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Reviewed Research Paper

The Response of 'Scott' and 'Redchief' Strawberries to a Raised Bed System of Culture

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Abstract

In 1980 'Scott' and 'Redchief' strawberry plants were established in a factorial experiment testing 2 bedtypes (flat and 25 cm raised), 2 mother plant spacings (13 and 50 cm) and 6 trickle irrigation/injected nitrogen treatments. Trickle irrigation/injected nitrogen treatments had no effect on growth or yield parameters. 'Scott' plants had larger root, crown and total dry weights on raised as compared to flat beds. 'Scott' total yield was lower on raised as compared to flat beds. 'Scott' yield was unaffected by mother plant spacing. 'Redchief' plants on raised beds had higher leaf Photosynthetically Active Radiation (PAR) penetration, higher leaf P, lower leaf Ca and lower early yields than those on flat beds. Bedtype did not influence total yield on 'Redchief.' 'Redchief' plants at 13 cm had higher first year yields than those at 50 cm.

Introduction

Grower reports have proported increased production with raised bed systems of strawberry culture in the East and Midwest, however, research reports have been inconsistent, often finding little difference or negative effects of these systems as compared to the traditional matted row systems (4, 9). Differences between cultivars may account for some of these inconsistencies. Variation among strawberry genotypes, not a specific ability to adapt within a given genotype, accounts for the strawberry plant's wide geographic range. Therefore, a high degree of variability among cultivars is to be expected. Hancock (10) reported complex interactions of 12 eastern/mid-western cultivars grown on different bedtypes. Breen and Martin (3) documented differences among cultivars in the capacity to absorb nitrogen. Albreghts and Howard (1) reported that while elemental accumulation in plant tissues differed from cultivar to cultivar (using Florida Belle, Tioga, and 1-729) the relative amounts of the elements remained constant. The objective of this paper is to compare the physiological responses of 2 strawberry cultivars ('Scott' and 'Redchief') to 2 bedtypes and 2 spacings.

Materials and Methods

In 1980, 'Scott' and 'Redchief' strawberry cultivars were planted at a commercial berry farm in Mt. Vernon, Ohio. Treatments included 2 bedtypes (25 cm raised and flat) and 2 mother plant spacings (13 and 50 cm) replicated 3 times in a factorial experiment. A series of trickle/injected nitrogen treatments were also tested with no detectable effects. Hence, results from these treatments will not be addressed in this paper.

Plants were maintained according to the current Ohio State Cooperative Extension Service recommendations. Overhead irrigation was applied as needed for frost control in both bearing years. In 1980, blossoms were removed on 24 June and again on 1 July. The herbicide schedule was supplemented with hand weeding as necessary. Plants were renovated on 1 July 1981 by mowing tops and narrow-

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ing rows to 16 inches with a rotovator. Runners were not controlled. Mulch was not applied in 1980-81, but was applied in December 1981 at a rate of 6700 kg per hectare.

Photosynthetically active radiation (PAR) was measured in October 1981 and June (harvest) of 1982. At both sampling dates, a quantum sensor (Licor 190SB) was used to measure PAR in 4 locations within the canopy at 6 locations (replications) within each bedtype and spacing treatment.

For nutrient analysis, fully expanded leaf blades were collected in August 1980 and 1981. Samples of 3 plants/treatment were collected in March 1981 before growth resumed. Crowns were separated from roots, and fresh weights recorded. All plant tissues were lyophyllized and dry weights recorded.

Leaf area was measured in October (the time of year when leaf area is most highly correlated with yield the following year (6)) 1981 and 1982, by removing all leaf blades in a 15 × 45 cm area in the canopy and measuring area with a Licor area meter (Model LI-3000). Marketable yield, cull weight and berry size (g/berry) were recorded from the center 3 meters of each 5.5 meter plot from 8 June through 17 June 1981 and from 6 June through 27 June 1982. Fruit yield was reduced in 1981 by severe leather rot *(Phytophthora cactorum)* infection.

Results and Discussion

'Redchief' had higher PAR penetration on the western edge of the canopy on raised beds as compared to flat, while with 'Scott,' there were no differences in light penetration due to bedtype (Table 1). This evidence, coupled with the generally higher PAR penetration in 'Redchief' at the 50 cm spacing confirms the observation that

Table 1. The influence of bedtype and spacing on photosynthetically active radiation (PAR), leaf nutrient concentration and plant dry weights of 'Scott' and 'Redchief' strawberry.

	PAR (% full sun)				Leaf analysis (1980)[x]					Dry Weight (g)			
	1	2	3	4[y]	N	P	K	Ca	Fe	Root	Crown	Total	r:c[w]
						'SCOTT'							
Treatment[z]													
Bedtype													
Raised	38.0	49.6	21.9	13.8	2.41	.26	1.72	.86	333	14.1	10.0	24.1	1.6
Flat	57.9	47.6	24.7	18.4	2.43	.24	1.70	.86	389	8.2	8.9	17.0	1.1
										°		°°	
Spacing													
50 cm	44.4	48.8	28.9	18.2	2.48	.24	1.75	.88	452	14.4	10.8	25.1	1.6
13 cm	51.5	48.5	17.6	14.1	2.40	.26	1.67	.89	269	8.0	8.0	16.0	1.1
									°°	°	°	°	
						'REDCHIEF'							
Bedtype													
Raised	52.9	57.4	14.1	22.9	1.37	.27	1.48	.84	459	13.7[v]	7.4	21.1	1.9
Flat	59.4	22.2	11.5	20.3	2.38	.24	1.48	.93	455	10.4	6.3	16.7	2.0
		°°				°		°				°	
Spacing													
50 cm	59.2	42.2	15.8	33.5	2.40	.26	1.47	.91	628	12.2[v]	7.0	19.2	2.0
13 cm	53.1	37.3	9.8	9.7	2.36	.36	1.49	.86	386	11.8	6.7	18.5	1.9
				°					°°				

[z] °and °° indicate means different at $p = .05$ and $p = .01$ respectively.
[y] numbers 1-4 indicate the location within the strawberry canopy: 1 = center, ½ canopy height; 2 = western edge, ½ canopy height; 3 = eastern edge, ½ canopy height; and 4 = center, ground level.
[x] N, P, K, and Ca measured as percentage values, Fe as ppm. Mg, Mn, B, Cu and Zn were not significantly different among bedtypes or spacings.
[w] r:c refers to ratio of root to crown dry weight.
[y] statistical interaction occurred between bedtype and spacing.

'Scott' was a more vigorous plant, which equalized light penetration among spacing and bedtype treatments.

In 1980 both cultivars had higher Fe concentrations under the less competitive 50 cm spacing (Table 1). 'Redchief' grown on raised beds also had higher leaf P and lower leaf Ca concentrations than plants on flat beds. Higher P in raised bed plants may be due to the larger total plant size on raised beds, giving the plants a larger area from which to forage for P. The lower Ca in raised bed plant leaves was consistent with another experiment by the author (8). The difference is probably due to drying out of the raised beds, resulting in reduced mass flow (11, 12).

With the exception of nitrogen, 1981 leaf analysis results were similar to those of 1980 (1981 data not shown). On 'Scott,' 1981 leaf nitrogen concentrations were unaffected by bedtype or spacing (data not shown). For 'Redchief,' however, plants on raised beds spaced at 50 cm had higher leaf nitrogen concentrations than any other treatment (Figure 1). Higher leaf nitrogen would be expected on both cultivars at the less competitive 50 cm spacing. It may be that 'Scott' so readily filled in the raised bed (plants were larger on raised than flat beds) that this intensified interplant competition negated the beneficial effects of the wider spacing. After a season's growth, the 'Scott' plant densities were essentially the same in both spacing treatments. For 'Redchief,' the individual plants maintained the advantage of a wider spacing because they never filled the beds completely.

Root and total dry weight of 'Scott' was higher on raised as compared to flat beds (Table 1). 'Scott' also had higher root, crown and total dry weight at wider spacings, indicating a response to the interplant competition at the 13 cm spacing. Dry weight of 'Redchief' was not dramatically affected by bedtype or spacing treatments.

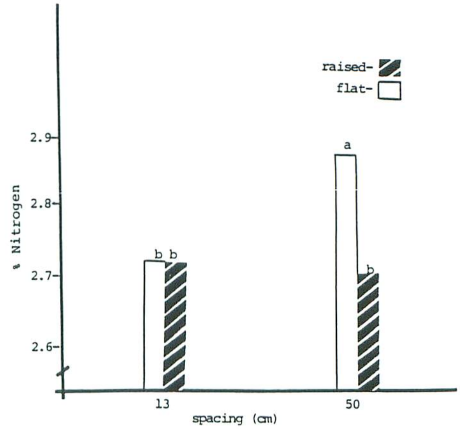

Figure 1. The influence of spacing and bedtype on leaf nitrogen concentration of 'Redchief' strawberry.

Yields of 'Scott' were dramatically lower on raised beds (Table 2). Berry size was larger on raised beds, probably due to the lighter crop load. Early yield of 'Redchief' in 1981 was higher on flat beds though total yield was unaffected by bedtype. Plants at 13 cm on either bedtype had higher yields than those at 50 cm. The increased yields per unit land area at denser spacings concurs with work by Tomkins (11), Freeman (6) and Craig (5). Fruit size was again smaller on raised as compared to flat beds. 'Redchief' had more cull fruit at the closer spacing.

In 1982, 'Scott' plants at 50 cm had a higher early yield on raised beds than plants on flat beds (Table 3). On raised beds, 'Redchief' had higher total yields at 13 cm spacings compared with 50 cm.

The vigorous nature of 'Scott' masked any differences between spacing treatments in PAR interception, nutrient uptake and yield. On 'Scott,' raised beds increased plant size dramatically, with total mean dry weight 30% greater on raised as compared to flat beds (p(F) = .01). This increase in plant size on raised beds was apparently at the expense of yield increase, since yields

Table 2. The influence of bedtype and spacing on marketable yield (kg/ha) and berry size of 'Scott' and 'Redchief' strawberries: 1st harvest, 1981.

Treatment[z]	6/8	6/11	6/15	Total	Cull	size (g/berry)
			'SCOTT'			
Bedtype						
Raised	1902.2	2363.3	2551.4	6946.0	5350.6	18.0
Flat	2448.6	3352.3	3839.4	9639.2	5714.2	16.1
		*	*	**		**
Spacing						
50 cm	1964.6	2770.6	2086.0[y]	6821.2[y]	5197.2	17.2
13 cm	2386.3	2945.0	2086.7	7418.0	5868.6	16.9
			'REDCHIEF'			
Bedtype						
Raised	2158.6	1585.5	1480.2	5202.3	4243.9	11.3
Flat	2724.8	2070.2	1384.3	6178.6	4783.3	10.0
	*			**	**	
Spacing						
50 cm	1683.2	1542.5	1002.7	4237.7	3132.1	10.7
13 cm	3169.3	2113.2	1861.4	7143.2	5895.1	10.6
	**			**	**	

[z]* and ** indicate means different at the .05 and .01 alpha levels, respectively.
[y]Statistical interaction occurred between bedtype and spacing.

Table 3. Bedtype/spacing interactions on marketable yield of 'Scott' and 'Redchief' strawberries: 2nd harvest, 1982.

Date	Spacing[z]	'SCOTT' Raised	'SCOTT' Flat	'REDCHIEF' Raised	'REDCHIEF' Flat
6/9	50 cm	2348.5	1279.7	2336.1	1726.5
	13 cm	1743.4	2298.6	2938.1	2808.4
		*			*
6/11	50 cm	2637.4[y]	2232.2[y]	1991.8	2985.6
	13 cm	2195.8	2776.1	3977.3	3073.3
			*	**	
6/14	50 cm	3077.8[y]	3970.0[y]	2239.1	3506.7
	13 cm	3350.0	4035.8	5120.4	3637.5
					**
6/17	50 cm	3282.8	3960.8	2794.0	3766.5
	13 cm	3409.4	2894.7	3370.9	2762.0
			**		**
6/21	50 cm	2110.4	2909.9	1805.7	2754.4
	13 cm	2629.5	2698.0	3024.8	2009.3
		*		**	**
TOTAL	50 cm	12316.6	12846.3	9745.5	14248.1
	13 cm	12922.4	13165.9	16423.6	13393.0
				*	

[z]* and ** indicate means different at the .05 and .01 alpha levels, respectively.
[y]means subject to a three way statistical interaction.

were concurrently reduced on raised beds.

'Redchief' plants were less vigorous and less apt to overcome initial spacing differences than 'Scott.' This is evidenced by the detectable differences in PAR interception, altered nutrient uptake and increased yield at closer spacings. The raised bed had less effect on yield, however complex statistical interactions made interpretation difficult. It can be concluded from this data that under the conditions of this experiment, 'Scott' is not an acceptable cultivar for use on raised bed, high density systems. 'Redchief' may prove a more suitable cultivar for raised bed, high density production systems in the East and Midwest.

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