From: Perry, R.L., J. Hull and J. Clements. 2008. International Symposium Precision Agriculture for Fruits and Vegetables Jan. 6-9, 2008 Orlando, FL. (Abstract pg. 73), proceedings In Press, Acta Hort (US standard units).

Apple Scion and Rootstock Selection and Planning for Michigan

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Keywords: *Malus xdomestica*, decision support, rootstock, cultivars, soil, vigor, management, irrigation, tree spacing.

Abstract

The training system that an apple (*Malus xdomestica*) grower selects must be one which best maximizes all the resources in making the enterprise a profitable venture. There are many parts to the orchard system decision "puzzle" which must fit together in a complementary arrangement to gain maximum precision and profitability. The most immediate question that must be answered regarding the establishment of a new orchard is spacing. Extension agents and growers often need assistance in determining optimum tree density for sites. Trees planted too close, cause excessive shading and competition for resources results in inadequate light penetration, poor quality fruit, low cropping, excessive labor in pruning to reduce shading impact, etc. Excessive distance results in inefficient planting designs where the land surface is under utilized and long term profitability may be compromised. In 1989, we made an initial attempt at trying to simplify the decision making process by considering the most important variables and assigning them values (number codes in parentheses) in a formula. Assessments on vigor are derived from rootstock and cultivar trials and field observations. Our experience gained from working with the high density orchards and with new cultivars and rootstocks has encouraged us to frequently update the model. The formula is available on the Michigan State University Department of Horticulture web site for general use by the public, students and extension field agents in an interactive mode (spacing calculator) http://www.hrt.msu.edu/department/Perry/Spacing_Fruit/mispacingPC.htm. More revision in the future will be necessary as we learn more of the technical intricacies of new rootstocks, cultivars, marketing demands and management constraints. The primary factors affecting spacing include; scion vigor, rootstock vigor, soil type, irrigation, management system and the interactions that take place between them.

This spacing recommendation is only relevant to Michigan sites and for single row arrangement of trees.

INTRODUCTION

Apple orchard systems have undergone tremendous changes over the last 60 years which have transitioned from traditional production systems established with large trees in wide spacing arrangements to high density orchards with smaller trees which are closely spaced (Robinson, 2004). Trees at one time in Michigan were planted primarily on seedling rootstocks and shaped in round to globular form and planted at a spacing of 40-60 trees per acre (100-150 trees per hectare). In Michigan today, many orchards are being established on dwarfing rootstocks, trained in a conical shape (Robinson, 2004a) at 300-600 trees per acre (750 to 1500 trees per hectare). Many of these new orchard systems were derived from Europe where land and labor has been at a premium since the early part of the twentieth century. Today in Michigan and in North America, apple growers have been compelled to move towards these new systems to make apple orchards more economically efficient. The orchards of today produce crops earlier in their life, continue with sustained high cropping levels and produce high quality fruit. These orchards must produce earlier in order to generate an earlier return on investment and improve profitability (Robinson, et. al. 2004a). The new orchards with smaller trees and closer spacing have also facilitated improved canopy light penetration/distribution and tree management regarding pest control, harvest and other practices. These systems have improved cropping and fruit quality. The decisions apple growers make during planning and establishment can make the difference between profitability and liability for that enterprise. The orchard management system that a grower selects must be one which best maximizes all the resources in making the enterprise a profitable venture. There are many components to the orchard system decision "puzzle" (Barritt, 1991) which must fit together in a complementary arrangement for a site to make it work. The most immediate question that must be answered regarding the establishment of the new orchard is spacing. Frequently, apple growers wrestle with this question which continues to be complicated with the advent of new and improved rootstocks and cultivars. Decision support systems and recommendations have been developed for fruit growing in different areas (Crassweller, et. al., 1989, Barritt, 1992). These recommendations are influenced by climate and soil characteristics for sites within a specific region and often do not apply to different fruit growing areas.

Spacing Decision Support for Michigan Apple Growing

In 1989, we made an initial attempt at trying to simplify the decision making process for Michigan apple growers by considering the most important variables and assigning them values (number codes in parentheses) in a mathematical formula. The formula has been revised and updated over the years as we gained a better understanding through research of new orchard systems and performance of rootstocks in various field trials. Additionally, we have added new scion cultivars to a list of options to accommodate changes in the market place. For example, in 1960-1980, “Red Delicious” was the dominant apple cultivar in the market place. In the last ten years, this cultivar has lost its importance in the national and international market place, and is today being replaced by new cultivars such as “Honeycrisp”, “Gala”, “Fuji”, “Braeburn”, etc. More revision in the future will be necessary as we learn more of the technical intricacies of new rootstocks, cultivars, marketing demands and management constraints. This model was developed as a decision support system with specific application to sites in Michigan. The formula is available on our department web site for general use by the public, students and extension field agents in an interactive mode (spacing calculator) http://www.hrt.msu.edu/department/Perry/Spacing_Fruit/mispacingPC.htm.The primary factors (important variables) affecting spacing include; scion vigor, rootstock vigor, soil type, irrigation, management system and the interactions that take place between them. The spacing recommendation in this writing pertains to single row arrangement of trees. This model was developed for general application to the entire state. Differences between Northern Michigan (lower and southern peninsula) and Southern Michigan (mid and southern region of the lower-peninsula) growing conditions do exist. In Northern Michigan, tree growth is less vigorous where soils are generally more coarse and less fertile and the growing season is cooler and shorter compared to Southern Michigan. Therefore, trees established in Southern Michigan are more vigorous than those established in Northern Michigan. The formula has been developed for grower use and thus, recommendations in spacing are expressed in feet. In the formula, an adjustment is made for growers who deploy an intense management system such as Vertical Axe with typical spacing of 5.2 X 14.7 ft; 570 trees / acre, Slender Spindle (4.1 X 10.7 ft; 993 trees / acre) , Tall Spindle (3.3 X 10.2 ft; 1300 trees / acre) and V Systems (2.45 X 13.1 ft; 1350 trees / acre), (Barritt, 1991, 1992, Marini, et al., 2001a, Perry, 1996, Perry, 2000, Perry, et al., 2001, and Robinson, 2004a and Robinson, 2004b). Spacing recommendations for Super Spindle are restricted, regardless of all factors, at 1.0-2.0 X 10; 2178, plus, trees / acre and for Tall Spindle at 10 feet in height (Robinson, DeMaree, Hoying, 2004).

Ultimate expected or desired tree height is a decision which is influenced by the manager. Experience, accessible equipment and labor constraints play an important role in this decision which can be adjusted through the course of the life of the enterprise. Note that ultimate or working tree height has a major influence on alleyway width/spacing of the orchard (Robinson, 2004). Under Michigan growing conditions related to latitude (ranges between 42 and 46 degrees North), growers are advised to plant orchards in a North / South direction for maximum efficiency. The ratio of row spacing to tree height must be 1.3. If the grower must plant in an East / West direction, then row spacing to tree height ratio must be 1.5. Ratios lower than 1.3 or 1.5, respectively, yield canopies with considerable shading and subsequent management expense to maintain. Ratios higher than these values make for inefficient land use.

Numeric codes for scion vigor represent relative comparative values in this formula which were derived from orchard observations made by Michigan fruit extension educators and cultivar trials. Numeric codes for rootstock vigor represent relative comparative values based on data collected from rootstock trials and on observations made in grower orchards in Michigan (Autio, et. al., 2005a., Autio ,et. al., 2005b., Autio, et al., 2006a., Autio, et al.,2006b, Barritt, 1992, Ferree and Carlson. 1987, Ferree and

Perry 1988, Marini, et al., 2000a, Marini, et al., 2000b, Marini, et al., 2001a, Marini, et al., 2001b, Perry, 1996, Perry, 1997, Perry and Byler, 2001, Perry, et al., 2002, Perry, 2005, Robinson, 2002, Robinson and Hoying, 2004, and Robinson, et al., 2004).

Scion Vigor (C)

Example/reference cultivars are listed below for each vigor category (code).

1. Low Vigor Spur-type Cultivars (1).

Redchief (Campbell)

2. Medium Low Vigor Spur-type and Precocious Cultivars (2).

Empire	Spur Rome	Braeburn	Honeycrisp
Idared	Spur Macs	Spur Red Delicious	
Vallee spur,	Scarlet, Ace,	Starkrimson, Stark spur, Sturdee Del. etc.	

3. Medium Vigor Cultivars (3).

Prime Red (Akane)	Redcort	Golden Delicious	Viking
Jonathan	Gala	Early Red 1Red.Del.	Jonamac
Jonagold	High Early Red Del.	Tydeman's Red	Goldrush

4. Vigorous Cultivars (4).

Rome	McIntosh	Spartan	Red Prince Red Del.
Liberty	Starking Red Del.	Melrose	Fuji
Novaspy	Priscilla	Jerseymac	Ginger Gold
Imperial Red Del.	Winesap	Redfree	Cortland
Lodi	Top Red Del.	Paulared	Wealthy

5. High Vigor Cultivars (6).

Northern Spy	Granny Smith	Mutsu	Rhode Isl. Grning.

Rootstock Vigor (R)

Example/reference rootstocks are listed below for each vigor category (code).

Rootstocks (grouped according to vigor)	Code
M[z].27, P.22, G.65	**0.0**
Mark, M.9NAKB , Bud.9, G.41, Supporter series 1, 2 & 3	**0.5**
M.9 EMLA, PJ 2, RN 29, G.16	**1.0**
M.26, Supporter 4, G. 935, G.11, G. 202,	**2.5**
G.30, CG.5087	**3.0**
M.7	**5.0**
MM.106	**7.0**
MM.111, Bud.118	**9.0**

[z]Abbreviations for rootstock names; G., Released clones of Cornell Geneva Series®, CG., Cornell-Geneva selections pending release, Bud., Budagovsky series, M. Malling, MM. Malling Merton, PJ., Pajam, RN., Renee Nicolai, (Barritt, 1992, Ferree and Carlson, 1987, Marini, et.al., 2000, Robinson. et.al, 2002).

Soil (S)

Soil Types	Code
Sandy or gravelly soil to 4 ft. (droughty)[z]	**0.0**
Low fertility sandy loam or shallow soil < 3 ft.	**1.0**
Moderate fertility, loam soil	**2.0**
High fertility, clay loam, with good moisture retention, ie., well drained but with good moisture in low areas.	**3.0**

[z]Refrain from using **rootstocks** in vigor code **0-1** noted above, unless deployed in Super Spindle system at over 2178 trees+ / acre.

Irrigation (I)

Irrigation[z]	Code
None	**0.0**
Applied when needed, portable sprinkler, etc.	**1.0**
Trickle or microsprinklers deployed to meet plant demands[Y].	**2.0**

[z]Note: Highly recommended for rootstocks in vigor code **0.0-1.0** noted above.

[y]Scheduling based on Evaporation Pan, and plant usage.

Management System (M)

Management System	Code
High intensity[1] winter and summer pruning and spread/tie limbs first 6 yrs., supported trees on dwarfing rootstocks.	**0.0**
Medium intensity (Central Leader) winter & summer pruning	**1.0**
Low intensity (Central Leader) winter pruning only	**3.0**

[1]For the following high density systems, use associated factors; Vertical Axe (0.7), Slender Spindle (0.6), Tall Spindle or V Trellis (0.4).

The formula and calculation

1. In-row Tree Spacing. Scion (C) + Rootstock vigor (R) + Soil (S) + Irrigation (I) + Management System (M) (where high density systems are applied, multiply sum by factors noted in Management category[1])

2. Row Spacing Width. North / South direction, 1.3 multiplied times expected or projected tree height (for East/West row direction, use 1.5). Tall Spindle limited to 10 ft. in height (Robinson, DeMaree and Hoying, 2004).

Example Calculations:

Example 1: Idared / M.26, sandy (droughty) soil, drip irrigated, on stakes, expect 12 ft. high tree:
In-row tree spacing = (2 + 2.5 + 1 + 2 + 0) = 7.5 ft
Row spacing = 1.3 x 12 = 15.6 ft
Recommended tree spacing = <u>7.5 x15.6 ft</u>
Trees per acre = 372

e.g. 2: McIntosh / MM.106, sandy soil, no irrigation, low intensity, expect 14 ft. high tree:
In-row tree spacing = (4 + 7 + 0 + 0 + 3) = 14 ft
Row spacing = 1.3 x 14 = 18.2 ft
Recommended tree spacing = <u>14 x18.2 ft</u>
Trees per acre = 171

e.g. 3: Jonagold / M.9 EMLA, fair vigor soil, drip irrigated, Vertical Axe, expect 10 ft. high tree:
In-row tree spacing = 0.7 (3 + 1 + 2 + 2 + 0) = 5.6 ft
Row spacing = 1.3 x 10 = 13 ft
Recommended tree spacing = <u>5.6 x13 ft</u>
Trees per acre = 598

e.g. 4: Empire / Mark, vigorous clay loam soil, drip irrigated, Slender Spindle, expect 8 ft. high tree:
In-row tree spacing = 0.6 (2+1+3+2+0) = 4.8 ft
Row spacing = 1.3 x 8 = 10.4 ft

Recommended tree spacing = 4.5 x 10.4 ft
Trees per acre = 873

ACKNOWLEDGEMENTS

The authors wish to thank Michigan State University tree fruit extension educators Philip Schwallier, Bill Shane, Bob Tritten, Jim Nugent, Mira Danilovich and others for their input, field observations, reviews and suggested revisions in this spacing recommendation formula.

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