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Methods for Collecting Ash (*Fraxinus* spp.) Seeds

Kathleen S. Knight
Robert P. Karrfalt
Mary E. Mason

Abstract

The threat of emerald ash borer (*Agrilus planipennis*) has necessitated ash seed collection to preserve the ash genetic resource. For ash species found only in natural areas, we have developed seed collection methods that require no special training or certification. Collection techniques for natural areas include pole pruners for branches lower than 30 ft (9 m) and ropes or rope saws for higher branches. Seed collection must be timed correctly by examining samara color, seed coat color, and embryo size to be sure that seeds are fully mature. Documentation of seed identity and post-harvest handling of seeds are discussed.

The Authors

KATHLEEN S. KNIGHT, Research Ecologist, U.S. Forest Service, Northern Research Station, Delaware, OH.

ROBERT P. KARRFALT, Director, U.S. Forest Service, National Seed Laboratory, West Lafayette, IN.

MARY E. MASON, Research Associate, The Ohio State University, Ohio Agricultural Research and Development Center, Wooster OH, Department of Entomology.

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INTRODUCTION

Ash (*Fraxinus*) is an important genus in North America with 16 species spread across the continent (USDA NRCS 2009). A prolific and regular producer of seeds, it readily establishes naturally in disturbed areas within its range. For some conservation and timber purposes, white and green ash seeds were collected and occasionally seed orchards were planted in the past; however, to date there has been only a small need to collect ash seeds in the wild. But arrival and spread of the emerald ash borer (*Agrilus planipennis*) from Asia, which has already killed tens of millions of ash trees in the U.S. and Canada (EAB Info 2009) and has the potential to devastate North American ash species (Cappaert et al. 2005), has created the need to preserve the ash genetic resource through long-term seed storage. The seeds may be used for future research or restoration. Therefore, techniques for seed collection in natural areas are now needed.

SEED COLLECTION TIMING

Timing seed collection correctly is as important as having a good technique for gathering the seeds. Seeds should be collected when they are physiologically mature, at which point they have the greatest ability to survive in storage and produce a strong seedling. Physiological maturity is reached just before the seed is naturally shed from the tree. Seed maturity dates differ among species, years, and locations. Ripening dates are listed in the Woody Plant Seed Manual for ash species that occur in regions currently infested by the emerald ash borer (Bonner and Karrfalt 2008) (Table 1). In Ohio, green ash samaras may

Table 1.—Seed maturity dates of ash species

Common name	Scientif c name	Seed maturity date
White ash	*F. americana*	October-November
Green ash	*F. pennsylvanica*	September-October
Pumpkin ash	*F. profunda*	September-October
Black ash	*F nigra*	June-September
Blue ash	*F. quadrangulata*	June-October
Carolina ash	*F. caroliniana*	August-October

persist on the tree until December, blue ash samaras may fall by mid-September, and pumpkin ash and black ash samaras may fall by mid-October (Knight and Mason, personal observation). Insect-damaged seeds, empty seeds, or storms can result in premature seed shed, which should not be confused with true mature seed shed.

Despite the published seed maturity dates, the best way to judge seed maturity is to dissect a few seeds. Botanically, the fruit of an ash is known as a samara, which contains a single ash seed. The samara changing color is the first sign that the seed is maturing. Samaras change from green to pale green, yellow-green, tan, and finally dark brown. Molds can also darken and spot the outer layer of the samara until some appear almost black. This apparently is not harmful because such seeds are found to germinate.

In addition to observing the color change of the samara, it is necessary to observe the internal structures of the seed to decide if the seed is mature and healthy enough to collect. There are three reasons for examining the internal structures. First, ash samaras may mature even if they do not have any true seeds inside. Secondly, insects can damage the seeds (Fig. 1). Finally, it is necessary to know that the seeds are mature. A seed can be removed from the samara to determine the color of the seed coat. The seeds are mature when the seed coat turns tan to dark brown (Fig. 2). The samara should also be cut lengthwise to expose the

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Figure 1.—Ash seeds damaged by insects are not viable. A weevil larva is inside the seed.

embryo inside the seed. The seeds of white ash, green ash, pumpkin ash, and Carolina ash are mature when a firm, white embryo fills the seed cavity (Bonner and Karrfalt 2008) (Fig. 3). Ripe seeds of blue ash (Mason, personal observation) and black ash (Bonner and Karrfalt 2008) have immature embryos that do not fill the seed cavity, so seed coat color and firmness of the embryo must be used to judge ripeness. Blue ash and black ash embryos will grow once dormancy is broken.

It is useful to scout potential seed collection areas beforehand to determine locations with enough healthy seeds to make collection worthwhile. Under normal circumstances, seeds should not be collected from trees where less than 80 percent of the seeds are good, particularly during a good seed year. However, if the trees will soon be lost to emerald ash borer, it may be necessary to collect from trees with somewhat poorer quality seeds. Mast seed crop years may occur

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Figure 2.—Blue ash samara pulled apart to expose seed. Seed removed (arrow). Seed coat is brown and ready for harvest.

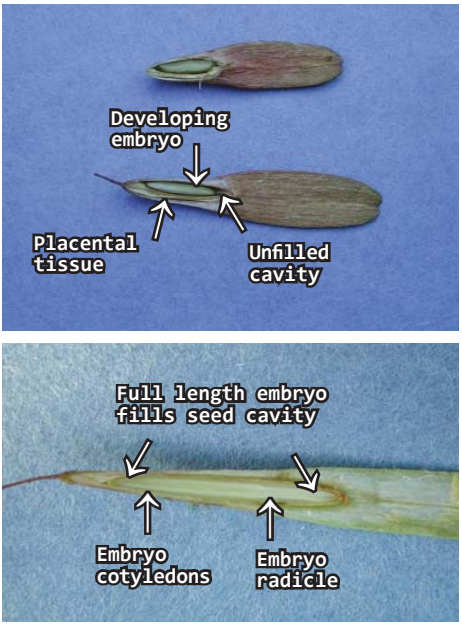

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Figure 3.—Green ash seeds cut lengthwise. Immature seed has placental tissue (arrow) taking up the right and lower portions of the seed, unf lled cavity (arrow) at the top and bottom, and the developing embryo (arrow) only f lling a portion of the seed. Mature seed has a f rm, full length embryo f lling entire seed (arrow).

every 1 to 5 years, depending on the ash species (Bonner and Karrfalt 2008), but in some non-mast years there may be few seeds produced (Knight, personal observation). Scouting also makes it easier to plan the distribution of samples across a location and determine which seed collection techniques will be needed.

SEED COLLECTION TECHNIQUES

Seeds of common ash species can be easily collected along roadsides, because open-grown ash trees can produce seeds throughout the crown, providing copious amounts of seeds that are easy to reach. Less common ash species may be found primarily in forested natural areas. In these areas, the lowest branches with samaras may be 6 to 24 m (20 to 80 ft) above the ground, making seed collection challenging. Tree climbing has frequently been used in the past to collect seeds from tall trees of other species, especially conifers. That method, however, requires specialized training and equipment to be carried out safely. Three productive and economical methods for collecting seeds in forested areas allow the worker to remain on the ground: pole pruners, rope, and rope saw. Using a shotgun to shoot down small branches with seeds and cutting down the entire tree are also appropriate methods in certain circumstances, but are not discussed here.

Pole Pruners

Pole pruners consist of pole sections and a cutting head with a long rope attached. Pole pruners are most useful for collecting seeds less than 9 m (30 ft) above the ground, and will cut a branch up to 4 cm (1.5 in.) in diameter (check individual pruner specifications). First, a tarp is spread on the ground beneath the lowest small diameter branch with samaras. Pole sections are added until the desired height is attained, the cutting head is hooked over the branch, and the rope is used to operate the cutting head to cut the branch (Fig. 4).

Pole sections can be made from fiberglass, aluminum, or wood, and a variety of cutting heads are available. The taller the pole pruner is, the more difficult it is to control from the ground, and the more upper body

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Figure 4.—Ian Chambers (Ohio State University) uses pole pruners to collect pumpkin ash seeds at Maumee Bay State Park.

strength is required to lift the pole to add new sections. It is helpful to wrap the rope around long, flexible poles to prevent them from bending when the rope is pulled to operate the cutting head. A lightweight cutting head and lightweight rope will help prevent the long poles from bending over. Resting the pole on a cross branch can support the pole while sections are added or steady the pole if it starts to sway. Care should be taken to keep the rope clear of small side branches. Most cutting heads have a lever action so the pruner head should be positioned to allow sufficient clearance (e.g., on the outside of a fork). For more leverage, one person can steady the pole and a second can operate the rope, or the butt of the pole can also be braced against the ground and

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Figure 5.—An ash branch, laden with ash seed, is gently lowered to the tarp using modif ed pole pruners (arrow).

boot instep to free both hands for pulling on the rope. The pole will be unsupported once the branch is cut and may start to fall, especially if the pole is angled during cutting. Bracing the bottom of the pole against the instep and keeping tension on the rope can slow the pole's fall and prevent damage. Cut branches often fall straight down toward the operator, especially when the pole must be kept nearly vertical to keep it from falling while cutting higher branches. Many poles have a hook for positioning, and the hook can be used to pull down branches that hang up after cutting.

Another way to use the pole pruner is to put a hook on the pole to allow the cut end of the branch to be lowered gently (Fig. 5). A simple hook can be made from flexible 3/8 in. water pipe. The hook is slid into the crotch of the branch and a lateral branch. The cutting head is then placed over the branch and the cut is made. The cut end of the branch is caught on the hook and can be lowered to the ground without shattering the seeds into the undergrowth. If the pole is not too long and

there is enough clear area, the pole can be simply swung to the ground. Otherwise, sections need to be taken off the pole in order to lower the cut branch. This technique can be used without the tarp, which is a good alternative where it is not possible to spread the tarp on the ground (e.g., areas with dense understory shrubs or ash branches above rivers or lakes).

Safety is important for all methods of ash seed collection. Pole pruners should never be used near power lines due to the risk of electrocution. Pole pruners operated very high have the potential to fall. Cut branches may fall directly toward the operator. Communication between the operator and the rest of the crew is important. Everyone on the crew should wear hard hats and eye protection and watch out for falling branches or equipment.

Rope

This method uses a strong rope over a branch to allow the seed collector to shake the branch so that samaras fall onto a large tarp on the ground, to bend the branch down so that the pole pruners can reach it, or to break the branch. First, a tarp is spread on the ground beneath the target branch with samaras. Then, a 340- to 450-g (12- to 16-oz.) throw bag with a lightweight throw line is thrown or shot over the target branch (Fig. 6). We have successfully used the Big Shot® slingshot from Sherrill Tree to shoot a 400-g (14-oz.) throw bag over branches 24 m (80 ft.) above the ground. The throw line is spooled into a bag or box so that it does not tangle, and the bottom end is attached to a heavier strong rope, which is spooled into its own bag so that it does not tangle. Once the throw line is over the target branch (binoculars are useful to determine this), the throw line is used to pull up the heavier rope (Fig. 7). Once the heavier rope is over the branch, the branch can be shaken or pulled down to remove seeds (Figs. 8 and 9).

In our experience, black ash branches are easiest to break, while pumpkin ash, blue ash, and green ash branches are very flexible and more difficult to break. Working with high branches on a windy day makes it difficult to get the samaras to land on the tarp if the shaking method is used. If

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Figure 6.—Tim Fox (U.S. Forest Service) uses the Big Shot® sling shot (arrow) to shoot a throw bag (arrow) over a black ash tree branch at Fowler Woods State Nature Preserve.

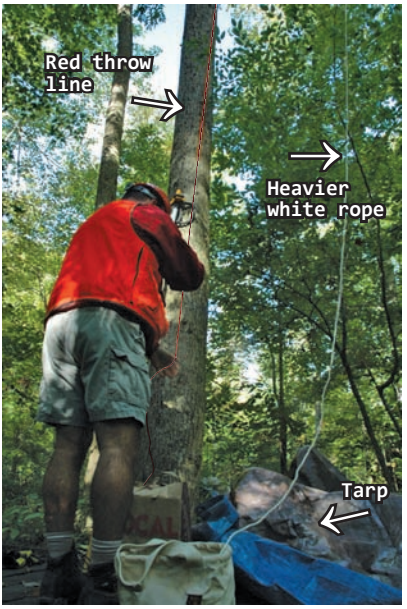

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Figure 7.—Tim Fox (U.S. Forest Service) uses the red throw line (arrow) to pull up the heavier white rope (arrow). The red throw line is spooled into the paper bag.

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Figure 8.—Tim Fox (U.S. Forest Service) uses the heavier rope to shake a black ash tree branch (left).

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Figure 9.—Pumpkin ash samaras fall on the tarp as a branch is shaken.

the wind is consistent, it may be possible to gently shake the branch so that a few samaras fall to determine where they will land, then set up the tarp in that area. Breaking off a small branch laden with samaras so that it falls on the tarp is often the most efficient method of seed collection.

Safety is important for all methods of ash seed collection. Rope should never be used to collect seeds from branches near power lines due to the risk of electrocution. A 400-g (14-oz) throw bag shot 24 m (80 ft) into the air will hit the ground with a velocity of 22 m/s (49 mph). It is best to shoot the sling shot at a slight angle, rather than straight up, and make sure no one is standing in the direction of its trajectory. Broken branches may fall directly toward the operator. Communication between the operator and the rest of the crew is important. Everyone on the crew should wear hard hats and eye protection and watch out for falling throw bags and branches.

Rope Saw

In this method, a strong rope is used to maneuver a rope saw into position on the branch and then to cut the branch. This method works best for branches at least 2 cm (3/4 in.) in diameter. First, a tarp is spread on the ground beneath the target branch with seeds. Then, a throw bag with throw line is thrown or shot over the target branch, preferably positioned so the rope is only over the target branch. Rope is attached to both sides of the rope saw, with one end attached to the throw line, which is used to pull the rope saw into the tree. When the rope saw is oriented over the branch to be cut, the ropes are used to move the rope saw back and forth to cut the branch (Fig. 10).

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Figure 10.—Tim Fox (U.S. Forest Service) operates a rope saw to cut a branch from a blue ash tree at Sharon Woods MetroPark.

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Figure 11.—Rope saw with custom attachment loops and 440 lb (200 kg) paracord.

Because some ash trees have flexible limbs, it is necessary to cut larger branches on these trees. One or two people can operate the saw (one as in Fig. 10, or two people on opposite sides of the branch). Standing to the side so the rope is at an angle (as in Fig. 10) allows the operator to cut the top, opposite side, and bottom of the branch, which may prevent bark tearing and branch hangups. Steeply angled branches should be avoided because the saw will slide down the branch. Sharp crotches should also be avoided because the saw or knots can become stuck in them.

Several different saws, varying in number of teeth, thickness, and other features, are available from different manufacturers. In our experience, the Pocket Chainsaw® manufactured by Supreme Products cuts quickly and readily orients with the cutting teeth toward the branch. We created larger attachment loops using 12 gauge high tensile wire and connectors (Fig. 11). The use of two different colors of brightly colored rope, one for each side of the saw, increases visibility of the line and saw position.

Safety is important for all methods of ash seed collection. A rope saw should never be used to collect seeds from branches near power lines due to the risk of electrocution. Cut branches may fall directly toward the operator. Pulling hard on a stuck saw may cause it to quickly fly toward

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Figure 12.—Voucher specimen of white ash.

the operator. Communication between the operator and the rest of the crew is important. Everyone on the crew should wear hard hats and eye protection and watch out for falling equipment and branches.

POST-HARVEST SEED HANDLING

Proper handling of the seeds after harvest is important to preserve the identity, viability and vigor of the seeds. Each collection must be properly documented by recording the location of the mother tree, species, collection date, and name of the seed collector(s). Additionally, a voucher specimen should be taken from each tree and pressed (Fig. 12). Ash species readily hybridize, and vouchers are important tools for verifying species identity. Ideally, the voucher specimen should consist of an older portion of the twig with leaf scars, a new twig with the terminal bud, a leaf, and a full cluster of samaras. A photo of the bark and a photo of the whole tree or the stand in which it was found are also helpful for species verification. Leaf and full fruit clusters may be difficult to obtain late in the collection season as leaves fall and seeds disperse.

Seeds should be placed in paper bags and, ideally, kept separate by mother tree. Keeping the seeds separate by mother tree provides more options for using the seeds in the future and gives the opportunity to verify species identity at a later time. If possible, separate collections by mother tree should be made because these are of greater value in breeding work and genetic studies and will greatly facilitate restoration work. In extreme circumstances, such as low seed yields, loss of seeds, and loss of documentation, it may be necessary to bulk seed collections by stand, but this is not the preferred option. Seeds should not be exposed to high temperatures, e.g., leaving them in a hot car in the sun, because this can reduce the viability of the seeds. Seeds should be kept in paper bags at room temperature until shipped to a seed storage facility along with documentation, vouchers, and photos, as soon as possible after collection.

After ash seeds are received at the National Seed Lab, protocols are followed to eliminate weevils and damaged or unfilled seeds and to prepare the seeds for long-term storage. Weevils (*Thysanocnemis bischoffi*, *T. helvola*, and *T. horridulus*) attack ash seeds (Barger and Davidson 1967, Solomon et al. 1993) and the larvae are usually in the seeds at harvest. If seeds are immediately dried following harvest, weevils will die and permanently remain in the seeds. Keeping the seeds below 21°C (70°F) after collection without drying and then placing them in a cold room at about 3°C for 2 to 4 weeks will cause the weevil larvae to leave the seeds in an attempt to go into the earth to pupate (Karrfalt, personal observation). After weevils are eliminated, the infested seeds are much lighter and can subsequently be more easily removed from the seed lot with a seed aspirator to improve the germination percentage. Next, the seeds should be equilibrated at about 30 percent relative humidity, rubbed free from the stems, aspirated, sealed in a moisture-proof container such as a heavy 6-mil poly bag to maintain low moisture content, and frozen at or below -8 °C (18 °F). It is expected that the ash seeds will remain viable for at least several decades for use in future research, breeding, or restoration work.

RESOURCES

Other resources are available from the National Seed Lab ash seed collection Web site: www.nsl.fs.fed.us/GeneticConservation_Ash.html.

- The rope technique for ash seed collection in natural areas – video by Kathleen Knight
- National Seed Lab protocol for ash seed collection – Powerpoint and Webinar by Robert Karrfalt

To participate in the U.S. Forest Service ash seed collection effort, contact:
Robert P. Karrfalt - Director, National Seed Laboratory
rkarrfalt@fs.fed.us 478-751-4134

LITERATURE CITED

Barger, J.H.; Davidson, R.H. 1967. **A life history of the ash seed weevils, *Thysanocnemis bischoffi* Blatchley and *T. helvola* Leconte.** Ohio Journal of Science. 67(2): 123-127.

Bonner, F.T.; Karrfalt, R.P., eds. 2008. **The woody plant seed manual.** Agric. Handbk. No. 727. Washington, DC: U.S. Department of Agriculture, Forest Service. 1,223 p. (http://www.nsl.fs.fed.us)

Cappaert, D.; McCullough, D.G.; Poland, T.M.; Siegert, N.W. 2005. **Emerald ash borer in North America: a research and regulatory challenge.** American Entomologist. 51(3): 152-165.

[EABInfo] Emerald Ash Borer Information. 2009. **Emerald ash borer information.** (http://www.emeraldashborer.info/index.cfm)

Solomon, J.D.; Leininger, T.D.; Wilson, A.D.; Anderson, R.L.; Thompson, L.C.; McCracken, F.I. 1993. **Ash pests: a guide to major insects, diseases, air pollution injury, and chemical injury.** Gen. Tech. Rep. SO-96. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 45 p.

U.S. Department of Agriculture. Natural Resources Conservation Service. 2009. **The PLANTS Database** (http://plants.usda.gov) (12 August 2009). National Plant Data Center, Baton Rouge.

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KEY WORDS: *Fraxinus*, ash, seed, samara, collection

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