Effects of Different Fertilization Methods on Growth and Fruit Quality of 'Aiganshui' Pear Tree

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Abstract. The choice of fertilization method was very important for improving fertilizer utilization and reducing the loss of fertilizer in pear production applications. The experiment material was 'Aiganshui' pear tree. In this experiment, the pear cultivar 'Aigan Water' was used as a test material. Three treatments were set up in the trial, such as the application of ordinary compound fertilizers, ordinary slow-release fertilizers and bag-controlled slow release fertilizers. Each process sets 4 repetitions. The results show that there was no significant effect of bag-controlled slow-release fertilizer on the morphological index of fruit quality. However, slow-release fertilizers in intrinsic quality increase the Vc content of fruits compared to ordinary compound fertilizers. And slow-release fertilizers increase the soluble solids content and the nutritional value of the fruit. The ratio of sugar to acid in the bag-controlled slow-release fertilizer was significantly increased, the flavor of the fruit was improved, the taste was better, and the cost of fertilizer for the 'Aiganshui' pear tree was decreased.

1. Introduction

Pear is one of the most important fruits in the world. The fruit tastes sweet and tastes good. The pear tree variety ‘Aiganshui’ was introduced from abroad in 2001. It was bred by longevity and Tama cross. The species has a strong sprouting ability and a moderate branching force. The budding period is in early March. The flowering period is from late March to early April. The fruit is ripe in the middle or late June. The fruit was oblate, with a vertical and horizontal diameter of about 5.4-7.5cm, an average fruit weight of 250g, more than 12% of soluble solids, about 9.12% of soluble sugar, 0.924% of titratable acid, and 3.207mg/100g of Vc [1-3]. The ‘Aiganshui’ pear was born with oyster buds. The second year can be used as a long fruit branch. The ‘Aiganshui’ pear has high yield and excellent quality [4].

Fertilization is an important agricultural technology measure for increasing pear production. Because of the frequent application of traditional fertilization methods, the loss of fertilizer efficiency is rapid. Not only does it cause waste of fertilizer, it also causes the soil to be hardened due to excessive fertilization. The loss of nitrogen is particularly serious. It not only caused direct economic losses, but also caused environmental pollution in some areas due to improper fertilization [5]. This study used ‘Aiganshui’ pear as a research object. Improve the utilization of fertilizers on the premise of improving the quality of fruits. In order to reduce the loss of fertilizers in fruit production applications and fertilizer application for the purpose of harm to the soil. Explore the role of new fertilizer bag controlled-release fertilizer in the application of fertilizers. The aim is to reduce the loss...
of fertilizer efficiency caused by excessive fertilization and the harm to the soil. Therefore, the production cost of fertilizer application is reduced. It provides a new direction and theoretical basis for fertility management of ‘Aiganshui’.

2. Materials and Methods

2.1 Test materials and utensils
The test materials were selected from mature trees that were grown robustly, free of pests and diseases, and had the same growth trend. They were three-year old grafted ‘Aiganshui’ pears. The light is suitable and well managed. Its area is about 100 acres. The place is cultivated in the open air. The plant spacing is 3×3m. The pear tree was grafted and survived with Pyrus betulaefolia as the rootstock and ‘Aiganshui’ for the scion.

2.2 experiment method.
This experiment sets 3 treatments. Respectively, ordinary compound fertilizers, ordinary slow-release fertilizers and bag-controlled slow-release fertilizers were applied to pear trees. The test was conducted using a completely random method. The experiment set a total of 12 pears in 4 replicates. On March 12, the pear trees were fertilized. The fertilization method used for common compound fertilizers is the ring ditch method. The common compound fertilizer and bag-controlled slow-release fertilizer are fertilized by digging a hole about 10cm deep at 25cm around the trunk. The fertilizer is buried in the pit and covered with soil. The amount of fertilizer used was judged to be 300g per plant based on production experience. The bag-controlled slow-release fertilizers are 15cm in length and 10cm in width, and have approximately 500 micropores on both sides. The diameter of the micropores is about 2mm. The fertilization period was carried out on March 12 and the length and thickness of new shoots were measured on the same day. From April to June, the growth and thickening of shoots were measured once a month. When selecting new shoots, each tree was selected to grow five robust fruiting branches and five fruiting shoots in the periphery of fruit trees. After the fruits matured in July, their intrinsic and external qualities were determined. When the fruit was picked, each tree was selected to grow normally outside the fruit trees, and there were 10 fruit without pests and diseases. Based on the results of analysis, the effect of bag-controlled slow-release fertilizers on the fertility of 'Aiganshui' pear trees was analyzed.

2.3 Data Processing and Analysis
The test data was analyzed using Excel 2010 and DPS v7.05 data software.

3. Results and Analysis

3.1 Effects of Different Fertilization Methods on the Growth of Aiganshui

| Table 1: Effects of Different Fertilization Methods on Shoot Growth. |
|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
|                         | April                   | May                     | June                    |                         |                         |
|                         | Increment /cm          | Thickness /cm           | Increment /cm          | Thickness /cm           | Increment /cm          | Thickness /cm           |
| Ordinary compound      | 9.96±0.15 a            | 0.024±0.00 b            | 15.31±0.28 a           | 0.037±0.00 b            | 15.74±0.35 a           | 0.043±0.00 a            |
| compound fertilizer    |                         |                         |                         |                         |                         |                         |
| Ordinary slow release  | 9.34±0.12 b            | 0.027±0.00 b            | 14.95±0.23 b           | 0.039±0.00 a            | 15.13±0.32 b           | 0.040±0.00 a            |
| release fertilizer     |                         |                         |                         |                         |                         |                         |
| Bag controlled         | 8.75±0.10 c            | 0.032±0.00 a            | 14.87±0.22 b           | 0.041±0.00 a            | 15.05±0.28 b           | 0.041±0.00 a            |
| release fertilizer     |                         |                         |                         |                         |                         |                         |
Note: The letters with the same letter in each column indicate that the difference is not significant (P>0.05), and those with different letters indicate that the difference is significant (P<0.05). The same applies below.

As shown in Table 1, the growth rate of shoots with common compound fertilizer was the largest, and there was a significant difference between ordinary slow-release fertilizer and bag controlled slow release fertilizer. There was no significant difference in shoot growth between ordinary slow-release fertilizers and bag-controlled slow release fertilizers. This shows that the use of bag controlled-release fertilizer to a certain extent inhibited the growth of shoots of 'Aiganshui' pears, but the application of bag-controlled slow-release fertilizers was longer than that of ordinary compound fertilizers. This greatly reduces the consumption of nutrients in pear trees. The order of the increase in the thickness of shoots from large to small is: bag controlled slow release fertilizer> ordinary slow release fertilizer> ordinary compound fertilizer. The use of bag-controlled slow-release fertilizers for pear stalk growth is more robust and more conducive to increasing the bearing capacity of the twigs on the fruit.

3.2 Effect of Different Fertilization Methods on the External Quality of Aiganshui

| Table 2. Effect of Different Fertilization Methods on Fruit External Quality. |
|---------------------------------------------------------------|
| **Single fruit weight (g)** | **hardness (N/cm²)** | **Horizontal path (cm)** | **Vertical (cm)** | **Fruit shape index (%)** |
| Ordinary compound fertilizer | 150.40±9.73 a | 6.32±0.07 a | 6.83±0.28 a | 5.54±0.30 a | 0.81±0.01 a |
| Ordinary slow release fertilizer | 154.31±8.61 a | 5.04±0.34 a | 6.92±0.12 a | 5.58±0.09 a | 0.80±0.01 a |
| Bag controlled release fertilizer | 155.50±5.07 a | 5.58±0.22 b | 6.60±0.31 a | 5.57±0.06 a | 0.80±0.04 a |

As shown in Table 2, the effects of different fertilization methods on the external quality indicators of fruits were not significantly different. The fruit weights of the three different fertilization methods were not significantly different, and they were all nearly 150g. There is no significant difference in the general fruit weight of the fruits of ‘Aiganshui’. There was no significant difference in the hardness of the bag-controlled slow-release fertilizers and the ordinary sustained-release fruits, but they were significantly lower than those of ordinary compound fertilizers. Because the 'Aiganshui' pear with slow-release fertilizer is more abundant, the hardness is significantly lower than that of ordinary compound fertilizer. The vertical and horizontal diameters of the three different fertilization methods were between 5.5 and 7.0 cm. The fruit shape index was between 0.8 and 0.9. The fruit shape is round or nearly round. The difference in the three treatments was not significant.

3.3 Effects of Different Fertilization Methods on the Inherent Quality of Aiganshui

| Table 3. Effect of Different Fertilization Methods on Intrinsic Quality of Fruit. |
|----------------------------------|
| **Vc (mg/100ml)** | **TSS (%)** | **sugar (g/100mL)** | **TA (g/100mL)** | **Sugar/TA** |
| Ordinary compound fertilizer | 2.37±0.09 b | 11.83±0.03 b | 10.56±0.32 b | 0.91±0.01 ab | 13.00±0.18 b |
| Ordinary slow release fertilizer | 2.97±0.24 a | 11.50±0.05 b | 9.35±0.18 c | 0.97±0.01 a | 11.86±0.21 b |
| Bag controlled release fertilizer | 2.86±0.04 a | 12.30±0.05 a | 11.10±0.31 a | 0.91±0.01 b | 13.52±0.32 a |

As shown in Table 3, different fertilization methods had a greater impact on the intrinsic quality of Aiganshui. The content of Vc in fruits with bag controlled-release slow-release fertilizer and ordinary slow-release fertilizer was significantly higher than that with ordinary compound fertilizer, but there
was no significant difference in the Vc content between ordinary slow-release fertilizer and bag-controlled slow release fertilizer. For soluble solids, there were significant differences in soluble solids and sugar content in different fertilization methods. The soluble solids and sugar content of the bag controlled release fertilizer was significantly higher than that of the ordinary compound fertilizer and ordinary slow release fertilizer. The application of bag controlled-release fertilizer has lower acid content than that of ordinary compound fertilizer and ordinary slow-release fertilizer. Therefore, the sugar-acid ratio of bag-controlled slow-release fertilizer is obviously higher than that of ordinary compound fertilizer and ordinary slow-release fertilizer. The application of the bag controlled release fertilizer has better fruit flavor.

4. Conclusion
The application of controlled-release slow-release fertilizers for bags not only satisfies the demand of tree growth results, but also avoids the vigorous growth of nutrients. Branches and long branches are more beneficial to fruit enlargement. Increased growth makes the tree grow more robust [6]. The test results on fruit trees such as apple, peach, and jujube showed that the use of fertilizer bag controlled-release technology can maintain the stability of soil available nutrient concentration [7]. The use of fertilizer bag controlled-release technology has significantly increased production and quality. It is the research direction of healthy fertilization of fruit trees in China.

In terms of fruit appearance quality, the difference between different fertilization methods was not significant except for hardness. There was no significant difference in the fruit shape index between the three treatments. They all ranged from 0.8 to 0.9 and they were round or nearly round. The difference in fruit firmness between ordinary compound fertilizer and bag controlled release fertilizer was significant. Because the application of slow-release fertilizer would make the fruit juice content higher than other. There was also no significant difference between the single fruit weights. This shows that the application of bag-controlled slow release fertilizer has no significant effect on the external quality of ‘Aiganshui’ pear fruit shape and weight. However, in terms of the intrinsic quality index of fruits, the application of controlled-release slow-release fertilizers is very different from that of ordinary compound fertilizers. Bag-controlled slow-release fertilizers increase the vitamin content of fruits compared to ordinary compound fertilizers. It increases the nutritional value of the fruit. Moreover, the soluble solids content and the sugar-acid ratio of the bag controlled-release fertilizer were significantly increased, which enhanced the flavor of the fruit and made it taste better.

In summary, the bag-controlled slow-release fertilizer reduces the fertilizer utilization rate and reduces the loss of fertilizer in the production of fruit trees on the premise of prolonged growth of pear trees and improvement of fruit quality. There is indeed a significant role in improving the consumption of fruit and economic value. The results of this study can provide the experimental basis for the production and application of ‘Aiganshui’ pears, and provide new directions for fertilization. The experimental results can solve the problem of large fertilizer loss and serious loss of fertilizer efficiency to some extent.

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