Revegetation Strategies for Rangelands

Russell Wilhelm, Seed Program Manager

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NDA
Nevada Department of Agriculture

About the Presenter

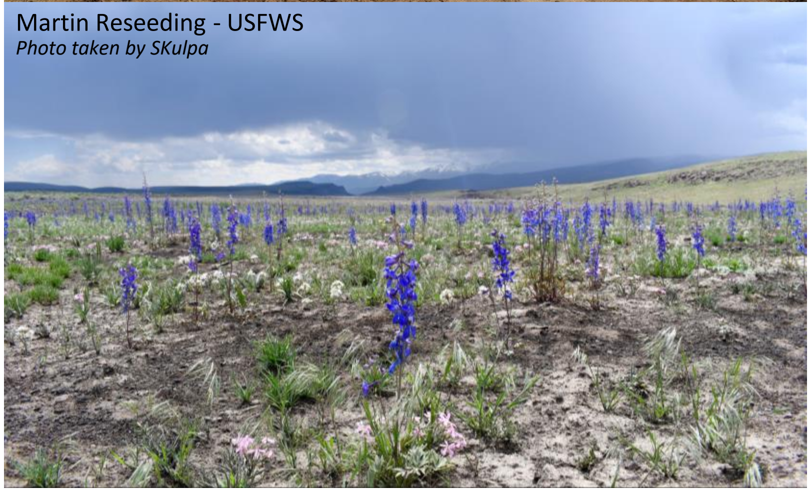
- **Russ Wilhelm**
- **Seed Program Manager at Nevada Dept. of Agriculture**
  - Since January 2015
- **Graduate from University of Nevada, Reno**
- **Been working intensively with native seed in NV for past 4 years**

Synopsis of Presentation

Restoration of rangelands throughout the intermountain West has been an excitedly discussed topic for centuries. New strategies are on the rise throughout the West that will help promote rangeland health and longevity, while assisting to suppress wildfire intensity and decrease frequency.

Several revegetation methods and new reseeding technologies will be investigated and the use of locally adapted, genetically appropriate, seed will be the focal point.


Martin Fire, 2018 – High Country News
440,000 acres burnt


Martin Reseeding - USFWS
Photo taken by SKulpa

Primary Reasons for Rangeland Restoration

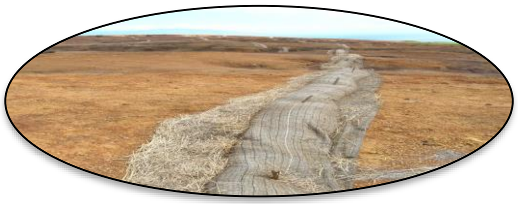
Wildfire rehabilitation

Fun fact: The most common use of native species revegetation in the West is to rehabilitate rangelands after wildfires

Mining reclamation

Fun fact: The state of Nevada has 232,984 active mining claims, the most by far in the United States.

Erosion control



Preventing spread of invasive species

Preserving wildlife habitat

Many, many more…

Common Restoration Methods

Revegetation

The use of plant propagules (seed), native or non-native, to reintroduce desirable species to a disturbed site.

Ex. Designing an herbicide protected seed mix, to re-apply to a burn site.

Grazing Management

Controlling grazing habits of livestock or game to decrease the level of disturbance to a landscape.

Ex. Implementing stockmanship principles to effectively rotate livestock across allotments.

Invasive Species Management

Preventing the introduction or spread of undesirable species to a vulnerable site.

Ex. ***Application of imazapic as a pre-emergent**** *to a wildfire site to prevent emergence of cheatgrass.*

Inventory & Monitoring

Assessing the conditions of an area to determine the needs and strategize on control methods.

Ex. Cataloguing plant population densities and rating native species displacement (ie. sagegrouse).

Revegetation Strategies & Application

"Revegetation is most successful when used as part of an IPM program. It is essential to control invasive plants in order to create an environment more conducive to establishment of desired vegetation that will fill the niche vacated by the controlled invader.

Selecting the right species is critical to the success or failure of rangeland revegetation programs. Seeded species must be capable of establishing and should be adapted to soil conditions, elevation, and climate on the site. Planted species should be competitive with invasive plants, and they should contribute to improved ecosystem function. Land managers are often faced with the decision of whether to use native or introduced plant materials that differ in cost, establishment success, and resistance to reinvasion."

-DiTomaso, Joseph, et al (Rangeland Invasive Plant Management)

Application Techniques:

- -Aerial Seeding
- -Drill Seeding
- -Transplanting
- -Hydroseeding

Plant (Seed) Species Selection

Rural settings, <u>especially rangelands</u> that are susceptible to wildfires, require quick establishment followed by long-term stabilization.

- *Find the ideal ratio that will encourage long-term, stable establishment:*
  - **Grass:Forb:Shrub Ratio**
    - *Grass: Monocot within the Poaceae family: High growth-rate, short-lived, quick reproduction/establishment*
    - *Forb: Non-grass herbaceous flowering plant: moderate growth-rate, medium/long lifespan, moderate reproduction, delayed establishment*
    - *Shrub: Woody plant species with multiple branches/stems: Slow growth-rate, long life span, limited reproduction, delayed establishment*

<u>4 major plant growth habits:</u> 1) Grass, 2) Forb, 3) Shrub, 4) Tree

<u>WORKHORSE SPECIES:</u>
A plant that's characteristics provide it with a high probability of success when planted in disturbed areas

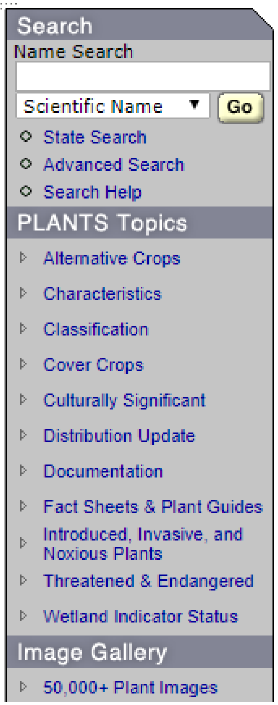
How to Select the Right Species

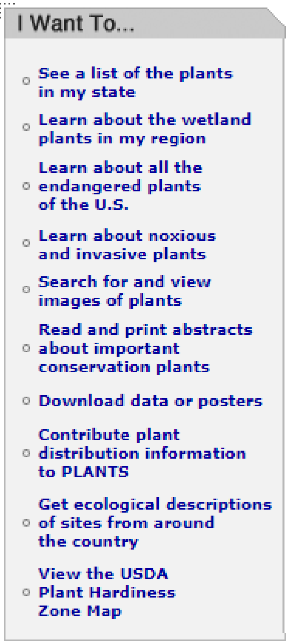
https://plants.sc.egov.usda.gov/java/

Using the NRCS PLANTS Database – Advanced Search Download

Another approach to using the NRCS PLANTS database involves the Advanced Search Download feature. This feature allows the user to select criteria in the PLANTS Core Data Fields including **Distribution, Taxonomy, Ecology** (such as Duration, Growth Habit, Native Status)**,** and **Legal Status.** About 2,500 important species have Conservation Plant Characteristics Data which allows the user to select among the following characteristics:

- **Morphology/Physiology** (e.g., Active Growth Period, Fire Resistant, Growth Form, Growth Rate, Height at Maturity, Lifespan).
- **Growth Requirements** (e.g., Adapted To Coarse Textured Soils, Adapted To Medium Textured Soils, Adapted To Fine Textured Soils, CaCO3 Tolerance, Fertility Requirement, Fire Tolerance, Moisture Use, Precipitation Minimum, Precipitation Maximum, Root Depth Minimum, Salinity Tolerance, Shade Tolerance, Temperature, Minimum (°F)).
- **Reproduction** (e.g., Bloom Period, Commercial Availability, Fruit/Seed Abundance, Fruit/Seed Persistence, Seed Per Pound, Seed Spread Rate, Seedling Vigor, Vegetative Spread Rate).
- **Suitability/Use** (e.g., Palatable Browse Animal, Palatable Graze Animal, Protein Potential).





Identify an end goal prior to selecting plant/seed mixture

Ground Cover | Fire Prevention | Erosion Control | Aesthetics

Typical Mix Used in Nevada

Can you spot the non-native?

- **Mixes vary based upon:**
  - Job type
    - Post-wildfire
      - **When formulating a post-fire seed mix, there are 4 primary factors that need to be considered:*
        - » Timing
        - » Precipitation
        - » Soil-Type
        - » Species
    - Roadside restoration
    - Fallow farmland
    - Riverbank erosion control
    - Etc.
  - Site conditions
    - Elevation
    - Soil Type
    - Annual Precipitation
    - Urgency
    - Etc.

Restoration Mix Example:

1) Bottlebrush Squirreltail (*Elymus elymoides*)
2) Desert Globemallow (*Sphaeralcea ambigua*)
3) Sandberg Bluegrass (*Poa secunda*)
4) Palmers Penstemon (*Penstemon palmerii*)
5) Needle & Threadgrass (*Hesperostipa comata*)
6) Forage Kochia *(Bassia prostrata)*
7) Winterfat *(Krascheninnikovia lanata)*
8) Antelope Bitterbrush (*Purshia tridentata*)
9) Bluebunch Wheatgrass (*Pseudoroegneria spicata*)
10) Indian Ricegrass (*Achnatherum hymenoides*)
11) Shadscale Saltbush *(Atriplex confertifolia)*
12) Western Yarrow *(Achillea millefolium)*
13) Yellow Beeplant *(Cleome lutea)*
14) Wyoming Big Sagebrush *(Artemisia tridentata)*
15) *Rubber Rabbitbrush (Ericameria nauseosa)*
16) *Creeping Wildrye (Leymus triticoides)*

GRASS		FORB		SHRUB
6	:	4	:	6

Seeding Rates: Calculating

- **Each species has a recommended seeding rate based on two factors:**
  - Pure Live Seed
    - (% Purity x % Germ)/100
  - Number of seeds/lb.
    - *Ex: 161,920 Indian Ricegrass seeds/lb.*

Growth Requirements:

Atriplex confertifolia

Compliments of USDA/NRCS PLANTS Database

Adapted to Coarse Textured Soils	Yes
Adapted to Fine Textured Soils	Yes
Adapted to Medium Textured Soils	Yes
Anaerobic Tolerance	None
CaCO3 Tolerance	High
Cold Stratification Required	No
Drought Tolerance	High
Fertility Requirement	Medium
Fire Tolerance	Low
Frost Free Days, Minimum	165
Hedge Tolerance	Medium
Moisture Use	Medium
pH, Minimum	7.5
pH, Maximum	9.0
Planting Density per Acre, Minimum	1200
Planting Density per Acre, Maximum	2800
Precipitation, Minimum	4
Precipitation, Maximum	12
Root Depth, Minimum (inches)	10
Salinity Tolerance	High
Shade Tolerance	Intolerant
Temperature, Minimum (°F)	-38
Total Seeds per Pound	*60,585*
PLS	*42.56%*

Total rate to plant per acre=0.05 lbs. or 22 grams

Application Styles Defined:

Aerial Seeding:

-The use of a plane, helicopter, drone, etc. to dispense seed over a designated area.

-Pro: Site access, rate of application

-Con: Expensive, limitations on seed quantity

Drill Seeding:

-The use of a rangeland drill seeder to sow seed directly into the ground, while effectively covering the seed after planting.

-Pro: Precision planting, ground cover

-Con: Limitations on access

Transplanting:

-Taking live plant material and directly sowing it into the ground.

-Pro: Higher rate of plant establishment

-Con: Rate of application, expensive, ground cover

Hydroseeding:

-Process of using a mixture of seed, mulch and liquid in order to broadcast a "slurry" of seeds onto a project site.

-Pro: Application control, higher rate of establishment

-Con: Expensive, rate of application

What's being used now in the GB?

-Mostly grasses

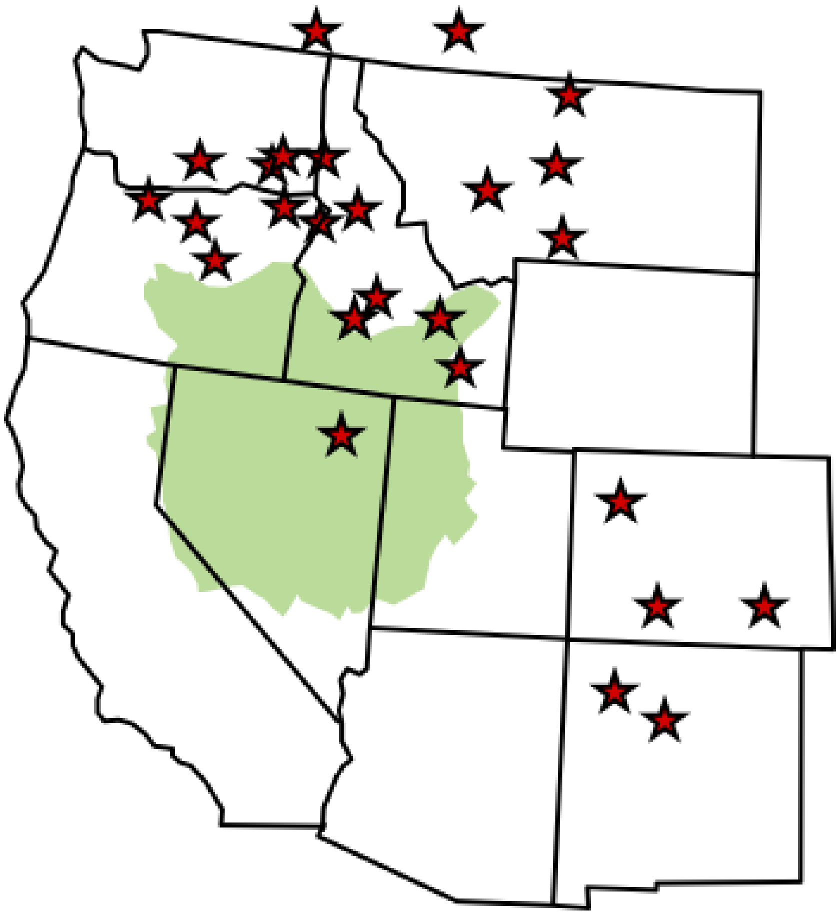
-Mostly cultivars

-Mostly from the northern, wetter edges of the Great Basin

-Selected for agronomic or forage qualities

-Shrubs and a few forbs are mostly wildland collected

Leger and Baughman, 2015



The Native vs. Non-Native Debate

- **What constitutes native status?**
  - Naturalization of species?
- **Pros and Cons to both?**
  - Can introduced species establish rapidly and out-compete invasive annual grasses?
  - Will using native species lead to higher success rates?

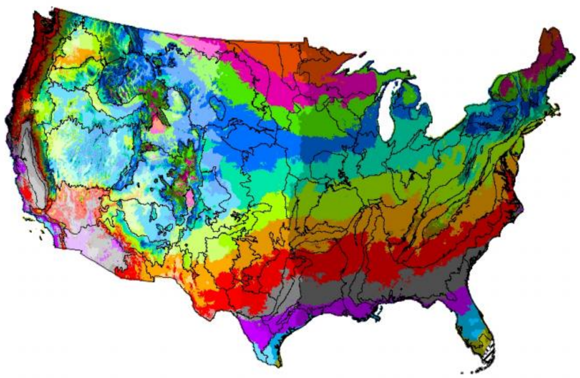
"…Reseeding with non-native grasses like crested wheatgrass to beat out cheatgrass achieves the goals of suppressing invasive species and providing forage, but it comes at the expense of biological diversity, as crested wheatgrass also outcompetes almost every other native species it's been measured against. The cost of that tradeoff hasn't gone unnoticed.

"Negative long-term effects of these species [of non-native grasses] on ecosystem functioning, biodiversity, and wildlife habitat have been documented," wrote (Francis) Kilkenny and other scientists in a 2019 study…
and that has led to a change in practice…"

Lohan, Tara – Reseeding after Wildfire Often Does More Harm than Good, 2020

Seed Zones & Local Adaptation – A novel approach to revegetation

- **Provisional Seed Zones:** Provisional seed zones are based on climate data and used for species for which empirical seed zones have not been developed. Provisional seed zones in combination with established ecoregions can be used to guide seed transfer.



Empirical Seed Zones:
Empirical seed zones are developed for individual species based on climate variables and a species' genetic variation across their distribution through the following steps:

(1) Researchers collect seed from diverse geographic and climatic areas of the targeted region;

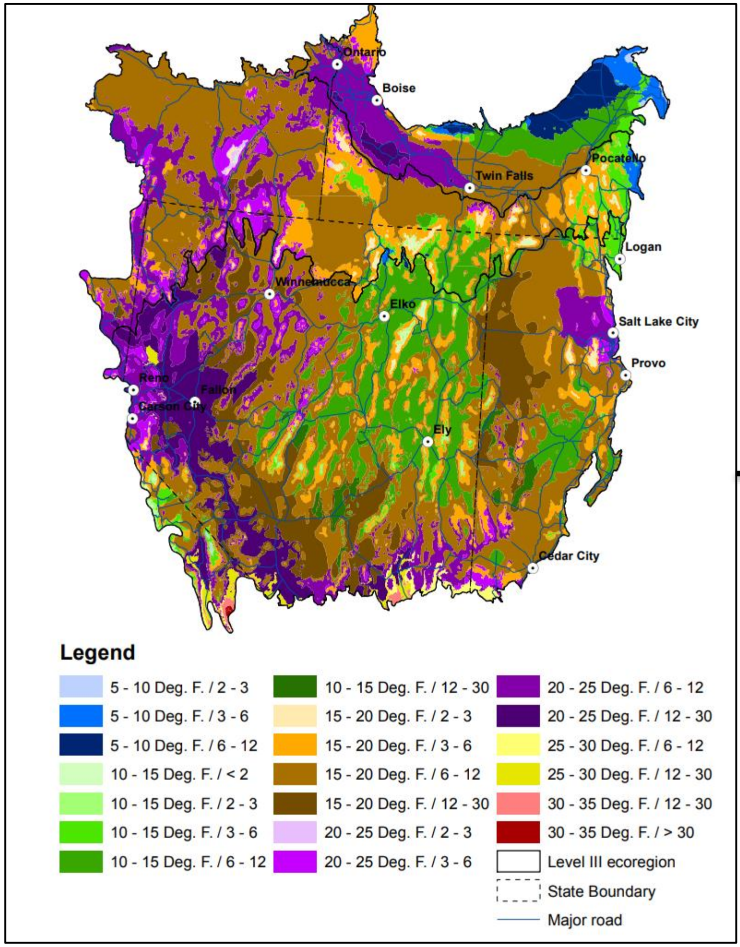
(2) Researchers evaluate plantings from collected seeds in common gardens for production, morphology, phenology, and physiological traits;

(3) Researchers develop regression models that link genetic variation across the landscape with collection location environments to delineate seed zones for the collected species.

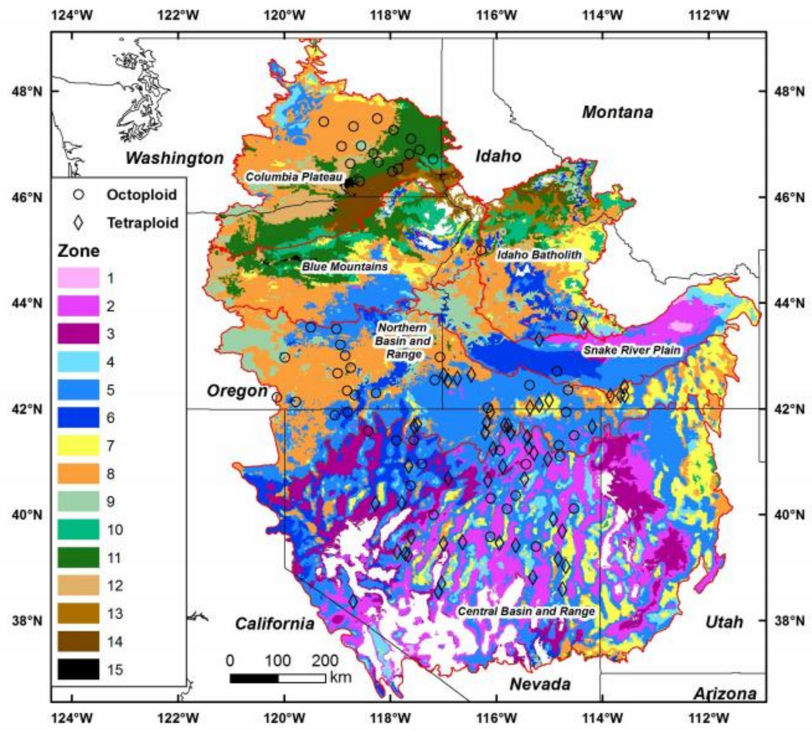
Land managers in NV are emphasizing the use of locally adapted seed…

Locally Adapted Plants: *A plant that performs better in a particular environment than other individuals of the same species and is more likely to establish and persist.*

Quantifying the Chances for Success



Provisional Seed Zone Map – Great Basin Region



Empirical Seed Zone Map – Basin Wildrye *(Leymus cinereus)*

We have active empirical seed zone data for ~20 species. There's over 800 known plant species within GBNP alone.

Problems with Current Approach

"Cultivated Variety" (Cultivar) vs. "Locally Collected"

"Cultivated Variety"
(Cultivar)

- Many cultivars and named releases are a poor "fit" between seed source and restoration site = less effective
- Does not restore or mimic natural population functioning
- Potentially disrupt ecological relationships
- Potentially undermines future resistance and resilience

"Locally Collected"

- Too much time to get seed
- Major limitations on supply of seed
- Local seed sources may no longer exist
- Climate shifts may mean local seed sources are not the best
- May not immediately germinate and grow

Bridging the Gap Between Cultivated and Collected Seed

- **Identification of new seeding methods is key to increase chances of plant establishment**
- **Finding common ground between cultivated and collected seed in order to meet market demands.**
- **Utilizing modern science and best management practices to modernize seeding practices.**

Providing farmers with <u>locally sourced</u>, collected seed, can be a means to increase supply over the long term.

Installing limits on generational increase can be a means to preserve species characteristics and offset genetic drift.

New Seeding Technologies:

- **Seed Treatments:**
  - Herbicide Protection Pods
  - Inoculants
  - Pesticide treatments
  - Dormancy & Hard Seed Breaking
    - *Reseeding after wildfires can be urgent and it’s critical to provide seed that will perform.*

Herbicide Protection Pods

- **Herbicide protection pods, or HPPs:**
  - *A mixture of seed within a capsule, typically comprised of activated carbon.*
    - *Carbon will absorb herbicides and render them inert, meaning that use of pesticide can still occur after seed has been sowed.*
    - *Studies show that the use of HPPs concurrently with seed application can lead to a higher rate of seedling establishment while simultaneously reducing pressure from invasive species.*

Herbicide Protection Pods (HPPs) Facilitate Sagebrush and Bunchgrass Establishment under Imazapic Control of Exotic Annual Grasses. Clenet, Danielle, et al. 2020

Seed Inoculation Treatments

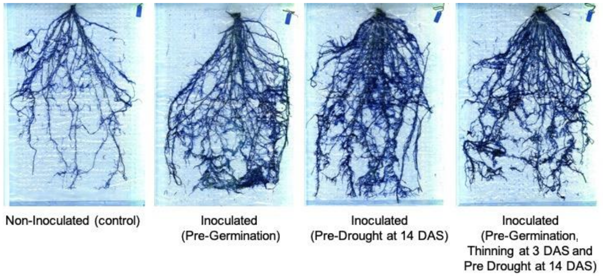
Seed Inoculation, what does it mean?

- The process by which seed is coated with beneficial microbes that promote stronger growth potential.
  - *Typically, nitrogen-fixing bacteria, such as Rhizobium or Bradyrhizobium are used.*
    - *Rhizobacterial inoculation of seed is practiced regularly in the commercial agriculture sector and more exploration needs to be done to identify value for restoration use.*
  - *A symbiotic relationship is formed between plant root nodules and the beneficial bacteria and/or fungi.*
    - *Fungus, such as Trichoderma, are also widely used to develop these symbiotic relationships to prevent pathogenic infection.*

"…interest in areas such as ecosystem restoration is growing (as a result of the environmental degradation and climate change), which can also represent an interesting opportunity for seed coating as a microbial delivery tool."

Seed Coating: A Tool for Delivering Beneficial Microbes to Agricultural Crops

Rocha, Inês, et al. 2019.



An Enhanced Root System Developmental Responses to Drought by Inoculation of Rhizobacteria (Streptomyces mutabilis) Contributed to the Improvement of Growth in Rice. 2017

Use of Pesticides in Restoration

- ***The use of pesticides in revegetation plans is nothing new.***
  - *Restoration work and weed control go hand-in-hand.*
  - *Herbicides can be an effective tool to control existing invasive issues and will prevent weed threats over the long term.*
    - *Application of a pre-emergent herbicide, such as Imazipic, will allow for an added layer of assurance after seed has been sowed.*
  - Seeds treated with fungicides* may help protect from pathogens that can reduce germination and seedling survival.
  - Disease-causing fungus, such as *Pythium*, can pose a threat to developing seedlings by causing the plant to dampen off.

**Fungicidal treatment of seed used for restoration is still being researched. Consult with the label and appropriate government agencies to ensure legal use of all products.*

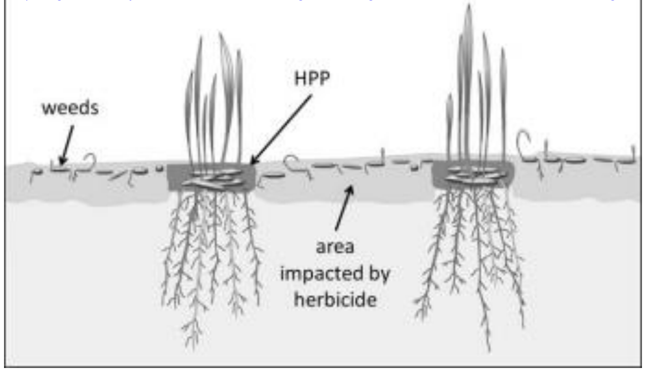
Treating seeds with fungicides may be beneficial under the following conditions:

1. Early planting in cold, wet soils
2. Reduced till and no-till fields
3. Seed with low germination rate (<80%)

Common fungicides used in seed treatments:

***Metalaxyl**: Excellent for control of *Pythium* and *Phytophthora*
***Carboxin**: Good for control of Smut and Rust causing agents
***Thiram**: Effective at preventing seed decay and damping off
****Always check label for proper use and registered states before applying any pesticides.***

Improving Restoration of Exotic Annual Grass-Invaded Rangelands Through Activated Carbon Seed Enhancement Technologies



Herbicide protection pods can be used in combination with a pre-emergent to increase the chances of seedling establishment

Beating Dormancy in Seeds

Many species of native origin have higher rates of physical and embryonic dormancy

- Dormancy: Seed characteristic that prolongs germination until ideal circumstances have been met.
- Seeds are permeable to water, but certain environmental conditions are necessary to modify the internal chemistry of the seed and thus allow germination.
  - One may be prolonged exposure to cold temperatures.
- Planting native seed mixes in the Fall can typically be beneficial if using seed with high dormancy traits:
  - Ex:
    - » Rocky Mountain Bee-Plant (*Cleome serrulata*)
    - » Big Sagebrush (*Artemisia tridentata*)
    - » Desert Globemallow *(Sphaeralcea ambigua)*

Fun fact: Using treatments such as gibberellic acid can help to not only break dormancy but will promote germination and encourage rapid growth.

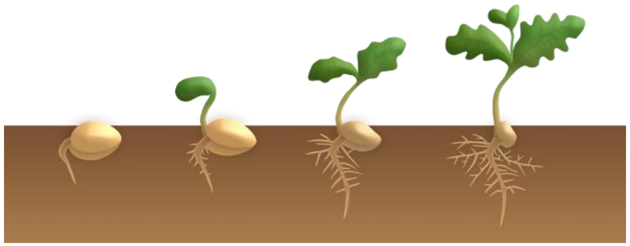
Planting early does still have risks with early germination

Seed treatments are also available to help reduce seed dormancy

Some common treatments include:

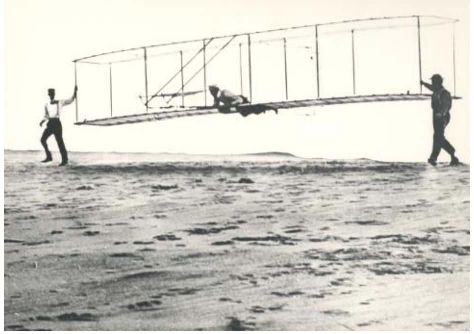
1) Pre-chilling or "cold-stratification"
2) Seed scarification
3) Chemical treatment of seed to break down both physical (**P**) dormancy and embryonic (**E**) dormancy
   a) Sulfuric acid (H_2SO_4) treatment (**P**)
   b) Potassium nitrate (KNO_3) treatment (**E**)
   c) Gibberellic (GA_3) acid treatment (**E**)

Before treating any seed, be sure to research which methods, rates and concentrations are appropriate for certain seed species.



21st Century Approach to Restoration

- **What does the future hold for rangeland restoration?**



NATIONAL SEED STRATEGY
FOR REHABILITATION AND RESTORATION

Questions?

Russell Wilhelm

Email: rwilhelm@agri.nv.gov
Office: (775) 353-3711
Mobile: (775) 750-5910