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THE EFFECT OF PRIMING ON GERMINATION AND GROWTH INDICES IN CHAMRAN WHEAT VARIETY IN NORTH OF KHUZESTAN PROVINCE, IRAN

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ABSTRACT. In order to study the plant growth regulator, using salicylic acid (SA) on germination and growth indices for laboratory research in crop year 2014-2015, which was conducted at the research center Safiabad-Dezful, Khuzestan province. The treatments included four levels of priming with salicylic acid {control (distilled water), 0.7, 1.2, 1.7 mM} in a completely randomized design in three replications. The results showed that the control treatment reduced the decrease in germination time. The highest percentage of germination and related characteristics of the control (distilled water) was obtained. Seed vigor and seedling vigor index were reduced in high concentrations of salicylic acid. The germination percentage of an average daily germination, seed vigor and seedling vigor index had a positive and significant correlation with the daily germination rate showed a significant negative correlation. The results of comparison of treatments showed that the treatment concentration of 0.7 mM salicylic acid highest (22.3 days) and control (distilled water) lowest (0.3 day) had mean germination time. Effects of priming showed the highest mean daily germination (15.44) related to the control and the lowest (2.97) related to the concentration of 7.1 mM salicylic acid. Also, the results showed that the 1.7 mM salicylic acid treatment had the highest number of germinated seeds per day (0.3880) and control treatment had the least number of germinated seeds per day (0.6467). The highest vigor index was observed in control treatment with seedling length of (8.15 cm) and the lowest vigor index was observed in 1.7 mM salicylic acid treatment with seedling length of (1.54 cm). The highest seedling vigor index was observed in control treatment (33.58) and the lowest seedling vigor index was observed in 1.7 mM salicylic acid treatment (17.20). The coefficient velocity germination rate in control treatment was highest (3) and in the 1.7 mM salicylic acid treatment was lowest (0.15). The correlation coefficient between vigor index and seedling vigor index has the highest value (98%). There was a positive correlation

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between germination percentage and mean daily germination and there was a negative correlation between germination percentage and daily germination speed.

Keywords: growth regulator; salicylic acid; seed vigor; daily germination; laboratory research.

INTRODUCTION

Wheat is one of the major crops that provides energy and protein for humans. It is of importance to increase the performance of this product per hectare using breeding and agronomic research is absolutely necessary. One of the most important and new approaches to improve performance, quality and quantity of crops, such as wheat, is the use of plant growth regulators. This material has low rates, prodigious ability to regulate some aspects of growth and development of their crops (Fathi & Esmaeilpour, 2010). Salicylic acid is a plant growth regulator that its use has become customary in recent years in most crops. The salicylic acid has a physiological impact on the structure and synthesis on different enzymes (particularly, anti-stress enzymes) play an important role in crop tolerance to biotic and abiotic stress factors and ultimately the performance of the plant. For example, in a field experiment conducted on wheat, application of (5.0 mM), salicylic acid was effective due to an increasing resistance to fungal diseases of wheat seedlings, and enabled growth and increases yield (Shakirova *et al.,* 1997, 2000).

Priming, this is a technique by which seeds are exposed to both environmental and ecological conditions before putting on bed, in terms of physiological and biochemical readiness to acquire germination.

This can cause biological and physiological numerous protests on primed seeds and plants, to be sure of this, germination, seedling establishment, operation of environmental inputs, also, in an early stage, it is important to increase the quality and quantity observed. Priming increases the speed and uniformity of germination of seed efficiency. The positive effects includes: improvement of the speed of plant growth, accelerate the maturity date, increase in the quantity and quality of seeds in throughput performance (Baalbaki *et al.,* 1999).

The results of several experiments show that priming causes quicker, better tolerance to drought, early flowering, plant growth peas, corn and wheat in semi-arid areas (Harris *et al.,* 2001b; Musa *et al.,* 1999; Burgne & Job, 2000).

In recent years, much research has been done on the effect of salicylic acid on multiple reaction, on plants and showed that this hormone (SA) helps in the regulation of important physiological processes, such as plant growth, flower formation, cell division, ion control by root absorption, photosynthesis, stomatal closure germination plays a vital role (Chavez *et al.,* 2003). Kaya *et al.* (2006) reported that priming

with salicylic acid cause increase daily germination rate and uniformity of germination and seed emergence, according to research Zare *et al.* (2010), Hsu & Sung (1997) and Sharafizadeh (2013). The effects of salicylic acid treatment on daily germination rate were significant. They concluded that seed priming with low concentrations of salicylic acid increases the antioxidant enzymes in the seeds, thus increasing the germination rate of seeds. El-Tayeb (2005) reported that the salicylic acid can be used to stimulate the germination of barley. In order to evaluate pretreatment by salicylic acid on germination of barley seeds, an experiment was conducted. In this test, priming with salicylic acid on seed germination average was significant. The results showed that pretreatment with salicylic acid increases the germination in different varieties of barley (Noori & Fotovat, 2013). Seeds pretreated with salicylic acid has the lowest average time required for germination of rape and compared to those with no salicylic acid showed significant differences (Miarsadeghi *et al.,* 2010). The results of Sharafizadeh (2013) showed that priming with salicylic acid in wheat seedling vigor index were significant. He said seedling vigor index, in addition to control without salicylic acid, salicylic acid treatment was lower by increasing the concentration of salicylic acid was less seedling vigor index. Similar results in this area by Saberi & Toveili (2010) and Korkmaz*et al.* (2005) have been reported. In another study, it was reported that an increase in the concentration of salicylic acid impairs germination and emergence of wild mustard seeds and seedling vigor index reduction of wild mustard (Fariduddin*et al.,* 2003). The study of Sharafizadeh (2013) revealed that priming effect of salicylic acid in Chamran seeds and on seed vigor index was significant and with increasing concentration of salicylic acid, vigor decreased. In their study, high concentrations of salicylic acid reduces the potential of water and reduces water absorption and slow down the germination enzymes activity and reduces the vigor of wheat seeds.

This study aimed to investigate the effect of salicylic acid and germination in seeds and accelerate the priming effect of salicylic acid on germination characteristics and growth indicators of Chamran variety in laboratory research.

MATERIALS AND METHODS

This research was conducted at Seed Technology Laboratory in the research center, Safiabad- Dezful, Khuzestan province, Iran. The treatments included four levels of priming with salicylic acid {control (distilled water), 0.7, 1.2, 1.7 mM} in a completely randomized design in three replications. Based on ISTA (2015), 50 seeds were soaked separately in these solutions for 12 h and then germination test was conducted using the inter paper method. To test germination, germinator was used at 25°C temperature and 60% humidity. The second day after the test, the number of

germinated seeds were counted each day (green criteria when the tip of the root to reach about 2 mm). At the end of the final day count (8 days) in the laboratory, mean daily germination, germination percentage, average time required for germination, germination rate index was calculated using the following formula:

Mean Time Germination (MTG)

The mean time required for germination, which is considered an indicator of the speed and acceleration of germination, was calculated from the following equation (Ellis & Roberts, 1981).

$$MTG = \frac{\sum(nd)}{\sum n},$$

where, n is the number of germinated seeds during the day, d is the number of days from the beginning of germination and Σn is the total number of germinated seeds.

Mean Daily Germination (MDG)

Mean daily germination index of daily germination speed. In this regard, FGP is the final germination percentage (viability) and d is the number of days to achieve maximum final germination (during the test period) (Scott *et al.,* 1984).

$$MDG = \frac{FGP}{d}$$

Daily Germination Speed (DGS)

Conversely mean daily germination and the following equation (Hunter *et al.,* 1984):

$$DGS = \frac{1}{MDG}$$

Coefficient Velocity Germination (CVG)

The speed and acceleration of seed germination was calculated using the following equation (Maguire, 1962):

$$CVG = \frac{G_1 + G_2 + G_3 + ... + G_n}{(1xG_1) + (2xG_2) + (3xG_n) + ... + (nxG_n)},$$

where, G1-Gn is the number of germinated seeds from the first day to the last day of the show.

Germination Percentage (GP)

The following equation was used to calculate the germination percentage:

$$\frac{S}{T} x100,$$

where, S is the number of germinated seeds and T is the total number of seeds.

Seedling Vigor Index (SVI)

After the determination of the normal and abnormal seedlings, five seedlings were randomly selected from each stand, then the seedling and leaf primordial and primary roots were determined. Using data from the past two seedling, vigor index was determined from the following equation (Waseem, 2006):

SVI = Viability × (Mean length of primary root + Mean length of primary stem)

Vigor Index (VI)

The following equation was used to calculate the index (Agrawal *et al.,*2005):

Seedling length × number of germinated seeds on the last day count

Statistical analysis

Statistical analysis was performed using SAS software. Means comparison was done by Duncan test. Tables and charts were drawn by Excel software.

RESULTS AND DISCUSSION

Mean time germination (MTG)

The effect of treatments on the mean time required for germination was significant at 1%. The results of comparison of treatments showed that the treatment concentration of 0.7 mM salicylic acid highest (22.3 days) and control (distilled water) lowest (0.3 day) had mean germination time. With increasing concentrations of salicylic acid increased the mean time required for germination. As Zare *et al.* (2010) also Jalilian & Tavakol Afshari (2005) reported. Increasing the concentration of salicylic acid, due to reduced osmotic pressure and reduce water absorption reduces the germination and increase the time required for germination. The results were consistent with the results of this test.

Mean daily germination (MDG)

Effect of different of levels priming on average daily germination was significant. The results of comparison of the effects of priming showed the highest mean daily germination (15.44) related to the control and the lowest (2.97) related to the concentration of 7.1 mM salicylic acid. Rajaskaran *et al.* (2002) suggest that high concentrations of abscisic acid and salicylic acid, the same effect as a deterrent GA is the duty of the synthesis of alpha-amylase enzyme responsible for the acts of the aleurone layer, which reduces daily average seed germination.

Daily germination speed (DGS)

The results of analysis of variance showed that the effect of salicylic acid treatment on germination rate was significant daily at 5% probability level. The results of the comparison showed that the treatment of 1.7 mM salicylic acid had the highest number of germinated seeds per day (0.3880) and the control treatment had the lowest amount of germinated seeds (0.6467). Kaya *et al.* (2006) reported that the priming with salicylic acid daily increased germination rate and uniformity of germination and emergence is sent.

Coefficient velocity germination (CVG)

The results of analysis of variance showed that the effect of salicylic acid treatment on germination rate coefficient was significant at 1%. The results of comparison of the effect of salicylic acid treatment revealed that control most (3.0 number of days for each single seed) and 1.7 mM treatment with salicylic acid (0.15 numbers of days for each single-seed) the coefficient velocity germination rate had. Significant effect of seed priming on germination of wheat seeds by Sharafizadeh (2013) was reported. Their results showed that the highest rate of germination rate, in addition to control, the low concentration of salicylic acid. It seems that with increasing concentration of salicylic acid and germination rates have fallen. Similar results in this area by

Saberi and Toveili (2010) have been reported.

Germination percentage (GP)

The results of analysis of variance revealed that the germination treated with salicylic acid were significant at 1%. The results of comparison of the effect of salicylic acid treatment revealed that control highest (100%) and 1.7 mM treatment with salicylic acid lowest (51.50%) had. Sharafizadeh (2013) also reported that the highest germination percentage of low mM concentrations of salicylic acid and the lowest germination percentage was the highest mM concentrations of salicylic acid. In many studies, the effect of pretreatment salicylic acid increased the germination percentage is sent. According to researches of Metraux (1970) and Shim *et al.* (1999), a low concentration of salicylic acid increased the germination been through ethylene biosynthesis. The results of this research can be concluded that salicylic acid pretreatment due to increased germination and seedling growth further reduces stress on the seed germination process.

Table 1 - Analysis of variance (mean square) of traits measured in the laboratory

S.O.V	df	MTG	MDG	DGS	CVG	GP	SVI	VI
Salicylic acid	3	0.0059**	0.0001**	0.0250**	0.0001**	0.0067**	0.0028**	0.0089**
Error	8	25.84	1.146	0.01	0.0001	152.35	6489.71	63516.8
CV		23.96	19.84	15.19	1.54	5.87	14.08	32.28

** refer to significant at 1% probability levels.

Seedling vigor index (SVI)

The results of analysis of variance showed that seed vigor treated with salicylic acid were significant at 1%. The results of comparison of the effect of salicylic acid treatment revealed that control highest (33.58) and 1.7 mM salicylic acid treatment lowest (17.20) had the seedling vigor index. Kaur *et al.* (2000) reported that priming with distilled water or low concentrations of osmotic ingredients like salicylic acid due to the activation of metabolic enzymes necessary for germination and increase the activity of alpha and beta amylase improve the quality of seed germination in the early stages of germination and then increased vigor seed. In his study, Sharafizadeh (2013) revealed that priming effect of salicylic acid in Chamran seeds on seed vigor index was significant. With increasing concentrations of salicylic acid decreases vigor. It seems that high concentrations of salicylic acid to reduce the potential for water and reduce water absorption and the lack of enzyme activity reduces the vigor of germination and vigor of wheat seeds is sent.

Vigor index (VI)

The results of analysis of variance showed that the effect of salicylic acid treatment on seedling vigor index were significant at 1%. The results of comparison of the effect of salicylic acid treatment revealed that control highest (8.15 seedling length by cm) and 1.7 mM salicylic acid treatment lowest (1.54 seedling length by cm) seedling vigor index had. The results of the research findings by Fariduddin *et al.* (2003) were consistent. He checked the Hindi mustard plant and said that increasing concentrations of salicylic acid reduces water potential was more like water stress and disruption of absence seed germination and seedling index reduction corresponded. The results of Sharafizadeh (2013) showed that priming with salicylic acid in wheat seedling vigor index was significant. He said seedling vigor index, in addition to low levels of salicylic acid treatment was in control. Seedling vigor index was lower by increasing the concentration of salicylic acid.

Correlation between traits in the laboratory

The correlation coefficient between germination percentage and seedling vigor index was (0.94). The correlation coefficient between germination percentage and vigor index was (0.91). The correlation coefficient between seedling and seedling vigor index has the highest value (0.98). There was a positive and significant correlation between germination percentage and daily average germination (0.74), and there was a negative and significant correlation between germination percentage and daily germination rate (-0.95). It seems that with increasing concentration of salicylic acid, due to reduced water uptake and thus reduce the activity of enzymes responsible for seed germination, decreased daily. Therefore, by increasing the concentration of salicylic, acid seed vigor and seedling vigor index also fell.

Table 2 - The correlation coefficient traits in the laboratory

	VI	SVI	GP	CVG	DGS	MDG	MTG
MTG							1
MDG						1	0.852**
DGS					1	0.7457**	0.5606ns
CVG				1	-0.5442ns	0.9512**	-0.8491**
GP			1	0.5265ns	-0.9552**	0.7423**	0.4723ns
SVI		1	0.9425**	0.6844*	-0.9211**	0.8629**	-0.6223*
VI	1	0.9834**	0.9147**	0.6413**	-0.8704*	0.8265**	-0.6039*

ns,*, ** refer to non significant, significant at 5% and 1% probability levels, respectively.

CONCLUSION

Germination percent, seed vigor index, seedling vigor index, average daily germination and speed germination rate in control (distilled water) was highest. This traits in concentration of 1.7 mM salicylic acid was lowest. In the treatment concentration of 1.7 mM salicylic acid, daily germination rate was highest and in control treatment this trait and mean germination time was the lowest. By increasing salicylic acid concentration, the potential for water absorption by seeds decreases because, in such a condition, the enzyme activity in the seed is interrupted. In fact, salicylic acid at optimal concentration increases some plant hormones, such as auxins and cytokinines, and reduces cell ion leakage and helps seed germination. Salicylic acid in stress conditions, due to stimulation of proline production in young seedlings, accelerates growth after stress relief.

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REFERENCES

Agrawal, S., Sairam, R.K., Srivastava, G.C., Tyagi, A. & Meena, R.C. (2005). Role of ABA, salicylic acid, calcium and hydrogen peroxide on antioxidant enzymes induction in wheat seedlings. *Plant Sci*., 169: 559-570.

Baalbaki, R.Z., Zurayk, R.A., Blelk, M.M. & Tahouk, S.N. (1999). Germination and seedling development of drought tolerant and susceptible wheat under moisture stress. *Seed Sci.Technol*., 27: 291-302.

Bourgne, S., Job, C. & Job, D. (2000). Sugarbeet seed priming: solubilization of the basic subunit of 11-S globulin in individual seeds. *Seed Sci.Res.,* 10: 153-162.

Chaves, M.M., Maroco, J.P. & Pereira, J.S. (2003). Understanding plant response to drought: from genes to the whole plant. *Funct.Plant Biol*., 30: 239-264.

Ellis, R.H. & Roberts, E.H. (1981). The quantification of ageing and survival in orthodox seeds. *Seed Sci.Technol.*, 9: 377-409.

El-Tayeb M.A. (2005). Response of barley grains to the interactive effect of salinity and salicylic acid. *Plant Growth Regul*., 45(3): 215-224. DOI: 10.1007/s10725-005-4928-1

Fariduddin, Q., Hayat, S. & Ahmad, A. (2003). Salicylic acid influences net photosynthetic rate, carboxylation efficiency, nitrate reductase activity and seed yield in *Brassica juncea*. *Photosynthetica*, 41(2): 281-284. DOI: 10.1023/ B:PHOT. 0000011962.05991.6c

Fathi, B.C. & Esmaeilpour, B. (2010). Plant growth regulators (Principles and Applications). *Publications University of Mashhad*, p. 288.

Harris, D., Pathan, A.K., Gothkar, P., Joshi, A., Chivasa, W. & Nyamudeza, P. (2001b). On-farm seed priming: using participatory methods to revive and refine a key technology. *Agric.Syst.,* 69:151-164.

Hunter, E.A., Glasbey, C.A. & Naylor, R.E.L. (1984). The analysis of data from germination tests. *J.Agric.Sci.,* Cambridge, 102(1): 207-213. DOI: https://doi.org/10.1017/S002185960 0041642

Hsu, J.L. & Sung, J.M. (1997). Antioxidant role of glutathione associated with accelerated aging and hydration of triploid watermelon seeds. *Physiol.Plant.*, 100: 967-974.

Jalilian, A. & Tavakol Afshari, R. (2005). The effect of osmopriming on germination of sugar beet seeds under drought stress. *The Sci. J. Agric.,* 27(2): 23-35.

Kaur, S., Gupta, A.K. & Kaur, N. (2000). Effect of osmo- and hydropriming of chickpea seeds on seedling growth and carbohydrate metabolism under water deficit stress. *Plant Growth Regul*., 37: 17-22.

Kaya, M.D., Okçu, G., Atak, M., Çıkılı, Y. & Kolsarıcı, Ö (2006). Seed treatment to overcome Salt and drought stress during germination in sunflower (*Helianthus annuus* L.). *Eur.J.Agro*. 24:291- 295.

Korkmaz, A., Ozbay, N., Tiryaki, I. & Nas M.N. (2005). Combining priming and plant growth regulators improve muskmelon germination and emergence at low temperature. *Eur.J.Hortic.Sci.,*70: 29-34.

Maguire, J.D., (1962). Speed of germination aid in selection and evaluation for seedling emergence and vigor. *Crop Sci.*, 2: 176-177. http://dx.doi.org/10.2135/cropsci1962.0011183X000200020033x

Metraux J.P. (2001). Systemic acquired resistance and salicylic acid: current state of knowledge. *Eur. J. PlantPathol.,* 107: 13-18.

Miar Sadeghi, S., Shekari, F., Fotovat, R. & Zangani, A. (2010). Effect of salicylic acid on vigor and growth of canola seedlings under water stress. *Plant Biol.*, 6, p. 55.

Musa, A.M., Johansen, C., Kumar, J. & Harris, D. (1999). Response of chickpea to seed priming in the High Barind Tract of Bangladesh. *International Chickpea and Pigeonpea Newsletter,* 6: 20-22.

Noori, M. & Fotovat, R. (2013). The effect of priming with salicylic acid on vigor and germination of barley cultivars. *Second National Congress of Organic Farming*, p. 318.

Rajasekaran, L.R. & Blake, T.J. (2002). New plant growth regulators protect photosynthesis and enhance growth under drought of jack pine seedlings. *J.Plant Growth Regul*., 18(4): 175-181.

Saberi, D. & Toveili, AS. (2010). The effect of priming on seed germination characteristics. *Iranian Journal of Range and Desert Research,* 17: 151-160.

Scott, S.J., Jones, R.A. & Williams, W.A. (1984). Review of data analysis methods for seed germination. *Crop Sci.,* 24: 1192-1199.

Shakirova, F.M., Bezrukova, M.V. & Sakhabutinova, A.R. (2000). Effect of salicylic acid on the yield of spring wheat and the phytohormone budget in plants during ontogeny. *Agrokhimiya*, 5: 52-56.

Shakirova, F.M. & Bezrukova, M.V. (1997). Induction of wheat resistance against environmental salinization by salicylic acid. *Biol.Bull.*, 24: 109-112.

Sharafizadeh, M. (2013). Effects of salicylic acid pretreatment characteristics drought stress on the germination of wheat Chamran. Agriculture PhD Thesis. Islamic Azad University, Science and Research Branch of Khuzestan, Iran.

Shim, L., Naruse, Y., Kim, Y.H., Kobayashi, K. & Usui, K. (1999). Scavenging activity of NaCl-induced activated oxygen in two rice (*Oryza sativa* L.) cultivars differing in salt tolerance. *Jpa.J.Trop.Agr.*, 43: 32-41.

Waseem, M. (2006). Influence of exogenously applied salicylic acid on drought tolerance of hexaploid wheat. Thesis of philosophy in department of botany University of Agriculture, Faisalabad, pp. 73-86.

Zare, R. (2010). The effect of different levels of salicylic acid to improve germination under salinity and drought for berry. *Journal of Range and Watershed Management (Iranian Journal of Natural Resources)*, 3(1): 29-39.