lowest radicle length (1.42 mm) was received from the 150 mM NaCl dose in the 24-hour pre-application.

Hypocotyl Wet, Dry Weight and Length:

Table 1 states the mean values of the hypocotyl wet weight, hypocotyl dry weight and hypocotyl length of different doses of NaCl concentrations in soybean seeds subjected to GA_3 pre-application times, and Duncan groups.

According to the results of the study conducted; as a result of the GA_3 pre-application on soybean seeds in different doses in the determined times, the highest hypocotyl wet weight (0.230 g) was obtained from the 12-hour pre-control (pure water) application and the lowest hypocotyl wet weight (0.155 g) was obtained from the 24-hour pre-application of 150 GA_3 ppm. In the seeds, the highest mean hypocotyl wet weight was obtained as 0.300 g from the 12-hour 50 mM NaCl application and the lowest radicle wet weight was obtained as 0.088 g from 150 mM NaCl dose in the 6-hour pre-application.

In terms of the hypocotyl dry weight of soybean seed, the highest value was obtained as 0.023 g from the 24-hour pre-application of GA_3 50 ppm. The lowest hypocotyl dry weight was obtained as 0.011 g from the 24-hour pre-application of 50 GA_3 ppm. In the seeds, the highest mean hypocotyl dry weight was obtained as 0.024 g from the 6-hour and 24-hour 50 mM NaCl and 100 mM NaCl application while the lowest hypocotyl dry weight was obtained as 0.009 g from the 150 mM NaCl dose in the 6-hour pre-application.

The highest mean hypocotyl length of soybean seeds was obtained as 7.95 mm from the 12-hour pre-application of GA_3 100 ppm, the lowest mean hypocotyl length was obtained as 4.16 mm from the pre-application of GA_3 100 ppm. In the soybean seeds on which certain NaCl doses were applied, the highest mean hypocotyl length was obtained as 10.47 mm from the control (pure water) application subjected to 12-hour pre-application while the lowest mean hypocotyl length was obtained as 2.54 mm from the 150 mM NaCl dose in the 6-hour pre-application.

Cotyledon Wet Weight and Cotyledon Dry Weight:

The mean values belonging to the cotyledon wet weight and cotyledon dry weight of NaCl doses in the soybean seeds subjected to GA_3 pre-application in different doses and determined times and the Duncan groups are given in Table 1.

In the seeds, the highest cotyledon wet weight was obtained as 0.346 g from the 12-hour pre-application of GA_3 100 ppm and the lowest cotyledon wet weight was obtained as 0.252 g from the 6-hour pre-application of GA_3 50 ppm. In the seeds, the highest mean cotyledon wet weight was obtained as 0.371 g from the 12-hour control (pure water) application while the lowest cotyledon wet weight was obtained as 0.237 g from the 150 mM NaCl dose in the 6-hour pre-application.

In terms of the cotyledon dry weight of soybean seed, the highest value was obtained as 0.095 g from the 6- and 24-hour pre-control (pure water) and GA_3 50 ppm application. The lowest cotyledon dry weight was obtained as 0.052 g from the 24-hour GA_3 pre-application of 150 ppm. In the seeds, the highest mean cotyledon dry weight was obtained as 0.097 g from the 6-hour 50 mM NaCl application while the lowest cotyledon dry weight was obtained as 0.067 from the 50 mM NaCl dose in the 6-hour pre-application.

Table 1. Effects of different doses of NaCl conditions on some yield parameters of soybean seeds pre-treated with GA_3 and results of variance analysis

Treatments	Germination Rates (%)			Germination Duration (day)			Radicula Wet Weight (g)			Radicula Dry Weight (g)			Radicula Length (mm)		
	Application Time			Application Time			Application Time			Application Time			Application Time		
	6	12	24	6	12	24	6	12	24	6	12	24	6	12	24
Control (pure water)	41.00^{a}	13.17^{c}	16.75^{a}	6.80^{a}	6.75^{b}	6.48^{a}	0.038^{a}	0.053^{a}	0.031^{b}	0.004^{a}	0.006	0.003	3.13^{a}	4.36^{a}	2.39^{b}
GA_3 50 ppm	27.83^{c}	14.17^{ab}	17.58^{c}	6.69^{b}	6.80^{a}	6.30^{b}	0.028^{b}	0.036^{b}	0.034^{a}	0.003^{ab}	0.004	0.003	2.32^{c}	2.77^{d}	2.53^{a}
$GA_3$100 ppm	15.67^{d}	14.58^{a}	25.92^{b}	5.05^{d}	6.14^{d}	6.21^{d}	0.018^{d}	0.046^{b}	0.029^{c}	0.002^{c}	0.004	0.003	1.98^{d}	3.30^{c}	1.75^{c}
$GA_3$150 ppm	39.50^{b}	14.00^{b}	26.00^{a}	6.50^{c}	6.32^{c}	6.27^{c}	0.027^{c}	0.048^{ab}	0.025^{d}	0.003^{b}	0.004	0.003	2.78^{b}	3.47^{b}	1.64^{d}
Control (pure water)	42.83^{a}	18.00^{a}	28.58^{a}	6.66^{c}	6.38^{d}	6.18^{d}	0.038^{a}	0.061^{a}	0.038^{a}	0.004^{a}	0.006	0.003^{b}	3.41^{a}	4.73^{a}	2.31^{a}
NaCl 50 mM	30.00^{b}	17.17^{b}	23.00^{b}	6.73^{b}	6.40^{c}	6.37^{b}	0.028^{c}	0.057^{a}	0.032^{b}	0.003^{ab}	0.005	0.003^{b}	2.60^{b}	3.97^{b}	2.24^{b}
NaCl 100 mM	28.92^{c}	12.42^{c}	19.08^{c}	6.81^{a}	6.54^{b}	6.32^{c}	0.031^{b}	0.035^{b}	0.030^{c}	0.003^{b}	0.003	0.004^{a}	2.64^{b}	2.98^{c}	2.33^{a}
NaCl 150 mM	22.25^{d}	08.33^{d}	15.58^{d}	4.84^{d}	6.69^{a}	6.40^{a}	0.016^{d}	0.030^{b}	0.021^{d}	0.002^{c}	0.003	0.002^{d}	1.58^{c}	2.22^{d}	1.42^{c}
	Hypocotyl Wet Weight (g)			**Hypocotyl Dry Weight (g)**			**Hypocotyl Length (mm)**			**Cotyledon Wet Weight (g)**			**Cotyledon Dry Weight (g)**		
Control (pure water)	0.180^{d}	0.230^{a}	0.167^{c}	0.016^{b}	0.018	0.016^{b}	5.88^{b}	7.47^{c}	4.87^{b}	0.325^{b}	0.326^{b}	0.257^{d}	0.095^{a}	0.092	0.075^{b}
GA_3 50 ppm	0.199^{b}	0.166^{b}	0.224^{a}	0.016^{b}	0.011	0.023^{a}	6.67^{a}	6.04^{d}	7.56^{a}	0.252^{d}	0.338^{ab}	0.345^{a}	0.072^{c}	0.089	0.095^{a}
$GA_3$100 ppm	0.188^{c}	0.216^{a}	0.184^{b}	0.015^{b}	0.017	0.016^{b}	5.10^{c}	7.95^{a}	4.16^{d}	0.312^{c}	0.346^{a}	0.285^{b}	0.094^{a}	0.076	0.067^{c}
$GA_3$150 ppm	0.217^{a}	0.226^{a}	0.155^{d}	0.020^{a}	0.018	0.014^{c}	6.71^{a}	7.76^{b}	4.46^{c}	0.330^{a}	0.304^{c}	0.281^{c}	0.088^{b}	0.088	0.052^{d}
Control (pure water)	0.259^{a}	0.269^{b}	0.222^{b}	0.019^{b}	0.019^{a}	0.018^{b}	7.65^{b}	10.47^{a}	6.15^{a}	0.319^{c}	0.371^{a}	0.290^{b}	0.087^{c}	0.090^{a}	0.070^{b}
NaCl 50 mM	0.246^{b}	0.300^{a}	0.184^{c}	0.024^{a}	0.023^{a}	0.015^{c}	7.90^{a}	9.32^{b}	6.02^{b}	0.329^{b}	0.318^{b}	0.280^{c}	0.097^{a}	0.091^{a}	0.067^{a}
NaCl 100 mM	0.191^{c}	0.152^{c}	0.233^{a}	0.016^{c}	0.011^{b}	0.024^{a}	6.28^{c}	5.46^{c}	6.01^{b}	0.334^{a}	0.314^{b}	0.350^{a}	0.091^{b}	0.069^{b}	0.081^{a}
NaCl 150 mM	0.088^{d}	0.119^{d}	0.091^{d}	0.009^{d}	0.011^{b}	0.011^{d}	2.54^{d}	3.97^{d}	2.86^{a}	0.237^{d}	0.312^{b}	0.246^{d}	0.076^{d}	0.095^{a}	0.071^{b}

Analysis of Variance	df	Parameters									
		GR	GD	RWW	RDW	RL	HWW	HDW	HL	CWW	CDW
Time (T)	2	10051.9**	19560.5**	1882.1**	41.3**	9689.9**	2260.5**	13.7**	8645.9**	5519.7**	1661.6**
Gibberellic acid (G)	3	1317.6**	141823.7**	278,3**	23.8**	2447.3**	81.5**	5.8**	1143.8**	11156.9**	80.9**
Salinity (S)	3	3798.0**	62347.1**	1466.8**	45.8**	7636.2**	43885.2**	329.8**	31788.4**	11156.9**	80.9**
TxG	6	2198.8**	47400.0**	184.1**	6.6**	911.6**	3057.2**	6.6**	3284.8**	5846.8**	1228.3**
TxS	6	265.8**	108814.7**	198.9**	17.2**	895.9**	5211.6**	124.9**	2764.9**	3898.4**	689.5**
GxS	9	292.6**	64735.3**	184.5**	14.2**	1506.6**	4681.3**	72.3**	3919.6**	18344.7**	1358.4**
TxSxG	18	449.6**	79155.3**	341.6**	8.9**	1403.5**	4493.7**	59.7**	2204.9**	10973.5**	1630.9**

*, ** Significant F-value at the p<0.05 and p<0.01 level, respectively. For each main effect, the difference between mean values shown on the same column with the same letter is not significant according to Duncan's Multiple Range test at *P* <0.05. GR: Germination rates, GD: Germination Duration, RWW: Radicula wet weight, RDW: Radicula dry weight, RL: Radicula length, HWW: Hypocotyl wet weight, HDW: Hypocotyl dry weight, HL: Hypocotyl length, CWW: Cotyledon Wet Weight, CDW: Cotyledon Dry Weight

DISCUSSION

According to the results we obtained, it was determined that the germination rate and germination time, which are among the important parameters of soybean seeds for the growth of the plant, significantly decreased as the rate of salinity increased. The researchers stated that the osmotic pressure emerging depending on the toxic effect of Na^+ and Cl^- ions and the negative effects of salt had a negative effect on the germination of the plant by stopping the water intake of plants (Khajeh Hosseini *et al.,* 2003; Ekmekçi *et al.,* 2005). The germination phase, which is the first step of the growth phase in plants, is the most sensitive period and in this period, excessive salt concentration in the soil significantly decreased the germination rate. In this phase, high salt concentration in the soil negatively affects the plant development by preventing water intake of the seed and stopping the enzyme activities that are necessary for the activation of germination (Essa, 2002; Sadeghian and Yavari, 2004). It was detected by many researchers that depending on the increase in the different salt doses applied to plants, there was a significant decrease in the germination rate, germination time, wet, dry weight and lengths of surface and subsurface organs (Sedeghian and Yavari, 2004; Radić *et al.,* 2007; Hakim *et al.,* 2010; Akbarimoghaddam *et al.,* 2011; Hassen *et al.,* 2014). The reaction given by the parameters examined on the soybean seeds used in the study we conducted to the salt concentration was similarly observed as a decrease as the dose increased. As a result of our study, it was clearly seen that in parallel with the statements of other researchers, salt stress had a negative effect on germination, which is the first step of the growth phases of the plant, root and shoot length, wet and dry weight.

It was stated in many research results that the gibberellin (GA_3) applications especially applied to the plants with low germination rate accelerated the germination of the seeds and enabled the germination to be higher (Nee *et al.,* 2016; Shu *et al.,* 2016). However, it was observed that the germinations of the soybean seeds treated with GA_3 were lower compared to the control (Leite *et al.,* 2003). It was also determined that 16-hour application increased the germination time in the sunflower seed subjected to GA_3 pre-application (Kaya *et al.,* 2006), similarly, the 8-hour GA_3 pre-application on the sunflower seed had a positive effect on germination (Erdemli and Kaya, 2015), 10-hour GA_3 pre-application applied to sugar beet seed shortened germination time and increased root, shoot length and seedling wet weight according to the research of Jamil and Rha (2007) and 12-hour GA_3 pre-application of *Digitalis lanata* provided the best results in the applications of 50-100 ppm (Gürbüz and Gümüşçü, 1996). Yildiz *et al.* (2017) observed that the GA_3 pre-application in the Sweet William seeds protected the plant seeds against salt and minimized the germination damages that could occur depending on the negative effect of salt. Ghodrat and Rousta (2012) detected that GA_3 applied to corn seeds decreased the negative effects of salt conditions on germination rate, root and shoot length, wet and dry weight. While there is no study related to the GA_3 pre-application on soybean seed, it is clearly seen in the studies conducted with different plants that the seeds treated with GA_3 were resistant to salinity and when they were kept with GA_3 for a certain period, it had a positive effect on growth parameters and our study results were similar to the results obtained by other researchers.

It is known that significant yield losses occur in every plant depending on the salt stress sensitivity. The results of this research, which was conducted with an aim to determine the reaction of the doses of GA_3, an important growth hormone subjected to different pre-applications for the minimization of this negative effect in soybean seed, against salt stress, are given below. It was observed in the 6-hour GA_3 pre-application applied on soybean seed that the mean germination rate of the seeds increased in the control (pure water) and 150 ppm doses salt stress and similarly, in the control application where NaCl was not applied, it gave the highest mean germination rate. In terms of the germination period, the mean germination time decreased since the control (pure water) and 100 ppm doses increased the germination speed in the 6-hour pre-application. The mean radicle wet, dry weight and length were obtained in the control (pure water) in the 12-hour pre-application. In the mean hypocotyl wet weight, the control (pure water) in the 12-hour pre-application, in the mean hypocotyl dry weight, 50 ppm GA_3 dose in the 24-hour pre-application and in the mean hypocotyl length, 100 ppm GA_3 dose in the 12-hour pre-application gave the best results. In the mean cotyledon wet weight, 100 ppm GA_3 dose in the 12-hour pre-application and in the mean cotyledon dry weight, control (pure water) and 50 ppm doses in the 6- and 24-hour pre-applications gave the best results.

Plants are exposed to stress depending on biotic and abiotic factors. One of these factors is salt stress. Especially with the evaporation occurring in arid regions depending on temperature, desertification is rapidly increasing due to salinity on agricultural areas. In such situations, plants release a number of growth hormones to resist stress. Gibberellic acid is one of these hormones. Soybean plant, which is very important in terms of protein and fat, is a cold climate plant that is very sensitive in terms of germination. In this respect, it was tried to examine the effects of NaCl stress of soybean seeds subjected to pre-application at certain time intervals (6, 12 and 24 hours) with different GA_3 doses (0, 50, 100 and 150 ppm) on the seed germination. It was observed that soybean seeds' germination rate, germination time, radicle wet, dry weight and length, Hypocotyl wet weight, Hypocotyl dry weight, Hypocotyl length, Cotyledon wet weight and Cotyledon dry weight decreased depending on the increasing salt rate, and accordingly, the plant development slowed down and began to rot. According to this result, it is clearly seen that soybean seed is very sensitive to salt.

As a result, the GA_3 application on soybean seeds in the determined times before plantation in the regions where salinity is high has an increasing effect on seeds' germination, root and shoot wet dry weight and length and enables resistance to salinity.

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