Aronia: Cultural and Production Considerations as an Alternative Crop©

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INTRODUCTION

Black chokeberry [*Aronia melanocarpa*, (Michx.) Elliot] or aronia, as it is known commercially, is a small fruit-bearing shrub in the rose family (*Rosaceae*) and apple sub family (*Amygdaloides*). Its range is from Newfoundland, west to Ontario, south into Alabama, and east to Georgia, and is hardy to Zone 3 (USDA NRCS, 2011).

Aronia is a landscape quality plant with few pests and diseases. Because of this, it is an ideal candidate for organic fruit production. The fruit is typically between 1 and 1.5 cm in diameter, very similar in size to commercial blueberries. Often misnamed as a berry, the fruit is actually a pome (apple) and grows in clusters of between 5 and 20 in cyme-like inflorescences. The aronia fruit has nutraceutical qualities, heightening its marketability and sales potential as a value added product. There is currently great interest in fruits and vegetables that contain high concentrations of flavonoids, considered potent antioxidants (Gu et al., 2004; Pietta, 2000). In a recent study (Wu et al., 2004), aronia was shown to contain high levels of flavonoids including anthocyanins and proanthocyanidins, and has a total oxygen radical absorbance capacity (T-ORAC) of 16,062 µmoles Trolox Equivalents (TE) per 100 g of fresh fruit (USDA ARS, 2010). In comparison, blueberries have 4,669 µmoles TE per 100 g of fresh fruit (USDA ARS, 2010). Trolox is a water-soluble derivative of vitamin E and a standard for antioxidant activity. A review by Kulling and Rawel (2008) of in vitro medical studies have suggested that aronia has many medicinal properties that may benefit coronary/pulmonary systems, urinary tract systems, gastrointestinal systems and possibly, persons with type II diabetes. A number of research institutions and government agencies have promoted the production of aronia as an alternative crop (Finn, C., 1999; King, 2007; Ristvey and Mathew, 2011). In Eastern Europe where the aronia has been cultivated for many years, fruit products include juices, extracts, coloring agents, and wine (Scott and Skirvin, 2007).

The *Aronia* genus has often been renamed, and as recently as 1991, Robertson et al. (1991) changed this genus to *Photinia* based on floral morphology. However, Campbell et al. (2007) found that sequenced genealogical data did not clearly support this phylogenetic relationship and determined that *Aronia* should be a stand-alone genus (Leonard, 2011). Furthermore, an attempt to distinguish the cultivated variety of *Aronia* from its progenitor *A. melanocarpa* was made by Skvortsov and

Maitulina (1982), naming *A. mitschurinii* as the newly developed species (Leonard, 2011). Skvortsov et al. (1983), deciphers the historical records of the breeding of this plant by the Russian plant breeder Ivan Michurin (Leonard, 2011). According to Skvortsov et al. (1983), Michurin used the European Mountain Ash (*Sorbus aucuparia*) and a plant retrieved from Germany that he called *S. melancocarpa*, "black-fruited mountain ash" or "American *Sorbus*" (Leonard, 2011). Through DNA analysis, Leonard (2011) determined that the present cultivars of *Aronia* including 'Viking' and 'Nero', utilized mainly for fruit production in Europe and the United States, are a cross between a black-fruited *Aronia* and the European Mountain Ash (*Sorbus aucuparia*).

The research performed at the University of Maryland was initiated to be the basis for a University of Maryland Extension program designed to inform the public about aronia as a potentially valuable alternative crop for farms and land owners. In the past, marketing the crop has been difficult because of the fruit's flavor, at first sweet, but astringent if masticated. However, proper processing, like freezing and squeezing the thawed fruit can yield a rich colored juice, which has little of the astringent flavor and can be sweetened with sugar to taste.

CULTIVARS

Several cultivars of aronia plants are presently in the market. Two of the most popular which were developed in Europe are *P. melanocarpa* 'Viking' and 'Nero', both very similar in yield performance (McKay, 2004). A recent introduction, 'Galijcanka' from Poland, has been touted to have more even ripening of fruit over time than 'Viking' or 'Nero'. However, neither 'Viking' nor 'Nero' showed problems with uneven fruit ripeness at harvest in Maryland. Other cultivars have been developed in North America, but are not as good for fruit production. For instance, 'Autumn Magic' and 'Iroquois Beauty' seem to have better fall foliage color than fruit production.

PHENOLOGY

Before the growing season, an undetermined dormancy period with cold temperatures is needed before bloom initiation. An estimation of a minimum of 800 chill hours is required to break dormancy; however no studies have been initiated yet. Depending on temperatures, dormant buds swell in late March and begin opening in early April with vegetative growth (leaves) visible first and flower buds showing soon after. In Maryland (Zones 6b to 7b) aronia blooms between late April and mid-May. The flowers are apomictic, but are still pollinated by several species of hymenopterans (bees). The bloom cycle is approximately 10 days. By late May, fruit set begins and potential yield can be determined. Throughout June and July vegetative growth continues, doubling or tripling the size of the plant during the first few establishment years after planting. Throughout June, fruit turn from green to a burgundy color, starting at the calyx and moving towards the peduncle. By mid-July, all fruit are colored burgundy and by harvest time in mid to late August, fruit are a dark purple. Bud set for next season's yield occurs between late July and mid-August. Some vegetative growth will continue throughout August, but sharply declines as September begins. Harvest is in mid to late August when fruit clusters are fully ripened. Mature plants can yield up to 11 kg or more of fruit. Soluble sugar content or Brix (°Bx) of fruit varies between 15% and 22%.

PEST AND DISEASES

Aronia has few pests and disease problems, however, in Maryland, 5 years of observation have revealed specific threats that can be managed through basic integrated pest management practices, leaving opportunities for organic production possible.

Insects. Insect problems have been noted throughout the growing season from April through August. One of the first insect problems occasionally seen early in the growing season is blister beetle (*Lytta* sp.) which consumes flower buds. Aphids are a common problem throughout the summer starting in June. They are seen on the fresh vegetative growth and tend to disfigure leaves. Pesticides are not needed because they are often controlled by lady bird beetles and lace wings within a week of arrival and usually do not constitute a threat. By mid-June, however, Japanese beetles emerge and become a major threat to canopy growth. During years of heavy infestation, much of the growing canopy is removed. This may have a detrimental affect towards carbohydrate production. Additionally, grasshopper damage during the late growing season can also remove a large portion of the canopy. Another insect of concern, noted within the last 2 years of production in Maryland, has been the cherry fruitworm (*Grapholita packardi).* Finally, the brown marmorated stink bug (*Halyomorpha halys*) has been seen on aronia fruit and feeding damage has been noted. More research into practical control measures is necessary, especially for organic production.

Pathogens. Aronia has few problems with pathogenic organisms. One fungal pathogen, seemingly of minimal concern, is rust (*Gymnosporangium* sp). Initially, during the first few years of establishment in Maryland, infection was limited to fruit, and the aronia plants would abort the fruit before the fungal infection moved into the teleospore stage. In 2010, it was noted that fruit did not abort before the teleospore stage and stem tissue below fruit showed infection. Infection rates are not consistent annually, with low rates in 2011 and moderate rates seen in 2012.

PROPAGATION CONSIDERATIONS

Aronia can be easily propagated by cuttings and is the preferred method of keeping the integrity of the commercial cultivars. However, seeds have been used for propagation and seem to carry on the parental traits for hardiness and yield in both 'Nero' and 'Viking' (McKay, 2004). Both early and late season cuttings can be made, although if stock plants are also used for fruit production, early June cuttings are better as to avoid taking dormant flower buds which would reduce the following year's yield. Cuttings should be made to partially hardened stem tissue which has a purple color. Any commercial rooting hormone will be effective. A typical propagation misting system is advisable. One can expect 95% or more of cuttings to successfully root, so long as typical hardwood cutting procedures are followed.

RESEARCH SUMMARY

Post Propagation. A 2-year research program looking at fertility of rooted cuttings was undertaken to determine the optimal nitrogen (N) rate for optimal growth and nutrient uptake efficiency. Specific procedures for these studies are outlined in Ristvey and Tangren (2008). The first year, rooted aronia cuttings planted in 2-gal containers were supplied with either 150 mg N or 75 mg N, once per week in soluble form, for 34 weeks between March and October. Phosphorus was supplied at 1/10 the N rate for both treatments. A total of 5.1 grams N and 2.6 grams N was supplied as a high and low treatment. At the end of 34 weeks, plants under the high N treatment had nearly 2.5 fold more dry mass as the low N treatment. Another study the following season was developed to indentify the effects of split applications of soluble N. Three treatments were used. A 150 mg N rate was applied as a single weekly dose or split into two applications per week. Likewise, a split 225 mg N per week rate was added as a treatment in a 29-week study from March to October. Results showed that aronia grew best with split applications of high N and had relatively high uptake efficiencies compared to other studies (Cabrera, 2003; Ristvey et al., 2004; Ristvey et al., 2007). This study's low and high rates actually corresponded to recommended low and medium rates for commercial slow-release fertilizer applications.

Fruit Production Research. Two European cultivars of aronia, 'Viking' and 'Nero', were planted in ground in May 2006 at Wye Research and Education Center in Queenstown, Maryland. The 'Viking' cultivar was planted as 24-month-old seedlings. The 'Nero' cultivar was planted as 12-month-old seedlings. Details outlining the first yield studies are given in Ristvey and Tangren (2009). In summary, plants were each given one of two N fertility rates amongst rows during the first yield studies. 'Viking' plants, being the most mature when planted, produced enough fruit during the third season (2008) to determine if fertility treatments affected yield. 'Viking' plants, each given a total of 24 g N during the period between planting and recorded yield (an initial 6 g at planting and 18 g throughout the next 2 years) produced an average of 2.2 kg (SE±0.16) per plant (4.8 lbs). This was significantly less than plants given 15 grams N (an initial 6 grams at planting and 9 g throughout the next 2 years), which averaged 2.8 kg (SE±0.25) per plant (6.2 lbs). The source of N was an Organic Materials Review Institute (OMRI) certified fertilizer consisting of 5% N. In spring of 2009, N treatments were expanded to include a total of four separate rates (0, 3, 7, and 14 g N) and where applied per plant within rows as a split plot study. A new OMRI certified N source was used with 11% N. Since beginning the new N rate study, three harvests have been recorded. Each year harvests have shown no differences in yield by N rate to either 'Nero' or 'Viking' cultivars. Brix was also measured. In each year, no difference in °Bx was found between N rates and cultivars. Jeppsson (2000) noted that high fertility, while increasing yield, negatively affected anthocyanin content in fruit. A recommendation from Jeppsson's study suggested that crops be fertilized with 50 kg N per hectare roughly translating to 45 lb of N per acre, however, in our studies, N rate did not affect yield. Based on our studies and anecdotal observations, new plants should be established in-ground with 7 g of N (0.25 oz) per plant and adjusted to plant needs in following years, never exceeding 14 g N per plant. Depending on plant density which may be between 1000 and 2000 plants per hectare, (roughly 400 to 800 plants per acre), this fertility would not exceed 30 kg N per hectare (27 lb per acre).

CONCLUSIONS

Aronia is an up-and-coming alternative crop in the U.S.A. While specific markets have yet to be completely defined, the marketing potential for this crop to be the next "superfood" is very likely. Because of its hardy character, the possibility for organic production with the correct IPM measures and very little input makes this a worthwhile crop to investigate. The aronia research summarized in this paper serves as the basis for a University of Maryland Extension program. In Maryland, aronia has been shown to tolerate a range of soil types, can be grown with sustainable rates of fertilizer, and is tolerant to many of the pest species that make other fruit crops more difficult to manage. Presently, a move for consumers to "buy local" may bring a renaissance for small farms to sell aronia as value added product. Future research will include the determination of cultural methods that may increase the nutritional value of the fruit to maximize its market value and the determination of processing methods that do not negatively affect the fruit's nutritional value.

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