Influence of Hardy Intermediate Stocks on Growth and Yield of Two Apple Cultivars[1]

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Trunk and scaffold limb injury due to low temperatures has occurred on apple trees in Ohio and other fruit growing areas of the world. This resulted in a search for methods which would reduce this type of winter injury. A study was initiated in 1955 to determine the influence of a series of hardy intermediate stocks from Canada and indirectly from the Soviet Union on the resistance to this low temperature injury. These stocks were propagated at Wooster on apple seedling rootstocks and subsequently topworked to 'Ruby' and 'Richared' in the orchard. Generally 4 primary scaffolds of the intermediate stocks were budded to either of the two cultivars. 'Ruby' and 'Richared' were also budded on apple seedling rootstocks with and without topworking as a basis of comparison to standard trees.

Trees of each cultivar were planted 17.5′ x 30′ in a completely randomized arrangement at The Ohio Agricultural Research and Development Center Horticultural Unit 2. A buffer tree separated each treatment tree. The planting consisted of 8 trees of each combination with the exception of 'Northern Queen' x 'Cranberry Pippin' and 'Chinese Shampanren' which had 4 and 2 trees respectively. The trees received standard care and did not require added support of posts. This study was terminated at the end of the 1971 growing season.

None of the hardy intermediate stocks materially increased the preco-

Table 1. Accumulative Yield, Trunk Circumference and Ratio of Tree Size to Yield of 'Ruby' on 13 Intermediate Stocks, 1958-1971.

Intermediate Stock	Accumulative Yield (lbs.)	Trunk Circumference (inches)	Ratio of Yield to Trunk Circumference
Mecca x Dolgo	2960	29.12	101
Kulon Kitaika	2951	30.66	96
Harbin Selection #16109	2941	32.45	90
Antonovka Zheltaia	2867	26.95	106
Apple Seedling	2759	28.62	96
Hibernal	2742	27.66	99
Malus Robusta No. 5	2674	26.91	99
Byshe Hardy Crab	2649	23.04	114
Columbia	2408	26.46	91
Bellflower Kitaika	2374	26.98	88
N. Queen x C. Pippin	2165	23.76	91
Ruby	2110	27.95	75
Chinese Shampanren	1606	21.84	73
LSD .05	483		14.5
.01	636		19.0

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city of either cultivar. In the 13 producing years, 'Ruby' produced 5580 pounds or 17% more fruit (Tables 1 and 2) than 'Richared' while the 'Richared' trees had significantly larger trunk circumferences than the 'Ruby' trees. These yield and growth differences were likely due to the longer time required for 'Richared' to come into bearing and its greater susceptibility to frost injury to blossom buds and flowers during bloom.

Trees of 'Ruby' have a marked tendency to produce very narrow crotch angles, and this characteristic was reduced by using certain wide angled intermediate stocks. 'Kulon Kitaika,' 'Mecca' x 'Dolgo' and 'Hibernal' were particularly promising in developing a well structured 'Ruby' tree.

'Northern Queen' x 'Cranberry Pippin,' 'Ruby' topworked on itself and 'Chinese Shampanren' were the only intermediate stocks that produced significantly lower yields than 'Ruby' on apple seedling (Table 1). 'Belflower Kitaika,' 'Northern Queen' x 'Cranberry Pippin,' 'Mecca' x 'Dolgo' and 'Chinese Shampanren' resulted in significantly lower yields of 'Richared' (Table 2) while the other intermediate stocks were similar to apple seedling.

'Ruby' on 'Harbin Selection #16109' had a significantly larger trunk circumference than 'Ruby' on apple seedling. 'Byshe Hardy Crab,' 'Northern Queen' x Cranberry Pippin' and 'Chinese Shampanren' resulted 18%, 17% and 24% reduction respectively in 'Ruby's' trunk circumference. 'Richared' apple seedling and 'Harbin #16109' resulted in the largest trunk circumferences while trees from the other interstocks were significantly smaller. The extreme dwarfing caused by 'Chinese Shampanren' was probably due to incompatability between this stock and 'Richared.'

When the relative efficiency of a tree was measured by comparing the ratio of yield to trunk circumference, 'Byshe Hardy Crab' stands out as the most efficient interstock for both 'Ruby' and 'Richared.' 'Chinese Shampanren' and 'Ruby' or 'Richared' topworked to itself were very inefficient combinations for these cultivars.

Essentially, 9 of 13 combinations resulted in standard sized trees with 4 causing some reduction in tree size. Although 'Chinese Shampanren' pro-

Table 2. Accumulative Yield, Trunk Circumference and Ratio of Tree Size to Yield of 'Richared' on 13 Intermediate Stocks, 1958-1971.

Intermediate Stock	Aucumulative Yield (lbs.)	Trunk Circumference (inches)	Ratio of Yield to Trunk Circumference
Harbin Selection #16109	2639	31.69	83
Apple Seedling	2610	34.55	75
Byshe Hardy Crab	2553	25.42	100
Malus Robusta No. 5	2492	29.19	85
Antonovka Zheltaia	2434	28.10	86
Kulon Kitaika	2274	29.89	76
Columbia	2229	28.54	78
Hibernal	2148	28.82	74
Richared	2105	32.55	64
Bellflower Kitaika	1934	27.21	71
N. Queen x C. Pippin	1767	23.98	73
Mecca x Dolgo	1753	26.57	65
Chinese Shampanren	688	18.31	37
LSD .05	517	2.40	15.4
.01	679	3.16	20.3

duced the smallest tree with both cultivars, this interstock also resulted in the lowest yield and efficiency value and thus would be impractical for use as a size controlling interstock. The hardy intermediate stocks in this study did not cause either cultivar to bear earlier than when propagated on apple seedling rootstocks.

Since the winter temperatures during this test were not cold enough at Wooster to cause trunk injury to apple trees, the hardiness of these intermediate stocks was not adequately tested. However, the efficiency (114 and 100) and tree size reduction (18% and 28%) caused by 'Byshe Hardy Crab' was very satisfactory with both cultivars. It appears that 'Ruby' on 'Byshe Hardy Crab' is similar in size and yield to the same cultivar on 'M.7.' Since it is reported to be hardy, 'Byshe Hardy Crab' might well be given consideration where a semi-dwarf trunk hardy tree is desired if it proves tolerant or resistant to problem diseases which were not present in this study and could not be evaluated. The infrequent occurrence of low temperatures that cause injury, coupled with the added propagation costs of topworked trees, make the widespread use of hardy interstock trees unlikely in Ohio. However, the need still exists for a hardy rootstock or interstock with size controlling ability and production efficiency that is resistant to problem disease.

Training Apple Varieties for Over-The-Row Harvester

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The transition period from standard large apple trees to the smaller compact, semi-dwarf semi-standard trees has come about in an orderly manner by growers following suggestions from persons working with experimental and grower tests. Production, efficiency in management, and general acceptance of the newer planting systems have been rewarding to all concerned. There have been some problems in tree losses, in improper tree spacing and tree training and pruning, in poor soil sites, etc.; however, these hurdles have been overcome by correcting mistakes and learning, and keeping informed.

The New Challenge — Now we are facing another new challenge—more mechanization in the apple orchards. The agricultural engineers, the innovative growers and the pomologists, who have worked hand in hand in developing the shake and catch system of harvesting fruit, are to be commended for their achievements. The system works well for some fruit crops, such as the cherries, plums, almonds, oranges, etc.; however, for the harvesting of apples, it appears to be a step toward something better.

Tree Training — Before the mechanical harvester will perform well in removing blemish-free apples from the trees, the pomologist and the fruit grower must train the trees to "mesh" with that special machine. One or two precise training patterns need to be developed. Although varieties differ in growth habits, the apple trees

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