Western Phytoworks

Colorado State University
Knowledge to Go Places

Western Colorado Research Center

Fall 2005

WCRC Native Plant Production Update

Native plant production at the WCRC Rogers Mesa site expanded in 2005. Dr. Ron Godin and his staff began working with the Uncompahgre Plateau Project (UPP) native seed program in 2003. The UPP, a collaboration between The Bureau of Land Management, Forest Service, Colorado Division of Wildlife, and the Public Lands Partnership, is working towards restoring large areas of the Plateau with native plants to bolster declining elk and mule deer populations. Dr. Godin is beginning his second year of a three year Western Sustainable Agricultural Research and Education (WSARE) grant designed to both research growing techniques needed to successfully grow selected native plants for seed and to begin to bring local growers into the seed production operation.

At the research center, four acres were planted with grass, forb, and shrub transplants in 2004. In 2005, direct seeding and transplants added another two acres. New species of grasses include two varieties of brome grass [Richardson's Brome (*Bromus anomolus)* and Mountain Brome *(Bromus marginatus)*], bottlebrush squirreltail *(Elymus Elemoide)*, Indian ricegrass (*Oryzopsis hymenoides)*, western wheatgrass *(Pascopyrum smithii)*, and sand dropseed *(Sporubolus crypandrus)*. New plantings of milkvetch *(Astragulus eastwoodiae)*, sulfur buckwheat *(Eriogonum umbellatum)*, blue flax *(Linum lewisii)*, and multi-lobed grounsel (*Scenicio multilobatus)* in addition to expanded plantings of Utah sweetvetch *(Hedysarum boreale)* and bluestem penstemon *(Penstemon cyanocaulis)* increased forb production. An irrigation study and a spacing study were also established including many species of grasses and forbs. Two growers began native seed production 2004 with grass transplants and direct seeding with an additional three growers set to begin seeding of grasses and forbs in November of this year.
This year was the first to yield harvestable quantities of native seed. Western yarrow *(Achilea lanulosa)* was our big producer this season with a third of an acre of yarrow yielding 100 pounds of seed. A quarter acre of wild aster *(Erigeron speciosus)* yielded 40 pounds of seed. A Hege plot-sized combine was used to harvest the yarrow and aster. Seed was also collected from plantings of junegrass *(Koeleria macrantha)*, muttongrass *(Poa fendleriana)*, needle and thread grass *(Stipa comata)*, sandberg bluegrass *(Poa secunda)*, shaggy fleabane *(Erigeron pumulus)*, and scarlet globemallow *(Sphaerilcea coccinea)* in lesser amounts using a portable seed stripper or by hand collection. Plans for 2006 include an additional acre of grasses and forbs to study seed increase techniques for bringing new varieties under cultivation.

For more information, contact Kim Schultz at kims@lamar.colostate.edu or (970) 872-3387 ext. 205 or Ron Godin at Ron.Godin@colostate.edu or (970) 872-3387 ext. 5.

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Fred Judson harvesting Wild Aster seed.

Soil Salinity: Assessment and Remediation

Introduction:

Sources of soil salinity are either native or introduced. Most arable soils in Colorado have native soil salinity because ancient shallow seas occupied much of Colorado and deposited large amounts of salts on the sea bed which has eventually become our farmland. The introduced salinity is through irrigation water containing soluble salts; evaporation of fresh water from the soil surface and/or uptake by plants leaves the salts in the soil to accumulate over time. A third source of soil salinity is upward percolation of water and it's accompanying salts from shallow water tables, again evaporation and plant uptake of fresh water leaves the salts behind in the soil. Soil salts hold on to water very tightly making it extremely difficult for plants to take up water and nutrients resulting in reduced plant vigor and plant growth.

There are three salts of concern to Colorado growers, calcium (Ca), magnesium (Mg) and sodium (Na). These salts are plant nutrients. However, each of these salts in and of themselves can cause problems if the soil contains excess concentrations. Soils with excess Ca and/or Mg (known as a saline soils) restrict water and nutrient uptake by plants stunting growth and reducing vigor. Soils with excess Na (known as sodic soils), along with restricting uptake, growth and vigor, cause a breakdown in soil structure. Hydrated Na (Na with water) disperses soil particles destroying the aggregation and the associated channels where water and air enter and exit in a healthy soil. In a sodic soil water and air cannot enter soil and hence plants cannot grow in a sodic soil.

Assessment:

Visual indications of salinity are stunted plant growth, poor fruit size and quality, patchy growth in pastures and/or a white crust on the soil surface when the soil dries. Soil sampling and testing is the only economical means of assessing soil salt concentrations. Two simple tests for salinity/sodicity are pH and EC (electrical conductivity). A pH test determines acidity or alkalinity of a soil. The EC determines salinity. If soil pH is above 8.5 an additional chemical analysis for salt concentrations (known as SAR or sodium adsorption ratio) is required. The SAR of a soil is the amount of Na in the soil with respect to the amounts of Ca and/or Mg and can indicate whether a soil is saline, sodic or saline-sodic (see table). It is critical to know which salt(s) are in excess in the soil in order to perform the correct remediation. You should consult a qualified soil professional PRIOR to attempting remediation.

Summary: Classification of Soils for Salinity/Sodicity

Soil Class	EC	pH	SAR or (ESP)*	Physical Condition
Normal	< 4	< 8.5	< 15	Normal
Saline	> 4	< 8.5	< 15	Normal
Sodic	< 4	> 8.5	> 15	Poor
Saline-Sodic	> 4	> 8.5	> 15	Poor to normal

*ESP (Exchangeable Na percentage) both give a similar reading and different soil testing labs have different preferences on which they report depending on their soil testing equipment.

Remediation:

It is critical to know which salt(s) are in excess in the soil PRIOR to attempting remediation as remediation techniques for saline soils differ from remediation techniques for sodic soils. In order to remediate either soil problem you must have adequate soil drainage or there is nowhere for the salts to go. In some cases tile drains may need to be installed to insure adequate drainage. In order to remediate a saline soil leaching of the soil with excess irrigation water is required to 'push' the salts below the crop root zone. A rule of thumb for reduction of salinity is that 'six inches of excess irrigation water will remove 50% of the salts from the top one foot of soil and twelve inches of excess irrigation water will remove 80% of the salts from the top foot of soil'. A qualified soil professional should be consulted before attempting remediation, as leaching will also remove nitrogen and other nutrients critical to good crop growth and this must be taken into consideration. In order to remediate sodic soil gypsum must be added and incorporated into the soil PRIOR to leaching. If these steps are not adhered to the problem will become much worse! The amount of gypsum required is dependent on the concentrations of the individual salts and the SAR and should be calculated by a qualified soil professional. Soils should be tested following leaching to determine if the desired effects have been achieved or if further action is required. Farmland with salinity or sodicity problems due to shallow water tables can be remediated with the installation of tile drains. Your soil professional can help you determine the amount, spacing and depth of tile drain for proper remediation.

If salinity is an ongoing problem, such as salinity from irrigation water, the addition of organic matter, not from manure sources, to the soil can help mitigate the problem to a degree but close monitoring of soil salinity/sodicity is still a must. Another avenue to help mitigate ongoing salinity problems is to add excess irrigation water at every irrigation in order to keep salts moving below the crop root zone. The excess irrigation application is called a 'leaching fraction'. The salt content of the irrigation water and the soil and the crop you intend to grow determines the amount of 'leaching fraction' you'll need to apply. A qualified soil professional can help you determine the correct leaching fraction for your particular situation. Regular soil testing for salinity, sodicity and pH monitoring is a must to insure that soil salt levels do not exceed thresholds for good crop production.

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Irrigation Water Acidification Shows Promise

Irrigation water on the western slope is typically high in carbonates, which raise irrigation water pH levels to above 8.0, and in many cases to 8.3 by the end of the irrigation season. Soil pH trends towards irrigation water pH. It makes sense that if you keep irrigating with pH 8.0 water on soil that has a pH of 7.2 your soil pH will keep increasing until it closely approximates the irrigation water pH. Ideal soil pH for maximum nutrient availability is pH = 6.5. Most of our western slope soils are in the 7.5 to 7.8 range and climbing. As soil pH increases crop nutrients become less available when they combine with carbonates in the water and become a solid. Therefore, irrigating with high pH water in and of itself will reduce nutrient availability, most notably the micronutrients zinc, iron, manganese and often boron. Many western slope growers now acidify their irrigation water to reduce the pH that in turn begins to lower soil pH increasing nutrient availability. An ongoing study of irrigation water acidification on sweet corn has shown significantly higher yields when compared to irrigating with non-acidified water. After 2 years of a 3 year study soil tests show a lowering of the soil pH from an average of 7.9 to 7.7. Availability of soil micronutrients have also increased without the addition of micronutrients. Irrigation water acidification is also being done on vineyards and orchards resulting in noticeable and quantifiable results, especially in peach orchards.

Irrigation water acidification can be done using any of several acids and simple injection or acid introduction systems. In the sweet corn study, a tank of sulfuric acid is connected to a plastic box that contains a float valve and a spigot which is placed on a pallet over the irrigation ditch. Once the irrigation is started the spigot is opened and the water pH is monitored with a pH meter and the acid adjusted until the water pH drops from 8.2 to approximately 6.5. The rate of acid used was approximately 2 gallons of sulfuric per acre-foot of irrigation water with the cost of acid (in spring of 2005) at approximately $2 per gallon. Extreme caution must be taken when handling acids as they are extremely caustic and direct contact with the acid must be avoided and safety precautions adhered to. However, once the system is set up it's as simple as turning on the spigot and adjusting the acid flow until the desired pH level is reached. Other acids that can be used are phosphoric acid, which is more expensive than sulfuric but can be used for an irrigation or two at the beginning of an irrigation season to easily accomplish two objectives, reducing irrigation water pH and adding phosphorus to the soil. Phosphorus is a typically deficient crop nutrient in our high pH soils. For organic growers, or those growers who do not want the hazards associated with handling sulfuric acid, concentrated acetic acid is available. It is not as effective as sulfuric in lowering water pH and not as cost effective as sulfuric. Also, concentrated acetic acid is moderately caustic and care must be taken to protect skin and eyes when handling. However, concentrated acetic acid is a viable alternative for growers that can not or do not want to handle sulfuric acid.

Observations from peach growers who acidify their irrigation water have been markedly less yellowing of the trees, more tree vigor, and noticeably better fruit quality. Vineyardists have observed healthier vines that are less susceptible to stress.

Other methods of lowering soil pH or mitigating some of the effects of high pH irrigation water to the soil are the addition of organic matter to the soil and/or the addition of elemental sulfur to the soil.

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Looking for Alternatives to Methyl Bromide for Orchard Renovation

Peach growers that used methyl bromide for soil fumigation need another alternative as of 2005. Methyl bromide was the fumigant of choice following WCRC research in the 1980's and 1990's, but it has been removed from the market as of 2005 because of the Kyoto treaty to eliminate / reduce chemicals that deplete the ozone layer.

Why fumigate? WCRC research in the 1980's and 1990's showed that, where stone fruits follow stone fruits in orchard renovation, trees grow poorly and production does not begin until year 4 (or occasionally year 5). This replant problem can be eliminated by proper soil loosening (ripping or backhoeing) and fall-application of soil fumigants. Trees planted in sites receiving such treatment grow 2 - 4 times larger in the first 3 years of growth and begin producing fruit in year 3. They reach maximum production in year 5 (planted at 512 trees / acre) or year 6 (planted at 256 trees / acre) compared to year 7 (planted at 512 trees / acre) or year 8 (planted at 256 trees / acre) for trees planted in non-treated sites. This difference in production from years 3 through 7 totals between 1800 and 1870 bu / acre and represents the benefit provided by pre-plant site preparation and treatment. The value of this difference (if one uses a very conservative value of $18 per bu for the increased production) less the cost of the site preparation and treatment (between $2,600 and $6,400 / acre, depending on tree density, site preparation method, and method of treatment application) is $27,000 to $31,000 per acre. Fruit prices have ranged as high as $35 / bu over the last 10 years; prices at this level during years 3 to 8 after planting would provide a benefit value of $59,000 to $63,000 per acre. So pre-plant site preparation and soil treatment are worth the hassle to the grower.

A major cost component in this approach is the cost of the soil fumigant. Chloropicrin (the primary soil fumigant examined in the earlier studies and which is still available) is known to be effective at 1 lb per tree site. Retail cost of chloropicrin in 2005 is $9.50 / lb. It must be applied while soil temperatures remain above 60 ^{o}F and the source tank must have pressurization provided by a regulated flow of nitrogen into the tank. It is closely related to tear gas and is extremely unpleasant to work with if leaks occur. The earlier studies demonstrated effectiveness of 0.5 lb per tree site for a blend of 33% methyl bromide / 67% chloropicrin. Thus it is possible (perhaps even likely) that lower rates of the chloropicrin or a blend of chloropicrin with other fumigants (like methyl iodide) may be equally effective and provide a more cost effective approach for growers. Additionally, it would be desirable to identify other effective alternatives to methyl bromide for control of stone fruit replant problems.

To this end, new studies were set up in fall of 2004 and again in fall of 2005 to examine / reexamine such alternatives. These included methyl iodide, chloropicrin, and a terpene-based product that is water soluble and capable of application in water; different rates of these materials were applied (1, 0.5, & 0.25 lb of chloropicrin; 1.3, 0.67, and 0.33 lb of 98% methyl iodide / 2% chloropicrin [=98:2 MI:Pic]; and 1000, 500, 250, 125, and 65 ppm of the terpene material per tree site). Fall 2005 studies involved chloropicrin, 98:2 MI:Pic, and a 33 % methyl iodide / 67% chloropicrin product [=33:67 MI:Pic] at 1, 0.5, 0.25 lb / tree site (+ a 0.125 lb rate for the 33:67 MI:Pic product). Trees were planted in spring of 2005 on the site treated in fall of 2004 and trees will be planted in spring of 2006 in the fall 2005 treated plots. Growth will be monitored each year and fruit production data collected in years 3 - 5 (possibly longer) for determination of benefit calculations.

Should the 0.25 or the 0.125 lb / tree site rate prove to be effective for the chloropicrin or the MI:Pic material, new measuring methods will need to be developed. Current gauges are available for the methyl bromide with 0.5 lb increments, but the chloropicrin and the MI:Pic materials have different densities that make the volume-based current gauge calibrations misleading. One possible measuring method was developed and used in 2005 for measurement of the smaller quantities of methyl iodide and the MI:Pic materials.

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