A COLOUR CODED GUIDE FOR FITTING ESTIMATED APPLE TREE GROWTH INTO FOUR PLANTING DENSITIES.

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Introduction

The establishment of a high density orchard at current costs of labour, trees and support systems is a major investment. Orchardists the world over are at considerable risk when selecting new cultivars, rootstocks and strains for new orchards. The risk increases when a new spacing (orchard design) is also selected.

A primary goal for the modern high density orchard is earlier production. This is achieved through the increased precocity of size controlling rootstocks and an increase in tree density or tree numbers per hectare (acre). It follows, however, that by reducing the juvenile (non-bearing) phase of the orchard, it's life span is also reduced.

A low density orchard of about 124 trees per hectare (50 trees per acre) takes 40 years to reach full bearing potential and is productive for another 40 years. The medium density orchard with 247-383 trees per hectare (100-150 trees per acre) begins producing at 5 years , reaches full production at 7-14 years and begins a slow decline at about 25 years. High and very high density orchards of 1500-2500 trees per hectare (600-1000 trees per acre) begin to produce in the second and third year after planting, reach full production in 4-5 years but decline quickly. Some researchers suggest that systems with over 2500 trees per hectare (1000 trees per acre) have a life expectancy of less than 8 years (1). In these orchards which utilize dwarfing rootstocks and support systems, all aspects of management must be fine tuned. Additionally, a small error in the planting design can leave either too much or too little space. Waste space or crowding could be the decisive factor in orchard profitability.

Tree Growth Guide

This publication is intended to serve as a guide for estimating mature tree spread (vigour) for a combination of cultivars, spur-type strains and rootstocks on three soil types (Tables 1,2,3). The information can be used to design the new orchard with adequate space for in row tree spread and between the row travel.

The cultivars chosen are intended as examples. Jonagold is a vigorous cultivar with characteristics similar to Gravenstein. Empire is a medium to low vigour cultivar similar to Idared and Golden Delicious in mature tree size. For other cultivars check their growth traits and match them up with a cultivar listed in this publication.

The spur-type strains grow much smaller than the regular strains. For McIntosh, however, the spur-type strains have such a wide range in vigour, they were classified into four vigour categories by Wright (2).

One well known rootstock form each size classification was selected as an example. There are an increasing number of useful rootstock in each category Ottawa 3 and Budagovsky 9 are examples in the dwarf category. For more information on rootstocks see reference (3,4).

The estimated soil effect on tree growth is divided into three levels (Tables 1,2,3). A high growth potential soil has no root growth restrictions for at least a metre deep and has high water and nutrient holding capacity. The medium growth potential soil is one with some restrictions in rooting depth and a reduced water and nutrient holding capacity. A low growth potential soil may have a single serious restrictions or a combination of minor growth restricting properties. It may also have a compact sub-soil or hardpan that will limit root growth. This type of soil will likely have low water and nutrient holding capacity. Orchard soil requirements are described in detail by Webster (5).

The System

Choice of a system is the first step in establishing a new orchard. Selecting the cultivar and rootstock is next. The mature tree spread must fit the allotted space. This is extremely critical for sustained production and profitability of each new planting.

To assist producers with the spacing choice for their new orchard, a colour code was developed for four planting densities. The densities and colour codes are illustrated in Table 4. The systems chosen were selected to cover a range of potential planting densities and rootstocks.

Many other systems may be preferred and the Tables can still be used to find the best rootstock for the cultivar on a particular soil type.

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TABLES 1, 2, 3: Estimated tree spread in metres and feet ( ) at 20 years for certain cultivars and spur-type strains on three soil types and four rootstock vigour classification.

Table 1: HIGH SOIL POTENTIAL

	ROOTSTOCKS						
	Dwarf		Semi Dwarf		Semi Vigorous		Vigorous
	30%	50%	60%	65%	75%	85%	100%
VARIETY	M9	M26	M7	MM106	MM111	B.A.	SEEDLING
Gravenstein	2.4 (8)	4.0 (13)	4.6 (15)	4.9 (16)	5.8 (19)	6.5 (21)	7.6 (25)
McIntosh	2.4 (8)	4.0 (13)	4.6 (15)	4.9 (16)	5.8 (19)	6.5 (21)	7.6 (25)
Cortland	2.4 (8)	4.0 (13)	4.6 (15)	4.9 (16)	5.8 (19)	6.5 (21)	7.6 (25)
Spy	2.4 (8)	4.0 (13)	4.6 (15)	4.9 (16)	5.8 (19)	6.5 (21)	7.6 (25)
Gala	2.4 (8)	4.0 (13)	4.6 (15)	4.9 (16)	5.8 (19)	6.5 (21)	7.6 (25)
Red Delicious	1.8 (6)	3.4 (11)	4.0 (13)	4.3 (14)	5.2 (17)	5.8 (19)	6.7 (22)
Spur McIntosh*	1.8 (6)	3.4 (11)	4.0 (13)	4.3 (14)	4.9 (16)	5.5 (18)	6.5 (21)
Spur Red Delicious	1.8 (6)	3.0 (10)	3.4 (11)	3.7 (12)	4.3 (14)	4.9 (16)	5.8 (19)
Idared	1.8 (6)	3.0 (10)	3.4 (11)	3.7 (12)	4.3 (14)	4.9 (16)	5.8 (19)
Spur McIntosh **	1.2 (4)	2.4 (8)	2.7 (9)	3.0 (10)	3.4 (11)	3.7 (12)	4.3 (14)

Table 2: MED. SOIL POTENTIAL

	ROOTSTOCKS						
	Dwarf		Semi Dwarf		Semi Vigorous		Vigorous
	30%	50%	60%	65%	75%	85%	100%
VARIETY	M9	M26	M7	MM106	MM111	B.A.	SEEDLING
Gravenstein	1.8 (6)	3.0 (10)	3.7 (12)	4.0 (13)	4.6 (15)	5.2 (17)	6.1 (20)
McIntosh	1.8 (6)	3.0 (10)	3.7 (12)	4.0 (13)	4.6 (15)	5.2 (17)	6.1 (20)
Cortland	1.8 (6)	3.0 (10)	3.7 (12)	4.0 (13)	4.6 (15)	5.2 (17)	6.1 (20)
Spy	1.8 (6)	3.0 (10)	3.7 (12)	4.0 (13)	4.6 (15)	5.2 (17)	6.1 (20)
Gala	1.8 (6)	3.0 (10)	3.7 (12)	4.0 (13)	4.6 (15)	5.2 (17)	6.1 (20)
Red Delicious	1.5 (5)	2.4 (8)	3.0 (10)	3.0 (10)	3.7 (12)	4.3 (14)	4.9 (16)
Spur McIntosh*	1.5 (5)	2.4 (8)	2.7 (9)	3.0 (10)	3.4 (11)	4.0 (13)	4.6 (15)
Spur Red Delicious	1.2 (4)	2.1 (7)	2.4 (8)	2.4 (8)	3.0 (10)	3.4 (11)	4.0 (13)
Idared	1.2 (4)	2.1 (7)	2.4 (8)	2.4 (8)	3.0 (10)	3.4 (11)	4.0 (13)
Spur McIntosh **	0.9 (3)	1.8 (6)	2.1 (7)	2.1 (7)	2.4 (8)	2.7 (9)	3.4 (11)

Table 3: LOW SOIL POTENTIAL

	ROOTSTOCKS						
	Dwarf		Semi Dwarf		Semi Vigorous		Vigorous
	30%	50%	60%	65%	75%	85%	100%
VARIETY	M9	M26	M7	MM106	MM111	B.A.	SEEDLING
Gravenstein	1.2 (4)	1.9 (6)	2.3 (8)	2.3 (8)	2.7 (9)	3.4 (11)	3.8 (12)
McIntosh	1.2 (4)	1.9 (6)	2.3 (8)	2.3 (8)	2.7 (9)	3.4 (11)	3.8 (12)
Cortland	1.2 (4)	1.9 (6)	2.3 (8)	2.3 (8)	2.7 (9)	3.4 (11)	3.8 (12)
Spy	1.2 (4)	1.9 (6)	2.3 (8)	2.3 (8)	2.7 (9)	3.4 (11)	3.8 (12)
Gala	1.2 (4)	1.9 (6)	2.3 (8)	2.3 (8)	2.7 (9)	3.4 (11)	3.8 (12)
Red Delicious	0.9 (3)	1.5 (5)	1.9 (6)	1.9 (6)	2.1 (7)	2.3 (8)	3.0 (10)
Spur McIntosh*	0.9 (3)	1.5 (5)	1.9 (6)	1.9 (6)	2.1 (7)	2.3 (8)	2.7 (9)
Spur Red Delicious	0.9 (3)	1.2 (4)	1.5 (5)	1.9 (6)	1.9 (6)	2.1 (7)	2.7 (9)
Idared	0.9 (3)	1.2 (4)	1.5 (5)	1.9 (6)	1.9 (6)	2.1 (7)	2.7 (9)
Spur McIntosh **	0.7 (2)	0.9 (3)	1.2 (4)	1.2 (4)	1.5 (5)	1.5 (5)	1.9 (6)

* Dewar, MacSpur (category 3)

**Hartenhof, Morspur, Stirling (category 2)

HOW TO USE THIS INFORMATION:

1. **Select the tree density you want to plant from Table 4, note the colour.**

   The 155 system is for the traditional free standing orchard. The 300 orchard has increased in row density but allows travel space for larger equipment. To increase the bearing surface trees can grow together to form a tree wall. The 605 tree per acre planting will likely have dwarfing rootstocks and a support system.

Table 4. Spacing for four planting densities

Spacing (m)	Trees/ ha	Spacing (ft)	Trees/ acre
4.3 x 6.1	383	14 x 20	155
3.7 x 5.5	494	12 x 18	200
2.6 x 5.5	741	8 x 18	300
[illegible]	[illegible]	6 x 12	605
Try	to	avoid	red

*If possible avoid combinations in red, trees will be too large or too small for any of the above densities.

2. **Select the proper table appropriate for your soil type: High , Medium or Low vigour (opposite page Tables 1, 2, 3).**

3. **Locate the chosen density colour and cultivars you plan to plant.**

4. **Make a list of the cultivars and rootstocks that fit the spacing for your new orchard.**

Note: If you want to plant a cultivar that is not listed within the colour you have chosen remember; this is an estimate so in some cases it is necessary to select from the next closest vigour category.

EXAMPLE:

1. **If you want to plant 494 trees/ ha (200 trees/ acre) the corresponding colour is BLUE**

2. **TABLE 2: Medium soil vigour**

3. **For the recommended spacing:**
   Gravenstein on M.7, MM.106
   Spur McIntosh on seedling**
   Cortland on M.7 or MM.106
   Spur Red Delicious on B.A or seedling
   Spy on M.7 or MM.106

The Management Factor

In developing an orchard it is important to make good use of the land available and yet have an orchard which is easy to manage and profitable (6). To achieve this, producers need to know and be skilled at managing the factors that influence tree growth and productivity. Growers should also have a clear vision of how to keep the orchard in the state of balance between vigour and fruiting during each phase of development (7). These phases include non bearing, early bearing, full production and declining productivity and fruit quality.

Higher density orchards are more costly to establish than are lower density orchards and require more intensive management. Their main advantage is in reaching the stage of full production more quickly; once this stage has been reached their productivity may be no greater than that of lower density orchards at the same stage and may in fact be lower if a larger proportion of land is required for travel space.

Higher density orchards require a higher return for the fruit produced in order to offset the greater establishment and operating costs. They would be particularly attractive if higher returns were available for only a relatively short time, such as in the case of a variety new to the marketplace.

Figure 2. Stirling McIntosh/MM106

Figure 1. Summerland Red McIntosh/ MM106

References

(1) Wertheim, S.J. 1986. Life span to shorten orchard rotation in a mere 8 years. Grower (UK) 105 (12):12.

(2) Wright, K. H. 1994. Spur-type McIntosh: Morphological Characteristics of Certain Strains and a proposed Classification of Tree Form. M. Sc. Thesis, Nova Scotia Agricultural College.

(3) Crowe, A.D. 1980. Apple Growing in Eastern Canada. Agriculture Canada. Publication # 1553.

(4) Embree, C.G.1993. Producing Apples in Eastern and Central Canada. Agriculture Canada. Publication # 1899/E.

(5) Webster, D, H.1991. Soil physical requirements for apple. ACSRM Pub. No. 1-91. Atlantic Provinces Agricultural Services Coordinating Committee.

(6) Estabrooks, E.A, C.G. Embree, A.D. Crowe,and W. Craig,. 1980.155 System. Atlantic Hort. Committee. Publication # 16.

(7)Embree, C.G.1973. Spur- type Apple Trees. NS Department of Agriculture and Marketing. November.

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