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Study on Temperature Disaster Indicators of Passion Fruit in Southwest Fujian, China

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Abstract

In China, meteorological forecasting relies on meteorological data obtained from regional and national stations. However, there were discrepancies between the data collected from the meteorological station at the passion fruit growing base and the data from regional and national stations. Consequently, the high and low temperature disaster indicators determined by the meteorological station at the passion fruit growing base cannot be applied to meteorological forecasting. To address this issue and facilitate the monitoring and early warning of high and low temperature disasters in passion fruit cultivation in Fujian, China, we used multi-source hourly temperature data (including the data from meteorological observation stations in passion fruit growing bases, the nearest regional stations, and national surface conventional meteorological observation stations) in three cities in southwestern Fujian (Longyan, Sanming, and Zhangzhou) spanning the years 2020 to 2022. By employing comprehensive statistical analysis methods (0.5 interval division and Cumulative frequency), we identified that passion fruit in southwestern Fujian was susceptible to high temperature disasters during the blooming-fruiting period, as well as low temperature disasters during the sprouting period. Consequently, we developed high and low temperature disaster indicators based on data from regional and national stations for different phenological periods of passion fruit in this region.

Keywords

Passion Fruit, High Temperature Disaster Indicator, Low Temperature Disaster Indicator, Disaster Frequency, Disaster Degree

1. Introduction

Passion fruit, commonly referred to as Brazil fruit, is one of the primary economic crops in Fujian Province. The juice derived from this fruit encompasses a diverse range of aromatic substances, exuding the delightful fragrance of over ten different fruits. With its versatility, passion serves as a valuable resource for various processed products such as juice, preserved fruit, jam, and jelly, offering both economic and edible value (Yan et al., 2022; De et al., 2023).

Fujian Province is one of the most important areas for the cultivation of passion fruit in China. The local climate conditions in this region are highly favorable for the accumulation of nutrients and the conversion of sugar in passion fruit. Longyan, Sanming, and Zhangzhou, located in the southwest of Fujian Province, are particularly concentrated areas for passion fruit cultivation. These regions encompass diverse terrains, ranging from mountainous areas to plains, and from coastal to inland areas. This diversity makes them ideal for studying the effects of high and low temperature disasters on passion fruit. The relevant results can serve as a valuable reference for passion fruit cultivation in similar regions.

Passion fruit thrives in a climate characterized by ample sunlight and warm, humid conditions. The optimal temperature range for its growth is between 20˚C - 30˚C, and areas an average annual temperature exceeding 18˚C most suitable for cultivation (Souto et al., 2019; Matsuda & Higuchi, 2020a). However, it is important to note that the Blue Book on Climate Change in China (2021), published by the China Meteorological Administration, highlights the increasing occurrence of extreme weather and climate events both in China and globally (Fen, 2021). These anomalies can have a detrimental impact on the quality of passion fruit. Discoloration, drying, and shrinkage of the fruit are potential consequences of such extreme weather events, which can significantly diminish the fruit's market value and sales.

The impact of high and low temperatures on the yield of passion fruit in the context of climate change has garnered significant attention from researchers both domestically and internationally. Scholars have conducted quantitative experiments to examine the impact of meteorological factors on the fruit setting rate of passion fruit (Zheng & Wei, 2018; Masakazu & Hiroshi, 2022), and have determined that excessive temperatures can decrease the fruit setting rate (Wang et al., 2022; Masakazu & Hiroshi, 2022). Additionally, some scholars have investigated the effects of extreme weather on passion fruit (Xiao et al., 2021) and have observed that frost resulting from extremely low temperatures often leads to varying degrees of damage to the growth and development of the fruit (Chen et al., 2022). A number of foreign scholars studied the relationship between passion fruit and climate factors by using stepwise backward reasoning method (Matsuda & Higuchi, 2020b) and quantitative analysis (Shimada et al., 2020), and found that excessive temperature would affect the normal flowering of passion fruit and reduce the sugar content of passion fruit. They compared several

physiological indexes and combined with biochemical experiments (Wang et al., 2023; Liang et al., 2023), revealed the genes that respond to high and low temperature stress (Chen et al., 2023; Xu et al., 2023), providing a theoretical basis for the study of high and low temperature disasters in passion fruit.

In the cultivation of passion fruit, various measures such as irrigation, covering with plastic film, and establishing a greenhouse are employed to artificially intervene temperature fluctuations within the passion fruit planting area. As a consequence, there are disparities in temperature readings between the meteorological station located within the passion fruit base and the regional and national stations. Additionally, real-time meteorological data from the passion fruit base is not publicly accessible, leading to practitioners engaged in the production, sales, and processing of passion fruit to rely on meteorological forecasts based on data from regional and national stations to assess the risk of high and low temperature disasters. This reliance on forecasts introduces significant uncertainty in monitoring and predicting high and low temperature disasters within the passion fruit base.

In this study, we used multi-source hourly temperature data from three cities in southwestern Fujian (Longyan, Sanming, and Zhangzhou) spanning the years 2020 to 2022. The temperature data was obtained from the meteorological station within the passion fruit growing base, the nearest regional station, and national surface conventional meteorological observation stations. Statistical methods, including 0.5 interval division and cumulative frequency, were utilized to establish indicators for mild, moderate, severe, and extremely severe high and low temperature disasters of passion fruit at both regional and national stations. These indicators were determined based on the cumulative frequency of high and low temperature disasters of passion fruit at 30%, 50%, 80%, and 100%. The objective of this study is to develop indicators that more accurately reflect the occurrence of high and low temperature disasters for passion fruit. The findings will assist practitioners in the production, sales, and processing of passion fruit in implementing precise and timely disaster prevention measures based on daily weather forecasts.

2. Data and Method

The data used in this study are provided by Fujian Meteorological Bureau. The detailed data are shown in **Table 1**, and the spatial distribution of meteorological stations and topography in Fujian are shown in **Figure 1**.

Longyan, Sanming, and Zhangzhou are located in the southwestern region of Fujian Province, characterized by a subtropical monsoon climate. These areas receive abundant rainfall, ample sunlight, and experience significant temperature fluctuations between day and night. These climatic conditions are favorable for the accumulation of nutrients and the conversion of sugar in passion fruit. Consequently, passion fruit cultivation is prevalent in these regions. Longyan, located in western Fujian, is characterized by a rugged terrain with numerous

Table 1. Observation information of stations in southwest Fujian.

	Site name	Site type	Coordinate	Observation period
Sanming	Rencun	Station in passion fruit base	26.32˚N, 117.45˚E	2020-09-05 2022-11-19
	Sanming	National station	26.27˚N, 117.62˚E	
	Sanyuanyanqian	Regional station	26.15˚N, 117.27˚E	
Longyan	Zhuoyangcun	Station in passion fruit base	25.14˚N, 116.89˚E	2021-02-03 2022-11-28
	Shanghang	National station	25.05˚N, 116.42˚E	
	Jiaoyang	Regional station	25.23˚N, 116.73˚E	
Zhangzhou	Pulicun	Station in passion fruit base	24.39˚N, 117.94˚E	2020-09-11 2022-12-31
	Kongjian	National station	24.50˚N, 117.65˚E	
	Tianbaorezuo	Regional station	24.63˚N, 117.52˚E	

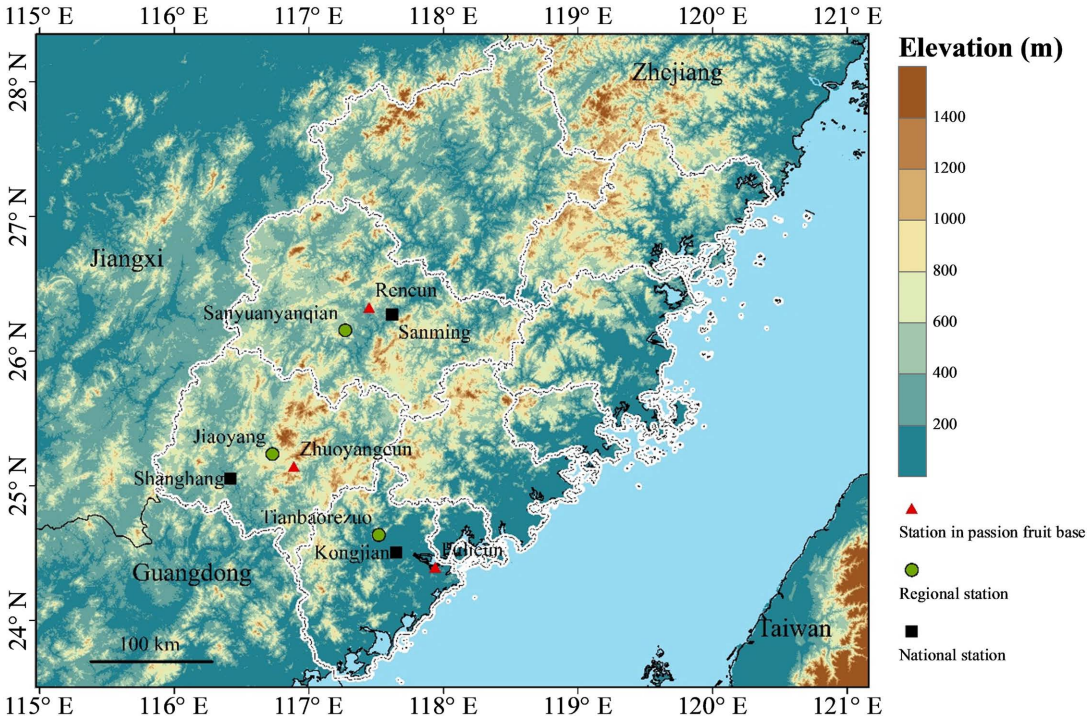

Figure 1. Spatial distribution of meteorological stations and topography in Fujian.

peaks and canyons. Sanming, located in the central region of Fujian, is predominantly mountainous. Zhangzhou, located in the southwest of Fujian, features a relatively flat terrain, primarily comprising coastal plains. The diverse topography of the three regions provides a valuable basis for the development and investigation of high and low temperature disaster indicators specific to passion fruit cultivation.

Based on literature researches (Zhang, 2022; You & Cheng, 2022) and consultation with experts from the Fujian Provincial Meteorological Bureau, we are able to obtain the high and low temperature disaster indicators for various phenological periods of the passion fruit in Fujian (**Table 2**).

Table 2. High and low temperature disaster indicators.

Phenological period	Sprouting period	Blooming-fruiting period	Overwintering period
Start and end dates	3.21 - 4.10	4.11 - 11.20	11.21 - 3.20
High-temp. disaster indicators	32.0˚C	33.0˚C	—
Low-temp. disaster indicators	15.0˚C	10.0˚C	2.5˚C

In order to construct disaster indicators of high and low temperature in southwest Fujian, first of all, we need to know in which phenological period the high and low temperature disasters of Fujian passion fruit mainly occurred. we defined the total number of observations of a certain phenology period as m, and the number of observations of temperature surpasses (or falls below) high (or low) temperature disaster index of this phenology period as n, then the frequency of high (or low) temperature disaster of this phenology period as f, which can be expressed as:

$$f = \frac{n}{m} \times 100\% \tag{1}$$

Then we calculated the frequency of high and low temperature disasters in different phenological periods, and can intuitively find the main phenological periods of high and low temperature disasters.

We further analyzed the disaster frequency of the main phenological period in which high and low temperature disasters occurred. Each time corresponds to a passion fruit base temperature t_{base}, regional station temperature $t_{regional}$ and national station temperature $t_{national}$. The temperature $t_{regional}$ at the regional station (or the temperature $t_{national}$ at the national station) is divided into intervals of 0.5˚C. Then, we calculate the frequency of high (or low) temperature disasters at passion fruit base in each interval, which can be expressed as

$$F = \frac{N}{M} \times 100\% \tag{2}$$

where, F is the frequency of high (low) temperature disaster at passion fruit in a certain range, M is the total number of observations in this phenological period. N is the number of observations within a selected temperature range where the temperature at the passion fruit base meteorological station in that interval is higher (or lower) than the high (or low) temperature disaster indicator during that phenological period.

The cumulative frequency approach is employed to aggregate the frequency (F) of high (or low) temperature disasters in each interval in an upward manner, resulting in the cumulative frequency (CF) of extreme temperature events (both high and low) occurring at various phenological stages of passion fruit. This expression serves to quantify the occurrence of such events.

Finally, in order to construct high and low temperature disaster index of passion fruit in southwest Fujian province, we employ regional station temperature

(national station temperature) as the independent variable and the cumulative frequency of high and low temperature disasters as the dependent variable to construct a continuous disaster curve. The temperature $t_{regional}$ at a regional station (temperature $t_{national}$ at a national station) associated with the cumulative frequency of high (or low) temperature disasters of passion fruit at 30%, 50%, 80%, and 100% is designated as the indicator for mild, moderate, severe, and extremely severe high (or low) temperature disasters of passion fruit at the regional station (or the national station).

3. Research Results

3.1. Frequency of High and Low Temperature Disasters in Different Phenological Periods

In order to determine the concentrated occurrence time of high and low temperature disasters of passion fruit, formula (1) is used to calculate the high temperature disaster frequency of passion fruit in different phenologies in southwest Fujian (Table 3 and Table 4).

During the sprouting period, the high temperature disaster frequency of passion fruit in Longyan, Sanming and Zhangzhou is 0.0%, and the low temperature disaster frequency is 41.6%, 36.3% and 20.7%, respectively. During the blooming-fruiting period, the frequency of high temperature disaster in Longyan, Sanming and Zhangzhou is 1.3%, 7.8% and 8.8% respectively, and the frequency of low temperature disaster is 0.7%, 1.7% and 0.4% respectively. During the overwintering period, the high temperature disaster frequency of passion fruit in Longyan, Sanming and Zhangzhou is 0.0%, and the low temperature disaster frequency is 20.7%, 0.4% and 2.0%, respectively.

To sum up, it is easy to have high temperature disaster during the blooming-fruiting period and low temperature disaster during the sprouting period in southwest Fujian. Next, we will further analyze the high temperature disaster during the blooming-fruiting period (research results 3-2) and the low temperature disaster during the sprouting period (research results 3-3).

Table 3. Frequency of high temperature disasters.

	Sprouting period	Blooming-fruiting period	Overwintering period
Longyan	0.0%	1.3%	0.0%
Sanming	0.0%	7.8%	0.0%
Zhangzhou	0.0%	8.8%	0.0%

Table 4. Frequency of low temperature disasters.

	Sprouting period	Blooming-fruiting period	Overwintering period
Longyan	41.6%	0.7%	2.2%
Sanming	36.3%	1.7%	5.0%
Zhangzhou	20.7%	0.4%	2.0%

3.2. High Temperature Disaster Indicators during the Blooming-Fruiting Period

In order to construct the high temperature disaster indicators of passion fruit in southwest Fujian during the blooming-fruiting period, the cumulative frequency (CF) of high temperature disaster of passion fruit is calculated according to the research method, and the disaster smoothing curve is drawn to obtain the change curve of the cumulative frequency of high temperature disaster (Figure 2). The temperature observation values of regional stations and national stations corresponding to 30%, 50%, 80%, and 100% of the cumulative frequency (CF) of high temperature disasters are respectively found on the disaster smoothing curve.

We find that: in Longyan, when the cumulative frequency of high temperature disaster is 30%, 50%, 80% and 100% of the total frequency, the corresponding $t_{regional}$ is 23.1˚C, 23.9˚C, 25.3˚C, 32.8˚C, and the corresponding $t_{national}$ is 26.7˚C, 27.6˚C, 28.9˚C, 34.3˚C, respectively (Figure 2(a)). In Sanming, when the cumulative frequency of high temperature disaster is 30%, 50%, 80% and 100% of the total frequency, the corresponding $t_{regional}$ is 24.1˚C, 24.5˚C, 27.2˚C, 35.1˚C, and the corresponding $t_{national}$ is 26.8˚C, 28.0˚C, 30.3˚C, 38.8˚C, respectively (Figure 2(b)). In Zhangzhou, when the cumulative frequency of high temperature disaster is 30%, 50%, 80% and 100% of the total frequency, corresponding $t_{regional}$ is 25.7˚C, 26.7˚C, 28.8˚C, 37.6˚C, and corresponding $t_{national}$ is 26.6˚C, 27.5˚C, 29.4˚C, 38.9˚C, respectively (Figure 2(c)).

Then, the observed temperature values of regional stations (national stations) corresponding to 30%, 50%, 80%, and 100% of the cumulative frequency of high-temperature disasters are used as indicators of mild, moderate, severe, and extremely severe high-temperature disasters of passion fruit, respectively, as shown in Tables 5-7.

For the Longyan area, the indicators of mild, moderate, severe and extremely severe high temperature disasters of passion fruit are 23.1˚C, 23.9˚C, 25.3˚C and 32.8˚C at regional stations, and 26.7˚C, 27.6˚C, 28.9˚C and 34.3˚C at national station, respectively (Table 5).

For the Sanming area, the indicators of mild, moderate, severe and extremely

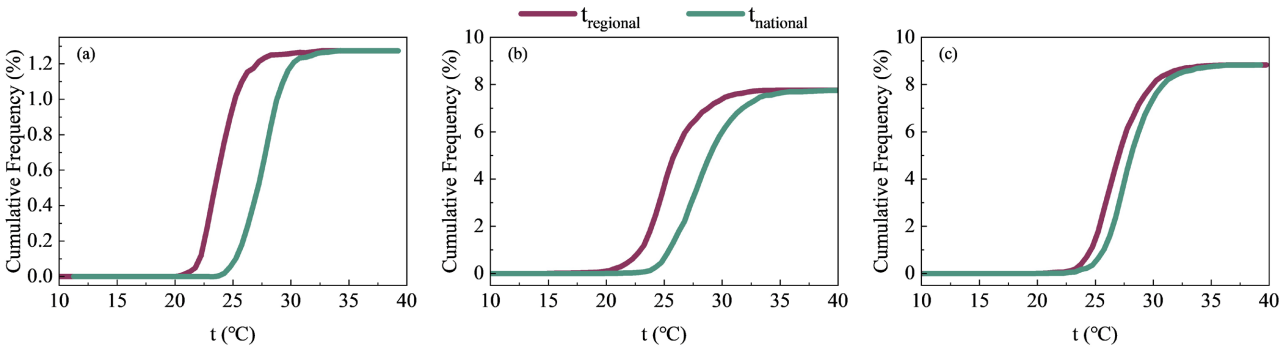

Figure 2. Cumulative frequency of high temperature disaster in (a) Longyan, (b) Sanming, and (c) Zhangzhou, respectively.

Table 5. High temperature disasters indicators of passion fruit in Longyan.

Disaster degree	Mild	Moderate	Severe	Extremely severe
$t_{regional}$	23.1˚C	23.9˚C	25.3˚C	32.8˚C
$t_{national}$	26.7˚C	27.6˚C	28.9˚C	34.2˚C

Table 6. High temperature disasters indicators of passion fruit in Sanming.

Disaster degree	Mild	Moderate	Severe	Extremely severe
$t_{regional}$	24.1˚C	24.5˚C	27.2˚C	35.1˚C
$t_{national}$	26.8˚C	28.0˚C	30.3˚C	38.8˚C

Table 7. High temperature disasters indicators of passion fruit in Zhangzhou.

Disaster degree	Mild	Moderate	Severe	Extremely severe
$t_{regional}$	25.7˚C	26.7˚C	28.7˚C	37.6˚C
$t_{national}$	26.6˚C	27.5˚C	29.4˚C	38.9˚C

severe high temperature disasters are 24.1˚C, 24.5˚C, 27.2˚C and 35.1˚C at regional station, and 26.8˚C, 28.0˚C, 30.3˚C and 38.8˚C at national station, respectively (Table 6).

For the Zhangzhou area, the indicators of mild, moderate, severe and extremely severe high temperature disasters are 25.7˚C, 26.7˚C, 28.8˚C and 37.6˚C at regional station, and 26.6˚C, 27.5˚C, 29.4˚C and 38.9˚C at national station, respectively (Table 7).

The above are the high temperature disasters indicators of passion fruit during the fruit and fruit period. These indicators allow for a passion fruit disaster risk assessment to help passion fruit practitioners better understand the potential risks and extent of impact so that targeted preparedness and recovery plans can be developed.

3.3. Low Temperature Disaster Indicators during the Sprouting Period

In order to construct the low temperature disaster indicators of passion fruit in southwest Fujian during the sprouting period, the cumulative frequency (CF) of low temperature disaster of passion fruit is calculated according to the research method, and the disaster smoothing curve is drawn to obtain the change curve of the cumulative frequency of low temperature disaster (Figure 3). The temperature observation values of regional stations and national stations corresponding to 30%, 50%, 80%, and 100% of the cumulative frequency (CF) of low temperature disasters are respectively found on the disaster smoothing curve.

We get: In Longyan, when the cumulative frequency of low temperature disaster is 30%, 50%, 80% and 100% of the total frequency, the corresponding $t_{regional}$ is 16.1˚C, 11.8˚C, 8.5˚C, 4.3˚C, and the corresponding $t_{national}$ is 17.5˚C, 14.3˚C, 11.6˚C, 6.8˚C, respectively (Figure 3(a)). In Sanming, when the cumulative fre-

quency of low temperature disaster is 30%, 50%, 80% and 100% of the total frequency, the corresponding $t_{regional}$ is 19.1˚C, 14.0˚C, 10.2˚C, 5.8˚C, and the corresponding $t_{national}$ is 18.1˚C, 14.2˚C, 11.5˚C, 8.3˚C, respectively (Figure 3(b)). In Zhangzhou, when the cumulative frequency of low temperature disaster is 30%, 50%, 80% and 100% of the total frequency, corresponding $t_{regional}$ is 20.7˚C, 16.2˚C, 13.6˚C, 7.3˚C, and corresponding $t_{national}$ is 19.7˚C, 15.7˚C, 13.5˚C, 9.3˚C, respectively (Figure 3(c)).

Then, the observed temperature values of regional stations (national stations) corresponding to 30%, 50%, 80%, and 100% of the cumulative frequency of low-temperature disasters are used as indicators of mild, moderate, severe, and extremely severe low-temperature disasters of passion fruit, respectively, as shown in Tables 8-10.

For the Longyan area, the disaster indicators of mild, moderate, severe and extremely severe low temperature are 16.1˚C, 11.8˚C, 8.5˚C and 4.3˚C at regional station, and 17.5˚C, 14.3˚C, 11.6˚C and 6.8˚C at national station, respectively (Table 8).

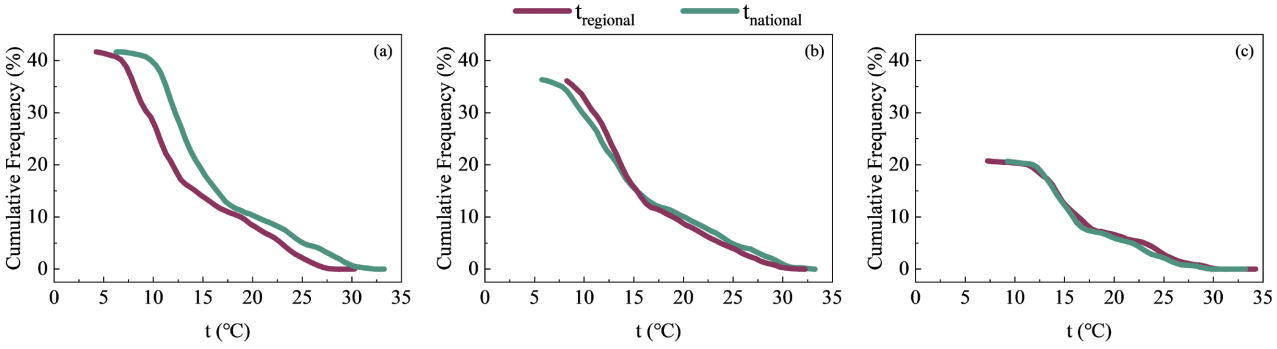

Figure 3. Cumulative frequency of low temperature disaster frequency in (a) Longyan, (b) Sanming, and (c) Zhangzhou, respectively.

Table 8. Low temperature disasters indicators of passion fruit in Longyan.

Disaster degree	Mild	Moderate	Severe	Extremely severe
$t_{regional}$	16.1˚C	11.8˚C	8.5˚C	4.3˚C
$t_{national}$	17.5˚C	14.3˚C	11.6˚C	6.8˚C

Table 9. Low temperature disasters indicators of passion fruit in Sanming.

Disaster degree	Mild	Moderate	Severe	Extremely severe
$t_{regional}$	19.1˚C	14.0˚C	10.2˚C	5.8˚C
$t_{national}$	18.1˚C	14.2˚C	11.5˚C	8.3˚C

Table 10. Low temperature disasters indicators of passion fruit in Zhangzhou.

Disaster degree	Mild	Moderate	Severe	Extremely severe
$t_{regional}$	20.7˚C	16.2˚C	13.6˚C	7.3˚C
$t_{national}$	19.7˚C	15.7˚C	13.5˚C	9.3˚C

For the Sanming area, the disaster indicators of mild, moderate, severe and extremely severe low temperature are 19.1˚C, 14.0˚C, 10.2˚C and 5.8˚C at regional station, and 18.1˚C, 14.2˚C, 11.5˚C and 8.3˚C at national station, respectively (Table 9).

For the Zhangzhou area, the disaster indicators of mild, moderate, severe and extremely severe low temperature are 20.7˚C, 16.2˚C, 13.6˚C and 7.3˚C at regional station, and 19.7˚C, 15.7˚C, 13.5˚C and 9.3˚C at national station, respectively (Table 10).

The above are the low temperature disasters indicators of passion fruit during the fruit and fruit period. These indicators can provide valuable data for researchers to further study the impact of low temperature on agriculture, promote the innovation of agricultural science and technology, and find more effective ways to adapt to and mitigate high temperature disasters.

4. Conclusion

In southwest Fujian province, passion fruit is prone to high temperature disaster in blooming-fruiting period, and low temperature disaster in sprouting period.

During the blooming-fruiting period, the indicators of mild, moderate, severe and extremely severe high temperature disasters in Longyan are 23.1˚C, 23.9˚C, 25.3˚C and 32.8˚C at regional stations, and 26.7˚C, 27.6˚C, 28.9˚C and 34.3˚C at national stations, respectively. The indicators of mild, moderate, severe and extremely severe high temperature disasters in Sanming are 24.1˚C, 24.5˚C, 27.2˚C and 35.1˚C at regional stations, and 26.8˚C, 28.0˚C, 30.3˚C and 38.8˚C at national stations, respectively. The indicators of mild, moderate, severe and extremely severe high temperature disasters in Zhangzhou are 25.7˚C, 26.7˚C, 28.8˚C and 37.6˚C at regional stations, and 26.6˚C, 27.5˚C, 29.4˚C and 38.9˚C at national stations, respectively.

During the sprouting period, the indicators of mild, moderate, severe and extremely severe low temperature disaster in Longyan are 16.1˚C, 11.8˚C, 8.5˚C and 4.3˚C at regional stations, and 17.5˚C, 14.3˚C, 11.6˚C and 6.8˚C at national stations, respectively. The indicators of mild, moderate, severe and extremely severe low temperature disaster in Sanming are 19.1˚C, 14.0˚C, 10.2˚C and 5.8˚C at regional stations, and 18.1˚C, 14.2˚C, 11.5˚C and 8.3˚C at national stations, respectively. The indicators of mild, moderate, severe and extremely severe low temperature disaster in Zhangzhou are 20.7˚C, 16.2˚C, 13.6˚C and 7.3˚C at regional stations, and 19.7˚C, 15.7˚C, 13.5˚C and 9.3˚C at national stations, respectively.

Passion fruit practitioners will use the high and low temperature disaster indicators in the daily weather forecast, can more intuitively understand the day's passion fruit base passion fruit disaster situation, and timely prevention.

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Conflicts of Interest

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

References

Chen, G., Xu, Y., Gui, J. et al. (2023). Characterization of Dof Transcription Factors and the Heat-Tolerant Function of *PeDof-11* in Passion Fruit (*Passiflora edulis*). *International Journal of Molecular Sciences, 24,* Article 12091. https://doi.org/10.3390/ijms241512091

Chen, Y., Lin, X., Huang, S. et al. (2022). Study on Cold Damage and Low Temperature Index of Golden Passion Fruit during Seedling Stage. *Meteorological Research and Application, 43,* 63-68. (In Chinese)

De, J. O. N., Silva, L. L. K., Dos, S. I. S. et al. (2023). Bright Red Passion Fruit—Evaluation of Colorimetry and Physicochemical Quality for the Fresh Fruit Market. *Scientia Horticulturae, 317,* Article 112016. https://doi.org/10.1016/j.scienta.2023.112016

Fen, D. (2021). China's Blue Book on Climate Change (2021) Is Released. *Environment, No. 11,* 75-77. (In Chinese)

Liang, J., Lu, L., Zhang, W. et al. (2023). Comprehensive Characterization and Expression Analysis of Enzymatic Antioxidant Gene Families in Passion Fruit (*Passiflora edulis*). *iScience, 26,* Article 108329. https://doi.org/10.1016/j.isci.2023.108329

Masakazu, N., & Hiroshi, M. (2022). Soilless Cultivation of 'Ruby Star' Passion fruit: Effects of NO_3-N Application, pH, and Temperature on Fruit Quality. *Scientia Horticulturae, 306,* Article 111462. https://doi.org/10.1016/j.scienta.2022.111462

Matsuda, H., & Higuchi, H. (2020a). Seasonal Changes in Passion Fruit Floral Morphology. *Tropical Agriculture and Development, 64,* 44-46. https://doi.org/10.11248/jsta.64.44

Matsuda, H., & Higuchi, H. (2020b). Effect of Temperatures on Passion Fruit Flowering: A Simulation Model to Estimate Number of Flowers. *Tropical Agriculture and Development, 64,* 54-60. https://doi.org/10.11248/jsta.64.54

Shimada, A., Kuramoto, K., Park, B. J. et al. (2020). Relationship between Temperature and Fruit Quality during Ripening Period in Passion Fruit. *Tropical Agriculture and Development, 64,* 47-53. https://doi.org/10.11248/jsta.64.47

Souto, A. G. D. L., Costa, J. C. F. D. C., Campos, N. L. F. et al. (2019). Effect of Temperature on Passion Fruit Emergence and Seedling Vigor. *Journal of Seed Science, 39,* 50-57. https://doi.org/10.1590/2317-1545v39n1169920

Wang, H., Zhao, J., Lai, M. et al. (2023). Differential Gene Expression Analysis and Physiological Response Characteristics of Passion Fruit (*Passiflora edulis*) Buds under High-Temperature Stress. *PeerJ, 11,* e14839. https://doi.org/10.7717/peerj.14839

Wang, W., Zheng, D., & Ling, L. (2022). The Impact of High Temperature and Drought on Passion Fruit and Corresponding Measures. *Fujian Science & Technology of Tropical Crops, 47,* 47-49. (In Chinese)

Xiao, T., Yuan, Q., Shi, B. et al. (2021). The Impact of Meteorological Disasters on Passion Fruit and Corresponding Measures. *Agricultural Technology Services, 38,* 93-94. (In Chinese)

Xu, Y., Li, P., Ma, F. et al. (2023). Characterization of the NAC Transcription Factor in Passion Fruit (*Passiflora edulis*) and Functional Identification of PeNAC-19 in Cold Stress. *Plants, 12,* Article 1393. https://doi.org/10.3390/plants12061393

Yan, P., Jin, Z., Wang, L. et al. (2022). Summer and Autumn Management Techniques of Passion Fruit. *Agricultural Technology Services, 39,* 69-72. (In Chinese)

You, S., & Cheng, Q. (2022). The Cultivation Technology of Passion Fruit Is Premature, High Yield and High Quality. *Fujian Science & Technology of Tropical Crops, 47,* 60-61+69. (In Chinese)

Zhang, W. (2022). Breeding of a New Variety of Passion Fruit, Fujian Passion Fruit No. 2. *China Fruits, No. 9,* 62-63+109+64. (In Chinese)

Zheng, X., & Wei, F. (2018). The Influence of Adverse Meteorological Conditions on the Production of Golden Passion Fruit. *Fujian Science & Technology of Tropical Crops, 43,* 34-36. (In Chinese)