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Effect of Temperature on Soluble Solids Content in Strawberry in Queensland, Australia

Christopher Michael Menzel

Department of Agriculture and Fisheries, SCMC, P.O. Box 5083, Nambour, QLD 4560, Australia; chris.menzel@daf.qld.gov.au

Abstract: Warmer conditions under climate change will alter plant, flower and fruit development in strawberry (*Fragaria* × *ananassa* Duch.). Most of the studies examining the relationship between soluble solids content (SSC) and temperature have been conducted in areas with a temperate or Mediterranean climate. I investigated the link between SSC and temperature in Queensland, Australia. Potted plants of 'Festival', 'Fortuna', 'Brilliance', 'Beauty' and 'Red Rhapsody' were planted on 19 April 2021 and information collected on productivity, SSC and titratable acidity (TA) from 14 July to 6 October. Additional data were collected on the concentrations of the main soluble sugars in the fruit from 4 August to 6 October. Nights were 2 to 4 °C warmer than the long-term average conditions from 1965 to 1990. Marketable yield was lower in 'Beauty' and higher in the other cultivars. Fruit were smaller in 'Festival', 'Fortuna' and 'Beauty' and larger in 'Brilliance' and 'Red Rhapsody'. Mean (±SE or standard error) SSC pooled across the cultivars was 7.6 ± 0.05%, and mean TA was 0.59 ± 0.005%. Fructose (30.2 ± 0.2 mg/g FW) and glucose (27.1 ± 0.3 mg/g FW) were the main sugars in the fruit, with lower concentrations of sucrose (0.05 ± 0.02 mg/g FW) and maltose (less than 1 mg/g FW). The mean concentration of all the sugars was 57.4 ± 0.5 mg/g FW. Soluble solids content decreased from 8.6 to 6.8% as the average daily mean temperature in the eight days before harvest increased from 14.5 to 19.5 °C ($p < 0.001$, $R^2 = 0.72$). These results are consistent with similar studies in Florida and suggest that higher temperatures in the future will decrease fruit quality in subtropical locations.

Keywords: fruit acids; harvest; soluble solids content; sugars

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1. Introduction

Climate change will have a strong impact on the yield and quality of strawberry (*Fragaria* × *ananassa* Duch.). Research in California indicated that yields under open-field conditions will decline by 10% by the middle of this century and by 43% by the end of this century, mainly because of temperature extremes and droughts [1–3]. Global warming will alter plant, flower and fruit development with smaller and less-sweet berries under higher temperatures [4,5].

Eating quality in strawberry and other crops is related to the concentrations of several components in the fruit including sugars, organic acids and volatiles [6–9]. Better quality is associated with high sugar levels, high sugar/acid ratios and high concentrations of specific volatile compounds. The main volatiles in strawberry include furonones, esters, terpenoids, sulphur compounds and benzenoids [10].

There are different sugars in strawberry. The main sugars in ripe fruit include fructose (46 to 66 mg/g FW), glucose (25 to 61 mg/g FW) and sucrose (16 to 68 mg/g FW), and these account for more than 95% of all the sugars [11]. The three main sugars have different levels of sweetness. Fructose and sucrose are 2.30 and 1.35 times sweeter than glucose [11]. These authors noted 14 other minor sugars with concentrations below 3.0 mg/g FW.

Many studies report data on soluble solids content (SSC) rather than on the concentrations of the sugars or the addition to the data on the sugars. There is a strong relationship between the two measures of sweetness [11–13]. Soluble solids content increases with an increase in the concentrations of sugars. Soluble sugars account for 80 to 90% of the soluble solids with values of SSC typically ranging from 6 to 12% [11–13].

Reports from North America, Europe and northern Asia indicate that SSC increases as solar radiation increases and decreases as the temperature increases, although there are a few contrary studies [4,14–16]. Krüger et al. [16] investigated the performance of two cultivars over two seasons across five locations from Norway to Italy. There were strong negative correlations between SSC and average daily mean temperature in the three weeks before harvest ($p < 0.001$, $r = -0.78$ or -0.70) and a positive correlation with solar radiation ($p < 0.001$, $r = 0.90$). These results suggest that poor eating quality could be an issue for commercial production under global warming.

Studies on the effect of environment on the growth and physiology of plants can be conducted in growth chambers and glasshouses or in the field. The response of plants to light, temperature or nitrogen under controlled conditions was a poor proxy to that recorded in the field [17–19]. For instance, Xu et al. [19] demonstrated that the effect of nitrogen on the biomass of plants under controlled conditions was three times higher than under field conditions.

This paper reports on the growth of five strawberry cultivars in Queensland, Australia. Information was collected on fruit soluble solids content (SSC), fruit titratable acidity (TA) and concentrations of the main sugars in the fruit. Changes in SSC over the growing period were used to evaluate the sensitivity of the berries to high temperatures. Most of the earlier studies on SSC were conducted in areas with a temperate or Mediterranean climate. There have been no reports on the changes in SSC in strawberry in Queensland or the main sugars found in local cultivars.

2. Materials and Methods

2.1. Experimental Design and Growing Conditions

Potted transplants of 'Festival' ('Strawberry Festival'), 'Fortuna' ('Florida Radiance'), 'Brilliance' ('Florida Brilliance'), 'Beauty' ('Florida Beauty') and 'Red Rhapsody' were planted on 19 April 2021 in the open field at Nambour in Queensland, Australia (latitude 26.6° S, longitude 152.9° E and elevation 29 m). The average (± SE, standard error) dry weight of the plants was 1.3 ± 0.2 g/plant.

The cultivars were planted in randomized blocks with six replicate blocks per cultivar. The transplants were planted through plastic, in double-row beds 70 cm wide and 130 cm apart from the centres and grown at 30 cm between the rows and 30 cm within the rows. This planting gave a density of 51,282 plants/ha. Irrigation was provided through drip-tape under the plastic when the soil water potential at a 25 cm depth fell below—10 kPa. The plants received a total of 117 kg/ha of N, 24 kg/ha of P, 165 kg/ha of K, 7 kg/ha of Ca and 13 kg/ha of Mg through the irrigation.

2.2. Data Collection

Information was collected on plant growth at the end of the experiment on 6 October. Mature fruit were harvested weekly to assess marketable yield from 14 July to 6 October. Marketable fruit were at least 12 g fresh weight and were not affected by rain or grey mould, or were misshapen or had other defects.

Data were collected on total soluble solids content (SSC), and titratable acidity (TA) as citric acid measured at 20 °C weekly from 14 July to 6 October giving 13 harvests, with six fruit sampled from each plot [12]. Additional data were collected on the concentrations of soluble sugars (i.e., sucrose, fructose, glucose and maltose) from 4 August to 6 October [20], giving ten harvests. Fruit samples (six berries) were homogenized with ultrapure water, filtered through a 0.22 µm syringe filter and stored in vials for later chemical analysis [11]. The analysis for the soluble sugar profile was conducted using high-performance liquid chromatography (HPLC) using an instrument from Shimadzu Corporation, Kyoto, Japan, equipped with a Shimadzu ELSD-LT detector [21]. The different sugars were separated utilizing a Luna C18-NH_2 column (250 mm × 4.6 mm, 5 μm) from Phenomenex, Lane Cove, Australia, at 40 °C, with a mobile phase of aqueous 80% acetonitrile using a flow rate of 2.0 mL/min. The concentration of the sugars was determined using standard solutions of fructose, glucose, sucrose and maltose from analytical-grade sugars obtained from Sigma–Aldrich (Castle Hill, Australia). There were six replicates per cultivar for each sampling.

Daily maximum and minimum temperatures, monthly rainfall and daily solar radiation data were collected at the site from the Bureau of Meteorology (www.bom.gov.au) accessed on 30 November 2021.

2.3. Data Analysis

There were 22 plants/plot for each cultivar for the data on yield, fruit size, SSC, TA and fruit sugars and 2 plants/plot for the data on plant growth.

Data on growth, yield, mean average seasonal fruit weight, SSC, TA and concentrations of fruit sugars were analysed by one-way analysis of variance (ANOVA, five cultivars × six blocks) using GenStat (Version 21; VSN International, Hemel Hempstead, UK). Treatment means were separated by calculating least significant differences (LSDs) from the ANOVAs.

The relationships between SCC and TA, and the average daily mean temperature and solar radiation in the eight days before harvest were analysed by regression and fitted using the graphical software program SigmaPlot (Version 14.5; Systat, Chicago, IL, USA). This follows the recommendation by MacKenzie et al. [4], where an eight-day interval was better at estimating SSC than other intervals from one day to twenty-one days before harvest in Florida.

3. Results

3.1. Weather

The average daily maximum temperature ranged from 21.8 to 28.4 °C, while the minimum ranged from 10.3 to 16.9 °C (Table 1). Solar radiation ranged from 12.3 to 20.8 MJ/m^2 and total monthly rainfall ranged from 4 to 190 mm. Days were close to long-term conditions, whereas nights were 2 to 4 °C warmer. Monthly solar radiation was similar in the two periods. It was drier in June, August, September and October in 2021 compared with the long-term data.

Table 1. Daily temperatures and solar radiation, and total monthly rainfall at Nambour. Long-term average temperatures (1965 to 1990), solar radiation (2004 to 2019) and rainfall (2007 to 2019) are also presented.

Period	April	May	June	July	August	September	October
2021							
Mean daily maximum temperature (°C)	25.8	24.0	21.8	21.9	23.7	25.2	28.4
Mean daily minimum temperature (°C)	15.6	13.4	11.0	10.3	11.4	12.9	16.9
Mean daily solar radiation (MJ/m^2)	15.7	13.8	12.3	13.2	16.0	18.9	20.8
Total monthly rainfall (mm)	190	125	59	71	4	20	58
Long-term average							
Mean daily maximum temperature (°C)	26.1	23.5	21.3	20.8	22.3	24.6	26.5
Mean daily minimum temperature (°C)	15.0	11.7	8.5	7.0	7.4	9.8	13.2
Mean daily solar radiation (MJ/m^2)	16.2	13.7	11.7	13.1	16.1	18.9	20.9
Total monthly rainfall (mm)	160	108	115	50	58	90	80

Temperature and solar radiation data for the eight days before the fruit were harvested were used to explore the relationships between SSC and environmental conditions [4]. There was a moderate positive relationship between maximum temperature and solar radiation (p = 0.002, R^2 = 0.55, n = 13).

3.2. Plant Growth

Leaf production was lower in 'Beauty' and higher in 'Festival', 'Fortuna' and 'Brilliance' (Table 2). Leaf area expansion was lower in 'Fortuna', 'Beauty' and 'Brilliance' and higher in 'Festival'. Leaf and crown dry weight were lower in 'Fortuna', 'Brilliance' and 'Beauty' and higher in 'Festival' and 'Red Rhapsody'. Root dry weight was lower in 'Brilliance' and higher in 'Festival', 'Beauty' and 'Red Rhapsody'.

Table 2. Variations in plant growth in five strawberry cultivars in Queensland. Data are the means (±SD or standard deviation) of six replicates per cultivar and were collected on 6 October. Means in a column followed by a common letter were not significantly different by the Fisher's least significant test at the 5% level of significance.

Cultivar	No. of Leaves/Plant	Leaf Area (cm^2/Plant)	Leaf Dry Weight (g/Plant)	Crown Dry Weight (g/Plant)	Root Dry Weight (g/Plant)
Festival	26.8 ± 2.0 bc	2010 ± 161 c	17.1 ± 1.9 b	4.8 ± 0.9 b	1.6 ± 0.4 bc
Fortuna	28.0 ± 5.5 c	1516 ± 120 ab	10.7 ± 1.2 a	3.3 ± 0.6 a	1.4 ± 0.4 ab
Brilliance	26.2 ± 2.3 bc	1474 ± 211 ab	10.1 ± 0.8 a	3.3 ± 0.4 a	1.1 ± 0.1 a
Beauty	21.1 ± 2.5 a	1395 ± 233 a	11.2 ± 2.1 a	3.4 ± 0.5 a	1.5 ± 0.3 bc
Red Rhapsody	24.2 ± 5.6 ab	1728 ± 368 bc	15.4 ± 3.8 b	4.4 ± 0.7 b	1.8 ± 0.1 c

3.3. Yield and Fruit Quality

Seasonal variations in accumulated yield followed sigmoid patterns ($p < 0.001$, R^2s = 0.99, $n = 13$) and were generally similar across the cultivars (data not presented). The equation used was: Yield (g/plant) = $S_m/(1 + \exp.(-k \times (\text{Day-m}))$, where S_m is the maximum yield, k is a rate constant (yield/day), and m describes the time to reach the maximum increase in yield. All the cultivars produced a marketable crop in the last few harvests, although at a lower rate than in the middle of the season.

Yield was lower in 'Beauty' and higher in the other cultivars (Table 3). Fruit were smaller in 'Festival', 'Fortuna' and 'Beauty' and larger in 'Brilliance' and 'Red Rhapsody'.

Table 3. Variations in marketable yield, mean seasonal fruit weight, fruit soluble solids content (SSC) and fruit titratable acidity (TA) in five strawberry cultivars in Queensland. Data are the means (±SD or standard deviation) of six replicates per cultivar. Means in a column followed by a common letter were not significantly different by the Fisher's least significant test at a 5% level of significance.

Cultivar	Marketable Yield (g/Plant)	Fruit Weight (g)	Soluble Solids Content (%)	Titratable Acidity (%)
Festival	493 ± 58 b	21.2 ± 0.6 a	7.9 ± 0.2 b	0.63 ± 0.01 d
Fortuna	483 ± 13 b	22.5 ± 0.6 b	7.2 ± 0.3 a	0.57 ± 0.01 b
Brilliance	440 ± 53 b	23.8 ± 0.8 c	7.1 ± 0.2 a	0.54 ± 0.02 a
Beauty	367 ± 64 a	21.5 ± 1.0 ab	8.2 ± 0.2 c	0.61 ± 0.01 c
Red Rhapsody	507 ± 42 b	25.0 ± 1.0 d	7.5 ± 0.1 b	0.61 ± 0.02 c

Soluble solids content (SSC) was lower in 'Fortuna' and 'Brilliance' and higher in 'Festival', 'Beauty' and 'Red Rhapsody' (Table 3). The relative order for increasing titratable acidity (TA) was 'Brilliance' < 'Fortuna' < 'Beauty' = 'Red Rhapsody' < 'Festival'. Mean (±SE or standard error) SSC pooled across the cultivars was 7.6 ± 0.05% and mean TA was 0.59 ± 0.005%. There was a weak positive relationship between SSC and TA ($p < 0.001$, $R^2 = 0.18$).

Fructose (30.2 ± 0.2 mg/g FW) and glucose (27.1 ± 0.3 mg/g FW) were the main sugars in the berries, with lower concentrations of sucrose (0.05 ± 0.02 mg/g FW) and maltose (less than 1 mg/g FW). The mean concentration of all the sugars measured was 57.4 ± 0.5 mg/g FW. Fructose accounted for 52.8 ± 0.1 % of all the sugars. There was a strong positive linear relationship between SSC and total sugars (Figure 1; $p < 0.001$, $R^2 = 0.77$).

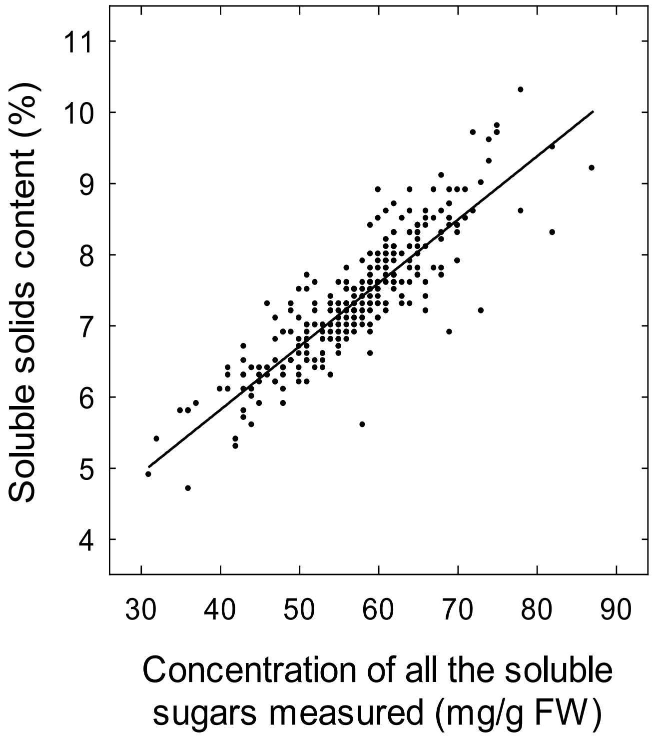

Figure 1. Relationship between fruit soluble solids content (SSC) and concentrations of all the soluble sugars measured (Sugars, %) from 4 August to 6 October in strawberries in Queensland (n = 10 harvests). Samples were collected from five cultivars with six replicates. Data are individual samples. SSC (%) = Intercept + 0.089 × Sugars (p < 0.001, R^2 = 0.77, n = 300).

The concentration of fructose across the cultivars ranged from 28.1 to 33.1 mg/g FW, glucose ranged from 24.7 to 30.4 mg/g FW, sucrose ranged from 0 to 0.2 mg/g FW and total sugars ranged from 53.1 to 63.9 mg/g FW (Table 4). Fructose accounted for 51.9 to 53.4% of all the sugars measured.

Table 4. Variations in the mean concentration of fructose, glucose and sucrose and total soluble sugars in five strawberry cultivars in Queensland. Data are the means (±SD or standard deviation) of six replicates per cultivar. Means in a column followed by a common letter are not significantly different by the Fisher's least significant test at 5% level of significance. FW = fresh weight.

Cultivar	Fructose (mg/g FW)	Glucose (mg/g FW)	Sucrose (mg/g FW)	Total Sugars (mg/g FW)
Festival	31.5 ± 3.6 c	28.2 ± 4.3 c	0 ± 0 a	59.7 ± 7.8 c
Fortuna	28.1 ± 3.6 a	24.7 ± 3.8 a	0.1 ± 0.5 a	53.1 ± 7.4 a
Brilliance	28.2 ± 3.6 a	25.4 ± 4.3 ab	0 ± 0 a	53.6 ± 7.8 a
Beauty	33.1 ± 3.7 d	30.4 ± 4.0 d	0.2 ± 0.7 a	63.9 ± 7.7 d
Red Rhapsody	30.1 ± 4.2 b	26.6 ± 4.7 b	0 ± 0 a	56.6 ± 8.8 b

Soluble solids content decreased over the season, with an increase at the last harvest (Figure 2; p < 0.001, R^2 = 0.77). The fruit at the last harvest were small (mean weight of 14.7 ± 0.8 g), had a dry flesh and a mean SSC of 8.2 ± 0.4%. There was a strong negative linear relationship between SSC and temperature in the eight days before the fruit were harvested (Figure 3; p < 0.001, R^2 = 0.72). Soluble solids content decreased from 8.6 to 6.8% as the average daily mean temperature increased from 14.5 to 19.5 °C. Data from the last harvest were excluded from this analysis. There was a moderate negative linear relationship between SSC and average daily solar radiation (p = 0.011, R^2 = 0.44).

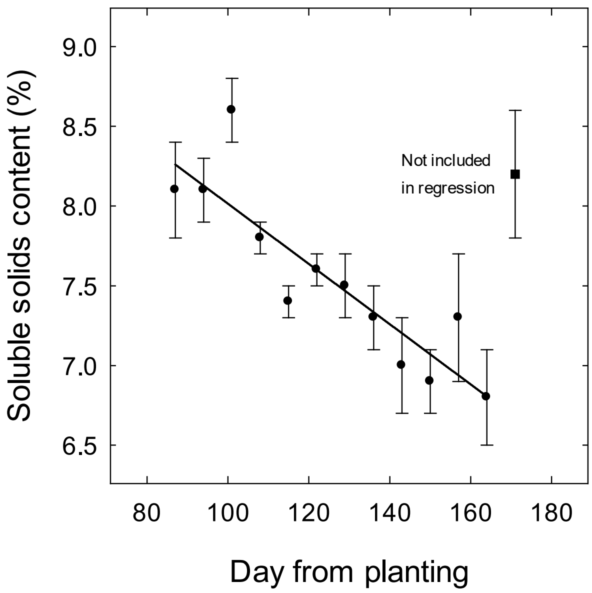

Figure 2. Seasonal changes in fruit soluble solids content (SSC) in strawberries in Queensland. Data are the means (±SEs) of five cultivars with six replicates for each cultivar. Day 1 was the date of planting on 19 April, and Day 171 was the last harvest on 6 October. For all, except the last harvest, SSC (%) = Intercept − 0.019 × Day ($p < 0.001$, $R^2 = 0.77$, $n = 12$).

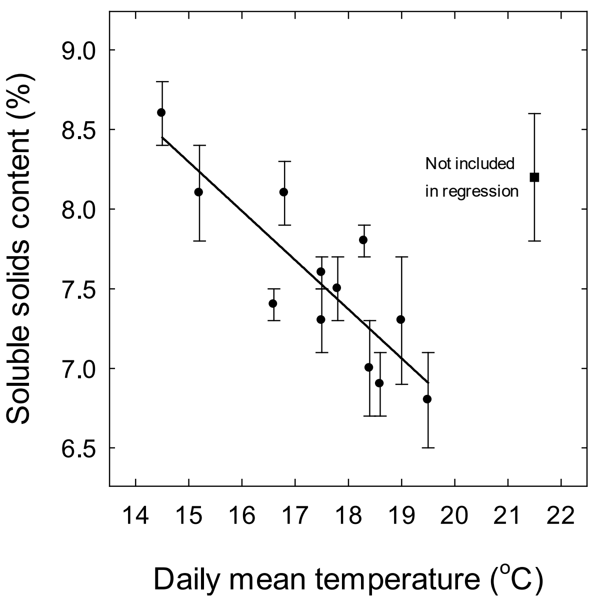

Figure 3. Relationship between fruit soluble solids content (SSC) and average daily mean temperature (Temperature) in the eight days before the fruit were harvested in strawberries in Queensland. Data are the means (±SEs) of five cultivars with six replicates for each cultivar. For all, except the last harvest, SSC (%) = Intercept − 0.313 × Temperature ($p < 0.001$, $R^2 = 0.72$, $n = 12$).

There was no trend in seasonal changes in TA ($p = 0.881$). There were also no significant relationships between TA and daily mean temperature ($p = 0.447$) or solar radiation ($p = 0.661$). Data from the last harvest were included in these analyses.

There was no relationship between SSC and weekly yield (g/plant, $p = 0.073$, $n = 13$). In contrast, there was a moderate negative linear relationship between TA and weekly yield (TA = Intercept − 0.004 × Weekly yield; $p < 0.001$, $R^2 = 0.61$, $n = 13$). Fruit TA decreased as weekly yield increased.

4. Discussion

Eating quality in strawberry is related to the concentrations of sugars, acids and volatiles in the berries [22]. The results of the experiment showed that soluble solids content (SSC) decreased as temperatures increased over the season in Queensland. Low SSCs under high temperatures were possibly related to higher respiration under warm nights and quicker fruit development under warm days and nights. Higher temperatures with global warming will decrease fruit quality and the profitability of strawberry cultivation in some locations.

4.1. Yields

The productivity of strawberry depends on the cultivar, growing system and the environment [16]. Yields were relatively low, reflecting the small size of the transplants (less than 2.0 g dry weight) and the late time of planting [23,24]. Chandler, Whitaker and colleagues provided information on the productivity of cultivars developed in Florida [25–28]. Mean (±SE) marketable yields ranged from 647 ± 87 g/plant for 'Beauty' to 854 ± 92 g/plant for 'Brilliance'. Ariza et al. [29] demonstrated that the yields of five cultivars in Spain were highly variable. Further experiments over multiple years are required to determine the productivity of cultivars in Queensland.

4.2. Effect of Cultivar on Soluble Solids Content and Titratable Acidity

There were only small differences in mean berry chemistry across the cultivars. This response reflects the low genetic diversity across the cultivars and common ancestors in the two breeding programs in Florida and Queensland.

Differences in fruit quality have been reported across strawberry species, hybrids and commercial cultivars [30–36]. Ogiwara et al. [30] indicated that total sugars ranged from 26.5 to 73.7 mg/g FW in 50 genotypes including wild species in Japan. In the same study, SSC ranged from 6.0 to 12.1% in 41 cultivars, and TA ranged from 0.48 to 1.09%. Hasing et al. [37] investigated changes in SSC in 410 genotypes in Florida. Harvest means ranged from 5.1 to 9.9% in the first season and from 6.5 to 10.6% in the second season. Approximately 90% of the genotypes were moderately stabile over the season, 5% were unstable and 5% were stable. Narrow-sense heritability for a stable SSC over the season was low (h^2 = 0.06 ± 0.05). However, there was a poor correlation between the stability of SSC and mean SSC over the harvests (r = 0.02). There were some individuals with stable SSCs and a high mean SSC.

4.3. Effect of Temperature on Soluble Solids Content and Titratable Acidity

Various approaches have been used to determine the effect of temperature on SSC in strawberry, including field and controlled-environment studies [4,14–16,38–53]. Some authors used the changes in temperature across seasons or harvests within a season to explore the relationship between SSC and temperature in the field. Other authors used different day and night temperatures under controlled conditions. Temperature, light levels and watering can be controlled separately in growth chambers or glasshouses. However, there are disadvantages to these experiments including inadequate lighting, small ranges in temperature used for different treatments, inadequate replication, inappropriate experimental design (no true blocks) and low yields [17–19,54–56].

High temperatures often decrease SSC [39–42], although there are a few contrary reports [50–53]. Variations in the response to temperature could be due to the differences in cultivars, solar radiation and the time of sampling. The concentration of sugars in berries varies across different plants, inflorescences and fruit [57,58]. In Queensland, SSC decreased by 0.313 ± 0.058% for each degree Celsius increase in temperature. This value was 0.345% in the field in Florida [4], 0.431 ± 0.054% in growth chambers in Japan [41] and 0.265 ± 0.030% in glasshouses in Maryland [46].

Fruit growth in strawberry is dependent on photosynthesis occurring in the leaves [59]. There is a broad temperature optimum for photosynthesis [60–63]. Maximum net CO_2 assimilation occurs from 18 to 32 °C, with assimilation decreasing at lower or higher temperatures. Respiration increased with increasing temperature following a Michaelis–Menten model [64]. The rate of respiration in fruit was 14, 43, or 72 mL O_2 consumed/kg FW/h at 10, 19 or 23 °C in this study.

Fruit growth depends on the balance between photosynthesis during the day and respiration during the night [65]. Net assimilation, fruit growth and the concentration of soluble sugars were all higher with warm days and cool nights in this study in China. Temperature can also affect the rate of fruit development, with high temperatures shortening the period between bloom and fruit harvest [4,66]. The period of fruit development decreased by 1.5 days for each degree Celsius increase in temperature in Florida. The effect of high temperatures on SSC in Queensland is probably related to higher respiration under warm nights and quicker fruit development under warm days and nights. Temperatures during the day were probably suitable for maximum photosynthesis. High temperatures decrease SSC during storage of strawberry fruit, and this response would mainly be due to the higher respiration in the dark [67–69].

There are mixed reports on the relationship between berry TA and temperature. Agüero et al. [48] found positive correlations between TA and temperature in Argentina ($p < 0.01$, $r = 0.65$ to 0.76). Cárdenas-Navarro et al. [49] reported negative correlations between TA and solar radiation ($p < 0.001$, $r = -0.66$) and temperature ($p < 0.001$, $r = -0.58$) in Mexico. Krüger et al. [16] indicated that there was a negative correlation between TA and temperature in Europe ($p < 0.001$, $r = -0.66$).

Determining the effect of temperature on SSC in the field can be problematic. This is because temperature is often correlated with solar radiation. There can also be changes in crop load over the season which can affect sugar levels in the fruit.

In Queensland, there was a positive relationship between daily maximum temperature and solar radiation and a negative relationship between SSC and solar radiation. Higher light levels would be expected to increase SSC, if temperatures are optimum for sugar accumulation in the fruit. Hoppula and Karhu [15] demonstrated that there was a negative correlation between SSC and temperature in Finland ($r = -0.63$) and a positive correlation between SSC and solar radiation ($r = 0.59$). MacKenzie et al. [4] studied the relationship between fruit development and temperature in Florida. They concluded that a heavy crop later in the season did not lower SSC and that low SSCs were mainly due to the higher temperatures. Kerr et al. [70] suggested that strawberry crops in California would be moderately susceptible to increases in day temperatures in summer and increases in night temperatures in winter under global warming over the next 30 years. They rated the sensitivity of the plants to higher temperatures as two or three. A rating of one indicated low sensitivity, while a rating of four indicated high sensitivity.

5. Conclusions

Soluble solids content decreased from 8.6 to 6.8% as the average daily mean temperature increased from 14.5 to 19.5 °C in Queensland. These results are consistent with those reported by MacKenzie et al. [4] in Florida. Higher temperatures in the future will decrease fruit quality and the economics of production in subtropical locations.

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Data Availability Statement: Contact the author for a copy of the data used in this research.

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Conflicts of Interest: The author declares no conflict of interest.

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