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Yields of Strawberry Plants over 20 Years in Subtropical Queensland, Australia

Christopher Michael Menzel

Department of Primary Industries, Sunshine Coast Mail Center, P.O. Box 5083, Nambour, QLD 4560, Australia; chris.menzel@dpi.qld.gov.au

Abstract

Productivity has a strong effect on the net returns of strawberry production. Returns are higher with high yields than with low yields, with productivity dependent on the cultivar, season and growing system. The main objective of this study was to determine the relationship between productivity and the time of planting and the time of the last harvest in Queensland, Australia. Information was collated on the yields of strawberry plants growing in this area over 20 years. Cultivars from Australia, Florida and California were planted from 2004 to 2024 and data collected on marketable yield (n = 41 cases). The transplants were planted from 16 March to 5 May, with the last harvest ranging from 6 August to 28 October. The fruit were harvested each week until they became small or soft or otherwise non-marketable. Mean yield (±standard deviation or s.d.) was 652 ± 327 g/plant, the median was 675 g/plant, and the range was from 142 to 1123 g/plant. There was a moderate linear relationship between yield and the time of the last harvest ($p < 0.001$, $R^2 = 0.43$). In other words, yields increased as harvesting was prolonged. There was a positive linear relationship between yield and the length of the growing season, which included the time of planting ($p < 0.001$, $R^2 = 0.58$). Yields increased as the length of the growing season increased from 108 to 205 days. These results suggest that early plantings (about mid-March for most cultivars) and a long growing season are associated with high yields in Queensland. Warm weather and intermittent rain impact fruit quality and end the harvest in this area. Yields are expected to decrease in the future under global warming in the absence of mitigating strategies.

Keywords: cultivar; season; temperature; time of planting; weather; yield

1. Introduction

Strawberry (*Fragaria* × *ananassa* Duch.) is an important and healthy fruit in the berry catalogue, with a total annual production around the world of 8 to 10 million tonnes in the past few years [1–3]. China has the largest crop, with 40% of production, followed by the United States with 10% of production. The crop is cultivated throughout much of Europe (22% of production), with Egypt in the Middle East and Mexico in Central America being the top producers in their respective regions. The species is adapted to a wide range of environments, with production in areas with a cool, temperate climate, a warm subtropical climate or a Mediterranean climate [4–7]. The plants are grown under different cultivation systems, including open-field and protected cropping [8,9]. Most of the crop is grown in the ground using conventional cultivation, although soilless and organic production are becoming more important [10–12].

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Net returns from the crop depend on the weather, productivity, the growing system and the costs of labour for planting, growing and harvesting the fruit [13–15]. Net returns are higher with high yields than with low yields. Harvesting accounts for more than 50% of total growing costs in some locations, and a shortage of labour often hinders industry expansion. The cost of labour is lower in Central and South America than in Australia, Europe and North America. Michuda et al. [13] analyzed the returns on production in California. They found that returns ranged from a loss of USD 23,799/ha to a profit of USD 121,880/ha, depending on conventional or organic cultivation and the use of soil fumigation. Mbarushimana et al. [14] studied the performance of plants under high tunnels and in the open field in Virginia. Nearly all the cultivars under the tunnels gave negative net returns because of heat stress under the plastic. The average net return for the plants in the open was USD 39,816 when the fruit were consigned to the wholesale market. Duan et al. [15] indicated that yield was the primary factor determining the profitability of open-field organic production in Florida. Yields below 10 t/ha gave negative net returns even when the price received for the fruit was high.

The selection of cultivar has a major impact on the success of commercial strawberry cultivation, with continued efforts to breed cultivars suitable for different growing areas [16–21]. The plants respond to changes in daylength and temperature, which affect several aspects of plant growth and flowering [22,23]. Cultivars have different times of flowering and ripening in a single location and across different locations. Cultivars have been bred to crop successfully in a range of environments, including Nordic, temperate, subtropical and Mediterranean locations [8,12,24,25].

Various authors have reported on the productivity of strawberry in warm locations in the United States such as Florida and North Carolina [26–35]. These areas have a similar climate to southern Queensland and often use similar cultivars. Mean yield ($\pm$ standard deviation or s.d.) was 613 $\pm$ 171 g/plant, the median was 585 g/plant, and the range was from 370 to 931 g/plant in these studies. Johnson and Hoffmann [32] recorded the productivity of 'Albion', 'Brilliance', 'Camino Real', 'Fronteras', 'Monterey', 'Florida Sensation' and 'Sweet Charlie' over two years in North Carolina. Mean yield was 650 $\pm$ 54 g/plant in the first year and 417 $\pm$ 64 g/plant in the second year. The Florida cultivars 'Brilliance' and 'Florida Sensation' had more consistent production than the long-day cultivars 'Albion' and 'Monterey'.

High yields are dependent on favourable weather during the growing period. Cold weather damages the plants and the flowers and inhibits pollination, while warm weather reduces floral initiation, fruit development and fruit quality [36–38]. Optimum temperatures for high yields range from 15 °C to 25 °C. Heavy rainfall or high humidity affect pollination and promote the development of several crown, leaf and fruit diseases along with direct rain damage to the fruit [39–42].

Australia produces about 90,000 tonnes of strawberries each year, with major production in Queensland (41% of total production), Victoria and Western Australia and minor production in South Australia, Tasmania and New South Wales [43–45]. A range in climatic conditions, cultivars and growing systems provides fruit over the whole year. Production in Queensland is mostly during the cooler part of the year, with the nursery material planted from mid-March to late April [46,47]. Harvesting of the fruit commences in June and continues to September or October, depending on the weather. The fruit are harvested until they become small or soft or otherwise non-marketable due to hot or wet weather.

This paper reports on the yields of strawberry plants growing in Queensland over 20 years. The time of planting ranged from March to May, and the last harvest ranged from August to October. The main objective of the study was to determine the relationship between productivity and the time of planting and the time of the last harvest. Suggestions for producing high yields in this environment are provided.

2. Materials and Methods

Information was collated to examine the productivity of strawberry plants growing in Nambour in south-east Queensland, Australia over 20 years. Cultivars from Australia, Florida and California were planted from March to May from 2004 to 2024 and data collected on marketable yield (Table 1, n = 41 cases). Transplanting occurred from 16 March to 5 May and the last harvest ranged from 6 August to 28 October. The fruit were harvested each week until they became small or soft or otherwise non-marketable. Marketable fruit weighed at least 12 g and were free from defects, including rain damage, diseases and pests. The non-marketable fruit were harvested and discarded. Each experiment was laid out in randomized blocks, with 2 to 6 replicates for each cultivar (mostly 4 replicates) and 10 to 30 plants for each plot (mostly 20 plants).

Nambour has a subtropical climate, with cool, dry winters and warm, wet summers. The average maximum and minimum temperatures in July are 21.6 °C and 10.6 °C, while the averages in December are 29.1 °C and 19.5 °C. Total annual rainfall is 1627 mm, and average solar radiation is 17.8 MJ/m^2/day. The soil at the experimental site was a well-drained sandy clay loam.

The transplants were pushed 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 each year.

Data on productivity are presented as mean yields with standard deviations (s.d.) for each experiment. The first analysis included the yields from all the experiments ('Festival' plus all the other cultivars). The second included the yields from the experiments with 'Festival' only and the yields from the experiments with the other cultivars with and without 'Festival'. A t-test was employed to determine if the mean yields from the two groups of experiments ('Festival' versus other cultivars with and without 'Festival') were similar.

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 October 2025). Average values for temperature and radiation for each season are presented along with total values for rainfall. The relationships between yield and the date of planting, date of the last harvest and the length of the growing season were analyzed by regression and fitted using the graphical software programme SigmaPlot (Version 15; Grafiti LLC, Palo Alto, CA, USA; www.grafiti.com). The first analysis included the data from all the experiments, the second the data from the experiments with 'Festival alone, and the third the data from the experiments with the other cultivars (with and without 'Festival'). The relationships between yield and average temperatures during the season, total rainfall and average solar radiation were also analyzed by regression.

Table 1. Details of the experiments examining the yield of strawberry plants in Queensland, Australia from 2004 to 2024 (n = 41 cases). Mean yields are presented with standard deviations (s.d.).

Exp.	Year	Cultivars	Reps./Cultivar	Plants/Plot	Date of Planting	Date of the Last Harvest	Length of the Season (Days)	Yield (g/Plant)
1	2004	Festival & Sugarbaby	2	10	20 April	6 August	108	189 ± 37
2	2005	Festival, Rubygem & Sugarbaby	4	10	19 April	3 October	167	703 ± 89
3	2006	Festival & Rubygem	4	20	11 April	26 September	168	480 ± 125
4a	2007	Festival	4	20	22 March	9 October	201	724 ± 26
4b	2007	Festival	4	20	1 April	9 October	191	745 ± 51
4c	2007	Festival	4	20	15 April	9 October	177	701 ± 43
4d	2007	Festival	4	20	29 April	9 October	163	543 ± 34
5a	2008	Festival	5	20	17 March	8 October	205	1092 ± 82
5b	2008	Festival	5	20	1 April	8 October	190	880 ± 56
5c	2008	Festival	5	20	13 April	8 October	178	675 ± 36
5d	2008	Festival	5	20	28 April	8 October	163	510 ± 28
6a	2009	Festival	5	20	16 March	6 October	204	933 ± 36
6b	2009	Festival	5	20	2 April	6 October	187	727 ± 32
6c	2009	Festival	5	20	14 April	6 October	175	605 ± 65
6d	2009	Festival	5	20	28 April	6 October	161	555 ± 38
7a	2010	Festival	4	20	31 March	13 October	196	875 ± 122
7b	2010	Festival	4	20	14 April	13 October	182	689 ± 102
7c	2010	Festival	4	20	28 April	13 October	168	643 ± 114
8a	2010	Fortuna	4	20	7 April	13 October	189	827 ± 119
8b	2010	Fortuna	4	20	21 April	13 October	175	518 ± 84
8c	2010	Fortuna	4	20	5 May	13 October	161	478 ± 77
9a	2011	Festival	4	20	30 March	12 October	196	966 ± 109
9b	2011	Festival	4	20	13 April	12 October	182	668 ± 48
9c	2011	Festival	4	20	27 April	12 October	168	740 ± 31
10a	2011	Fortuna	4	20	6 April	12 October	189	823 ± 141
10b	2011	Fortuna	4	20	20 April	12 October	175	749 ± 46
10c	2011	Fortuna	4	20	4 May	12 October	161	643 ± 54
11	2012	Festival, Rubygem & two breeding lines	4	30	21 March	10 October	203	720 ± 70
12	2013	Festival, Rubygem & two breeding lines	4	30	21 March	11 September	174	479 ± 44
13	2014	Festival, Fortuna & Winter Dawn	4	20	10 April	8 October	181	796 ± 152
14a	2015	Festival	6	20	20 April	21 October	184	1123 ± 97
14b	2015	Festival	6	20	29 April	21 October	175	1037 ± 98
15	2016	Festival	4	14	13 April	20 October	190	991 ± 16
16	2017	Festival	4	18	19 April	31 August	134	268 ± 14
17a	2019	Festival	6	20	17 April	5 September	141	390 ± 75
17b	2019	Fortuna	6	20	27 March	5 September	162	357 ± 78
18	2020	Festival, Fortuna, Red Rhapsody, Scarlet Rose & Sundrench	6	24	29 April	28 October	182	588 ± 96
19	2021	Festival, Fortuna, Red Rhapsody, Brilliance & Beauty	6	22	19 April	6 October	170	458 ± 71
20	2022	Festival, Fortuna, Red Rhapsody, Fronteras, Grenada & Petaluma	6	24	20 April	19 October	182	371 ± 49
21	2023	Festival, Fortuna, Brilliance, Red Rhapsody, Sundrench & Suzie	6	22	30 March	6 September	160	331 ± 55
22	2024	Festival, Fortuna, Brilliance, Red Rhapsody, Sundrench & Suzie	6	20	22 April	18 September	149	142 ± 59

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3. Results

3.1. Weather

During the experiments, the average daily mean temperature ranged from 16.5 to 19.0 °C, total rainfall ranged from 57 to 970 mm, and average solar radiation ranged from 12.7 to 15.7 MJ/m^2/day (Table 2). The average daily maximum from April to October, which covered the main growing season from 2004 to 2024, was 24.2 ± 0.6 °C, the minimum was 12.9 ± 0.8 °C and the mean was 18.5 ± 0.5 °C. The relevant temperatures from 1967 to 1990 were 23.6 ± 0.5 °C, 10.5 ± 0.9 °C and 17.1 ± 0.6 °C. This period covered the time when weather data were available at Nambour and before the impact of global warming on average temperatures became severe. The analysis indicates that the nights were about 2.5 °C warmer during the experiments than the long-term values. There were significant trends in daily mean temperature (p = 0.001, R^2 = 0.40; Figure 1) and daily minimum temperature (p < 0.001, R^2 = 0.52) from 2004 to 2024. Mean temperatures increased by 1.31 °C over the period, while minimum temperatures increased by 2.23 °C. Maximum temperatures were stable (p = 0.454; increase of 0.38 °C).

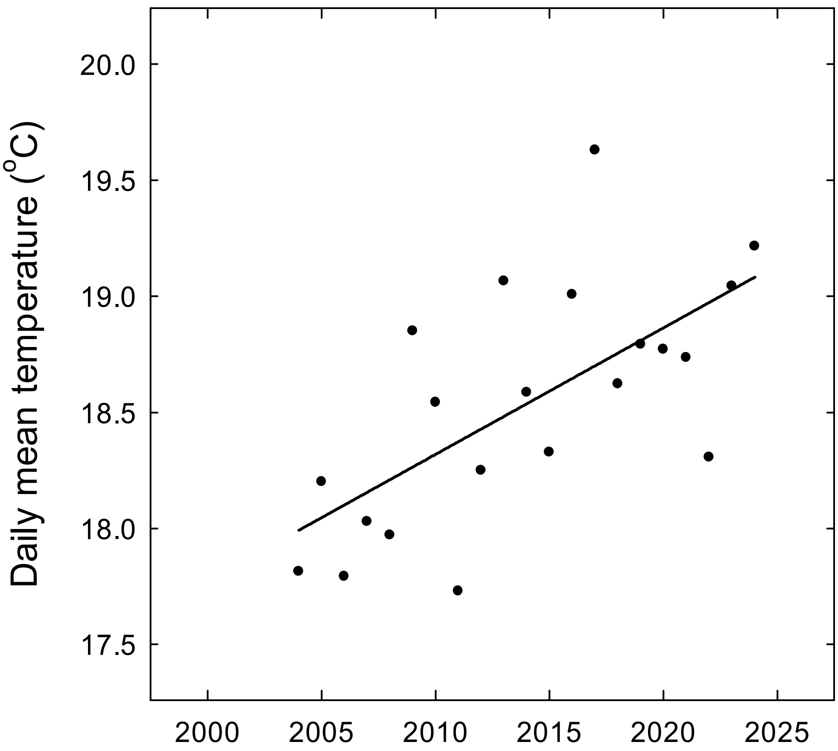

Figure 1. Changes in average daily mean temperature over the experiments with the strawberry plants in Queensland, Australia from 2004 to 2024 (n = 41 cases). The data were collected from April to October. Temperature (°C) = Intercept + 0.0545 × Year (p = 0.001, R^2 = 0.40).

Table 2. Weather conditions during the experiments examining the yield of strawberry plants in Queensland, Australia from 2004 to 2024 (n = 41 cases).

Exp.	Year	Max. Temperature (°C)	Min. Temperature (°C)	Mean Temperature (°C)	Total Rainfall (mm)	Solar Radiation (MJ/m^2/Day)
1	2004	23.3	9.6	16.4	57	14.2
2	2005	23.1	11.0	17.1	494	15.2
3	2006	23.5	10.7	17.1	414	15.6
4a	2007	24.1	11.8	17.9	810	15.7
4b	2007	23.9	11.4	17.6	794	15.4
4c	2007	23.7	11.0	17.4	781	15.2
4d	2007	23.4	10.8	17.1	773	14.9
5a	2008	23.4	12.5	18.0	766	15.3
5b	2008	23.3	12.3	17.8	766	15.2
5c	2008	23.1	12.0	17.5	758	14.9
5d	2008	22.9	11.7	17.3	725	14.7
6a	2009	24.5	13.4	19.0	947	15.7
6b	2009	24.2	12.9	18.6	852	15.5
6c	2009	24.2	12.4	18.3	569	15.7
6d	2009	23.9	12.1	18.0	399	15.5
7a	2010	23.3	13.6	18.5	764	13.6
7b	2010	22.9	13.2	18.1	729	13.4
7c	2010	22.7	12.9	17.8	608	13.3
8a	2010	23.1	13.5	18.3	759	13.5
8b	2010	22.9	13.1	18.0	669	13.3
8c	2010	22.6	12.7	17.7	589	12.7
9a	2011	22.4	12.0	17.2	548	14.4
9b	2011	22.7	11.6	17.2	436	14.4
9c	2011	22.5	11.1	16.8	367	14.5
10a	2011	22.8	11.8	17.3	511	14.5
10b	2011	22.6	11.4	17.0	389	14.5
10c	2011	22.4	10.9	16.7	331	14.5
11	2012	23.6	12.9	18.2	527	15.4
12	2013	23.7	13.2	18.4	551	14.0
13	2014	23.5	12.4	18.0	518	14.9
14a	2015	23.3	12.3	17.8	520	15.2
14b	2015	23.1	12.2	17.7	512	15.2
15	2016	24.2	13.1	18.6	575	14.9
16	2017	24.0	12.8	18.4	147	14.3
17a	2019	23.3	12.2	17.8	436	13.9
17b	2019	23.7	12.9	18.3	607	14.0
18	2020	23.5	12.8	18.1	360	15.4
19	2021	23.6	12.0	17.8	379	15.2
30	2022	22.4	12.6	17.5	970	13.6
21	2023	24.3	12.7	18.5	317	14.6
22	2024	23.5	12.7	18.1	406	14.5

3.2. Yield

Mean yield (±standard deviation or s.d.) across all the experiments was 652 ± 327 g/plant, the median was 675 g/plant, and the range was from 142 to 1123 g/plant (n = 41) (Figure 2). In the experiments with just 'Festival', mean yield was 743 ± 220 g/plant, the median was 724 g/plant, and the range was from 268 to 1123 g/plant (n = 23). In the experiments with the other cultivars (with and without 'Festival'), mean yield was 536 ± 210 g/plant, the median was 499 g/plant, and the range was from 142 to 827 g/plant (n = 18). The results of the t-test indicated that the mean yield with just 'Festival' was higher than that with the other cultivars with and without 'Festival' (p = 0.004).

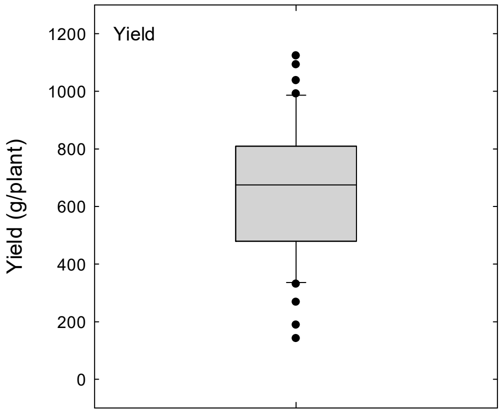

Figure 2. Box plot of the yield of strawberry plants in Queensland, Australia from 2004 to 2024 (n = 41 cases).

There was no clear relationship between yield and the time of planting (p = 0.063, R^2 = 0.06). In contrast, there was a moderate linear relationship between yield and the time of the last harvest across all the experiments ($p < 0.001$, R^2 = 0.43, and n = 41; Figure 3). In other words, yields increased as the last harvest was delayed. There was a positive linear relationship between yield and the length of the growing season, which included the time of planting ($p < 0.001$, R^2 = 0.58, and n = 41; Figure 3). Yield increased as the length of the growing season increased from 108 to 205 days. There were also linear relationships between yield and the length of the season with only 'Festival' ($p < 0.001$, R^2 = 0.62, and n = 23) and with the other cultivars with and without 'Festival' ($p < 0.001$, R^2 = 0.49, and n = 18).

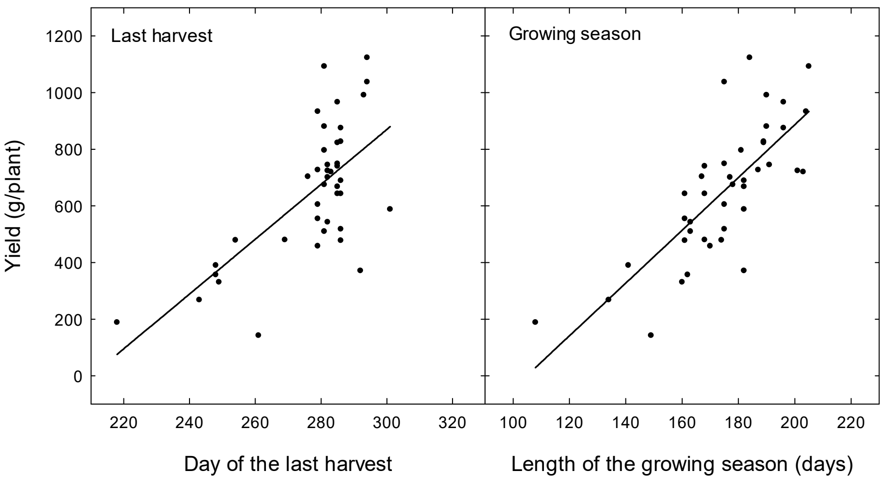

Figure 3. Relationship between yield and the date of the last harvest and length of the growing season for strawberry in Queensland, Australia (n = 41 cases). Yield (g/plant) = Intercept + 9.68 × Day of the last harvest ($p < 0.001$, R^2 = 0.43). Yield (g/plant) = Intercept + 9.32 × Length of the growing season (Days) ($p < 0.001$, R^2 = 0.58).

There were no clear relationships between yield and average seasonal maximum, minimum or mean daily temperature (Table 3). There were weak relationships between yield and the total rainfall and average irradiance (Table 3). Higher yields were associated with higher rainfall or higher radiation, although the data were variable.

Table 3. Linear relationships between yield and weather conditions during the experiments with the strawberry plants in Queensland, Australia from 2004 to 2024 (n = 41 cases).

Variable	Intercept	Slope	Value of p	Value of R^2
Maximum temperature (°C)	1127	−20.3	0.761	-
Minimum temperature (°C)	121	43.5	0.310	-
Mean temperature (°C)	40.4	−66.0	0.537	-
Total rainfall (mm)	38.3	0.471	0.008	0.14
Solar radiation (MJ/m^2/day)	17.4	0.410	<0.001	0.29

4. Discussion

The productivity of strawberry plants varied across 20 years in Queensland, Australia. Yields ranged from 142 to 1123 g/plant, with high yields associated with early plantings and a long growing season in this environment. The responses to the length of the growing season were similar across the different cases ('Festival' alone versus other cultivars with and without 'Festival').

4.1. Yields over the Different Years

There was a large variation in the yields of the strawberry plants over the different years. The mean yield was 652 ± 327 g/plant, the minimum was below 200 g/plant in 2024 and the maximum was above 1000 g/plant in 2008 and 2015. In other words, yields varied by a factor of five or more across the different years. Several authors have shown that there is a strong interaction between cultivar and year on the yields of strawberry plants. Verma et al. [48] studied the performance of crosses amongst 13 cultivars over two years in Poland. There were significant ($p < 0.01$) effects of genotype, year and genotype × year for marketable yield (kg/plot). Chacon et al. [33] conducted a similar experiment with 12 cultivars planted over seven years at two locations in the United States. The effect of cultivar explained 28% of the total variation in yield, while the interaction term (cultivar × year) explained 25% of the total variation. The results of these studies suggest that cultivars should be evaluated over several years if there are wide fluctuations in environmental conditions in the growing location. These studies should be followed up by on-farm evaluations to test the cultivars under commercial conditions. Variations in the productivity of strawberry cultivars across years probably reflect different weather and growing conditions.

4.2. Relationship Between Yield and the Time of Planting

There was no clear relationship between yield and the time of planting (p = 0.063). In contrast, there was a strong linear relationship between yield and the length of the growing season, which included the time of planting and the time of the last harvest. Yield increased as the length of the growing season increased, with a similar response from 'Festival' and from the other cultivars with and without 'Festival'. In Queensland, the time of planting ranges from mid-March to late April, depending on growing conditions in the commercial nurseries. Harvesting commences in June and continues until September or October, depending on the weather. Producers harvest the fruit until they become small or soft or otherwise non-marketable due to hot or wet weather later in the season.

Research has demonstrated that the time of planting affects the productivity of strawberry plants. Menzel [47] collated data from various warm regions and found that there were linear or quadratic responses between yield and the time of planting. In the linear relationships, yields decreased as planting was delayed (n = 23 studies). In the quadratic relationships, optimum yields occurred with an intermediate planting, with lower yields with earlier or later plantings (n = 7 studies). There was a quadratic relationship between yield and the time of planting when the first planting was in early September in the Northern Hemisphere (e.g., Florida) or in early March in the Southern Hemisphere (e.g., Queensland). Low yields with early plantings were associated with small plants, few stored reserves and inadequate temperatures in the nursery [47]. Low yields with later plantings were associated with a short growing season.

There is a complex relationship between yield, the time of planting and the accumulation of chilling in strawberry nurseries. It is agreed that optimal temperatures for floral initiation are between 12 and 21 °C, with some variation across different cultivars [49,50]. Temperatures below 10 °C and above 25 °C are ineffective. This research suggests that very low temperatures (below 2 or 7 °C) are not required for floral initiation in strawberry nurseries. Longer periods of chilling increase the concentration of stored carbohydrates in the nursery plants, but these periods of chilling are of no benefit if the transplants are planted late [47]. Chilling is more effective for higher yields if the plants are exposed to lower temperatures naturally in the open field rather than in a cold room. Yields are higher for plantings from mid-March to early April in Queensland and a late harvest in mid- to late October (a long growing season).

4.3. Relationship Between Yield and the Weather

Strawberry production is sensitive to the weather during the growing season. The fruit are small, soft or affected by diseases after hot or wet weather, bringing harvesting to an end.

Twitchen et al. [51] studied the impact of temperature on strawberry plants in glasshouses in the United Kingdom. They found that there were moderate negative linear relationships between berry weight and temperature in two ever-bearing cultivars (R^2 = 0.44 or 0.48). Fruit weight decreased as the temperature increased from 13 to 28 °C. Chen and Dale [52] conducted similar work to that of Twitchen and colleagues in Ontario and Florida. The results of their studies indicated that the optimum temperature for fruit development was 12 °C, with a daily range from 6 to 18 °C. In the current study, there was no clear relationship between yield and average temperatures during the growing season (Table 3). During the experiments, the average maximum ranged from 22.4 to 24.5 °C and the minimum ranged from 9.6 to 13.6 °C (Table 2).

The flowers and the fruit of strawberry are susceptible to several pathogens promoted by warm, wet weather. Grey mould incited by *Botrytis cinerea* is one of the most important pathogens of strawberries in the world [53]. Under wet conditions, more than 80% of the flowers and fruit are lost when the plants are not sprayed with fungicides. The other important disease is anthracnose fruit rot (AFR) incited by *Colletotrichum acutatum* and related species. This disease causes crop losses of up to 70% in commercial fields planted with susceptible cultivars [54]. Wilson et al. [55] demonstrated that the optimal temperature for infection was between 25 and 30 °C with 13 h of leaf wetness. Menzel et al. [56] found that there were strong negative linear relationships between marketable yield and the incidence of unmarketable fruit due to rain damage, AFR and other fruit rots in Queensland (R^2 = 0.82 to 0.93). Up to 35% of the fruit was affected by rain and disease. In the current study, there was a weak positive relationship between yield and total rainfall (Table 3). Yield increased as total rainfall for the season increased, but this reflected the length of the growing season. Further experiments are required to determine the relationship between yield and rainfall in this location.

4.4. Effect of Global Warming on Yield

Several reports indicate that global warming will decrease the yields of strawberry in different areas (e.g., Sierra-Almeida et al., 2025 in Chile; da Silva et al., 2024 in Brazil; Unnikrishnan et al., 2024 in California; and Rodríguez-Aguirre et al., 2023 in Mexico) [7,37,57,58]. The impact of global warming on plant growth, flowering and fruit growth varies in different areas. In cool areas (e.g., northern Europe), high temperatures decrease floral initiation, while in warm areas, high temperatures decrease fruit development or induce heat stress in the plants (e.g., southern Queensland or Victoria in Australia). In some regions, the area suitable for commercial strawberry production will decrease over the next 50 to 100 years [7]. In the current research, the average daily maximum temperature from 2004 to 2024 ranged from 22.4 to 24.5 °C, and the minimum ranged from 9.6 to 13.6 °C. Wagstaffe and Battey [59] indicated the highest yields in strawberry occurred with temperatures from 18 to 23 °C. Hopf et al. [60] proposed that the optimum temperature for yield (fruit initiation) ranged between 12 and 16 °C. It can be concluded that temperatures were above those required for good fruit production for part of the growing season in Queensland. The average daily mean temperature has increased by 2 °C during winter on the Sunshine Coast since 1967 ($p < 0.001$, $R^2 = 0.69$) [61].

Research is required to develop strawberry cultivars with better heat tolerance in different growing areas [62,63]. Other strategies that can be investigated in the short term include protected cropping, the use of shade nets to reduce the impacts of extreme temperature and radiation conditions, earlier times of planting and higher plant densities [37,64–66].

5. Conclusions

The mean yield of the strawberry plants in Queensland over 20 years was 652 ± 327 g/plant. There were strong relationships between yield and the length of the growing season, which included the time of planting and the time of the last harvest. Yield increased as the length of the growing season increased from 108 to 205 days. These results suggest that early plantings (about mid-March for most cultivars) and a long growing season are associated with high yields in Queensland. Warm weather and intermittent rain end the harvest in this area. Yields are expected to decrease in the future under global warming in the absence of mitigating strategies such as the breeding of heat-tolerant cultivars and the use of protected cropping.

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