Effects of zeolite and chicken manure on the growth of soybean and rapeseed

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Abstract. Zeolite, chicken manure and their mixtures were added to the soil in different proportions, and their effects on the growth of soybean and rapeseed were studied through pot experiments. The results showed that the addition of zeolite, chicken manure, or a mixture (1:1) all contributed to the plant height and fresh weight of soybean and rapeseed compared to CK treatment, but the plant height was greatly affected by the growth cycle. The weight gradually increases with the addition ratio. After the two are added in a 1:1 ratio, the advantages of plant height and fresh weight of soybean and rapeseed are more significant. The SPAD of soybean increased with the growth period, while the SPAD of rapeseed decreased significantly during the maturity period. The SPAD of both was greatly affected by the growth cycle, and the effects of each treatment were less. To sum up, in this experiment, the mixed ratio of zeolite and chicken manure can be used as a better soil improvement material, and the addition ratio of 20% is better.

Keywords: Zeolite; chicken manure; soybean; rapeseed; growth index.

1. Introduction
In recent years, with the rapid development of China's industrialization and urbanization, China's cultivated land area has been reduced. For this reason, the country has proposed a policy of requisition and replenishment balance to maintain the area of cultivated land. As one of the core technologies of organic restructuring of soil, the selection and application of functional soil-forming materials provide an effective way to realize the open source and throttling of land resources, which is of great significance to poor soil areas. Studies have shown that zeolite can significantly promote the formation of soil aggregates, increase the total soil porosity, loosen the soil and improve soil permeability [1-3], which plays an important role in improving soil nutrients and supplying plant growth [4-6]. In addition, the addition of chicken manure helps to significantly increase the content of soil organic matter, available phosphorus and available potassium, and also helps increase the activity of protease, urease and microbial biomass carbon[7-10]. Existing studies have mainly focused on the individual effects of zeolite and chicken manure on soil organic matter, nutrient content, soil enzyme activity, crop quality
and other factors, however, studies on the direct effects of crop height, SPAD and biomass are less, and these three are important indicators to measure crop growth. In view of this, zeolite, chicken manure and their mixtures were selected as soil additives in this experiment to study their effects on the growth indexes of different types of crops, and to provide a theoretical basis for exploring better improved materials and ratios for organic reconstruction of soil.

2. Material and Method

2.1. Test material

The test soil is selected from the non-contaminated soil of the Qinling Field Monitoring Station Test Base of Shaanxi Land Construction and Land Engineering Technology Research Institute. The soil pH is 7.7, total nitrogen content of the soil is 0.45g/kg, available potassium content is 343.38 mg/kg, and the available phosphorus content is 178.8 mg/kg. The test materials zeolite, chicken manure and flower pots were all collected from Yangling Supply and Marketing Station.

2.2. Test design

The pot experiment was set at the Qinling Field Monitoring Center Station, and the selected soil was loess. A total of 10 treatments are set for different substrates, and each treatment is repeated 3 times, as shown in Table 1. Use a uniform size plastic basin with a diameter of 30cm and a height of 50cm, and fill it manually with a structure of 10cm gravel, 15cm of different proportion matrix, and 5cm of sand from the bottom to the surface. Apply urea (22.5 g/m²), superphosphate (45 g/m²) and potassium sulfate (18 g/m²) as base fertilizer to the soil after different substrate treatments. Carry out pot planting experiments by rotation, and select soybean and rapeseed for sowing and cultivation in different seasons. After emergence, plant one seedling per pot, watering and top dressing irregularly to ensure the same amount of water and fertilizer added in each pot.

| Code | Treatment (mass ratio of occupied loess) |
|------|------------------------------------------|
| CK   | loess                                    |
| A1   | zeolite 5%                               |
| A2   | zeolite 10%                              |
| A3   | zeolite 20%                              |
| B1   | chicken manure 5%                        |
| B2   | chicken manure 10%                       |
| B3   | chicken manure 20%                       |
| C1   | zeolite: chicken manure 1:1-5%           |
| C2   | zeolite: chicken manure 1:1-10%          |
| C3   | zeolite: chicken manure 1:1-20%          |

2.3. Index test

During the soybean seedling stage (30th day after sowing), the flowering and podding stage (60th day after sowing), the maturity period (80th day after sowing) [11] and the wintering period of rape (60 days after sowing) (120 days after sowing), carob period (170 days after sowing) and maturity period (200 days after sowing) [12, 13], the plant height from the base of soybean stem to the top bud with a ruler (cm) is measured and the SPAD value with hand-held chlorophyll meter is tested. After harvesting, the whole plant biomass of soybean and rapeseed (fresh weight, g/plant) was measured with a balance [11].
3. Result and analysis

3.1. Growth index of soybean

Figure 1 showed that the average plant height of soybeans at seedling stage was 19.25 cm, the minimum plant height of CK treated soybean was 15.65 cm, and the maximum plant height of C1 treatment (zeolite: chicken manure 1: 1-5%) was 24.30 cm. With the growth of soybean, the average plant height of soybean during flowering and podding was 24.40 cm, which increased by 5.15 cm on average compared with seedling. Under A1 (zeolite 20%) and C1 (zeolite: chicken manure 1: 1-5%) treatments, soybeans increased significantly, respectively 6.15cm and 9.80cm. The average plant height of soybean during maturity was 27.60 cm, and the growth was relatively slow. In summary, compared with the CK group, the addition of zeolite and chicken manure was helpful to the soybean growth. Among them, under C1 (zeolite: chicken manure 1: 1-5%) treatment, soybean has the best growth, and B1 (chicken manure 5%) second.

![Fig.1 Plant height changes of soybean under different treatments](image)

In figure 2, the whole average SPAD of soybeans at seedling stage was 19.24, of which A3 (20% zeolite) soybean SPAD was the highest at 22.8 and C1 (zeolite: chicken manure 1:1-5%) SPAD was at least 15.7. By the time of flowering and pod stage, the mean value of SPAD was 23.6, which was a slight increase compared to the seedling stage. The whole SPAD of soybeans increased significantly during the mature period, with an average value of 52.82. A3 treatment (zeolite is 20% ), the SPAD of soybean was up to 60.95. The changes of SPAD were not consistent with the changes of plant height.
Figure 3 showed that compared with the CK group, the soybean fresh weight of A (added zeolite), B (added chicken manure), and C (zeolite: chicken manure 1:1) increased in sequence, and increased with the addition of the proportion of each treatment. Zeolite can be used as a matrix for soil structure improvement and slow-release fertilizer [2], and chicken manure provides the nutrients needed for crop growth and helps increase crop yields [14]. The combination of the two in this experiment played a synergistic role, so the fresh weight of soybean increased significantly.

3.2. Growth index of rapeseed

In figure 4 that the average plant height of rapeseed in the overwintering period was 26.63 cm, and the difference was very small. Rapeseed grew slowly at the sedge stage, the average plant height was 34.92 cm, and C treatment (zeolite: chicken manure) > B treatment (add chicken manure) > A treatment (zeolite). Among them, only C1 and B1 plant height increase were larger, the difference of other group was not significant. The growth trend of the plant height of rapeseed in the carrageenan stage was similar to that in the bolting stage, with the average plant height of 45.10 cm. The plant height of rapeseed in each treatment increased significantly during the maturity period. In group A, the plant height of rapeseed did not increase with the increase of the proportion of zeolite, while in group B, the plant height
of rapeseed decreased with the increase of the proportion of chicken manure, which may be related to the time limit for nutrient release from chicken manure. With the increasing addition ratio in group C, the plant height gradually increased, which may be related to the fact that zeolite delayed the fertilizer efficiency of chicken manure.

**Fig.4** Plant height changes of rapeseed under different treatments

Figure 5 showed that the whole SPAD changes of rapeseed were quite different from those of soybeans. In terms of different growth cycles, the average SPAD of rapeseed during the wintering period was 37.69. Compared with CK group, SPAD of the zeolite-added group decreased, and SPAD of the chicken manure group and the mixed group increased. Only B3 treatment (chicken manure accounted for 20%) had a SPAD of 65.43. The average SPAD of rapeseed in the bolting stage was 63.63, which was significantly higher than that in the overwintering stage. The average value of rapeseeds in the podding stage was 61.81, a slight decrease, and to the maturity stage, the average SPAD of rapeseeds was 45.61, only higher than the overwintering stage. In terms of different treatments, the average SPAD of rapeseed in the zeolite group was not significantly different from that in the CK group. The SPAD in the mixed group decreased slightly as its proportion increased, while the SPAD in the chicken manure group increased with the proportion of chicken manure, and the SPAD of B3 in each growth stage reached the maximum.

**Fig.5** SPAD changes of rapeseed under different treatments
The fresh weight changes of rapeseed after harvest was similar to that of soybean (Figure 6). In terms of different treatments, group C (zeolite: chicken manure 1:1) had the highest yield of rapeseed, of which C3 (zeolite: chicken manure 1:1-20%) average fresh weight was 16.55g, and C2 (zeolite: chicken manure 1:1-10%) followed by 12.34g, the fresh weight of rapeseed increased with the dosage of the mixed group. The overall treatment of group A (zeolite) and group B (chicken manure) also increased with the increasing dosage, but the difference was not significant. In summary, compared with CK group, the addition of zeolite or chicken manure alone can help increase the fresh weight of rapeseed, but the increase was not obvious. The addition of zeolite and chicken manure (1:1) was beneficial to increase the fresh weight of rapeseed, and the increase was more significant.

![Figure 6 Fresh weight of rapeseed under different treatments](image)

4. Conclusion
Compared with CK treatment, the addition of zeolite, chicken manure alone or zeolite and chicken manure added in a 1:1 ratio can contribute to the plant height and fresh weight of soybean and rapeseed, but the plant height was greatly affected by the growth cycle. The fresh weight gradually increases with increasing proportion of addition. After the two were added in a 1:1 ratio, the plant height and fresh weight advantages of soybean and rapeseed were more significant. The SPAD of soybeans increased with the growth period, while the SPAD of rapeseed decreased significantly during the maturity period. Both SPADs were greatly affected by the growth cycle, and the effects of each treatment were less. To sum up, in this experiment, the mixed ratio of zeolite and chicken manure can be used as a better soil improvement material, and the addition ratio of 20% was better.

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