

The Effects of Selenium Fulvic Acid on Seed Germination and Seedling Growth of Rapeseed (*Brassica Napus* L.)

Jing Li [1], Lanfen Li [2], Yiting Yin [3], Yourui Li [4], Xuejun Tian [5*]
[1-3, 5] College of Food and Biology, Jingchu University of Technology, Jingmen, Hubei 448000, China
[4] Hubei Chuyan Technology Co., Ltd., Jingzhou, Hubei 434000, China

* Corresponding Author: **Xuejun Tian**

Article Info

ISSN (Online): 2582-7138
Volume: 07
Issue: 06
Received: 20-08-2026
Accepted: 22-09-2026
Published: 24-10-2026
Page No: 131-135

Abstract
This study used rapeseed cultivar 'Hengheyou 985' as the experimental material and investigated the effects of fulvic acid selenium on rapeseed seed germination and seedling growth through seed soaking and foliar spraying, aiming to provide a theoretical basis for selenium-enriched rapeseed breeding and production practices. Compared with the control, seed soaking with 2 mg/L fulvic acid selenium significantly enhanced the seed vigor index. Foliar spraying with 20 mg/L fulvic acid selenium significantly increased seedling height, stem diameter, biomass, photosynthetic pigment content, peroxidase (POD) activity, and catalase (CAT) activity. These results indicated that an appropriate concentration of fulvic acid selenium promoted rapeseed seed germination and seedling growth to a certain extent.

DOI: https://doi.org/10.54660/.IJMRGE.2026.7.6.131-135

Keywords: Selenium fulvic acid, Rapeseed, Seed germination, Seedling growth

1. Introduction

Selenium is an essential trace element for plants and plays an important role in plant growth and development. In plants, selenium at an appropriate concentration can promote seed germination and enhance antioxidant capacity. It can also improve stress resistance, promote mineral ion uptake, and increase crop yield and quality. Studies have shown that selenium significantly promotes seed germination in crops such as soybean (*Glycine max*)[1], wheat (*Triticum aestivum*) [2], common bean (*Phaseolus vulgaris*)[3], and peanut (*Arachis hypogaea*)[4]. It also significantly promotes seed germination and seedling growth in vegetables such as Chinese cabbage (*Brassica pekinensis*)[5], tomato (*Lycopersicon esculentum*)[6], and carrot (*Daucus carota*)[7]. Specifically, seed soaking with a low concentration of selenium promotes seed germination and seedling growth. However, concentrations above a certain threshold inhibit these processes. This effect varies among species and with seed-soaking duration.

Rapeseed (*Brassica napus* L.) is an important oil crop in China and is widely grown across the country. Its rapeseed oil accounts for more than 50% of China's total domestic vegetable oil production. Its tender bolting stems can also be eaten as a vegetable, and rapeseed meal is a high-quality protein feed. Thus, rapeseed has notable economic value. As a selenium-rich plant, rapeseed can grow in soils with high selenium concentrations. It can absorb and assimilate selenium from the soil and distribute and accumulate it in various organs. This allows its internal selenium concentration to exceed that of the environment. Except when excessive soil selenium addition inhibits rapeseed growth, an appropriate increase in selenium supply can effectively promote growth and enhance and maintain vigorous physiological activity. Selenium fulvate is formed by coupling fulvic acid with organic selenium. Most current studies apply selenium in combination with fulvic acid. The combination of Se and fulvic acid significantly reduced Cd accumulation in rice, decreased Cd uptake by rice plants, and inhibited Cd translocation to aboveground parts and grains[8]. Root irrigation with 22.50 kg·hm^{-2} of fulvic acid selenium at the germination and silking stages significantly promoted the growth parameters of waxy maize at the seedling and jointing stages and improved its yield-related parameters,

ultimately significantly increasing both the grain yield and grain quality of waxy maize[9]. At present, detailed reports on the effects of selenium fulvate on rapeseed seed germination and seedling growth are lacking. This experiment investigated the role of an appropriate concentration of selenium fulvate in rapeseed seed germination and seedling growth. The aim was to provide a theoretical basis for the scientific use of selenium and for selenium-enriched rapeseed production.

2. Materials and Methods

2.1. Experimental Materials

The experimental material was rapeseed cultivar 'Hengheyou 985' (*Brassica napus* L.), a major cultivar grown in Hubei Province, provided by Hubei Chuyan Technology Co., Ltd.

The test reagent was selenium fulvate with a Se content of 910 mg kg^{-1} and a fulvic acid proportion of 48.9%, purchased from Heilongjiang Humusi Biotechnology Co., Ltd.

2.2. Seed Germination

Rapeseed seeds were evenly placed in Petri dishes lined with three layers of filter paper. Each Petri dish contained 100 seeds, and each treatment had three replicates. The control (CK) received 5 mL of distilled water per Petri dish. The selenium fulvate treatment (SeT) received 5 mL of 2 mg/L selenium fulvate solution per Petri dish. The dishes were then placed in a constant-temperature incubator at 28°C for the germination test.

Germination was defined as radicle protrusion through the seed coat by 2 mm. The number of germinated seeds was observed and recorded daily. Germination energy was determined on day 3, and germination percentage was determined on day 7. On day 10, 30 seedlings were randomly selected from each treatment to measure plumule and radicle lengths.

2.3. Seedling Growth

Rapeseed seeds were sown evenly in pots filled with peat soil as the substrate. The pots were placed in an artificial climate chamber for cultivation. The chamber was set at 28°C, with a 16 h d^{-1} photoperiod and a light intensity of 100 μmol m^{-2} s^{-1}. Fifteen rapeseed seedlings were established per pot, and each treatment had three replicates. After one week of growth, the CK group received a daily foliar spray of 2 mL of distilled water per pot. The SeT group received a daily foliar spray of 2 mL of 20 mg/L selenium fulvate solution per pot. Foliar spraying was continued for 5 consecutive days.

At 20 days after sowing, 6 seedlings were randomly selected from each treatment for measurement of growth and physiological indicators.

2.4. Determination of Indicators

Germination energy (%) = (number of normally germinated seeds within 3 days / total number of tested seeds) × 100%.

Germination percentage (%) = (number of normally germinated seeds within 7 days / total number of tested seeds) × 100%.

Germination index (GI) = ∑(Gt/Dt). Vigor index (VI) = GI × S. Gt is the number of germinated seeds on day t, Dt is the number of germination days, S is the fresh weight per seedling.

Plumule and radicle lengths were measured with a vernier caliper.

Seedling height, stem diameter, root length, fresh weight, and dry weight were measured using the bioassay method[10].

Photosynthetic pigment content was determined by ethanol extraction and colorimetry[10].

MDA content was determined by the thiobarbituric acid method[11].

SOD activity was determined by the nitroblue tetrazolium method[12].

POD activity was determined by the guaiacol method[12].

CAT activity was determined by the xylenol orange method[13].

2.5. Data Processing

Data were processed in Microsoft Excel 2023. Significance analysis was performed using IBM SPSS Statistics 27.0.

3. Results

3.1. Effect of Selenium Fulvate on Rapeseed Seed Germination

The effects of selenium fulvate seed soaking on rapeseed seed germination are shown in Figure 1 and Table 1. Compared with the CK group, the SeT group showed increases of 0.20%, 1.16%, and 12.42% in germination energy, germination index, and vigor index, respectively. The difference in vigor index was significant ($P < 0.05$). However, the final germination percentage reached 100% in both the CK and SeT groups. These results indicate that seed soaking with 2 mg/L selenium fulvate improved rapeseed seed vigor but had no significant effect on germination percentage.

The effects of selenium fulvate seed soaking on rapeseed plumule and radicle growth are shown in Figure1 and Table1. Compared with the CK group, the SeT group showed an 8.81% increase in plumule length and a 2.43% decrease in radicle length. Neither difference was significant ($P > 0.05$). These results indicate that seed soaking with 2 mg/L selenium fulvate promoted plumule elongation to some extent but inhibited radicle elongation.

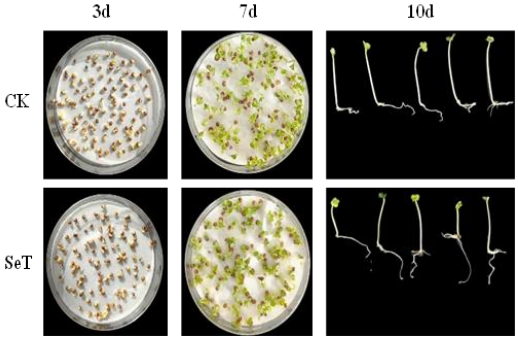


Fig 1: Effects of selenium fulvic acid on the seed germination of rape

Table 1: Effects of selenium fulvic acid on the seed germination indexes of rape

Indexes	CK ($\bar{x}$ ± s)	SeT ($\bar{x}$ ± s)	*P*
Germination energy (%)	97.800 ± 2.280	98.000 ± 2.550	0.899
Germination index (%)	48.430 ± 2.400	48.990 ± 0.900	0.527
Seed vigor (%)	2.149 ± 0.111	2.416 ± 0.024	0.009
Germ length (cm)	0.193 ± 0.044	0.210 ± 0.035	0.194
Radicle length (cm)	3.365 ± 1.222	3.155 ± 1.184	0.584

3.2. Effect of Fulvic Acid on the Growth Phenotype of Rapeseed Seedlings

The effects of foliar spraying with selenium fulvate on the growth phenotype of rapeseed seedlings are shown in Figure 2 and Table 2. Compared with the CK group, the SeT group showed increases of 11.81%, 15.38%, 60.58%, and 55.44% in seedling height, stem diameter, fresh weight per plant, and dry weight per plant, respectively. All these differences were significant ($P < 0.05$). Root length in the SeT group was 14.55% shorter than that in the CK group, but the difference was not significant ($P > 0.05$). These results indicate that foliar spraying with 20 mg/L selenium fulvate promoted morphogenesis in rapeseed seedlings. It also slightly inhibited root growth in rapeseed seedlings.



CK **SeT**

Fig 2: Effects of selenium fulvic acid on the seedling growth of rape

Table 2: Effects of selenium fulvic acid on the seedling growth indexes of rape

Indexes	CK ($\bar{x}$ ± s)	SeT ($\bar{x}$ ± s)	*P*
Seedling height (cm)	6.171 ± 0.206	6.900 ± 0.130	0.004
Stem diameter (cm)	0.130 ± 0.005	0.150 ± 0.004	0.003
Root length (cm)	3.753 ± 0.205	3.207 ± 0.240	0.091
Fresh weight (g)	1.408 ± 0.131	2.261 ± 0.250	0.003
Dry weight (g)	0.285 ± 0.045	0.443 ± 0.060	0.033

3.3. Effect of Selenium Fulvate on Photosynthetic Pigment Content in Rapeseed Seedlings

As shown in Figure 2, the leaves of SeT seedlings were darker green than those of the CK group. The effects of foliar spraying with selenium fulvate on photosynthetic pigment content in rapeseed seedlings are shown in Table 3. Compared with the CK group, the SeT group showed increases of 49.03%, 25.54%, and 43.24% in chlorophyll a, chlorophyll b, and total chlorophyll, respectively. All these differences were significant ($P < 0.05$). Carotenoid content in the SeT group was 2.44% higher than that in the CK group, but the difference was not significant ($P > 0.05$). These results indicate that foliar spraying with 20 mg/L selenium fulvate increased photosynthetic pigment content in rapeseed seedlings. This increase promoted photosynthesis and benefited seedling growth and development.

Table 3: Effects of selenium fulvic acid on the photosynthetic pigment content of rape seedlings

Indexes	CK ($\bar{x}$ ± s)	SeT ($\bar{x}$ ± s)	*P*
Chlorophyll a content (mg/g)	2.003 ± 0.085	2.985 ± 0.151	0.013
Chlorophyll b content (mg/g)	0.654 ± 0.027	0.821 ± 0.076	0.006
Carotenoid content (mg/g)	0.697 ± 0.056	0.714 ± 0.028	0.637
Total Chlorophyll content (mg/g)	2.657 ± 0.113	3.806 ± 0.226	0.021

3.4. Effect of Selenium Fulvate on Malondialdehyde Content in Rapeseed Seedlings

The effect of selenium fulvate on MDA content in rapeseed seedlings is shown in Table 4. Compared with the CK group, the SeT group showed a 12.40% increase in MDA content, but the difference was not significant ($P > 0.05$). This indicates that foliar spraying with 20 mg/L selenium fulvate can induce MDA accumulation in rapeseed seedlings.

Table 4: Effects of selenium fulvic acid on the MDA content of rape seedlings

Indexe	CK ($\bar{x} \pm s$)	SeT ($\bar{x} \pm s$)	*P*
MDA content (nmol/g)	8.898 ± 0.629	10.001 ± 0.566	0.058

3.5. Effect of Selenium Fulvate on Antioxidant Enzyme Activities in Rapeseed Seedlings

The effects of foliar spraying with selenium fulvate on antioxidant enzyme activities in rapeseed seedlings are shown in Table 5. SOD activity in the SeT group was 5.30% higher than that in the CK group, but the difference was not significant ($P > 0.05$). Compared with the CK group, POD and CAT activities in the SeT group increased by 15.47% and 25.46%, respectively. Both differences were significant ($P < 0.05$). These results indicate that foliar spraying with 20 mg/L selenium fulvate effectively increased antioxidant enzyme activities in rapeseed seedlings. It helped maintain ROS metabolic balance and alleviate oxidative stress damage.

Table 5: Effects of selenium fulvic acid on the antioxidant enzyme activity of rape seedlings

Indexes	CK ($\bar{x} \pm s$)	SeT ($\bar{x} \pm s$)	*P*
SOD activity (U/g)	236.356 ± 51.397	248.891 ± 29.466	0.143
POD activity (U/g)	963.306 ± 58.901	1112.335 ± 50.924	0.027
CAT activity (U/g)	1012.468 ± 61.113	1270.232 ± 31.988	0.015

4. Discussion

After seed soaking with selenium fulvate during the germination stage, the SeT group showed slightly higher values than the CK group for germination energy, germination index, plumule length, and radicle length. However, these differences were not significant. This finding is consistent with the results of studies on the effect of seed soaking with selenium fertilizer on sorghum seed germination[14]. The vigor index of rapeseed seeds in the SeT group was significantly higher than that in the CK group, indicating that seed soaking with selenium fulvate clearly improved overall seed vigor; however, it did not markedly promote growth and development during the germination stage. After foliar spraying with selenium fulvate at the seedling stage, seedling height, stem diameter, biomass, photosynthetic pigment content, POD activity, and CAT activity in the SeT group were significantly higher than those in the CK group. This indicates that selenium fulvate had a favorable promoting effect on rapeseed seedling growth and development. This is consistent with the finding that exogenous selenium promotes the growth and development of Langao konjac[15]. Studies have also shown that exogenous selenium can increase the photosynthetic pigment content and the activities of peroxidase (POD) and catalase (CAT) in highland barley seedlings[16]. Therefore, an appropriate amount of exogenous selenium has positive effects on the growth and development of most crops.

In summary, within an appropriate concentration range, selenium fulvate promoted both rapeseed seed germination and seedling growth. This effect showed an obvious time-dependent pattern. At the germination stage, seed soaking with 2 mg/L selenium fulvate significantly enhanced the vigor index of rapeseed seeds. At the seedling stage, foliar spraying with 20 mg/L selenium fulvate significantly increased seedling height, stem diameter, biomass, photosynthetic pigment content, peroxidase (POD) activity, and catalase (CAT) activity in rapeseed seedlings.

5. Funding

This work was supported by grants from the College Student Innovation and Entrepreneurship Training Program (KC2026029) and the Horizontal Research Project (HZ260038) of Jingchu University of Technology.

References

1. He SM, Qin JS, Wu G. Physiological and biochemical effects of selenium seed soaking on soybean seed germination[J]. Soybean Science, 2011, 30(1): 158-160.
2. Miao SY, Liang DL, Zhao WL, Hu B. Effects of selenate and selenite on seed germination and seedling growth of seven wheat genotypes[J]. Journal of Agro-Environment Science, 2013, 32(10): 1934-1940.
3. Zhou DZ, Zhu YC, Zhang C, Xia DD. Effects of selenium seed soaking on germination of kidney bean seeds[J]. Journal of Hubei Minzu University, 2007, 25(1): 91-93.
4. Zhang C, Liu XP, Zhou DZ, Tian GZ. Effects of selenium on seed germination and lipase activity of peanut[J]. Hubei Agricultural Sciences, 2003, 42(3): 36-37.
5. Peng C, Ding L, Wang J. Effects of selenium on germination rate and seedling growth of Chinese cabbage[J]. Journal of Hubei Minzu University, 2006, 24(1): 91-93.
6. Wang YF, Xu X, Sun QW. Effects of selenium seed soaking on tomato seed germination[J]. Hubei Agricultural Sciences, 2009, 48(10): 2461-2463.
7. Luo JM, Du HB. Effects of selenium on germination rate and seedling growth of carrot[J]. Crop Research, 2017, 31(7): 747-748.
8. Liu B, Huang DY, Zhou JL, Zhu QH, Long SF, Xu C, Wang S. Effects of selenium and fulvic acid combination on cadmium uptake in rice[J]. Journal of Soil and Water Conservation, 2019, 33(2): 350-355, 362.
9. Gao SB, Zhang YL. Effects of root irrigation with fulvic acid selenium on growth, development and yield of waxy maize[J]. Heilongjiang Agricultural Sciences, 2025(6): 14-21.
10. Zhou JC, Cao YL, Liu FL. Effects of exogenous selenium seed soaking on root growth and physiological characteristics of rapeseed seedlings[J]. Seed, 2019, 38(10): 107-109, 118.
11. Zhang ZL. Experimental Guide for Plant Physiology[M]. Beijing: Higher Education Press, 1992: 88-154.
12. Gao JF. Experimental Guide for Plant Physiology[M]. Beijing: Higher Education Press, 2006: 68-77.
13. Li ZG, Song YQ, Gong M. Xylenol orange method for determination of hydrogen peroxide in plant tissues[J]. Journal of Yunnan Normal University, 2007(3): 50-54.
14. Shi LJ, Bai WB, Cao CL, Zhang JH, Li Guang, Fan Na,

Peng ZD, Guo RF, Jiang BY. Effects of sodium selenite seed soaking on growth and development, yield and grain selenium content of sorghum[J]. Journal of Agriculture, 2016, 6(10): 12-15.
15. Cai YG, Qin JF, Chen G, Guo BL, Duan LF. Effects of exogenous selenium on growth and development of Langao Amorphophallus konjac[J]. Journal of Shanxi Agricultural University, 2018, 38(6): 35-42.
16. Wu XZ, Liu N, Li ZX, Ma JX, Su B, Li DD, Chen MN, Qiao F. Effects of different concentrations of sodium selenite on physiological and biochemical characteristics and selenium content of highland barley seedlings[J]. Journal of Shaanxi University of Science and Technology, 2025, 43(4): 21-30.

How to Cite This Article
Li J, Li L, Yin Y, Li Y, Tian X. The effects of selenium fulvic acid on seed germination and seedling growth of rapeseed (brassica napus l.). Int J Multidiscip Res Growth Eval. 2026;7(6):131-135. doi:10.54660/.IJMRGE.2026.7.6.131-135.

Creative Commons (CC) License
This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution NonCommercial-ShareAlike 4.0 International (CC BY-NC-SA 4.0) License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms