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Yield of Young Apple Trees Affected by Heading and Support of the Central Leader

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Many apple growers have not been interested in orchard systems in which tree support is a requirement. While trees on seedling, MM.111, and MM.106 are freestanding, trees on many of the dwarfing stocks being planted today often require support. In the opinion of many, if not most, trees on rootstocks in the size range of M.26 and smaller should be supported (Barritt, 1992). Whether or not it is possible to grow such trees without support depends on a number of factors. For example, with the vertical axis training system, leader support is mandatory because of the weakness of the unheaded central leader. On the other hand, if the leader is headed severely each year, it may be possible to grow the trees without support.

Perhaps the key question is whether or not increased yields of supported trees will more than repay the costs of supporting the trees. The need for support may also vary with the scion variety. This fact was emphasized after the fringe of Hurricane Hugo went through our plots in 1989. While Delicious/M.7 wallowed badly, Golden Delicious/M.7 in adjacent rows were unaffected by the winds.

For many years the pruning-training system developed by Heinicke (1975) was widely used and involved annual heading of the central leader and the scaffold limbs. In more recent years, there has been a trend away from heading cuts, especially of the scaffold limbs. Barden et al. (1989) found that heading of scaffold branches of Delicious trees suppressed yields in proportion to the severity of the cuts. Elfving (1990) reported that heading of terminal extension shoots on 2-year-old trees of Empire/M.26 EMLA decreased fruiting for at least 2 years. Marini et al. (1993) found that heading of scaffold limbs delayed fruiting of young Redchief Delicious/MM.111 trees.

The objective of this study was to determine the interactive effects of support and annual heading of the central leader on height and productivity of young apple trees on dwarfing rootstocks.

MATERIALS AND METHODS

Trees used in these experiments were planted as 1-year-old whips in 1988 at the Virginia Tech College of Agriculture and Life Sciences Farm near Blacksburg, VA. The three blocks of trees were as follows: Redchief Delicious (Campbell strain)/M.26 at 10 x 21 feet (3 x 6.4 m); Commander York (Ramey strain)/Mark at 11.5 x 21 feet (3.5 x 6.4 m); and Golden Delicious (Smoothee strain)/M.26 at 11.5 x 21 feet (3.5 x 6.4 m). All trees were headed to 30 inches (76 cm) at planting. The spacings used were wider than normal for these scion/rootstock combinations because the orchard will be used for other experiments requiring separate treatments for individual trees.

For each variety, 24 trees were selected for uniformity and divided into six blocks of four trees each. The heading, pruning and support treatments were initiated in 1989 and continued through 1995.

Heading consisted of annually heading the dormant central leader by one-half vs. not heading the central leader. No heading of scaffolds was done in any treatment. Support consisted of tying the leader to a vertical metal conduit pole to a height of 7 feet (2.1 m). The conduit was supported by a wire at 2.0 m. The control trees were not supported but were headed, approximating common commercial practice.

For each variety, the experimental design was a randomized complete block with a 2 x 2 factorial arrangement of tree support and heading treatments. The four treatment combinations were:

1. not supported, headed (control).
2. not supported, not headed.
3. supported, headed.
4. supported, not headed.

Tree height, spread, and trunk circumference were measured each year except for 1994. Fruits from each tree were harvested, counted, and weighed for years 3 through 8. At harvest, drops (fruits on the ground) were picked up and included in the total yields.

RESULTS AND DISCUSSION

Overall tree height varied with the scion/rootstock combination with the Golden Delicious/M.26 being the tallest, followed by Redchief Delicious/M.26. York/Mark were the shortest trees. There was not a significant interaction between heading and support. Heading suppressed tree height of

both unsupported and supported trees of all varieties, particularly from 1989 through 1991 (Table 1). Differences in tree height were most apparent from 1989 to 1991, and by the end of the experiment in 1995 height differences due to heading were quite small. In general, supported trees were taller than unsupported trees.

It is noteworthy that trees in this study were supported only to a height of 7 feet (2.1 m). At the end of the second leaf (1989), most of the unheaded trees were already taller than the support (Table 1). The central leader was hand-thinned above the support as necessary to avoid breakage. Had we supported the leaders to 10 feet (3 m) or more, as now recommended (Barritt, 1992), additional fruit could have been carried and yields in the supported trees would have probably increased.

The yield data are presented in Table 2 as % of the control treatment (not supported, headed). In general, the effect of heading the leader was to suppress yield, particularly in the early cropping years. The effect of heading was apparent in both the supported and non-supported treatments, but the reduction in cropping due to heading tended to be more severe in the supported trees. The cumulative yield for all varieties for years 3-5 (1990-1993) averaged 15% lower for headed trees than for unheaded trees. As the experiment continued, the negative effect of heading on yield declined to where for years 3-8 (1990-1995), the reduction in yield due to heading was 7%.

We compared yield suppression in this experiment with that in some earlier ones. Marini et al. (1993) and Elfving and McKibbon (1992) reported a 15% to 19% reduction in yield following heading of scaffolds. Considering that we made only one heading cut per tree per year, the estimated 7% reduction in yield appears to agree quite well with the 15% to 19% reductions reported when all scaffolds were headed.

The average accumulated yield per tree for the three varieties for 1990-1995 was 11.8 bu (225 kg). A 12% increase in yield is 1.4 bushels per tree or approximately 260 bushels per acre (12.2 t/ha) over the first 8 years. Had the trees been spaced at a more realistic 8.2 x 16.4 feet (2.5 x 5 m), the estimated yield increase from supported unheaded trees compared to the unsupported headed trees would exceed 475 bushels per acre (22.4 t/ha). Using a cost estimate of $1500 per acre for tree support, the yield increases should more than cover these expenses, at least with fresh market varieties.

Increased early yields may be particularly important to the economic viability of a young orchard. For example, the prices received for new varieties such as Gala, Fuji, and Braeburn are highest

until production reaches the point where supplies begin to match demand. Obviously, the increase in early yields for a high-priced fresh market variety has a very different impact on the economics than for a processing variety.

There was no benefit of the heading of the leader at any time in these experiments. The results may well have been influenced by the varieties used. Redchief Delicious is a spur-type tree with relatively stout shoots of moderate length. Such leaders are therefore probably much less likely to break or fall over without heading or support than would the leaders of a variety such as Gala which tends to have both long shoots and brittle wood. The York/Mark in this trial bore heavily from the first cropping year. As soon as fruiting started, vegetative growth slowed dramatically and has been minimal since that time. Because of the limited vegetative growth as well as the "willowy" habit of York, the trees have remained very compact and perhaps only minimally subject to leaning or breakage. We also thinned the central leaders to decrease the likelihood of breakage. Had we not done so, the unheaded leaders would have been lost and the trees essentially destroyed.

It is important to point out the situation with respect to the orchard site and the lack of heavy wind except during Hurricane Hugo in 1989 at which time the trees were small enough to be little affected. The site is on an east-facing slope with considerable protection from the prevailing westerly winds. Since 1989 there has not been much stress on the trees so tree stability has not been tested. Were we to experience heavy winds, especially when there is a crop on the trees, the presence or absence of support as well as tree height could dramatically affect tree survival. It would not take a very heavy tree loss to cover the cost of a tree support system.

It is also important to note that none of the scion/rootstock combinations has an inherent weakness at the union as do certain others, notably Gala on several rootstocks. The presence of a brittle union makes support mandatory, at least to provide trunk stability.

Although heading of the leader is usually considered to induce branching, it also removes buds that are potential laterals. We did not count laterals on the headed vs. unheaded leaders, but other studies indicate that, except under extreme vigor, unheaded leaders will branch adequately. Secondly, as we have learned with vertical axis training, the laterals on unheaded leaders are not as upright or vigorous as those that result from heading cuts.

CONCLUSIONS

1. The combination of supporting but not heading the leader can increase yield in the early years of an orchard, compared to the typical heading of an unsupported leader.

2. The yield increase found in this study should more than cover the costs of the support system, at least for fresh market varieties.

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Table 1. Tree height (as % of unsupported, headed controls) for three varieties of apples influenced by support and heading of the leader.

		Tree height as % of control					
Support[z]	Heading[y]	1989	1990	1991	1992	1993	1995
		Golden Delicious (Smoothee)/M.26					
No	Yes	100 (1.89)[x]	100 (2.41)	100 (2.80)	100 (3.60)	100 (3.69)	100 (4.60)
No	No	111	108	111	103	111	100
Yes	Yes	100	96	104	100	100	100
Yes	No	132	121	114	106	108	107
		Commander York (Ramey)/Mark					
No	Yes	100 (l.80)	100 (2.10)	100 (2.29)	100 (2.59)	100 (2.71)	100 (2.90)
No	No	106	114	117	115	93	97
Yes	Yes	100	110	113	119	111	108
Yes	No	122	129	130	127	119	117
		Redchief Delicious (Campbell)/M.26					
No	Yes	100 (l.80)	100 (2.29)	100 (2.71)	100 (3.29)	100 (3.20)	100 (3.78)
No	No	111	104	107	97	100	84
Yes	Yes	106	104	104	100	103	105
Yes	No	128	126	126	112	116	103

[z]Support: leader tied to 2.1 m conduit which was supported by a wire at 2.0 m.
[y]Heading: one-half of previous year's growth removed annually from central leader.
[x]Data in parentheses = tree height (m).

Table 2. Cumulative yield per tree (as % of unsupported, headed controls) for three varieties of apples as influenced by support and heading of the leader.

		Cumulative yield as % of control				
Support[z]	Heading[y]	1990-91	1990-92	1990-93	1990-94	1990-95
		Golden Delicious (Smoothee)/M.26				
No	Yes	100 (11.8)[x]	100 (19.1)	100 (93.9)	100 (145.6)	100 (280.3)
No	No	95	112	119	102	101
Yes	Yes	107	96	85	91	94
Yes	No	107	122	113	113	107
		Commander York (Ramey)/Mark				
No	Yes	100 (31.7)	100 (45.8)	100 (109.3)	100 (115.7)	100 (225.0)
No	No	117	122	106	127	102
Yes	Yes	112	118	115	118	106
Yes	No	106	143	127	126	115
		Redchief Delicious (Campbell)/M.26				
No	Yes	100 (11.8)	100 (32.2)	100 (67.6)	100 (99.3)	100 (173.3)
No	No	112	129	110	113	108
Yes	Yes	93	100	102	108	107
Yes	No	122	125	121	120	115

[z]Support: leader tied to 2.1 m conduit which was supported by a wire at 2.0 m.
[y]Heading: one-half of previous year's growth removed annually from central leader.
[x]Data in parentheses = yield in kg per tree.