bruised were judged to be unacceptable for marketing. The percentage of unmarketable berries for each PT was not affected by treatment (Table 2). In lots held 24 hr at 1.1 and 4.4°C plus 48 hr at 10°, there were considerably fewer marketable berries than in those held 24 hr at 10°. Deterioration of surface tissue at apparent sites of bruising was the most common cause of berries being rated as not acceptable after storage. Watery, dull, pinkish, slightly indented areas developed, although the berries were visually free of bruising when prepared for testing. Most of this bruising apparently occcurred during the picking operation, but was not visible until the berries were kept at 10°. No decay was detected at this final evaluation.

Freshness, based on visual subjective impressions, was not different among treatments at each of the time/temperature storage periods; however, berries held at 1.1°C for 24 hr plus 24 hr at 10° appeared fresher than those held at 4.4° for 24 hr plus 24 hr at 10° for each packaging treatment.

The ambient temperatures during the Florida strawberry season may consistently be in the 27°C range; therefore, it is important to precool strawberries to 4° and maintain that temperature until berries are loaded on board air freighters. Pulp temperatures may well approach 16° on arrival in Western Europe, even when berries are precooled to 4° prior to shipping. Therefore, berries should be handled as rapidly as possible at transfer points and during other operations when they are not held under controlled refrigeration. Berries shipped in PT2 should arrive in Western European markets with less weight loss than those shipped in PT1 or PT3.

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Cultivar Variation in Yield Components of Strawberries

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Abstract. **Differences were observed both within and between strawberry cultivars in the relative importance of yield components. Most cultivars had high coefficients among yield, crown density at harvest, and fruit number/crown, but there was variation among cultivars in the coefficients between yield and fruit weight.**

Several population and growth characteristics may influence strawberry yield, including density, yield/plant, fruit number/plant, fruit size, crowns/plant, and peduncles/plant (4, 7, 10, 11, 12). These have been shown to be under both genetic (1, 8) and environmental controls (2, 3, 4, 13).

Crown density is often the most critical determinant of total yield in a strawberry field, but fruit numbers and fruit size have also been shown to be important (3, 4). In this study, we examined the composition of yield in 12 strawberry cultivars that are grown in the eastern and midwestern United States. We were interested in whether the relative importance of different yield components vary across cultivars traditionally grown in matted rows.

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The experiments were performed at the Sodus Horticultural Research Farm of Michigan State Univ. at Sodus. A complete description of the site has been reported previously (5).

On April 15 and 16, 1980, dormant, spring-dug plants of 12 cultivars were planted in 3-m plots at spacings of 45, 60, and 75 cm within rows and 1.5 m between rows. Flowers were removed in the first year and the plants were trained to 35-cm-wide matted rows. A randomized block design was used with 4 replicates of each treatment. The cultivars were grown according to conventional cultural practices (6).

In the first bearing year, fruit was picked and counted every 4–5 days and berry weights were determined from a randomly selected 25 fruits. Crown numbers were also counted in each of the matted rows immediately after harvest. Yield components were analyzed using the path-coefficient procedure of Wright (14), where path coefficients are calculated as standardized regression coefficients (9). Five variables were included in the analysis: 1) total yield; 2) crown numbers at planting; 3) crown numbers at harvest; 4) fruit numbers; and 5) mean fruit weight. The hypothesized causal relationships are: Crown numbers at planting, 1 → Crown numbers at harvest, 2 → Fruit number, 3 → Fruit weight, 4 → Total yield, 5. Crown numbers at harvest included original mother plants, branch crowns, and rooted runners. Cultivar means were calculated for each of the above-listed variables and these were compared using analysis of variance procedures. No attempt was made to measure daughter plant size and date of rooting, although there appeared to be a relationship between plant density and plant size.

There were significant differences among cultivars in crown number, fruit number, fruit weight, and yield (Table 1). Plots of 'Badgerbelle', 'Scarlet', and 'Stoplight' had significantly higher crown densities than did the other cultivars. 'Bounty' and 'Redchief' had the most fruits/plant, while 'Badgerbelle', 'Scarlet', and 'Stoplight' had the fewest. Fruit of 'Delite', 'Guardian', 'Holiday', and 'Scarlet' were the heaviest and those of 'Earliglow', 'Midway', and 'Redchief' were the lightest.

There was also substantial variation in path coefficients among cultivars (Table 2). 'Midway' and 'Badgerbelle' showed little relationship between initial and final crown numbers (P_{12}), while 'Delite', 'Earliglow', 'Raritan', and 'Scott' had significant associations. Initial crown numbers were not associated significantly with fruit weight (P_{14}) in 'Guardian', 'Holiday', 'Raritan', and 'Scarlet'. The coefficients between fruit number/crown and mean fruit weight (P_{34}) were negative in 'Badgerbelle', 'Bounty', and Scarlet', and positive in 'Earliglow' and 'Midway'. Initial crown numbers were associated significantly with fruit numbers/crown (P_{13}) in 'Delite', 'Scott', and 'Stoplight'. 'Badgerbelle', 'Delite', 'Earliglow', 'Guardian', 'Redchief', and 'Scott' had significant negative relationships between final crown density and fruit number/plant (P_{23}).

All the cultivars showed strong relationships between yield and initial crown numbers (P_{15}), final plant numbers (P_{25}), and fruit numbers (P_{35}). Only 'Bounty' and 'Scarlet' had significant coefficients between fruit weight and yield (P_{45}). The coefficient between fruit numbers and yield (P_{35}) was highest in 'Badgerbelle', 'Earliglow', 'Delite', 'Guardian', 'Midway', 'Redchief', 'Scarlet',

Table 1. Mean values of yield components of 12 strawberry cultivars grown in matted rows.

Cultivar	Crowns at harvest/ crowns at planting	Fruit no./crown	Mean fruit wt (g)	Total yield (kg/3m)
Bounty	14.8 a[z]	13.0 c	7.2 a	10.1 d
Badgerbelle	25.8 b	5.6 a	9.8 bc	8.5 c
Stoplight	27.6 b	5.5 a	9.2 b	8.4 c
Delite	16.8 a	7.5 ab	11.1 d	8.4 c
Redchief	15.4 a	10.3 bc	8.5 ab	8.0 bc
Scott	18.8 ab	6.8 ab	9.6 b	7.6 b
Scarlet	21.3 b	5.4 a	11.0 d	7.6 b
Raritan	15.3 a	7.9 ab	10.1 b	7.3 b
Midway	15.5 a	8.9 b	8.5 ab	7.1 ab
Holiday	15.2 a	7.2 ab	10.8 c	7.1 ab
Earliglow	16.8 a	7.3 ab	8.7 ab	6.7 a
Guardian	13.5 a	6.3 ab	11.1 c	6.3 a

[z]Mean separation in columns by Duncan's multiple range test, 5% level.

Table 2. Path coefficients between yield components of 12 strawberry cultivars grown in matted rows. The components are: 1 = initial crown number/plot; 2 = crown number at harvest/plot; 3 = fruit numbers/crown; 4 = mean fruit weight; and 5 = total plot yield. Coefficients significant at 5% level are underlined.

Cultivar	Path coefficient									
	P_{12}	P_{13}	P_{14}	P_{15}	P_{23}	P_{24}	P_{25}	P_{34}	P_{35}	P_{45}
Badgerbelle	0.00	−0.40	−0.20	0.99	−0.64	−0.18	0.90	−0.63	1.44	0.51
Bounty	−0.21	−0.16	−0.30	0.85	−0.47	−0.51	1.05	−0.62	1.04	0.67
Delite	−0.67	−0.67	−0.28	1.13	−0.99	−0.46	1.35	−0.32	1.43	0.22
Earliglow	−0.71	−0.47	0.58	0.64	−0.99	1.35	0.67	0.76	1.14	0.14
Guardian	−0.50	0.33	−0.92	0.83	−0.78	−0.21	1.01	0.11	1.21	0.40
Holiday	−0.38	−0.19	−0.70	0.89	−0.58	−0.31	1.16	−0.40	1.11	0.51
Midway	0.01	−0.54	−0.36	0.56	−0.54	0.85	0.84	0.87	0.90	0.34
Raritan	−0.71	0.04	−0.71	0.83	−0.35	−1.00	1.00	−0.16	0.97	0.36
Redchief	−0.43	−0.52	−0.30	0.61	−0.99	−0.05	0.68	0.24	1.47	−0.06
Scarlet	0.15	−0.05	−0.76	0.53	−0.15	−0.14	0.67	0.57	1.17	0.58
Scott	−0.66	−0.70	−0.13	0.99	−0.75	−0.15	0.90	−0.15	1.14	0.45
Stoplight	−0.24	−0.64	−0.13	0.65	−0.52	−0.12	0.78	−0.28	1.26	0.38

'Scott', and 'Stoplight', while P_{25} was greatest in 'Bounty', 'Holiday', and 'Raritan'. The difference between P_{35} and P_{25} in 'Bounty', 'Delite', 'Holiday', 'Midway', and 'Raritan' was slight, but in several of the other cultivars the difference was more pronounced ('Badgerbelle', 'Earliglow', 'Redchief', 'Scarlet', and 'Stoplight'). P_{15} was higher than P_{45} in all the cultivars, although it was generally lower than P_{25} or P_{35}.

In summary, the relative importance of individual yield components varied both within and among cultivars. Clearly, more factors (such as cultural system and plant source) affect yield than we have described. However, the data presented here do indicate that the interaction of yield components vary among cultivars that commonly are grown in matted rows in the eastern and midwestern United States. The presence of inter-cultivar variability in yield components suggests there are different routes to high yield.

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