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Effects of Selenium on Rape Seed Germination and Its Physiological and Biochemical Indexes

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Abstract: Rape is the main vegetable oil raw material and has a large planting area. It is of great significance to study the effect of selenium on rape. The purpose of this study is to find the effects of selenium on rape seed germination and its physiological and biochemical indexes, in order to find a feasible way to increase rape yield. In this paper, a comparative experiment was conducted to study the effect of different concentrations of selenium solution on rapeseed biomass, so as to achieve the research purpose. This study found that soaking seeds with a certain concentration of selenium solution is conducive to improving the germination rate and germination potential of the seed, especially when treated at a concentration of 15-25 μg / ml, selenium can promote the germination of the seed, in the range of selenium mass concentration less than 20 μg / ml With the increase of selenium mass concentration, the reduction rate of rape root system increased, and the selenium mass concentration was too high. When the selenium mass concentration was more than 20 μ / ml, the reduction rate of rape root system decreased, and it can be seen that high-quality selenium inhibited the growth and development of the root system. Therefore, supplementing appropriate amount of selenium can promote the growth and development of rape, which is beneficial to improve the growth environment of the root system, improve reducing power, increase biomass, and properly supplement selenium in rape cultivation to improve selenium nutrition of rape and promote growth and development of rape., Thus increasing yield, improving quality, etc. will have an impact.

1. Introduction

Selenium is one of the indispensable trace elements for the growth of plants and animals. Some news media have long reported the effects of selenium on other crops. The results of their studies have shown that different concentrations of selenium solutions have different agricultural and economic characteristics of crops. The effect of selenium on rape seed germination was rarely reported. At the same time, rape is the main source of vegetable oil, with a wide range of consumption, and China's annual rapeseed planting area and yield are the world's first. Therefore, the study of selenium on rape seed germination and physiological and biochemical indicators is of great significance.

Mehdi Aghighi Shahverdi and others investigated the effects of different concentrations of selenium on plant growth, chemical indicators, and mineral nutrients. The pot method was used to determine the growth, chemical indicators, and mineral nutrients (N, P, K, Ca, Mg, Mn, Zn, Cu) content. The results showed that the contents of mineral nutrients (N, P, K, Ca, Mg, Mn, Zn, Cu) in the roots, stems and leaves of flue-cured tobacco reached the maximum value at 4. The content of nicotine, reducing sugar and protein in tobacco leaves was within the optimal range when selenium treatment was 4mg ·kg-1. Low-level selenium (selenium ≤ 4.4mg · kg-1) promotes the absorption of mineral nutrients by flue-cured tobacco, especially the absorption of N, K, Ca, mg, and Mn, and promotes the growth of flue-cured tobacco with more coordinated chemical components. However, high selenium levels (selenium ≥11.1 mg · kg-1) inhibited the absorption of mineral nutrients by flue-cured tobacco, especially the absorption of nitrogen, phosphorus, and potassium, and ultimately inhibited the growth of flue-cured tobacco. Therefore, different selenium concentrations in the soil affect the growth and chemical indicators of flue-cured tobacco by regulating the absorption of mineral elements by plants. This study provides a theoretical basis for guiding selenium-rich agricultural production [1]. Rocio Castillo Godina studied the effects of six selenium concentrations (0, 5, 10, 25, 50, 75, 100 mg / kg) on the physiological characteristics and selenium accumulation of lettuce in a pot experiment. 5 mg / kg selenium concentration can promote the biomass of lettuce The selenium has an inhibitory effect on the growth of rice. The selenium content in the high selenium soil is rich. The selenium content in the root system is higher than that in the aerial part. As the selenium concentration increases, the selenium content in the root system and the aerial part increases. At kg / kg, the selenium content in the roots were 1.34, 4.49, and 5.44, 11.20 times higher than 5mg / kg, 17.42 times higher than 5mg / kg, 1.91 times higher than 5mg / kg, 4.14 times higher than 5mg / kg, and 5mg / kg higher. 5.13 times higher than kg, 6.14 times higher than 5mg / kg, 8.69 times higher than 5mg / kg, 1.15 times higher than 5mg / kg, 3.70 times higher than 5mg / kg, 3.58 times higher than 5mg / kg, and higher than 5mg / kg 4.36 times, 4.50 times higher than 5mg / kg, 1.31 times higher than 5mg / kg, 1.56 times higher, and 1.61 times higher. When the selenium concentration is 100mg / kg, the selenium content and selenium accumulation of alfalfa reach the maximum, so When the selenium concentration is 100mg / kg, the alfalfa selenium enrichment effect is the best [2]. Le Yuan Ma et al. Studied the effects of selenium (Se: 0.36 μ · mol·L-1) on the aging-related oxidative stress of garlic at two sulfur levels using a hydroponic method. We evaluated the yield of plants harvested 160 and 200 days after sowing. Plants grown under low selenium (0.3 μ · mol·L-1) had higher chlorophyll concentrations than the control (fresh weight increased by 12.0% and dry weight increased by 13.7%). Compared with the control, selenium-treated plants had lower levels of lipid peroxidation. Selenium-treated plants also showed higher glutathione peroxidase and catalase activities, but lower superoxide dismutase activities. The effect of S over Se on the inFv / fm value and proline content is greater. The results show that selenium plays a key role in the antioxidant system of garlic seedlings. It delays aging by reducing peroxidative stress, but may be toxic at high concentrations. High sulfur levels can increase plant tolerance to high selenium by reducing selenium accumulation in plants [3-4].

In this paper, by comparing the changes in physiochemical parameters of rapeseed germination under different concentrations of selenium solution, the experimental results of different effects of different selenium solutions on the growth and development of rapeseed were finally obtained. Amount of selenium.

2. Proposed Method

2.1. Related Theories of Selenium

(1) Chemical properties of selenium

Selenium is a chemical element with the chemical symbol Se. It is located in Group VIA of the fourth cycle in the periodic table of chemical elements and is a non-metal. Selenium exists in two ways in nature: inorganic selenium and plant active selenium. Inorganic selenium generally refers to sodium selenite and sodium selenium, including yeast selenium and malt selenium that have a large amount of inorganic selenium residues.Inorganic selenium obtained from by-products of metal minerals has greater toxicity and is not easily absorbed and is not suitable for people And animal use. Plant active selenium is a combination of selenium and amino acids through biotransformation, and generally exists in the form of selenomethionine [5-6].

Selenium element is a red or gray powder with a metallic luster of gray metal. Of the six solid allotropes known, three crystals (α mono italic, β mono italic, and gray triangular) are the most important. Among the crystals, the gray hexagonal system is the most stable, with a density of 4.81 g / cm3. It also exists in three amorphous solid forms: red and black two amorphous glassy selenium. The former is brittle with a density of 4.26 g / cm3; the latter has a density of 4.28 g / cm3; the other is colloidal selenium. Its chemical property has a first ionization energy of 9.752 electron volts. Selenium burns in the air and emits a blue flame, producing selenium dioxide (SeO_2). It directly interacts with hydrogen and halogen and can directly combine with metal to form selenide. It cannot interact with non-oxidizing acids, but it is soluble in concentrated sulfuric acid, nitric acid and strong bases. Selenium dioxide is obtained by oxidation of selenium. Hydrogen selenide dissolved in water can precipitate many heavy metal ions into selenide particles. Selenium and metals with an oxidation state of +1 can generate two kinds of selenides, namely orthoselenide (M_2Se) and acid selenide (MHSe). Positive aqueous solutions of alkali metal and alkaline earth metal selenides will dissolve elemental selenium to form polyselenium compounds (M_2Sen), similar to sulfur that can form polysulfides.

As one of the scattered non-metals, crude selenium is a by-product of the copper smelting process. The selenium output has been growing slowly and the annual supply is limited. The use of selenium is very wide, it can be used in many fields such as metallurgy, glass, ceramics, electronics, solar energy, feed, etc., and with the development of the world economy and the emergence of new application fields, the downstream demand for selenium has continued to increase, to a certain extent As a result, the price of selenium has been rising. However, as the price of selenium continues to rise, its downstream consumption structure will continue to adjust to changes in prices. It is expected that the profit margin of traditional selenium products will remain at a medium level, while the profit margin of high-end selenium products with higher technical thresholds is expected. Will remain at a high level.

(2) The impact of selenium on the human body

Selenium is an essential trace element for the human body and is an essential element involved in the formation of various selenium-containing amino acids.A component of a protein that performs some important enzyme functions. If the human body lacks selenium, it may cause Keshan disease. At the same time, selenium deficiency is also considered to be an important cause of Kashin-Beck disease. Kashin-Beck disease is an endemic, multiple, deformable osteoarthritis. It mainly occurs in adolescents and severely affects bone development and future labor and living ability. But excess selenium can also cause poisoning. It is characterized by dry and brittle hair, easy to fall off, brittle nails, white spots and longitudinal lines, easy to fall off, skin damage and nervous system abnormalities, and death in severe cases. Selenium fortification (200 μg per day) for many years can help reduce the overall incidence of cancer and the incidence of prostate cancer.

Men need selenium supplements, because most of the selenium supplied to the body is concentrated in the reproductive organs and can be excreted with semen. In particular, residents living in high-pollution areas and residents living in selenium-depleted areas need supplemental selenium [7].

Since there is no organ that stores selenium for a long time in the human body, the body needs selenium to continuously obtain a sufficient amount of selenium from the diet. The balance of selenium concentration has important protective and promoting effects on the physiological functions of many organs and tissues [8-9].

Normally, the total daily requirement of each person, Chinese adults supplemented with more than 25 micrograms of selenium daily food has a health effect; adults with selenium deficiency supplemented with 50 micrograms or 75 micrograms of selenium daily. Due to the lack of selenium in 72% of the soil in China, the selenium content of cereals such as wheat, rice, corn and other major food crops in natural foods is less than 40 μg / kg, and the daily selenium intake of Chinese people is lower than the World Health Organization. The recommended minimum intake of 50 μg, the daily selenium intake is only 30 ~ 45 μg, which is lower than Japan, Canada, the United States and other countries. Selenium-rich rice, 100 micrograms (selenium-enriched corn flour), animal offal, fish, seafood, mushrooms, eggs, garlic, ginkgo and other selenium-containing elements are relatively high. People who lack selenium can appropriately increase food in this area. Bio-organic selenium is obtained through plant transformation, which is ingested into the human body through diet, which is beneficial to human body absorption and thus meets health care needs. As one of the main oil crops, rapeseed has a strong ability to enrich selenium. Rape seedlings can be eaten as selenium-containing vegetables and processed into selenium-rich animal feed. Rapeseed oil can also be used as a selenium-containing edible oil for people to eat .

(3) Mechanism of selenium and plants

Selenium is a beneficial element in plants and plays an important role in plants. Plant antioxidant systems include antioxidant enzymes and small molecule antioxidants. Appropriate concentration of exogenous selenium can enhance plant antioxidant capacity and reduce malondialdehyde (MDA) content, while excessive selenium will aggravate plant oxidative damage. Therefore, selenium shows two sides to plants [10]. When the selenium content is low, it can be beneficial to plant growth. Selenium is present in plants as volatile selenium, organic selenium and inorganic selenium. Among them, most of the selenium in plants that the human body can absorb is organic selenium, such as some amino acids containing selenium. Depending on the valence of the selenium supplied to the plant, the selenium's form in the plant is also different. If selenite is applied, the plant needs to organicize the selenite before it can be transported to the aerial part of the plant, so it mostly exists in the organic state; but if applied, the plant can transport the selenate directly to the aerial part. The organic selenium in the plant is reduced.

The selenium content of different parts of the plant is different, and the selenium content of each part will also vary due to different varieties, different growth periods, and different methods of fertilization. Studies have shown that cereals are smaller than legumes and less cruciferous; selenium content in straw is less than selenium content in grains; in vegetable varieties, selenium content in leaf and stem parts is less than that in roots [11-12].

Selenium also has a certain relationship with the quality of crops [13]. Although the quality of crops is mainly determined by genetic factors, selenium can affect the level of certain organic compounds in the plant to a certain extent and thus affect the quality of crops [14]. Selenium can promote the assimilation of carbon products to the root and promote the synthesis and accumulation of secondary biomass such as stored sugar, structural sugar, and structural protein. Application of selenium (foliar application to soil. Soil application of selenium) cannot increase tea yield. However, the application of selenium in soil is conducive to improving the quality of fresh leaves [15-16]. Increasing selenium nutrition can increase the total sugar, reducing sugar, chlorophyll, soluble protein content of plant stems and leaves, and reduce the content of crude fiber and nitrite. Nitrite is the precursor of human carcinogen nitrosamine. Selenium can reduce the content of nitrite in lettuce, and can prevent the accumulation of nitrite in lettuce and protect human health.

Because selenium has a good promotion effect on the growth and development of many plants, especially those selenium-accumulating crops, by applying inorganic selenium fertilizers (such as Na2SeO3), it can enrich higher concentrations of selenium in plants (but it is important for both plants and humans). Safe). Due to the metabolism of plants, the inorganic selenium in the environment is converted into organic selenium in the plant, which not only improves the physiological activity and absorption rate of selenium, but also reduces the toxicity of selenium, so that people can use natural food and daily diet to Perform safe and reasonable selenium supplementation. For example, "selenium-rich sprouts" is a new type of green food, and it is also one of the new ways for the human body to supplement selenium.

2.2. Selenium-Enriched Mechanism

(1) Selenium-enriched soil cultivation

Soil selenium application is a traditional and simple way to enrich selenium. Generally, a compound fertilizer of selenium and phosphorus and potassium is applied to the soil, or coal ash or other selenium-containing substances are applied, and the method is applied to the soil. Plants have different active absorption sites for different forms of selenium, such as selenate and selenite, so the root system absorbs and operates them differently. As for Se6 + and Se4 +, Se6 + is active absorption, its concentration in the plant body exceeds that in the external environment; Se4 + is passive absorption, and its absorption and accumulation are lower than Se6 +. Compared to selenite, plant roots absorb and transfer selenate more easily. At present, it is not known that active and passive absorption of selenium is present in the roots of all plants; at the same time, it is not certain that selenite operates at a lower rate than selenate. There are many factors that affect the absorption of selenium in the soil by vegetables. The most important factor is the existence form of selenium, which is also affected by the pH of the soil. In soils with pH 4.5 to 6.5, selenium is a difficult species. Water-soluble iron selenite exists in the form of vegetables, and its utilization is very low. In soil with pH 7.5 ~ 8.5, selenium exists in the form of water-soluble selenate ions. Vegetables It has a higher absorption and utilization. Secondly, the types of soil organic compounds also affect the use of selenium in plants. The addition of humus in the soil reduces the utilization of selenium in the soil; and the addition of some organic acids (such as oxalic acid and citric acid) will increase the selenium in the plant. Utilization. Furthermore, the type of soil has an effect on the absorption of selenium. As the clay content in the soil decreases, the absorption of selenium by plants gradually increases. In addition, the presence of sulfur will affect the plant's absorption of selenium. Under the conditions of low selenium soil, selenium can replace the sulfur in the protein, so some sulfur-rich vegetables also have a strong absorption of selenium.

(2) Foliar spraying method

Through foliar spraying, selenium can be transferred from the sprayed part of the plant to other parts, but this process requires the respiratory potential to provide a certain amount of energy from the outside. Studies have found that in plants sprayed with selenium, a "outer leaf → inner leaf" pathway is formed to transport selenium. In this pathway, mitochondrial activity is strengthened and energy consumption is increased. The growth stage of plants will affect the selenium spraying effect on the leaves, so the selenium spraying treatment is required to be performed at a specific growth stage of the plant; secondly, the application of detergent will promote the plant's absorption of selenium. In addition, the spraying season and the fertilizer applied will also affect the plant's absorption and transformation of sprayed selenium.

(3) Selenium-rich method of solution culture

In the process of hydroponic selenium enrichment, the selenium element is transferred in anionic form from the cultured solution to the roots of plants, and then from the roots to other parts such as stems and leaves. The transfer of selenium in plants is consistent with the mechanism of selenium transfer in soil. Attention should be paid here to the use of different strength of the culture medium.

In the process of crop growth and development, the above methods are used to absorb inorganic selenium into the crops through the leaves and roots, and then through the physiological and biochemical reactions of the crops, the inorganic selenium is converted into organic selenium and enriched in agricultural products. When the selenium content reaches the specified value in GB28050, it becomes a selenium-rich agricultural product.

3. Experiments

3.1. Materials

This experiment uses "Nanyang 41" rapeseed.

3.2. Instruments and Reagents

25ml burette, 100ml Erlenmeyer flask, mortar, 25ml graduated cylinder, 100ml pipette, burette, GZ025 full-automatic light incubator, 1/10 000 electronic balance.

3.3. Experimental Design

(1) Use flotation to select rapeseed with full grains and uniform size, disinfect the selected seeds and wash them. The fully absorbed seeds were evenly placed in a petri dish covered with two layers of moist filter paper, and cultured in a SPX-250BSH-II biochemical incubator at a constant temperature of (25 ± 2) °C for 3 days, and distilled water was added twice a day during the cultivation period . Set the selenium concentration to 0, 5, 10, 15, 20, 25g / ml for 6 selenium levels and controls.

(2) Accelerating germination. Use a petri dish and inner pad to soak the filter paper with the same selenium concentration (the inner pad and the upper cover filter paper, and weigh it with the petri dish before wetting). Put the drained seeds of each treatment into the petri dish and cover it with light. The germination rate, germination potential and fatty acid content were measured in an incubator (automatically controlled at 25 °C for 12h and dark reaction for 12h) for 48h.

(3) After 3 days of germination, the seeds are sown in plastic pots filled with equal amounts of sand and continued to be cultivated. During the period, 1: 2 Hogland nutrient solution is poured

twice daily. When the seedlings grow 3 to 4 cotyledons and the root system is developed, Seven seedlings were taken as a group to measure plant height, root length and biomass, and then moved to a plastic bowl vessel filled with Hogland's nutrient solution. The seedlings were fixed with foam to prevent lodging. About 10 days began to determine the physiological and biochemical indicators of seedlings.

3.4. Determination Method

(1) Biomass: The washed samples are separated according to organs, and placed in a drying box with a temperature of 105 °C in advance for 1 h. Instead, it was blow-dried at 80 °C for 72h, then taken out and placed in a desiccator to cool to room temperature and weighed. Root length and plant height of each group of seedlings before and after treatment with different concentrations of selenium solution were measured with a scale.

(2) Determination of fatty acids. The unsoaked 2g seeds were used as a control, and the germinated seeds and the control were ground separately. Washed with 30n, J95% ethanol, introduced into a triangular flask (00mI), plugged with lemon peel, and extracted 30m ‰ in a 70t: water bath. After incubation, add 0.2g activated carbon to each bottle, shake, filter with a funnel, and take the respective filtrate 12m1, add 3 additional 100mI Erlenmeyer flasks (repeated 3 times for each treatment), add 2 drops of phenolphthalein indicator, titrate with 0.1n10l / L standard NaOH solution to the point of weak red, record the volume of NaOH solution as fatty acid The amount.

(3) Determination of the reducing power of rape root system According to the TTC (Triphenyltetrazolium Chloride) method introduced in Zhang Xianzheng's "Crop Physiology Research Method".

(4) Determination of chlorophyll content. According to the absorption of the visible spectrum of the chlorophyll extract, the absorbance of the spectrophotometer is measured at a specific wavelength, and the content of each pigment in the extract can be calculated by the formula. The ratio of chlorophyll a and chlorophyll b in higher plants can reflect the plant's efficiency of light energy utilization. The higher the ratio is, the lower the ratio is. In the determination of chlorophyll a and b, in order to exclude the interference of carotenoids, the wavelength of the monochromatic light used was selected at 663 nm and 645 nm (the absorption peaks of chlorophyll a and b in the red light region, respectively).

Chlorophyll a (mg / g) = (12.71A663-2.59A645) V / (1000 W)

Chlorophyll b (mg / g) = (22.88A645-4.67A663) V / (1000 W)

Total chlorophyll concentration (mg / g) = (8.04A663 + 20.29A645) V / (1000 W)

Light energy use efficiency = chlorophyll a / chlorophyll b

In the formula: V represents the total volume of the extraction liquid, and W represents the mass of the leaves.

4. Test Results and Analysis

4.1. Effects of Different Concentrations of Selenium Solution on Rapeseed Biomass, Root Length and Plant Height

The biomass, root length, and plant height of the seedlings in each group after treatment with different concentrations of selenium solution were measured, and the changes before and after are shown in Table 1 below:

Table 1. Root growth under different concentrations of selenium solution

Selenium concentrations (μg/ml)	Root-shoot ratio	The root biomass (g)	The total biomass (g)
0	0.28	1.12	6.28
5	0.35	1.39	6.62
10	0.33	1.51	7.65
15	0.31	1.52	7.85
20	0.26	1.27	7.47
25	0.25	1.19	6.99

From the Table 1 we can know that selenium can significantly affect the growth and development of rapeseed. At <10 μg / ml, rapeseed biomass shows an increasing trend with the increase of selenium concentration, and when the concentration is> 15 μg / ml, it begins to show an inhibition and a decline. The concentration of 10 ~ 15μg / ml selenium solution is most suitable for rape seedling growth. Appropriate amount of selenium can accelerate the growth rate, enhance the redox capacity of the root system, improve the quality of seedlings, and promote the growth and development of rape at the seedling stage.

4.2. Effect of Different Concentrations of Selenium Solution on Seed Germination Rate

Soak the seeds with 0, 5, 10, 15, 20, 25μg / ml selenium solution. The effects of different concentrations of selenium solution on seed germination rate are shown in Figure 1 below:

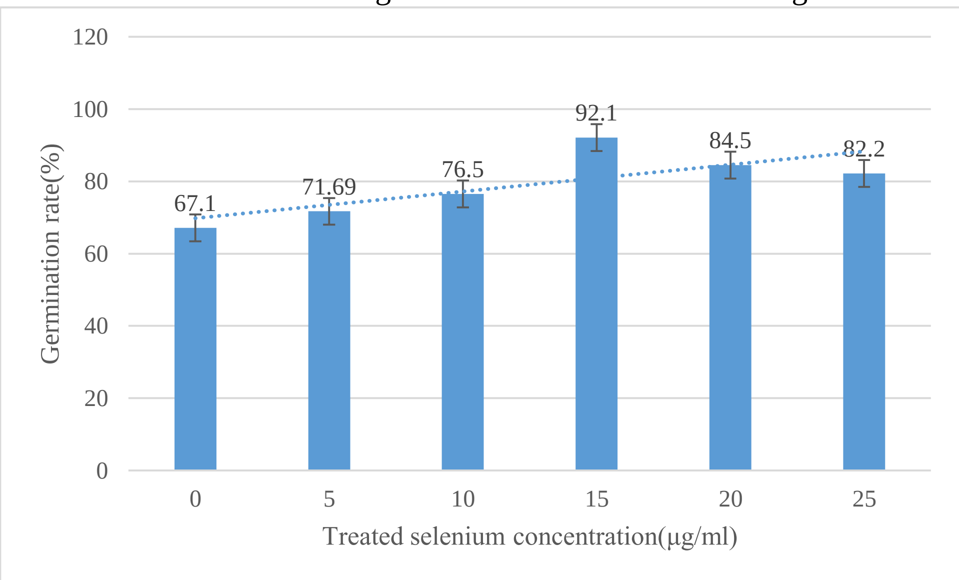

Figure 1. Germination rate of seeds treated with different concentrations of selenium solution

It From Figure 1 can be seen that in the detection of the germination rate, it can be seen that the selenium treatment is beneficial to improve the germination rate of the seeds in the 6 germination rates, and the germination rate is the highest when treated with 15 μg / ml selenium solution. That is, seed soaking with a certain concentration of selenium solution is conducive to improving the germination rate and germination potential of the seed, especially the treatment with a concentration of 15 to 25 μg / ml is better, and selenium can promote the seed shade. At the seedling stage, a proper amount of selenium can accelerate the growth rate, improve the quality of seedlings, make the seedlings more vigorous and vital, and maintain the physiological activities of the plants, which is beneficial to the formation of rape yield traits and can significantly increase the yield of rape.

4.3. Effect of Selenium Solution of the Same Concentration on Seed Germination Potential

In the 0, 5, 10, 15, 20, 25 μ/ml selenium solution concentration test, according to the bud length o.2-0.5cm, the statistical germination potential is one group, and the dew is one group. The statistical results of the germination potential of rape seeds treated with some different selenium solution concentrations are shown in Figure 2.

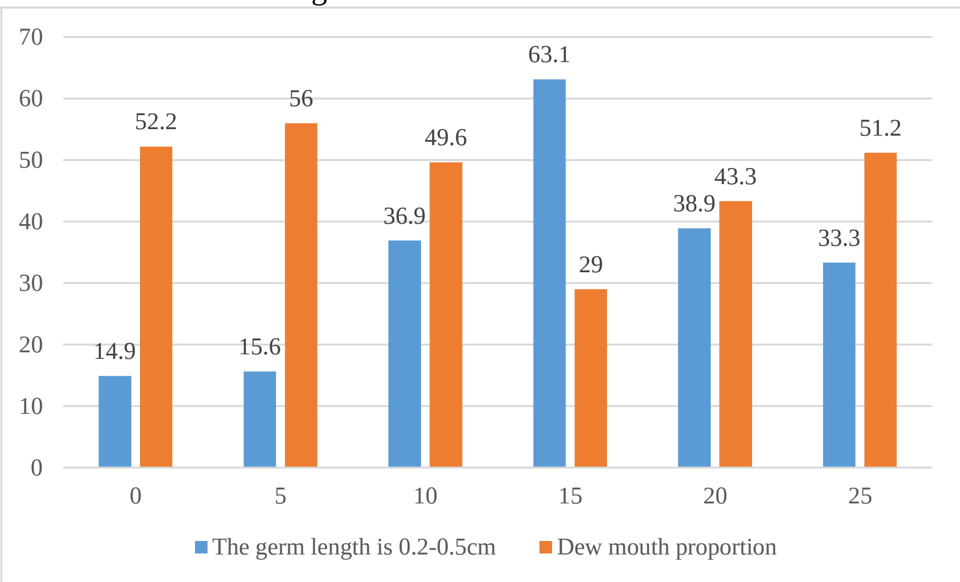

Figure 2. Germination potentials of seeds treated with selenium solutions of different concentrations

It can be seen from Figure 2 that 15 μ g / ml treatment is conducive to the growth of embryo, with strong germination potential, and low concentration of selenium can promote germination, but the germination potential is weak, but both of them are stronger than the control. The same concentration of selenium solution had some effect on the activity of lpase in rape seeds, which proved that selenium had effect on the germination mechanism of rape seeds. The analysis of fatty acid production was consistent with the germination status of seeds. The concentration of selenium solution affects the activity of enzyme and plays an important role in physiology and biochemistry. It should be noted that when the selenium concentration is too high, the growth of plant and root system will be inhibited, and the activity of root system will be reduced.

4.4. Effects of Selenium Treatment on Seed Lipase Activity

The volume results of NaOH consumed by titration with NaOH in O, 5, 10, 15, 20, 25 μg / ml and control experiments are shown in Figure 3:

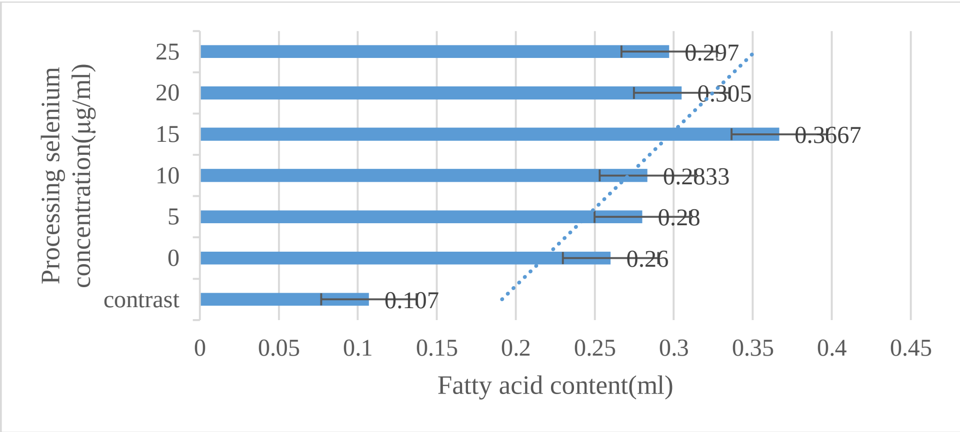

Figure 3. Fatty acid contents treated with different concentrations of selenium

It can be seen from Fig. 3 that the content of fatty acid was the highest at 15 μg / ml, followed by 20 μg / m, and the lowest was the treatment with re-distilled water. The selenium-added treatment produced more fatty acids than the control, thereby verifying that a certain concentration of selenium is beneficial to promote seed germination, increase germination rate, and promote growth and germination potential.

4.5. Effects of Selenium on Rape Root Development and Redox Capacity

The effects of different concentrations of selenium on the growth and development of rapeseed are particularly evident in the response of rapeseed root growth. It was observed in the experiment that the dark brown roots decreased with the increase of the selenium concentration. The results of the seedling measurement are shown in Table 2. The low-concentration selenium solution treatment (<15 μg / ml) showed a high proportion of roots and above-ground biomass. However, the selenium concentration exceeded 15 μg / ml, and the root-shoot ratio decreased, and both were lower than the control, indicating that the growth of the root system was strongly inhibited. It can be seen that the proper amount of selenium can promote the root growth of rape more significantly than other organs.

Table 2. Effects of selenium on root development and REDOX capacity of rapeseed

Selenium concentration (μg/ml)	The root biomass (DW)/g	The total biomass (DW)/g	Root activity (mg/g)	Chlorophyll content (mg/g)
0(CK)	1.122	5.160±0.025	1.187±0.012	1.566
5	1.202	5.202±0.016	1.189±0.017	1.598
10	1.409	6.105±0.018	1.329±0.001	1.618
15	1.515	6.337±0.023	1.366±0.003	1.642
20	2.283	6.199±0.022	1.382±0.002	1.708
25	1.193	5.782±0.018	1.324±0.003	1.962

It can be known from Table 2 that proper supplementation of selenium fertilizer is an important agronomic measure to increase yield and improve quality in areas with low selenium and low selenium. Growth and development in the environment, strong flowering, but an appropriate increase in selenium nutrition supply is obviously beneficial to rape growth, delay senescence, increase chlorophyll content, promote photosynthesis, and have a good yield increase effect.

In order to further understand the effect of selenium on the growth and development of root system, TTCC method was used to measure the reducing power of root system of rape seedlings treated with Selenium Solution of different concentration combined with hydroponics and soil culture. The results are shown in Figure 4.

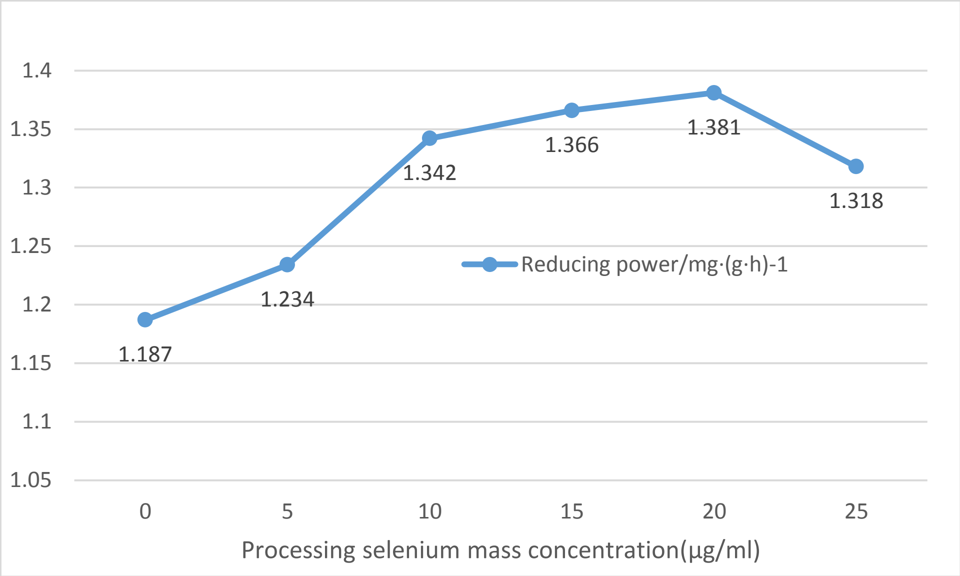

Figure 4. Relationship between selenium and reducing power of rape root system

It can be seen from Figure 4 that in the range of selenium concentration < 20 μ g / ml, the reduction rate of rape root system increases with the increase of selenium concentration. When selenium concentration > 20 μ g / ml, the reduction rate of rape root system decreases, which proves that high concentration of selenium has an inhibitory effect on the growth and development of root system. The effect of selenium on rape is in accordance with the law of general microelements. It has toxic effect at high concentration, and appropriate application is conducive to production and development. Appropriate selenium supplement treatment has obvious effect of increasing production. The suitable concentration of selenium as micro fertilizer in rape production should be determined according to the soil fertility and the different varieties and growth periods of rape. The soil structure is good, the fertility is strong, the single application amount can be larger, and the application amount can be larger in the later growth period. For the general low selenium soil, the concentration of no more than 20 μ g / ml is suitable, and the way of application is base fertilizer and top dressing. According to the results of this experiment, the recommended application amount of one-time base fertilizer is 15-20 μ g / ml. rape plants with higher biomass can be obtained, which can be used as vegetables directly, and selenium compounds can be extracted from them for separation and purification as medicine, food, feed and other applications, or processed into animal feed to supplement selenium, so as to improve the selenium nutrition level of human and animal.

4.6. Effects of Different Concentrations of Selenium on the Activities of Several Enzymes in Rape

(1) Effects of different concentrations of selenium on rapeseed peroxidase

Peroxidase (pemxidase) is a kind of enzyme with high activity generally existing in plants. It is closely related to respiration, photosynthesis, and auxin oxidation. Its activity reflects changes in plant metabolism in a period . After selenium application, the peroxidase activity in rapeseed generally decreased. When the selenium concentration was between 10 and 15 μg / mL, the enzyme activity increased with the increase of selenium concentration. When the concentration was 15-25 μg / mL, the peroxidase activity was It decreases with increasing selenium concentration.

(2) Effect of different concentrations of selenium on nitrate reductase in rapeseed

Nitrate reductase (NR) is a key enzyme for nitrate nitrogen metabolism in plants. It can be seen from Table 2 that under low concentration of selenium treatment (<15 μg / mL), the activity of nitrate reductase increases with the increase of selenium concentration, the maximum is 15 μg / mL treatment. When the selenium concentration reached a certain value, the enzyme activity began to decline, but even under high concentration treatment, the nitrate reductase activity was still higher than the control. This shows that selenium can increase the nitrate reductase activity. It should be noted that one day before the determination of nitrate reductase activity, a certain amount of nitrate nitrogen fertilizer should be applied to the material. In addition, the selenium concentration at which the nitrate reductase activity reaches the maximum remains to be further explored.

(3) Effect of different concentrations of selenium on rapese amylase activity

The intensity of amvlase activity reflects the condition of starch being converted into reducing sugar. According to Yiyi amylase is not acid-resistant, can quickly passivate below pH 3.6, B-amylase is not heat-resistant, passivated at 70 ℃, 15min, one of them can be passivated during measurement Out of another vitality. Yiyi amylase activity increased with the increase of selenium concentration in the range of 10-15 μg / ml, and then began to decline, but the selenium-added treatment was lower than the control, which is conducive to the accumulation of dry matter.

5. Conclusion

In this paper, the effects of selenium on the development of rapeseed are studied by observing the determination of a series of physiological and biochemical indicators of rapeseed. This study shows that selenium can significantly affect the growth and development of rapeseed. In rapeseed cultivation, the application of appropriate selenium has the following aspects: Good effect: In the seedling stage, the appropriate amount of selenium can accelerate the growth rate, enhance the redox capacity of the root system, improve the quality of seedlings, promote the growth and development of rapeseed at the seedling stage, and can maintain the vigorous vitality of the root system and the physiological activity of the plant, which has a significant delay The effect of senescence; selenium is beneficial to the formation of rape yield traits and can significantly increase rape yield.

The root system is an important organ for plants to absorb water and nutrients, and has a critical role in the growth and development of plants. The research in this paper shows that selenium affects the growth and development, reducing activity, and growth of rape roots. The appropriate selenium supplementation concentration is beneficial to Improving the growth environment of the root system, increasing reducing power, increasing biomass, and proper selenium supplementation in rape cultivation will have an impact on improving selenium nutrition in rapeseed and promoting growth and development of rapeseed, thereby increasing yield and quality.

In addition, this study found that selenium participates in the metabolism of rapeseed material, promotes protein synthesis and chlorophyll content, increases material accumulation and can affect the activities of various enzymes, playing an important physiological and biochemical role. It is worth noting that when the environmental selenium concentration is too high, it will inhibit the growth of plants and roots, and reduce root vigor. In addition, rapeseed has a strong bio-enrichment function for selenium and can accumulate more selenium elements. Rapeseed seedlings can be used directly as vegetables and processed into animal feed. So as to solve the problem of selenium malnutrition in China's vast selenium-deficient areas. It can be seen that proper supplementation of selenium to crops has very important applications for promoting agricultural and animal husbandry production and ensuring people's health.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Mehdi Aghighi Shahverdi, Heshmat Omidi, & Sayed Esmail Mousavi. (2017). "Effect of Chitosan on Seed Germination and Biochemical Traits of Milk Thistle (Silybum Marianum) Seedling Under Salt Stress", Iranian Journal of Seed Research, 3(2),pp.105-118. https://doi.org/10.29252/yujs.3.2.105

[2] Rocio Castillo Godina, Rahim Foroughbakhch, & Adalberto Benavides Mendoza. (2016). "Effect of Selenium on Elemental Concentration and Antioxidant Enzymatic Activity of Tomato Plants",Journal Of Agricultural Science,18(1),pp.233-244.

[3] Le Yuan Ma, Nian Lai Chen, Guo Jun Han, & Liang Li. (2017). "Effects of Exogenous Salicylic Acid on Seed Germination and Physiological Characteristics of Coronilla Varia Under Drought Stress",Ying Yong Sheng Tai Xue Bao = The Journal Of Applied Ecology / Zhongguo Sheng Tai Xue Xue Hui, Zhongguo Ke Xue Yuan Shenyang Ying Yong Sheng Tai Yan Jiu Suo Zhu Ban,28(10),pp.3274-3280.

[4] Y. Tanko, A. Jimoh, A. Ahmed, A. Adam, & J.O. Ayo. (2017). "Effects of Selenium Yeast on Blood Glucose and Antioxidant Biomarkers in Cholesterol Fed Diet Induced Type 2 Diabetes Mellitus in Wistar Rats",Nigerian Journal of Physiological Sciences Official Publication of the Physiological Society of Nigeria,31(2),pp.147-152.

[5] Yang Hu, Shanyi Shi, Lu Lu, Chunying Teng, & Juanjuan Qu. (2017). "Effects of Selenizing Modification on Characteristics and Antioxidant Activities of Inonotus Obliquus Polysaccharide", Macromolecular Research, 25(3), pp.1-9. https://doi.org/10.1007/s13233-017-5030-z

[6] Adil, M., Khan, M. K., Jamjoom, M., & Farouk, A. (2021). MHADBOR: AI-enabled Administrative Distance based Opportunistic Load Balancing Scheme for an Agriculture Internet of Things Network.IEEE Micro. https://doi.org/10.1109/MM.2021.3112264

[7] Hongyan Sun, Huaxin Dai, Xiaoyun Wang, & Guohui Wang. (2016). "Physiological and Proteomic Analysis of Selenium-Mediated Tolerance to Cd Stress in Cucumber (Cucumis Sativus l.)",Ecotoxicology & Environmental Safety, 133, pp.114-126.

https://doi.org/10.1016/j.ecoenv.2016.07.003
[8] Huiping Dai, & Genliang Jia. (2017). "Effects of Se on the Growth, Tolerance, and Antioxidative Systems of Three Alfalfa Cultivars",Environmental Science & Pollution Research,24(6), 1-6. https://doi.org/10.1007/s11356-017-9137-8
[9] Surinder Kaur, Diksha Kumari, Vandana Kumari, Control of Enviornmental Parametrs in A Greenhouse, Fusion: Practice and Applications, 2020, Vol. 1, No. 1, pp: 14-21 (Doi : https://doi.org/10.54216/FPA.010102)
[10] Leonardo Susumu Takahashi, Jaqueline Dalbello Biller-Takahashi, Cleber Fernando Menegasso Mansano, Elisabeth Criscuolo Urbinati, & Marcos Vinícius Saita. (2016). "Long-Term Organic Selenium Supplementation Overcomes the Trade-Off Between Immune and Antioxidant Systems in Pacu (Piaractus Mesopotamicus)",Fish & Shellfish Immunology,60,pp.311-317. https://doi.org/10.1016/j.fsi.2016.11.060
[11] Lv-Hui Sun, Ding-An Pi, Ling Zhao, Xiu-Ying Wang, & Yu-Lan Liu. (2016). "Response of Selenium and Selenogenome in Immune Tissues to Lps-Induced Inflammatory Reactions in Pigs",Biological Trace Element Research, 177(1), pp.1-7. https://doi.org/10.1007/s12011-016-0863-4
[12] Ying Jiang, Zhao Hai Zeng, Qi Sheng Yang, Jie Zhao, & Yue Gao Hu. (2016). "Selenium (Se) Uptake and Transformation Mechanisms and Physiological Function in Plant: a Review",Chinese Journal of Applied Ecology,27(12),pp.4067-4076.
[13] Muhammad Naveed Jafar, Muhammad Saqlain, Ahmad Raza Shafiq, Muhammad Khalid, Hamza Akbar, Aamir Naveed, New Technology in Agriculture Using Neutrosophic Soft Matrices with the Help of Score Function, International Journal of Neutrosophic Science, 2020, Vol. 3, No. 2, pp: 78-88 (Doi : https://doi.org/10.54216/IJNS.030204)*
[14] Selçuk Topal, Ferhat Tas, Said Broumi, Oguz Ayhan Kirecci, Applications of Neutrosophic Logic of Smart Agriculture via Internet of Things, International Journal of Neutrosophic Science, 2020, Vol. 12, No. 2, pp: 105-115 (Doi : https://doi.org/10.54216/IJNS.120205)
[15] Zou Ying, Li Qingcheng, Liao Xiaoling, & Liu Yongqiong. (2017). "Analysis of Selenium in Tobacco with Atomic Fluorescence Spectrometry", Tobacco Science & Technology, 50(7),pp.69-75.
[16] Runxiang Zhang, Yanan Wang, Chao Wang, Peng Zhao, & Jun Bao. (2016). "Ameliorative Effects of Dietary Selenium Against Cadmium Toxicity is Related to Changes in Trace Elements in Chicken Kidneys", Biological Trace Element Research, 176(2), pp.1-10. https://doi.org/10.1007/s12011-016-0825-x