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# Influence of Crop Load on Tree Growth, Yield, and Fruit Quality of Scab Resistant Apples at Harvest

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# Influence of Crop Load on Tree Growth, Yield, and Fruit Quality of Scab Resistant Apples at Harvest

## **Abstract**

Apple scab, caused by *Venturia inaequalis*, is a major disease affecting apple production. Breeding programs have developed over 30 releases of scab-resistant cultivars since 1970 with recent ones having much improved quality. Redfree and GoldRush are from a cooperative breeding program involving Purdue, Rutgers, and Illinois universities while Liberty was introduced from the Cornell University breeding program. For these cultivars to gain better acceptance, more information is needed on their cropping capacities and the effect of crop load on fruit quality attributes. Our study was conducted to determine the relationship between increasing crop load on tree growth, fruit size, and fruit quality variables of the three cultivars under Iowa conditions.

## **Keywords**

RFR A1135, Horticulture

## **Disciplines**

Agriculture | Fruit Science | Horticulture

# Influence of Crop Load on Tree Growth, Yield, and Fruit Quality of Scab Resistant Apples at Harvest

## RFR-A1135

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### Introduction

Apple scab, caused by *Venturia inaequalis*, is a major disease affecting apple production. Breeding programs have developed over 30 releases of scab-resistant cultivars since 1970 with recent ones having much improved quality. Redfree and GoldRush are from a cooperative breeding program involving Purdue, Rutgers, and Illinois universities while Liberty was introduced from the Cornell University breeding program. For these cultivars to gain better acceptance, more information is needed on their cropping capacities and the effect of crop load on fruit quality attributes. Our study was conducted to determine the relationship between increasing crop load on tree growth, fruit size, and fruit quality variables of the three cultivars under Iowa conditions.

### Materials and Methods

Part of an 8-year-old scab-resistant apple orchard located at ISU Horticulture Research Station, Ames, Iowa, containing Redfree, Liberty, and GoldRush apple trees on M.9 rootstock and trained to a vertical axis was used for this study. Trees were manually adjusted to crop loads ranging from 3 to 12 fruits per cm<sup>2</sup> trunk cross-sectional area and crop load treatments were applied in a completely randomized design. Tree growth was determined by computing the difference in trunk cross-sectional area (TCSA) of the spring and fall 2011 measurements for all the trees used in the study.

At harvest, the number and weight of fruits per tree were recorded. Fruit size was expressed as average fruit weight obtained by dividing total fruit weight by the number of fruits per tree and also by passing the fruits from each tree through a rotary fruit sorting machine (Greefa A3). Firmness was measured using an Instron penetrometer and soluble solids content was determined using a digital refractometer. Starch index values were determined by staining half fruit slices with iodine solution for two minutes and comparing the area of the fruit tissue covered by iodine with standard color charts on a scale of 1 to 9 (1 = high staining with starch throughout the flesh and 9 = less staining with little or no starch in the flesh). Crop load was made a continuous variable to improve on the efficiency of the analysis and data were analyzed using analysis of covariance.

### Results and Discussion

Increasing crop load was associated with reduced change in trunk cross-sectional area for Liberty and GoldRush but not for Redfree apple trees (Table 1). Fruit yield was positively related with crop load across all the cultivars. Increasing crop load negatively affected average fruit weight and percentage of fruits that were greater than 2.7 in. in diameter (Table 1). The negative relationship between tree growth and crop load was probably caused by the competing sinks for assimilates, especially assimilates being channeled to the fruits instead of tree growth and development.

Soluble solids (sugar content) was negatively related to crop load for Redfree and GoldRush apples but crop load did not affect soluble solids of apples harvested from Liberty trees. Fruit firmness increased with increasing crop

load for the Redfree apples but was not affected by crop load for the Liberty and GoldRush apples (Table 1). Starch index values increased with increasing crop loads for apples from cultivars Redfree and GoldRush implying a reduction in starch content in the fruit flesh. This decline in starch content at higher crop load levels in conjunction with lower soluble solids suggests that assimilates available for fruit growth became limited as the trees were adjusted for higher crop loads. As a result, less starch was being stored in the fruit during the growing season.

In conclusion, crop load needs to be carefully managed by growers through determining the

current season's densities and thinning the trees as these preliminary results indicate that it can significantly affect fruit weight, percentage of fruits greater than 2.7 in. in diameter (which is usually the marketable fruit receiving premium price), and the level of sugars in the fruits.

### Acknowledgements

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**Table 1. Influence of crop load on tree growth, yield, and fruit quality of Redfree, Liberty, and GoldRush apples at harvest.**

Treatment		Increase in TCSA (cm <sup>2</sup> )	Yield per tree (lbs)	Avg. fruit wt. (g)	% fruits > 2.7 in. dia.	Fruit firmness (N)	Soluble solids (%)	Starch index <sup>y</sup>
Cultivar	Crop load <sup>z</sup>							
Redfree								
	3	5.5 <sup>x</sup>	40.6	159.6	95	110.2	11.2	2.3
	6	5.1	50.5	142.5	73	114.3	10.9	2.4
	9	4.6	60.2	125.3	52	118.4	10.6	2.6
	12	4.2	70.1	108.2	31	122.5	10.2	2.7
		NS	*	*	*	*	*	*
Liberty								
	3	7.6	36.2	160.8	44	91.3	13.8	3.7
	6	5.9	43.9	152.1	35	90.3	13.4	3.6
	9	4.3	51.8	143.4	26	89.4	12.9	3.6
	12	2.7	59.7	134.7	17	88.4	12.5	3.6
		*	*	*	*	NS	NS	NS
GoldRush								
	3	8.3	50.5	182.2	89	133.2	14.4	3.3
	6	7.2	66.4	165.3	74	132.4	13.6	3.6
	9	5.9	81.8	148.4	58	131.6	12.8	3.8
	12	4.8	97.2	131.5	42	130.8	12.1	4.0
		*	*	*	*	NS	*	*

<sup>z</sup>Number of fruits per cm<sup>2</sup> of the trunk cross-sectional area (TCSA) measured in the spring.

<sup>y</sup>Starch pattern index is an index of starch disappearance in the flesh and was based on a scale of 1-9 at the time of harvest where 1 = starch throughout the flesh and 9 = no starch in the flesh. The minimum harvesting stage is 3 because at this stage a good portion of the apple has converted from starch to sugars.

<sup>x</sup>LS means for the response variables estimated for the four crop load levels that were within the range of our study. NS denotes non-significant difference in means for a given response variable and cultivar at a p-value of 0.05.

\*Denotes significance of the estimate at a p-value of 0.05.