Whitebark Pine Direct Seeding Results in Northern Idaho and Montana

5-Year Summary

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Whitebark pine direct seeding field trials were established on six whitebark pine sites in northern Idaho and Montana in the fall of 2009 and 2010 to determine if direct seeding is practicable and if seed or seedling treatments can enhance germination and survival. Eight hundred seeds collected from local seed sources were planted at each site in a randomized complete block design to test four seed treatments. Treatments included: 30-day warm stratification at 21° C.; seed scarification by sanding; a combination of warm stratification plus scarification and an untreated control. One half of the seed in each treatment was covered with a wire mesh cage to minimize rodent predation for the first two years. The 2009 sites were: Fairy Lake on the Gallatin National Forest near Bozeman, MT; Thompson Peak on the Lolo National Forest near Plains, MT; Ulm Peak on the Idaho-Montana state line west of Thompson Falls, MT; and Gold Pass on the Idaho-Montana state line west of St. Regis, MT. In 2010, additional trials were established on Toboggan Ridge in the Clearwater National Forest north of Powell, ID, and Pioneer Mountain west of Big Sky, MT (Figure 1).

In addition, 3-seed caches were planted next to two-year old (2-0) nursery seedlings at each site to compare seed germination success and survival with survival of seedlings in the same microenvironment. This also provided an opportunity to compare 3-seed caches with individual seed planting at each site. The 2009 trials used untreated seed for the caches while the cached seed in 2010 were all given a 30-day warm stratification prior to planting. One half of the 2010 cached seed were coated with a mycorrhizal powder prior to planting. About 34 seedlings and 3-seed caches were established at the 2009 trials and about 100 seedlings and 3-seed caches were planted at the 2010 trial locations. Half of the 2-0 seedlings planted in 2010 were also given a mycorrhizal treatment about 30 days prior to planting. The third year after planting, the wire cages were removed and a sample of non-emerged seed in each treatment was dug up to record seed condition if found. Heights and diameters of all surviving seedlings were recorded in 2015.

Successful restoration requires good germination of seeds followed by successful seedling establishment. These sites have been monitored for at least five years to document germination success and seedling establishment.

Germination (seedling emergence)[2] results (Table 1):

Although there was wide variation in germination levels observed between sites, some seed treatments consistently outperformed others:

- Warm-stratified seed germinated best at five of six sites (> 50% average germination at four of six sites).
- Seed scarification was only beneficial at Pioneer Mountain and was less successful than the untreated control seed on all other sites.
- The benefit of warm stratification was reduced when combined with scarification at 5 of 6 sites.

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[2] Many seeds germinated but died before emerging. In this report "germination" refers to seedling emergence.

- Germination of treated seed primarily occurred the first spring following planting; (e.g. 97% of warm-stratified seed germinated the first year) while nearly half (42%) of the untreated seed didn't germinate until the second year.
- No seed germinated after the second year.
- Very little rodent predation of planted seed was observed either inside or outside cages.

Results from 3-seed caches (Table 2):

- The percent of seed that germinated from 3-seed caches was less than individual warm-stratified seed germination at all sites except Thompson Peak. This indicates that caching three seeds usually did not improve germination on the same sites.
- The percent of 3-seed caches with one or more seedlings was always greater than the percent of cached seed that germinated.

Survival and establishment of seedlings from direct seeding after germination:

- Once germinated, seed treatments had little effect on survival.
- An average of about 50% of seedlings from individually planted seed survived at least five years, but this varied widely by site.
- Survival increased with seedling size; minimal losses were observed in five-year-old seedlings that were greater than 15 cm tall.

Planting success of nursery seedlings and direct seeding (Figure 2):

- Survival and establishment of nursery stock on all sites was much better than seedlings from direct seeding of warm-stratified or cached seed. Many of the 2-0 nursery seedlings were more than 61 cm tall and were well established.
- Survival of seedlings from all sources was best on good sites (Toboggan Ridge and Thompson Peak) and declined with harshness of the site (Gold Pass and Ulm Peak).
- Pioneer Mountain had good germination but seedling survival was severely impacted by gophers after the 4th year. Rodent damage was minimal on other sites.
- Rodents did not appear to seek out planted seeds.
- Mycorrhizal effects are still being monitored, but did not appear to be very effective in increasing germination or seedling survival.

Conclusions:

Early germination success with warm-stratified seed at some sites indicated that direct seeding might be a potential tool for whitebark pine restoration. Treating seeds with 30 days of warm stratification just prior to late fall planting appears to enhance germination, but declines if combined with seed scarification.

However, successful restoration of whitebark pine requires successful survival and seedling establishment as well as germination. Even though planted seedlings consistently outperformed the directly planted seed, these trials indicate that direct seeding may be a viable restoration tool especially on good sites where planting nursery stock may be logistically challenging or restricted. A cost-benefit analysis could be performed if seed germination and site quality can be determined as well as costs for seed, seedlings, and planting.

The patterns observed in these direct seeding trials provide insight into the practicality of direct seeding, however, the wide variation observed between sites and treatments indicates the need for additional testing before direct seeding can be widely implemented or rejected.