AMF and Camellia Plants

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Camellia is a genus of evergreen shrubs or trees, such as C. japonica, C. sinensis, C. oleifera, etc. A group of beneficial soil microorganisms, arbuscular mycorrhizal fungi (AMF), inhabit the rhizosphere of these Camellia spp. A total of eight genera of Acaulospora, Entrophospora, Funneliformis, Gigaspora, Glomus, Pacispora, Scutellospora, and Sclerocystis were found to be associated with Camellia plants with Glomus and/or Acaulospora being most abundant. These mycorrhizal fungi can colonize the roots of Camellia spp. and thus form arbuscular mycorrhizal symbionts. AMF is an important partner of Camellia spp. in the field of physiological activities. Studies indicated that AMF inoculation has been shown to promote plant growth, improve nutrient acquisition and nutritional quality, and increase resistance to drought, salinity and heavy metal contamination in potted Camellia.

Keywords: diversity ; mycorrhizas ; symbiosis ; tea

1. Introduction

Arbuscular mycorrhizal fungi (AMF) are widely found in various soils [1]. AMF colonize roots of about 80% of vascular plants and thus form arbuscular mycorrhizas in host roots [2]. AMF promote plant growth, increase mineral element absorption, and improve plant stress tolerance [3][4][5]. AMF absorb more water for the host through the extraradical hyphae [6][7], and also secrete glomalin into the soil (defined as glomalin-related soil protein) to cement soil aggregates and improve soil moisture-holding capacity and permeability [8]. In addition, AMF can mitigate the toxicity of heavy metals by competitive uptake of heavy metal ions from the soil [9][10], as well as improve the soil environment [3][4][11][12].

Camellia is a genus of evergreen shrubs or trees in the Camelliaceae family, which is mainly concentrated in eastern and southeastern Asia [13]. Camellia is mainly composed of Camellia sinensis (one of the three major beverages in the world), C. oleifera (an oil seed crop), and C. japonica with ornamental value. C. sinensis grows in acidic soil [14][15], where a certain amount of AMF communities are inhabited in their rhizosphere [16].

2. AMF Diversity in Rhizosphere of Camellia spp.

2.1. Morphological Identification

AMF diversity of Camellia spp. has been reported, based on morphological identification (**Table 1**). Tunstall [17] first identified arbuscular mycorrhizas from the roots of C. sinensis. In India, Singh et al. [18] conducted morphological identification of AMF diversity in “natural” and “cultivated” tea trees in Uttaranchal Himalaya and found 51 AMF species belonging to four genera, including Glomus, Gigaspora, Acaulospora and Scutellospora, of which 21 species were identified, with Glomus as the dominant genus. Gupta and Sharma [19] isolated six AMF species from four tea districts of Dehradun based on their morphology, and three identified AMF species belonged to Glomus. Sharma et al. [20] identified Acaulospora, Glomus, and Gigaspora in four tea plantations in Dehradun Himalaya (India), with the dominant genera being Glomus and Acaulospora. In China, Lu and Wu [21] identified 12 AMF species in tea plantations in the southern region of Henan province, belonging to Acaulospora, Glomus, Gigaspora, and Scutellospora, of which the dominant genera are Acaulospora and Glomus. Wu et al. [22] isolated 22 AMF species of three genera in the tea of Qingdao, including 13 species of Acaulospra, 8 species of Glomus and 1 species of Gigaspora, and the relative abundance of Glomus and Acaulospra was higher than that of other genera. In ten regions of Guizhou with five tree varieties, Xing et al. [23] identified 31 species of AMF belonging to four genera, including 18 species of Glomus, 9 species of Acaulospora, 3 species of Gigaspora and 1 species of Entrophospora, with the dominant genera Glomus and Acaulospora. Due to the large geographical difference between China and India, the growth environment of tea is quite different, but the dominant genera of AMF in tea in the two countries are similar, both of which are Glomus and Acaulospora. AMF community in C. oleifera was studied by Chinese scholars only. In Hunan province, Deng et al. [24] identified eight AMF species, belonging to Glomus, Acaulospora, and Scutellospora, with Glomus as the dominant genus.

Table 1. AMF diversity of Camellia plants.

Camellia Plants	Sampling Regions	Identification Method	Identified Genena of AMF	Dominant Genus of AMF	Reference
C. sinensis	Uttaranchal Himalaya (India)	Morphology	Acaulospora; Gigaspora; Glomus; Scutellospora	Glomus	[18]
	Dehradun District (India)	Morphology	Glomus	Glomus	[19]
	Dehradun Himalaya (India)	Morphology	Acaulospora; Glomus; Gigaspora	Acaulospora and Glomus	[20]
	Henan (China)	Morphology	Acaulospora; Gigaspora; Glomus; Scutellospora	Acaulospora and Glomus	[21]
	Qingdao (China)	Morphology	Acaulospra; Gigaspora; Glomus	Acaulospra and Glomus	[22]
	Guizhou (China)	Morphology	Acaulospora; Entrophospora; Gigaspora; Glomus	Acaulospra and Glomus	[23]
	Hunan (China)	Morphology	Acaulospora; Glomus; Scutellospora	Glomus	[24]
C. oleifera	Wuhan (China)	High-throughput sequencing of 18S rRNA gene	Acaulospora; Ambispora; Archaeospora; Claroideoglomus; Diversispora; Gigaspora; Glomus; Paraglomus; Redeckera; Scutellospora	Glomus	[25]
	Jiangxi (China)	High-throughput sequencing of 18S rRNA gene	Acaulospora; Ambispora; Archaeospora; Claroideoglomus; Diversispora; Geosiphon; Gigaspora; Glomus; Pacispora; Paraglomus; Scutellospora; Septoglomus	Glomus	[26]
	Guiyang (China)	High-throughput sequencing of 18S rRNA gene	Acaulospora; Archaeospora; Claroideoglomus; Diversispora; Glomus; Paraglomus	Glomus	[27]
C. japonica	Fanjing Mountain (China)	Morphology	Acaulospora; Funneliformis; Glomus; Pacispora; Scutellospora;	Glomus	[28]
	Chongqing (China)	Morphology	Acaulospora; Gigaspora; Glomus; Scutellospora	Acaulospora and Glomus	[29]
	Shimane prefecture (Japan)	High-throughput sequencing of 18S rRNA gene	Acaulospora; Ambispora; Archaeospora; Claroideoglomus; Diversispora; Funneliformis; Geosiphon; Gigaspora; Glomus; Paraglomus; Redeckera; Rhizophagus; Scutellospora	Glomus and Rhizophagus	[30]
	Diankwan Island (Korea)	High-throughput sequencing of 18S rRNA gene	Acaulospora; Ambispora; Claroideoglomus; Glomus; Rhizophagus; Scutellospora	Acaulospora and Rhizophagus	[31]

AMF population diversity of C. japonica was rarely reported, relative to C. sinensis and C. oleifera. A total of five genera and nine species of AMF were isolated from the rhizosphere of C. japonica forests in the Fanjing Mountains [28], including Acaulospora, Glomus, Scutellospora, Pacispora and Funneliformis, with the dominant genus being Glomus. He [29] conducted an AMF diversity study on the rhizosphere of C. japonica in Nanshan Botanical Garden, Chongqing, and found five species of Acaulospora, two species of Gigaspora, ten species of Glomus and one species of Scutellospora, with a total of four genera and 18 species, of which the dominant genera were Glomus and Acaulospora.

In short, a total of eight genera of Glomus, Gigaspora, Acaulospora, Scutellospora, Entrophospora, Sclerocystis, Pacispor and Funneliformis were found in the genus Camellia by morphological identification, with the dominant genera being Glomus and/or Acaulospora. The AMF resources of Camellia spp. are relatively abundant, but few genera of AMF were detected in these studies because the spore isolation of AMF is accidental. However, some studies have shown that AMF diversity in roots is relatively higher than in rhizosphere soil [25][32]. Morphological identification is inconsistent, limited, and contingent [33], which completely depends on the identifier's own knowledge and discrimination of AMF genera species [34].

2.2. Molecular Identification

Relative to morphological identification, molecular identification of AMF displayed different numbers of AMF species in the root and rhizosphere of C. oleifera. Liu et al. [25] analyzed the AMF community in roots and rhizosphere of C. oleifera grown in Wuhan (China) through high-throughput sequencing of 18S rRNA, and detected 411 and 351 OTUs of AMF, respectively, a total of 467 OTUs, belonging to 10 genera and 138 species, of which Glomus was dominant (>86%), and the rest Paraglomus, Claroidoglomus, Diversispora, Ambispora, Acaulospora, Archaeospora, Gigaspora, Redeckera and Scutellospora wer lower. In the rhizosphere of five cultivated varieties of C. oleifera in Jiangxi, Lin et al. [26] identified 2538 OTUs, based on high-throughput Illumina sequencing of 18S rRNA, belonging to 1 phylum, 1 class, 4 orders, 10 families and 12 genera, with Glomus as the dominant genus. Zhou et al. [27] found 58 OTUs of AMF in the rhizosphere of C. oleifera in Guiyang (China) through high-throughput Illumina sequencing of 18S rRNA, belonging to 42 species in 6 genera (Glomus, Archaeospora, Claroidoglomus, Acaulospora, Paraglomus, and Diverspora) with Glomus as the dominant genus (87.63%). In conclusion, the dominant genus of C. oleifera is still Glomus.

South Korean and Japanese researchers also sequenced the AMF community of C. japonica, and found more than 10 genera and more than 100 kinds of AMF. Berruti et al. [30] observed a total of 254 OTUs in C. japonica in Shimane (Japan), and the AMF diversity of the root (216 OTUs) was greater than that of the soil (125 OTUs), which was similar to the result of Liu et al. [25] in C. oleifera. Through the comparison of OTU sequences, the 254 OTUs were classified into 1 phyla, 1 class, 4 orders, 9 families, 13 genera (Rhizophagus, Glomus, Paraglomus, Scutellospora, Gigaspora, Claroidoglomus, Funeliformis, Diversipora, Acaulospora, Redeckera,Ambispora, Archaeospora, and Geosiphon), and the dominant genera were Rhizophagus and Glomus. Lee et al.[31] sampled the rhizosphere of C. japonica in Dian Guan Island, South Korea, isolated 248 spores of AMF, and conducted high-throughput sequencing of 18S rRNA to obtain 11 species of AMF belonging to 6 genera, of which Acaulospora (49.60%) and Rhizophagus (31.29%) were the dominant genera, followed by Glomus (12.03%), Scutellospora (4.09%), Claroidoglomus (2.39%) and Ambispora (0.58%). The dominant AMF genera of C. japonica in Japan and South Korea are different, which may be caused by environmental factors, implying that AMF diversity shows regional distribution characteristics.

Based on molecular identification, Glomus, Paraglomus, Gigaspora, Archaeospora, Acaulospora, Ambispora, Scutellospora, Diversispora, Pacispora, Geosiphon, Septoglomus, Claroideoglomus, Rhizophagus, Funneliformis, and Redeckera were found in Camellia, and the detected AMF resources were more abundant than the morphological identification. The dominant genus, Glomus, was detected from the root and rhizosphere soil of C. oleifera, which was consistent with morphological identification. The dominant genera detected from C. japonica were Rhizophagus, Glomus and Acaulospora, which were higher than the dominant genera (Glomus and Acaulospora) previously identified by morphology, because molecular identification was more comprehensive [35][36].

3. AMF Colonization of Camellia Plants and Its Influencing Factors

3.1. Root AMF Colonization of Camellia Plants

AMF can colonize the roots of plants to form intraradical hyphae, which are denser and finer than the root [37]. Thus, mycorrhizal hyphae help host plants absorb more nutrients than non-mycorrhizal plants. Singh et al. [18] observed that AMF colonization in natural and planted tea plantations in India could be as high as 97.33% and 98.13% during the dormant stage. However, Morita and Konishi [38] observed an AMF colonization rate of only 17% in tea trees, and Gao et al. [39] revealed 7.01% of root mycorrhizal colonization rate in tea trees under open field, indicating relatively low root colonization. In Himalayas of India, AMF colonization (**Figure 1**a) was 62.29%, 55.68%, 33.10% and 63.36% in tea trees in four different areas [20]. In southern Henan (China), tea trees recorded 66.07% of root mycorrhizal colonization [21]. These results suggest that the root of the tea tree could be colonized by indigenous AMF. In tea, arbuscules are arum-type, and mycelium in roots is rare [39]. Interestingly, arbuscules are digested by the host cells and then changed into spongy structures [39]. Vesicles are sac-like structures formed by the apical expansion of the intraradical mycelium, mostly oval (64–80 × 112–128 μm), but also spherical in the shape [40]. When the cortex of the root is shed, the vesicles may also enter the soil with the root tissue and become a new infester and dormant spores.

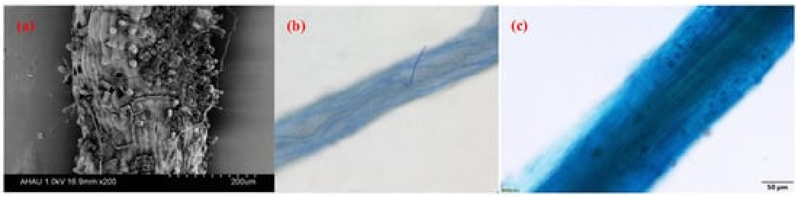

Figure 1. Root mycorrhizal colonization of Camellia spp. (**a**) mycorrhizal colonization in roots of Camellia sinensis; (**b**) mycorrhizal colonization in roots of C. oleifera; (**c**) mycorrhizal colonization in roots of C. japonica. These figures were derived from unpublished data by the authors.

However, AMF colonization (**Figure 1**b) in C. oleifera is relatively low, with 30.73–41.68% of AMF colonization in Wuhan (China) [25], which was close to the 20–42% of root colonization observed by Lin et al. [26] in Jiangxi (China). Mejstrik [41] found root mycorrhizal colonization of C. japonica in New Zealand, coupled with typical vesicles and arbuscules (**Figure 1**c). Later Borriello et al. [42] in Piedmont (Italy) observed 14.12%, 32.55%, and 9.92% of root AMF colonization in three regions. In short, Camellia spp. is colonized by indigenous AMF thus forming a symbiosis, but the degree of AMF colonization varies.

3.2. Factors Affecting AMF Colonization

3.2.1. Seasonal Variations

AMF diversity of plants varies with seasonal climate [43][44]. Sharma et al. [20] studied AMF colonization of tea plants in annual dynamic change and found that AMF colonization rates of tea trees varied drastically with seasonal changes, with the highest AMF infestation rates occurring in summer (rainy season). Their results were consistent with those of Chandra et al. [45], who observed that AMF activity in the soil was highest in summer, along with the highest spore numbers and colonization rates [46]. Similarly, Singh et al. [18] also pointed out seasonal changes in root AMF colonization of tea plants, followed by the highest colonization in summer.

3.2.2. Soil Factors

Root AMF colonization can be affected by levels of mineral elements in the soil [47]. The colonization rate of AMF on tea trees decreased significantly with the increase of soluble P application [48]. Soil pH value significantly affected the AMF community of tea trees, because most AMF species prefer to inhabit slightly acidic soils [49]. Among five soil factors (pH, hydrolytic N, Olsen-P, available K and organic matter), the root AMF rate of tea trees was significantly more influenced by soil organic matter content than by available K and Olsen-P [39]. In C. oleifera, root AMF colonization was significantly and positively correlated with soil ammonium nitrogen and available potassium, but negatively correlated with soil pH value [25]. In C. japonica, soil mineral elements like N, P, K, and Mg are associated with root mycorrhizal development [30][43]. The excess of soil mineral elements such as N and P negatively affects the growth of mycorrhizal mycelium [50], and soil pH value is even more directly affecting AMF diversity [35]. Thus, soil physico-chemical properties strongly affect AMF colonization in Camellia plants [28].

References

1. Yang, L.; Zou, Y.N.; Tian, Z.H.; Wu, Q.S.; Kuča, K. Effects of beneficial endophytic fungal inoculants on plant growth and nutrient absorption of trifoliate orange seedlings. Sci. Hortic. 2021, 277, 109815.
2. Meng, L.L.; He, J.D.; Zou, Y.N.; Wu, Q.S.; Kuča, K. Mycorrhiza-released glomalin-related soil protein fractions contribute to soil total nitrogen in trifoliate orange. Plant Soil Environ. 2020, 66, 183–189.
3. Wu, Q.S.; Gao, W.Q.; Srivastava, A.K.; Zhang, F.; Zou, Y.N. Nutrient acquisition and fruit quality of Ponkan mandarin in response to AMF inoculation. Ind. J. Agric. Sci. 2020, 90, 1563–1567.
4. Zou, Y.N.; Zhang, F.; Srivastava, A.K.; Wu, Q.S.; Kuča, K. Arbuscular mycorrhizal fungi regulate polyamine homeostasis in roots of trifoliate orange for improved adaptation to soil moisture deficit stress. Front. Plant Sci. 2021, 11, 600792.
5. Eid, K.E.; Abbas, M.H.H.; Mekawi, E.M.; ElNagar, M.M.; Abdelhafez, A.A.; Amin, B.H.; Mohamed, I.; Ali, M.B. Arbuscular mycorrhiza and environmentally biochemicals enhance the nutritional status of Helianthus tuberosus and induce its resistance against Sclerotium rolfsii. Ecotox. Environ. Saf. 2019, 186, 109783.
6. Karthikeyan, A.; Muthukumar, T.; Udaiyan, K. Response of tea (Camellia sinensis (L). Kuntze) to arbuscular mycorrhizal fungi under plantation nursery conditions. Biol. Agric. Hortic. 2005, 22, 305–319.
7. Zhang, F.; Zou, Y.N.; Wu, Q.S. Quantitative estimation of water uptake by mycorrhizal extraradical hyphae in citrus under drought stress. Sci. Hortic. 2018, 229, 132–136.
8. Wu, Q.S.; Srivastava, A.K.; Zou, Y.N. AMF-induced tolerant to drought stress in citrus: A review. Sci. Hortic. 2013, 164, 77–87.
9. González-Chávez, M.C.; Carrillo-González, R.; Wright, S.F.; Nichols, K.A. The role of glomalin, a protein produced by arbuscular mycorrhizal fungi, in sequestering potentially toxic elements. Environ. Pollut. 2004, 130, 317–323.
10. Cornejo, P.; Meier, S.; Borie, G.; Rillig, M.C.; Borie, F. Glomalin related soil protein in a Mediterranean ecosystem affected by a copper smelter and its contribution to Cu and Zn sequestration. Sci. Total Environ. 2008, 406, 154–160.
11. He, J.D.; Chi, G.G.; Zou, Y.N.; Shu, B.; Wu, Q.S.; Srivastava, A.K.; Kuča, K. Contribution of glomalin-related soil proteins to soil organic carbon in trifoliate orange. Appl. Soil Ecol. 2020, 154, 103592.
12. Cheng, H.Q.; Giri, B.; Wu, Q.S.; Zou, Y.N.; Kuča, K. Arbuscular mycorrhizal fungi mitigate drought stress in citrus by modulating root microenvironment. Arch. Agron. Soil Sci. 2021.
13. Luo, C.Q.; Tan, X.F.; Ling, L.L. A Classification summary on plant of genus Camellia. J. Cent. South For. Univ. 1999, 19, 78–81.
14. Mondal, T.K.; Bhattacharya, A.; Laxikumaran, M.; Ahuja, P.S. Recent advance of tea (Camellia sinensis) biotechnology. Plant Cell Tiss. Org. 2004, 76, 195–254.
15. Singh, S.; Pandey, A.; Kumar, B.; Palni, L.M.S. Enhancement in growth and quality parameters of tea through inoculation with arbuscular mycorrhizal fungi in an acid soil. Biol. Fert. Soils 2010, 46, 427–433.
16. Lin, X.G.; Hao, W.Y. Mycorrhizal dependency of various kind of plants. Acta Bot. Sin. 1989, 31, 721–725.
17. Tunstall, A.C. Mycorrhiza in tea plants. Quart. J. Indian Tea Assoc. Indian 1926, 159.

18. Singh, S.; Pandey, A.; Chaurasia, B.; Palni, L.M.S. Diversity of arbuscular mycorrhizal fungi associated with the rhizosphere of tea growing in ‘natural’ and ‘cultivated’ ecosites. Biol. Fert. Soils 2008, 44, 491–500.

19. Gupta, R.K.; Sharma, C. Diversity of arbuscular mycorrhizal fungi in Camellia sinensis in Uttarakhand State, India. Afr. J. Biotechnol. 2013, 9, 5313–5319.

20. Sharma, C.; Gupta, R.K.; Pathak, R.K.; Choudhary, K.K. Seasonal colonization of arbuscular mycorrhiza fungi in the roots of Camellia sinensis (tea) in different tea gardens of India. ISRN Biodivers. 2015, 2013, 593086.

21. Lu, D.S.; Wu, X.Q. Species of VAM fungi around tea roots in the southern area of Henan province. J. Nanjing For. Univ. 2005, 29, 33–36.

22. Wu, L.S.; Wang, Y.; Li, M.; Liu, R.J.; Ding, Z.T. A survey of arbuscular mycorrhizal fungi in the rhizosphere of Camellia sinensis in Laoshan. J. Qingdao Agric. Univ. 2009, 26, 171–173.

23. Xing, D.; Zhang, A.M.; Li, Z.; Chen, J.; Wang, Z.X.; Tu, Y.Y.; Gao, X.B. Resources and morphological characteristics of arbuscular mycorrhiza fungi around tea rhizosphere in Guizhou. Guizhou Agric. Sci. 2015, 43, 102–106.

24. Deng, X.J.; Zhou, G.Y.; Liu, J.A.; Li, L.; Bu, T.T. Diversity and community structure of arbuscular mycorrhizal fungi in Camellia oleifera stands in Hunan. J. Cent. South Univ. For. Tech. 2011, 31, 38–42.

25. Liu, R.C.; Xiao, Z.Y.; Hashem, A.; Abd_Allah, E.F.; Wu, Q.S. Mycorrhizal fungal diversity and its relationship with soil properties in Camellia oleifera. Agriculture 2021, 11, 470.

26. Lin, Y.L.; Li, Z.Y.; Wu, F.; Pei, Y.; Zhang, Y.; Zhang, L.P.; Yang, T.; Tan, M.X. Community structure characteristics of arbuscular mycorrhizal fungi among Camellia oleifera cultivars. For. Res. 2020, 33, 163–169.

27. Zhou, G.R.; Shang, K.; Jiang, L. Diversity survey of AM fungi in rhizosphere soil of wild Camellia oleifera. J. Guizhou Univ. 2019, 36, 26–31.

28. Yuan, T.; Tao, G.Y.; Jiang, L. Arbuscular mycorrhizal fungi in the rhizospheric soil of four forest types in Fanjingshan national nature reserve. J. Northeast For. Univ. 2018, 46, 83–86.

29. He, W. AM Fungi Diversity in the Main Ornamental Gardens of Chongqing Nanshan Botanical Park. Master’s Thesis, Southwest University, Chongqing, China, 2009.

30. Berruti, A.; Demasi, S.; Lumini, E.; Kobayashi, N.; Bianciotto, V.; Bianciotto, V. Wild Camellia japonica specimens in the Shimane prefecture (Japan) host previously undescribed AMF diversity. Appl. Soil Ecol. 2017, 115, 10–18.

31. Lee, E.H.; Ka, K.H.; Eom, A.H. Diversity of arbuscular mycorrhizal fungi in rhizospheres of Camellia japonica and neighboring plants inhabiting Wando of Korea. Korean J. Mycol. 2014, 42, 34–39.

32. Wu, Q.S.; Srivastava, A.K. AMF diversity in citrus rhizosphere. Ind. J. Agric. Sci. 2017, 87, 653–659.

33. Gai, J.P.; Feng, G.; Li, X.L. Review of researches on biodiversity of arbusculay mycorrhizal fungi. Soils 2005, 37, 236–242.

34. Yang, C.X.; Li, L.L. Research progress in arbuscular mycorrhizal fungi identification method application. Guizhou Agric. Sci. 2014, 42, 93–97.

35. Guo, X.H.; Gong, J. Differential effects of abiotic factors and host plant traits on diversity and community composition of root-colonizing arbuscular mycorrhizal fungi in a salt-stressed ecosystem. Mycorrhiza 2014, 24, 79–94.

36. Yang, F.; Cao, J.M.; Chen, Y.Y.; Wang, J.L. Research progress on structure and identification method of arbusular mycorrhizal fungi. Mod. Agric. Sci. Tech. 2019, 17, 152–154+157.

37. Smith, S.E.; Smith, F.A. Roles of arbuscular mycorrhizas in plant nutrition and growth: New paradigms from cellular to ecosystem scales. Annu. Rev. Plant Biol. 2011, 62, 227–250.

38. Morita, A.; Konishi, S. Relationship between vesicular-arbuscular mycorrhizal infection and soil phosphorus concentration in tea fields. Soil Sci. Plant Nutr. 1989, 35, 139–143.

39. Gao, X.B.; Chen, J.; Zhao, J.F.; Li, Z.; Guo, C.; Zhou, F.Y.; Wang, Z.X.; Tu, Y.Y.; Zhou, Y.F. Colonization characteristics of arbuscular mycorrhiza fungi in rhizosphere of local tea trees in Guizhou. Southwest China J. Agric. Sci. 2016, 29, 1328–1335.

40. Ren, M.X.; Luo, Y.P. Advances in the study of VA mycorrhizae of tea trees. J. Tea 2005, 31, 28–31.

41. Mejstrik, V. The frequency of vesicular-arbuscular mycorrhizae in the roots of Camellia japonica L. from different sites in New Zealand. Pac. Sci. 1974, 28, 73–77.

42. Borriello, R.; Berruti, A.; Lumini, E.; Beffa, M.T.D.; Scariot, V.; Bianciotto, V. Edaphic factors trigger diverse AM fungal communities associated to exotic camellias in closely located Lake Maggiore (Italy) sites. Mycorrhiza 2015, 25, 253–265.

43. Bencherif, K.; Boutekrabt, A.; Dalpé, Y.; Sahraoui, A.L.H. Soil and seasons affect arbuscular mycorrhizal fungi associated with Tamarix rhizosphere in arid and semi-arid steppes. Appl. Soil Ecol. 2016, 107, 182–190.
44. Varela-Cervero, S.; López-García, A.; Barea, J.M.; Azcón-Aguilar, C. Spring to autumn changes in the arbuscular mycorrhizal fungal community composition in the different propagule types associated to a Mediterranean shrubland. Plant Soil 2016, 408, 1–14.
45. Chandra, K.K.; Jamaluddin, A. Seasonal variation of VAM fungi in tree species planted in coalmine overbunden of Kusmunda (MP). J. Trop. For. 1998, 14, 118–123.
46. Gould, A.B.; Hendrix, J.W.; Ferriss, R.S. Relationship of mycorrhizal activity to time following reclamation of surface mine land in western Kentucky. I. Propagule and spore population densities. Can. J. Bot. 1996, 74, 247–261.
47. Liang, S.M.; Zheng, F.L.; Abd_Allah, E.F.; Muthuramalingam, P.; Wu, Q.S.; Hashem, A. Spatial changes of arbuscular mycorrhizal fungi in peach and their correlation with soil properties. Soudi J. Biol. Sci. 2021.
48. Lin, Z. Effect of VA mycorrhizal species on tea tree growth and absorption of mineral elements. J. Tea Sci. 1993, 13, 15–20.
49. Pandey, A.; Palni, L.M.S. Bacillus species: The dominant bacteria of the rhizosphere of established tea bushes. Microbiol. Res. 1997, 152, 359–365.
50. Avio, L.; Castaldini, M.; Fabiani, A.; Bedini, S.; Sbrana, C.; Turrini, A.; Giovannetti, M. Impact of nitrogen fertilization and soil tillage on arbuscular mycorrhizal fungal communities in a Mediterranean agroecosystem. Soil Biol. Biochem. 2013, 67, 285–294.