

## Summary

The aim of this project was to establish an extensive review of apple and pear cultivars for successful organic management in cold humid climates of the U.S. Specifically, an established block of apple and pear trees, representing over 400 distinct varieties, will be assessed as to their commercial feasibility to certified organic orchardists and diversified farms. The fact that cultivar choice has great influence on the success rate of the farming venture, there is little room for error. Available information on plant stock for the cold humid areas of the country is inadequate, and information regarding organic management is further lacking. There is little information available to the public from universities and extension services, a formerly common vehicle for dissemination. Our extensive research over the last 20 years, has found scant (unbiased) cultivar reviews, most being antiquated or presented by nursery catalogs and other partisan sources. Organic fruit growers in the northeast are at a competitive disadvantage with the milder growing regions of the U.S. and overseas. Although the cold and humid climate of this area presents more difficulties for organic tree fruit growers, there is great opportunity if a proper cultivar choice is made. Studying varieties will help create a pool of choices that will allow growers to capitalize on new trends in the market like heirlooms, hard cider cultivars, red-fleshed varieties and other specialty types.

### Introduction and Study Impetus

Reasoning for engaging in the study hinges on the lack of information regarding organic pome fruit growing in the colder climates. Specifically, well documented assessments of apple and pear cultivars under such conditions are almost nonexistent. The northeastern U.S., with its cold and humid climate, is at a competitive disadvantage (commercially) due to this lack of knowledge. Of the thousands of commercially available pome fruits, few have been researched under organic management regimes, and still fewer in cold humid climates. Making matters worse, little information on the subject is available to the public. The high competition of a select few organic varieties (Honeycrisp, Fuji) from overseas and the Western U.S. make it very difficult for Eastern growers to compete. Regional growers can make gains in the market through diversity, while supplying a local and low carbon alternative to imported apples and pears. An extensive review of the possible cultivar choices in their region, under organic management will be of great merit to these growers.

Of concern is the lack of consistent and well documented points. Disease resistance, being of particular importance to the organic growers, should be listed for all major diseases, or stated as not reviewed. Cold hardiness should be mentioned with respect to its zone, and include the frost free days it will need to ripen satisfactorily (this last point is almost never mentioned at all). With the growing popularity of sustainable growing practices, including organic, this information will be all the more important. Zone hardiness has particular importance to farmers in colder climates, as the upsurge in the interest for locally grown food may allow for financially successful orchards to be planted in those areas. Cultivar choices are choices that will have to be lived with for years to come, and the most in depth information on the subject should be afforded to these farmers.

### Objectives

We addressed the issues outlined above by compiled data over the course of one year, reviewing the information, and then recompiling it into forms that may be useful for fruit growers. In some

cases, information from previous years was used.

Specifically this entailed :

A data collection period - in which spreadsheets were created. These were intended to be useful in their raw form so growers could evaluate particulars on their own or specifically look up attributes or conditions. It was also the vehicle for our creation of other, more finely tuned data sheets, and for our lists of recommendations.

Analysis - in which various narratives was employed to discuss each body of data, in order to investigate any findings, correlation, and concepts that growers may find helpful. These pages accompany every datasheet we compiled, both to aid in understanding the data, and to help the data become more useful.

Recommendations – lists were created to help farmers make some initial choices. These of course express our preferences based on our experiences, the outcomes and workload considered. This includes both a general list of reasonable choices, and a fine tuned list as well. Also, lists addressing specific issues such as scab resistance, or keeping ability were also created as an adjunct to recommended variety listings.

### What This Study is Not

The aim of the work undertaken was to create a body of data distinct from what is already available. That is, a representation of some of the physical traits expressed by the cultivars in this climate, and under this type of management. It includes some disease and insect experiences, physiology, and fruit quality aspects. What it did not attempt to do is repeat general descriptions of either the crop, history, or breeding information. While these particulars are important to many, there is ample literature describing such information currently. We did, however give some additional description of the fruit and trees in the recommendation documents (ss6 and ss 15).

### Study Location, Climate and Management Practices

The orchard used in the study was Walden Heights Nursery and Orchard. It is located in Walden, which is within Caledonia County in the Northeast Kingdom of Vermont, and at Latitude: 44-27'08" N, Longitude: 072-15'25" W. It sits at an elevation of 1703 feet at the point of entrance, and deviating approximately 50 feet in elevation higher and lower. Various aspects are present in the geography, but most, and generally they are on northwestern sloping land. Soil conditions are sandy loam, generally, with very good drainage in most areas. Orchard was installed in a formerly high density woodland environment of mixed hard and softwood species. Landscape is extremely hilly.

Average yearly rainfall in Walden is 45 inches, snowfall is 126 inches, and total days of measureable precipitation is 159 out of 365. It is located in US hardiness zone 3a. Cold temperature data since 1997 (year of orchard establishment) is supportive of the zone rating, having a 2009 low of -41F. Eleven years have seen temperatures below -30F during the period 1997 to 2014. Frost free days average 100-120 days. Mean temperature for July in 2014 was 64.2F, in January 2014, 9.4F.

Details of soil are :

Vershire-Lombard complex, 15 to 25 percent slopes, rocky (22.7% of orchard)  
Buckland loam, 8 to 15 percent slopes (12.7% of orchard)  
Buckland very fine sandy loam, 15 to 35 percent slopes, very stony (64.6% of orchard)

The general management of the orchard are as a low input, certified organic system, with emphasis upon hand work and a rich ecosystem. Specifically this means a diverse landscape including various fruit types, and indigenous flora. The test orchard contains bushes, vines and herbaceous planting within and at the peripheries. No tillage is done to minimize leaching and to improve soil quality. No tractors or other heavy machinery is allowed in the orchard, to prevent compaction, damage, offgassing and to maintain a low carbon footprint in our enterprise. Mulching is employed throughout the orchard, generally with farm sourced materials, but some periodic backfeeding with outsourced material is used. These outsourced mulching materials include hay, wood chips, and less commonly, compost. Manure application is not employed in the orchard due to health safety concerns. Commercially prepared fertilizers, including organically approved materials, are very seldom used. This includes lime applications. Instead, the system is supplied with farm supplied organic material, farm produced wood ash, and farm produced composts. Enough organic material is imported into the orchard system to replace losses from produce leaving the farm. Leaching of nutrients is low due to non-tillage, terracing, a wide range of perennial plant life in place, mulching, and other emphases of non-disturbance. Soil lab test have put the soil organic matter in many areas of the orchard at over 10 %, which not only improves the health and resiliency of the matrix, it also buffers a generally low pH in the area. These facts should prove useful in creating a picture of the possibility of creating a healthy orchard, but more importantly to the study is to give growers a clear picture of what environment the study sample was managed under. Although it is clearly distinct from the modern practice of high-density sod or cultivated systems, it has consistently produced healthy plants with good growth rate and fine fruit. For instance, since a majority of the cultivars showed good and healthy growth under such management and conditions, the varieties failing to thrive appears to be an artifact of the genotype and not the growing conditions.

Crop management all conforms to organic protocol. The farm and nursery, in its entirety, is certified organic. We do spray a moderate amount to address disease and pest pressures. Generally it is quite low. We use cultural practices to do most of the work of producing salable fruit and healthy plants. This includes removing or composting materials that may serve as disease vectors, hand removal and physical traps for insects, timely policing of the orchard to remove pathogen strikes, hand thinning and weeding. It should be noted that the test trees in this study were taken out of the spray regime for the test year of 2014. This fact we feel gave a better assessment of the possibility of not only an organic approach, but a low spray program. Furthermore, it gave a better picture of the characteristics of the particular varieties, and especially the fruit quality.

### Test Orchard

The test orchard consisted of several blocks within the farm. It comprised mostly apple at 475 distinct varieties, and a small selection of pears, of which were 23 varieties. (It should be noted that many pear cultivars have not survived over the years here. This number is close to 100 but records for these are not part of the study).

The orchard is a very wide pool of cultivars, and of ages. The plantings began approximately 18 years ago, but some trees existed here prior. There are a number of additional cultivars growing on site, but were considered too young to be useful in the study.

Tree variety selections were generally made, with some exceptions, with the environmental conditions in mind. This means a great number of the plantings were made with cold hardiness in mind. Marginal varieties have been periodically trialed when literature was unclear, or showed argument over hardiness. Some were also included to act as material for breeding, regardless of cold susceptibility. The fact that such a high percentage of the orchard was selected based on this prescreening for resistance to environmental stress, is likely responsible for the survivability and general good health of the trees.

Rootstock should be discussed as regards the study sample. All stock in the test is grafted to standard, full vigor stock. The types were chosen for cold hardiness, but also for consistency in growth rate and anchorage in mind. Dolgo, antonovka, ranetka, prunifolia, Selkirk seedling are used, and in a limited sampling, budagovsky 118 (full vigor) clonal stock was used. Nearly all accessions have various rootstock represented. Although testing was done with dwarfing rootstocks, and a few remain in the orchard, nearly all examples (of over 100) died for various reasons. No dwarf trees were used as grafted rootstock in the study. Some cultivars used as rootstock were tested as trees, and some were grafted upon seedling stock as the scion cultivar. (These were all examples from the budagovsky series).

Trees were grafted here at Walden Heights by the proprietors. As mentioned all varieties are on standard rootstock, and whip grafted.

### Data Collection Methods

Particulars of the methods is specifically addressed in each section of the study. These are outlined in the text document accompanying each data sheet or sheets. However, the following is pertinent :

**Record Keeping:** Each variety in the study was on visited numerous times throughout the growing season. Information was gathered via notebook and audio recording devices, and transferred to a data file. Still digital photos were taken, as needed to document the information.

**Observations:** It must be stressed that the objective was to observe the results of casual infection and attack from pests in the study location, since plants was not be inoculated directly with pathogens, or pests brought to the location. This is of merit, since the primary issues organic apple and pear growers in northern New England face is with a small very apparent subset of the many diseases and pests that affect these plants.

**Disease Assessment:** Of greatest concern to organic pome fruit growers is apple scab, which will represent the bulk of the monitoring. Not only are there to date very few cold hardy scab resistant varieties, but our own research has found misinformation regarding those advertised as such. All detected infections of other pathogens will be noted.

The larger scope or disease monitoring encompassed apple scab fungus (*venturia inaequalis*), fireblight (*erwinia amylovora*), anthracnose (*Cryptosporiopsis curvispora* black rot

(*Botryosphaeria obtusa*), nectria canker (*Nectria galligena*). These pathogens are widely distributed in our region and will make for a good general assessment of susceptibility. Some minor affectations were discussed in comments. Not all potential diseases will be discussed; Cedar apple rust for instance, cannot be investigated as we have no natural intermediate host in the area. Varieties will not be directed inoculated with pathogens; casual infection will have to occur.

Insect pest damage on each variety will be noted. Although little resistance has historically been shown with respect to insect damage on fruit, monitoring will still be done. Woolly Aphids resistance in northern spy and apple maggot resistance in denser late apple cultivars are two examples of varietal resistance to insect damage.

Methods for disease and pest identification:

1. Project manager during rotational monitoring will record instances of infection, including severity. Conversations during the test period, and visits during past years with plant pathologists aided the experiment. The orchard was visited, and assessment methods were discussed with the project technical advisor.

Physiological attributes: Growth rate, general health, branch crotch angle, caliper, fruiting, bloom, and cold or frost damage were investigated. Lengths and calipers were measured using mechanical calipers and tape measures. An angle finder/protractor was used in assessing angles. Damage was observed directly, and through occasional dissection where warranted.

Fruit Qualities: On the varieties that are fruiting, a report on the general quality will be given. Brix reading, texture, sugar, tartness, and to a limited degree, tannin, was reviewed. Date of ripening, and length of keeping in cold storage was also recorded. A general narrative was given as to the merits of the fruit.

Recording: Done by myself (Todd Parlo, project manager). Visiting approximately 1300 trees (in general at least two examples of each cultivar. Each tree was visited periodically throughout the season for general monitoring. During bloom assessment, the visits were done as often as 4 times a week for several weeks. Other visits were done often, but much less frequently.

## Outcomes and Impacts

The project resulted in producing a body of work intended to aid potential and current fruit growers in making a more intelligent decision in selecting pome varieties intended for cold, humid climates. The research is directed also to low impact and organic methods of management. We have produced sets of data, along with explanatory narratives to accompany them. The data, compiled generally over the course of the year (2014), is represented as 18 separate data files (attached pdf files). These are accompanied by documents expanding on the methods and interpretations.

These include:

**Table 1** : Tree Physical Characteristics – various tree characteristics master sheet with performance factors.

-Document 1 : Accompanying narrative outlining table 1, table 8

- Table 2** : Bloom Time Master Sheet – Full data sheet with all bloom stages and commentary  
 -Document 2 : Accompanying narrative outlining table 2 and the following related tables:
- Table 3** : Dates of First Bloom – table listing varieties in order of date of first bloom
- Table 4** : Dates of Full Bloom – table listing varieties in order of full bloom
- Table 5** : Dates of Petal Fall – table listing varieties in order of bloom termination
- Table 6** : Fruit Scab Evaluation – Varieties are grouped according to fruit scab infection  
 - Document 6 : Accompanying narrative outlining table 6
- Table 7** : Fruit Evaluation – Full data sheet on all fruit aspects evaluated. Includes pH, brix, size, weight, harvest date, scab occurrence, keeping ability, and comments.  
 - Document 7 : Accompanying narrative outlining table 7, 9, 10, 12, and 13
- Table 8** : Leaf Scab Assessment – Full variety list noting leaf scab occurrence (see doc 1)
- Table 9** : Fruit pH – Varieties are arranged according to pH levels in this datasheet (see doc 7)
- Table 10** : Harvest Dates – Varieties are listed according to harvest date (see doc 7)
- Table 11** : Arthropod damage- master sheet of variety vulnerabilities to selected orchard pests  
 - Accompanied by 4 data sheets showing rankings of each pest in the review:  
 -Document 11a: Apple Maggot – Discusses findings regarding infection to particular varieties  
 -Document 11b: Codling Moth – Discusses findings regarding infection to particular varieties  
 -Document 11c: European Apple Sawfly – Discusses its infection in particular varieties  
 -Document 11d: Leafroller – Discusses findings regarding infection to particular varieties
- Table 12** : Fruit Keeping Ability – Varieties are arranged according to storage ability (see doc 7)
- Table 13** : Fruit Brix Levels – Varieties are arranged according to Brix levels (see doc 7)
- Table 14** : Best Selections – List of Varieties as a recommended short list, with comments  
 --Document 14 : Outlines the recommendations in tables 14 and 15 and reasoning
- Table 15** : Recommended Fruit Cultivars – Longer list of suitable varieties with comments
- Table 16** : Cold Damage – Compilation of varieties and their susceptibility to cold conditions  
 -Document 16 : Winter Hardiness – Outlines table 16 and 18 and general hardiness issues
- Table 17** : Pear Assessment – Selected pear cultivars and their performance in the orchard  
 -Document 17 : Pear Assessment – Accompanying discussion of table 17
- Table 18** : Mortality – List of variety specimens not surviving, with suspected causes and notes  
 -Document 18 : Tree mortality – Outlines table 18 and survivability issues of varieties  
 - Document 19 : Layout and Soils – Aerial photos of orchard and soil mapping

The preceding data and discussions is intended to be used as an aid in choosing varieties for cold climates under organic management. It should be thought of as a body of work to aid in a larger decision process. Furthermore, it will see its greatest usefulness as part of a larger group of study. Repeating and reviewing results in similar climates and different locations would be a great help in pursuing the best candidates for difficult growing areas and practices. This project, however, should prove of merit as a review of a large body of pome cultivars. We feel we have produced a good variety of information not readily obtained elsewhere. This encompassed a single year in a single location, but did allow for some data from our previous experiences and years in the orchard. It will be a starting point for further study and evaluations as the years progress in this test orchard in Walden, Vt.

## Accomplishments

The study accomplished what it set out to do at its inception. To gather a body of data, attempt to

interpret it, and allow us to make some observations and recommendations. It also acted as a template for us and other orchardists to evaluate their orchards by using careful record keeping. As with any research project, there were surprises, gaps, and ironies present, but the general result was successful. We compiled a basic review of 498 pome varieties, a review of 128 fruits with attribute testing, recorded bloom histories for 209 pome varieties, investigated pest susceptibilities amongst cultivars, assessed disease occurrence, studied cold hardiness effects on varieties, and developed lists of recommended selections. This was done while growing, managing and harvesting this orchard, allowing us a close relationship with the study blocks. The project, even though ambitious in the number of subjects and cultivars involved, is only a small piece of a larger potential for education on the matter. The information displayed here has immediate usefulness, but it bears repeating that it has larger possibilities with further study, and repeat projects elsewhere. It holds the possibility of a very large multiyear investigation and assessment of the thousands of new and heirloom pome varieties that exist, instead of the very limited investigations involving new releases, particularly patented and trademarked varieties, and those pushed by extensive marketing campaigns. We believe we have made a helpful step in helping folks make some more informed decisions regarding what they may plant on their farms and homesteads.

## Potential Contributions

We feel the data compiled here, along with our observations and interpretations will be of service to prospective tree fruit growers in the future. This is particularly the case for those in climates such as our, and who are or wish to employ organic management practices. We hope to keep the information updated and the studying continual, and aim to distribute this through our website and other vehicles. Those who view the material included here, will hopefully become more empowered to make an intelligent decision while choosing cultivars. The data can be used to fine tune research, develop databases related to preferences, or used immediately as a referral. The recommendations should be a contribution to many who desire a quick narrowing down of choices, especially for an initial planting in climates such as ours.

Generally, the hope we have is that growers, new and veteran will seek out a wider selection of varieties, both to increase their success in growing organically in colder climates and increase the marketing possibilities. Furthermore, we hope the greater diversity will help foster a richer and more diverse culture in farming and, well, eating. We feel the information here will help those causes.

