Processing Apple Planting Systems Trials

Terence Robinson[1] and Steve Hoying[2]

[1]Department of Horticultural Sciences, New York State Agricultural Experiment Station, Geneva, NY
[2]Cornell Cooperative Extension, Lake Ontario Fruit Program, Newark, NY

Our goal was to evaluate the usefulness of high density planting systems for processing orchards that would allow growers to replant and improve orchard production efficiency.

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The New York apple industry is an important part of the agricultural economy of New York State, contributing an average farm gate value of $125 million annually for the past five years (New York Ag. Statistics, 1995-2000). Apples are produced on about 50,000 acres with an average statewide production of 1.1 billion pounds. In an average year, about 50-55 percent of the crop is processed and 45 percent is sold fresh.

The processing market is very important to the economic success of New York apple growers, particularly in Western New York. However, the number of fruit processing businesses has declined in the state and the future of those that remain depends on the ability of New York growers to produce the varieties needed at a competitive price. Fruit growers in New York State have excellent fruit soils and a favorable climate. However, yields per acre are relatively low (500 bu/acre for apples) while production costs have continued to climb and prices for fruit have remained static, especially in the processing market.

A large part of the production problem is due to aging orchards with outdated varieties. Although much higher yields and better fruit quality are possible, they can only be achieved with new orchards where they can utilize the newest varieties, rootstocks and production systems. Growers have been slowly replanting to higher density systems for the last 20 years. The acreage of standard size trees declined 25 percent from 1985-1995 while the acreage of dwarf and semi-dwarf trees increased 200 percent. However, most of this new production is aimed at the fresh market only. For the processing market to remain viable, growers need to modernize orchards for that market. Most of the new orchards for fresh apple production have been planted to higher-density dwarf trees which begin production in the third or fourth year and reach full production by years 6-8. Typically, these new orchards are trained with the vertical axis system. The value of high density orchards for the processing market has not been studied. Our goal was to evaluate the usefulness of high density planting systems for processing orchards that would allow growers to replant and improve orchard production efficiency. This should strengthen the ability of New York growers to produce what the processors need at a competitive price and with a reasonable profit for the grower.

The new high density production systems which were compared in this study are based on three principles aimed at increasing the production efficiency and profitability of processing orchards when compared to the traditional production system used in processing orchards in New York. They are: (1) increased tree density, (2) dwarfing rootstocks that promote early production of fruit, (3) tree training systems requiring reduced inputs of labor. Our studies were done with both standard New York processing apple varieties and new varieties of apples recently developed in the apple breeding program at the New York State Agricultural Experiment Station that are either resistant to major apple diseases, or have special properties such as anti-browning characteristics when sliced.

Photo 1. Vertical Axis planting on M.26 rootstock in the Mark Lagoner planting.

Materials and Methods

Two semi-commercial research plots were established on two farms in Wayne County, NY, in 1994 and 1995. The first block was located at the farm of Mark Lagoner in Williamson, NY, which has a relatively sandy soil that had previously had an apple orchard (Photo 1).The second block was at the farm of Ned Morgan in Marion, NY, which is on a hillside that has silt loam soil and had never had apples. The Lagoner block was 2.5 acres in size and utilized three well established process

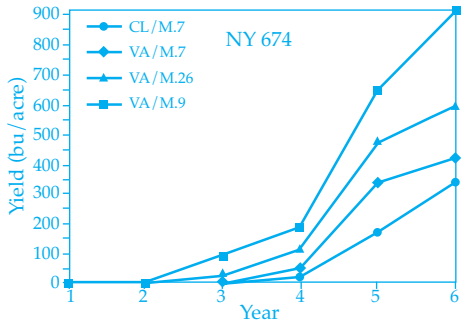

Figure 1. Annual yields of NY674 trained to 4 systems at the Morgan research plot.

TABLE 1

Characteristics of orchard production systems at the Lagoner and Morgan research orchards.

Research Block	Production System	Rootstock	Tree Density (trees/acre)	Tree Spacing
Lagoner	Central Leader	M.7	165	12' X 22'
	Vertical Axis	M.7	303	8' X 18'
	Vertical Axis	M.26	389	7' X 16'
	Vertical Axis	M.26	484	6' X 15'
Morgan	Central Leader	M.7	156	14' X 20'
	Vertical Axis	M.7	340	8' X 16'
	Vertical Axis	M.26	484	6' X 15'
	Vertical Axis	M.9	670	5' X 13'

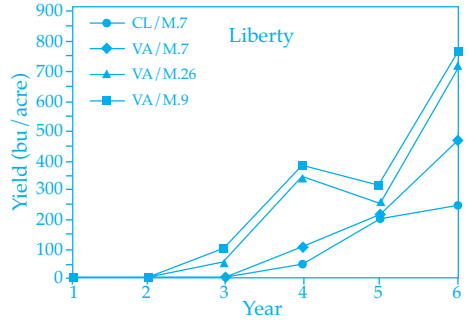

Figure 2. Annual yields of Liberty trained to 4 systems at the Morgan research plot.

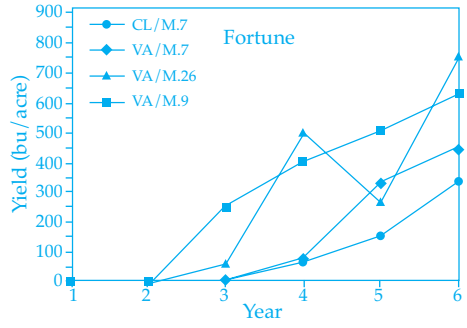

Figure 3. Annual yields of Fortune trained to 4 systems at the Morgan research plot.

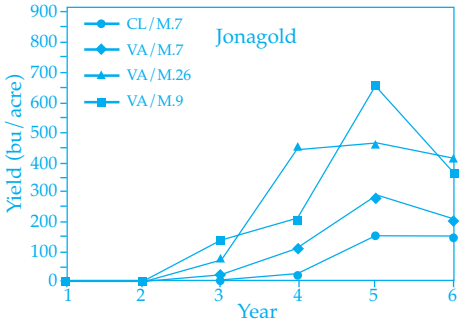

Figure 4. Annual yields of Jonagold trained to 4 systems at the Morgan research plot.

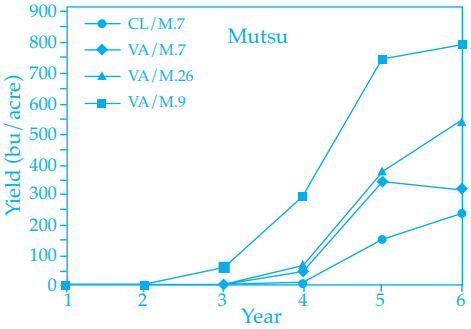

Figure 5. Annual yields of Mutsu trained to 4 systems at the Morgan research plot.

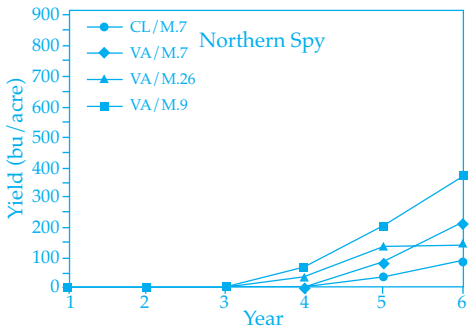

Figure 6. Annual yields of Northern Spy trained to 4 systems at the Morgan research plot.

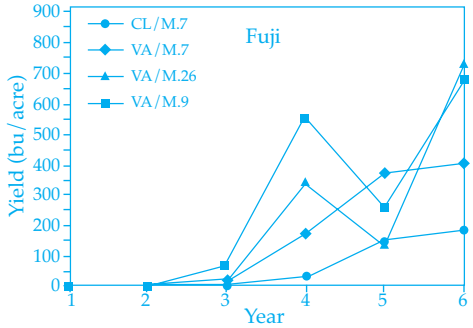

Figure 7. Annual yields of Fuji trained to 4 systems at the Morgan research plot.

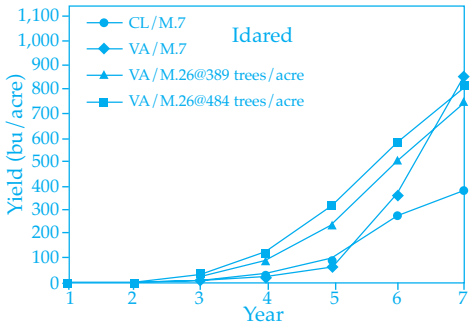

Figure 8. Annual yields of Idared trained to 4 systems at the Lagoner research plot.

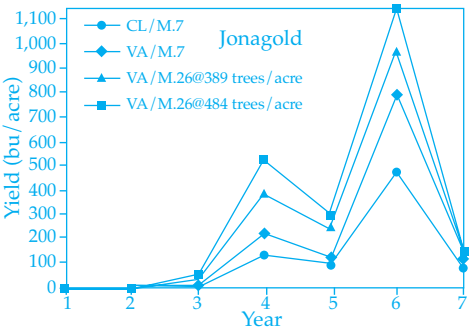

Figure 9. Annual yields of Jonagold trained to 4 systems at the Lagoner research plot.

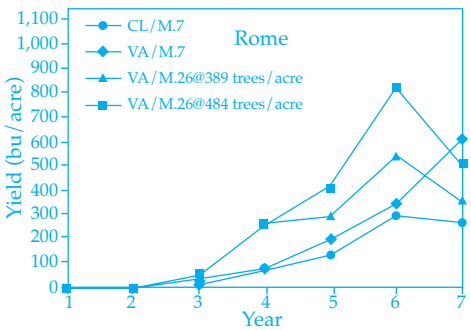

Figure 10. Annual yields of Rome trained to 4 systems at the Lagoner research plot.

ing apple varieties each grown in four production systems of differing planting densities. The Morgan block was 5.5 acres in size and utilized seven varieties of both established and new processing varieties each grown in four production systems of differing planting densities. Both blocks were laid out as randomized complete block experiments with four replicates of 100 feet of row length for each replicate of each variety.

The four systems used in each block are listed in Table 1. The traditional system in both blocks utilized a semi-vigorous rootstock (M.7) and a relatively low tree density of 156 or 165 trees/acre (Photo 2). Tree densities of the new high-density production systems ranged from 303 to 670 trees/acre and utilized the more dwarfing and precocious rootstocks M.26 and M.9.

During the developmental years (1-5), the horticultural inputs of labor and materials of the four production system were minimized and included only those items essential to the success of the system. With each system the inputs of labor and materials were recorded and used in an economic analysis. Fruit production, fruit size and fruit color were recorded each year. A simulated commercial grade-out for the processing market was calculated each year and an economic analysis of gross returns was done.

Results

In the first two years there was no fruit production in any system as the trees developed a large canopy. Beginning in the third year there was a small crop on all systems that utilized either M.26 or M.9 rootstock but not on systems that utilized M.7 rootstock. Yields increased in the fourth year and were largely a function of tree density. As density increased, yield per acre increased. In the 5-7 years, the trees approached full production with some varieties in the highest density systems

TABLE 2

Cumulative yield of 4 production systems at the Lagoner research orchard (1994-2000).

Production System	Tree Den. (trees/acre)	Idared (bu./acre)	Jonagold (bu./acre)	Rome (bu./acre)	Average of all Varieties
Central Leader/M.7	165	763 b	779 c	716 b	753 c
Vertical Axis/M.7	303	1301 ab	1267 bc	1175 ab	1248 bc
Vertical Axis/M.26	389	1614 ab	1758 ab	1431 ab	1601 ab
Vertical Axis/M.26	484	1855 a	2181 a	1983 a	2006 a

TABLE 3

Cumulative gross returns of 4 production systems at the Lagoner research orchard (1994-2000).

Production System	Tree Den. (trees/acre)	Idared ($/acre)	Jonagold ($/acre)	Rome ($/acre)	Average of all Varieties
Central Leader/M.7	165	2566 b	2618 c	2406 b	2530 c
Vertical Axis/M.7	303	4372 ab	4256 bc	3947 ab	4192 bc
Vertical Axis/M.26	389	5422 ab	5907 ab	4808 ab	5379 ab
Vertical Axis/M.26	484	6233 a	7328 a	6664 a	6741 a

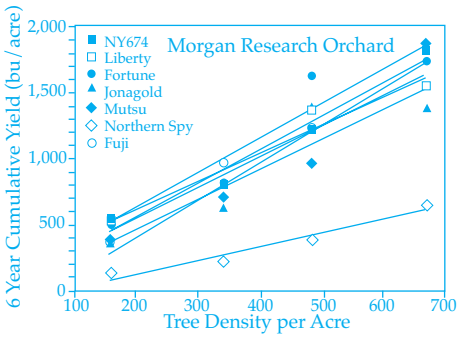

Figure 11. Relationship between tree density and 6-year cumulative yield with 7 varieties at the Morgan Research Orchard.

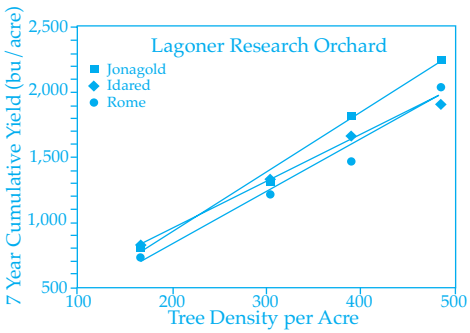

Figure 12. Relationship between tree density and 7-year cumulative yield with 3 varieties at the Lagoner Research Orchard.

TABLE 4

Cumulative yield of 4 production systems at the Morgan research orchard (1995-2000).

Production System	Tree Den. (trees/acre)	NY674 (trees/acre)	Liberty (bu./acre)	Fortune (bu./acre)	Jonagold (bu./acre)	Mutsu (bu./acre)	N. Spy (bu./acre)	Fuji (bu./acre)	Average of all Varieties
Central Leader/M.7	156	536 b	522 b	519 b	354 b	396 c	125 a	361 b	402 b
Vertical Axis/M.7	340	807 ab	802 ab	817 ab	625 ab	709 bc	231 a	974 ab	697 b
Vertical Axis/M.26	484	1218 ab	1377 ab	1630 ab	1400 a	973 ab	383 a	1231 ab	1173 a
Vertical Axis/M.9	670	1826 a	1553 a	1738 a	1384 ab	1891 a	644 a	1561 a	1513 a

TABLE 5

Cumulative gross returns of 4 production systems at the Morgan research orchard (1995-2000).

Production System	Tree Den. (trees/acre)	NY674 ($/acre)	Liberty ($/acre)	Fortune ($/acre)	Jonagold ($/acre)	Mutsu ($/acre)	N. Spy ($/acre)	Fuji ($/acre)	Average of all Varieties
Central Leader/M.7	156	1908 b	1803 b	2080 b	1310 b	1444 c	542 a	1555 b	1520 b
Vertical Axis/M.7	340	2795 ab	2821 ab	3158 ab	2274 ab	2657 bc	1082 a	4006 ab	2656 b
Vertical Axis/M.26	484	4532 ab	4637 ab	6051 ab	5015 a	3647 ab	1761 a	5414 ab	4437 a
Vertical Axis/M.9	670	6451 a	5212 a	6213 a	4818 ab	6682 a	2850 a	6543 a	5538 a

Photo 2. Vertical Axis planting on M7 rootstock were tall at the Ned Morgan planting. Cropload finally bent over trees in year 7 for this rootstock.

reaching 1,000 bushels per acre (Figs. 1-10).

At the end of 2000, the Lagoner block had completed seven years and the Morgan block had completed six years. In both cases, the trees have essentially filled their allotted space and the development period of the block is complete. Cumulative yields were largely a function of tree density with systems on dwarfing rootstocks (M.9 and M.26) giving the highest yields (Tables 2 and 4). There was considerable variation among the productivity of varieties. At the Lagoner plot the most productive variety was Jonagold but it suffered from extreme biennial bearing with low crops in 1998 and in 2000. Rome and Idared were much more annual but slightly lower yielding. Averaged over all varieties, the highest density system produced almost three times that produced by the traditional low density system over the first seven years (Table 2). At the Morgan block, Mutsu, NY674 and Fortune were the most productive varieties when grown in the highest density system. Liberty, Fuji and Jonagold were intermediate and Northern Spy was very unproductive regardless of the training system. Averaged over all varieties, the highest density system produced almost four times that produced by the traditional low density system over the first six years (Table 4).

Estimates of gross returns over the first seven years using a price of $0.08 per pound showed at the Lagoner block that Jonagold was the most profitable variety followed by Rome and then Idared (Table 3). On average the highest density system had 2.7 times the level of gross returns after 7 years as did the low density conventional system. For the Morgan block the most profitable varieties were Mutsu, Fuji, NY674 and Fortune (Table 5). The least profitable variety was Northern Spy while Liberty and Jonagold were intermediate. On average the highest density system had 3.6 times the level of gross returns after six years as did the low density conventional system.

Discussion

For both research blocks, yields were largely a function of tree density (Fig 11 and 12). It is noteworthy that with the highest tree density and with high yielding varieties such as Jonagold, Mutsu or NY674 yields of 1000 bushels per acre were achieved in the sixth or seventh year after planting. In contrast, the traditional system of Central leader on M.7 rootstock achieved less than one-third of the high density system. This increase in production will likely translate into improved profitability. A complete economic analysis of the production systems in these blocks with the 2001 yield data and assumed future yields is currently being conducted. These analyses will determine the annual expenses and returns over the life of the orchard including, the Net Present Value (NPV) the Internal Rate of Return (IRR), and the annualized cost per pound of apple produced. These figures will be useful in determining the optimum tree density for processing orchards of the future as well as the break-even fruit price required to allow growers to replant older less productive processing orchards.

If the higher density production systems prove to be more profitable, they should be used to replace older conventional orchards that are currently relatively unprofitable because of low yields, poor fruit quality, relatively low processing prices and the continuing need for high horticultural inputs to maintain production.

Acknowledgements

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Terence Robinson is an associate professor of pomology in horticultural sciences at the Experiment Station in Geneva. Steve Hoying is cultural practices specialist with CCE's Lake Ontario Fruit Program.