Chapter

Research Progress of Forest Land Nutrient Management in China

Zhi Li, Yanmei Wang, Xiaodong Geng, Qifei Cai and Xiaoyan Xue

Abstract

Forest land fertilization is a supplement and regulation method based on the regular pattern of forest physiological activity and nutrient demand, combined with the ability of soil to supply nutrient elements. We summarized the important achievements and influential events of forest land fertilization and nutrient management in modern times, and discussed the main problems of forest land fertilization at this stage. The main theories of comprehensive nutrition diagnosis method, formula fertilization method, site nutrient effect fertilization model, and ASI-based balanced fertilization method were analyzed. The main scientific research institutions, main tree species, and main research results of forest fertilization research are described. The development trend of the comprehensive nutrition diagnosis method, the combination of forest fertilization theory and environmental ecology principle, the combination of fertilization and forest oriented cultivation goal, the application of precise fertilization technology in forest land, the development of new forest specific fertilizer, the research of plant nutrition molecular genetics, the research of root state and rhizosphere microecosystem, the application of advanced technology and technology, and the development and application of new nonpollution fertilizer were discussed. It is an important research direction to apply the existing research results to forestry production and improve the quality.

Keywords: forest land fertilization, nutrient cycle, forest soil, nutrient management, new fertilizer

1. Introduction

Forest resource is one of the most important resources on earth and the basis of biodiversity. It can not only provide a variety of precious wood and raw materials for production and life but also provide a variety of food for human economic life. More importantly, it can regulate climate; conserve water and soil; prevent and mitigate natural disasters such as drought and flood, sandstorm, hail, etc.; purify air and eliminate noise; and other functions [1, 2]. With the growth of global population and some sudden natural risks, similar events such as the continuous spread of the current COVID-19, people are under the pressure of living space and means of life, which increases the demand for food and timber, and at the same time, the area of forests in many regions is sharply reduced, which requires more forest products to be produced in a short time, especially some economic forests, which require the same production cycle to get more output [3, 4].

At present, China's forestry industry is still in extensive development. Although the state has increased the investment in forestry industry in recent years, the overall quality of forestry industry needs to be improved, which is manifested in the strong singleness of forestry construction and the failure to form a good forestry ecosystem [5, 6]. In addition, in the utilization of forestry resources, the ability of fine finishing of products is not strong, and the technical content of forest products is low, which will inevitably affect the overall economic benefits of forestry and will be detrimental to the sustainable development of forestry industry [7].

Forest fertilization is a supplement and adjustment method based on the regular pattern of forest physiological activities and nutrient demand, combined with the ability of soil to supply nutrient elements [8]. It is also a forest management measure to improve soil fertility, improve forest nutrient status, and promote tree growth, so as to achieve high quality, high yield, high efficiency, and low cost. Some countries began to apply fertilizer to forest land before the Second World War, such as Europe, the United States, Japan, Australia, etc. Due to the rapid economic development after the War, the demand for wood is increasing, and the application of fertilizer measures in forest production is increasingly extensive [9, 10]. China's forestry fertilization research began in the late 1950s and then developed slowly until the 1970s. The fertilization area increased year by year [11]. Through the efforts of generations, people have made significant progress in plant nutrition physiology, nutrition diagnosis, fertilization technology, and fertilizer creation and made outstanding contributions to the protection of human food supply [12]. Forestry fertilization has also been recognized by most forestry producers in production, but up to now, the research on forest fertilization is still in the experimental stage. In addition, the lack of knowledge and technical experience leads to the phenomena of poor afforestation effect, slow growth of trees, high afforestation cost, and low yield [13]. In many developed countries, forest fertilization is regarded as an important means to build fast-growing artificial forest, and the yield-increasing effect of forestry fertilization is very significant [14].

Combined with relevant research results, we reviewed the landmark events and their impacts on forest land fertilization; analyzed the existing problems and put forward corresponding solutions; then looked forward to the future development direction of forest land fertilization, in order to provide basis for domestic and foreign forestry fertilization; and also provided reference for forestry management and fertilizer research.

2. Research progress of forest fertilization

After 1840, Leibig put forward the theory of plant mineral nutrition, which is widely accepted [15]. However, what elements are needed in the process of plant growth and development has become a research hotspot at that time. The essential nutrient elements for plant growth refer to the indispensable nutrient elements in the process of crop growth. If the essential nutrient elements lack, the plant cannot grow and develop normally, blossom, and bear fruit and will cause disease. At present, there are 17 kinds of essential nutrients for crops, which are carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), manganese (Mn), copper (Cu), zinc (Zn), boron (B), molybdenum (Mo), nickel (Ni), and chlorine (Cl) (**Figure 1**). According to the demand of crops for various elements, 17 elements are divided into a large number of elements (C, H, O, N, P, K), medium elements (Ca, Mg, S), and trace elements (Fe, Mn, Cu, Zn, B, Mo, Ni, Cl). They are equally important in the growth process of plants and irreplaceable. In addition, there are also some nutritional elements called beneficial elements; although these elements are not necessary for plant growth, they have certain nutritional effects on plants, such as cobalt (C_O), which is necessary for nitrogen fixation of legume rhizobia, so it has a good impact on legume growth. Sodium (Na), silicon (Si), iodine (I), selenium (Se), strontium (Sr), and vanadium (V) are also beneficial elements.

France is the first country to carry out the experiment of forest land fertilization. In 1847, French scientists applied fertilizer to forest land with plant ash, ammonium salt, and slag, which increased the growth of trees by 17–26% [16]. In the middle nineteenth century, German scientists found that harvesting dead branches and leaves from forest land would lead to a sharp decline in forest productivity and began some early fertilization experiments [17, 18]. Some other countries in Europe have also carried out afforestation and fertilization experiments and achieved results, but due to the slow effect of forest fertilization, the research process is relatively slow [19, 20]. Forest land fertilization did not enter the practical stage until the 1950s. With the reduction of forest resources, global economic recovery, and the development of fertilizer industry, forest land fertilization-related scientific research and production applications have been developed rapidly [21]. In 1973, the Food and Agriculture Organization of the United Nations (FAO) and the International Union of Forest Research Organizations (IUFRO) held an International Symposium on forest fertilization in Paris, with a wide range of research contents. After that, the research on forest fertilization has become more and more comprehensive and in-depth in the world, which has changed from a single direction to a multi-level and multi-functional comprehensive research. Some countries have carried out long-term

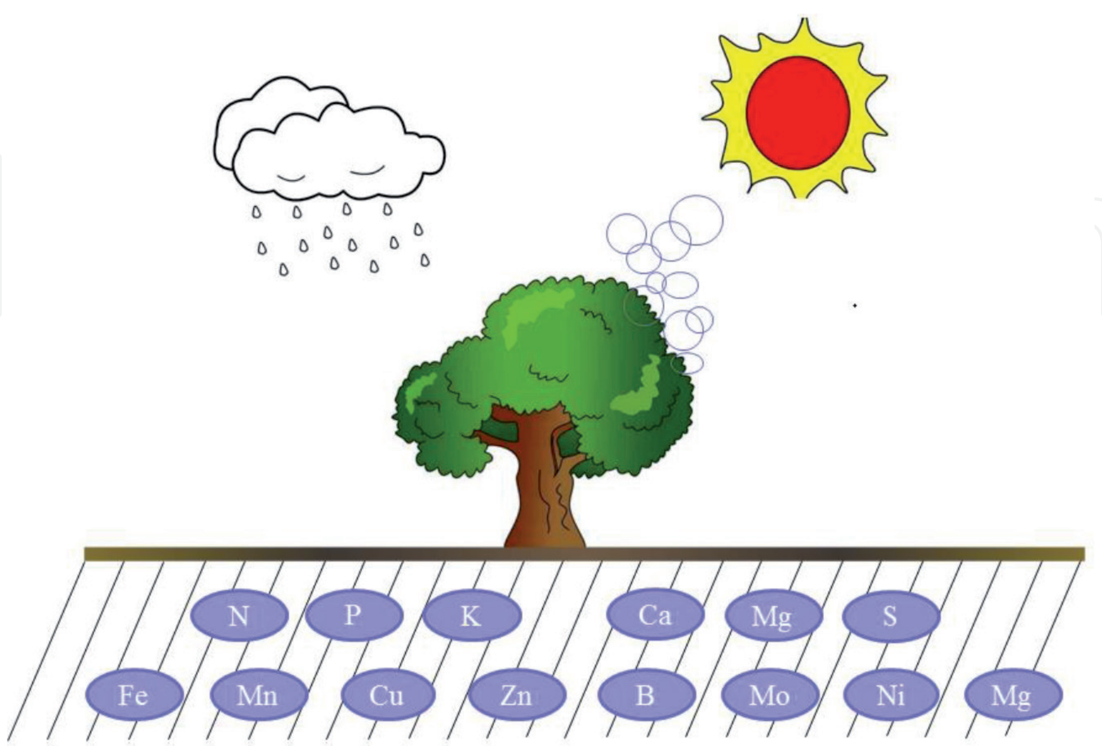

Figure 1.
Nutrient elements for plant growth. Drawing: Zhi Li.

positioning observation on forest fertilization in combination with the research on forest ecosystem [22].

In the 1950s, China began to carry out forest fertilization experiments and small-scale productive fertilization and then gradually developed from economic forest to timber forest [23]. At the national forest fertilization conference held in 1985, there are many species studied, such as *Cunninghamia lanceolata* (Lamb.) Hook, *Phyllostachys edulis* (Carrière) J.Houz, *Vernicia fordii* (Hemsl.) Airy Shaw, *Camellia oleifera* Abel., *Juglans regia* L., *Populus tomentosa* Carrière, *Eucalyptus robusta* Smith, etc. The main research contents covered the effects of different fertilizers, different amounts and proportions on the growth and yield of forest trees; the control of forest diseases through fertilization; the application of isotope tracer technology; the diagnosis of forest nutrition, etc. Until at the end of the twentieth century, the cultivation direction of short-term timber forest was defined, and the special topic of "Research on fertilization technology and measures for maintaining soil fertility of main industrial timber forest" was set up. In 1995, a seminar on forest fertilization and nutrition was held in Beijing. The results of the research were exchanged among the seedlings and young forests of *Cunninghamia lanceolate*, *Ziziphus jujuba* Mill. var. *spinosa* (Bunge) Hu ex H. F. Chow, *Eucalyptus robusta*, *Populus*, *Pinus elliptic*, *Pinus caribaea* Morelet, and the middle-aged and mature forests of some species (*Pinus massoniana* Lamb.). Based on the theory of forest site productivity and nutrient productivity, the model of site nutrient effect fertilization was discussed systematically [24]. Up to now, a set of mature technology of nutrition diagnosis and fertilization has been formed in China's agriculture. However, due to the long cycle of forestry production, the single function of fertilizer, and the short duration of fertilizer effect, the utilization ratio of forest trees to fertilizer is relatively low, and some even pollute the environment. Therefore, the research and promotion of forest-specific fertilizer can improve the nutritional status of trees and promote the growth of trees, which is an important direction of fertilizer research in the new century [25].

Looking at the development of forest fertilization experiment in China, it can be seen that the main research object of fertilization effect at this stage is mostly the young forest period of forest trees, usually using the conventional method of agricultural fertilization, lacking systematic technology, and theoretical support system, so there is a big controversy. Because the growth cycle of forest is long, the natural environment factors of forest are complex, and the amount of fertilization is difficult to control. However, the implementation of large-scale organization is more difficult, which often results in the phenomenon of excessive or insufficient amount of fertilization. Therefore, it is necessary for researchers to conduct in-depth study on the methods and theories of forest fertilization. With the rapid development of modern economy and the continuous improvement of forest intensification, China needs to vigorously carry out in-depth research on forest fertilization technology, strive to develop forest modernization and intensification, create an efficient and high-quality ecological environment, and realize the sustainable development of forestry.

3. Main theories and methods of forest fertilization research in China

The purpose of fertilization is to improve the nutritional status of trees, promote the growth of trees, and increase the unit yield. At the same time, through fertilization, the forest soil status is improved and the soil fertility is improved. Over the years, forestry researchers have studied fertilization technology in the aspects of fertilizer selection, amount and time, and gained valuable experience and achievements.

Comprehensive nutrition diagnosis and steady-state nutrition method are based on plant nutrition mechanism. Forest nutrition diagnosis is a technology to study the correlation and influence between forest nutrition and various nutrients held by forest soil. It is a method to predict, judge, and evaluate fertilization effect [26].

Formula fertilization method is based on field experiment, soil classification, and pre-production ration. According to the regular pattern of plant fertilizer demand, soil fertilizer supply capacity and fertilizer efficiency, the researchers put forward the proportion scheme of microelements and microelements and the corresponding fertilization technology [27]. The main methods are soil fertility grading ratio method, nutrient balance quantitative method, soil fertility difference subtraction method, nutrient abundance and deficiency index method, field experiment proportion method, yield determination by soil, nitrogen determination by yield, fertilizer supplement method due to lack of elements, etc. Before using these methods, there should be a large number of information data about the characteristics of crop fertilizer demand, soil fertilizer supply capacity, fertilizer effect, and so on. In the process of using these methods, we should closely combine the high-yield and high-quality cultivation techniques such as irrigation, cultivation, soil improvement, and soil and water conservation.

Based on the theory of forest environmental productivity and nutrient productivity, a fertilization model of environmental nutrient effect was established [28]. Different from the conventional methods of forest fertilization experiment, the formula fertilization model of forest site nutrient effect is used to determine the necessity of forest land fertilization, the dynamic and static relationship between forest growth and nutrient absorption, the curve of soil nutrient capacity and intensity, and the target benefit equation through the measurement of site and nutrient effect parameters and correlation coefficient. Based on this set of curves and equations, the optimal target yield increase, the increment of effective nutrients required for reaching the target, the corresponding amount and formula of fertilizer application, and the optimal period and method of fertilizer application are determined. It is widely applicable, not limited by the region and the growth stage of trees, and has high accuracy and popularization value in application.

There is also a forest nutrient diagnosis balanced fertilization method, also known as ASI method (the method recommended by the Agro Services International Inc., ASI for short) [29]. It is mainly aimed at the soil conditions in different regions, the fertilizer demand characteristics of different tree species, and the research contents of formula fertilization and balanced fertilization technology. A variety of special compound fertilizers rich in N, P, K, Zn, Fe, Mn, B, and other large, medium, and microelements, organic matter, and humus have been developed. Now, they are mostly used in economic tree species.

At present, the development and application of various compound fertilizers have fundamentally solved and met the needs of fertilization for fast-growing and high-yield forests and economic forests in forestry and made forestry fertilization develop from simple fertilizer, formula fertilizer, to organic multiple special fertilizer to high-tech direction.

4. Main units and species of forest fertilization research in China

According to the reality of China's economic reform and forestry practice, many scientific research institutions and forestry workers in China have done a lot of relevant research and put forward the forestry development theory and practice results of fertilization for different forest management processes. These theories have played a positive role in guiding China's forestry development, such as:

Beijing Forestry University has carried out researches on *Populus* [30], *Castanea mollissima* BL. [31], *Larix gmelinii* (Rupr.) Kuzen. [32], and *Acacia mearnsii* De Will [33]; Nanjing Forestry University has carried out researches on *Populus* [34], *Carya illinoinensis* (Wangenh.) K. Koch [27], *Ginkgo biloba* L. [35], and *Cyclocarya paliurus* (Batal.) Iljinsk. [36]; Northeast Forestry University has carried out researches on *Larix gmelinii* [37], *Fraxinus mandshurica* Rupr. [38], and *Betula platyphylla* Suk. [39]; Northwest Agricultural and Forestry University has carried out researches on *Malus domestica* “Changfu-2” [40], *Ziziphus jujuba* [41], etc.; Hebei Agricultural University has carried out researches on *Juglans regia* [42], *Castanea mollissima* [43], *Malus domestica* Borkh.CV.Red Fuji [44], and others; Central South University of Forestry and Technology has carried out research on *Camellia oleifera* [45], *Vernicia fordii* [46], *Pyrus pyrifolia* “Whangkeumbae” [47], *Cunninghamia lanceolate* [48], *Phyllostachys edulis* [49], etc.; Zhejiang Agriculture and Forestry University has carried out research on *Phyllostachys praecox* C. D. Chu et C. S. Chao “Prevernalis” [50], *Phyllostachys edulis* [51], *Castanea mollissima* [52], *Carya cathayensis* Sarg. [53], *Torreya grandis* Fort.et lindl [54], etc.; Fujian Agriculture and Forestry University has carried out research on *Cunninghamia lanceolata* [55], *Castanea henryi* (Skan) Rehd. et Wils. [56], etc.; Chinese Academy of Forestry has been carried out research on *Populus* [57], *Castanea mollissima* [58], *Paulownia* Sieb.et Zucc. [59], etc.; and Jiangxi Agricultural University has carried out research on *Camellia oleifera* [60], *Phyllostachys edulis* [61], *Eucalyptus robusta* [62], *Cinnamomum camphora* var. *linaloolifera* Fujita [63], *Evodia rutaecarpa* (Juss.) Benth. [64], etc.

Take the research of Jiangxi Agricultural University that I studied as an example. The College of Forestry in Jiangxi Agricultural University is at the forefront

Figure 2.
The College of Forestry, Jiangxi agricultural university, has developed the special fertilizer for Camellia oleifera *to guide the precise fertilization and intensive nutrient management. Photo: Zhi Li. Notes: (A) special formula fertilizer for* Camellia oleifera*. (B) Special fertilizer for organic and inorganic oil tea. (C) the* Camellia oleifera *forest land. (D) Farmers apply special fertilizer for* Camellia oleifera*.*

of the country in terms of high-yield and intensive management measures and balanced fertilization technology of *Camellia oleifera*, and its achievements have reached the international leading level. It has developed the special fertilizer for *Camellia oleifera*, which ensures the high-quality and high-yield of *Camellia oleifera.* It is used to guide the precise fertilization and intensive management of *Camellia oleifera*, and realize the sustainable management of *Camellia oleifera* forest (**Figure 2**) [65].

In recent years, the forest fertilization research team of Jiangxi Agricultural University has also carried out research on balanced fertilization technology and formula of *Eucalyptus robusta*, *Evodia rutaecarpa*, *Ziziphus jujuba*, *Cunninghamia lanceolata*, and other tree species, meeting the needs of Jiangxi forestry production [66]. The vegetation restoration of rare earth mines in South Jiangxi relies on good nutrient management technology, which makes afforestation of barren wasteland successful [67]. The related research results include: (1) establishing the indicators of soil nutrient abundance and deficiency and leaf nutrient diagnosis (critical value) of economic forest species such as *Phyllostachys edulis* (**Figure 3**), *Camellia oleifera*, *Eucalyptus robusta* (**Figure 4**), and *Evodia rutaecarpa*, which provide the basis and scientific basis for the diagnosis and balanced fertilization of main economic forest species in Jiangxi Province; (2) based on this, the balanced fertilization formula for *Phyllostachys edulis* and *Camellia oleifera*, in Jiangxi Province, was formulated, and special fertilizers for *Phyllostachys edulis* and *Camellia oleifera* were developed; (3) the spatial heterogeneity of soil nutrients in *Phyllostachys edulis* and *Camellia oleifera* plantation was studied, which provided scientific

Figure 3.
The College of Forestry, Jiangxi agricultural university, has developed the special fertilizer for Phyllostachys edulis *to guide the reconstruction after freezing disaster, precision fertilization, and intensive nutrient management. Photo: Zhi Li. Notes: (A) the* Phyllostachys edulis *forest suffered from freezing disaster; (B) the special formula fertilizer for* Phyllostachys edulis*; (C) Farmers apply special fertilizer for* Phyllostachys edulis*; and (D) after precision fertilization and intensive nutrient management, the growth of* Phyllostachys edulis *forest was exuberant.*

Figure 4.
Vegetation restoration and afforestation with nutrient management technology in rare earth mines in South Jiangxi Province, China. Photo: Zhi Li. Notes: (A and B) Rare earth tailings are barren. (C and D) Successful afforestation through nutrient management technology.

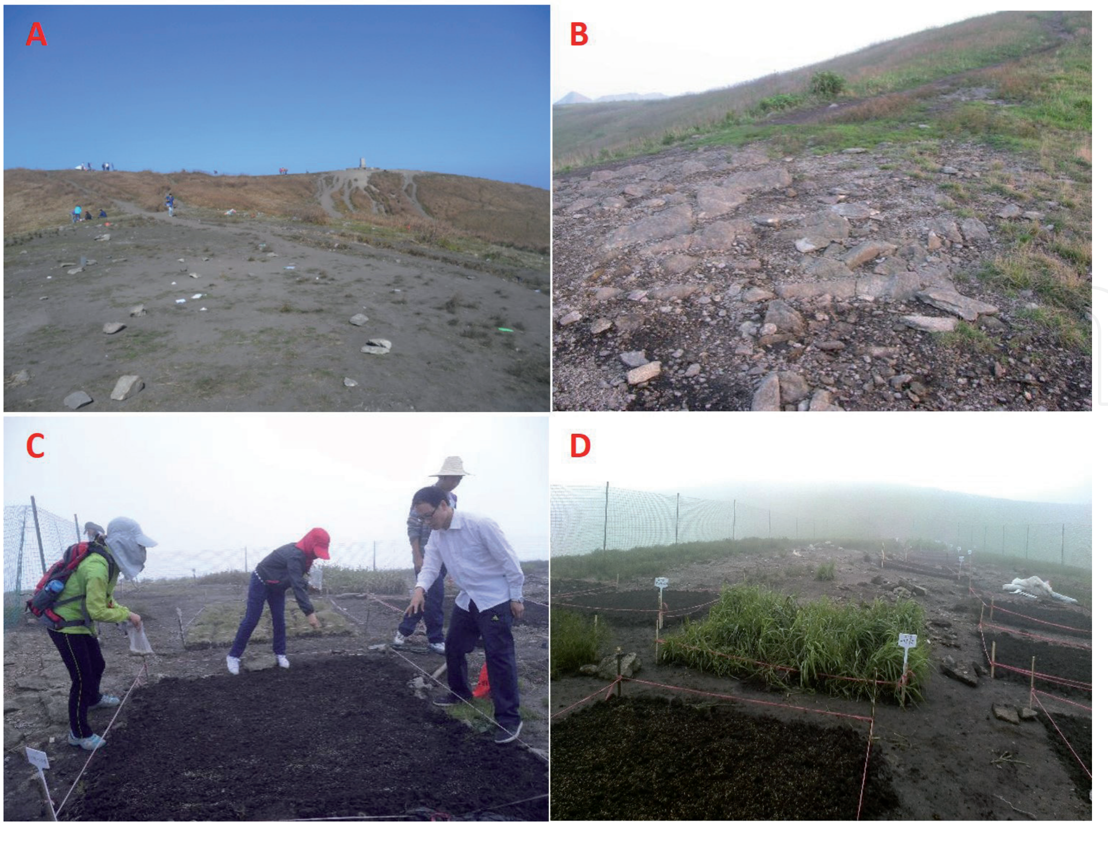

Figure 5.
Soil nutrient management and vegetation restoration in the subtropical mountain meadow of Wugong Mountain, Jiangxi Province, China. Photo: Zhi Li. Notes: (A and B) Seriously degraded Wugong Mountain meadow. (C and D) Our researchers are doing vegetation restoration experiments.

basis for precise fertilization; (4) using artificial neural network to predict the DBH of *Phyllostachys edulis* forest, the average simulation accuracy is 93.13%; (5) a computer nutrient management information system for balanced fertilization of *Phyllostachys edulis* in a small area has been developed, which provides an advanced technology and decision-making platform for large-scale balanced fertilization and sustainable management of *Phyllostachys edulis*; (6) the coupling technology of water and fertilizer was studied to improve the yield and quality of *Camellia oleifera*; and (7) studies on nutrition and physiological/mechanism of tree growth and development.

In addition, the researchers of Jiangxi Agricultural University have carried out systematic research on soil nutrient management of subtropical mountain meadow [68–71] (**Figure 5**) and obtained a series of scientific research results [72–75], providing a good scientific guidance for the protection and degradation restoration of mountain meadow which was a special ecosystem element [76–78].

5. Characteristics and difficulties of fertilization in forest land

Forest land soil is the soil under forest cover, which is one of the organic components of forest ecosystem. Compared with conventional farmland and other uses of soil, forest land soil has special characteristics because of the impact of forest litter, woody plant root group, forest biological community, and special environmental conditions of forest ecosystem.

5.1 Characteristics of forest fertilizer demand

The regular pattern and absorptive capacity of forest trees are obviously different from that of most crops, with deep root, large root range, and low nutrition demand; most trees are perennial, immobile, and non-intercropped, with long-term and continuous nutrient supply; the growth cycle of general trees is long, with complex influencing factors and difficult nutrition diagnosis; moreover, the growth and development law of different trees is different [79].

5.2 Fertilization requirements for forest land

The fertilization in forest land is mainly based on base fertilizer, supplemented by top dressing; the spacing between plants and rows is large, and hole fertilization is often used, so it is difficult to apply fertilizer in mountainous area, and the times of fertilization are not many; the time, method, and amount of fertilization vary according to the characteristics of tree species [25].

5.3 Difficulties in forest land fertilization

The spatial heterogeneity of forest land nutrients is large, and the difficulty of nutrient diagnosis is large. The growth cycle of forest trees is long, the effect is slow, and the short-term fertilizer effect is not necessarily obvious. The spacing between trees and rows is large; there are many weeds in the forest, which need to be applied in caves; and the workload is large. The trees grow in mountainous areas, but the transportation conditions in mountainous areas are poor, so the cost of fertilization is high. The research on forest fertilization is also relatively late, and the nutrient characteristics of most trees are unknown. The method of fertilization is still in its infancy; at present, there are few special fertilizers for trees in the market [80].

6. Development trend of forest land fertilization

The main direction of forest land nutrient management and fertilizer research is still to improve the utilization efficiency of forest nutrient elements and reduce the environmental pollution caused by nutrient elements or some non-nutrient elements brought in by fertilization [81]. According to the needs of the industry, the targeted cultivation and intensive management of trees will be carried out to realize the fertilization of trees (specialization, long-term, and precision), so as to achieve the development goal of high yield, high quality, and efficiency, taking into account the ecological benefits of the environment and the overall social benefits [82].

At present and in the future, the development mode of forest land fertilization includes using the comprehensive nutrition diagnosis method, combining with the principle of site productivity, improving the accuracy and comparability of analysis, revealing the law of forest nutrition balance, detecting the mechanism of nutrient absorption and utilization, and determining the relationship between the growth and absorption of different growth stages of plants and the rate of soil fertilizer supply [83]. Combining the theory of forest fertilization with the principle of environmental ecology, we can improve the productivity of forest land and keep the human ecological environment in harmony [84, 85]. Fertilization should be combined with the goal of forest-oriented cultivation. As a basic technical measure of forest cultivation, fertilization should be classified under different cultivation goals, and its research results should also be carried out in production according to the cultivation goal [86]. The application of forest land precision fertilization technology and the application of forest nutrition management information system supported by 3S technology in forest land fertilization will achieve precision fertilization for different tree species, different soil, and different development stages and improve fertilizer utilization rate [87]. In view of the long-term nature of the absorption of nutrient elements by trees and in order to meet the demand of large-scale operational fertilization in mountain forest areas, the development of new forest-specific fertilizer will gradually develop to high concentration, slow effect, and special compound fertilizer [88]. In the study of plant nutrition molecular genetics, while improving the fertilization methods, we should focus on the research and cultivation of good varieties to adapt to the specific soil environment, so as to realize the transformation from suitable trees to suitable varieties [89]. The research frontier of root state and rhizosphere micro ecosystem is to explore the dynamics of soil root interface nutrients and their environment, so as to clarify the biological effectiveness of soil nutrients [90]. The application of high-tech technology, such as atomic absorption spectrometer, electron probe, and various automatic analyzers, provides necessary conditions for diagnosis and fertilization [91]. In forest is a very important factor in the formation of water source of rivers and lakes. The safety of fertilizer application in forest land is closely related to the safety of water body, so the research and application of new nonpollution fertilizer is particularly important [92].

7. Conclusion

As an important green raw material, trees are favored under the great development of ecological construction. In recent years, China's demand for wood is growing day by day. The cultivation of artificial forest, timber forest, and the construction of industrial raw material forest have been greatly supported by policies and funds. With the rapid development of plantation and the continuous improvement of its area, it still faces the problems of insufficient total amount of forest resources and poor quality. However, for a long time, the utilization rate of fertilizer in China is low, which has caused great economic losses and also brought great impact on the environment. Research and development of new fertilizer can effectively solve the above problems. Although there are still some problems in the manufacturing process of new fertilizer, due to its outstanding advantages, it will usher in greater development in the near future.

The research of forest land fertilization is developing rapidly, and rational fertilization has become an important technical measure to cultivate short rotation industrial timber forest and accelerate economic forest benefits. At the same time, many forestry workers realize that the simple fertilization cannot achieve the expected effect on greatly improving the growth of trees. In addition to some technical problems that limit the fertilizer effect to a certain extent, how to reasonably apply fertilizer according to the water status of forest land is the key to the problem. It needs to be especially pointed out that at present, most of the research on water and fertilizer balance is in agricultural production and has made great achievements, while the research on water and fertilizer balance in forestry is still in its infancy. Therefore, how to apply the existing research results to the forestry production and speed up the solution to the backward situation of China's forestry production should be one of the future research topics for forestry workers.

In addition, nutrient management in forest ecosystems should consider the ecological effects of fertilization under the context of global climate change, considering the potential interactions among global change factors [93, 94], nutrient input [95], and internal element cycling within forest ecosystems [96–101]. For example, in plantations experiencing intensive management, N input may induce more N leaching due to excessive application, especially in areas characterized by acid soils [101, 102]. To prevent such N loss from soil to happen, soil amelioration should be employed to decrease N leaching via runoffs, trace gas emissions, or volatilization [102, 103], increasing the fertilization efficiency of agricultural practice [101, 102]. Presently, biochar has been widely used in soil amelioration or mitigation of soil trace gas (especially those containing N) [103, 104]. Thereby, future fertilization practice could be combined with soil amelioration strategies to obtain efficient fertilization practice and nutrient management in forest or plantation soils [103, 104].

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Conflict of interest

The authors declare no conflict of interest.

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