Intensive Apple Plantings—The New Zealand Context

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I raise the question "Have we been too timid with our apple planting densities?" I think the answer is a qualified "Yes." This does not necessarily mean that we should rush off and move into extremely high densities.

If you look beyond the tree density arguments, the fundamental message that comes out is that orchard efficiency is determined by establishing a light-efficient canopy as rapidly as possible. In places where light levels are low and the growing season short, very high density dwarf trees have the advantage over less intensive orchards because they fill the canopy area quickly, even where vegetative growth is poor, and give substantial advantage over less dense plantings.

In New Zealand we have very good light levels and a long growing season. In these conditions, apple tree growth is much better than in the northern hemisphere growing areas where ultra-high density systems were developed. Another point to bear in mind is that subtle forms of subsidy incentive that favored high early yields were often in place. Under these conditions the short-term revenue advantage from very intensive plantings pushed planting densities above and beyond what could be justified in the absence of such incentives.

Now that the apple industry worldwide is having cash flow problems, the enthusiasm for ultra-high density plantings has waned. In Europe the majority of new plantings are in the vicinity of 3000 trees/ha (1214 trees/acre), usually planted 1 x 3.3 m (3.3 x 10.8 ft) in single rows.

TRIALS SUPPORT 2000 TO 2500 TREES/HA

Dr. John Palmer has established several tree density trials with Royal Gala/M.9 in the Nelson area on commercial orchards. Tree densities in these trials ranged from just under 1500 to 3000 trees/ha (607 to 1214 trees/acre) on a vigorous site and about 1600 trees to approximately 3600 trees/ha (648 to 1457 trees/acre) on a weak growing site. Data from the first 5 years show that the highest yields per hectare come from the highest tree densities, as one would expect. However, by years 4 and 5 production levels for the two higher tree densities were beginning to level off. For the more vigorous site, yields per hectare in the 2000 to 2500 tree/ha (809 to 1012 trees/acre) range were similar to those of the higher density plant spacings. These densities can be achieved by tree spacings at 1 to 1.5 m (3.3 to 4.9 ft) in the row with between-row spacings of 3.3 to 4 m (10.8 to 13.1 ft) (Table 1).

In general terms, plant performance will be better at the wider in-row spacings due to the effect of rectangularity on yield and quality. [Ed. note: Trees planted on a square (equal between-tree and between-row spacing) have higher yields and fruit quality compared to trees arranged in rectangles

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TABLE 1

In-row tree spacings for trees/ha at different row spacings.

	In-row spacing	
Between-row spacing	**2000 trees/ha**	**2500 trees/ha**
3.3 m	1.5 m	1.21 m
3.5 m	1.43 m	1.14 m

(in-row spacing less than between-row spacing) because each individual tree has more space.] At 2000 trees/ha (809 trees/acre) greater orchard performance would be expected from the 3.3 x 1.5 m (less rectangular) spacing than the 4 x 1.25 m spacing (more rectangular).

Equipment access is the main factor limiting between-row spacing. As a general principle, you need to plant at the closest between-row spacing you are comfortable with for machinery access. It is important here to take the long-term view and take into account replacing existing equipment with narrow equipment sometime in the future.

We are aware of some intensive M.9 orchards that have more than covered direct cash operating costs in their second year.

To some extent, site vigor will determine planting density. Replant sites require closer spacing than new soil sites. Increasing tree density on replant sites to compensate for lower tree vigor is seen by many people as an alternative to soil fumigation for specific apple replant disease where rootstocks reasonably tolerant of replant such as M.9 are being used. The cost of fumigation for a 3.5 m between-row planting will pay for about 400 more trees.

M.9 INTERSTOCKS

There are now a number of 4- and 5-year M.9 interstock blocks using either MM.106 or M.793 rootstocks. The M.9/MM.106 combination is considerably more dwarfing than the M.9/M.793 combination.

M.9/MM.106 has suffered *Phytophthora* crown rot in replant sites and anywhere that soil drainage is suspect. The M.9/M.793 option is fairly bulletproof when it comes to *Phytophthora* but is giving quite a severe sucker problem. With both of these combinations we have seen the occasional tree death due to fire blight killing the M.9 interstock. Fire blight problems are, however, much lower in incidence than we have seen with M.26 rootstock.

Most of the earlier plantings of interstock trees have been at tree densities in the range of 2 x 4 m out to 2.5 x 4.5 m (6.5 x 13 ft to 8.2 x 14.8 ft), giving spacings ranging from 889 to 1250 trees/ha (360 to 506 trees/acre). These trees have been very precocious, particularly when planted on the M.9/MM.106 combination, and have failed to fill the allotted space as fast as anticipated.

Now that we have some of these orchards more or less mature, it is not hard to see that we could live with more tree density, maybe as close as 3.5 x 1.5 m giving 1905 trees/ha (11.5 x 4.9 ft giving 771 trees/acre) for the M.9/MM.106 combination and certainly 4 x 2 m (13 x 6.5 ft) for the M.9/M.793 combination. Compared to the densities we usually planted, these spacings would represent a 1.4 to 1.5-fold increase in tree density which would give yield increases over the first 4 to 5 years of a similar magnitude.

A partial budget of returns for one block of Galaxy for which we have data gives estimates of what the returns could have been had the trees been planted more intensively (Table 2).

TABLE 2

Partial budget of returns (NZ$) for a young block of Galaxy Gala.

Trees/ha	1111/planted 4.5 x 2 m	
Cartons/tree	2nd leaf 0.44	
Cartons/tree	3rd leaf 1.17	

	2nd leaf	3rd leaf
Revenue/tree^Z	$8.58	$24.45
Pruning	0.2	0.4
Thinning	0.3	0.6
Harvesting	0.44	1.76
Packing	0.35	1.88
Crop-related expenditure/tree excluding spraying	$1.29	$4.64
Surplus/tree	$7.29	$19.81
Surplus/ha at 1111 trees/ha	$8,099	$22,009
Surplus/ha at 1905 trees/ha (3.5 x 1.5 m)	$13,887	$37,738
Difference in revenue due to increased tree density	$5,788	$15,729
Cumulative difference after 2 years' cropping	—	$21,517^Y

^{Z}Being early harvest due to the interstock influence, the nonexport content of the crop was sold on the local market for a good price.

^{Y}Additional establishment costs for this block at the higher density would have been 794 trees @ $7.50 = $5,955 plus the cost of support structure and irrigation pipe for an extra 635 m of row.

TREE FORM AND ARCHITECTURE DETERMINE SPACING

My experience in working with trees planted at close spacings shows that by controlling tree spread it is possible to tighten up tree spacings while continuing to maintain a satisfactory vigor/cropping balance within the tree. The technique is really quite simple and involves adhering to the slender pyramid tree form throughout the life of the tree.

The key is systematic removal of any strong branches that show signs of growing too far beyond the space allotted to the tree. Rather than growing a tree with a few large, widely spaced, spreading branches, the canopy is made up of more numerous weaker branches that, because of their lower vigor, will set fruit buds rather than push more vegetative growth. This type of tree is very fruitful and can be contained at relatively close spacings without running into light penetration problems.

QUALITY VERY GOOD

A feature of the interstock and dwarf rootstock orchards we have observed over the last 2 to 3 years has been their uniformly high fruit quality, particularly in respect to fruit firmness and brix level. Fruit size also has been larger than on standard rootstocks at similar specific crop loadings. This is a real advantage with smaller-fruited varieties such as Royal Gala, Southern Snap™ and Pacific Queen™.

The better uniformity of maturity and fruit quality has enabled harvesting to be completed in fewer picks than with standard semi-intensive plantings. This together with the smaller, more easily harvested tree will mean a lower labor requirement for picking.

One of the side effects of the move to intensive plantings overseas has been accelerated removal of older, less intensive plantings simply because it became impossible to get people to pick them. I suspect we could suffer a similar problem once pickers discover how much easier it is to harvest dwarf tree orchards.

THE FUTURE

If you are in the apple growing business and determined to stay there, it is clear that successful orchards of the future will be planted much more intensively than those we have planted in the last 30 to 40 years.

We still do not have a commercial dwarf rootstock really suited to our conditions. Among the present ones, virus-free M.9 is the most widely used rootstock worldwide but for us it lacks woolly apple aphid resistance. In soils that do not favor root infestation by this pest it is a very good rootstock.

If we want to maintain woolly apple aphid resistant root systems, the M.9/MM.106 or M.9/M.793 interstock combinations are the best option, but be prepared to fight root suckers.

In cooler districts where fire blight is less virulent, M.26 still has a useful place.

In several years' time, two Geneva rootstocks from the United States, CG.4202 and CG.6210, will become available. These have woolly apple aphid tolerance as well as some resistance to fire blight and will give tree sizes similar to M.26 and M.9/M.793. CG.6210 also may be highly tolerant of specific apple replant disease. This will make it a very useful rootstock.