Effects of Different Formula Fertilization on Fruit Quality of 'Fenghuang plum'

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Abstract. In this experiment, the 5-year-old 'Fenghuang plum' is used as experimental material to study the effects of different formula fertilization on the quality of 'Fenghuang plum'. The result shows that the effect of treatment 2 (Pre-flowering fertilizer: The amount of NPK use per plant is 265 g, 205 g, 217 g; Top dressing: The amount of NPK use per plant is 64 g, 60 g, 150 g; Fertilization treatment is carried out once 25 days and 51 days after flowering) is better than that of the control. Among them, the fruit weight, soluble solids, sugar-acid ratio and vitamin C increase by 5.87%, 6.71%, 25.57%, 44.09% and the titratable acid content decrease by 24.64%. Therefore, treating 'Fenghuang plum' with treatment 2 can effectively improve the internal quality, and can be promoted in the cultivation area.

1. Introduction

Plum is a kind of Rosaceae plant. Plum is characterized by a wide variety, very high yield and adaptability [1], there is about 3,000 years of cultivation history in China [2]. China plum cultivation is widely distributed, but very scattered. Among them, Hunan, Zhejiang, Sichuan, Xinjiang and other places are more cultivated [3]. The fruit is ripe, sweet and sour, nutritious and contains a variety of vitamins and trace element in July-August. It's fresh fruit contains of sugar 7-17 g · 100 mL^{-1}、Acid content 0.16-3 g · 100 mL^{-1}、Vitamin C content 2-11 g · 100 mL^{-1}. Amino acids such as serine, glycine, proline, and glutamine in fresh plum meat, it's role is beneficial to urinary swelling, promote gastric acid and gastric digestive enzyme secretion, improve appetite and promote digestion, high levels of antioxidants, anti-aging, anti-disease [4].

'Fenghuang plum' has the characteristics of early maturity and high yield. Plum begin to mature in mid-June, the skin is purple-red, freestone slagging, and the gas is rich. The sugar content of fresh fruit can reach 16 g · 100 mL^{-1}. Chen *et al* [5] shows that different fertilizer types have different effects on the quality of plum fruit. Fertilizer combined with organic fertilizer and formula fertilization can significantly improve yield and fruit quality. Different ratios of nitrogen, phosphorus and potassium is beneficial to increase the yield and fruit weight of plum fruit, and the suitable ratio of nitrogen, phosphorus and potassium fertilizer is more conducive to improving plum fruit's nutrient.

This experiment study the effects of different formula fertilization on the quality of 'Fenghuang plum', and found a good fertilization program, which provide a certain theory and basis for the growth and fruit ripening of 'Fenghuang plum'.

2. Materials and Methods

Test materials. 'Fenghuang plum' is planted in Xiuwen Town, Meishan City, in the Sichuan Basin, southwest of the Chengdu Plain, with an altitude of 450-850 m. The place annual average temperature is 17℃, the average annual rainfall is 1009.4 mm, the annual average sunshine is 1196.6 h, and the frost-free period is 312 d. The test materials were selected from 12 plants five-year-old 'Fenghuang plum' trees with strong growth, basically the same tree, no pest and

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disease, and a row spacing of 3 m × 4 m.

Test design. Trial design 3 treatments, take one plant as one, set 3 repetitions, using local experience to fertilize as a control, fertilization treatment is carried out once every 25 days (fruit expansion period) and 51 days (fruit ripening period) after flowering.

The experiment adopts the annular fertilization method. When fertilizing, it is carried out around the canopy drip line. The depth and width of the ring are 20-30 cm. It is better to see the root without hurting the root. The specific fertilization formula is shown in Table 1, Table 2. Other management measure is consistent across processes.

Table 1 Fertilization formula of single-plant base fertilizer (unit: g)

treatment	N	P_2O_5	K_2O
1	265	205	217
2	265	205	217
3	265	205	217
CK	265	205	217

Note: This formula is a fertilization formula before flowering and the fruit is applied after harvesting.

Table 2 Single plant topdressing fertilization formula (unit: g)

treatment	N	P_2O_5	K_2O
1	46	40	90
2	64	60	150
3	73	70	180
CK	55	50	120

Note:25 days after flowering (fruit enlargement period), 51 days (fruit ripening period) for one fertilization，this experiment focused on the effects of post-flowering topdressing on the quality of ‘Fenghuang plum’, and the treatment of base fertilizer before flowering is consistent.

After the fruits are ripe, the fruit materials are collected in 4 treatment zones. According to the east, south, west, north and middle directions, 10 fruits are randomly selected from each plant, and 30 fruits are collected from each plot. After harvesting, it is placed in a low temperature environment and quickly brought back to the laboratory for fruit quality and intrinsic quality determination.

Test Methods. Weigh the total weight of 20 fruits with a balance and calculate the average single fruit weight. The weight of the pulp and the weight of the core are weighed by an electronic balance, and the edible rate is calculated; Determination of soluble solids uses a WYT-4 hand-held refractometer; The titratable acid content is determined by NaOH neutralization titration [6]; Vitamin C content is determined by 2,6-dichloroindophenol (2,6-D) method [7]; The total sugar content is determined by the Fehling's solution method [8], The determination of each indicator is repeated three times. Data is collated, statistically and analyzed with Excel 2010 and DPS 7.05.

3. Results

Effects of different fertilization on appearance and quality of ‘Fenghuang plum’. It can be seen from Table 3 that in the four different formula fertilization treatments, treatment 2 has the best effect, and the average fruit weight per fruit is the largest reaching 32.5 g, which is 5.87% higher than the control, which is significantly different from treatment 1. The longitudinal diameter of the fruit increase by 4.80% compared with the control, and the transverse diameter increase by 5.37% compared with the control, which is significantly different from the control; the difference of fruit shape index, edible rate and hardness is not significant between treatments.

Table 3 Effect of different treatments on the appearance quality of ‘Fenghuang plum’

Treat-ment	Single fruit weight（g）	Longitudinal diameter（mm）	Cross diameter（mm）	Fruit shape index（%）	Edible rate（%）	Fruit hardness（kg · cm^{-1}）
CK	30.59 ± 0.25a	33.70 ± 0.90b	37.00 ± 0.20ab	91.08 ± 1.00a	96.50 ± 1.55a	3.78 ± 0.05a
1	24.32 ± 1.61b	31.90 ± 0.90c	34.40 ± 1.40b	92.73 ± 3.00a	96.80 ± 1.25a	3.65 ± 0.13a
2	32.50 ± 1.78a	35.40 ± 0.60a	39.10 ± 0.30a	90.53 ± 1.00a	97.80 ± 1.25a	3.77 ± 0.05a
3	28.16 ± 3.21a	33.00 ± 0.20c	36.90 ± 0.30ab	89.43 ± 1.00a	97.90 ± 1.55a	3.68 ± 0.04a

Note: Lowercase letters after the same column indicate the significance of the difference at the P<5 % level.

Effects of different formula fertilization treatments on the intrinsic quality of ‘Fenghuang plum’. It can be seen from Table 4 that compared with the control, the three different fertilization formulas have a greater influence on the intrinsic quality of the ‘Fenghuang plum’. Compared with the control, the total sugar content of Treatment 1 increase by 1%, and the total sugar content of Treatment 2 and Treatment 3 decrease by 5.31% and 10.89%; The titratable acid content of treatments 1, 2, and 3 is reduce by 4.35%, 24.64%, and 31.88%, and the treatment 2 and 3 are significantly different from the control; The ratio of sugar to acid in treatments 1, 2, and 3 is 5.61%, 25.57% and 25.48% respectively, and the difference between treatments is not significant; The vitamin C content of fruits treated with treatment 1, 2, and 3 increase by 28.35%, 44.09%, and 2.36% respectively, and the difference between treatments is not significant; The soluble solids content of treatments 1 and 2 increase by 5.65% and 6.71% respectively, but the soluble solids of treatment 3 decrease by 5.86% compared with the control, which is significantly different from the control.

Table 4 Effect of different treatments on the intrinsic quality of ‘Fenghuang plum’

Treat-ment	Total sugar（g · 100 mL^{-1}）	Titrate acid（g · 100 mL^{-1}）	Vitamin C（mg · 100 mL^{-1}）	TSS（%）	Sugar to acid ratio（%）
CK	14.87 ± 0.55ab	0.69 ± 0.10a	12.73 ± 3.83a	18.77 ± 0.06b	21.55 ± 3.74a
1	15.02 ± 1.00a	0.66 ± 0.04a	16.27 ± 4.45a	19.83 ± 0.00a	22.76 ± 2.70a
2	14.07 ± 0.51ab	0.52 ± 0.05b	18.30 ± 5.51a	20.03 ± 0.12a	27.06 ± 1.85a
3	13.25 ± 1.14a	0.49 ± 0.04b	13.23 ± 1.96a	17.67 ± 0.06c	27.04 ± 4.47a

Note: Lowercase letters after the same column indicate the significance of the difference at the P<5 % level.

4. Discussion and Conclusion

After fertilization with different formulas, the fruit treated with treatment 2 performed best, and the fruit is higher in appearance quality and intrinsic quality than the control. Compared with the control, the single fruit weight, soluble solids, sugar-acid ratio and vitamin C increase by 5.87%, 6.71%, 25.57%, 44.09% and the titratable acid content decrease by 24.64%. Ji *et al* [9] shows that N has a great influence on the yield. Within a certain range, N is positively correlated with the yield. With the increase of nitrogen application rate, the single fruit weight of plum increase, but the excess N will have a certain inhibitory effect on the yield. This is consistent with the result of this study.

The study also found that after different formulations of fertilization treatment, the fruit’s edible rate, hardness and fruit shape index have no significant effect, which may be related to variety, tree age, soil condition and other factors. After formula fertilization treatment, the quality of ‘Fenghuang plum’ is greatly improved, especially the fruit weight, soluble solids, sugar-acid ratio and vitamin C content increase significantly.

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