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Strawberries Grown Under Protected Cultivation on the Texas High Plains

Russell W. Wallace and C. Joel Webb

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Abstract

Strawberry production on the Texas High Plains is limited due to extreme spring weather conditions that reduce yields, quality and potential profitability for small growers. High tunnels are utilized in many areas throughout the U.S. for climate modification, and may offer the protection needed to grow strawberries in the region. Seven strawberry varieties grown annually under protected cultivation (high tunnels) were compared over two seasons to open-field production at the Texas A & M AgriLife Research and Extension Center in Lubbock for yield and quality. During Season 1, marketable strawberry yields in high tunnels were 7.5 times greater compared to yields in the open field, and this was largely due to a severe hailstorm that damaged open-field plants during early growth. In Season 2, a moderate hailstorm also damaged the open-field plants, though not as severely. High tunnel strawberry yields were 3.5 times greater than those harvested in the open field. During both seasons, high tunnel strawberries were harvested for six to eight weeks longer than those in the open field. Though more research is needed, these results suggest that when protected using high tunnels, strawberry production on the Texas High Plains has potential for success.

Adverse weather, particularly in the form of high wind speeds, hail, low humidity and high temperatures have prohibited the economic production of strawberries (*Fragaria sp.*) on the semi-arid Texas High Plains. As a result, there has been little to no research evaluating strawberries in that region. However, the increased interest by consumers for local-grown, fresh produce, and the potential for increased profits by growers in the region have created a new interest.

While the typical adverse weather conditions (January through early June) increase the risk of growing high-value strawberries in the open field, protected cultivation using high tunnels has been shown to be successful in other regions, and may be of benefit to the region. Research in Utah and Kansas has shown success for high tunnels utilized specifically for season extension and climate modification (Kadir et al. 2006; Rowley et al., 2010; Rowley et al., 2011). In the past, although High Plains' specialty crops growers have expressed interest in high tunnels, most perceived they were not sufficiently durable to withstand local climatic conditions. With this in mind, trials were initiated at the Texas A & M AgriLife Research & Extension Center in Lubbock to evaluate the effects of protected cultivation using high tunnels on strawberries grown during adverse climate conditions on the Texas High Plains.

Materials and Methods

Seven fall-transplanted strawberry cultivars were evaluated for yield and quality during fall 2010–spring 2011 (Season 1) and fall 2011–spring 2012 (Season 2) in high tunnels (ClearSpan™ Colossal; ClearSpan Fabric Structures, South Windsor, CT) measuring 9.1 x 29.3 m (30 x 96 ft), and in open-field plots at the Texas A & M AgriLife Research & Extension Center at Lubbock as part of a multi-state 3-year experiment (Fig. 1). Cultivars evaluated included the June-bearers 'Strawberry Festival', 'Chandler', 'LCN' (Season 1 only), and 'Florida Radiance' (Season 2 only); and the everbearing/day-neutrals 'San Andreas,' 'Seascape', and 'Albion'. Strawberries were transplanted in either Oc-

Associate Professor and Extension Vegetable Specialist, and Research Technician
Texas A & M AgriLife Research & Extension Center, Lubbock, TX 79403

Fig. 1. One of four research high tunnels used for season extension and adverse weather protection of strawberries and other specialty crops at Lubbock, Texas from 2010 and 2012.

tober 2010 (Season 1) or September 2011 (Season 2) onto beds previously laid with drip irrigation and black polyethylene mulch. Each strawberry plot measured 1.5 x 4.3 m (5 x 14 ft) and 7.6 cm (3-inch) holes were punched through the plastic forming two staggered rows at 30 cm (12 inches) apart, with the drip tape centered between the two rows into which the strawberries were transplanted. Each subplot contained a total of 28 plants. Strawberry beds were covered with Agribon+™ medium weight row covers (allowing 70% light transmission) placed over hoops for protection against freezing temperatures during crop development and growth. The row covers were removed during the daytime or as-needed when temperatures reached 7°C (45°F) or above. Row covers were placed on strawberry beds both in the open field and under high tunnels.

All plots were fertilized, irrigated and pests controlled using standard grower practices as recommended by Texas A & M AgriLife Extension Service and as observed in surrounding regions of Texas. Data collected included percent foliar growth (a visual estimate of row coverage), harvest dates, and fruit yield and quality. Depending on cultivars and maturity, berries were hand-harvested one-to-three times weekly, and total and marketable fruit yield were evaluated by counting and weighing the berries separately by subplot. The trials were conducted under high tunnels or in open-field plots (main-plots) with cultivars as subplots in a randomized complete block split-plot design with four replications. Data were subjected to analysis of variance (ANOVA) [PROC MIXED (SAS version 9.2; SAS Institute, Cary, NC)] and means separated using Duncan's multiple range test at the 0.05 level.

Results and Discussion

Climate influence on foliar growth. Strawberries are typically sensitive to adverse climatic conditions including wind, hail and heavy rains which can influence crop growth and development, as well as berry yield and quality. In Lubbock, cultivars in the open field were damaged by the typical Texas High Plains climate including average wind speeds of 20 km per hr (13 mph), peak winds at 109 km per hr (68 mph), and average wind gusts of 44 km per hr (27 mph) during each

trial. Blowing dust also accompanied most wind events above 32 km per hr (20 mph). In both seasons, a single hail event damaged open field cultivars, though more severely in Season 1 (March 21) compared to Season 2 (April 16).

These single hail events damaged cultivars including broken stems and leaves, as well as damaged fruit. In Season 1, hail severely injured all cultivars so that crop recovery was slow and foliar growth reduced. Percent foliar growth averaged across cultivars from open-field plots was only 23% in mid-May, while those same cultivars grown under protected cultivation averaged 90% row coverage. 'Strawberry Festival' (51%) and 'Albion' (43%) had higher ($P < 0.0001$) percent foliar growth in open-field plots when compared to all other cultivars, while under the high tunnels growth averaged 90%, with 'Strawberry Festival' and 'Chandler' averaging 99% row coverage.

During Season 2, a single hail event, though not as severe as Season 1, caused only slight to moderate damage in open-field cultivars. By late April, average cultivar foliar growth in the open field was 61%, with 'Chandler' (83%) and 'San Andreas' (78%) showing significantly greater foliar growth ($P < 0.0001$) compared to all other cultivars. Under high tunnels, foliar growth ranged from a low of 75% ('Seascape') to a high of 98% ('Strawberry Festival' and 'Chandler') averaging 89% across all cultivars. Finally, under protected cultivation, June-bearing cultivars had 10 – 13% higher average foliar growth compared to day-neutral cultivars in both years. However, in the open field, there was no difference between June-bearers and day-neutrals evaluated in Season 1, though day-neutrals had slightly greater growth (6%) in Season 2.

Cultivar yield and quality. Overall berry quality in open-field plots both seasons was considered poor to fair, as berries were damaged from hail and winds, as well as minor bird and rodent feeding. Under protected cultivation, misshapen berries were formed during the winter months (December through February) as a result of colder temperatures. When temperatures warmed in the early spring, only moderate rodent and bird damaged was observed. Finally, during both seasons, commercially unacceptable amounts of soil particulates, blown inside the tunnels during dust storms, were often observed on the plants and berries. However, this dust was removed with a light wash of the plants following dust storms, and had no effect on berry quality.

During Season 1, ripened berries were first harvested in high tunnels on February 21, while in the open field, the first harvest occurred on April 5. However, during Season 2, when strawberries were transplanted into the plots one month earlier (September), harvesting was initiated in high tunnels on November 17, 2011; while in the open field, harvesting was delayed approximately 90 days until mid-March 2012.

Strawberries grown under protected cultivation during both seasons produced strawberries earlier and with higher quality compared to those in the open field. In addition, harvesting under the tunnels was extended approximately six to ten weeks longer than in open-field plots. In Season 1, severe hail reduced strawberry foliar growth in the open field, which also reduced marketable berry quality and yield. As a result, berries in the open-field plots averaged only 45 g (0.10 lbs) per plant; while those in high tunnels averaged 0.34 kg (0.74 lbs), a 7.4-fold increase. Hail as well as bird feeding damage accounted for more than 50% of culls in open-field plots.

In Season 2, overall marketable yields were higher, averaging 0.27 kg (0.6 lbs) and 0.64 kg (1.4 lbs) per plant in open-field and high tunnel plots, respectively. In Season 1, 'Strawberry Festival' had the highest yields in both high tunnel and open-field plots; however, in Season 2, 'Florida Radiance' (1.09 kg (2.4 lbs) per plant) had higher ($P < 0.0001$) yields compared to all other cultivars, followed by 'Chandler' and 'Straw-

berry Festival', respectively. Similar to that of the foliar growth, yields of June-bearing cultivars averaged across both seasons inside high tunnels were 1.8-fold higher than day-neutrals, while in the open field yields were similar regardless of strawberry growth type. These results suggest that for semi-arid regions like the Texas High Plains, June-bearing cultivars may likely produce higher yields compared to day-neutral types.

Potential revenues. The acceptance of locally-grown strawberries in Lubbock and the surrounding High Plains is currently unknown, and needs further evaluation before growers significantly invest in high tunnels and production. Regardless, higher yields from protected cultivation may lead to greater profitability for potential strawberry producers (Jett, 2011). Potential revenues (when averaged across cultivars and based on an estimated $3.00 per pint) from high tunnel strawberry production differed ($P < 0.0001$) from that of the open field during both seasons. In Season 1, potential revenues averaged $2,566 per tunnel ($9.6·m^{-2}), while in the open field; revenues were only $352 ($1.32·m^{-2}) (largely due to the severe hail event). During Season 2, higher yields and berry quality inside high tunnels increased revenues an average 90% over the previous season, with potential revenues of $4,889 per tunnel or $18.31·m^{-2}. In open-field plots, revenues increased 544% to $1,916 or $7.18·m^{-2}, likely the result of very little damage from the hail that occurred during that season. When comparing cultivars in Season 2, potential revenues were highest with 'Florida Radiance' ($8,202 or $30.72·m^{-2}) and 'Chandler' ($2,376 or $8.9·m^{-2}) in high tunnels and the open field, respectively.

Results of this research suggest that strawberry production on the semi-arid Texas High Plains has potential to be successful and profitable. However, to achieve profitable yields, strawberries should be grown under protected cultivation, including high tunnels that provide protection against adverse weather common to the area. Additionally, this research suggests that when strawberries are grown under field conditions and left exposed to the High Plains' climate, that foliar and berry growth may be reduced by the consistent winds, even when no hail events occur. Finally, extending the strawberry harvest season under protected cultivation significantly increases the potential of growers to obtain higher revenues. More research is needed before small and/or large-scale commercial strawberry production can be recommended for the Texas High Plains.

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About the Cover:

Mechanised harvesting of 'Meeker' raspberries in Washington, USA (Enfield Farms, Lynden). Plantings of berryfruit crops can be very extensive, covering many hectares. Their cultivation is managed specially to allow such mechanisation of many on-farm activities including harvesting. In contrast, some other berryfruit plantings are less extensive and rely on hand-harvesting, especially for local markets and "pick your own" sales. *(Photograph: D. Karp)*