



Appalachian Plant Materials Center

Alderson, West Virginia

2011-2012

Technical Report



Study Number(s): WVPMC-T-1101-CP

Study Title(s): Soil Health/Quality Study

Introduction:

Soil quality, also referred to as soil health, is defined as how well soil does what we want it to do. Healthy soil gives us clean air and water, bountiful crops and forests, productive grazing lands, diverse wildlife, and beautiful landscapes. The basic principles used to improve soil quality include: cessation of tillage, maximization of soil organic matter, residue and live roots, and maximization of plant diversity through crop rotations, winter and summer cover/green manure crops.

Objective(s):

The objective of this study is to quantify and document changes (improvements) to soil health/quality parameters resulting from application of crop rotations, winter and summer cover crops, and select soil amendments; e.g. calcium, magnesium, phosphorus, potassium, and nitrogen.

Discussion:

This project was initiated in 2011 and is expected to continue for at least 10 years. A project methodology summary is presented in Appendix 1 of this Report.

Study Number(s): WVPMC-T-1102-CP

Study Title(s): Optimum Cover Crop Roll Down Date Study

Introduction:

There is increasing interest in and use of non-chemical means of terminating cover crop stands to prepare for the succeeding crop. Much attention has been focused upon use of the Rodale style of roller crimper, yet little or no information is available regarding proper timing of the rolling and crimping operation in order to maximize termination of the cover crop, especially within the PMC area of service. Many times, the rolling operation must be followed with a herbicide application to ensure adequate cover crop termination.

Objective(s):

The objective of this study is to establish dates whereby efficacy of mechanical termination of cover crops is maximized, thus reducing dependence on chemical control methods.

Discussion:

This study was initiated in September of 2012 with the planting of plots of cover crop species commonly used throughout the PMC service area. Seeding rates were based upon recommendations provided in the West Virginia Cover Crop Standard and Specification (340). Roll down began in the Spring of 2013. Onset of cereal rye anthesis determined the initial roll down date. A portion of each cover crop plot was rolled at weekly intervals following the initial roll down date and roll down efficacy was visually determined at one week after each roll down date. This study is to be repeated for at least three years, and the technology developed will be transferred to NRCS field staff through updates to the Cover Crop Standard and Specification, Technology Notes, and field days.

Study Number(s): WVPMC-T-1001-WL

Study Title(s): USFS-Monongahela National Forest High Elevation Plant Propagation Reimbursable Study

Introduction:

The USFS-Monongahela National forest has a need to propagate native species for use in ecological restoration projects, especially in conjunction with the Central Appalachian Red Spruce Restoration Initiative (CARSI). The USFS focus is to develop propagation techniques for native plants that are most beneficial to high interest game species, especially ruffed grouse, snowshoe hare, and woodcock. Emphasizing restoration of natural communities will reduce future maintenance costs and increase the probability of success, while improving hunting opportunities.

Objective(s):

The objective of this study is to propagate and conduct seed trials on at least 10 native species to determine which native species would be best suited for future propagation by commercial nurseries.

Discussion:

Since the inception of this project, the PMC has collected plant materials from some 40 native species within the confines of the Monongahela National Forest. During 2011 and 2012 the PMC worked extensively with perfecting propagation techniques for several of these species, including: big-toothed aspen, quaking aspen, red and black elderberry, and black cherry. The technology developed from working with these native species will be transferred to NRCS field staff, project partners and the public primarily through publication of Plant Propagation Protocols. Technology products developed in 2011 and 2012 are presented in Appendix 3 of this report.

Study Number(s): WVPMC-T-0201-0T

Study Title(s): Stones River National Battlefield Reimbursable Agreement

Introduction:

Stones River National Battlefield has a need to preserve native plant resources and revegetate parklands with germplasm from within park boundaries where possible to maintain the genetic resources within the park. The NPS does not have the personnel, expertise, or equipment needed to propagate quantities of the required seed and plants. The NRCS has the personnel and is equipped to propagate and clean quantities of seed sufficient to meet the NPS needs within the required time frame and conduct evaluations on plant species to determine adaptation and cultural requirements for establishment.

Objective(s):

The objective of this study is to produce transplants of local ecotype native plants for use in landscape restoration within the confines of the battlefield, while developing technology products, e.g. propagation protocols, plant guides, etc., for these native species. Information on the culture of most of the native plants in this study is nonexistent.

Discussion:

To date, the Appalachian PMC has conducted evaluations of approximately 35-40 native plant species for the NPS, and has propagated and delivered several thousand plants for use in landscape restoration within Stones River National Battlefield. Several technology products, e.g. plant propagation protocols, have been developed from this study, and several additional technology products are in process. Technology products for this project developed in 2011-2012 are presented in Appendix 2 of this Report.

Study Number: WVPMC-T-0104-OT

Study Title: US Army Corps. of Engineers Ecosystem Restoration Reimbursable Project

Introduction:

The Marmet Locks and Dam are located in Kanawha County, WV, on the Kanawha River a short distance upstream of Charleston, WV. The Marmet Locks and Dam Project includes building a new lock and approach channel located on the river right side to accommodate larger tows. The USACE, as a part of their site mitigation plan, wishes to preserve local plant ecotypes for re-establishment on the site upon completion of construction. The local ecotypes of interest are not available commercially.

Objective:

The objective of this project is to assemble or propagate and maintain specific numbers of local ecotypes of six woody species for use by the USACE at their Marmet construction site.

Discussion:

This project was initiated during 2001. Seedling plants of *Acer saccharinum* - silver maple, *Lindera benzoin* – spicebush, *Sambucus canadensis* – elderberry, *Asimina triloba* – pawpaw, and *Sassafras albidum* sassafras were lifted from the construction site during the spring and early summer. These plants were placed into pots and transported to the Alderson PMC. These plants are being maintained in shade structures at the PMC until completion of construction. Seed of *Acer saccharinum*, *Lindera benzoin*, *Asimina triloba*, and *Aesculus octandra* –yellow buckeye were also harvested from the site during 2001. These seeds were used to produce seedlings at the PMC to assist with fulfillment of the agreement with the USACE. It is important to note that all plants produced under this agreement are for the exclusive use by the USACE at the Marmet construction site. However, one or more of these species may be made available to the public by the Alderson PMC in the future as source identified releases in conjunction with the USACE. Reintroduction of plants to the site was begun in 2007, but was not completed until 2009 because of extensive construction delays. Plant performance on this highly disturbed site will be monitored for at least 5 years. Potential technology products resulting from this project include: propagation protocols, plant guides, journal articles, and technology notes pertaining to post construction establishment and management of native woody species. Technology products for this project are presented in Appendix 3 of this Report.

Study Number: WVPMC-T-0902-CP

Study Title:

Transition to Organic Production Cover Crop Trial and Field Corn Nitrogen Response to Rolled Cover Crop Mulches

Introduction:

Transition to organic production requires cessation of chemical herbicides for cover crop and weed suppression. The purpose of this study is to refine and transfer organic crop management techniques to the organic farming community.

Objective(s):

To evaluate the effectiveness of several cereal grains and annual legumes as soil cover in cropland.

To evaluate the effectiveness of delivery of nitrogen from the annual legume component of the cover crop to the succeeding crop.

To evaluate the effectiveness of a mechanical roller crimper as a non-herbicide means of achieving cover crop suppression.

Discussion:

This study was initiated in 2009 and will be repeated for at least 3 years. This project was terminated in 2012. Data gathered is being analyzed by the West Virginia University Cooperative Extension Service, with the objective transferring the technology developed to NRCS field staff and the general public circa 2013.

APPENDIX 2.

Treatment Summary for Soil Quality/Soil Health Study

SOIL QUALITY STUDY

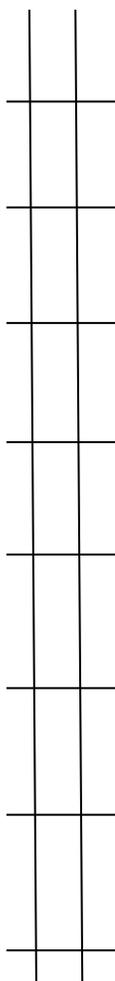
PLOT MAP AND TREATMENT RANDOMIZATION



Appalachian PMC Field 4

Plot Number = Arabic Numerals

Treatment Number = Roman Numerals



1	2	3	4
II	III	II	IV
5	6	7	8
III	V	V	I
9	10	11	12
IV	I	IV	III
13	14	15	16
V	IV	I	V
17	18	19	20
I	II	III	II

Treatment I – Control.

Treatment II – Balance soil for cations on Base Saturation of CEC as follows:

Calcium (Ca) – 78%

Magnesium (Mg) – 13 % (Approximate Ratio of 6 Ca: 1 MG)

Potassium (K) – 5 %

Hydrogen (H) – 4 %

**** Soil cations corrected by local sources of material. pH may approach or exceed 7.3**

Treatment III – Balance soil for cations on Base Saturation of CEC as follows:

Calcium (Ca) – 85 %

Magnesium (Mg) – 12 % (Approximate Ratio of 7 Ca: 1 MG)

Potassium (K) – 2 %

Hydrogen (H) – 1 %

**** Soil cations corrected by local sources of material. pH may approach or exceed 7.3**

Treatment IV - Balance soil for cations on Base Saturation of CEC as follows:

Calcium (Ca) – 78 %

Magnesium (Mg) – 13 % (Approximate Ratio of 6 Ca: 1 MG)

Potassium (K) – 5 %

Hydrogen (H) – 4 %

*** Soil cations corrected by source of material that will not increase pH above 6.8**

Treatment V - Balance soil for cations on Base Saturation of CEC as follows:

Calcium (Ca) – 85 %

Magnesium (Mg) – 12 % (Approximate Ratio of 7 Ca: 1 MG)

Potassium (K) – 2 %

Hydrogen (H) – 1 %

*** Soil cations corrected by source of material that will not increase pH above 6.8**

APPENDIX 2.

Stones River National Battlefield Technology Products

Protocol Information

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Family Scientific Name: **Lamiaceae**

Family Common Name: **mint**

Scientific Name: ***Monarda clinopodia* L.**

Common Name: **white bergamot**

Species Code: **MOCL**

Ecotype: **Monongahela National Forest**

General Distribution: **White bergamot is widely distributed throughout eastern North America from Vermont south to Georgia and Alabama and west to Missouri.**

Known Invasiveness: **none**

Propagation Goal: **Plants**

Propagation Method: **Seed**

Product Type: **Container (plug)**

Stock Type: **1+0 container plug**

Time To Grow: **6 Months**

Target Specifications: **A well developed plant suitable for mechanical transplanting that has at least 6 inches of top growth and a dense, fibrous root system.**

Propagule Collection: **Seed of Monongahela National Forest**

ecotype white bergamot was hand harvested from existing populations within the West Virginia confines of the Monongahela National Forest.

Pre-Planting Treatments: Seed is planted into round cell greenhouse flat liners with 38 cells per flat that have been filled with coarse processed bark and composted pine bark growing medium. Seed is surface sown at a rate of 3-5 seeds per cell and lightly covered with starter sized, 1/16" - 1/8" diameter, granite poultry grit to combat damping off diseases. Prepared flats are lightly hand watered to slightly moisten the growing medium and cold stratified at 35 degrees Fahrenheit for a minimum of 21 days.

**Growing Area Preparation/
Annual Practices for Perennial Crops: Stratified seed is placed in a greenhouse maintained under natural lighting and at a minimum temperature of 70 degrees Fahrenheit. Soil moisture is maintained during germination by an automatic overhead watering system set to cycle for 20 seconds every thirty minutes during daylight hours.**

Establishment Phase: Germination typically occurs 7 - 10 days after placement in the greenhouse.

Length of Establishment Phase: 7-10 days

Active Growth Phase: After germination, seedlings are maintained in a greenhouse environment 2-4 months to promote development of a plug with at least 6 inches of top growth and a dense, fibrous root system suitable for mechanical transplanting. Watering is reduced to overhead hand watering once daily. seedlings receive a water soluble complete fertilizer bi-weekly until hardening.

Length of Active Growth Phase: 2-4 months

Hardening Phase: Acclimation is typically accomplished through placement of seedlings outdoors in a protected location for a 1-2 week period prior to transplanting.

Length of Hardening Phase: 1-2 weeks

Outplanting performance on typical sites: To re-establish white bergamot into natural

landscapes, plugs are randomly hand transplanted into an unprepared (untilled) seedbed.

References: **USDA, NRCS. 2013. The PLANTS Database (<http://plants.usda.gov>, 21 March 2013). National Plant Data Team, Greensboro, NC 27401-4901 USA.**

Citation:

Vandevender, John 2013. Propagation protocol for production of container *Monarda clinopodia* L. plants (1+0 container plug); USDA NRCS - Appalachian Plant Materials Center, Alderson, West Virginia. In: Native Plant Network. URL: <http://www.nativeplantnetwork.org> (accessed 21 March 2013). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.

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Plant Materials Program

Family Scientific Name: **Fagaceae**
Family Common Name: **Beech**
Scientific Name: *Quercus stellata* Wangenh.
Common Name: **post oak**
Species Code: **QUST**
Ecotype: **Stones river source**
General Distribution: **Post oak is found throughout the eastern two-thirds of the continental United States with the exception of the New England states of Vermont, New Hampshire, and Maine and the North Central states of Wisconsin, Minnesota, North Dakota and South Dakota.**
Known Invasiveness: **None**
Propagation Goal: **Plants**
Propagation Method: **Seed**
Product Type: **Bare root (field grown)**
Stock Type: **1-0**
Time To Grow: **2 Years**
Target Specifications: **A second spring seedling ranging in height from 8" to 16" with a 1/16" to 3/16" caliper stem and a compact, well developed tap root system.**
Propagule Collection: **Seeds are collected from established natural stands within the confines of Stones River National Battlefield in the fall immediately after the acorns have matured and begun to fall from the tree.**

Propagule Processing: **Post oak reproduces readily from seed. Seed has no physiological dormancy and should be sown immediately upon harvest for best results. Fall sown seed typically exhibits >90% germination, while seeds stored overwinter exhibit greatly reduced germination; typically <50%.**

Pre-Planting Treatments: **Seed may be floated in water to help determine viability. Seed that floats is normally poorly filled and has low or no viability. Floaters are discarded, while the seed that sinks is retained for planting.**

Growing Area Preparation/
Annual Practices for Perennial Crops: **Best germination and growth of seedlings is in raised beds or sandy soil with adequate moisture. Prepare beds by deep rototilling or other tillage methods that achieve thorough loosening and mixing of soil. Seed are placed into 3/4" to 1" deep furrows scribed into the tilled soil. Furrows are spaced 2" apart and seed are placed 1" apart within furrows to optimize seedling development. Seed are covered with soil to a depth equal to 1 and 1/2 times the average diameter of the seed; usually 3/4" to 1" of soil. Beds should then be covered with a 2 - 3 inch thick layer of straw to insulate against frost heaving. When seedlings begin to emerge, one-half of the straw should be removed.**

Establishment Phase: **A radicle is produced in the fall soon after planting. Top growth is initiated the following spring.**

Length of Establishment Phase: **4-6 months which includes the overwintering period.**

Active Growth Phase: **Plants require little maintenance during active growth other than application of at least 1 inch of water per week during drought conditions and elimination of weed competition. Weeds must be removed during early growth phases to avoid uprooting the chinquapin oak seedlings.**

Length of Active Growth Phase: **6-8 months**

Hardening Phase: **Since the plants are grown outside, no additional hardening is required.**

Length of Hardening Phase: **None**

Harvesting, Storage and Shipping: **Seedlings are harvested in late winter while dormant. The best harvesting method employs a nursery bed lifter/shaker which undercuts the seedlings and gently loosens the soil around the roots. Bare root seedlings are then plucked from the loosened soil by hand. Refrigeration is employed to maintain seedling dormancy after harvest until shipping. Optimal temperatures for maintenance of dormancy are 35-40 degrees Fahrenheit. Root desiccation during storage is prevented through packing in aged, moistened hardwood sawdust.**

Length of Storage: **1-2 months**

Outplanting performance on typical sites: **Best survival and growth of post oak is achieved by planting while the plants are dormant between the date of the first frost in the fall and the date of the last frost in the spring. Plantings for wildlife habitat improvement or forest restoration should be established at a ten foot spacing between plants and rows. Plantings for seed orchards or wildlife habitat improvement where seed production is a primary goal should be established at a spacing of fifteen to twenty feet. Dipping bare root plants in root gel before planting to retain moisture around the roots may enhance survival and growth. Applying a slow release fertilizer at planting will also enhance survival and early growth.**

References: **Bonner, F.T. and R. P. Karrfalt, 2008. The Woody Plants Seed Manual. USDA Forest Service. Agriculture Handbook 727.**

Dirr, Michael A.,1998. Manual of Woody Landscape Plants, 5th ed. Stipes Publishing, LLC. Champaign, IL.

USDA, NRCS. 2013. The PLANTS Database (<http://plants.usda.gov>, 30 August 2013). National Plant Data Team, Greensboro, NC 27401-4901 USA

Citation:

Vandevender, John 2013. Propagation protocol for production of field-grown *Quercus stellata* Wangenh. plants (1-0); USDA NRCS - Appalachian Plant Materials Center, Alderson, West Virginia. In: Native Plant Network. URL: <http://www.nativeplantnetwork.org> (accessed 13 September 2013). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.

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Plant Materials Program

Family Scientific Name: **Fagaceae**
Family Common Name: **Beech**
Scientific Name: *Quercus muehlenbergii* Engelm.
Common Name: **chinkapin oak**
Species Code: **QUMU**
Ecotype: **Stones River source**
General Distribution: **Chinquapin oak is common throughout the eastern two-thirds of the continental United States with the exception of the New England states of New Hampshire, and Maine and the North Central states of North Dakota and South Dakota.**
Known Invasiveness: **None**
Propagation Goal: **Plants**
Propagation Method: **Seed**
Product Type: **Bareroot (field grown)**
Stock Type: **1-0**
Time To Grow: **2 Years**
Target Specifications: **A second spring seedling ranging in height from 8" to 16" with a 1/16" to 3/16" caliper stem and a compact, well developed tap root system.**
Propagule Collection: **Seeds are collected from established natural stands within the confines of Stones River National Battlefield in the fall immediately after the acorns have matured and begun to fall from the tree.**

Propagule Processing: **Chinquapin oak reproduces readily from seed. Seed has no physiological dormancy and should be sown immediately upon harvest for best results. Fall sown seed typically exhibits >90% germination, while seeds stored overwinter exhibit greatly reduced germination; typically <50%.**

Pre-Planting Treatments: **Seed may be floated in water to help determine viability. Seed that floats is normally poorly filled and has low or no viability. Floaters are discarded, while the seed that sinks is retained for planting.**

Growing Area Preparation/
Annual Practices for Perennial Crops: **Best germination and growth of seedlings is in raised beds or sandy soil with adequate moisture. Prepare beds by deep rototilling or other tillage methods that achieve thorough loosening and mixing of soil. Seed are placed into 3/4" to 1" deep furrows scribed into the tilled soil. Furrows are spaced 2" apart and seed are placed 1" apart within furrows to optimize seedling development. Seed are covered with soil to a depth equal to 1 and 1/2 times the average diameter of the seed; usually 3/4" to 1" of soil. Beds should then be covered with a 2 - 3 inch thick layer of straw to insulate against frost heaving. When seedlings begin to emerge, one-half of the straw should be removed.**

Establishment Phase: **A radicle is produced in the fall soon after planting. Top growth is initiated the following spring.**

Length of Establishment Phase: **4-6 months which includes the overwintering period.**

Active Growth Phase: **Plants require little maintenance during active growth other than application of at least 1 inch of water per week during drought conditions and elimination of weed competition. Weeds must be removed during early growth phases to avoid uprooting the chinquapin oak seedlings.**

Length of Active Growth Phase: **6-8 months**

Hardening Phase: **Since the plants are grown outside, no additional hardening is required.**

Length of Hardening Phase: **None**

Harvesting, Storage and Shipping: **Seedlings are harvested in late winter while dormant. The best harvesting method employs a nursery bed lifter/shaker which undercuts the seedlings and gently loosens the soil around the roots. Bare root seedlings are then plucked from the loosened soil by hand. Refrigeration is employed to maintain seedling dormancy after harvest until shipping. Optimal temperatures for maintenance of dormancy are 35-40 degrees Fahrenheit. Root desiccation during storage is prevented through packing in aged, moistened hardwood sawdust.**

Length of Storage: **1-2 months**

Outplanting performance on typical sites: **Best survival and growth of chinquapin oak is achieved by planting while the plants are dormant between the date of the first frost in the fall and the date of the last frost in the spring. Plantings for wildlife habitat improvement or forest restoration should be established at a ten foot spacing between plants and rows. Plantings for seed orchards or wildlife habitat improvement where seed production is a primary goal should be established at a spacing of fifteen to twenty feet. Dipping bare root plants in root gel before planting to retain moisture around the roots may enhance survival and growth. Applying a slow release fertilizer at planting will also enhance survival and early growth.**

References: **Bonner, F.T. and R. P. Karrfalt, 2008. The Woody Plants Seed Manual. USDA Forest Service. Agriculture Handbook 727.**

Dirr, Michael A.,1998. Manual of Woody Landscape Plants, 5th ed. Stipes Publishing, LLC. Champaign, IL.

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Citation:

Vandevender, John 2013. Propagation protocol for production of field-grown *Quercus muehlenbergii* Engelm. plants (1-0); USDA NRCS - Appalachian Plant Materials Center, Alderson, West Virginia. In: Native Plant Network. URL: <http://www.nativeplantnetwork.org> (accessed 13 September 2013). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.

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Family Scientific Name: **Fagaceae**
Family Common Name: **Beech**
Scientific Name: *Quercus shumardii* Buckley
Common Name: **Shumard's oak**
Species Code: **QUSH**
Ecotype: **Stones River source**
General Distribution: **Shumard''s oak is found throughout the eastern two-thirds of the continental United States with the exception of the New England states, Delaware, New Jersey and the North Central states of North Dakota, South Dakota, Minnesota, Wisconsin, and Nebraska.**
Known Invasiveness: **None**
Propagation Goal: **Plants**
Propagation Method: **Seed**
Product Type: **Bareroot (field grown)**
Stock Type: **1-0**
Time To Grow: **2 Years**
Target Specifications: **A second spring seedling ranging in height from 8'' to 16'' with a 1/16'' to 3/16'' caliper stem and a compact, well developed tap root system.**

Propagule Collection: **Seeds are collected from established natural stands within the confines of Stones River National Battlefield in the fall immediately after the acorns have matured and begun to fall from the tree.**

Propagule Processing: **Shumard's oak reproduces readily from seed. Seed has no physiological dormancy and should be sown immediately upon harvest for best results. Fall sown seed typically exhibits >90% germination, while seeds stored overwinter exhibit greatly reduced germination; typically <50%.**

Pre-Planting Treatments: **Seed may be floated in water to help determine viability. Seed that floats is normally poorly filled and has low or no viability. Floaters are discarded, while the seed that sinks is retained for planting.**

Growing Area Preparation/
Annual Practices for Perennial Crops: **Best germination and growth of seedlings is in raised beds or sandy soil with adequate moisture. Prepare beds by deep rototilling or other tillage methods that achieve thorough loosening and mixing of soil. Seed are placed into 3/4" to 1" deep furrows scribed into the tilled soil. Furrows are spaced 2" apart and seed are placed 1" apart within furrows to optimize seedling development. Seed are covered with soil to a depth equal to 1 and 1/2 times the average diameter of the seed; usually 3/4" to 1" of soil. Beds should then be covered with a 2 - 3 inch thick layer of straw to insulate against frost heaving. When seedlings begin to emerge, one-half of the straw should be removed.**

Establishment Phase: **A radicle is produced in the fall soon after planting. Top growth is initiated the following spring.**

Length of Establishment Phase: **6-8 months**

Active Growth Phase: **Plants require little maintenance during active growth other than application of at least 1 inch of water per week during drought conditions and elimination of weed competition. Weeds must be removed during early growth phases to avoid uprooting the**

Shumard's oak seedlings.

Length of Active Growth Phase: **6-8 months**

Hardening Phase: **Since the plants are grown outside, no additional hardening is required.**

Length of Hardening Phase: **None**

Harvesting, Storage and Shipping: **Seedlings are harvested in late winter while dormant. The best harvesting method employs a nursery bed lifter/shaker which undercuts the seedlings and gently loosens the soil around the roots. Bare root seedlings are then plucked from the loosened soil by hand. Refrigeration is employed to maintain seedling dormancy after harvest until shipping. Optimal temperatures for maintenance of dormancy are 35-40 degrees Fahrenheit. Root dessication during storage is prevented through packing in aged, moistened hardwood sawdust.**

Length of Storage: **1-2 months**

Outplanting performance on typical sites: **Best survival and growth of Shumard's oak is achieved by planting while the plants are dormant between the date of the first frost in the fall and the date of the last frost in the spring. Plantings for wildlife habitat improvement or forest restoration should be established at a ten foot spacing between plants and rows. Plantings for seed orchards or wildlife habitat improvement where seed production is a primary goal should be established at a spacing of fifteen to twenty feet. Dipping bareroot plants in root gel before planting to retain moisture around the roots may enhance survival and growth. Applying a slow release fertilizer at planting will also enhance survival and early growth.**

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USDA, NRCS. 2013. The PLANTS Database (<http://plants.usda.gov>, 30 August 2013).

**National Plant Data Team, Greensboro, NC
27401-4901 USA**

Citation:

Vandevender, John 2013. Propagation protocol for production of field-grown *Quercus shumardii* Buckley plants (1-0); USDA NRCS - Appalachian Plant Materials Center, Alderson, West Virginia. In: Native Plant Network. URL: <http://www.nativeplantnetwork.org> (accessed 13 September 2013). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.

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Plant Materials Program

Family Scientific Name: **Fabaceae**

Family Common Name: **Pea family**

Scientific Name: *Cercis canadensis* L.

Common Name: **eastern redbud**

Species Code: **CECA4**

Ecotype: **Stones River source**

General Distribution: **Eastern redbud is common throughout the eastern two-thirds of the continental United States with the exception of the New England states of Vermont, New Hampshire, and Maine and the North Central states of Wisconsin, North Dakota, and South Dakota.**

Known Invasiveness: **None**

Propagation Goal: **Plants**

Propagation Method: **Seed**

Product Type: **Bareroot (field grown)**

Stock Type: **1-0**

Time To Grow: **2 Years**

Target Specifications: **A well-developed plant suitable for transplanting by hand with at least 8 inches of top growth and a healthy, dense root system.**

Propagule Collection: **Mature seed pods were harvested by hand from existing healthy stands of eastern redbud within the confines of Stones River National Battlefield near Murfreesboro, Tennessee. Seed pods can be collected in autumn after the pods have turned tan or brown.**

Propagule Processing: Collected seed pods are spread out and allowed sufficient time to completely air dry. Once air dried, seed is extracted from the pods by hand threshing. Seeds are separated from the chaff by screening and fanning. Nearly 100% seed purity can be obtained in cleaning the smooth redbud seeds.

Pre-Planting Treatments: Seeds are direct sown into prepared beds in the fall to achieve natural cold stratification. Seed may be mechanically scarified prior to planting in order to weaken the hard, water impermeable seed coat.

**Growing Area Preparation/
Annual Practices for Perennial Crops:** Slightly raised beds are prepared by deep plowing in a manner that throws the soil toward a central point, resulting in a n area roughly five feet in width and varying in length. The deep plowed area is then rototilled to break up large clumps and smooth the bed surface. The surface of the bed may require a final raking by hand to create a smooth, uniform surface for planting.

Establishment Phase: Seeds are sown by hand onto the surface of the prepared bed and pressed into the soil by deliberate foot traffic to ensure good seed to soil contact. Planted beds are covered with a light layer of straw to help prevent frost heaving overwinter. Mulched beds are then covered with heavy hardware cloth to anchor the straw mulch and to deter rodents from feeding on the seeds.

Length of Establishment Phase: 6 months

Active Growth Phase: Germination of redbud seed is epigeous; that is, the cotyledons are lifted above the soil surface by rapid growth of the stem below the cotyledons or seed leaves. Seedlings may achieve a height of 6 to 12 inches during the first growing season.

Length of Active Growth Phase: 6 -8 months

Hardening Phase: N/A

Length of Hardening Phase: N/A

Harvesting, Storage and Shipping: Seedlings are lifted with a mechanical bed lifter/shaker in late winter or early spring before the plants break dormancy. Plants are

stored at 35 degrees Fahrenheit in plastic garbage barrels until shipped to planting sites. Roots are covered with aged, moistened sawdust to prevent desiccation while in storage. Seedlings are typically bundled together in groups of 25 plants for shipment and the roots are covered with damp sphagnum moss to prevent desiccation during shipment.

Length of Storage: 4-6 weeks

References: **Bonner, F.T. and R. P. Karrfalt, 2008. The Woody Plants seed Manual. USDA Forest Service. Agriculture Handbook 727.**

Dirr, Michael A., 1998. Manual of Woody Landscape Plants, 5th ed. Stipes Publishing, LLC. Champaign, IL.

USDA, NRCS. 2013. The PLANTS Database (<http://plants.usda.gov>, 30 August 2013). National Plant Data Team, Greensboro, NC 27401-4901 USA

Citation:

Vandevender, John 2013. Propagation protocol for production of field-grown *Cercis canadensis* L. plants (1-0); USDA NRCS - Appalachian Plant Materials Center, Alderson, West Virginia. In: Native Plant Network. URL: <http://www.nativeplantnetwork.org> (accessed 13 September 2013). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.

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Family Scientific Name: **Oleaceae**
Family Common Name: **olive**
Scientific Name: ***Forestiera ligustrina* (Michx.) Poir.**
Common Name: **upland swampprivet**
Species Code: **FOLI**
Ecotype: **Stones River**
General Distribution: **Upland swampprivet is commonly found in lowland areas throughout Kentucky, Tennessee, and South Carolina south to Florida and westward to Louisiana and Texas.**
Known Invasiveness: **none**
Propagation Goal: **Plants**
Propagation Method: **Seed**
Product Type: **Container (plug)**
Stock Type: **1 gallon container stock**
Time To Grow: **1 Years**
Target Specifications: **A second spring seedling ranging in height from 6" to 12" and having a compact, well developed root system.**
Propagule Collection: **Mature fruit was hand harvested from populations of *Forestiera ligustrina* growing within the confines of Stones River National Battlefield.**
Propagule Processing: **The fleshy pericarp was separated from the seed by**

hand using a corrugated hard rubber rubbing board. Depulped seed was washed with tap water and allowed to air dry before being placed in cloth seed bags and stored in a temperature and humidity controlled environment.

Pre-Planting Treatments: Subjecting *Forestiera ligustrina* seeds to a 14 hour light period followed by an 8 hour period of darkness with a 12 hour period of 25 degrees Centigrade followed by 12 hours of 15 degrees Centigrade resulted in approximately 70 percent germination within 7 to 10 days. A moistened commercially available potting soil mix was used as germinating media.

Establishment Phase: Seedlings were removed from the germination media and transplanted into nursery trade 1 gallon pots filled with a commercial potting mix. Potted seedlings were maintained in a greenhouse environment maintained under natural lighting and at a minimum of 65 degrees Fahrenheit throughout the establishment phase.

Length of Establishment Phase: 1-2 months

Active Growth Phase: Established plants were moved to a structure which provided a minimum of 50 percent shade. Established plants required little maintenance other than provision of at least 1 inch of water per week and monthly fertilization with a water soluble general purpose fertilizer.

Length of Active Growth Phase: 2-6 months

Hardening Phase: Minimal hardening is required, since the plants were produced in a shade house under natural climatic conditions.

Length of Hardening Phase: 1-2 weeks

References: USDA, NRCS. 2013. The PLANTS Database (<http://plants.usda.gov>, 20 June 2013). National Plant Data Team, Greensboro, NC 27401-4901 USA.

Citation:

Vandevender, John 2013. Propagation protocol for production of container *Forestiera ligustrina* (Michx.) Poir. plants (1 gallon container stock); USDA NRCS - Appalachian Plant Materials Center, Alderson, West Virginia. In: Native Plant Network. URL: <http://www.nativeplantnetwork.org> (accessed 25 June 2013). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.

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Family Scientific Name: **Juglandaceae**
Family Common Name: **Walnut**
Scientific Name: *Juglans nigra* L.
Common Name: **Black walnut**
Species Code: **JUNI**
Ecotype: **Stones River National Battlefield**
General Distribution: **Widely distributed throughout the eastern
2/3 of the United States.**
Known Invasiveness: **None**
Propagation Goal: **Plants**
Propagation Method: **Seed**
Product Type: **Bareroot (field grown)**
Stock Type: **1+0 bareroot**
Time To Grow: **2 Years**
Target Specifications: **A well developed plant suitable for
transplanting by hand with at least 12" top
growth and a healthy tap root.**
Propagule Collection: **Seeds of the Stones River National
Battlefield ecotype black walnut are
harvested from existing populations within
the boundaries of the park.**
Propagule Processing: **Seeds are processed through a macerator to
remove the husks. This process is completed**

shortly after seed collection to prevent the husks from becoming too hard and difficult to remove. The unfilled seeds are then removed from the filled seeds using a water floatation method. The filled seeds sink to the bottom and the unfilled ones float on the top.

Pre-Planting Treatments: **Seeds are direct sown in the fall to allow for natural cold stratification.**

Growing Area Preparation/

Annual Practices for Perennial Crops: **Area for planting of the seeds is roto-tilled to a depth of 4 - 6 inches in long strips.**

Establishment Phase: **Seeds are hand sown directly onto the tilled soil surface with an approximate rate of 12 seeds per square foot. Seeds are pressed into the soil by walking on them to ensure good seed to soil contact. They are then covered with a 1 - 2 inch layer of soil. A layer of clean straw is placed on top of the soil surface to reduce heaving in the winter. Screens are placed over the beds to prevent predation by rodents.**

Length of Establishment Phase: **8 months**

Active Growth Phase: **Germination begins in the spring after the cold stratification period. A radicle is produced first and then the shoot emerges.**

Length of Active Growth Phase: **6 - 9 months**

Hardening Phase: **A hardening phase is not required.**

Length of Hardening Phase: **N/A**

Harvesting, Storage and Shipping: **Seedlings are lifted in early spring prior to breaking dormancy. The tap roots are often very long and the seedlings may be difficult to remove from the soil. Seedlings are placed in barrels with the roots covered with moist sawdust. Seedling are stored in a cooler at 34 degrees Fahrenheit until ready to be shipped in early spring. Seedlings are bundled together for shipment with moist sphagnum placed around the root systems to prevent drying out.**

Length of Storage: **1 - 2 weeks**

Outplanting performance on typical sites: **Because of the long tap roots, bareroot black walnut seedlings are difficult to transplant. It may be necessary to use an auger or**

shovel to prepare an adequate planting site. A 3 - 4 foot diameter area around the seedlings should be cleaned and maintained for the first 2 - 3 years to reduce competition and improve survivability. Black walnut prefers full sun locations.

References: **Bonner, F.T. & R.P. Karrfalt, 2008. The Woody Plants Seed Manual. USDA Forest Service. Agriculture Handbook 727.**

USDA, NRCS. 2012. The PLANTS Database (<http://plants.usda.gov>, 12 July 2012). National Plant Data Team, Greensboro, NC 27401-4901 USA.

Citation:

Lester, Randall K.; Vandevender, John C. 2012. Propagation protocol for production of field-grown *Juglans nigra* L. plants (1+0 bareroot); USDA NRCS - Appalachian Plant Materials Center, Alderson, West Virginia. In: Native Plant Network. URL: <http://www.nativeplantnetwork.org> (accessed 16 September 2013). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.

APPENDIX 3.

US Forest Service-Marlinton Ranger District Technology Products

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Family Scientific Name: **Rosaceae**
Family Common Name: **Rose family**
Scientific Name: *Prunus serotina*
Common Name: **Black cherry**
Species Code: **PRSE2**
Ecotype: **Monongahela National Forest**
General Distribution: **Widely distributed throughout the eastern
1/2 of the US.**
Known Invasiveness: **Not known to be invasive in the US.**
Propagation Goal: **Plants**
Propagation Method: **Seed**
Product Type: **Bareroot (field grown)**
Stock Type: **1+0**
Time To Grow: **2 Years**
Target Specifications: **A well developed plant suitable for
transplanting by hand with at least 12" top
growth and a healthy root system.**

Propagule Collection: **Mature fruit are harvested from existing healthy stands of black cherry within the boundaries of the Monongahela National Forest.**

Propagule Processing: **Fruit was harvested, placed in a container and allowed to ferment to facilitate the seed cleaning process. The fruit was rubbed on a screen with holes just large enough for the seed to pass through. A water floatation method was used to separate the seed from the pulp. The viable seed sinks to the bottom while the pulp and unfilled seed float to the top.**

Pre-Planting Treatments: **Seeds are direct sown in the fall to allow for natural cold stratification.**

Growing Area Preparation/
Annual Practices for Perennial Crops: **Area for planting of the seeds is roto-tilled to a depth of 4 - 6 inches in long strips.**

Establishment Phase: **Seeds are hand sewn directly onto the tilled soil surface with an approximate rate of 30 seeds per square foot. Seeds are pressed into the soil by walking on them to ensure good seed to soil contact. They are then covered with a 1/2 - 1 inch layer of soil. A layer of clean straw is placed on top of the soil surface to reduce heaving in the winter. Screens are placed over the beds to prevent predation by rodents.**

Length of Establishment Phase: **8 months**

Active Growth Phase: **Germination begins in the spring after the cold stratification period. A radicle is produced first and then the shoot emerges.**

Length of Active Growth Phase: **6 - 9 months**

Hardening Phase: **No hardening phase is required because the seedlings are being produce in a natural setting and are still dormant when lifted.**

Length of Hardening Phase: **N/A**

Harvesting, Storage and Shipping: **Seedlings are lifted in early spring prior to breaking dormancy. The tap roots are often very long and the seedlings may be difficult to remove from the soil. Seedlings are placed in barrels with the roots covered with moist sawdust. Seedling are stored in a**

cooler at 34 degrees Fahrenheit until ready to be shipped in early spring. Seedlings are bundled together for shipment with moist sphagnum placed around the root systems to prevent drying out.

Length of Storage: **1 - 4 weeks**

Outplanting performance on typical sites: **Black cherry is a shade-intolerant species so it does not do well under heavy canopy growing conditions. It typically performs well in forest openings, along fence rows, and old fields.**

Other Comments: **Care should be taken when selecting sites for outplanting of black cherry. The leaves, twigs, bark and seeds produce a cyanogenic glycoside which can be harmful or fatal to some livestock. The wilted leaves tend to have higher concentration of the toxin.**

References: **Bonner, F.T. & R.P. Karrfalt, 2008. The Woody Plants Seed Manual. USDA Forest Service. Agriculture Handbook 727.**

USDA, NRCS. 2012. The PLANTS Database (<http://plants.usda.gov>, 12 July 2012). National Plant Data Team, Greensboro, NC 27401-4901 USA.

Citation:

Lester, Randall K.; Vandevender, John C. 2012. Propagation protocol for production of field-grown *Prunus serotina* plants (1+0); USDA NRCS - Appalachian Plant Materials Center, Alderson, West Virginia. In: Native Plant Network. URL: <http://www.nativeplantnetwork.org> (accessed 3 January 2013). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.

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Plant Materials Program

Family Scientific Name: **Caprifoliaceae**
Family Common Name: **Black elderberry**
Scientific Name: *Sambucus nigra L. ssp. canadensis*
Species Code: **SANIC4**
General Distribution: **Widely distributed throughout most of the United States.**
Known Invasiveness: **None**
Propagation Goal: **Plants**
Propagation Method: **Seed**
Product Type: **Container (plug)**
Time To Grow: **2 Years**
Target Specifications: **A well developed plant suitable for transplanting with at least 12" of top growth and a healthy root system.**
Propagule Collection: **Seeds were collected from multiple existing populations within the boundaries of the Monongahela National Forest. The seeds should be mature when the drupe turns black.**
Propagule Processing: **Ripe fruit was collected in late August and placed in sealable plastic bags. The bags were placed in the cooler for 3 weeks to allow the fruit to ferment which aided in the separation of the seeds from the pulp. The fruit was mascerated by hand and placed on top of a series of screens (9, 1/12, 1/18).**

Water was then used to wash the seeds through the screens. The seeds were collected on the 1/18 screen and placed on kraft paper in a thin layer to air dry.

Pre-Planting Treatments: No pretreatment was used.

Growing Area Preparation/

Annual Practices for Perennial Crops: Pro-mix BX with biofungicide was moistened and placed in heavy plastic trays. The soil was compacted somewhat to prepare a firm seedbed.

Establishment Phase: Seed was spread evenly by hand on the soil surface and then covered with 1/8 to 1/4 inch of additional soil. The top layer was pressed down slightly to ensure good seed to soil contact. The trays were placed in the greenhouse for 2 months to allow for the warm, moist stratification period. The trays were then moved outside to the shadehouse for 5 months to allow for the cold stratification period. The trays were then moved back into the greenhouse and allowed to germinate.

Length of Establishment Phase: 9 months

Active Growth Phase: Germination began in the spring after the cold stratification period. Once the seedlings had sufficient root systems, they were transplanted into 1 gallon plastic pots filled with Metro-mix 510 growing medium.

Length of Active Growth Phase: 6 - 9 months

Hardening Phase: Plants were moved back into the shadehouse to allow for hardening off before shipping.

Length of Hardening Phase: 2 weeks

Harvesting, Storage and Shipping: Plants with sufficient top growth were loaded on trailers and shipped back to the Monongahela National Forest. Trailers were covered with tarps to prevent wind burn.

Length of Storage: 1 day

Outplanting performance on typical sites: Black elderberry prefers moist, loamy soils for optimum growth. This species can tolerate some shade but prefers sunny exposures.

References: **R.P. Karrfalt, 2008. The Woody Plants Seed Manual. USDA Forest Service. Agriculture Handbook 727.**

USDA, NRCS. 2012. The PLANTS Database (<http://plants.usda.gov>, 12 July 2012). National Plant Data Team, Greensboro, NC 27401-4901 USA.

Citation:

Lester, Randall K.; Vandevender, John C. 2013. Propagation protocol for production of container *Sambucus nigra L. ssp. canadensis* plants; USDA NRCS - Appalachian Plant Materials Center, Alderson, West Virginia. In: Native Plant Network. URL: <http://www.nativeplantnetwork.org> (accessed 19 September 2013). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.

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Plant Materials Program

-
- Family Scientific Name: **Caprifoliaceae**
Family Common Name: **Honeysuckle**
Scientific Name: *Sambucus racemosa*
Common Name: **Red elderberry**
Species Code: **SARA2**
General Distribution: **Widely distributed throughout 3/4 of the continental United States. This species is found primarily at high elevations in the Appalachian Mountains.**
Known Invasiveness: **None**
Propagation Goal: **Plants**
Propagation Method: **Seed**
Product Type: **Container (plug)**
Time To Grow: **2 Years**
Target Specifications: **A well developed plant suitable for transplanting with at least 12" of top growth and a healthy root system.**
Propagule Collection: **Seeds were collected from multiple existing populations within the boundaries of the Monongahela National Forest. The seeds should be mature when the drupe turns scarlet or red.**
Propagule Processing: **Ripe fruit was collected in late July and placed in sealable plastic bags. The bags were placed in the cooler for 3 weeks to allow the fruit to ferment which aided in the**

separation of the seeds from the pulp. The fruit was mascerated by hand and placed on top of a series of screens (9, 1/12, 1/18). Water was then used to wash the seeds through the screens. The seeds were collected on the 1/18 screen and placed on kraft paper in a thin layer to air dry.

Pre-Planting Treatments: **No pretreatment was used.**

Growing Area Preparation/
Annual Practices for Perennial Crops: **Pro-mix BX with biofungicide was moistened and placed in heavy plastic trays. The soil was compacted somewhat to prepare a firm seedbed.**

Establishment Phase: **Seed was spread evenly by hand on the soil surface and then covered with 1/8 to 1/4 inch of additional soil. The top layer was pressed down slightly to ensure good seed to soil contact. The trays were placed in the greenhouse for 2 months to allow for the warm, moist stratification period. The trays were then moved outside to the shadehouse for 5 months to allow for the cold stratification period. The trays were then moved back into the greenhouse and allowed to germinate.**

Length of Establishment Phase: **9 months**

Active Growth Phase: **Germination began in the spring after the cold stratification period. Once the seedlings had sufficient root systems, they were transplanted into 1 gallon plastic pots filled with Metro-mix 510 growing medium.**

Length of Active Growth Phase: **6 - 9 months**

Hardening Phase: **Plants were moved back into the shadehouse to allow for hardening off before shipping.**

Length of Hardening Phase: **2 weeks**

Harvesting, Storage and Shipping: **Plants with sufficient top growth were loaded on trailers and shipped back to the Monongahela National Forest. Trailers were covered with tarps to prevent wind burn.**

Length of Storage: **1 day**

Outplanting performance on typical sites: **Red elderberry prefers moist, loamy soils**

for optimum growth. This species can tolerate some shade but prefers sunny exposures.

References: **Bonner, F.T. & R.P. Karrfalt, 2008. The Woody Plants Seed Manual. USDA Forest Service. Agriculture Handbook 727.**

USDA, NRCS. 2012. The PLANTS Database (<http://plants.usda.gov>, 12 July 2012). National Plant Data Team, Greensboro, NC 27401-4901 USA.

Citation:

Lester, Randall K.; Vandevender, John C. 2013. Propagation protocol for production of container *Sambucus racemosa* plants; USDA NRCS - Appalachian Plant Materials Center, Alderson, West Virginia. In: Native Plant Network. URL: <http://www.nativeplantnetwork.org> (accessed 19 September 2013). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.

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Family Scientific Name: **Lamiaceae**
Family Common Name: **mint**
Scientific Name: *Monarda clinopodia* L.
Common Name: **white bergamot**
Species Code: **MOCL**
Ecotype: **Monongahela National Forest**
General Distribution: **White bergamot is widely distributed throughout eastern North America from Vermont south to Georgia and Alabama and west to Missouri.**
Known Invasiveness: **none**
Propagation Goal: **Plants**
Propagation Method: **Seed**
Product Type: **Container (plug)**
Stock Type: **1+0 container plug**
Time To Grow: **6 Months**
Target Specifications: **A well developed plant suitable for mechanical transplanting that has at least 6 inches of top growth and a dense, fibrous root system.**
Propagule Collection: **Seed of Monongahela National Forest ecotype white bergamot was hand harvested from existing populations within the West Virginia confines of the Monongahela National Forest.**
Pre-Planting Treatments: **Seed is planted into round cell greenhouse flat liners with 38 cells per flat that have been filled with coarse processed bark and composted pine bark growing medium. Seed**

is surface sown at a rate of 3-5 seeds per cell and lightly covered with starter sized, 1/16" - 1/8" diameter, granite poultry grit to combat damping off diseases. Prepared flats are lightly hand watered to slightly moisten the growing medium and cold stratified at 35 degrees Fahrenheit for a minimum of 21 days.

Growing Area Preparation/

Annual Practices for Perennial Crops: **Stratified seed is placed in a greenhouse maintained under natural lighting and at a minimum temperature of 70 degrees Fahrenheit. Soil moisture is maintained during germination by an automatic overhead watering system set to cycle for 20 seconds every thirty minutes during daylight hours.**

Establishment Phase: **Germination typically occurs 7 - 10 days after placement in the greenhouse.**

Length of Establishment Phase: **7-10 days**

Active Growth Phase: **After germination, seedlings are maintained in a greenhouse environment 2-4 months to promote development of a plug with at least 6 inches of top growth and a dense, fibrous root system suitable for mechanical transplanting. Watering is reduced to overhead hand watering once daily. seedlings receive a water soluble complete fertilizer bi-weekly until hardening.**

Length of Active Growth Phase: **2-4 months**

Hardening Phase: **Acclimation is typically accomplished through placement of seedlings outdoors in a protected location for a 1-2 week period prior to transplanting.**

Length of Hardening Phase: **1-2 weeks**

Outplanting performance on typical sites: **To re-establish white bergamot into natural landscapes, plugs are randomly hand transplanted into an unprepared (untilled) seedbed.**

References: **USDA, NRCS. 2013. The PLANTS Database (<http://plants.usda.gov>, 21 March 2013). National Plant Data Team, Greensboro, NC 27401-4901 USA.**

Citation:

Vandevender, John 2013. Propagation protocol for production of container *Monarda clinopodia* L. plants (1+0 container plug); USDA NRCS - Appalachian Plant Materials Center, Alderson, West Virginia. In: Native Plant Network. URL: <http://www.nativeplantnetwork.org> (accessed 23 September 2013). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.

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Family Scientific Name: **Lamiaceae**
Family Common Name: **mint**
Scientific Name: *Monarda didyma* L.
Common Name: **scarlet beebalm**
Species Code: **MODI**
Ecotype: **Monongahela National Forest**
General Distribution: **Scarlet beebalm is widely distributed throughout eastern North America from Quebec and Ontario in Canada south to Georgia and west to Missouri, Iowa and Minnesota. It is also found in Oregon and Washington.**
Known Invasiveness: **None**
Propagation Goal: **Plants**
Propagation Method: **Seed**
Product Type: **Container (plug)**
Stock Type: **1+0 container plug**
Time To Grow: **6 Months**
Target Specifications: **A well developed plant suitable for mechanical transplanting that has at least 6 inches of top growth and a dense, fibrous root system.**
Propagule Collection: **Seed of Monongahela National Forest ecotype scarlet beebalm was hand harvested from existing populations within the West Virginia confines of the Monongahela National Forest.**
Pre-Planting Treatments: **Seed is planted into round cell greenhouse flat liners with 38 cells per flat that have**

been filled with coarse processed bark and composted pine bark growing medium. Seed is surface sown at a rate of 3-5 seeds per cell and lightly covered with starter sized, 1/16" - 1/8" diameter, granite poultry grit to combat damping off diseases. Prepared flats are lightly hand watered to slightly moisten the growing medium and cold stratified at 35 degrees Fahrenheit for a minimum of 21 days.

Growing Area Preparation/
Annual Practices for Perennial Crops:

Stratified seed is placed in a greenhouse maintained under natural lighting and at a minimum temperature of 70 degrees Fahrenheit. Soil moisture is maintained during germination by an automatic overhead watering system set to cycle for 20 seconds every thirty minutes during daylight hours.

Establishment Phase: Germination typically occurs 7 - 10 days after placement in the greenhouse.

Length of Establishment Phase: 7-10 days

Active Growth Phase: After germination, seedlings are maintained in a greenhouse environment 2-4 months to promote development of a plug with at least 6 inches of top growth and a dense, fibrous root system suitable for mechanical transplanting. Watering is reduced to overhead hand watering once daily. seedlings receive a water soluble complete fertilizer bi-weekly until hardening.

Length of Active Growth Phase: 2-4 months

Hardening Phase: Acclimation is typically accomplished through placement of seedlings outdoors in a protected location for a 1-2 week period prior to transplanting.

Length of Hardening Phase: 1-2 weeks

Outplanting performance on typical sites: To re-establish scarlet beebalm into natural landscapes, plugs are randomly hand transplanted into an unprepared (untilled) seedbed.

References: USDA, NRCS. 2012. The PLANTS Database (<http://plants.usda.gov>, 10 July 2012). National Plant Data Team, Greensboro, NC

27401-4901 USA.

Citation:

Vandevender, John 2012. Propagation protocol for production of container *Monarda didyma* L. plants (1+0 container plug); USDA NRCS - Appalachian Plant Materials Center, Alderson, West Virginia. In: Native Plant Network. URL: <http://www.nativeplantnetwork.org> (accessed 23 September 2013). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.