Effects of Waterlogging On Maize Seedling Growth during Seed Germination

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Abstract. In order to understand the resistance of maize seed germination characteristics, to varying degrees of early germination of maize seeds flooding stress, explore the seed germination of maize seedling vigor and growth period of flooding stress, help to understand inverse resistant mechanism of corn seed germination period, to help agricultural production results show that the seeds of waterflooded development, continue to develop at a young age, compared with control, corn seedling variety of enzyme activity and soluble sugar and soluble protein in different degree of change Compared with the control group, the chlorophyll content of Lu yu 36 maize seedlings decreased, while the chlorophyll content of Zheng Dang 958 showed a trend of first decreasing and then increasing. Peroxidase (POD), malondialdehyde (MDA) and soluble sugar all showed an increasing trend. These results provided a basis for better understanding of the waterlogging stress tolerance of maize seeds during germination.

Keywords: Seed Germination, Maize, Flooding Stress

1. Introduction

As one of the three major grain crops, corn worldwide has a very wide range of planting area with the global climate change, frequently, disaster flooding in some areas in southern China last long continuous waterlogged disaster not only will cause serious impact on agricultural production, will bring great economic losses to people, such as heavy rain and flooding in a large amount of rainfall will lead to food production, therefore, to explore the flooded length of corn seed vigor and seedling growth impact is very be necessary, so that we can further identify the corn stains waterlogging disasters, in a certain period to reduce the harm of corn In this period, we can adopt all kinds of effective measures to reduce the economic loss.

1.1 Seed Vigor:
Seeds, including high energy and low seed vigor, germination of good seed called high vigor seeds, the seeds of poor performance as low vigor seeds seed or seed vitality of height and seed types of genetic factors and related to the natural environmental conditions of seed during development, and is associated with the storage conditions of seed in general, the higher seed life force, the growth and development of seed and seedling growth of the field in the process of growth and storage performance, etc. Comprehensive characteristics are good The seed vigor is low, and the seed may sprout under the suitable environment, but the growth status of the seed may be uneven. Under the bad environmental conditions, the seed may even not sprout. After a certain period of storage, the seed vigor, germination rate and germination potential and other indicators of the seed are mostly declining.

1.2 Effects of Flooding on Seeds:
In different year, frequent flooding, soil flooded conditions, soil flooded major hazard is soil moisture is overmuch, cause plant cannot get enough oxygen flooded parts of the plant is a lack of oxygen, the whole plant physiological changes, resulting in death so withering plant flooded water stress can seriously affect crop growth and development To explore the germination period of flooding stress corn seedling vigor and growth, the influence of the brand in this experiment chooses the firm jade 36 and Zheng 958 two maize varieties as research materials, set up not long flood water treatment at the same time, and then develop into seedlings, analysis its seed vigor, for each processing long seedling chlorophyll content determination of SOD MDA content of soluble protein, POD analysis resistant ability and flooded flooded after germination ability to restore growth, according to two kinds of maize varieties seeds flooded the length, understand the changes in all aspects of the corn seed.

2. Materials and Methods

2.1 Test Materials
Corn hybrid Lu Yu 36 and Zheng Dan 958 were used as test materials

2.2 Experimental Methods
Test will take two factor randomized block design two varieties of maize seeds are sown in containing two layers of paper bed of germinating box, carton 25 seed and 4 times repeated trials, flooded time set 6 treatments, respectively 0 h, 6 h, 12 h, 24 h and 36 h, 48 h will sprout box in the cultivation of the 30, 48 hours training in the flood submerged water depth of 2 cm for 48 hours after statistical paper bed break through seed coat on the number of corn seeds and germination of maize seeds transplanting to sand bed to make it continue to grow, sand bed by 150 drying under 400 grams of sand and 80 ml of distilled water Will sprout box under 24-26 incubator for training regularly every day to check the number of seed germination radicle length is greater than 2 cm (as germination standard), every two days on a regular basis to sprout box of distilled water and nutrient solution to just submerged sand computational germination potential and germination rate, germination cut-off continues to develop, after 15 days of maize seedlings sampling inspection (4 set of duplicate samples mixed when sampling, to reduce the error).

2.3 Index Measurement
Determination of chlorophyll Content Determination of peroxidase (POD) activity Determination of malondialdehyde (MDA) Content Determination of soluble protein content refer to li Hesheng et al[1].

2.4 Statistical Analysis
Use Office and DPS for data processing statistics.

3. Results and Analysis

3.1 Effect of Water Flooding On Chlorophyll Content of Maize during Seed Germination
Figure 1. Chlorophyll content of Zheng dan 958(A) and Lu yu 36(B)

It can be seen from figure 1 that there was no significant difference in chlorophyll content between the two varieties after waterlogging. Previous experiments [2] showed that the chlorophyll content of plants would decrease after prolonged submersion treatment. In this experiment, the contents of chlorophyll A, chlorophyll B and carotenoids of the two maize varieties were not significantly different at the six treatment levels. The discussion result was that the seeds were flooded after being exposed to white, and the seeds did not contain chlorophyll and there was no chlorophyll production. Secondly, the duration of submergence is relatively short in this experiment, and the seeds themselves have the ability to cope with adverse environmental impacts. Therefore, the difference of chlorophyll content in the six treatment levels was not significant.

3.2 Effects of Waterlogging On the Content of Peroxidase in Corn during Seed Germination

Figure 2. Peroxidase activity of Zheng dan 958(A) and Lu Yu 36(B)

Can be seen from figure 2 two maize varieties under water after the water treatment plant peroxidase activity have significant differences, Zheng dang "958" in flooded the POD activity of 48 hours compared with flood water 24 hours a day and 36 hours have significant differences, POD activity increased significantly, speculated that flooded for a long time, the development of seeds of flooded to make corresponding changes to adapt to bad environment. After a long time of seed flooding, free radicals increased, and free radical scavenging enzymes such as peroxidase increased. In the treatment level of the variety "Lu Yu 36", there was significant difference between the 6-hour waterlogging treatment and the 36-hour and 48-hour waterlogging, and the POD activity content of the 6-hour waterlogging was higher.

3.3 Effects of Water Flooding On Malondialdehyde Content in Corn during Seed Germination
Figure 3. Malondialdehyde content of Zheng dan 958(A) and Lu Yu 36(B)

The accumulation of malondialdehyde will lead to membrane lipid peroxidation and deoxidation in the cell membrane, causing damage to the cell membrane, reducing membrane resistance and fluidity, loss of membrane selective absorption function, and intracellular electrolyte leakage. The loss of cell membrane function will affect other physiological and biochemical activities of plants [3].

Figure 3 showed the determination of malondialdehyde content in two maize varieties. There was no significant difference in malondialdehyde content in the six treated plants of "Zheng Dan 958". Malondialdehyde content of the plants in the six treatment levels of Lu Yu 36 was significantly different, showing a trend of first increasing and then decreasing.

3.4 Influence of Water Flooding On Soluble Sugar Content of Maize during Seed Germination

Figure 4. Soluble sugar content of Zheng dan 958(A) and Lu Yu 36(B)

When plants are subjected to the stress of flooding, they also show certain reaction measures in terms of substance metabolism, specifically, the decomposition of sugar is greater than the synthesis. Under the stress of flooding, plants can reduce the water potential of plants by osmotic regulation and increasing the content of soluble sugar, so as to alleviate the degree of water deficit. This is consistent with the result that the availability sugar content of Ginkgo biloba increased after flooding [4].

As can be seen from figure 4, there was no significant difference in the soluble sugar content of "Zheng Dan 958" and "Lu Yu 36".

3.5 Effect of Water Flooding On Soluble Protein Content of Maize during Seed Germination
Most of the soluble proteins in plants are enzymes involved in various metabolism. The content of soluble proteins is an important physiological and biochemical index, and its measurement is an important index to understand the total metabolism of plants.

There was no significant difference in soluble protein content between "Zheng dan 958" and "Lu Yu 36" maize seedlings among the six control groups.

4. Discussion and Conclusion

4.1 Relationship between Waterlogging and Chlorophyll Synthesis in Maize Seed Germination Stage
Under the stress of water flooding during germination, the energy supply of maize seeds gradually decreased, and the maize seedlings grew slowly, thus saving energy and reducing the consumption of material energy. Therefore, this phenomenon led to changes in the metabolism of crop seedlings. Chlorophyll is one of the important physiological characteristics of plants, and it is also an indispensable material basis for photosynthesis of plants. There was no significant difference in chlorophyll content between "Lu Yu 36" and "Zheng dan 958" maize seeds after waterlogging during germination. This result was related to the duration of flooding during germination. This situation is similar to the relevant research results of Lilac by Li Juan jian et al [5]. With the extension of waterlogging time in germination stage of maize seeds, the respiration of seeds changed from aerobic respiration to anaerobic respiration. As the duration of waterlogging lasted, the oxygen concentration in the environment of seeds would decrease. At the same time, the content of oxygen free radicals in seedling cells increased, chlorophyll in seedling leaves was destroyed and decomposed, and finally chlorophyll content was reduced. This phenomenon can lead to the growth of seedlings or a series of defects. If the waterlogging tolerance of crops is very strong, the damage caused by waterlogging during seed germination can be alleviated, and the physiological functions of waterlogging during seed germination can be quickly restored to the stunted growth and damaged seedlings themselves [6].

4.2 Relationship between Water Flooding and POD Activity Content at Germination Stage of Maize
POD is a kind of enzyme which exists widely in plants and has high activity. It can work together with CAT to reduce hydrogen peroxide in seedling body, reduce the damage caused by hydrogen peroxide, and also participate in the synthesis of hydrogen peroxide, reduce the harm of hydrogen peroxide to the cell lipid membrane of maize seedling. In the experiment of waterlogging in the germination stage of maize, POD activity of two maize varieties showed a trend of up-down-down and up-up. The results showed that seedlings would respond to waterlogging stress and POD activity increased after 6-hour waterlogging. After waterlogging treatment, the decreased activity may be related to seed adaptability. A further rise may result in a longer duration of flooding, more hydrogen peroxide produced in plants, and significantly increased POD activity.

4.3 Relationship between Flood and MAD Content in Maize Seeds during Germination
MDA content is often used as an important indicator of membrane lipid peroxidation damage in plants, and the level of MDA content can reflect the degree of membrane lipid peroxidation[7-8]. The higher MDA content is, the more serious membrane lipid peroxidation will occur; on the contrary, the lower MDA content is, the lighter membrane lipid peroxidation will occur [7]. There was no significant difference in malondialdehyde content of Zheng dan 958. At the beginning of the experiment, MDA content of "Lu Yu 36" maize varieties showed a trend of slow increase, which indicated that a large number of reactive oxygen species in the plant could promote the degreasing effect of membrane lipid. After that, MDA content of "Lu Yu 36" maize varieties showed a trend of slow decline, and the free radical scavenging ability of the plants was improved, thus limiting the peroxidation of membrane lipids, and the growth and development of the plants gradually returned to the normal physiological state.

4.4 Relationship between Water Flooding and Soluble Sugar During Germination Of Maize Seeds
The content of soluble sugar is an important marker of the damage of plants under the stress of flooding under adverse environment [8]. It is also an extremely important small molecule involved in osmotic stress[9-11]. Plants will store soluble sugar in the body, it can let the plants in a bad environment, through its own regulation system to adjust content and transform the osmotic pressure of the plant body, at the same time also can relieve stress to harm the plants, can also to provide the energy of the growth of plants, mediation of plant metabolism. The soluble sugar content of the seedlings of the two maize cultivars varied with the time of submersion. In this experiment, there was no significant difference in the soluble sugar content of "Zheng dan 958", while "Lu Yu 36" showed an overall upward - downward trend in soluble sugar according to the duration of water flooding during seed germination.

4.5 Relationship between Water Flooding and Soluble Protein during Germination of Maize Seeds
Soluble protein content is often referred to as an important indicator of water tolerance in screening because of its protective effect on the cell's living matter and biofilm. There was no significant difference in soluble protein content in six treatment levels between "Zheng dan 958" and "Lu Yu 36" corn varieties.

In conclusion, there was no correlation between the duration of flooding and the germination rate of the two maize varieties. There was no obvious promotion or inhibition to chlorophyll biosynthesis in maize seedlings. The POD activity of maize seedling was promoted in certain duration of water submersion. MDA content increases slowly at first and decreases gradually with the increase of the duration of flooding. It also increases the soluble sugar in the short term of flooding and changes the osmotic pressure. It can obviously promote or inhibit the soluble protein.

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