Original Article
Food Science and Technology

ISSN 0101-2061 (Print)
ISSN 1678-457X (Online)

DOI: https://doi.org/10.1590/fst.103622

Effects of hairy vetch cultivation on soil quality and productivity in Chinese orchards: a meta-analysis

Xueting MA[1,2], Jiean LIAO[1,2*], Jinfei ZHAO[1,2], Linqiao XI[3*]

Abstract

To find out the effects of hairy vetch cultivation on soil quality and productivity in Chinese orchards, all relevant papers in China National Knowledge Infrastructure (CNKI) published from 2000 to 2021 were collected to quantitatively analyze the effects of hairy vetch cultivation in orchards on soil physicochemical properties and nutrient content, soil enzyme activity, microbial activity, fruit yield and quality based on meta-analysis. The results showed that the effect sizes of hairy vetch cultivation on soil quality and productivity changed in a positive direction, but part of the effect sizes did not change significantly. This paper provides some support and reference for the development of grass cultivation in orchards.

Keywords: grass cultivation in orchards; hairy vetch cultivation; a meta-analysis; soil quality; productivity.

Practical Application: Effects of hairy vetch cultivation on soil quality and productivity in orchards.

1 Introduction

The management of orchard production is closely related to the development of the fruit industry. In recent years, the grass cultivation in orchards model has gradually emerged, which marks the beginning of the orchard industry's modern management. After the grass cultivation in the orchards, the soil-atmosphere contact mode of the traditional clean tillage orchard is transformed into a new soil-grass-atmosphere mode (Wei et al., 2021a; Xiao et al., 2022). The temperature and humidity of the fruit trees have been significantly adjusted, thereby improving the absorption and utilization of water and fertilizer (Wu et al., 2021). Grass cultivation can also increase the content of soil organic carbon (SOC) in the topsoil and the abundance of microbial communities in orchards, contributing to the improvement of the soil environment (Zheng et al., 2021). The increase in the number of microorganisms promotes the decomposition of grass residues and secretions, and the interpenetration of grassroots helps to solve the problems of soil compaction and fertility decline (Li et al., 2022b). A large number of studies have shown that grass cultivation in orchards management plays an important role in improving orchard soil nutrient content (Wang et al., 2021), fruit quality (Wei et al., 2021b), soil enzyme activity (Luo et al., 2021) and soil microbial content (Wan & He, 2021).

Artificial grass cultivation and natural grass cultivation are the main modes at present. Among them, artificial grass cultivation has the advantage of easy control and is widely used (Yang et al., 2022). At present, some advanced fruit-producing countries such as the United States, Japan, and France all adopt the grass cultivation model, while China still focuses on clean tillage (Li et al., 2022c). The grass cultivation model in China is still in the stage of application in a small area. The land area of China is large, and the soil quality and climate are different in different regions. A comprehensive assessment of the effects of grass cultivation in orchards on local soil nutrient content in Xinjiang, China, has not yet been reported. Therefore, based on the meta-analysis method, this paper studies the effects of the grass cultivation of hairy vetch on soil physical and chemical properties, soil nutrients, soil activity, and fruit quality in the orchards, and provides a certain reference for the implementation and further development of this model.

2 Materials and methods

2.1 Data collection

Through the China National Knowledge Infrastructure (CNKI, China), using the subject search in the advanced search mode, enter the keywords "orchard" and "hairy vetch" to conduct a literature search. The papers were screened according to the following conditions:

(1) The paper is a field trial conducted in China, and is not a review paper; (2) The paper includes the study on the effects of hairy vetch on at least one of soil temperature, water content, bulk density, pH value, organic matter, alkali hydrolyzable nitrogen, available phosphorus, available potassium, sucrase, catalase, urease, bacteria, fungi, actinomycetes, yield per plant, weight per fruit, soluble solids and soluble sugar. (3) In this paper, the clean tillage management model was used as the control group, and the grass cultivation model (hairy vetch)

Received 12 Oct., 2022
Accepted 02 Dec., 2022
[1] *College of Mechanical and Electrical Engineering, Tarim University, Alar, China*
[2] *Modern Agricultural Engineering Key Laboratory at Universities of Education Department of Xinjiang Uygur Autonomous Region, Tarim University, Alar, China*
[3] *College of Animal Science, Tarim University, Alar, China*
*Corresponding author: jiean107@163.com; gsxlq666@163.com

was used as the experimental group. After screening, a total of 17 papers were eligible.

2.2 Analysis methods

In this study, Excel software was used to classify the valid data from the papers. If the standard deviation *SD* in the paper was missing, 1/10 of the value of the experimental group and the control group were taken as the standard deviation according to the Andreas Gattingera method (Yan et al., 2021; Feng et al., 2021). If the 95% confidence interval (CI) of a set of data does not coincide with the 0 line, it is considered that the treatment has a significant effect on the target variable; if the interval is on the left side of the 0 line, there is a negative effect; if the interval is on the right side of the 0 line, there is a positive effect (Cai et al., 2020; Saigre-Tardif et al., 2022). The preliminary data extraction and screening were done in Excel software, and the forest plot and correlation analysis were done in GraphPad Prism software.

To make the results of the various studies comparable, the effect size of each independent study was calculated in the meta-analysis. In this study, the logarithm of the response ratio (*RR*) was used as the effect size to measure the effect of hairy vetch on the soil quality and productivity of the orchard. The effect size was calculated by Equation 1 (Wang et al., 2022; Zhang et al., 2022).

$$E = \ln RR = \ln\left(\frac{X_t}{X_c}\right) = \ln X_t - \ln X_c \quad (1)$$

In the formula, X_t and X_c are the average values of the study items in the experimental group and the control group, respectively. If $E > 0$, hairy vetch cultivation in orchards has a positive effect on the study items; if $E = 0$, hairy vetch cultivation in orchards has no effect on the study items; if $E < 0$, hairy vetch cultivation in orchards has a negative effect on the study items. Assuming that X_t and X_c are normally distributed, and $X_c \neq 0$, then ln*RR* is also normally distributed, and the variance was calculated by Equation 2 (Melo et al., 2022; O'Dea et al., 2021):

$$V_{\ln R} = \frac{S_t^2}{N_t X_t^2} + \frac{S_c^2}{N_c X_c^2} \quad (2)$$

In the formula, S_t, S_c, X_t, X_c, N_t, and N_c are the standard deviation, mean, and sample size of the treatment group and the control group, respectively.

There are two hypothetical models in meta-analysis: the fixed-effects model and the random-effects model. The fixed-effects model assumes that all studies have only one true combined effect size, and random sampling will result in different actual measured effect sizes; random-effects models assume that true effect sizes differ between studies and that there is an inherent random component in the variation in effect size, independent of sampling error (Chen et al., 2021; Namin et al., 2022). The orchard experiments included in this study came from different regions, different experimental years, different fruit trees, different soil qualities, etc. All independent studies cannot share a combined effect size. To improve the result accuracy, a random effect model was used to calculate the effect size. In the collected papers, some data are represented in the form of images, and the images can be digitized with the help of GetData software (Najafi et al., 2022). If the data provided in the paper is the standard error (*SE*), the standard deviation (*SD*) can be calculated by Equation 3 (Avci et al., 2022; Ma et al., 2022).

$$SD = SE\sqrt{n} \quad (3)$$

3 Results and analysis

3.1 The effects of hairy vetch cultivation on soil physicochemical properties

Compared with clean tillage treatment in orchards, the effects of hairy vetch cultivation on soil physicochemical properties based on 192 samples about soil physicochemical properties were shown in Figure 1. The effect size of hairy vetch cultivation on soil water content was 0.3838, and the 95% CI was (0.3622, 0.4055), which was on the right side of the 0 line as a whole, indicating that it had a positive effect on the soil moisture content. The effect size of hairy vetch cultivation on soil pH is -0.0637, and the 95% CI was (-0.1218, -0.0057), which was on the left side of the 0 line as a whole, indicating that it had a mitigating effect on acidic soil. The effect size of hairy vetch cultivation on soil bulk density was -0.0375, indicating that it could alleviate the problem of soil compaction in orchards, which is beneficial to the growth of fruit tree roots and the improvement of microbial activity, but the effect is insignificant. The effect size of hairy vetch cultivation on soil temperature was 0.1784, and the 95% CI was (0.0927, 0.2640), which was on the right side of the 0 line as a whole, indicating that it had a warming effect on the orchard soil.

After hairy vetch cultivation in orchards, abundant plant residues or secretions can be produced, which has a good regulating effect on soil acid and alkali (Xie et al., 2022). Compared with the clean tillage treatment, the hairy vetch cultivation treatment enhanced the soil water storage capacity, and the grass mulching could slow down the water evaporation rate (Tang et al., 2022). The grass reduces the light intensity on the surface, slows down the transfer of heat to the deep soil, improves the heat condition of the soil, and plays a role in stabilizing the ground temperature (Hu et al., 2022).

Since most of the paper temperatures used for meta-analysis were obtained in autumn, and some experiments were conducted

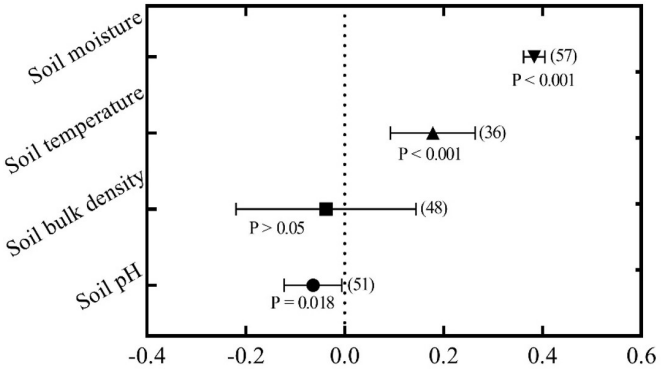

Figure 1. The effects of hairy vetch cultivation on soil physicochemical properties.

on the ground after the grass was mowed, which was equivalent to covering the soil surface with a layer of "quilt", the temperature after grass cultivation was grown to some extent. In addition, the root-piercing effect of grass and plant residues or exudates are conducive to the formation of good soil structure and improving soil bulk density, which is the basis for high-quality and high-yield fruit trees. At the same time, soil bulk density status can reflect soil water storage status. Soil bulk density decreased and porosity increased after grass cultivation, and with the increase of grass cultivation years, soil physical properties improved more significantly, and soil water holding capacity could be greatly improved.

3.2 The effects of hairy vetch cultivation on soil nutrients

Compared with clean tillage treatment in orchards, the effects of hairy vetch cultivation on soil nutrients based on 313 samples about soil nutrients were shown in Figure 2. The effect size of hairy vetch cultivation on soil organic matter was 0.2099, and the 95% CI was (0.1414, 0.2784), which was on the right side of the 0 line as a whole, indicating that it had a positive effect on the organic matter content. The effect sizes of hairy vetch cultivation on soil alkali-hydrolyzable nitrogen, available phosphorus, and available potassium were 0.2359, 0.1895, and 0.179, respectively, and the 95% CI were (0.1293, 0.3424), (0.0898, 0.2891), and (0.0951, 0.2629) respectively, which were all on the right side of the 0 line, indicating that hairy vetch cultivation in orchards could significantly increase the content of soil nitrogen, phosphorus and potassium ($P < 0.05$).

Hairy vetch cultivation in orchards can increase soil nutrient content (organic matter, alkali-hydrolyzed nitrogen, available phosphorus, and available potassium). Among them, organic matter enrichment is one of the important indicators for evaluating the soil fertility level. Compared with clean tillage, grass cultivation can increase the content of humus in the soil, thereby increasing the content of soil organic matter. After the organic matter decomposes, the dispersed soil particles can be cemented with each other, which helps to form more aggregate structures and reduce soil bulk density. In addition, hairy vetch cultivation can improve soil microbial activity, so that insoluble nutrients in the soil can be converted into fast-acting or easily soluble nutrients. Therefore, hairy vetch cultivation has the function of activating organic nitrogen, phosphorus and potassium, which can improve the actual supply capacity of nitrogen, phosphorus and potassium in the soil (Zheng et al., 2021), and is conducive to the absorption and utilization of nitrogen, phosphorus and potassium nutrients by fruit trees.

3.3 The effects of hairy vetch cultivation on soil activity

Compared with the clean tillage treatment in orchards, the effects of hairy vetch cultivation on the soil activity based on 54 samples about soil activity were shown in Figure 3. The effect sizes of hairy vetch cultivation on soil invertase, soil catalase and soil urease were 0.2377, 0.1059 and 0.0296 respectively, and the 95% CI were (0.1217, 0.3536), (-0.0188, 0.2307), (-0.0688, 0.1280), indicating that the soil enzyme activity could be increased after hairy vetch cultivation in the orchard, and the effect on the soil sucrase activity was significant ($P < 0.05$).

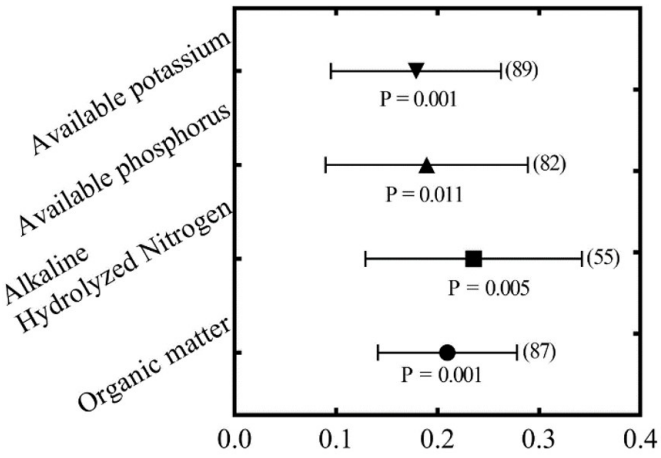

Figure 2. The effects of hairy vetch cultivation on soil nutrients.

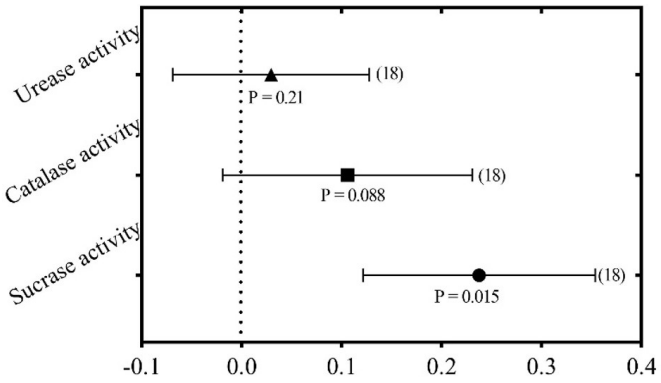

Figure 3. The effects of hairy vetch cultivation on soil activity.

Generally, soil fertility and invertase activity and catalase activity are positively correlated with soil organic matter content and the number of microorganisms. The increase in the activities of these two enzymes can reflect the increase in soil fertility and the richness of microbial communities. Ammonia, the catalyzed product of urease, is one of the nitrogen sources for plants, and the increased activity of this enzyme can reduce the amount of nitrogen fertilizer used to a certain extent.

Soil enzymes are mainly derived from the metabolic process of soil microorganisms, and can also be produced by the decomposition of animal and plant residues, which are catalysts in the soil (Du et al., 2021). Various biochemical reactions in the soil are completed with the participation of various corresponding enzymes. The enzyme activity is closely related to the areas where animals, plant residues and microorganisms are densely concentrated in the soil. The level of enzyme activity directly affects the recycling and transformation of nitrogen, phosphorus, potassium and organic matter (Li et al., 2022a). After hairy vetch cultivation, the organic matter content of the soil increases, the nutrients available to microorganisms are abundant, and the number of microorganisms increases, thereby the enzyme content and activity are increased.

3.4 The effects of hairy vetch cultivation on soil microorganisms

Compared with the clean tillage treatment in orchards, the effects of hairy vetch cultivation on the soil microorganisms based on 54 samples about soil microorganisms were shown in Figure 4. The effect sizes of hairy vetch cultivation on bacteria, fungi and actinomycetes in soil were 0.2707, 0.5516 and 0.5828, respectively, and the 95% CI were (0.0636, 0.4778), (-0.2480, 1.3512) and (-0.0924, 1.2580), respectively, indicating that the number of soil microorganisms could be increased after hairy vetch cultivation in orchards, and the effect on the number of bacteria in the soil was significant ($P < 0.05$).

Soil microorganisms participate in the decomposition of organic matter and the synthesis of humus, which have a benign effect on the development and formation of ideal soil structure, material circulation and fertility evolution (Xue et al., 2022). Certain microorganisms can also play a role in nitrogen fixation, converting nitrogen in the air into solid nitrogen in the soil for fruit trees to absorb.

The possible reason is that the root system can produce a large number of exudates during the growth of hairy vetch in the orchards, and stems and leaves of hairy vetch cover the surface of the soil and gradually decompose after they die. A large amount of decomposing matter provides nutrients for the growth of microorganisms and promotes the reproduction of microorganisms.

3.5 The effects of hairy vetch cultivation on fruit yield and quality

Compared with the clean tillage treatment in orchards, the effects of hairy vetch cultivation on the fruit yield and quality based on 48 samples about fruit yield and quality were shown in Figure 5. The effect sizes of hairy vetch cultivation on fruit soluble sugar, soluble solids, single fruit weight, and single plant yield were 0.1421, 0.0478, 0.2474, and 0.4043, respectively, and the 95% CI were (-0.0894, 0.3737), (-0.0411, 0.1368), (0.1103, 0.3846) and (-0.0911, 0.8997), respectively, indicating that the fruit yield and quality could be improved after hairy vetch cultivation in orchards, and the effect on single fruit weight was significant ($P < 0.05$).

The optimization of soil physicochemical properties and the improvement of nutrient supply can promote the growth of fruit tree roots, improve the metabolic function of the tree body, and promote the absorption of nutrients and water by fruit trees. The improvement of soil enzymes and microbial activities can promote the decomposition of twigs and secretions of hairy vetch, promote the production of humus, and then help to improve soil nutrients, and ultimately increase fruit yield and quality. However, due to the single study of the effect of hairy vetch, the overall sample size found is small, and it is difficult to classify some subgroups to explore its laws in more detail, such as the effect of hairy vetch on nutrients and physicochemical properties of different soil depths, and the effect on different fruit tree species. We should continue to accumulate relevant papers over time.

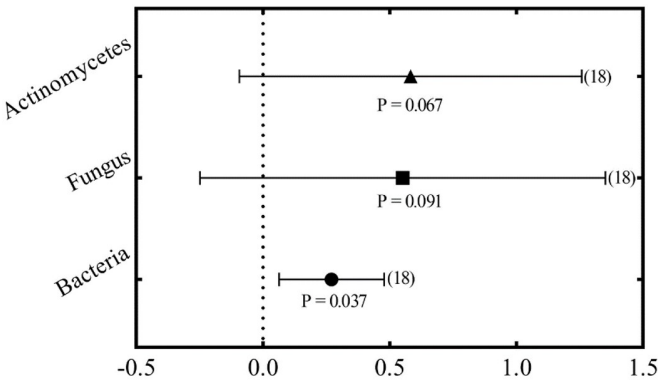

Figure 4. The effects of hairy vetch cultivation on soil microorganisms.

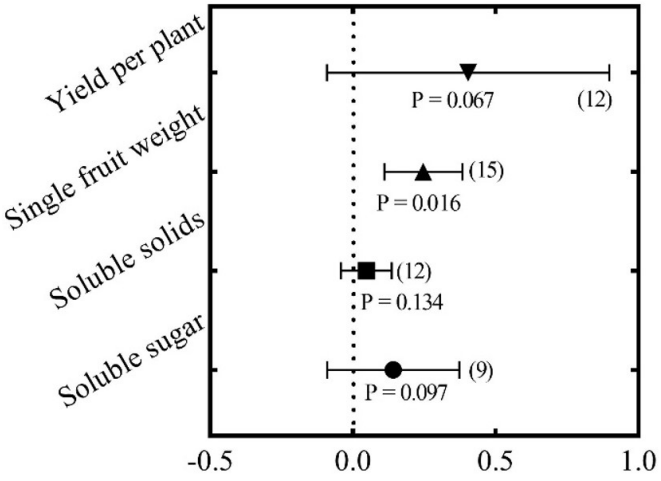

Figure 5. The effects of hairy vetch cultivation on fruit yield and quality.

4 Conclusion

Based on a meta-analysis, the effects of hairy vetch cultivation in the orchards on orchard ecology and productivity from 2000 to 2021 in CNKI were studied in this paper. It showed that hairy vetch cultivation in the orchards is conducive to the improvement of soil physicochemical properties, soil enzyme activity and microbial activity, which can improve fruit quality and yield. However, some results also showed that the effects of hairy vetch cultivation on some indicators is not obvious, which may be related to the small sample size and the different geographical environment. This provides a certain reference for future research directions.

Conflict of interest

The authors declare no conflict of interest.

Funding

This study was supported by the China Agriculture Research System of MOF and MARA (CARS-22), Bingtuan Science and Technology Program (2021CB022), the Finance Science and Technology Project of Alar City (2021NY07), the Key neighborhood

Science and Technology Project of Xinjiang Construction Corps (2018AB037), President's Foundation Innovation Research Team Project of Tarim University (TDZKCX202203) and the Finance Science and Technology Project of Alar City (2022NY13).

Acknowledgements

We would like to thank and acknowledge the support of Dr. Zhijiang Li at Tarim University in discussions and suggestions regarding the structure of this paper.

References

Avci, Y. D., Gözüm, S., & Karadag, E. (2022). Effect of telehealth interventions on blood pressure control: a meta-analysis. *Computers, Informatics, Nursing*, 40(6), 402-410. http://dx.doi.org/10.1097/CIN.0000000000000852. PMid:35120370.

Cai, T., Tang, S., Zheng, B., Guangming, W., Ji, W., Qian, C., Wang, Z., Li, E., & Chen, H. (2020). Ultrawideband chromatic aberration-free meta-mirrors. *Advanced Photonics*, 3(1), 016001. http://dx.doi.org/10.1117/1.AP.3.1.016001.

Chen, L. J., Jia, F., Li, T. Y., & Zhang, T. Y. (2021). Supply chain leadership and firm performance: a meta-analysis. *International Journal of Production Economics*, 235, 108082. http://dx.doi.org/10.1016/j.ijpe.2021.108082.

Du, J., Hou, F., & Zhou, Q. (2021). Response of soil enzyme activity and soil bacterial community to PCB dissipation across different soils. *Chemosphere*, 283, 131229. http://dx.doi.org/10.1016/j.chemosphere.2021.131229. PMid:34146884.

Feng, G. C., Su, X. L., Lin, Z. L., He, Y. R., Luo, N., & Zhang, Y. T. (2021). Determinants of technology acceptance: two model-based meta-analytic reviews. *Journalism & Mass Communication Quarterly*, 98(1), 83-104. http://dx.doi.org/10.1177/1077699020952400.

Hu, J. G., Bai, S. J., Zhao, R. H., Chen, G., & Cai, J. S. (2022). Effects of black geotextile mulch and grass mulch on the microclimate, fruit quality and anthocyanin components of 'Xinyu' table grape. *New Zealand Journal of Crop and Horticultural Science*, 1-18. Online. http://dx.doi.org/10.1080/01140671.2022.2108066.

Li, T., Wang, Y., Kamran, M., Chen, X., Tan, H., & Long, M. (2022a). Effects of grass inter-planting on soil nutrients, enzyme activity, and bacterial community diversity in an apple orchard. *Frontiers in Plant Science*, 13, 901143. http://dx.doi.org/10.3389/fpls.2022.901143. PMid:35837455.

Li, X. L., Yue, H. Y., Chu, Y. N., Jia, Y. H., & Tian, J. W. (2022b). The planting of licorice increased soil microbial diversity and affected the growth and development of apple trees. *Communications in Soil Science and Plant Analysis*, 53(9), 1113-1125. http://dx.doi.org/10.1080/00103624.2022.2043342.

Li, X., Chu, Y., Jia, Y., Yue, H., Han, Z., & Wang, Y. (2022c). Changes to bacterial communities and soil metabolites in an apple orchard as a legacy effect of different intercropping plants and soil management practices. *Frontiers in Microbiology*, 13, 956840. http://dx.doi.org/10.3389/fmicb.2022.956840. PMid:36003931.

Luo, J., Xu, M., Liu, C. L., Wei, S. S., & Tang, H. (2021). Effects comparation of different mulching methods on soil in pitaya orchards. *International Agrophysics*, 35(3), 269-278. http://dx.doi.org/10.31545/intagr/142845.

Ma, J. G., Zhang, B., Zhang, S. L., Guan, Z. H., Sun, B., & Chang, X. J. (2022). Association between XPD Lys751Gln polymorphism and esophageal cancer susceptibility in China: a meta-analysis based on 12 case-control studies. *Food Science and Technology*, 42, e39820. http://dx.doi.org/10.1590/fst.39820.

Melo, R. G., Duarte, G. S., Lopes, A., Alves, M., Caldeira, D., Fernandes, R. F., & Pedro, L. M. (2022). Incidence and prevalence of thoracic aortic aneurysms: a systematic review and meta-analysis of population-based studies. *Seminars in Thoracic and Cardiovascular Surgery*, 34(1), 1-16. http://dx.doi.org/10.1053/j.semtcvs.2021.02.029. PMid:33705940.

Najafi, A., Mohammadi, I., Sadeghi, M., Bruhl, A. B., Sadeghi-Bahmani, D., & Brand, S. (2022). Evaluation of plasma/serum adiponectin (an anti-inflammatory factor) levels in adult patients with obstructive sleep apnea syndrome: a systematic review and meta-analysis. *Life*, 12(5), 738. http://dx.doi.org/10.3390/life12050738. PMid:35629405.

Namin, B. H., Ogaard, T., & Roislien, J. (2022). Workplace incivility and turnover intention in organizations: a meta-analytic review. *International Journal of Environmental Research and Public Health*, 19(1), 25. http://dx.doi.org/10.3390/ijerph19010025. PMid:35010292.

O'Dea, R. E., Lagisz, M., Jennions, M. D., Koricheva, J., Noble, D. W. A., Parker, T. H., Gurevitch, J., Page, M. J., Stewart, G., Moher, D., & Nakagawa, S. (2021). Preferred reporting items for systematic reviews and meta-analyses in ecology and evolutionary biology: a PRISMA extension. *Biological Reviews of the Cambridge Philosophical Society*, 96(5), 1695-1722. http://dx.doi.org/10.1111/brv.12721. PMid:33960637.

Saigre-Tardif, C., Faqiri, R., Zhao, H. T., Li, L. L., & Hougne, P. (2022). Intelligent meta-imagers: from compressed to learned sensing. *Applied Physics Reviews*, 9(1), 011314. http://dx.doi.org/10.1063/5.0076022.

Tang, W. Z., Yang, H. S., Wang, W. E., Wang, C. X., Pang, Y. Y., Chen, D. Y., & Hu, X. T. (2022). Effects of living grass mulch on soil properties and assessment of soil quality in chinese apple orchards: a meta-analysis. *Agronomy*, 12(8), 1974. http://dx.doi.org/10.3390/agronomy12081974.

Wan, P., & He, R. R. (2021). Short-term effects of cover grass on soil microbial communities in an apple orchard on the Loess Plateau. *Forests*, 12(12), 1787. http://dx.doi.org/10.3390/f12121787.

Wang, Y. X., Wang, L., Guo, J., Wang, Z. Y., & Hua, S. C. (2022). The efficacy and safety of endostar combined gemcitabine and cisplatin in the treatment of non-small cell lung cancer: a meta-analysis. *Food Science and Technology*, 42, e40720. http://dx.doi.org/10.1590/fst.40720.

Wang, Y., Huang, Q., Gao, H., Zhang, R., Yang, L., Guo, Y., Li, H., Awasthi, M., & Li, G. (2021). Long-term cover crops improved soil phosphorus availability in a rain-fed apple orchard. *Chemosphere*, 275, 130093. http://dx.doi.org/10.1016/j.chemosphere.2021.130093. PMid:33652274.

Wei, C. B., Qiao, J., Ma, Z. L., Ma, H. Y., Tang, X. M., Zhao, W. F., Yan, Q. Z., Tang, L. Z., & Du, L. Q. (2021a). Stylo grass affecting soil respiration in latosol guava orchard of southern subtropical region of China. *Agronomy Journal*, 113(2), 721-733. http://dx.doi.org/10.1002/agj2.20437.

Wei, Z. Y., Zeng, Q. C., & Tan, W. F. (2021b). Cover cropping impacts soil microbial communities and functions in mango orchards. *Agriculture*, 11(4), 343. http://dx.doi.org/10.3390/agriculture11040343.

Wu, Y., Wang, X., Hu, R., Zhao, J., & Jiang, Y. (2021). Responses of soil microbial traits to ground cover in citrus orchards in Central China. *Microorganisms*, 9(12), 2507. http://dx.doi.org/10.3390/microorganisms9122507. PMid:34946109.

Xiao, L. T., Lai, S., Chen, M. L., Long, X. Y., Fu, X. Q., & Yang, H. L. (2022). Effects of grass cultivation on soil arbuscular mycorrhizal fungi community in a tangerine orchard. *Rhizosphere*, 24, 100583. http://dx.doi.org/10.1016/j.rhisph.2022.100583.

Xie, B., Chen, Y. H., Cheng, C. A., Ma, R. P., Zhao, D. Y., Li, Z., Li, Y. Q., An, X. H., & Yang, X. Z. (2022). Long-term soil management practices influence the rhizosphere microbial community structure and bacterial function of hilly apple orchard soil. *Applied Soil Ecology*, 180, 104627. http://dx.doi.org/10.1016/j.apsoil.2022.104627.

Xue, B., Yu, J. J., Zhang, J. C., Hao, F. K., Zhang, X. M., Dong, J. H., Sun, J., & Xue, J. (2022). Microbial diversity analysis of vineyard son the eastern foothills of the Helan Mountain region using high-throughput sequencing. *Food Science and Technology*, 42, e66320. http://dx.doi.org/10.1590/fst.66320.

Yan, L. P., Luo, W. J., Xiao, X. H., Luo, T. W., & Liu, H. (2021). A meta-analysis: association between Beta-2 adrenergic receptor Arg16Gly polymorphism and asthma in China. *Food Science and Technology*, 41(3), 564-569. http://dx.doi.org/10.1590/fst.18520.

Yang, J., Duan, Y., Wu, X., Tian, Y., Yang, L., Zhang, Y., Liu, Z., Awasthi, M. K., & Li, H. (2022). Long-term grass mulching waste recycling and evaluation activation of dissolved organic carbon. *Chemosphere*, 287(Pt 4), 132454. http://dx.doi.org/10.1016/j.chemosphere.2021.132454. PMid:34610376.

Zhang, K. L., Zhuo, H. L., Guo, J. Y., Li, D. L., & Dai, R. Z. (2022). Paraoxonase 1-L55M polymorphism and coronary heart disease risk in the Chinese population: evidence from a meta-analysis. *Food Science and Technology*, 42, e56721. http://dx.doi.org/10.1590/fst.56721.

Zheng, J. Y., Zhao, J. S., Shi, Z. H., & Wang, L. (2021). Soil aggregates are key factors that regulate erosion-related carbon loss in citrus orchards of southern China: bare land vs. grass-covered land. *Agriculture, Ecosystems & Environment*, 309, 107254. http://dx.doi.org/10.1016/j.agee.2020.107254.