Effects of Formulated Fertilization on Soil Physical and Chemical Characteristics of Early Ripe Peach Orchard

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Abstract. The effects of formulated fertilization on the soil physical and chemical characteristics of early ripe peach orchard were studied in Shanquan Town, Longquanyi District, Chengdu City, Sichuan Province of China. Base fertilizer of organic fertilizer is 600 kg/667m², urea is 12-20 kg/667m², monoamine phosphate is 24 kg/667m², superphosphate is 80 kg/667m², potassium sulfate is 56 kg/667m²; germination fertilizer application borax is 6 kg/667m², urea is 10 kg/667m²; hard-core fertilizer compound fertilizer 40 kg/667m², potassium sulfate 20 kg/667m² increased the soil organic matter content by 64.04%-98.95%, soil total phosphorus and available phosphorus by 22.43%-29.52%, 52.38%-75.16%, total potassium and available potassium by 21.71%-31.11%, 19.4%-39.59%, exchangeable calcium by 31.76%-35.36%, and exchangeable magnesium by 2.24%-5.88%, respectively, compared with the control. By formulated fertilization, fertilizer application decreased by 23.53%-28.24%.

1. Introduction
Through soil testing and formula fertilization according to local conditions, practically improve people blind fertilization for quantitative fertilization, reverse single fertilization for organic fertilizer based, nitrogen, phosphorus, potassium, boron, calcium, magnesium and other combined application, thereby changing soil acidification. The status quo of salinization, compaction and soil nutrient imbalance, improve the quality of fruit safety, regulate soil physical and chemical properties and balance soil nutrients [1-2]. At present, formula fertilization studies have been carried out on cherries, grapes, etc. [3-5], which have improved fruit quality such as single fruit weight, soluble solids, and significantly improved soil organic matter content and soil acidity and alkalinity, and other physical and chemical properties of the soil. In recent years, some researchers have also explored the study of balanced soil fertilization of peaches [6], which confirmed the important role of formula fertilization in the cultivation of peaches.

This study aim at rationally formulating a formula for fertilization in Longquanyi District, Chengdu City, Sichuan Province, where the standards of abuse of fertilizers were not uniform and the fertilization period was not standardized. Study the combination of organic fertilizer and inorganic fertilizer, increase the application of organic fertilizer, reduce the effect of chemical fertilizer on the physical and chemical properties of peach orchard soil, and reduce the application rate of chemical fertilizer by 20%-30% through chemical fertilizer reduction.
2. Materials and methods

2.1 Materials
The tested variety was 5-year-old 'Beijing 2' peach with consistent growth and robust growth. Its cultivar characteristics are large fruit, good coloration, high hardness, storage and transportation, and the mature fruit hangs the tree for about 10 days to maintain the same quality. Pre-harvest fruit drop phenomenon [7]. Using open field cultivation, the planting density of 667 m$^2$ was 40.

The test site is located in Shanquan Town, Longquanyi District, Chengdu. It is a subtropical humid climate. The landform is mainly shallow hills. It is affected by the Longquan Mountains and forms an independent microclimate area. The climate is mild and humid throughout the year, with four distinct seasons and abundant rainfall [8]. The average annual precipitation is 895.6 mm, the annual average pressure is 956.4 hpa (hundreds of pascals), the annual average relative humidity is 81%, the average annual sunshine hours are 1032.9h, the annual average wind speed is 1m/s, and the wind direction is mostly north. The wind is 46% and the annual average frost-free period is 297 days.

Basic physical and chemical properties of the soil at the test site: The soil in the test site is a limestone sandstone deposit. Organic matter content 23.15 g/kg, pH 6.34, total nitrogen content 1.05 g/kg, available nitrogen content 122.4 mg/kg, total phosphorus 495 mg/kg, available phosphorus content 16.20 mg/kg, total potassium content 24.73 mg/kg. The available potassium content is 72.73 mg/kg, the exchangeable calcium content is 419 mg/kg, and the exchangeable magnesium content is 147 mg/kg.

Test fertilizer: urea (N content 46%), organic fertilizer (main ingredient is dried chicken manure), potassium sulfate (K$_2$O content 50%), monoammonium phosphate (P$_2$O$_5$ content 46%, N content 12%), superphosphate (P$_2$O$_5$ content 12%).

2.2 Experimental design
The experiment controlled the yield of 1500-2000 kg/667m$^2$. The base fertilizer was applied from the end of September to the beginning of October. According to the previous study of the research group, urea was 0.3, 0.4, 0.5kg/plant, and potassium sulfate was 1.3, 1.4 and 1.5 kg/plant. There is a total of 9 levels are combined. The local conventional fertilization is used as a control, and a total of 10 treatments are used. The other fertilizers were applied in the same amount, that is 15 kg/plant of organic fertilizer, 0.6 kg/sodium phosphate, and 2 kg/strain of superphosphate; the sprouting fertilizer was 10-15 days before flowering (from the end of February to the beginning of March), urea is applied according to 0.25 kg/plant and borax 0.15 kg/plant; pre-harvest fertilizer is applied 15 days before harvest (from the end of May to the beginning of June), and the compound fertilizer is applied together with potassium sulfate. The local conventional fertilization applied 2.50 kg/plant of compound fertilizer in the sprouting fertilizer and pre-harvesting fertilizer, and the base fertilizer was applied with organic fertilizer 5.00 kg/plant +compound fertilizer 3.00 kg/plant +urea 0.5 kg/plant. Compared with local conventional fertilization, it increased the application of organic fertilizer by 400kg/667 m$^2$ and the reduction of chemical fertilizer by 80-96 kg/667 m$^2$.

When the fruit matured, removal of ground vegetation and soil cover, 5 soil samples in each treatment, and soil at 40 cm from the trunk of the main distribution of peach roots, with a depth of 0 to 30 cm; unfertilized organic fertilizer, 1.0 kg of soil samples were selected for soil nutrient determination. The soil pH value was determined by portable pH meter, the soil organic matter content was determined by potassium dichromate-sulfuric acid method, the total nitrogen content of soil was determined by Kjeldahl method, and the soil was determined by antibiotic method using sodium bicarbonate leaching method. Available phosphorus, soil available potassium was determined by ammonium leaching-flame photometer method, and exchangeable calcium and magnesium was determined by by EDTA-acetic acid ammonium salt exchange method [9-10].
2.3 Statistical analysis
Statistical analysis was conducted using SPSS 18.0 statistical software. Data analysis by one-way ANOVA with least significant difference at 5% confidence level.

3. Results and discussion
Through the application of organic fertilizer 15 kg in autumn, the soil organic matter content of each treatment during fertilization was higher than that of the control, and the organic matter content could be increased by 64.04% to 98.95% (P < 0.05, Table 1), treatment 6 had the best effect which reached 30.32 g/kg. Therefore, it is necessary to add organic matter to the soil after fruit picking every year to maintain the balance of organic matter.

By formulated fertilization, the pH value of each treatment after pick was stable at 6.33-6.40, and the formula fertilized soil was higher than the conventional fertilization in the control period. The pH value is mainly regulated by the balance of organic matter and mineral nutrition. However, due to the fertilization and management problems of the control, the pH value is reduced from 6.34 to 5.96, and the soil is acidified. Without balanced fertilization, soil acidification will gradually occur. Therefore, it is necessary to strengthen the regulation of organic matter and mineral nutrient balance.

The nitrogen content of the control was significantly higher than the individual treatments. Alkaline nitrogen was at a relatively high level after fruit picking, and the highest content of alkaline nitrogen in treatment was 163.00 mg/kg. The alkaline nitrogen content of the control was 172.52 mg/kg, which was significantly different from the treatment and background values. The soil alkaline nitrogen content in the control soil is higher, which is related to the excessive application of nitrogen in conventional production, and the application of nitrogen fertilizer should be reduced.

The content of total phosphorus and available phosphorus in each treatment after formula fertilization was higher than that in the control (Table 1), and the total phosphorus content was increased by 22.43% -29.52% compared with the control. The effect of treatment 9 was the best; the treatment of available phosphorus content was the best, compared with the control. Increased by 52.38 -75.16%. The amount of phosphorus applied in conventional production is slightly less, and the total phosphorus is lower than the background value during the whole growth period, which is related to the premature application of phosphate fertilizer in local fertilization management.

Table 1. Effect of formulated fertilization on physical and chemical characteristics of peach orchard

| Treatments | Organic matter (g/kg) | pH Value | Total N (g/kg) | Available N (mg/kg) | Total P mg/kg | Available P (mg/kg) | Total K (mg/kg) | Available K (mg/kg) | Exchangeable Ca (mg/kg) | Exchangeable Mg (mg/kg) |
|------------|-----------------------|----------|---------------|---------------------|---------------|---------------------|-----------------|---------------------|------------------------|------------------------|
| CK         | 15.24g                | 5.96c    | 1.98a         | 172.52a             | 437h          | 14.49g              | 23.40d          | 81.24f              | 322.36f                | 114.65e                |
| 1          | 29.61b                | 6.40a    | 1.28f         | 145.40f             | 554b          | 23.19e              | 28.48h          | 97.00ef             | 429.82c                | 119.30b                |
| 2          | 28.90c                | 6.37ab   | 1.39d         | 156.90d             | 547c          | 24.28c              | 28.58g          | 96.00e              | 425.36e                | 120.97a                |
| 3          | 25.00f                | 6.38ab   | 1.47bc        | 162.40b             | 546cd         | 25.08b              | 28.51h          | 98.00e              | 424.74e                | 117.10d                |
| 4          | 26.50d                | 6.35ab   | 1.28f         | 146.00f             | 554b          | 25.38a              | 29.94d          | 102.00d             | 436.36a                | 118.90bc               |
| 5          | 25.91e                | 6.33ab   | 1.38d         | 157.00d             | 544b          | 25.08b              | 29.56e          | 103.00c             | 427.37d                | 121.00a                |
| 6          | 30.32a                | 6.33ab   | 1.46c         | 162.00b             | 535f          | 23.27d              | 29.35f          | 104.00c             | 432.36b                | 118.10cd               |
| 7          | 29.90ab               | 6.34ab   | 1.28f         | 147.80e             | 545e          | 22.08g              | 30.68a          | 110.00b             | 429.36c                | 119.20bc               |
| 8          | 29.40bc               | 6.33ab   | 1.35e         | 158.70c             | 555b          | 23.22de             | 30.32c          | 112.20a             | 432.36b                | 121.40a                |
| 9          | 29.91ab               | 6.34ab   | 1.48b         | 163.00b             | 566a          | 23.08f              | 30.82b          | 113.40a             | 432.26b                | 117.20d                |

The lowercase letters in the table indicate the difference in the same column data at the 0.05 level.

Increasing the application of potassium fertilizer can significantly improve fruit yield and quality [11]. The total potassium and available potassium content of each treatment were higher than the control (Table 1), and the total potassium content of treatment 9 was the highest, which was 30.82 g/kg. It was 31.11% higher than the control (P < 0.05). The available potassium content of each treatment was higher than the control (Table 1), the highest available potassium content was 93.4
mg/kg, which was higher than the control (39.59 %, \( P < 0.05 \)). The available potassium has the highest content after fruit picking, and the formula fertilization can increase the content and utilization of potassium in the soil.

The exchangeable calcium was significantly higher in the treatment than the control (Table 1), which was increased by 31.76% to 35.36% (\( P < 0.05 \)). Treatment 4 had the highest exchangeable calcium of 436.36 mg/kg. The content of exchangeable magnesium in the soil was significantly higher than control, which increased 1.68%-5.88%, and the magnesium content gradually decreased with time, indicating that the content of water-soluble magnesium in the soil can be effectively improved by applying magnesium sulfate.

4. Conclusions
Base fertilizer of organic fertilizer is 600 kg/667m², urea is 12-20 kg/667m², monoamine phosphate is 24 kg/667m², superphosphate is 80 kg/667m², potassium sulfate is 56 kg/667m²; germination fertilizer application borax is 6 kg/667m², urea is 10 kg/667m²; hard-core fertilizer compound fertilizer is 40 kg/667m², potassium sulfate is 20 kg/667m² increased the soil organic matter content by 64.04%-98.95%, soil total phosphorus and available phosphorus by 22.43%-29.52%, 52.38%-75.16%, total potassium and available potassium by 21.71%-31.11%, 19.4%-39.59%, exchangeable calcium by 31.76%-35.36%, and exchangeable magnesium by 2.24%-5.88%, respectively, compared with the control. By formulated fertilization, fertilizer application decreased by 23.53%-28.24%.

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References
[1] Huang, A.Z. (2019) Effect of soil testing and formula fertilization on agricultural production and income increase. Farm Staff, 1: 36-36.
[2] Li, F.C. (2019) Soil fertilizer problems and countermeasures in agricultural sustainable development. Agricultural Development and Equipment, 2: 57-57.
[3] Pan, F., Huang, S.P., Liang, L.B., Lv, X.L., Wang, J., Qi, X., Lin, L.J., Liang, D., Xia, H. (2018) Effects of formulated fertilization on fruit quality and soil physical and chemical properties of sweet cherry in Aba Prefecture. South China Fruit, 47: 97-100.
[4] Qiao, X.Y. (2016) Effects of different potassium application rates on nutritional status and fruit quality of peach trees. Northwest A & F University.
[5] Shi, P.L., Ma, X.L., Wang, J., Liang, D., Lv, X.L. (2016) Effects of soil testing and formula fertilization on soil physical and chemical properties and fruit quality of ‘Jufeng’ vineyard. Sino-Overseas Grapesvine & Wine, 5: 21-24, 29.
[6] Luo, Q.H., Tang, D.Y., Cao, Q.L., Liang, D. (2017) Effects of formulated fertilization on soil physicochemical properties and fruit quality of ‘Ball Peach’. Northern Horticulture, 22: 113-119.
[7] Lv, Z.W. (2009) Introduction performance and cultivation techniques of ‘Beijing 2’ peach. China Fruit Industry Information, 26: 50-50.
[8] Lin, M., Feng, L.Y., Li, Y.F., Zhang, J., Ye, Q. (2018) Promoting the Quality Improvement and Efficiency of rural tourism in Longquanyi District of Chengdu—taking Shanquan Town as an example. Journal of the Party School of Chengdu Municipal Committee of the Communist Party of China, 4: 80-84.
[9] Huang, X.T., Liu, L.Q. (2009) Food Chemistry and Analysis Comprehensive Experiment (2nd Edition). Beijing: China Agricultural University Press.
[10] Hu, H.R., Tian, K. (2012) Soil Science Experiment Guide. Beijing: China Forestry Publishing House.
[11] Zhao, L. (2015) Fertilization characteristics of peach trees and scientific fertilization techniques. Northwest Horticulture (Fruit Tree), 4: 38-40.