United States Department of Agriculture

2018 Progress Report
NRCS Plant Materials Center, Corvallis, OR
November 2018

Kincaid's Lupine Transplant Study:

First Year Progress Report

Amy Bartow

Introduction

Kincaid's lupine (*Lupinus oreganus*) is federally listed threatened plant and is also a larval host of the endangered Fender's blue butterfly (*Icaricia icarioides fenderi*). Both species are threatened largely due to loss of oak savanna habitat in western Oregon through conversion to other land uses such as urban/suburban development and agriculture. Attempts to re-establish Kincaid's lupine plants into oak savannas have been mostly unsuccessful. Direct seeding has resulted in very low rates of plant establishment, with 2.1- 30% survival (Kaye and Brandt 2005). Nursery production of Kincaid's lupine has also been fraught with problems. Plants are difficult to propagate in a greenhouse. They are sensitive to high temperatures and pathogens such as botrytis and pithium. As a taprooted species, lupines do not create branched root systems that are needed to fill out nursery containers. This can create a high level of root disturbance at transplanting time, since most of the media will fall away from the narrow taproot when removed from the container. The Corvallis Plant Materials Center (PMC) staff have become proficient in growing high quality plugs for out-planting, however, transplant survival has still been low and unpredictable. Typical out-planting procedures use Ray Leach stubby "cone-tainers" (1.5-in diameter by 5.5-in length) that are transplanted out into sites in late March to mid-April. Typical survival rates are between 5-50% (Esterson 2018). Summer drought and weed competition are assumed to be major factors in transplant survival. If plants cannot get their roots down into the soil profile before the soil dries out, they will die. The highest survival rates (up to 80%!) have occurred in years when rain and cool weather extended into late June. And, conversely, lowest survival (1-5%) has occurred in years when May and June were excessively dry (Esterson 2018). Since spring weather is not predictable, earlier transplanting dates might be a way to overcome this issue because transplants would have more time to develop roots deeper in the soil. Also, using containers that facilitate rapidly growing, branched root systems should give transplants an advantage over the standard stubby cell cone-tainers. The purpose of this study was to evaluate the effects of two different container types and two planting dates on the survival of transplanted Kincaid's lupine at two recovery locations in the Willamette Valley of western Oregon.

Materials and Methods

Kincaid's lupine seeds from two local populations were provided to PMC staff by the Yamhill County Soil and Water Conservation District (SWCD) and US Fish and Wildlife Service (USFWS). Plants grown from Yamhill seeds were planted back at the Yamhill site and plants grown from the USFWS seed was planted at Baskett. We received 150 g of seed from the Yamhill County population and 135 g of seed

Amy Bartow, Seed and Plant Production Manager, USDA-NRCS Corvallis Plant Materials Center, 3415 NE Granger Ave, Corvallis OR 97330, amy.bartow@or.usda.gov

from the Baskett Slough National Wildlife Refuge population. Seeds were scarified prior to sowing using a lab-sized brush machine fitted with a sandpaper lined “scarifier drum”.

Figure 1. Comparison of containers used in this study. RootMakers (left) Hiko (center) and the standard Stubby conetainer (right).

Two different types of propagation containers were used in this study (new Figure 1—photo of containers). The small containers were RootMakers® 1.6 cu. in. (1 x 1 x 2-in cells). RootMakers are designed to create fibrous, non-circling root systems horizontally and vertically to equip plants for transplanting success. A fibrous root system means a greater root tip surface area and translates to a greater efficiency in the absorption of water and nutrients; an increase in growth rate, establishment, and vigor; and a higher transplant survivability. The larger containers used in the study were Hiko HV90AB 5.5 cu. in. (1.5 x 1.5 x 3.5-in cells). According to the Hiko catalog, “cells have vertical root training ribs and side slits. Side slits assure good aeration of the roots and create active root tips”.

Containers were filled with a sterilized peat-based media (Pro-Mix HP Biofungicide + Mycorrhizae) which is a high porosity mix that contains a higher percentage perlite than the standard Pro-Mix BX. All containers were placed in an unheated greenhouse (heat was set at 35°F to keep the plants from freezing). Daytime temperatures ranged from 50-65°F and nights ranged from 35-40°F. Seeds were sown directly into containers on November 24, 2018. Once the cotyledons emerged, they were fertilized with a very light rate (1 tsp per gallon) of a general purpose 20-20-20 water soluble fertilizer which contains micronutrients about once a week for several weeks. When the plants entered their active growth phase (after about 4 weeks of growth), 2 tsp per gallon was applied every 7-10 days until the plants were transplanted.

Planting Locations

Kincaid’s lupine plugs were transplanted at two locations in the Willamette Valley of western Oregon. At Baskett Slough National Wildlife Refuge, Polk County, Oregon, two sites were planted. Sites were chosen by refuge staff based on existing native cover and lack of competing vegetation. Sites are on a

southeast facing slope at 340 ft elevation. Soils are a Chehulpum complex, characterized by being shallow, well drained, and having a bedrock layer about 10-20 inches below the surface. Slopes vary from 12-40%.

*Figure 2. Kincaid's lupine (*Lupinus oreganus*) transplants grown in Hiko containers (left) and RootMaker containers (right). March 7, 2018.*

Site 1 at Baskett Slough had been sprayed with glyphosate four weeks prior to the early planting date to reduce competition with the existing plant community. At the PMC, staff have noticed that Roemer's fescue plants do not completely die when sprayed with glyphosate in the fall/winter. We expected the spray to stunt the Roemer's slightly, but kill most other plants growing in the plot. This would reduce competition around the lupine plants, but still leave some surviving fescue plants as cover. At planting time in early March, Site 1 had some yellowing Roemer's fescue clumps, but was mostly bare and mossy. This seemed to be an area with low plant cover prior to spraying. While transplanting, PMC staff noticed how shallow the soil was and decided to move the location of Site 2. Site 2 at Baskett Slough was supposed to be located next to Site 1 on top of a ridge where vegetation was thin, but PMC staff moved the plot down the ridge, closer to the depression between two ridges. Vegetation was thicker in this area, and it was evident while planting that the soil was deeper here. The early planting date for both Sites 1 and 2 at Baskett Slough was March 7th, 2018, and the late planting date (closer to typical Kincaid's lupine out-planting dates) was March 27th, 2018. RootMaker and Hiko plugs were planted in alternating rows of 18 plants on 1 by 1-ft spacing. Ten rows were planted in each block (total of 180 plants in each planting date block, 360 plants per Site, and 720 plants total planted at Baskett Slough).

At Mt Richmond (Yamhill County, Oregon), two sites were planted. Sites were chosen by PMC staff based on existing native cover, low weed composition, and lack of standing water in the winter. Sites are on a west facing slope at 400 ft elevation. Soils are a Witham silty clay loam complex, characterized by being deep, somewhat poorly drained, and having a clay layer about 11-20 inches below the surface. Slopes vary from 12-40%. Sites were not sprayed with herbicide prior to planting. Both sites had existing weedy and native vegetation. Early planting occurred on March 8, and late planting occurred on March 30, 2018 in blocks adjacent to each other. RootMakers and Hikos were planted in alternating rows of 40 plants. Eight rows were planted per block (320 plants per seeding date block, 640 plants per Site, and 1280 plants total planted at Mt Richmond). The late-planted RootMakers were rootbound, but the plants were not stunted. More plants were planted at Mt Richmond than Baskett Slough because we received more seed, which produced more plants.

In late June 2018, survival data were recorded at both locations. Individual plants were scored based on the following criteria:

- Alive + = plant is thriving and has put on significant growth since transplanting
- Alive = plant is alive
- Dead + = plant is near death (possibly summer senescence?)
- Dead = clearly dead

The experiment was treated as a completely randomized design with planting rows as replications. Survival results for each container type, planting date, and site were analyzed in Statistix 10 (Analytical Software, Tallahassee, FL) using the analysis of variance procedure (AOV). Mean separation was performed at α=0.05 by Tukey Honestly Significant Difference (HSD).

Results and Discussion

Weather

The spring of 2018 was much drier than usual in May for both planting locations (Figure 2). Average monthly rainfall totals are 2.8 and 2.2 inches for April and May, respectively. In 2018, rainfall totals in April were above average (5 in), but most of the rain fell during two big storms in the first half of the month, and there was very little precipitation in May (0.21 in). This started the summer drought about a month earlier than normal.

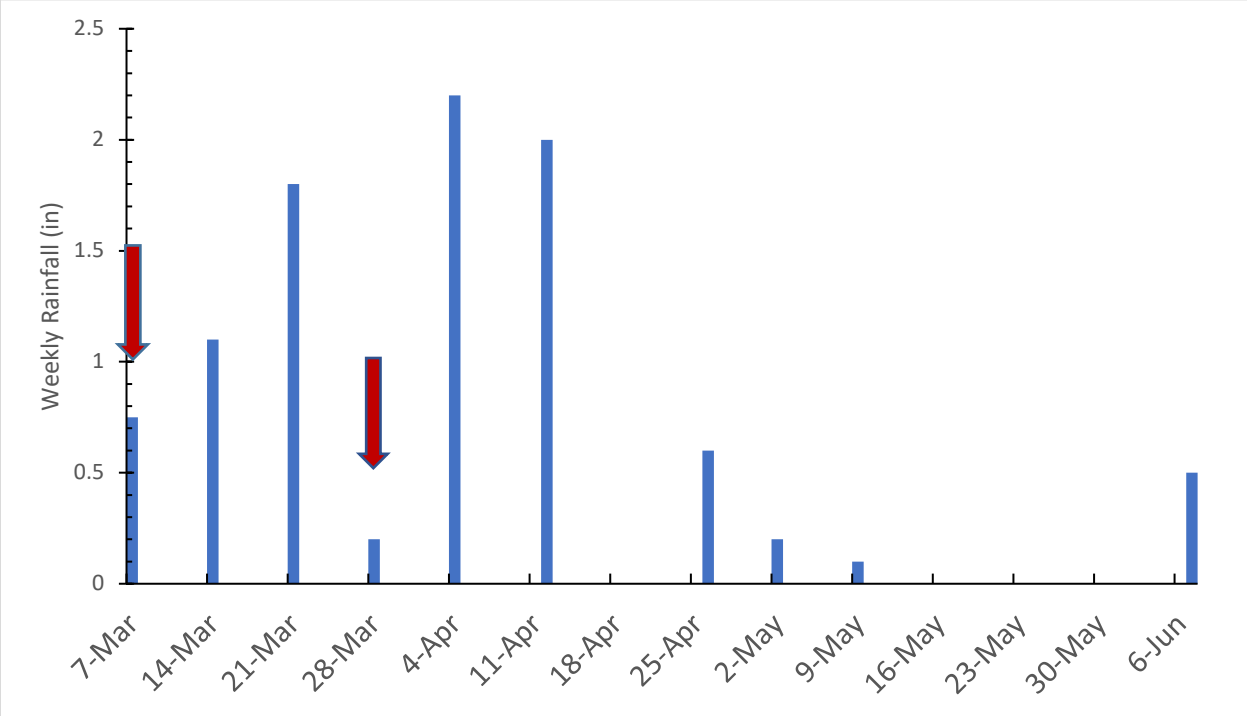

Figure 3. Weekly precipitation totals during the spring of 2018 in the Willamette Valley, Oregon (NOAA 2018) Red arrows indicate early and late out-planting dates for Kincaid's lupines.

Baskett Slough

When PMC staff visited the site on May 28, 2018, vegetation surrounding Site 1 was turning brown and senescing. The brown vegetation lines followed the slope patterns. The higher parts of the ridges were turning brown first, while the lower spots remained green. The areas that were turning brown had more annual species than perennial species. It appeared that the brown areas were drying out faster; we assume that the soils are thinner here and there is bedrock about 6-10 inches below the surface. Site 1 fell directly in one of these brown patches. The site was specifically chosen by refuge staff due to the "lack of competing vegetation". As predicted, the glyphosate spray did not kill the Roemer's fescue within the plot, but did stunt it. The sprayed Roemer's fescue plants in the plot looked healthy but were not flowering like the surrounding plants that had not been sprayed in February. The lupines in this plot looked very stressed, and most had died. It's possible that the plants were entering their summer dormancy, but we believe that they were dead. Surveys in spring of 2019 will help us understand if the plants survived the summer drought, but it seems unlikely for many of them in Site 1. Site 2 looked much better, mainly because it had been moved from the top of the ridge (Figure 3). Existing vegetation was still green, and the lupines had grown since they were transplanted. Many had large, new leaves.

Figure 4. Site 2 at Baskett Slough NWR on May 28, 2018. Dashed red line shows original placement of plot, and solid red line shows where the site was moved to.

Mt Richmond

*Figure 5. Mt Richmond, Yamhill County site chosen for Kincaid's lupine (*Lupinus oreganus*) out-planting trial. March 8, 2018.*

In late June, both Sites 3 and 4 at Mt Richmond looked similar to each other in terms of dryness and competing vegetation. Gopher activity was high at Mt Richmond and was certainly a factor for individual lupine survival. However, the gopher activity appeared to be randomly distributed across treatments, so it was unlikely to affect our results.

Container Type and Planting Date

Container type did not have a significant effect on transplant survival ($p = 0.29$). Mean survival across all sites and locations was 49% for RootMakers and 46% for Hikos. Both containers produced quality transplants with active roots (Figure 1—move from above). RootMakers were very easy and efficient to transplant, requiring very little root disturbance (the small root plug held together very well). The late-planted RootMakers were slightly rootbound, but plants were not stunted. The Hiko containers were generally harder to transplant. It was difficult to remove the plants from the Hiko container because roots began to grow out of the side slits and became lodged in the slit when trying to remove the plants. At the early planting date, most of the plant roots had not fully filled out the larger Hiko containers, causing some soil to fall away and roots to break when removing plants from the containers.

With the unusually dry May and early onset of the summer drought in 2018, early planting proved to be especially beneficial. The overall mean survival for early-planted lupines across all sites and locations was significantly greater than survival of the late-planted individuals (59% vs. 36%, respectively, $p = 0.01$). The additional 3 inches of rain that fell between the early and late planting dates in March appeared to make a big difference in the transplants' abilities to grow roots deep enough to survive the on-coming summer drought.

There were also large differences in survival among planting sites (Figure 5), which can mostly be attributed to site selection criteria. Site 1 at Baskett Slough had very low survival, likely due to summer drought exacerbated by thin soils with poor available water capacity. The mean survival for Sites 1 and 2 at Baskett Slough was 15% and 65%, respectively, while survival at Sites 3 and 4 at Mt Richmond was 50% and 61%, respectively. The difference in survival between Sites 3 and 4 was not statistically significant and is most likely due to random variations in soil type, gopher activity, and individual plant vigor.

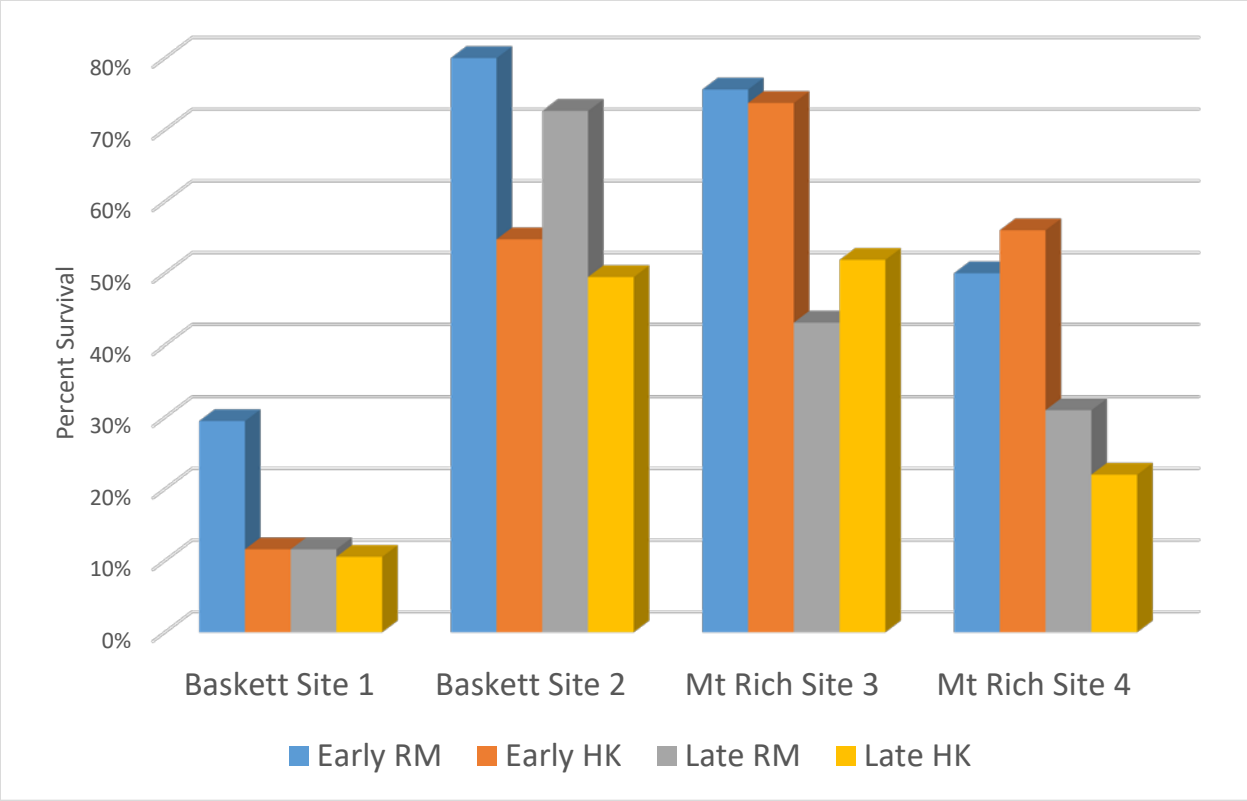

*Figure 6. Survival of first-year Kincaid's lupine (*Lupinus oreganus*) transplants planted in early and late March of 2018 at Baskett Slough National Wildlife Refuge (Sites 1 and 2) and Mt Richmond, Yamhill County, OR (Sites 3 and 4). Transplants were either grown in RootMaker (RM) or Hiko (HK) containers.*

Preliminary Conclusions and Recommendations

The purpose of this study was to compare the effects of planting dates and container type on Kincaid's lupine transplant survival. While early planting increased survival rates, site selection appears to have had the greatest effect on plant survival. When choosing a site, it is important to avoid areas with standing water in winter or a water table that is less than 12 in below the surface. Sites also need to be well drained and have at least 12-18 inches of soil. Thin soils with a clay or bedrock layer within 12 in of the surface will most likely not be able to support this plant. Using a probe or digging a hole at planting sites can help identify areas where this might be an issue if it is not apparent by looking at the existing vegetation.

Although container type did not affect plant survival rates, we saw a practical advantage to using the RootMaker plugs. Lupines only needed to grow in the RootMaker plugs for two months in an unheated greenhouse before they were ready for out-planting. The smaller RootMaker containers use less media than larger Hiko or Ray Leach stubby cells, saving time and money. Also, they were incredibly easy and fast to transplant.

Planting in late February or early March is very important in a dry spring. Since spring rain cannot be predicted it is best to plan to out-plant Kincaid's lupine before mid-March. This gives the plants more time to grow roots before the soil dries out in summer.

References

Esterson, A. 2018. West Eugene Wetlands Augmentation of Threatened and Endangered Plant Species: 2017 Annual Report. Unpublished report for the Bureau of Land Management, Northwest Oregon District. Institute for Applied Ecology, Corvallis, OR.

Leininger, S. 2001. Promoting and restoring Kincaid's lupine (*Lupinus sulphureus ssp. kincaidii*) and Willamette Daisy (*Erigeron decumbens var. decumbens*) at Baskett Slough NWR. http://people.oregonstate.edu/~wilsomar/PDF/L_OSU_01.pdf.

Kaye, T., and A. Brandt. 2005. Seeding and transplanting rare Willamette Valley prairie plants for population restoration. https://appliedeco.org/wp-content/uploads/LOBR05-seedingandreintro.pdf

NOAA Climate Data Online. Accessed 2018. https://www.ncdc.noaa.gov/cdo-web/