Effects of different aquasorb on germination and drought resistance of *lavandula* Angustifolia seeds

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**Abstract.** Experiments were carried out to simulate the effects of three water-retaining agents on germination and drought resistance of *Lavandula* seeds. The germination rate, germination potential, germination index, and the changes of catalase and amylase activities during germination were observed after treatment with water-retaining agent. Our results show that (1) the use of a suitable water retention agent can promote the germination rate of *Lavandula* seeds, and the best germination result is obtained by using water retention agent B in 0.25%. (2) The peroxidase activity after using the water-retaining agent was lower than that of the control group; meanwhile, the amylase activity was higher than that of the control group. The best treatment results of water-retaining agent A, B and C are 0.5%, 0.25%, and 0.1%, respectively. We conclude that the water-retaining agent B in 0.25% is optimum concentration for *Lavandula* seeds.

**1. Introduction**

*Lavender* (*Lavandula angustifolia* Mill.) is a perennial spice plant of the genus Lavender. Its stems and leaves can be used as medicine, which has the effects of stomach, sweating and pain relief. Its essential oil products have the functions of decompression, anti-depression and treating insomnia, etc. The aromatic oil in flowers can be used as the primary raw material for making cosmetics and soap essence [1-3]. Meanwhile, lavender has high ornamental value, which is the plant material for arranging flower beds, flower quilts, creating flower seas and other garden landscapes, and can not only be used for viewing but also for purifying the air. Besides, the construction of a lavender theme park can drive the development of local tourism. Therefore, in recent years, lavender has been favored by people and introduced and cultivated in many places in China. Due to the flat precipitation in north China and the low germination rate caused by seeds, the large-scale cultivation of lavender in north China is limited. Water retention agent is a kind of functional polymer material. It having powerful water absorption capacity can be repeated water absorption and release. Water retention agent through the surface adsorption and ion exchange, in the absorption of moisture at the same time keep the soluble nutrients in the soil in the molecular mesh structure, release to the external environment changes slowly, agriculture compared it to "reservoir" [4-6]. Studies at home and abroad have shown that the use of water-retaining agent can not only effectively reduce the leaching loss of soluble nutrients in soil, but also stabilize the soil structure, reduce soil bulk density and promote the formation of soil aggregates, improve the germination rate of seeds, encourage plant growth and
development and delay the wilting time [7]. Due to the different physical and chemical properties of various water-retaining agents and the limitation of the seeds themselves, the treatment effects of different water-retaining agents on seeds are different. In this experiment, three water-retaining agents with different water-retaining properties and efficacy were selected. By observing the effects of different concentrations on seed germination and drought resistance, the type and optimal absorption of water-retaining agents suitable for lavender seeds were selected to provide a theoretical basis for large-scale cultivation of lavender in northern China.

2. Materials and methods

2.1. Experimental materials
Lavender seeds characteristics of import and export trade co, LTD. (Shanghai), water-retention agent, a sodium carboxymethyl cellulose (CMC-Na), water-retention agent B (polyacrylic acid sodium (PAAS) ), water retention agent C (starch grafted poly (sodium acrylate) ), 3, 5-2 nitro salicylic acid, maltose, and sodium-potassium tartrate, starch, guaiacol, quartz sand, NaOH, C₆H₈O₇, Na₃C₆H₅O₇ꞏ2H₂O, H₂O₂, KMnO₄, NaH₂PO₄, KH₂PO₄.

2.2. Experimental methods

2.2.1. Determination of water absorption ratio of water-retaining agent. Put 0.50g of water-retaining agent in a 500mL beaker, add excess distilled water, and let stand for 2~3h to make the water-retaining agent absorbs water to saturation state, filter out the no absorption water, weigh the water retaining agent crystal mass M, and calculate the water absorption multiple of water-retaining agent by the ratio of water-retaining agent mass before and after water absorption. Three sets of parallel experiments were conducted for each water-retaining agent to obtain the average value.

2.2.2. Lavender seed treatment. Three concentration gradients of 0.1%, 0.25% and 0.5% were prepared. After hydrogel is formed, the seeds are evenly sprinkled into the hydrogel and stirred to mix the seeds with the hydrogel fully. After standing for 4~6h, the seeds are taken out and spread out to dry to remove excess water. When a film is formed on the surface of the seeds, seeds can be sown. The results were compared with the seed (CK) without water retaining agent.

2.2.3. Seed drought simulation experiment. In this experiment, a petri dish culture experiment was adopted. At room temperature, water was watered once every 48h and evenly sprinkled on the surface of filter paper. Firstly, the variation trend of the germination rate of lavender seeds under different water supply was observed. A total of 5 gradients of 2.0 ml, 3.0 ml, 4.0 ml, 5.0 ml, and 6.0 ml were set up for each watering. To observe the trend of seed germination rate under different water supply and choose the appropriate water supply to simulate the drought state of lavender seeds.

2.2.4. Determination of physiological indexes of seed germination. On the 12d of sowing, Guaiacol method and 3,5-dinitrosalicylic acid colorimetry (DNS) were used to determine the activity of peroxidase (POD) and Amylase during seed germination [8-9].

2.2.5. Data processing. After the 1st watering, the number of germination was counted every day (with 12d as the final stage of germination), and the germination rate, germination potential, and the germination index of seeds were calculated. All data were compared and analyzed by Excel and SPSS 20.0 statistical software, and the values were mean ± standard deviation.

3. Results and analysis

3.1. Water absorption ratio of different water-retaining agents
Water absorption ratio is one of the indexes to test the performance of water-retaining agent. Due to
the different types of water retaining agents, there are significant differences in the water absorption ratios of the three water retaining agents (Fig. 1). Among the three water retaining agents, the water retaining agent A (carboxymethyl cellulose sodium CMC-Na) has the weakest water absorption capacity (88 times), and the water retaining agent C (starch grafted sodium polyacrylate) has the strongest water absorption capacity (160 times).

3.2. Influence of water supply on seed germination rate
There is a significant difference in seed germination between different water supplies. When the water supply is 3.0~5.0mL, the seed germination rate is greatly improved. After reaching 5.0 mL, the growth rate began to decrease (Fig. 2). When the water supply is 3.0 mL, the seed germination rate is low, and the increase of water has a great influence on the seed germination (slope starts to become larger). Therefore, a 3.0 mL water supply was used to simulate drought conditions.

3.3. Effects of different water-retaining agents on seed germination
The experiment controlled the water supply to simulate the drought to limit the germination of lavender seeds. The control experiments were carried out on the treated and untreated seeds, and the germination rate, germination potential and the germination index of the seeds were statistically analyzed. In the drought state, the germination rate, germination potential and the germination index of the seeds treated with different concentrations of three water retention agents were significantly different, and were higher than the control group (CK, bold data). Among them, the water-repellent agents A, B, and C had the best germination status at 0.5%, 0.25%, and 0.1% (underlined data). The germination state of the water retention agent B reached a peak at a concentration of 0.25%, and the germination rate, germination potential and germination index were 40.6%, 27.3% and 24.56, respectively (Table 1).

| Type of water-retaining agent | Mass concentration (%) | Germination rate (%) | Germination potential (%) | Germination index |
|-------------------------------|------------------------|----------------------|--------------------------|------------------|
| Super absorbent polymers A    | CK                     | 11.7±0.5d            | 6.0±0.8d                 | 5.22±0.36d       |
|                               | 0.10%                  | 21.3±1.2c            | 14.3±1.7c                | 14.11±1.43c      |
|                               | 0.25%                  | 30.3±0.5b            | 17.6±0.5b                | 18.61±0.36b      |
|                               | 0.50%                  | 33.5±1.2a            | 22.3±0.5a                | 22.01±0.76a      |
| Super absorbent polymers B    | CK                     | 11.7±0.5d            | 6.0±0.8c                 | 5.22±0.36c       |
|                               | 0.10%                  | 26.3±1.2c            | 14.0±2.1b                | 13.96±1.28b      |
|                               | 0.25%                  | 40.6±1.2a            | 27.3±2.5a                | 24.56±2.05a      |
|                               | 0.50%                  | 29.7±1.2b            | 16.3±0.5b                | 16.49±0.43b      |
3.4. Effects of water-retaining agent on enzyme activity during seed germination

3.4.1. Peroxidase (POD). The POD activity of the control group (CK, 250) was higher than that of the treatment group. When the application concentrations of water retention agents A, B and C were 0.5%, 0.25% and 0.1%, respectively, the POD activity of lavender seeds was the lowest (Fig. 3). It can be seen from the standard error bars that the POD activity is most affected at the level of the water retention agent A treatment and is minimally affected by the water treatment agent C treatment concentration.

3.4.2. Amylase. The amylase content of the control group was lower than that of the treatment group (CK, 20.5). When the application concentrations of A, B and C were 0.5%, 0.25% and 0.1%, respectively, the amylase activity of lavender seeds was the highest (Fig. 4). It can be seen from the standard error bars that the amylase activity treated by the water retaining agent B is most affected by the concentration, while the water retaining agent C is lowest affected by the level.

4. Discussion and conclusion

The experiment showed that the germination rate, germination potential, and the germination index of seeds were improved by applying different concentrations of three kinds of water retention under drought conditions. Among them, the germination effect of water-retaining agent B was significant when the focus was 0.25%. Combined with the experiment, it is found that under the condition of limited water content, the water-retaining agent with a high level and strong water absorption capacity forms the phenomenon of water competition with the seed during the process of water absorption and expansion, thus restricting the germination of seeds. Therefore, we can not only apply water-retaining agent from the strength of water absorption, but also consider the concentration, soil moisture, and water requirements of different crops when seeds germinate.

Peroxidase (POD) is an essential protective enzyme for scavenging oxygen free radicals. To reduce the peroxidation effect of the body under stress, the plant body alleviates the damage of free radicals by enhancing the activity of POD, to achieve the purpose of adapting to drought stress [10]. The experimental results showed that the peroxidase activity of lavender seeds treated with three water-retaining agents of different concentrations were lower than that of the control group, indicating that the appropriate level of water-retaining agents could improve the stress of drought on seed germination.
Amylase plays an essential role in seed germination. The experimental results showed that the amylase activity was enhanced to different degrees after application of water-preserving agent, which accelerated the process of starch decomposition into soluble sugar in endosperm of seeds to supply the consumption of seed respiration, thus providing energy for seed germination and improving the physiological activities of seeds so as to promote seed germination [11]. Among them, the amylase activity was the strongest and the germination state was the best when the concentration of water-preserving agent B was 0.25%.

In summary, from the changes of germination status of seeds and the activities of the two related enzymes, it can be seen that the treatment effect of water-retaining agent B is the best, and the treatment effect is the best when the concentration is 0.25%. Therefore, water retention agent B can be used as an ideal material for lavender seed germination.

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