standard strains and their compact growth habit and earlier fruiting (5) permits more intensive planting which improves orchard efficiency. On the basis of these factors, spur type Delicious trees would be recommended over standard habit. However, the differences among spur strains are not great enough to suggest one over the other. Although M.7 was not as efficient in fruit production as M.2 in this study, its availability and greater adaptability to various soil types would recommend continued use of M.7 in Ohio. If the efficiency of M.2 in improving the productivity of Delicious can be verified in other studies on other soil types, M.2 stock should be considered for this cultivar as it makes a very desirable sized tree with a spur type scion and early central leader training. The rootstock influence on the various Delicious strains appeared to be consistent enough so that all possible combinations would not have to be evaluated. General performance could likely be predicted from limited testing of a small number of promising strains on new rootstocks.

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Rooting Apple Cultivars for the "Meadow Orchard"

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The "meadow orchard" conceived by English workers requires about 75,000 trees/ha. Economic success of such a system is dependent on very low-priced trees (2). Producing own-rooted trees of cultivars with high rooting potentials could be the most practical means of achieving this requirement. There is also substantial interest in own-rooted trees for more conventional planting systems.

Seventeen cultivars were examined for rooting capacity as modified trench layers (1). One-year whips on MM 106 rootstocks were topped 50 cm above the bud unions and set in trenches at 45° inclination. Two to 6 shoots grew from each whip; soil was ridged up around these shoots in June and July; and the planting was dug the following May. Shoots were graded as well-rooted, poorly rooted, or non-rooted (Table 1). Spigold, a vigorous triploid (2), was outstanding both for rooting success and for degree of root development.

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Table 1. Rooting of modified trench layers of some apple cultivars.

Cultivar	No. layers	Well rooted %	Poorly rooted %	Total rooted %
Burgundy	24	0	33	33
Cortland	9	0	67	67
Delicious (Gardner strain)	20	0	25	25
Golden Delicious	24	0	8	8
Holiday	40	8	37	45
Julyred	78	0	24	24
Lodi	22	0	27	27
Macoun	21	0	0	0
Mutsu	65	0	29	29
Niagara	17	0	53	53
Quinte	40	0	58	58
Roanoke	36	0	44	44
Shenandoah	11	0	63	63
Spartan	45	0	20	20
Spigold	72	86	2	88
Tydeman Early	39	0	26	26
Wellington	36	0	72	72

Table 2. Rooting of nurse-root grafts of some apple cultivars.

Cultivar	No. nurse-root grafts	Well rooted %	Poorly rooted %	Total rooted %
Antonovka Kamenichka	60	0	3	3
Antonovka Polutorafuntonaya	58	2	12	14
Arkad Zimnyi	36	13	20	33
Chestnut	33	24	18	42
Garland	10	100	0	100
Haralson	14	0	3	3
Irish Peach	32	6	6	12
Kanorkowa	85	0	0	0
Luke	9	88	12	100
Oldenburg	43	0	12	12
Ottawa 391	46	4	88	92
Wedge	56	2	44	46

small amount of strained juice in a refractometer and pH by using a pH meter. Titratable acidity (T.A.) was determined by titrating a 10 ml sample of macerate to pH 8.0 with 0.1 N NaOH and applying the formula:

$$\text{T.A.} = \frac{\text{ml NaOH} \times \text{N of NaOH} \times .067 \text{ (milli equivalent wt. malic acid)}}{\times 10 \text{ grams of sample}}$$

Both exterior and macerated tissue color were determined by using the Hunter color method (11).

Results and Discussion

Field Tests: The FRF of Meteor was slightly lower than that of Montmorency harvested at what was estimated to be comparable maturity dates (Table 1), but both showed the same downward trend with each successive harvest. The value of FRF as a maturity index is evident by comparing it with the two most reliable maturity indices, soluble solids (SS) (sugar level) and color (Table 1) (12). For Montmorency FRF values below 300 g indicate acceptable maturity (8). Meteor was firmer than Montmorency by 7 to 9 durometer units in most cases, and firmed more rapidly than Montmorency upon soaking (Table 2), 4 hr being required vs. 10 hr for Montmorency. Firmer fruit increase pitting efficiency, making it a desirable trait (2). In Montmorency, field heat is removed within 2 hours, but 8 to 10 hours are needed before the cherries become firm enough for pitting (8). Assuming that field heat in Meteor is also removed within 2 hours, the fruit appears to be firm enough for pitting after a 2 hr soak.

Three to four percent of the Meteor fruits cracked during the 10 hour soak (Table 2). Cracking occurred at a tear or puncture in the skin, so cracking was attributable to water absorption through blemishes. Since Meteor is described as having a thin skin, it may be more prone to tears and punctures. Commercial processors evaluated the cracked fruit and considered it fully marketable, since cracks occurred after onset of soaking and no brown rot or other decay was evident. The cracked fruit pitted satisfactorily.

Laboratory tests: As expected (10), soluble solids in Montmorency increased between harvest 1 and 2 and then remained constant; in Meteor they followed the same pattern, except for a decline at harvest 3. This is probably explained by sampling pro-

Table 1. Fruit removal force (FRF) and flesh and juice characteristics of Meteor and Montmorency cherries.

Cultivar	Date of Harvest	FRF[1] (g)	SS	pH	Titratable acidity	Skin color L (darker)	Skin color a (redder)	Color of macerate L (darker)	Color of macerate a (redder)
Meteor	7/27	271	12.4	3.2	1.23	16.7	19.6	20.5	29.4
	8/03	267	14.8	3.3	1.23	15.9	17.5	18.0	29.9
	8/07	228	12.3	3.3	1.23	14.0	20.7	18.3	30.6
	Mean	255	13.2	3.3	1.23	15.5	19.3[2]	18.9[2]	30.0
Montmorency	7/12	301	13.4	3.3	1.40	16.3	26.9	23.9	29.4
	7/17	300	14.0	3.4	1.28	14.6	25.5	24.1	31.5
	7/27	261	13.9	3.6	1.13	15.6	23.2	23.2	26.4
	Mean	287	13.8	3.4	1.27	15.5	25.2	23.7	29.1

[1]Means for 45 fruits.
[2]Values significantly different than Montmorency at the .05 level.

Table 2. Fruit firmness of Meteor and Montmorency before and during soak and percent fruit cracked during soak.

Cultivar	Date of harvest	After harvest (hr): 0	0.5	After soaking for (hr): 2	4	6	8	10	% Fruits cracked after 10 hr soak
Meteor	7/27	51	47	48	50	52	53	52	2.9
	8/03	51	48	49	50	50	51	52	4.0
Montmorency	7/17	44	39	42	41	41	40	43	0

cedures. For the first two harvests samples from all 6 trees were mixed, but when the third sample was taken only the heaviest cropping tree had fruit remaining. The fruits on this tree with a heavy crop were slower in maturing and had lower sugar level.

In Montmorency the pH and titratable acidity were inversely related, as expected. In Meteor the pH and % acid averaged slightly lower than in Montmorency, and remained constant during the 3 harvests. This may indicate that the fruit retains its quality longer on the tree than Montmorency which could lengthen the harvest season if growers so desired.

Skin or external color and color of macerated tissue was tested for 2 qualities. intensity or "L," with 0 being black and 100 white, and redness or "a" with the highest number being the most red.

Macerated tissue of Meteor was a darker red (orange-red) than that of Montmorency, but skin color was lighter and not as red at most harvest dates. The skin of Meteor fruits had a darkening trend with time. In Montmorency intensity declined. then increased, while redness declined with time.

In 1979 Meteor fruit from 2 fourth leaf trees growing in a grower-cooperator cultivar evaluation planting near Coloma, MI were harvested and processed by a commercial processor. About 250 pits were randomly chosen for evaluation. Thirty-seven percent of these pits had breakage caused by the Dunklee mm cup pitter which has a mm opening for pit elimination. Subsequent pitting tests of Meteor fruit by another commercial processor and the New York Agricultural Experiment Station corroborated these results. Data on pit shape for selected large Montmorency fruit and Meteor from the Coloma planting are shown in Table 3. Montmorency is nearly round in shape, while Meteor is longer and thinner. Pit chipping was a severe problem in 1979 and may preclude the commercial acceptability of this cultivar since the tolerance for pit chips is zero in graded processed fruit.

Meteor was either equal to, or better than Montmorency in all aspects tested. except for cracking and pitting. Meteor matured about 14 days after Montmorency.

This is a preliminary study. hence firm conclusions cannot be drawn. Larger samples from more vigorous trees should be tested to fully evaluate Meteor's commercial potential. However. Meteor possesses several promising attributes for breeding and if it can be pitted without the pit chipping or shattering may complement Montmorency and help even out supplies and market prices while extending the harvest season.

Table 3. Pit size of Montmorency and Meteor fruit in 1979.

Cultivar	Length[1]	Width[1] suture	Width[1] non-suture
Meteor[2] (chipped)	0.81 a	1.15 a	0.60 a
(unchipped)	0.75 a	1.13 a	0.57 a
Montmorency[3]	0.98 b	0.98 b	0.75 b

[1]Mean of 10 fruit in cm.
[2]250 Meteor pits were obtained from a commercial processing of fruit from a 4 year old commercially grown tree and sorted into chipped and unchipped and 10 randomly selected seeds per sample were measured.
[3]The pits were from the 10 largest Montmorency fruit on an 8 year old tree carrying a full crop at the Michigan State University Horticulture Research Center.

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