Selected Apple Research Trials

at the Horticultural Experiment Station

Simcoe

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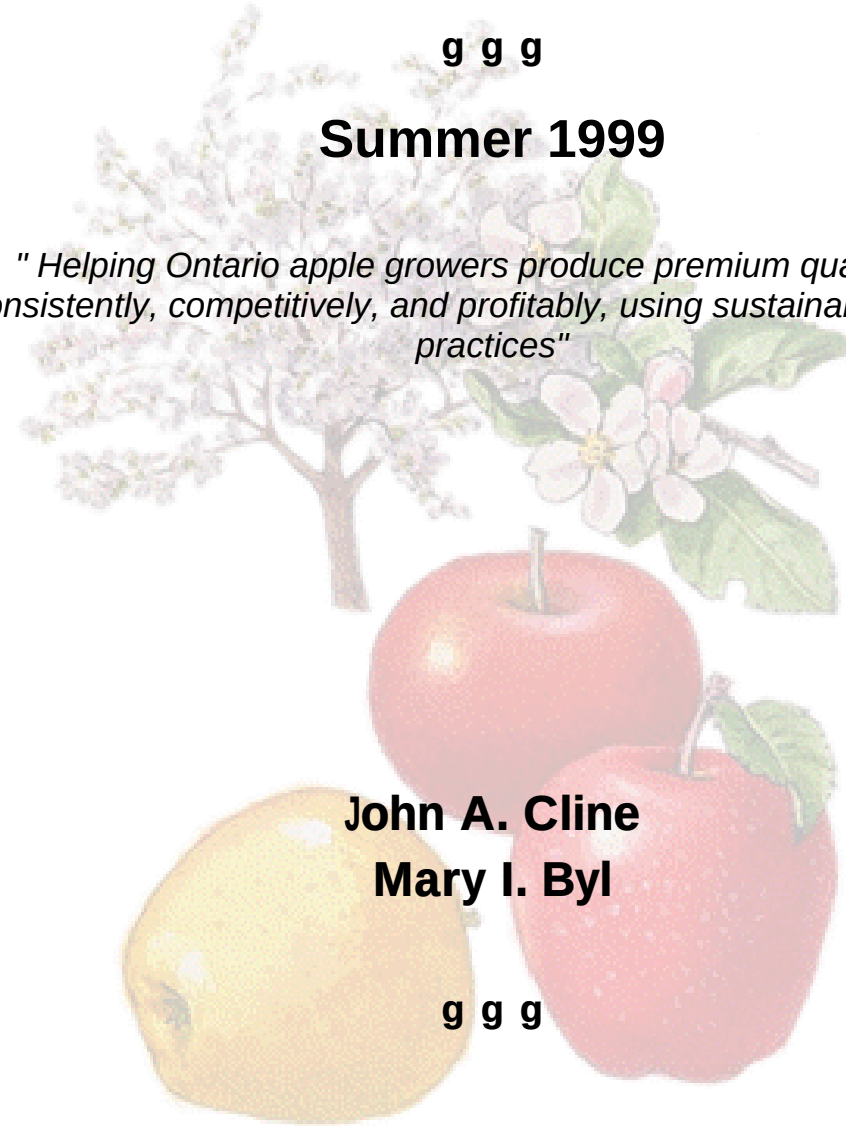
Summer 1999

" Helping Ontario apple growers produce premium quality fruit consistently, competitively, and profitably, using sustainable orchard practices"



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1.0 OVERVIEW OF THE APPLE RESEARCH PROGRAM

The Horticultural Experiment Station, Simcoe, has 15 hectares of orchard dedicated to apple research. The programme takes a holistic approach to solving practical cultural management problems. Research concerns reflect the techniques required for growing modern intensive orchards planted with dwarfing rootstocks. Major thrusts include the evaluation of new cultivars for suitability under Ontario's soil and climatic regime, evaluation of dwarfing rootstocks on precocity, cropping efficiency, and tree vigour, and the performance of various cultivar/rootstock combinations in different intensive orchard systems. Efforts are also directed towards developing and testing new fruit thinning strategies. Soil management studies to evaluate the benefits of soil amendments recycled from agricultural sources on tree establishment, cropping, and soil sustainability. and plant nutrition studies focusing on the improvement of fruit quality and yield have been more recently initiated. In general, our research endeavors are devoted to helping Ontario apple growers produce premium quality fruit consistently, competitively and profitably, using sustainable agricultural practices.

2.0 GENERAL ORCHARD MANAGEMENT PRACTICES USED IN OUR EXPERIMENTAL ORCHARDS

*Herbicide*s: Our herbicide program is based on a fall application of Sinbar (1.1 kg/ha) and spring applications of Paraquat (1 kg/ha) and Simazine (2 kg/ha). Spot treatments of Ignite or Roundup are used in the summer.

Pesticides: We follow an integrated pest management programme.

Orchard Cover: the sod mixture used on station is 40% creeping red fescue, 40% tall fescue, and 20% perennial rye grass. This ratio is selected for its known resistance to drought and heat, and suppression of root lesion nematodes.

Table 1. Temperature and rainfall conditions around Ontario as of September 5, 1999[1]

	Degree days (Base 5^0)					Rainfall (mm)													
						Actual (1999)								30 Year Normals					
Location	To Date, 1999	% of 'normal'	Days ahead/ (Behind)' normal'	To date 1998	30 - Year Normal	Total to date	Past week 8/30-9/5	Sep to date	August	July	June	May	April	September	August	July	June	May	April
Cedar Springs	2023	-[2]	-	2046	-	177	0	0	5	30	31	31	80	80	97	87	85	74	-
Clarksburg	1700	109	14	1690	1556	359	0	0	60	125	74	80	21	-	-	-	-	-	-
Guelph	1622	104	4	1646	1577	408	0	0	44	160	101	47	56	90	93	90	80	76	73
Harrow	2175	110	20	2138	1938	232	0	0	28	49	33	31	92	85	82	92	81	80	81
Kemptville	1819	-	-	-	-	209	0	0	5	87	80	37	-	-	-	-	-	-	-
London	1904	120	23	2017	1679	302	0	0	60	30	87	47	77	86	90	77	82	76	79
Ottawa	1937	114	31	1919	1689	244	0	0	33	113	46	33	20	84	88	87	84	77	65
Ridgetown	1989	108	14	1972	1821	285	0	0	49	39	50	25	122	80	97	87	85	74	-
Simcoe	1942	108	14	1931	1781	375	0	0	145	35	79	55	62	89	80	77	82	74	53
Vineland	2010	115	21	2028	1766	286	0	0	49	79	45	44	70	82	86	68	79	63	74
Average	1912	111	18	1932	1726	288	19	0	48	75	62	43	67	85	89	83	82	74	71

[1] - Source: Ontario Ministry of Agriculture, Food and Rural Affairs

[2] - indicates values not available

3.0 INFLUENCE OF TREE QUALITY AND IRRIGATION ON THE EARLY PERFORMANCE OF 'EMPIRE', 'GALA', AND 'JONAGOLD'.

Apple trees established from well-branched (feathered) nursery trees develop vigorous, strong branch frameworks and crop earlier and more heavily than trees established from poorly branched, 1-yr-old nursery trees.

Objective: to evaluate the influence of tree quality (number of lateral branches) and irrigation on the early growth and productivity of 'Empire', 'Jonagold', and 'Gala' apple trees.

Plant Material: 'Empire', 'Gala', 'Jonagold' on M.9 rootstock planted in 1994 at a spacing of 2.0 m x 4.5 m (6.6' x 14.8'; 1111 trees/ha; 500 trees/acre).

Experimental Design: Split plot design with irrigation as main factor and cultivar and tree quality as split plots.

Treatments: This trial consists of three cultivars, two tree qualities at the time of planting, in combination with two levels of trickle irrigation (+/-). For example, combinations for each of the following factors are being tested:

Cultivar	Tree Quality	Irrigation
'Empire',	Whips	no
'Jonagold'	Feathered trees	yes
'Gala'		

Results: Since the feathered trees were larger than 1-yr-old whips at the time of planting, the trunk cross sectional area (TCSA) of the former was also greater at the time of planting. The difference in TCSA, however, became less with time as the whips made more trunk circumference growth than the feathered trees. Average shoot length was greater for the whips than for the feathered trees. At the end of the first growing season, feathered trees had a greater overall shoot length, however, when the shoot length and number are adjusted for tree size there is no significant treatment difference. Irrigation also had an effect on the growth of the trees in their first leaf. At planting there was no significant difference in TCSA between irrigated and unirrigated trees, but by the autumn of 1994 TCSA was significantly greater for the irrigated trees. By 1998, the tree size between irrigated and unirrigated trees was not significantly different, however cumulative yield of irrigated trees has surpassed unirrigated trees by 40%.

Table 1. Influence of irrigation, tree quality, and cultivar on early establishment and tree production. Trees planted in 1994.

			Cumulative									
	Yield		yield		TCSA(cm^2)				Avg. fruit weight (g)			
	(bu/acre)		(bu/acre)		Fall		Fall					
	1998		95-'98		1997		1998		1997		1998	
Irrigation												
Irrigated	220	a	563	a	9.1		11.8		154		193	a
Non Irrigated	131	b	401	b	8.1		10.5		157		181	b
Significance	**		**		ns		ns		ns		*	
LSD (p=0.05)[z]	49		97		1.1		1.2		9		10	
Cultivar-Tree Quality												
Empire whips	94	c	325	cd	6.5	a	9.0	cd	128	d	171	de
Empire feathered	71	c	278	d	6.8	b	8.9	cd	126	d	167	e
Gala whips	262	a	574	b	8.0	c	10.1	c	188	a	204	ab
Gala feathered	327	a	822	a	11.2	d	14.0	b	164	bc	182	cd
Jonagold whips	126	c	372	c	6.3	d	8.7	d	152	c	192	bc
Jonagold feathered	194	b	563	b	12.7	d	16.3	a	176	ab	205	a
Significance	***		***		***		***		***		***	
LSD (p=0.05)[z]	67		91		1.1		1.4		14		12	
Interaction	ns		ns		**		**		ns		ns	

[z] ns, *** , **, * indicates non significance and statistical significance at P= 0.001, P= 0.01, and P = 0.05.

4.0 FRUIT GROWTH

Objective: to evaluate the effect of irrigation and growing season (year) on the diametric growth of fruit of three cultivars during fruit growth and development

Plant Material: 'Empire', 'Gala', and 'Jonagold' on M.9 rootstock planted in 1994 at a spacing of 2.0 m x 4.5 m (6.6' x 14.8'; 1111 trees/ha; 500 trees/acre).

Experimental Design: Split plot design with irrigation as main factor and cultivar as split plot. Six single tree replicates.

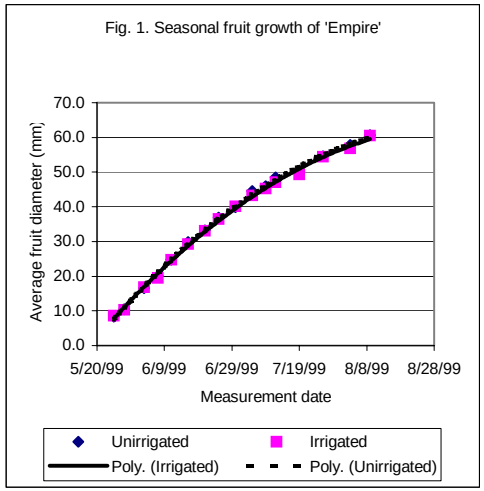
Treatments: The length and diameter of twenty five randomly selected fruit were measured on each replicate tree approximately every 4 days during the first 6 weeks of development and at weekly intervals thereafter until harvest.

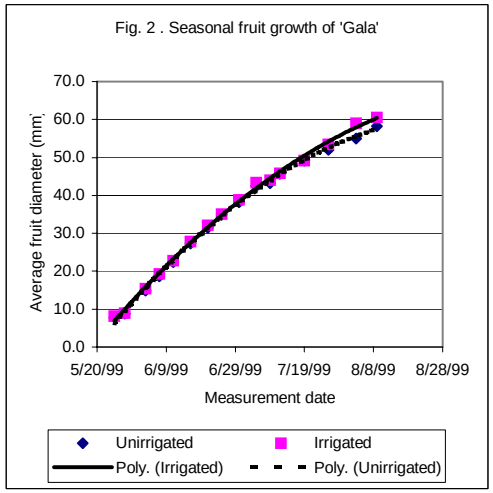
Results: Despite the coarse sandy soil in this orchard block there has been no significant difference in fruit diamter between irrigated and unirrigated trees. Reasons for this are not entirely clear at this time, and treatment difference may become more apparent by harvest. Nevertheless, a short disruption in irrigation during late June and early July, slight crop load differences among trees and a fairly extensive root system which be adequate to obtain sufficient water despite lack of irrigation may, in part, be why benefits of irrigation have not been detected to date.

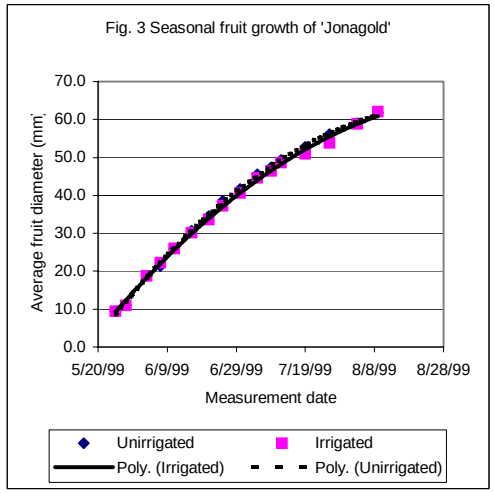
Table 2. Mean diameter (mm) of 25 fruitlets per tree on three cultivars with and without irrigation. Data collected 1999. University of Guelph, Horticulture Research Station, Simcoe.

		5/25/99	5/28/99	6/3/99	6/7/99	6/11/99	6/16/99	6/21/99	6/25/99	6/30/99	7/5/99	7/9/99	7/12/99	7/19/99	7/26/99	8/3/99	8/9/99
Irrigated		8.7	10.1	17.0	20.3	24.5	29.1	32.9	36.3	39.8	43.8	45.3	47.2	49.9	53.9	58.2	61.0
Unirrigated		8.5	10.1	16.7	20.0	24.4	29.3	33.1	36.8	39.9	44.2	45.5	47.8	50.8	54.3	57.2	60.3
significance[y]		ns	ns	ns	ns	ns	ns	ns	*	ns	ns	ns	ns	ns	ns	ns	ns
LSD (p=0.05)		0.3	0.2	0.2	0.9	0.5	0.6	0.5	0.5	0.6	1.0	1.2	0.8	1.4	1.2	1.4	1.5
Empire		8.5	10.3	16.7	19.8	24.7	29.6	33.2	36.7	40.0	44.0	45.6	47.8	49.9	54.5	57.3	60.6
Gala		7.9	8.9	15.2	18.9	22.6	27.6	31.8	35.0	38.5	42.8	43.6	45.7	49.2	52.7	57.0	59.4
Jonagold		9.4	11.0	18.8	21.8	26.0	30.4	34.1	37.9	41.2	45.1	47.0	49.0	51.9	55.0	58.9	62.0
significance[y]		***	***	***	***	***	***	***	***	***	**	**	***	**	**	ns	*
LSD (p=0.05)		0.3	0.3	0.3	1.1	0.6	0.7	0.6	0.6	0.7	1.2	1.5	1.0	1.7	1.5	1.7	1.9
interaction		ns	ns	ns	ns	ns	ns	*	ns	ns	ns	ns	ns	ns	*	*	ns
Irrigated	Empire	8.6	10.3	16.8	19.5	24.7	29.3	33.1	36.5	40.1	43.3	45.2	47.1	49.4	54.4	56.8	60.5
Unirrigated	Empire	8.4	10.4	16.6	20.1	24.7	29.8	33.2	36.9	39.9	44.6	45.9	48.5	50.4	54.6	57.8	60.7
Irrigated	Gala	8.1	8.9	15.4	19.3	22.8	27.8	32.1	35.1	38.8	43.3	44.0	45.8	49.2	53.4	59.0	60.5
Unirrigated	Gala	7.7	8.8	14.9	18.6	22.4	27.3	31.5	34.9	38.2	42.4	43.2	45.7	49.2	52.0	55.0	58.2
Irrigated	Jonagold	9.4	11.0	18.8	22.2	26.0	30.2	33.6	37.2	40.6	44.7	46.5	48.6	51.0	53.8	58.9	62.1
Unirrigated	Jonagold	9.4	11.0	18.7	21.4	26.0	30.7	34.6	38.5	41.7	45.6	47.4	49.3	52.8	56.2	59.0	61.8

[y] ns, *, **, ***, indicates not significant, and significant differences at P= 0.05, P=0.01, and P=0.001 respectively







5.0 CULTIVAR DEVELOPMENT

Objective: To evaluate the suitability of new or untested cultivars for production in Southern Ontario.

Year of Planting	Details of Plantings
1986	Approximately 25 cultivars and strains on 'Mark' rootstock.
1987	Approximately 50 cultivars and strains on M.26 rootstock.
1992 & 1993	Several numbered selections originating from the Agriculture Canada breeding program in Summerland, British Columbia on M.9 rootstock.
1994	A randomized planting of approximately 20 cultivars on M.9 rootstock, including some from the 1994 Western Ontario Fruit Testing Association's selections - Braeburn, Thome Empire, as well as various strains of Gala, Jonagored, and Fuji.
1995	A randomized planting of 21 of the newest and most promising named and numbered selections from around the world (NE-183 trial).
1999	A randomized planting of approximately 20 of the next generation of most promising named and numbered selections from around the world was planted this spring. This forms the second planting of the NE-183 USDA Cooperative Cultivar Evaluation Trials

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DESCRIPTION OF SELECTED APPLE CULTIVARS

Arlet (also called 'Swiss Gourmet')

Originating in Switzerland, this cultivar is a cross between Golden Delicious and 'Idared'. Trees have a moderate vigour. Fruit ripens late September to early October. There is a tendency for pre-harvest fruit drop. Fruit can become greasy when overmature, however, still remain internally sound. There is some susceptibility to russeting, especially around the calyx. Fruit have a red blush on a green background and tend to be large. Arlet stores and retains its flavour well with time

Creston (BC-8M-15-10)

This is a red striped fruit on a yellowish-green background, introduced as an advanced selections from the Agriculture and Agri-Food Canada breeding program in Summerland, B.C. It ripens in late September with Empire. It has a crisp and juicy texture, does not easily oxidize, and has an excellent and distinctive flavour.

Braeburn

This cultivar originated as a chance seedling in New Zealand. It is precocious and produces large oval fruit with a dull stripy blush on a green background. The fruit ripens late in the season around the time of Rome Beauty, Fuji, and Granny Smith . Trees are low to moderate in vigour with wide crotch angles. The pleasant aromatic flavour improves with storage. Braeburn is very susceptible to mites and fireblight, and is prone to bitterpit.

Cameo (formerly Carousel)

This chance seedling was discovered in Washington. The fruit matures in mid to late October along with Rome Beauty and Braeburn. The round, slightly elongate fruit have an attractive bright red stripe with a yellow-green background. They have a good, sweet-tart, eating quality. Firmness is maintained for long periods. The fruit are not prone to russet and are only slightly susceptible to bitter pit.

Enterprise

This disease resistant cultivar originates from the Purdue, Rutgers, Illinois breeding program. Its parentage includes McIntosh and Delicious. The tree is moderately to highly vigourous, annual in bearing, and its production is moderate to good. The fruit matures two weeks after Delicious - corresponding with Rome Beauty. The fruit hangs well on the tree even when over mature. The medium to large fruit is bright, dark red with a smooth, thick skin and prominent lenticels. The moderately acid, spicy flavour improves with storage. This cultivar is immune to apple scab, resistant to cedar apple rust and fireblight, and moderately tolerant to powdery mildew. In some areas lenticel spotting is a problem.

Gala Supreme

This is a separate cultivar, not a sport of Gala.

The medium to large fruit is similar in appearance to Gala, although the tree resembles a Rome. The flesh is firm and crisp, sweet, and slow to oxidize.

Ginger Gold

This yellow apple shows is resistant to russeting. It matures in late August. The fruit hangs well and can be picked over a long period. The fruit is medium to large with firm juicy flesh which oxidizes slowly. The fruit resembles a non-russetted Golden Delicious, and is one of the best of the early Golden types. It can be kept for up to 3 months in refrigerated storage.

Goldrush

This deep yellow, disease resistant cultivar originates from the Purdue, Rutgers, Illinois breeding program. The fruit is medium in size with a thin, non-waxy skin and conspicuous, russetted lenticels. The flavour is good and improves in storage. The fruit can be kept for up to seven months in cold storage. Trees are moderately vigourous with some tendency toward biennial bearing. The fruit matures 3-4 weeks after Red Delicious. The fruit hangs well on the tree even when overripe. The cultivar is immune to apple scab, susceptible to cedar apple rust, moderately resistant to fireblight, and moderately tolerant to powdery mildew.

Golden Supreme

This yellow apple, developed in California, has a pink blush and ripens 10 days before Golden Delicious. It does not russet. The flesh is crisp and juicy and the flavour is sweet with a taste of licorice.

Honeycrisp

This cultivar was developed in Minnesota from a cross between Macoun and Honeygold. The tree is weak, annual, hardy, and productive. The harvest season extends from 10 days before McIntosh to 5 days after. The fruit hangs well. Fifty to ninety percent of the fruit is covered with a unattractive scarlet blush over a yellow background. The fruit is medium to large with a dull, dimpled surface and small conspicuous lenticels. This is an excellent dessert apple.

Fortune (NY 429)

This is a very productive cultivar, though, if cropped too heavily, it can become biennial. The fruit is large, even when fruit set is heavy. The attractive fruit is red, smooth and somewhat irregular in shape.

NY 75414-1

This Macoun look-alike, developed from a cross of Liberty and Macspur, is less precocious than Empire or Liberty. It matures in mid October with Delicious. The fruit is deep red with conspicuous light lenticels, and the flesh is crisp. The tart flavoured fruit has a chalky aftertaste under some growing conditions. Crispiness and flavour are retained during storage.

Orin

Like Mutsu, this cultivar has Golden Delicious and Indo as its parents. It is a large, oblong conic yellow green apple with prominent, russetted lenticels. The flesh is greenish white, firm crisp and juicy. The flavour is excellent and the fruit has a good shelf life.

Pioneer Mac

This McIntosh strain has excellent fruit quality and colours well. The tree is a non-spur with apparent resistance to late-season drop. The tree is less vigourous than Marshall McIntosh.

Pristine

This disease resistant cultivar is a product of the Purdue, Rutgers, Illinois breeding program. It is immune to apple scab, slightly resistant to cedar apple rust, moderately resistant to fireblight, and resistant to powdery mildew. The tree is moderately vigourous. The round, moderately sized fruit are yellow with a slight orange blush. The fruit matures in early August and retains excellent quality in cold storage for four to six weeks. A greasy cuticle may develop after longer storage. The fruit has a pleasant, mildly acid flavour.

Sansa

This cultivar was developed in Japan from a cross of Gala and Akane. The tree is precocious and productive. The bright red, conical fruit matures in mid-August. Fruit is small to medium in size. The flavour is excellent resembling that of Gala. The flesh is crisp, fine and juicy. It can be stored for up to two months. Sansa is resistant to apple scab and cedar apple rust.

Shizuka

This Japanese cultivar has the same parentage as Mutsu. Like Mutsu it is a triploid, producing a vigourous tree. The fruit matures a week before Mutsu, is large, somewhat elongate, and is yellow with a pink blush. The fruit is attractive and the flavour is sweeter and fruiter than Mutsu. Shizuka also stores longer than Mutsu and apparently is not prone to blister spot.

Suncrisp

This cultivar, a product of the New Jersey breeding program, is harvested a week after Fuji. The conic fruit has a distinctive orange-red colour over a yellow background. The flesh is crisp.

The flavour is excellent and improves with storage. This cultivar appears to have long-term storage potential.

Sunrise

This cultivar, a cross between McIntosh and Golden Delicious, is a product of the Agriculture and Agri-food Canada breeding program in Summerland,B.C. The tree is vigourous and spurry. The fruit ripens in mid-late August in Simcoe. The somewhat irregular, large, ribbed fruit are pale yellow with 50% bright pinkish striped blush. When good colour develops. fruit are often overripe. The flavour is mild and subdued. The flesh is crisp and juicy.

Yataka

This bud mutation of Fuji matures two to three weeks earlier than Fuji. Even when it is allowed to remain on the tree, the fruit does not develop a good blush colour. The taste is a little different from other Fuji. While other Fuji strains must be stored to develop a good flavour, Yataka tastes good directly off of the tree.

Table 3. Bloom and maturity estimates and growth habit for some of the new promising cultivars.

Cultivar	Status at Univ. of Guelph, Simcoe [1]	Bloom season	Comments	Estimated typical harvest date(Simcoe)	Vigor	Habit
Pristine	B	Early	Early August	5-Aug	Moderate	Spreading
Jerserymac	X	Early	1 month before McIntosh.	15-Aug	Moderate	Upright and spreading
William's Pride	B	Mid	Mid August	15-Aug	Vigorous	Standard
Akane	B	Mid	3-5 days before Gala	25-Aug	Moderate	Standard
Earligold	B	Mid	1 wk. Before McIntosh	25-Aug	Moderate to High	Standard
Ginger Gold	B	Mid	Late August	25-Aug	Moderate to High	Open spreading
Paulared	B	Mid	Late August, Early Sept.	25-Aug	Moderate	Standard
Sunrise	B	Mid	2-3 wks before Gala	25-Aug	Moderate	Semi spur
Zesta	N	Early	With Paulared	25-Aug	Vigorous	Upright
Sansa	B	Mid	1 wk before or with Gala	1-Sep	Low	Upright and spreading
Dayton	B	Mid	4 wks. Before Red Del.	5-Sep	Vigorous	Standard and semi spreading
Gala	B	Mid	1 wk. Before and with McIntosh	5-Sep	Vigorous	Standard
Southern Snap	X	Mid	with Gala in PNW	5-Sep	Vigourous	Standard
Elstar	B	Mid to Late	Late Sept., and overlaps with Gala	10-Sep	Moderate to High	Standard
Senshu	X	Mid	1 wk after Gala	10-Sep	Moderate	Standard
McIntosh	B	Mid	Mid to late September	14-Sep	Moderate	Standard or spur-type
Novamac	B	?	with McIntosh	14-Sep	Moderate	Upright and spreading
Arlet	B	Early to Mid	After Cox Orange Pippin and before Red Del.	15-Sep	Moderate	Standard
BC 8B-14-56	X	?	Mid Septmber	15-Sep	Moderate to High	Standard
Pioneer Mac	B	?	10 days after Rogers McIntosh	18-Sep	Moderate	Standard
Empire	B	Mid	with Red Del.	20-Sep	Weak	Standard
Honeycrisp	B	Mid	1 wk after McIntosh	20-Sep	Weak	Standard
Spartan	X	Mid	after McIntosh	20-Sep	Vigorous	Standard and spurry
Cortland	B	Early to Mid	before and with Del.	25-Sep	Moderate	Spreading
Fortune	B	Mid	with or a little after Empire	25-Sep	Vigorous	Standard and upright
Freedom	B	Mid	Late September	25-Sep	Vigorous	Spreading
Liberty	B	Mid	Late Sept.	25-Sep	Moderate	Semi spur
Orin	B	Early to Mid	Late September	28-Sep	Moderate	Standard and upright
Coop 39	N	Mid to Late	Mid Septmber in Indiana	1-Oct	Moderate	Upright
Creston (8M-15-10)	B	Mid to Late	with Gold. Del.and Jonagold	1-Oct	Moderate	Standard
Goldensupreme	B	Mid to Late	1-2 wks before Gold. Del.	1-Oct	Moderate	Standard
Hampshire	N	Mid	with Empire and Red Del.	1-Oct	Moderate	Semi spur
Jonagold	B	Mid	Early Oct., before Gold. Del.	1-Oct	Vigorous	Semi spur
Shizuka	B	Mid	After Red Del.	1-Oct	Vigorous	Spreading and tip bearing
Silken	N	Early to Mid	Early Sept. In PNW	1-Oct	Vigorous	Standard
Scarlet O'Hara	N	Mid	1 wk. Before Red Del.	5-Oct	Moderate	Spreading
Elliott	X	Mid to Late	with Red Del.	5-Oct	Vigorous	Standard
Galasupreme	B	Mid to Late	Early Oct. (150-165 days from bloom)	5-Oct	Vigorous	Upright
NY-75414-1	B	Mid	Mid to late September	5-Oct	Moderate	Upright
Pinova	N	Mid	with Gold. Del	5-Oct	Low to Moderate	Standard
Chinook	B	Mid to Late	with Red Del.	10-Oct	Low to Moderate	Standard
Golden Delicious	B	Mid to Late	Early to mid October	10-Oct	Moderate to High	Standard or spur-type
Macoun	B	Mid	1 month after McIntosh	10-Oct	Moderate	Upright
Mutsu/Crispin	B	Mid	with Gold. Del.	10-Oct	Vigorous	Standard, upright
Novaspy	B	Mid	between Red Del. And Northern Spy	10-Oct	Moderate	Upright and spreading
Red Delicious	B	Mid	Early to mid October	10-Oct	Moderate	Standard or spurry
Runkel	N	Mid	Early to mid October	10-Oct	Vigorous	Standard, upright, and spur-type
Ambrosia	N	Mid	Mid October	15-Oct	Vigorous	Upright
Cameo	B	Mid to Late	Mid Oct. with or before Rome and Braeburn	15-Oct	Moderate to High	Standard
Coop 29	N	Mid to Late	1 wk. after Red Del.	15-Oct	Moderate	Upright
Idared	B	Early to Mid	mid Oct.	15-Oct	Moderate	Standard and spurry
Northern Spy	B	Late	Mid Oct.	15-Oct	Vigorous	Spreading
Yataka Fuji	B	Mid	2-3 wks before Fuji	15-Oct	Moderate	Standard
Delbush	N	Mid	10 days after Gold. Del.	20-Oct	Moderate	Standard
Enterprise	B	Mid	with Rome, before Braeburn	20-Oct	High	Standard
Goldrush	B	Mid to Late	Late Oct.	20-Oct	Moderate	Standard, spreading, semi-spur
Suncrisp	B	Mid	1 wk after Gold. Del.	20-Oct	Moderate	Semi erect
Autumn Gold	N	Mid	2 wks. After Gold. Del.	25-Oct	Moderate	Spreading
Braeburn	B	Mid	Late- with Rome, Fuji, and Granny Smith	25-Oct	Low to Moderate	Standard
Cox Orange Pippin	X	Mid	Late Sept., and overlaps with Red Del.	25-Oct	Moderate	Standard
Fuji	B	Mid to Late	Late- before Granny.	25-Oct	Moderate to High	Standard
Rome	B	Late	Late October, with Fuji	25-Oct	High	Spreading
Russet	X	?	Very late.	25-Oct	Moderate	Spreading
Granny Smith	B	Mid	Late Oct. or later.	30-Oct	High	Standard to spreading
Pacific Rose	X	Mid	?	?	Moderate	Standard
Pink Lady	X	Mid	Late- (Late Oct. in PNW)	won't mature	High	Standard and upright

[1] B=Bearing; N= Non bearing; X= Not on campus

Table 4a. Sensory evaluation of selected cultivars grown at HES, Simcoe in 1998. Ratings for each characteristic were obtained by taking the average scores determined by 2 to 6 people in a trained taste panel.

			Weighting ->		1	-1	1	1	1	1	-1	-1	3	3	2
					Scale (1=low; 3=moderate; 5 = high)										
Cultivar	Harvest Date	Evaluation Date	Overall Score	Ranking	Visual Attractiveness	Regularity of shape	Crispness	Juiciness	Sweetness	Acidity	Astringency	Skin Toughness	Overall Flavour	Overall Desirability	Flesh Firmness
HARVEST EVALUATIONS															
Sunrise	AUG.12	AUG.13	43.6	1	4.0	2.0	4.3	4.3	3.5	2.5	1.0	3.0	4.5	4.5	3.3
Sunrise	AUG.20	AUG.20	42.0	2	4.2	2.2	3.7	4.4	4.0	2.0	1.2	3.3	4.5	4.3	3.0
Creston	SEPT.29	SEPT.29	40.8	3	3.5	2.3	4.0	4.0	4.0	1.0	1.0	2.8	4.3	4.0	3.3
Honeycrisp	SEPT.15	SEPT.15	40.7	4	4.0	1.0	3.7	3.7	3.0	3.0	2.3	3.3	4.7	4.3	3.0
Sansa	AUG.21	AUG.21	39.0	5	3.7	2.7	3.7	4.0	4.7	1.0	1.0	2.7	4.0	4.0	2.7
Shizuka	SEPT.29	SEPT.29	38.3	6	3.5	2.0	3.3	3.3	3.8	2.0	1.3	2.3	3.8	4.3	3.0
8S-27-2	SEPT.30	SEPT.30	38.1	7	3.0	2.3	3.7	4.0	3.7	2.7	1.7	2.3	3.7	3.7	4.0
Arlet	SEPT.9	SEPT.11	38.0	8	3.5	1.3	3.8	3.5	3.8	2.3	1.8	2.8	4.0	3.8	3.0
Arlet	SEPT.16	SEPT.16	38.0	9	3.3	1.3	4.0	4.0	3.7	2.0	1.3	3.0	3.7	3.7	3.3
8S-29-18	OCT.9	OCT.9	37.7	10	4.0	1.7	4.3	3.3	4.3	1.0	1.3	2.7	3.7	3.0	3.7
8S-31-52	OCT.9	OCT.9	37.0	11	3.0	.	4.0	4.0	4.0	4.0	1.0	1.0	3.0	3.0	3.0
8S-27-2	OCT.8	OCT.8	36.0	12	2.5	2.5	3.0	4.0	3.5	2.5	1.5	3.0	4.0	4.0	3.0
8S-46-2	OCT.14	OCT.14	36.0	13	4.0	2.6	3.6	4.0	3.8	2.2	1.8	3.2	3.6	3.8	3.0
8M-2-871	SEPT.16	SEPT.16	35.7	14	3.8	1.4	4.2	3.1	2.8	2.1	1.6	3.0	3.7	3.3	3.3
Shizuka	OCT.9	OCT.9	35.5	15	3.0	2.5	3.5	3.5	3.5	2.5	1.5	3.5	4.0	3.5	3.5
Creston	SEPT.16	SEPT.16	35.3	16	3.5	1.5	3.5	3.5	3.8	2.3	1.3	2.5	3.5	3.3	3.0
Gingergold	AUG.28	AUG.28	35.0	17	2.7	3.0	3.7	2.7	4.0	1.7	1.0	3.0	4.0	3.7	3.0
Creston	SEPT.18	SEPT.18	34.7	18	3.3	1.3	3.7	3.3	3.3	2.3	1.7	2.0	3.3	3.3	3.0
Idared	OCT.8	OCT.8	34.5	19	4.0	2.0	3.5	4.0	3.0	4.5	3.5	3.5	3.5	3.5	4.0
8C-28-27	SEPT.9	SEPT.11	34.5	20	3.3	1.0	4.0	3.0	3.5	1.8	1.0	3.3	3.5	3.5	2.5
8S-69-23	SEPT.30	SEPT.30	34.5	21	2.3	2.0	4.0	3.5	4.3	1.3	1.0	2.5	3.3	3.3	3.3
4E-12-35	SEPT.9	SEPT.11	34.3	22	4.3	1.3	2.8	3.3	4.0	1.0	1.3	2.3	4.0	3.3	1.5
8C-12-30	SEPT.30	SEPT.30	33.8	23	3.5	1.5	3.3	3.8	3.5	2.0	1.8	3.5	3.3	3.8	2.8
8C-34-18	SEPT.30	SEPT.30	33.8	24	3.5	2.0	4.0	3.8	3.8	2.3	1.3	3.5	3.5	3.0	3.0
Golden Supreme	SEPT.15	SEPT.15	33.7	25	3.7	2.0	3.3	3.0	3.7	1.3	2.3	4.0	4.0	3.7	2.7
Creston	SEPT.9	SEPT.11	33.7	26	3.7	1.5	3.8	3.5	3.0	2.5	1.5	2.5	3.3	3.5	2.5
8B-20-73	AUG.26	AUG.28	33.5	27	3.0	1.5	2.5	2.0	3.0	3.0	1.5	2.0	3.5	3.5	3.5
Sunrise	AUG.26	AUG.28	33.5	28	3.5	1.5	3.5	3.0	4.0	1.5	1.0	2.5	3.0	3.5	2.5
8S-29-18	SEPT.29	SEPT.30	33.3	29	3.5	2.3	3.8	2.8	4.0	1.0	1.0	3.0	3.3	3.3	3.0
8S-46-2	OCT.9	OCT.9	33.0	30	4.0	2.5	4.0	3.0	3.0	2.5	2.5	2.5	3.5	3.0	3.5
8S-69-23	SEPT.16	SEPT.16	32.7	31	2.3	2.0	3.7	3.3	3.0	1.7	1.0	3.0	3.0	3.3	3.7
8S-31-52	SEPT.16	SEPT.16	32.7	32	3.3	1.3	3.3	2.3	3.3	2.0	2.0	3.0	3.3	3.3	3.3
Delicious, Al Ferri	OCT.8	OCT.8	32.5	33	3.5	3.5	4.0	4.0	4.5	1.5	1.0	3.0	3.0	3.0	3.0
8S-29-18	SEPT.16	SEPT.16	32.3	34	3.3	1.0	3.3	2.7	3.7	1.7	1.7	2.7	3.0	3.0	3.3
8S-31-52	SEPT.30	SEPT.30	32.3	35	2.3	2.3	3.3	3.7	3.7	1.0	1.0	3.3	3.3	3.3	3.0
8M-2-871	SEPT.10	SEPT.11	32.2	36	3.3	2.3	3.6	3.3	3.3	1.5	1.3	2.8	3.0	3.3	3.1
4E-12-35	AUG.26	AUG.28	32.0	37	4.0	1.0	2.7	3.0	3.7	2.0	1.3	3.7	3.3	3.3	2.3
8S-69-5	SEPT.16	SEPT.16	32.0	38	2.3	2.0	3.3	3.3	3.3	2.0	1.3	2.0	3.0	3.3	3.0
Creston	OCT.19	OCT.19	32.0	39	3.3	2.0	3.3	3.7	3.7	1.3	1.0	2.7	3.3	3.0	2.3
8S-69-23	SEPT.9	SEPT.11	31.9	40	2.3	1.8	3.8	2.6	3.8	1.6	1.4	2.8	3.2	3.0	3.4
8M-2-871	OCT.1	OCT.1	31.6	41	3.4	2.2	3.6	3.2	3.1	2.0	1.3	3.3	2.9	3.2	3.5
8S-31-56	SEPT.30	SEPT.30	30.9	42	3.5	2.0	3.7	3.5	2.8	1.8	1.5	3.0	3.0	3.0	3.0
9P-15-30	AUG.19	AUG.20	30.6	43	2.4	2.2	3.4	3.4	3.4	2.4	1.6	3.2	3.0	3.2	3.2
8C-12-30	OCT.8	OCT.8	30.5	44	3.5	2.0	3.0	3.5	4.0	1.5	1.5	4.0	3.0	3.0	3.0
8M-2-871	SEPT.9	SEPT.11	30.2	45	4.3	1.1	4.3	2.5	3.0	2.8	1.4	3.7	2.7	2.6	3.3
8S-27-51	OCT.9	OCT.9	30.0	46	2.0	2.5	4.0	3.0	2.5	3.5	2.5	3.0	3.5	3.0	3.5
8S-31-52	SEPT.9	SEPT.11	29.3	47	2.3	2.0	3.5	2.5	2.8	2.0	1.7	4.3	3.0	3.3	3.8
8M-2-871	AUG.26	AUG.28	29.3	48	3.6	1.6	3.3	2.7	1.8	3.7	1.3	3.5	2.6	2.9	3.9
Regent	SEPT.16	SEPT.18	29.3	49	2.7	2.7	3.8	3.3	2.5	3.0	2.0	3.3	2.8	3.3	3.5
8C-28-27	OCT.9	OCT.9	29.0	50	3.3	2.5	3.5	3.0	3.5	2.0	1.3	2.5	2.8	2.8	2.8
8C-31-110	OCT.19	OCT.19	28.8	51	2.0	1.5	3.7	2.7	2.7	2.3	2.0	2.7	2.7	2.7	4.0
Regent	OCT.1	OCT.1	28.4	52	2.9	1.6	3.7	3.3	3.2	2.7	2.3	3.4	3.0	2.6	3.0
Magnolia Gold	OCT.1	OCT.1	28.4	53	3.6	2.1	3.4	3.1	2.8	2.0	1.4	3.1	2.9	2.8	2.6
McIntosh, Wijcik	SEPT.10	SEPT.11	28.4	54	3.7	1.7	3.7	3.0	2.5	3.5	3.4	3.7	2.7	3.5	3.0
8S-562-56	SEPT.9	SEPT.11	28.0	55	4.0	1.5	3.5	2.8	3.5	2.6	1.3	4.0	2.8	2.8	2.3
Pioneer Mac	SEPT.15	SEPT.15	28.0	56	3.5	2.3	3.8	2.8	2.5	3.0	3.3	3.5	3.0	3.0	3.3
8C-12-30	SEPT.16	SEPT.16	27.7	57	3.0	2.0	3.3	2.0	3.0	1.7	1.7	2.7	2.7	2.7	3.3
Braeburn	OCT.19	OCT.19	27.7	58	3.3	1.7	3.3	3.3	2.7	3.0	2.0	3.0	2.3	2.7	3.3
8C-46-2	OCT.19	OCT.19	27.7	59	3.0	1.7	2.0	2.7	2.7	1.7	1.0	3.0	3.0	3.3	2.0
Pioneer Mac	SEPT.10	SEPT.11	27.5	60	4.0	1.0	4.0	3.5	2.5	4.0	3.5	3.0	2.0	3.0	3.0
Suncrisp	OCT.14	OCT.14	27.4	61	3.8	2.2	3.8	3.4	2.6	3.6	2.8	2.8	2.6	2.6	3.0
Braeburn	OCT.14	OCT.14	27.2	62	3.0	2.2	4.0	3.6	2.4	3.4	2.6	2.6	2.4	2.4	3.6
8S-31-56	SEPT.16	SEPT.16	27.0	63	3.3	1.3	3.7	3.3	3.0	1.0	1.0	2.3	2.3	2.0	2.7

Table 4b. Sensory evaluation of selected cultivars grown at HES after air storage. Fruit harvested in 1998. Ratings for each characteristic were obtained by taking the average scores determined by 2 to 6 people in a trained taste panel.

			Weighting ->		1	-1	1	1	1	1	-1	-1	3	3	2
					Scale (1=low; 3=moderate; 5 = high)										
Cultivar	Harvest Date	Evaluation Date	Overall Score	Ranking	Visual Attractiveness	Regularity of shape	Crispness	Juiciness	Sweetness	Acidity	Astringency	Skin Toughness	Overall Flavour	Overall Desirability	Flesh Firmness
STORAGE EVALUATIONS															
Braeburn	OCT.19	DEC.16	35.0	1	3.0	2.0	3.5	3.0	3.0	1.5	2.0	2.0	4.0	3.5	3.0
Creston	SEPT.9	DEC.4	34.0	2	3.5	2.0	3.5	3.5	3.5	2.0	1.5	3.0	3.0	3.5	3.5
Braeburn	OCT.14	DEC.15	33.5	3	3.5	1.5	3.5	3.0	3.0	3.0	1.5	2.0	3.0	3.5	3.0
8S-562-56	SEPT.10	DEC.7	33.1	4	4.3	1.5	3.8	2.9	3.2	2.7	1.1	3.2	3.2	3.1	2.8
Elstar	SEPT.2	NOV.30	32.0	5	3.0	1.5	3.0	3.0	2.0	2.5	1.5	2.5	3.5	3.0	3.5
8C-31-110	OCT.19	DEC.17	32.0	6	2.5	1.5	4.0	2.5	3.0	1.5	2.0	2.5	3.0	3.0	4.0
8S-69-23	SEPT.9	DEC.4	32.0	7	3.0	2.0	4.0	3.0	3.0	1.0	1.0	2.0	3.0	3.0	3.0
8S-31-56	SEPT.30	DEC.10	31.5	8	3.5	2.5	3.5	2.5	3.0	2.0	1.5	2.5	3.0	3.5	3.0
Sunrise	AUG.12	NOV.24	30.5	9	3.5	2.5	2.5	2.5	3.5	1.5	1.0	2.5	3.5	3.0	2.5
Sunrise	AUG.20	NOV.26	30.3	10	3.0	2.0	2.7	3.3	3.3	3.3	1.0	3.0	3.0	3.0	3.0
8S-27-2	SEPT.9	DEC.7	30.0	11	3.0	2.0	4.0	3.0	3.0	2.5	1.5	2.5	3.0	3.0	2.5
Idared	OCT.8	DEC.14	29.0	12	3.5	1.5	3.0	3.0	3.0	2.5	1.5	3.0	3.0	2.5	3.0
Empire	SEPT.28	DEC.14	29.0	13	3.5	1.0	2.0	2.5	3.5	3.0	2.0	2.5	3.0	3.0	2.5
Magnolia Gold	OCT.1	DEC.10	28.6	14	3.5	2.4	2.5	2.5	3.3	2.0	1.6	3.4	3.4	3.0	2.4
Fuji, Redsport	OCT.14	DEC.16	28.5	15	3.0	2.3	3.5	3.5	3.3	1.8	1.8	3.3	2.8	2.8	3.0
8S-69-23	SEPT.16	DEC.9	28.0	16	2.7	2.0	3.3	2.7	3.3	1.7	1.3	3.0	3.0	2.7	2.7
8C-562-56	AUG.26	NOV.27	27.7	17	3.8	2.4	3.3	2.4	2.4	2.6	1.6	3.3	3.0	2.7	3.0
8S-69-23	SEPT.30	DEC.11	27.7	18	2.7	2.7	4.0	3.0	4.0	1.7	1.3	3.0	2.7	2.3	3.0
8M-2-871	AUG.26	NOV.27	27.6	19	3.4	1.6	3.3	2.7	2.2	2.9	1.3	3.1	2.6	2.7	3.0
Empire, Thome	SEPT.28	DEC.14	27.6	20	2.9	1.9	2.9	2.8	2.9	3.0	1.5	2.8	2.7	2.8	2.9
8S-46-2	OCT.14	DEC.16	27.5	21	3.5	1.5	2.5	3.0	3.0	1.0	1.0	2.0	2.5	2.5	2.5
8S-46-2	OCT.14	DEC.15	27.5	22	3.5	2.0	2.5	3.0	3.5	1.5	1.0	2.0	2.5	2.5	2.5
Fiesta	AUG.19	NOV.26	27.5	23	2.5	2.5	3.5	2.5	3.0	2.5	2.5	3.0	3.0	3.0	3.0
8S-27-2	SEPT.30	DEC.11	27.3	24	4.0	1.7	3.0	3.0	3.0	2.0	3.7	3.3	3.0	2.7	3.0
Fuji, Redsport	OCT.14	DEC.16	27.3	25	3.5	1.6	3.1	2.9	3.1	2.2	1.1	3.8	2.9	2.7	2.1
8S-29-18	SEPT.16	NOV.30	27.0	26	3.0	1.0	3.5	3.0	2.5	1.0	1.5	3.5	2.5	2.5	3.0
8S-29-18	SEPT.9	DEC.7	27.0	27	2.5	1.5	3.5	3.5	3.0	1.5	1.0	2.5	2.0	2.5	3.0
8S-46-2	OCT.9	DEC.14	27.0	28	4.0	2.0	3.0	2.5	3.5	2.0	1.5	2.5	2.5	2.5	2.5
8C-562-56	AUG.26	NOV.27	26.8	29	3.3	2.5	3.3	2.5	2.5	2.3	2.3	3.3	3.0	2.8	3.0
Delicious, Redspur	SEPT.25	DEC.10	26.7	30	3.3	3.0	2.7	2.8	3.2	2.7	2.2	3.8	3.5	2.8	2.3
8S-69-5	SEPT.10	NOV.30	26.4	31	2.1	2.3	3.5	2.8	2.8	1.5	1.3	2.8	2.5	2.5	3.3
R98T486	AUG.26	NOV.27	26.3	32	3.0	2.2	2.6	2.6	2.6	2.5	1.4	3.1	2.8	3.1	2.3
8S-29-18	OCT.9	DEC.15	26.0	33	3.0	2.0	2.0	3.0	4.0	1.0	1.0	2.0	3.0	2.0	2.0
8C-9-23	OCT.1	DEC.11	25.7	34	3.2	2.3	3.1	2.8	2.3	2.4	2.6	3.3	3.0	2.7	2.8
8S-31-52	SEPT.9	DEC.4	25.5	35	3.0	1.5	3.5	2.5	2.5	1.5	1.5	3.0	2.5	2.5	2.5
8S-27-2	OCT.7	DEC.11	25.3	36	3.7	2.7	3.7	2.7	3.3	2.7	2.7	3.3	2.7	2.7	2.3
8C-28-27	SEPT.9	DEC.7	25.0	37	3.0	1.0	2.0	2.0	5.0	1.0	1.0	5.0	3.0	3.0	1.0
8S-26-52	SEPT.9	DEC.7	25.0	38	2.5	2.0	3.0	2.5	2.5	1.5	1.0	4.0	3.0	2.5	2.5
Magnolia Gold	SEPT.10	DEC.7	24.9	39	3.4	2.2	3.1	2.8	2.9	2.2	2.3	3.3	2.6	2.3	2.8
Pioneer Mac	SEPT.10	DEC.4	24.5	40	3.0	2.0	2.5	2.0	1.5	2.5	2.5	2.5	3.0	2.5	3.0
8C-12-30	SEPT.16	DEC.9	24.5	41	3.0	1.0	1.5	2.5	3.0	1.5	2.0	2.0	2.5	2.0	3.0
Creston	SEPT.16	DEC.9	24.5	42	3.5	1.5	2.0	3.0	3.0	1.5	2.0	3.5	2.5	2.5	2.5
Shamrock	SEPT.9	DEC.9	24.5	43	2.5	1.5	1.5	2.5	3.5	1.5	1.5	2.5	2.5	2.5	2.5
8S-31-52	SEPT.16	DEC.9	23.7	44	3.3	2.3	2.3	2.7	2.7	1.7	2.0	2.7	2.3	2.7	2.3
Magnolia Gold	OCT.14	DEC.16	23.6	45	3.3	2.3	2.4	3.1	3.1	1.4	2.2	3.1	2.4	2.2	2.8
McIntosh, Imperial	SEPT.11	DEC.7	23.5	46	3.5	1.5	2.0	2.5	2.0	2.5	2.5	3.0	3.0	2.5	2.0
Arlet	SEPT.16	DEC.15	23.5	47	4.0	1.5	3.0	2.5	2.5	2.0	1.0	3.0	2.5	1.5	2.5
Creston	SEPT.29	DEC.10	23.0	48	2.0	3.0	3.5	3.0	3.5	2.5	1.0	3.5	2.5	2.0	2.5
Regent	SEPT.10	DEC.9	22.6	49	3.0	1.9	2.9	2.6	2.3	2.2	2.6	3.1	2.5	2.1	2.8
4E-12-35	SEPT.9	DEC.4	22.5	50	3.5	2.0	2.0	2.5	2.5	1.5	1.0	2.5	2.5	2.0	2.0
8C-28-27	SEPT.9	DEC.7	22.5	51	2.5	2.5	3.5	3.0	3.0	2.5	3.0	4.5	2.5	2.0	3.5
R98T486	SEPT.10	DEC.4	22.5	52	3.0	2.1	2.7	2.4	2.4	2.1	1.3	3.0	2.4	2.5	1.8
4E-12-35	AUG.20	NOV.26	22.0	53	3.0	3.0	2.5	3.0	2.5	1.0	1.5	3.0	2.5	2.0	2.5
8S-27-51	OCT.9	DEC.14	22.0	54	2.0	1.5	3.5	2.5	3.5	2.0	2.0	4.5	2.0	1.5	4.0
8S-31-52	OCT.9	DEC.14	22.0	55	2.0	2.0	3.0	2.5	3.5	1.5	1.0	1.5	2.0	1.5	2.5
8S-31-56	SEPT.16	DEC.9	22.0	56	3.0	2.3	3.3	2.7	2.0	1.3	1.3	2.7	2.3	1.7	2.7
8S-31-56	SEPT.9	NOV.30	21.5	57	3.0	2.0	3.5	2.5	1.5	1.5	1.0	4.0	2.5	1.5	3.0
Creston	OCT.19	DEC.16	21.5	58	3.5	1.5	2.0	2.5	3.0	1.5	1.0	2.5	2.0	1.5	2.5
8C-12-30	SEPT.9	DEC.9	21.3	59	2.7	1.7	1.7	3.0	2.3	2.0	2.0	2.0	2.3	1.7	2.7
8C-9-23	OCT.9	DEC.15	21.2	60	3.6	2.1	3.1	2.7	2.0	3.6	3.1	3.3	2.3	1.9	3.0
8S-31-52	SEPT.30	DEC.10	21.0	61	3.0	3.0	2.5	2.5	3.5	1.5	1.5	4.0	2.0	2.0	3.0
9P-15-30	AUG.12	NOV.24	20.5	62	2.5	2.0	1.5	2.5	2.5	1.5	1.0	3.5	2.5	2.5	1.5
Arlet	SEPT.9	DEC.7	20.5	63	3.0	2.0	3.0	2.0	2.0	1.8	1.0	3.5	2.0	2.0	2.5

6.0 BENEFITS OF TRICKLE IRRIGATION, IRRIGATION SCHEDULING, AND A COMPARISON OF DRIP AND MICROSPRINKLER EMITTERS

Objective : To determine the influence of irrigation frequency and type of emitter on the growth and development of 'Crimson Gala' on two rootstocks.

Plant Material: 'Crimson Gala' on M.9 and B.9 rootstock planted in 1998 at a spacing of 1.8 m x 4.5 m (6' x 13', 1380 trees/ha, 559 trees/acre).

Experimental Design: Split plot with irrigation as the main plot and rootstock as the split plot.

Table 5. Effect of irrigation frequency and emitter type on growth of 'Crimson Gala' on B.9 or M.9 rootstocks in 1998.

	Fall 1998 TCSA (cm^2)	1998 Increase in TCSA (%)	Total number of shoots	Avg. shoot length (cm)	Number of blossom cluster /tree (1999)
Rootstock					
M.9	2.2	42.6	36.9	24.6	41.4
B.9	2.2	18.7	33.9	22.8	24.6
Significance[y]	ns	***	ns	*	*
LSD (p=0.05)	0.2	8.1	4.7	1.4	14.2
Irrigation Treatment					
Control	1.9	17	34.6	23.2	31.7
Daily Drip	2.4	34	36.8	24.1	41.8
On Demand Drip	2.2	32	29.6	23.8	23.8
Weekly Drip	2.3	24	37.3	23.0	40.3
Weekly Microsprinkler	2.4	48	38.6	24.4	27.3
Significance[y]	*	ns	ns	ns	ns
LSD (p=0.05)	0.3	13	7.4	2.3	22.5
interaction	ns	ns	ns	ns	ns

[y] ns, *, **, ***, indicates not significant, and significant differences at P= 0.05, P=0.01,

Table 6. Effect of various irrigation frequency and emitter type on percentage volumetric soil moisture content (measured with TDR technology). University of Guelph, Horticulture Experiment Station, Simcoe, 1999.

Date of measurement	5/31	6/22	7/8	7/27	5/31	6/22	7/8	7/27	6/22	7/8	7/27
Soil depth (cm)	15	15	15	15	30	30	30	30	45	45	45
Unirrigated control	7.8	8.3	19.0	13.0	23.4	7.6	11.1	13.3	30.7	28.4	26.3
Daily drip irrigation	8.0	10.5	22.5	17.6	23.7	8.7	15.5	18.9	32.6	29.9	31.1
weekly drip irrigation	8.2	10.3	20.5	20.0	23.4	8.2	12.3	19.2	28.1	30.2	33.6
weekly mircosprinkler	6.9	16.0	25.4	24.3	22.1	12.8	20.0	26.7	34.0	32.8	33.0
Significance[y]	ns	ns	**	**	ns	*	***	***	ns	ns	ns
LSD (p=0.05)	2.0	5.9	3.1	4.7	2.8	3.0	3.2	3.2	7.7	5.9	9.9
Contrasts											
control vs. irrigation	ns	ns	**	**	ns	ns	**	***	ns	ns	ns
Weekly drip vs. sprinkl	ns	ns	**	ns	ns	**	***	***	ns	ns	ns
drip : daily vs. weekly	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

[y] ns, *, **, ***, indicates not significant, and significant differences at P= 0.05, P=0.01, and P=0.001 respectively

7.0 VEGETATIVE GROWTH CONTROL OF APPLES USING PROHEXIDIONE-CA

Objective : To evaluate the efficacy of an experimental product called prohexidione-Ca for controlling vegetative growth.

Plant Material: Heavily pruned 16 year old 'Starkrimson Delicious'/MM.106 and 20 year old 'Empire'/M.26 planted at a spacing of 3.7 x 5.5 m (12' x 18') (493 trees/ha, 199 trees/acre).

Experimental Design: Randomized complete block design with two treatments, a control and 4 sprays of 63 ppm prohexidione-Ca with 0.1% Agral 90 as a surfactant. Eight tree plots were sprayed in the 'Delicious' and 7 tree plots were sprayed in the 'Empire'.

Table 7. Effect of Apogee on shoot length of 20 year old 'Empire'/M.26. Horticulture Experiment Station, Simcoe, Ontario. Treatments applied 21 May, 31 May, 9 June, and 18 June 1999.

	5/27/99	6/3/99	6/16/99	6/24/99	7/2/99	7/8/99	7/15/99	7/22/99	8/9/99
Control	14.0	23.2	40.0	46.8	53.3	56.8	58.4	58.7	58.1
Apogee	14.5	23.8	38.2	43.1	46.7	48.3	49.6	51.2	49.9
significance[z]	ns	ns	ns	*	**	***	**	*	**
LSD (p=0.05)	1.7	2.1	3.0	3.2	2.8	2.1	4.2	4.1	3.6

[z] ns, *, **, ***, indicates not significant, and significant differences at P= 0.05, P=0.01, and P=0.001 respectively

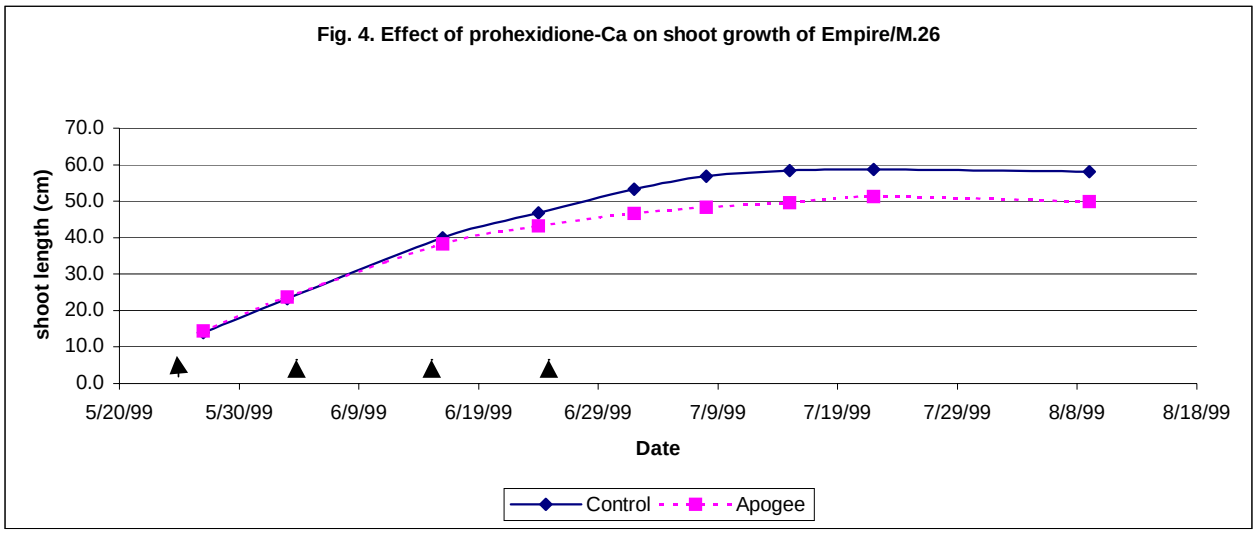
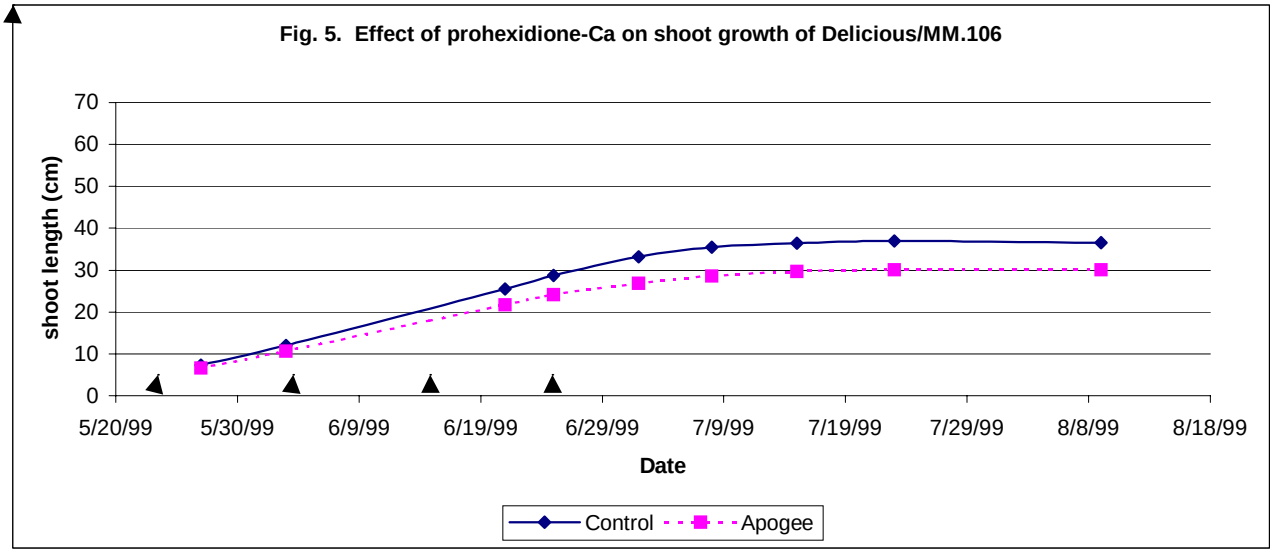


Table 8. Effect of Apogee on shoot length of year old 'Delicious'/MM.106. Horticulture Experiment Station, Simcoe, Ontario. Treatments applied 21 May, 31 May, 9 June, and 18 June 1999.

	5/27/99	6/3/99	6/21/99	6/25/99	7/2/99	7/8/99	7/15/99	7/23/99	8/9/99
Control	7.3	12.0	25.5	28.8	33.2	35.5	36.4	37.0	36.6
Apogee	6.6	10.7	21.7	24.2	26.9	28.6	29.7	30.1	30.0
significance[z]	*	*	**	**	**	**	**	**	*
LSD (p=0.05)	0.6	1.0	2.4	2.6	3.4	4.2	3.7	4.2	5.1

[z] ns, *, **, ***, indicates not significant, and significant differences at P= 0.05, P=0.01, and P=0.001 respectively



8.0 EARLY PERFORMANCE OF THREE APPLE VARIETIES ON 5 VINELAND ROOTSTOCKS

Objective: to evaluate the performance of various commercial apple cultivar differing in vigor on 5 Vineland and 3 commercial rootstocks.

Plant Material: 'Decoster Jonagold', 'Empire', 'Northern Spy' planted in 1997 at a spacing of 3.0 m x 4.5 m (4.9' x 13.1'; 740 trees/ha; 300 trees/acre).

Experimental Design: Randomized complete block design 3 cultivars, 8 rootstocks, and 8 single tree replications

Rootstocks: V.1, V.2, V.3, V.4, V.7, M.9, M.26, O.3

Table 9. Early growth of 'Empire', 'Jonagold' and 'Northern Spy' on five Vineland series rootstock in comparison with M.9 (T337), M.26, and O.3 planted in 1997. HRIO Simcoe, Ontario.Rootstocks ranked according to increasing vigour

	Number of blossom clusters per tree 1998	TCSA (cm^2) fall 1998	Percent increase in TCSA '97-'98	Total number of shoots (>5 cm) 1998	Adjusted number of shoots (>5cm) 1998	Average shoot length (cm) 1998	Number of suckers per tree 1998
Cultivar							
Empire	0.0	3.8	176	18	4.8	34	0.4
Jonagold	0.7	5.2	202	28	5.6	30	0.3
Northern Spy	1.5	5.6	232	16	2.8	45	0.2
Significance[z]	ns	***	*	***	***	***	ns
LSD (p = 0.05)	1.9	0.4	37	2	0.3	3	0.3
Rootstock							
O.3	0.0	3.2	126	15	5.1	38	0.0
M.9 T337	1.8	3.9	161	16	4.3	33	1.0
V.2	0.2	4.6	187	21	4.7	33	0.1
V.3	0.5	4.7	227	21	4.7	33	0.2
M.26	0.3	4.9	246	18	3.7	40	0.1
V.1	0.3	5.0	186	21	4.2	36	0.0
V.7	0.0	6.2	229	27	4.6	37	0.6
V.4	3.0	6.6	265	25	3.9	38	0.4
Significance[y]	ns	***	***	***	***	**	***
LSD (p=0.05)	3.2	0.6	60	3	0.5	4	0.4
Interaction	ns	ns	ns	*	ns	ns	ns

[y] ns, *, **, ***, indicates not significant, and significant differences at P= 0.05, P=0.01, and P=0.001 respectively

9.0 NON-CHEMICAL BIO-CONTROL OF ORCHARD REPLANT DISEASE USING VARIOUS SOIL AMENDMENT/ WASTE PRODUCTS

Objective: 1) to evaluate the efficacy of soy meal, meat and bone meal, and chicken manure in controlling apple replant disease; 2) to compare two methods of application for controlling the above.

Material: 1-yr-old 'Gingergold'/M.9 T337 whips planted in the Spring of 1997. Planted at a spacing of 2.0 m x 4.5 m (6.6' x 14.8'; 1111 trees/ha; 500 trees/acre).

Exp. Design: A split plot design with treatment (product) as the main plot and method as the split plot replicated 6 times. Two trees per plot.

Treatments:

Main Plot -Method
1) Soil amendment incorporated into 1 m^2 surrounding tree to a depth of 20 cm (8 inches)
2) Soil amendment incorporated into planting hole (60 cm dia., 46 cm deep)

Split-Plot -Product
A. Untreated control
B. Chemical fumigation
C. 2% (w/w) soy meal (5.33 kg/ m^2 to a depth of 30 cm)
D. 2% (w/w) meat and bone meal (5.33 kg/ m^2 to a depth of 30 cm)
E. 4% (w/w) chicken manure (dry) (10.67 kg/ m^2 to a depth of 30 cm)

Table 10. Comparison of different soil ammendments and application methods on the early growth of 'Gingergold'/M.9 trees planted in 1997. HRIO Simcoe, Ontario. 1998 data.

	Number of fruit per tree 1998		Yield (kg/tree) 1998		TCSA (cm^2) 1997		TCSA (cm^2) 1998		Total number of shoots 1998		Average shoot length (cm) 1998		Average shoot length (cm) 1999
Application Method													
Broadcast/Incorporated	1		0.4		1.3		3.7		28.0		27.4		36.5
Planting hole	2		0.4		1.2		3.4		24.4		28.1		38.1
Significance[y]	ns		ns		ns		ns		ns		ns		ns
LSD (p=0.05)	0.8		0.22		0.1		0.4		3.5		2.4		1.9
Ammendment													
Control	1	bc	0.4	bc	1.1	c	3.3	ab	20.4	b	30.7	a	36.1
Bone and blood meal	2	ab	0.6	ab	1.3	ab	3.5	ab	29.0	a	26.5	b	38.2
Soya meal	1	c	0.2	c	1.2	bc	3.1	b	25.8	ab	24.0	b	36.9
Fumigation	1	bc	0.2	bc	1.2	bc	3.8	a	25.0	ab	32.4	a	38.7
Chicken manure	3	a	0.8	a	1.4	a	3.8	ab	30.7	a	25.2	b	36.6
Significance[y]	**		**		**		ns		**		***		ns
LSD (p=0.05)	1.3		0.36		0.2		0.6		5.5		3.8		3.0
interaction	ns		ns		ns		ns		ns		ns		ns

[y] ns, *, **, ***, indicates not significant, and significant differences at P= 0.05, P=0.01, and P=0.001 respectively

10.0 NC-140 1994 GALA DWARF AND SEMI-DWARF ROOTSTOCK TRIAL

Dwarfing Trial

In year five (1998) six rootstocks (P.22, M.27E, P.16, B.491, V.3, and B.469) were significantly smaller, and three rootstocks (M.9 Pajam 2, M.26, V.1) were significantly larger than M.9E (Table 5). Total yields in 1998 were significantly greater for V.1, M.26, M.9 Pajam2 , O.3, and significantly less for P.22 and M.27, in comparison with M.9E. 0.3, Mark, and P.16 were the most efficient rootstocks. There was no significant effect of rootstock on fruit size or bloom density. With respect to cumulative yield (3 years) Mark, O.3, and V.1 have exceeded M.9E.

Rootstock suckering has been significantly greater for P.16, M.9 Pajam2, Nicolai 2, Pajam 1,and Mark, in comparison with M.9E.

Semi-dwarf Trial

Table 11. 1998 yield and tree growth measurements from the NC-140 'Gala' dwarfing rootstock trial planted in 1994 at the University of Guelph, Horticultural Experiment Station, Simcoe, Ontario. Trees trained to the slender spindle orchard system.

Rootstock[x]	Number of fruit / tree 1998	Total yield per tree (kg) 1998	Average fruit weight (g)	Cum. Yield '96-'98 (kg)	Rank	Cum. yield efficiency ($kg.cm^{-2}$) ('96-'98)'98 tcsa	1998 Autumn TCSA (cm^2)	Number of suckers per tree
DWARF PLANTING								
P.22	32-	4.8-	152	11.4-	16	1.80+	6.4-	1.1
M.27 ELMA	34-	5.8-	168	9.3-	17	1.45+	6.7-	0.9
P.16	51	8.6	171	15.8	12	1.87	8.5-	16.4+
B.491	54	9.3	174	13.9	14	1.28+	11.0-	1.6
V.3	56	9.5	173	13.1	15	1.13	12.0-	3.9
B.469	70	11.7	168	21.4+	8	1.44+	14.8-	3.9
P.2	69	12.1	171	18.9	9	1.32+	16.6-	0.3
M.9 NAKBT337	66	11.1	168	14.5	13	0.85	17.9	2.6
MARK	99+	17.3+	175	32.9+	1	1.75+	19.3	7.6+
B.9	82	13.5	168	22.2+	6	1.12	19.8	2.5
O.3	103+	18.0+	175	32.5+	2	1.63+	20.2	3.3
M.9 EMLA[z]	**68**	**11.9**	**175**	**16.8**	10	**0.83**	**20.8**	**1.1**
M.9 Pajam1	75	13.0	172	16.6	11	0.80	21.2	7.0+
M.9 RN29	85	15.2	179	21.5+	7	0.89	24.4	6.7+
M.9 Pajam2	111+	19.6+	179	31.1+	3	1.21+	26.5+	15.0+
M.26 EMLA	112+	19.2+	171	24.1+	5	0.82	30.9+	0.4
V.1	144+	24.1+	169	30.3+	4	0.89	33.7+	3.4
Significance[y]	***	***	ns	***		***	***	***
LSD (p=0.05)	23	3.8	14.0	4.5		0.32	3.7	5.1
SEMI-DWARF PLANTING								
M.26 EMLA[z]	**141.4**	**23.5**	**166**	**26.8**	4	**0.96**	**28**	**0.3**
V.2	165.6	26.7	162	33.4	1	1.01	33.8	0.3
G.30	143.4	24.7	173	28.2	3	0.83	34.1	13.7+
P.1	153.8	24.5	168	30.3	2	0.82	40.9+	6.6
Significance[y]	ns	ns	ns	ns		ns	ns	**
LSD (p=0.05)	50	7.6	14.7	8.5		0.27	4.1	8.1

[x] Rootstocks ranked in order of increasing vigour (tcsa).[z]

[z] Parameters significantly greater (+) or significantly less (-) than M.9EMLA(dwarf planting) or M.26 EMLA (semi-dwarf planting) using LSD (P=0.05)

[y] ns, *, **, ***, indicates not significant, and significant differences at P= 0.05, P=0.10, and P=0.01 respectively

[v] rating of density of blossom clusters from 1= very few, 3= good crop, 5=snowball bloom

Of the four remaining rootstock under evaluation, trees on P.1 were significantly larger than M.26. Although there was no significant difference in yield or yield efficiency among rootstocks in 1998, V.2 has tended to have the greatest cumulative yield, and cumulative yield efficiency to date. Average fruit size has not been influenced by rootstock. G.30 has had a significantly greater suckering than any of the other rootstocks.

11.0 FERTILIZATION WITH CALCIUM NITRATE

Calcium Nitrate is being evaluated for its efficacy as a nitrogen and calcium source on young Jonagold and Northern Spy, two cultivars which are very susceptible to calcium deficiency disorders. Various combinations of fertilizers are being evaluated in order to isolate the effects of the calcium and the nitrogen. Split applications through the season are also being compared to the traditional spring application prior to budbreak..

Table 12. Effect of various fertilizers on tree growth and precocity of 'Jonagold'/M.9 and 'Northern Spy'/M.9 trees planted in 1998 at the Horticulture Experiment Station, University of Guelph, Simcoe, Ontario.

Fertilizer treatment	Ratio of actual to recommended rate of N	1998 Leaf N conc. (% dw)		TCA (cm^2) 1998	Percentage increase in TCA ('97-'98)	Number of shoots per cm^2 TCA 1998	Average shoot length (cm) 1998	Average shoot length (cm) 1999	Number of blossom clusters on tree 1999
Cultivar- 'Jonagold'									
None	0	2.0		1.6	21	3	18.9	31.7	0.0
$CaNO_3$ - Split	0.9/0.375/0.225	2.1		2.1	30	6	14.1	27.7	4.0
$CaNO_3$	0.75	2.1		2.1	21	6	11.5	27.0	2.0
$CaNO_3$	1	2.0		1.8	30	5	16.2	29.8	1.3
$CaNO_3$	1.5	2.2		2.1	19	5	12.4	30.8	2.3
$CaNH_4NO_3$	1	2.1		2.2	33	5	17.0	27.9	4.5
$CaSO_4 + NH_4NO_3$	1	2.0		1.8	41	6	16.8	29.1	6.5
$CaNO_3 + KSO_4$	1	2.2		1.7	24	7	12.5	32.8	1.0
KNO_3	1	2.0		2.0	27	6	14.4	32.5	5.8
Significance[y]		ns		ns	ns	ns	ns	ns	ns
LSD (p=0.05)		0.2		0.6	16	3	8.0	8.1	6.0
Cultivar- 'Northern Spy'									
None	0	2.1	de	4.9	22	3	15.9	22.3	2.3
$CaNO_3$ - Split	0.9/0.375/0.225	2.1	cde	5.3	29	5	17.7	21.0	2.5
$CaNO_3$	0.75	2.0	e	4.4	31	4	16.5	23.1	2.5
$CaNO_3$	1	2.1	de	5.2	27	6	15.2	25.7	1.5
$CaNO_3$	1.5	2.3	a	4.7	28	5	15.6	18.8	0.5
$CaNH_4NO_3$	1	2.3	abc	5.8	33	5	16.3	23.2	2.3
$CaSO_4 + NH_4NO_3$	1	2.2	bcd	5.4	24	5	17.6	22.9	0.8
$CaNO_3 + KSO_4$	1	2.3	ab	5.6	48	4	20.2	24.1	2.0
KNO_3	1	2.2	abc	5.4	32	5	18.5	21.3	0.3
Significance[y]		**		ns	ns	ns	ns	ns	ns
LSD (p=0.05)		0.2		1.4	15	1	4.0	7.3	3.74

[y] ns, *, **, ***, indicates not significant, and significant differences at P= 0.05, P=0.10, and P=0.01 respectively

Purpose: To compare tree growth and fruit quality of 'Jonagold' and 'Northern Spy' trees on M.9 rootstock fertilized with various sources of calcium, potassium, nitrogen fertilizers.

Experimental Design: A randomized complete block design with 9 treatments and 4 replications.

12.0 1990 NC-140 ORCHARD SYSTEMS TRIAL

This is a cooperative trial which is planted in 9 different locations in North America. It is actually two trials in one. The main trial is a comparison of 'Empire' and 'Jonagold' on 10 different rootstocks-training system combinations.

The different training systems in this trial are separated by guard rows which actually form a second, separate trial. This trials is designed to compare 'Gala' on 8 different rootstocks.

Purpose: To compare growth and production performance of 'Empire' and 'Jonagold' on various rootstock, spacing, and orchard system configurations.

Experimental Design: A split plot design with orchard system as the main factor and cultivar and rootstock as split plots. In total, there are two cultivars and ten training system-rootstock combinations, replicated four times.

Orchard System	Rootstocks	Spacing	Tree Density
Central Leader	M.26 EMLA Mark	4.5 x 2.0 m 14.8 x 6.5 ft	(1110 trees/ha) (450 trees/acre)
Vertical Axis	M.26 EMLA M.9 EMLA Mark, Ottawa 3, P.1	4.0 x 1.6 m 13.1 x 5.2 ft	(1560 trees/ha) (630 trees/acre)
Slender Spindle	B.9, Mark M.9 EMLA	3.25 x 1.25 m 10.7 x 4.1 ft	(2460 trees/ha) (996 tress/acre)

Results: (Table 13)

The 1990 orchard systems trial produced a lighter crop of 'Empire' and 'Jonagold' in 1998 in comparison with 1997 - indicating that it is becoming biennial. Crop load was adjusted by chemical thinning and follow-up hand thinning to 15 cm spacings, as required. Crop loads for 'Empire' and 'Jonagold' ranged from 27-78 (0.9-2.9 fruit per cm^2 tcsa) and 38-83 (1.0-1.6 fruit per cm^2 tcsa) fruit per tree, respectively. Yields for 'Empire' and 'Jonagold' ranged from 9.5-19.2 and 15.7-36.7 MT/ha, respectively. P.1 continues to be the least efficient rootstock irrespective of cultivar. The most productive rootstock based on cumulative yield per trunk cross-sectional area, irrespective of orchard system, continues to be M.9E for 'Empire' and Mark for 'Jonagold'. However, production efficiency based on cumulative yield per canopy volume continues to indicate that Mark and B.9 are comparable with M.9E for the scion 'Empire', while Mark remains the most efficient rootstock for 'Jonagold'. Trees on P.1 and M.26 have been least efficient of all the rootstocks, based on a yield per canopy volume basis. Over the pass five years of production, M.9E has been the most productive rootstock for both ‘Empire’ and ‘Jonagold’ .

Table 13. 1998 yield and tree growth measurements of cv. 'Empire' and 'Jonagold' from the NC-140 orchard systems trial planted in 1990 at the University of Guelph, Horticultural Experiment Station, Simcoe, Ontario.

System	Rootstock[x]	Yield (kg/tree) 1997 Year 8	Yield (kg/tree) 1998 Year 9	TCSA (cm^2) 1998 Year 9	Yield effic. (kg/cm^2) 1998 Year 9	Cum. Yield effic. (kg/cm^2) Yield '92-98/ '98 TCSA	No. fruit per tree 1998	Average fruit size (g) 1998	Yield (MT/ha) 1998 Year 9	Yield (MT/ha) Cum. yield	Rank	1998 canopy volume (m^3)	Fruit Density (no. fruit/ cm^2 TCSA)
EMPIRE													
CL	Mark	14.8	12.0	32.0	0.38	2.00	78	157	13.3	68.7	10	5.0	2.5
CL	M.26 EMLA	16.5	8.5	48.5	0.18	1.38	56	155	9.5	72.0	9	9.2	1.2
SS	Bud.9	8.7	5.1	26.2	0.19	1.59	32	158	12.5	103.1	4	4.7	1.2
SS	Mark	6.5	4.0	24.2	0.17	1.58	27	149	9.9	92.7	8	3.0	1.2
SS	M.9 EMLA	8.8	6.3	27.0	0.24	1.90	39	165	15.6	125.5	1	4.0	1.5
VA	M.9 EMLA	15.5	12.3	26.9	0.46	2.50	78	156	19.2	104.4	3	6.5	2.9
VA	O.3	15.3	10.9	31.8	0.37	1.95	73	150	17.0	93.5	7	7.5	2.5
VA	Mark	13.8	10.0	26.2	0.38	2.34	66	150	15.6	94.8	5	4.8	2.5
VA	M.26 EMLA	16.1	8.4	48.1	0.18	1.47	58	147	13.1	109.8	2	10.3	1.3
VA	P.1	15.5	7.9	61.2	0.14	1.00	54	144	12.3	94.1	6	10.7	0.9
Significance[y]		***	***	***	***	***	***	ns	*	**		***	***
LSD (p=0.05)		3.4	3.4	9.8	0.12	0.55	24	14	5.4	26.5		1.85	0.8
JONAGOLD													
CL	MARK	23.4	16.0	48.1	0.33	2.11	72	223	17.7	112.0	9	5.6	1.5
CL	M.26 E	25.3	13.1	56.3	0.24	1.69	59	232	14.5	102.2	10	8.1	1.1
SS	MARK	12.5	8.3	36.5	0.22	1.77	38	216	20.5	158.6	3	4.1	1.0
SS	B.9	15.3	12.2	40.9	0.30	1.71	50	246	30.1	173.3	2	5.9	1.2
SS	M.9 E.	14.7	14.9	44.0	0.35	1.66	61	243	36.7	177.0	1	5.8	1.4
VA	MARK	19.2	10.1	37.2	0.26	2.21	46	218	15.7	123.9	8	4.5	1.2
VA	O.3	25.7	18.1	48.1	0.38	1.98	78	232	28.2	148.1	5	7.3	1.7
VA	M.26 E	24.9	16.4	53.8	0.30	1.74	70	231	25.5	146.2	6	8.9	1.3
VA	M.9 E.	23.7	18.9	54.3	0.36	1.85	83	229	29.4	153.9	4	7.8	1.6
VA	P.1	22.2	18.3	65.6	0.30	1.43	81	233	28.5	142.2	7	9.6	1.3
Significance[y]		***	ns	**	ns	ns	ns	ns	**	***		***	ns
LSD (p=0.05)		4.2	7.4	12.7	0.17	0.45	35	24	11.8	27.1		2.00	0.8

[x] Parameters are grouped by orchard system and rootstock and are ranked in decreasing order of cumulative yield efficiency.

[y] ns, *, **, ***, indicates not significant, and significant differences at P= 0.05, P=0.10, and P=0.01 respectively

13.0 NC-140 1990 GALA ROOTSTOCK PLANTING

Objective: To evaluate the performance of the scion cultivar 'Royal Gala' on eight size controlling rootstocks.

Plant Material: 'Royal Gala' on 8 rootstocks planted in 1990 and trained to a vertical axis system at a spacing of 4.0 m x 1.6 m (13.1' x 5.2 '; 1560 trees/ha; 630 trees/acre) .
Experimental Design: A randomized complete block design with eight rootstocks and four replications.

Treatments: 8 rootstocks: B.9, M.26 EMLA, M.27 EMLA, M.9 EMLA, MAC.39, Mark, Ottawa 3, P.1

Results: (Table 14)
Based on trunk cross-sectional area in year nine (1998), M.27E trees were the smallest and P.1 and M.26E were the largest with small differences in tree size among the other rootstocks (Mark MAC.39, O.3, and B.9) in comparison with M.9E. There were no significant differences in yield between any of the rootstock in 1998. Cumulative yields in year 9 were highest for P.1, O.3, M.26, MAC.39 and B.9 and lowest for M.27. Cumulative yield efficiency was greatest for M.27E and slightly less for the other rootstocks, with the exception of Mark, M.26E. and P.1 where it was significantly less. Average fruit size in 1998 was similar among rootstocks. Based on tree canopy volume, P.1, M.26 and Bud.9 were significantly greater than M.9. Trunk circumference and canopy volume of B.9 was 25 and 105% greater than M.9, respectively.

Table 14. 1998 yield and tree growth measurements from the NC-140 'Royal Gala' dwarfing rootstock trial planted in 1990 at the University of Guelph, Horticultural Experiment Station, Simcoe, Ontario. Trees trained to the HYTEC orchard system.

	Yield (kg/tree)		TCSA (cm^2)	Yield effic. (kg/cm^2)	Cum. yield effic. (kg/cm^2)	No. of fruit per	Average fruit	Yield (MT/ha)			1998 canopy	Fruit density
Rootstock[x]	1997 Year 8	1998 Year 9	1998 Year 9	1998 Year 9	Yield '92-98/ '98 TCSA	tree 1998	size (g) 1998	1998 Year 9	Cum. yield	Rank	volume (m^3)	(no. fruit/ cm^2 TCSA)
M.27 EMLA	11.5-	13.5	22.1-	0.62	2.86	93	148	21.1	97.0 -	8	3.0 -	4.22
M.9 EMLA[z]	**16.1**	**19.2**	**36.7**	**0.56**	**2.47**	**124**	**156**	**30.0**	**134.6**	**7**	**6.2**	**3.59**
MAC 39	14.0	20.3	42.1	0.53	2.22	124	164	31.7	142.5	6	9.4 +	3.22
Ottawa 3	21.4+	26.6	45.4	0.59	2.52	179	152	41.5	178.4 +	1	8.5 +	3.91
MARK	19.8	18.9	45.4	0.41	2.34	119	159	29.5	166.5	4	5.9	2.62
BUD.9	17.2	24.2	46.2	0.56	2.46	153	159	37.8	173 +	3	9.1 +	3.57
M.26 EMLA	17.4	20.8	58.0+	0.36	1.66 -	137	155	32.4	151.4	5	10.9 +	2.35
P.1	15.9	26.2	80.0+	0.33	1.43 -	172	152	40.8	174.4 +	2	12.8 +	2.22
Significance[y]	***	ns	***	ns	***	ns	ns	ns	***		***	ns
LSD (p=0.05)	3.9	8.8	13.9	0.25	0.56	64	15	13.7	34.8		2.08	1.77

[x] Rootstocks ranked in order of increasing vigour (tcsa).[z]

[y] ns, *, **, ***, indicates not significant, and significant differences at P= 0.05, P=0.10, and P=0.01 respectively

[z] Parameters significantly greater (+) or significantly less (-) than M.9 EMLA using LSD (P=0.05)

14.0 APPLE REPLANT TRIAL

This trial, initiated in 1992, was established to investigate the use of non-chemical means to control soil replant disease of apples. It is thought that in sandy orchard soils, soil nematodes can be a main causal agent of replant disease. Therefore, to ensure that sufficiently high levels of root-lesion nematodes were initially present to adequately evaluate the above experimental treatments, the soil was left untreated after removal of a 20-yr-old 'McIntosh' orchard the year prior to planting. In addition, these McIntosh trees were de-fruited during their last few growing seasons to stimulate root growth.

Purpose: To investigate the use of new environmentally acceptable measures to control non-specific soil replant disease, and to measure their effect on the growth and development of 'Jonagold' apple trees.

Plant material: 'Jonagold' on M.9 T337 rootstock planted at a spacing of 4.5 m x 2.2 m (7.2'x14.8'; 1010 trees/ha, 409 trees/acre). Orchard system - slender spindle. Herbicide strip- 1 m on each side of the tree.

Experimental Design: Randomized complete block design with two factors and four replications. Each plot consists of a single row of 20 trees planted in a N-S orientation. The previous orchard, removed in 1991, was planted in an east-west direction.

Treatments: Treatments consist of untreated and fallow controls, low and high rates of Vorlex, and a relatively new concept of growing Indian mustard as a cover crop (*Brassica jonquia* cv. Domo) for one season and incorporating it into the soil at flowering to suppress soil borne nematode. Glucosinolate, a naturally occurring compound of Indian mustard, breaks down chemically to form methylisothicyanate (the active ingredient of Vorlex). Trickle irrigation at zero and approximately 2.5 cm (1 inch) per week is superimposed on each of the above treatments. Trees in untreated control treatments were planted in the Spring of 1992, and the remainder were planted the following year.

Treatment	Trees Planted	Soil Treatment
1) untreated control	1992	-
2) high fumigation	1993	30 gal Vorlex/acre, fall 1992
3) low fumigation	1993	15 gal Vorlex/acre, fall 1992
4) oilseed rape	1993	planted in August, 1992 and ploughed under at flowering in the Autumn.
5) soil fallow 1992	1993	frequent soil cultivation

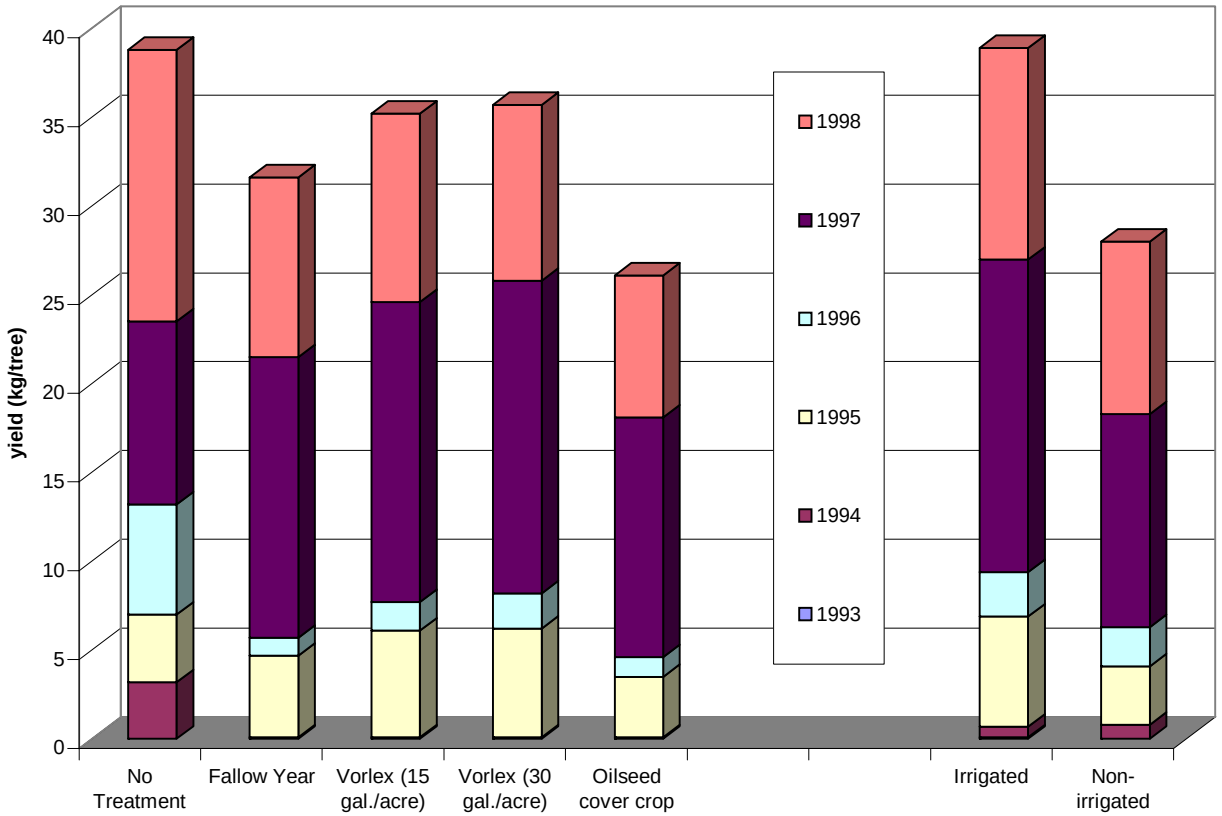
Results: Untreated 'control' trees continued to give the greatest differences in terms of tree growth and yield in comparison with the other treatments (Table 1). This can principally be attributed to the fact that these trees are one year older than the rest of the treatments. In 1993, trees treated with Vorlex tended to have greater growth than trees in the fallow and the oilseed cover crop treatments. . By 1998 trees treated with either low or high rates of Vorlex were significantly larger than all other treatments, even though the untreated trees were one year older. Cumulative yields have been greatest on the fumigated and no treatment trees. The oilseed cover crop treatment has not performed as well and the fumigated treatments, however, has performed better than the no treatment trees when compared with trees the same age. With respect to trickle irrigation, there has been no significant interaction between soil treatments and irrigation in terms of tree growth and cumulative yield. By 1998, irrigated trees have produced approximately 38 and 36% more cumulative yield and tree growth in comparison ithunirrigated trees.

Table 15. Tree growth and Fruit Yields of 'Jonagold' /M.9 treated with various soil replant treatments in relation to trickle irrigation. HRIO Simcoe. No Treatment trees planted in 1992, rest planted in 1993.

	Trunk cross-sectional area (cm^2)		% decrease in # of root lesion nematodes	Yield (bu/acre)		Cum. Yield (kg/tree)	Avg. fruit weight	Average annual yield
	1997	1998	('92-'94)	1997	1998	('92-'98)	1998	(bu/acre)
Irrigation								
Irrigated	16.8	23.4	65	377	255	39.0	201	135
Non-irrigated	12.7	17.2	79	257	208	28.1	192	96
Significance[y]	***	***	-	***	ns	***	*	***
LSD (p=0.05)	0.9	1.2	-	27	48	3.7	8	12
Soil Treatment								
No Treatment	15.9 b	21.0 b	18	221 c	328 a	38.7 a	201	118 a
Fallow Year	13.3 b	18.4 c	73	338 a	216 b	31.5 bc	201	111 a
Oilseed cover crop	11.9 a	17.1 c	54	289 b	171 b	26.0 c	189	92 b
Vorlex (15 gal./acre)	15.9 a	21.6 ab	95	362 a	227 b	35.3 ab	193	126 a
Vorlex (30 gal./acre)	16.7 a	23.3 a	93	377 a	212 b	36.0 ab	199	129 a
Significance[y]	***	***	-	***	***	**	ns	**
LSD (p=0.05)	1.41	1.8	-	42	75	5.8	12.3	20
Interaction	ns	*	-	*	ns	ns	ns	ns

[y] ns, *, **, ***, indicates not significant, and significant differences at P= 0.05, P=0.01, and P=0.001 respectively

Figure 6. Cumulative Yield (1992-1998)



N O T E S