Our Replies to the Reviewers' Comments

and the Revisions Made to the Manuscript

Comments by Reviewer #2:

1. The authors should further refine the language as there are some typos and grammatical errors present, such as line 139, line 197....

Reply: Thank you for the correction. We corrected these errors in our revised manuscript and improved our writing with the help of academic English editing.

2. The abstract should explain the research method and then discuss the research results.

Reply: Thank you for the correction. We explain the research method in the abstract.

Revision:

Page 2, Line 21-26

The plant diversity such as Margalef index (M), Simpson index (H), Shannon-Wiener index (D), and Pielou index (J), and soil properties (soil pH, soil water content (SWC), and soil bulk density (SBD), soil organic matter (SOM), available nitrogen (AN) and microbial biomass carbon (MBC)...) were investigated in four sites of different ecological restoration patterns and study the coupling relationship between them.

3. Line 83: Soil nitrogen and phosphorus limit the growth of vegetation? Please verify the accuracy of this description!.

Reply: Thank you for the correction. We deleted this sentence.

4. Materials and methods: the experimental investigation design needs to be more detailed.

Reply: Thank you for the comment. We simplified the section on vegetation for mine restoration.

Revision:

Page 7, 140-148

We made ground vegetation investigation to collect data on plant diversity in June 2022. The investigation sites were depended on the plant community size, five 10 m $\times$ 10 m quadrat were selected in each vegetation ecological restoration site as arbor layer, recorded the species name, quantities of trees, height, the branch diameter and coverage. Two 5 m $\times$ 5 m quadrat were mechanically arranged as shrub layer squares in each arbor quadrat, and one 1 m $\times$ 1 m herb layer quadrat was set in the center of each shrub quadrat. And heights, the number of shrubs. In the herb layer, species name, average coverage and average height of each specie were recorded in shrub layer and herb layer.

5. All abbreviations used in the manuscript should be defined in full at their first appearance, regardless of whether they are commonly recognized.

Reply: Thank you for the correction. We defined all abbreviations.

6. Line 430-433: the words "abandoned coal mine area" are repeated and should be deleted

Reply: Thank you for the correction. We deleted the redundant words.

Revision:

Page 26, Line 431-434

The results also indicated that for the abandoned coal mine area vegetation ecological restoration, planting dominant plants mixed with other vegetation was a suitable measure to efficiently rebuilt ecological functions in abandoned coal mine area.

7. The "Discussion: 4.3 Coupling relationship between plant diversity and soil properties" lack of depth, the relationship between soil properties and plant diversity can be discussed in detail.

Reply: Thank you for the correction. We discussed the relationship between soil properties and plant diversity in detail.

Revision:

Page 26, Line 498-537

It was well known that plant diversity was strongly related to soil properties, which can determine the distribution of plant species (Wang et al., 2018). Soil physicochemical properties were important indicators affecting the growth and development of forest trees, in which SBD and SWC can effect the extension of plant roots, root respiration and soil nutrient absorption. Our results indicated that the relationship between plant diversity and soil properties in different layers was significant, and the correlation trend on 10-20 cm soil layer was stronger than that on other layers (**Fig. 9**). The main reason was that the litter decomposition and roots activity provided nutrients, soil-vegetation ecosystem had feedback mechanisms between soil and vegetation, and they can interact with each other (Li et al., 2021). SOM was an important factor in plant diversity to sustain the function of plant growth (Kooch et al., 2020), and litter was the main source of SOM. In this study, SOM was negatively correlated with the Shannon-Wiener index, Simpson index, and Pielou index but negatively correlated with Margalef index. On one hand, under the condition of poor soil nutrients, vegetation improved the growth through the increase of water availability and degree of mineralization, while sufficient soil nutrients can also improve the growth of vegetation, and suitable good water conditions can also accelerate the degradation of understory litter, increase the SOM, and indirectly improve the soil quality (Petersen et al., 2015). On the other, the soil microbial activity can promote SOM accumulation, resulted in increased plant pathogen attack, deterioration plant living environment (Bongiorno et al., 2019; Hagen-Thorn et al.,

2004). Therefore, only optimum soil nutrient conditions can improve plant diversity. Our results indicated that SBD was positively correlated with the Shannon-Wiener index, Simpson index, and Pielou index but negatively correlated with Margalef index, while SWC was positively correlated with plant diversity in the surface soil layer, indicating that SBD was significantly affect the plant diversity. SBD and SWC played an important role in soil hydrological processes (Katherine et al., 2010), and affected the geochemical cycle of plants and microorganisms (Vereecken et al., 2014). Studies have reported that soil pH decrease resulted in the degradation of plant diversity (Xu et al., 2022a; Xue et al., 2019). However, although the decrease of soil pH had a negative effect on plant growth, it provided more space for increasing plant diversity (Zhao et al., 2022b). This indicated that species composition led to changes in community environment, resulted in complex interaction among plant and soil and resources for plant growth, which might diminish the importance of soil properties on plant diversity (Härdtle et al., 2003; Pérez-Bejarano et al., 2008). Therefore, the plant growth in abandoned coal mine was not only a process of plant adaptation to soil nutrients, but also the interaction of plant growth and soil properties. In summary, mixed coniferous with broad-leaved forests can improve SBD and SWC better, and is beneficial to improve soil nutrient conditions, which plays an important role in the enhancement of soil ecosystem functions in abandoned coal mine area.