

# Effect of Glycine Betaine on Quality and Yield of Little Cherry

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## Abstract

To investigate the effects of glycine betaine (GB) on the quality and yield of little cherry, a foliar spray experiment was conducted for two consecutive years (2024 and 2025) using the 6-year-old little cherry variety “Hongfei” as the test material. Three treatment groups (0.1% GB, 0.3% GB, 0.6% GB) and a control group with water were established. Foliar spraying was performed once during the bud break stage (early March), fruit setting stage (early April), and initial fruit enlargement stage (late April). Fruit appearance quality, internal quality, and yield-related indicators were measured. The results showed that the 0.3% GB treatment group exhibited the most significant growth-promoting effect: the average single fruit weight increased by 35.1% compared to the control over two years, with longitudinal and transverse diameters increasing by 15.7% and 12.4%, respectively. The fruit color depth significantly improved, and the soluble solids content reached 18.5%, an increase of 17.1% compared to the control. The vitamin C content increased by 14.2%, while the titratable acid content decreased by 11.0%. The yield per 666.7 m<sup>2</sup> reached 768.08 kg (2024) and 807.79 kg (2025), representing increases of 36.0% and 37.7% over the control, respectively. Therefore, foliar spraying of 0.3% glycine betaine solution during critical growth stages of little cherry can significantly improve fruit quality and yield, demonstrating high practical value in little cherry cultivation.

## Keywords

Little Cherry, Glycine Betaine, Foliar Spraying, Fruit Quality, Yield

## 1. Introduction

The little cherry (*Prunus pseudocerasus*) usually refers to the China cherry, a deciduous fruit tree of the genus *Prunus* in the Rosaceae family. Its fruits are small

and round, with delicate and juicy flesh, rich in vitamin C, anthocyanins, and various minerals, possessing high edible value and market recognition [1] [2]. Compared with the common large cherry (sweet cherry), the little cherry tree is shorter in stature and has a shorter fruiting cycle, but it commonly suffers from issues such as smaller fruits, insufficient internal sugar accumulation, and weaker stress resistance. Moreover, improper fertilization in planting often leads to soil fertility imbalance and a decline in fruit quality, which hinders the efficient development of the little cherry industry.

Fertilization is a critical measure for regulating fruit tree growth and fruit quality [3]. In recent years, the application of functional bio-stimulants in fruit tree cultivation has become a research hotspot both domestically and internationally [4] [5]. Among them, glycine betaine (GB), a natural quaternary ammonium alkaloid, exhibits outstanding performance in enhancing crop stress resistance and improving quality due to its green, safe, and easily absorbable characteristics [6]. Studies [7] [8] have demonstrated that exogenous application of glycine betaine can mitigate the damage caused by low temperature and salt stress by regulating plant photosynthetic efficiency and enhancing antioxidant capacity. Additionally, it promotes the accumulation of soluble sugars and vitamin C in fruits and vegetables, reduces organic acid content, and improves fruit flavor. Currently, the application effects of glycine betaine on crops such as zucchini, chrysanthemum, and peony have been validated [7]-[13]. However, for the specialty variety little cherry, the specific impacts of application concentration, timing, and effects on fruit quality and yield remain unclear.

This study took the little cherry “Hongfei” as the test material, through two consecutive years of field experiments, explored the effects of different concentrations of glycine betaine foliar spray on the appearance quality, intrinsic quality and yield of little cherry, screened the optimal application scheme, and provided scientific basis for the high-quality and high-yield cultivation of little cherry.

## 2. Materials and Methods

### 2.1. Test Materials

The tested cherry variety was “Hongfei”, a 6-year-old tree planted at the Little Cherry Planting Base in Dianjun District, Yichang City, Hubei Province, with a density of approximately 70 trees per 666.7 m<sup>2</sup> (plot size 3 m × 3.2 m). The trees exhibited a naturally open-crowned shape, uniform growth vigor, and were free from pests or diseases. The soil type at the test site was yellow-brown soil with a pH of 6.5 and 1.8% organic matter content. The glycine betaine used in the experiment was an analytical-grade reagent, and during the test, it was diluted with distilled water to prepare three spray solutions with mass concentrations of 0.1%, 0.3%, and 0.6%.

### 2.2. Experimental Design

The experiment adopted a randomized block design with four treatments: T1 (0.1% glycine betaine solution), T2 (0.3% glycine betaine solution), T3 (0.6% gly-

cine betaine solution), and CK (equal volume of distilled water as control). Seven uniformly growing cherry saplings were selected for each treatment, with three replicates (total 21 saplings) per treatment. Isolation rows (two rows) were established between plots to prevent interference. The experiment was conducted over two cycles (2024 and 2025). Spraying was performed at three key stages: the first during the budding stage (March 8, 2024; March 10, 2025), the second during fruit setting (April 8, 2024; April 10, 2025), and the third during early fruit enlargement (April 28, 2024; April 30, 2025). A backpack sprayer was used for foliar spraying, with optimal results achieved when water droplets covered both sides of the leaves without dripping. Throughout the experiment, all field management practices (including irrigation, pest control, and pruning) were conducted according to standard procedures, except for the spraying treatments.

### 2.3. Assay Items and Methods

#### 2.3.1. Appearance Quality Assessment

During the maturation period of little cherry (May 10-12), 50 mechanically undamaged fruits were randomly collected from each treatment. The following indicators were measured according to the method described by Liu Kun *et al.* [14]: 1) Single fruit weight: Weighed using an electronic analytical balance (precision 0.01 g) and averaged. 2) Fruit dimensions: Measured with a vernier caliper (precision 0.01 mm) and averaged. 3) Fruit color: The surface L value (brightness) and a value (red-green chroma, with higher values indicating deeper red) were determined using a colorimeter (CR-400, Konica Minolta). Three measurement points were taken per fruit, and the average was calculated. The statistical software SPSS was used for analysis of variance and significance level.

#### 2.3.2. Measurement of Intrinsic Quality

After removing the skin and core from the fruits with the measured appearance quality, homogenize them and conduct the following measurements according to the method described by Zhang Zaihua *et al.* [15]: 1) Soluble solids content: Determine using a handheld sugar meter, with three repetitions; 2) Vitamin C content: Determine by the 2,6-dichloroindophenol titration method, expressed as mg/100g; 3) Titratable acid content: Determine by acid-base titration (using 0.1 mol/L NaOH standard solution), measured as malic acid, expressed as %.

#### 2.3.3. Yield Measurement

For each batch of 7 little cherry saplings, the fruits of each little cherry tree were weighed together and the fruit number per plant was recorded using photoelectric counter, and the average yield per plant was calculated. This yield was then converted to per-mu (666.7 m<sup>2</sup>) yield (calculated by planting 70 saplings per 666.7 m<sup>2</sup>).

## 3. Results and Analysis

### 3.1. Effects of Glycine Betaine on the Appearance Quality of Cherry

As shown in **Table 1**, compared with the control (CK), spraying different concen-

trations of glycine betaine significantly improved the appearance quality of little cherry, with the T2 treatment (0.3% GB) showing the best effect. In 2024, the single fruit weight of the T2 treatment was 2.82 g, an increase of 34.3% compared to CK; the longitudinal and transverse diameters were 18.7 mm and 17.2 mm, respectively, representing increases of 15.4% and 12.4% over CK; the a-value (red-greenness) was 28.6, up 15.3% from CK, while the L-value (brightness) was 34.2, down 8.7% from CK, indicating deeper red coloration and more vibrant hues. The trend of each indicator in 2025 was consistent with 2024, with the single fruit weight, longitudinal diameter, transverse diameter, and a-value of the T2 treatment increasing by 35.8%, 16.0%, 12.3%, and 16.3% respectively compared to CK, and the differences between T2 and CK in both years were statistically significant ( $P < 0.01$ ). The T1 treatment (0.1% GB) and T3 treatment (0.6% GB) showed weaker effects on appearance quality improvement compared to T2, with some fruits in the T3 treatment exhibiting slight surface wrinkling, suggesting that high concentrations of glycine betaine may have a certain impact on fruit skin development.

**Table 1.** Effects of different concentrations of glycine betaine on the appearance quality of little cherry.

Year	Treatment	Single fruit weight (g)	Longitudinal diameter (mm)	transverse diameter (mm)	a	L
2024	CK	2.10 ± 0.12	16.2 ± 0.3	15.3 ± 0.3	24.8 ± 0.5	37.4 ± 0.6
2024	T1	2.51 ± 0.10	17.9 ± 0.2	16.4 ± 0.2	26.9 ± 0.4	35.6 ± 0.5
2024	T2	2.82 ± 0.11	18.7 ± 0.3	17.2 ± 0.2	28.6 ± 0.5	34.2 ± 0.6
2024	T3	2.58 ± 0.13	18.0 ± 0.2	16.5 ± 0.2	27.1 ± 0.5	35.3 ± 0.5
2025	CK	2.15 ± 0.13	16.3 ± 0.3	15.5 ± 0.3	25.1 ± 0.5	37.6 ± 0.6
2025	T1	2.55 ± 0.11	18.0 ± 0.3	16.5 ± 0.2	27.2 ± 0.4	35.8 ± 0.5
2025	T2	2.92 ± 0.12	18.9 ± 0.3	17.4 ± 0.3	29.2 ± 0.6	34.0 ± 0.6
2025	T3	2.63 ± 0.14	18.1 ± 0.2	16.6 ± 0.2	27.4 ± 0.5	33.1 ± 0.6

### 3.2. Effects of Glycine Betaine on the Intrinsic Quality of Cherry

As shown in **Table 2**, the application of glycine betaine significantly improved the intrinsic quality of little cherry, with the T2 treatment demonstrating the most optimal results. In 2024, the soluble solids content in the T2 treatment was 18.3%, an increase of 16.6% compared to the CK; the vitamin C content was 49.8 mg/100 g, up by 13.9% from the CK; and the titratable acid content was 0.62%, a decrease of 10.1% from the CK. In 2025, the soluble solids content and vitamin C content in the T2 treatment further increased to 18.7% and 50.5 mg/100g, respectively, representing increases of 17.6% and 14.5% from the CK; while the titratable acid content decreased to 0.60%, a reduction of 11.8% from the CK. The differences between the T2 treatment and CK were statistically significant ( $P < 0.01$ ) in both years. Although the intrinsic quality indicators of the T1 treatment were superior

to those of the CK, they were lower than those of the T2 treatment: in 2025, the soluble solids content in the T1 treatment was 17.2%, 8.0% lower than that of the T2 treatment; and the vitamin C content was 46.2 mg/100g, 8.5% lower than that of the T2 treatment. The intrinsic quality of the T3 treatment was similar to that of the T1 treatment, with its soluble solids content being 7.5% lower than that of the T2 treatment.

**Table 2.** Effects of different concentrations of glycine betaine on the intrinsic quality of little cherry.

Year	Treatment	Soluble solids (%)	Vitamin C (mg/100g)	titratable acid (%)
2024	CK	15.7 ± 0.2	43.7 ± 0.4	0.69 ± 0.02
2024	T1	17.1 ± 0.3	46.1 ± 0.4	0.65 ± 0.01
2024	T2	18.3 ± 0.3	49.8 ± 0.5	0.62 ± 0.01
2024	T3	17.2 ± 0.3	46.3 ± 0.4	0.64 ± 0.02
2025	CK	15.9 ± 0.2	44.1 ± 0.4	0.68 ± 0.02
2025	T1	17.2 ± 0.3	46.2 ± 0.4	0.64 ± 0.01
2025	T2	18.7 ± 0.3	50.5 ± 0.5	0.60 ± 0.01
2025	T3	17.3 ± 0.2	46.5 ± 0.5	0.63 ± 0.02

### 3.3. Effect of Glycine Betaine on Little Cherry Yield

As shown in **Table 3**, the application of glycine betaine significantly increased the yield of little cherry, with the T2 treatment demonstrating the most pronounced yield-enhancing effect. In 2024, the T2 treatment achieved a single-plant yield of 10.97 kg and a yield per 666.7 m<sup>2</sup> of 768.08 kg, representing a 36.0% increase compared to the control (CK). In 2025, the T2 treatment yielded 11.54 kg per plant and 807.79 kg per 666.7 m<sup>2</sup>, showing a 37.7% yield increase over CK, with an average yield improvement of 36.9% over two years. The T1 treatment increased

**Table 3.** Effects of different concentrations of glycine betaine on little cherry yield.

Year	Treatment	Number of fruits per plant	Yield per plant (kg)	Yield per 666.7 m <sup>2</sup> (kg)	yield increase rate compared to CK (%)
2024	CK	3841 ± 135	8.07 ± 0.28	564.63 ± 19.85	-
2024	T1	3878 ± 152	9.73 ± 0.38	681.36 ± 26.71	20.7
2024	T2	3891 ± 164	10.97 ± 0.46	768.08 ± 32.37	36.0
2024	T3	3882 ± 143	10.02 ± 0.37	701.09 ± 25.83	24.2
2025	CK	3897 ± 126	8.38 ± 0.27	586.50 ± 18.96	-
2025	T1	3936 ± 139	10.04 ± 0.35	702.58 ± 24.81	19.8
2025	T2	3952 ± 158	11.54 ± 0.46	807.79 ± 32.30	37.7
2025	T3	3930 ± 132	10.34 ± 0.35	723.51 ± 24.30	23.4

yield by 19.8% - 20.7% compared to CK, achieving a yield of 702.58 kg per 666.7 m<sup>2</sup> in 2025. The T3 treatment increased yield by 23.4% - 24.2% over CK, yielding 723.51 kg per 666.7 m<sup>2</sup> in 2025. These results indicate that an appropriate concentration of glycine betaine enhances yield by increasing fruit weight and plant fruiting capacity, while concentrations that are either too low or too high may limit yield improvement.

#### 4. Discussion

This study demonstrates that foliar application of glycine betaine significantly improves the appearance quality, intrinsic quality, and yield of little cherry, with 0.3% being the optimal concentration, which aligns with the effects observed in other crops [16] [17]. In terms of appearance quality, glycine betaine promotes fruit enlargement in little cherry, increases single fruit weight and length/diameter, and enhances fruit redness. This is likely due to glycine betaine's ability to enhance leaf photosynthetic efficiency, facilitate the transport of photosynthetic products to fruits, and regulate the activity of enzymes related to anthocyanin synthesis (e.g., phenylalanine deaminase, chalcone synthase), thereby increasing anthocyanin accumulation [18]. In this study, the T3 treatment (0.6% GB) resulted in slight fruit shrinkage, suggesting that high concentrations of glycine betaine may disrupt leaf osmotic balance, impair water transport to fruits, and consequently inhibit normal fruit development. This finding is consistent with the results reported by Xu Ting *et al.* [19] in melons, where excessively high concentrations of glycine betaine exhibited a reverse inhibitory effect on crop growth.

From an intrinsic quality perspective, glycine betaine significantly enhances soluble solids and vitamin C content in little cherry while reducing titratable acid levels, which is closely associated with its metabolic regulatory function. On one hand, glycine betaine promotes the activity of sucrose synthase and sucrose phosphatase, accelerating sugar accumulation. On the other hand, it enhances the activity of antioxidant enzymes (e.g., superoxide dismutase, catalase), reduces the oxidative degradation of vitamin C, and simultaneously inhibits enzymes related to organic acid synthesis (e.g., citrate synthase), thereby decreasing organic acid content [20] [21]. Consequently, glycine betaine markedly improves the flavor profile of little cherry and elevates their commercial value. In terms of yield, the increased production of glycine betaine primarily stems from higher single-fruit weight and increased fruit set per plant. Glycine betaine alleviates environmental stresses (e.g., low temperatures during flowering and drought during fruit setting), improves fruit setting rates, and promotes fruit enlargement, thereby increasing single-fruit weight. In this study, the T2 treatment achieved an average yield increase of 36.9% per 666.7 m<sup>2</sup> over two years, significantly higher than the T1 and T3 treatments, further validating the importance of optimal concentration.

In summary, the optimal application protocol for glycine betaine in little cherry cultivation involves three key spraying stages: 0.3% glycine betaine solution at the bud break, fruit setting, and initial fruit enlargement phases. This paper only con-

ducted experiments on a single variety of local little cherry in Yichang for two cycles. The appropriate concentration and dosage of glycine betaine for different orchards require further verification. Future research will investigate the synergistic effects of glycine betaine with other biological stimuli (e.g., humic acid, amino acids) and determine optimal concentrations under varying soil fertility conditions, thereby providing comprehensive technical support for high-quality and high-yield little cherry production.

## 5. Conclusion

Two consecutive field trials demonstrated that foliar application of glycine betaine significantly improved the quality and yield of little cherry. The 0.3% glycine betaine treatment showed the most effective results, with the following improvements observed: On average over 2024 and 2025, the average fruit weight increased by 35.1%, while the longitudinal and transverse diameters grew by 15.7% and 12.4%, respectively. The fruit coloration became more intense, with a 18.5% increase in soluble solids content, a 14.2% rise in vitamin C levels compared to the control, and a 11.0% decrease in titratable acid content. The yield per 666.7 m<sup>2</sup> increased by 36.9% compared to the control. Therefore, it is recommended to apply 0.3% glycine betaine during the budding, fruit setting, and early fruit enlargement stages of little cherry, providing a technical reference for high-quality and high-yield cultivation.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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