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The Allelopathic Properties of Infested European Buckthorn Soil (*Rhamnus cathartica*) on Plant Germination Rates

Abstract:

Allelopathy is a plants ability to prevent competition for resources by inhibiting the germination and growth of other plants through biochemical reactions caused by the release of plant fruit, leaf, and root material (Boyd). European buckthorn (*Rhamnus cathartica)* has very invasive properties and out-competes native plants for nutrients, light, and moisture. The plant has become a major problem throughout the state of Minnesota due to the very large and dense even-aged thickets that it produces. European buckthorn is often described as having allelopathic properties, but there has been very little primary research supporting such claims.

An experiment was set up to test the allelopathic effects of European buckthorn infested soil on the germination rates of perennial ryegrass (*Lolium perenne*), radish (*Raphanus sativus*), and a legume species (*Fabaceae*). As predicted, there was no statistically significant difference in the germination rates of the infested European buckthorn soil compared to our controlled reps of native woodland soil mixture. This study can serve as a jumping off point for future studies being done on restoration efforts of buckthorn infested areas.

Introduction:

European buckthorn is an invasive plant that was introduced into the U.S. in the mid 1800's as a landscape/ornamental plant. Shortly after its introduction, it was found to be quite invasive in natural areas. Buckthorn is such a big problem due to its ability to out-compete native plants and its lack of "natural controls" like insects or disease that would help curb its population growth. The plant also holds onto its leaves very late into the season and produces a plethora of fruiting berries that are disbursed by birds. There has been an enormous amount of assumptions that European buckthorn might be allelopathic, which could explain why it is such a

great competitor. However, very little research has been done to support the claim that buckthorn is allelopathic.

Methods:

The buckthorn alleopathy experiment was set up in three reps. Three reps were chosen so that a statistical analysis would be possible. Each rep contained two flats. One flat was filled with buckthorn infested soil that was gathered from around the trunks of varying sized buckthorn plants in a very dense thicket/stand of buckthorn. The second flat was filled with a woodland soil mixture gathered from around native shrubs and trees. In each flat 50 seeds from each of three tested plants (radish, bean, and perennial ryegrass) were planted. These three tested plants were chosen for their fast germination rates, along with having a variety of different plant families represented in the experiment. The plants were grown up for two weeks in the greenhouse and periodically checked on to make sure the environmental conditions were the same for each of the flats, as well as, the germinated seedlings were counted 4 times throughout the two week period.

Results:

After the two weeks concluded a final counting of the germinated seedlings was done. After the seedlings were counted the results were put into Excel and an F-Test was done. The chart below was generated from Excel. The F-Test shows no significance between any of the reps, which concludes that there is no allelopathic effect from infested buckthorn soil.

Chart 1:

TRT	SEED TYPE	AVG. GERM	F-TEST
		14 d.	
woodland	bean	12.7	
buckthorn	bean	8.3	0.48 NS
woodland	p.rye	47	
buckthorn	p.rye	45	0.60 NS
woodland	radish	40	
buckthorn	radish	36.3	0.07 NS

Discussion:

After obtaining the results from the experiment, one can see that the data shows there are no allelopathic effects from the buckthorn infested soil. These results show that restoring areas that are heavily infested with buckthorn is possible. If the results showed that there were allelopathic effects in the buckthorn soil it would be a lot more difficult to restore areas that are infested with buckthorn. With that being said, we used the field guide to Native Plant Communities of Minnesota to classify the forest type of the arboretum grounds so that a list could be generated of the possible native shrub and forbs species that could be used to restore buckthorn areas. We classified the forest type on the arboretum grounds as a southern mesic oak-basswood forest. Then the attached list of 10 native forbs and 10 native shrubs was generated. This list includes the plant characteristics, growing conditions, seed propagation, and seed harvest. The results from this experiment and the native plant list that was created can be a great jumping off point for further studies on restoring buckthorn infested areas.

References:

Boyd, E. 2007. The Allelopathic Properties of Fruit and Leaf Extracts of the Invasive European Buckthorn (*Rhamnus cathartica*) and White Mulberry (*Morus alba*). Northwestern College.

Dirr, M. 2009. Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses. Stipes Publishing.

Minnesota Department of Natural Resources (2005). Field Guide to the Native Plant Communities of Minnesota: The Eastern Broadleaf Forest Province. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. MNDNR St. Paul, MN.

Common Name	Scientific Name	Plant Characteristics	Growing Conditions	Seed Propagation	Seed Harvest
Gray dogwood	*Cornus racemosa*	10-15’ in height and width	Very adaptable	Soak in sulfuric acid for 2 hours plus 120 days stratification at 41°F in sand	Harvest in late September to early October
American hazelnut	*Corylus americana*	8-10’ in height and spread is 2/3’s the height	Well-drained loamy soil, pH adaptable, full sun or light shade	3 months cold stratification or plant seed in the fall	Harvest as the seeds become loose in their husks
Nannyberry	*Viburnum lentago*	15-18’ in height and spread is variable	Very adaptable	150 to 270 days at 68 to 86°F followed by 60 to 120 days at 41°F	Harvest the seeds in late September to early October
Chokecherry	*Prunus virginiana*	Can grow to 20-30’ in height and 18-25’ in spread	Dry-soil tolerance, shade tolerant, needs full sun though to produce a good fruit crop	Remove pulp by soaking in water and place in cold stratification for 3-4 months at 36-41°F	Late August to September
Pagoda dogwood	*Cornus alternifolia*	15-25’ in height and 1 ½ times that in spread	Moist, acidic, and well-drained soils, partial shade to full sun	Needs a variable period of warmth (2-5 months) followed by 2-3 months of cold	Collect and clean seeds in Fall, separate seed from pulp and plant immediately
Prickly gooseberry	*Ribes cynosbati*	2-4’ tall, have two types of	Partial sun, mesic to dry	Cold stratification at 41°F for 2-3	Harvest seeds in late June and extract

		thorns	conditions	months	seeds from ripened fruit and let dry for a couple of days
Red-berried elder	*Sambucus racemosa*	8-12’ tall	Fairly dry sites and full sun to part shade Intolerant to flooding	Seed requires 30-60 days warm and moist at 68°F and a 90-150 day cold period	Collect when fruit is scarlet in color in July and early August
Highbush cranberry	*Viburnum trilobum*	8-12’ in height and 8-12’ spread	Prefers well-drained moist soil, sun or partial shade	Require normal warm/cold routine	Harvest bright red drupe in early September through fall into February
Missouri gooseberry	*Ribes missouriense*	2-4’ tall	Partial sun, mesic to slightly dry conditions, and loamy or rocky soil	Cold stratification at 41°F for 2-3 months	Harvest seeds in late June
Red-osiered dogwood	*Cornus sericea*	7-9’ in height and spreading to 10’ or more	Very adaptable but does best in moist soil	Stratified for 60-90 days at 41°F	As soon as fruit begins to ripen from August to October

Sweet Joe-pye Weed	*Eupatorium purpureum*	4-7’ tall	Sun or light shade, average to moist soil	Keep in moist cold period for 30-42 days	Harvest in the fall
Jacob’s ladder	*Polemonium caeruleum*	18-24” erect plant	Full sun or partial shade in soil of average fertility and	Takes 3-4 weeks to germinate seed at 70°F	Late September and early October

			good drainage		
Solomon's seal	*Polygonatum biflorum*	2-3' tall plant and 2' wide	Shade and cool, moist soil	Sow seeds right after harvest in autumn and germination will occur in the spring	Harvest in the autumn when seeds have become ripened
Wild ginger	*Asarum europaeum*	6-10" spread	Shaded soil that is moist and rich in organic matter	Spread by rhizomes	Division in the spring or early fall
Columbine	*Aquilegia flabellata*	12-18" tall and 12" spread	Sun or partial shade in well-drained, moist soil	Put seeds in cold stratification for 2-3 months and then sow in the spring	Harvest when seed packets are dry and rattle
Baneberry	*Actaea pachypoda*	18-30" tall and 2-3' spread	Partial to full shade, moist	Period of cold stratification	Fall harvest, sow seed too
Jack-in –the-Pulpit	*Arisaema triphyllum*	1-2' tall and 12" wide	Moist wet site in partial shade	Remove pulp after harvest and stratify for 2 months in moist moss	Harvest seed when they turn red
Zigzag goldenrod	*Solidago flexicaulis*	1-3' in height	Well-drained soil, with full sun to medium shade	Seed requires a 2-3 month cold stratification period	Harvest seed in mid to late October
Dwarf Bush Honeysuckle's	*Diervilla lonicera*	3' tall	Dry mesic, dry	Seed requires a cold period of 2-3 months	Harvest in October

Arrow-leaved Aster	*Aster sagittifolius*	3’ tall	Full sun, mesic soil	Plant in the fall and seeds will germinate in the spring	Allow seeds to dry on plant, remove and collect seeds