United States Department of Agriculture

Great Basin
Plant Materials Center
2055 Schurz Highway, Fallon, NV 89406
Phone 775-423-7957
https://www.plant-materials.nrcs.usda.gov/nvpmc

2023 Annual Progress Report of Activities

Introduction

The Great Basin Plant Materials Center (GBPMC) is one of 25 Plant Materials Centers (PMC) operated by the United States Department of Agriculture-Natural Resources Conservation Service (NRCS). Each center is strategically located in an ecologically distinct area, creating a network of PMCs uniquely positioned to address local, regional, and national natural resource concerns. Our objective is to evaluate plants and vegetative technologies to support NRCS conservation programs and practices. The GBPMC is specifically tasked with resource concerns in the Great Basin, with a focus on rangeland restoration, soil health, and water conservation.

The GBPMC opened in 2006 and is the newest PMC in the nation. We are located in a cold desert in the rain shadow of the Sierra Nevada mountains where we receive a mean of 4.9 inches of annual precipitation, mostly in the winter. We manage 79 flood irrigated acres, 3 non-irrigated acres, and we conduct off-center field trials as needed.

Figure 1: Summer cover crop trial, with a frame in the foreground where biomass was clipped

This report highlights the activities of the GBPMC in fiscal year 2023. For more detailed information, please contact Christopher Bernau at 775-423-7957 ext. 4, or email at Christopher.Bernau@usda.gov.

Technology Development Studies
Thickspike Wheatgrass and Basin Wildrye Rangeland Adaptation Trial

Figure 2: Year 3 planting for the Thickspike Wheatgrass and Basin Wildrye Rangeland Adaptation Trial

This three-year study evaluated the adaptation of several commercially available releases of thickspike wheatgrass (*Elymus lanceolatus*) and basin wildrye (*Leymus cinereaus*) to salt desert scrub habitats. Also included in the study were 'Vavilov II' Siberian wheatgrass (*Agropyron fragile*) and 'Snowstorm' kochia (*Bassia prostrata*). The study was conducted in a grazing enclosure maintained by the Agricultural Research Service (ARS) in the northern end of Edwards Creek Valley, NV; 68 miles east of the GBPMC. Soil at the site was silt-loam, contains ~2% organic matter, has a pH of ~7.6, and tends to be high in salt. Seeding rate was 8lb/acre for the native grasses, 7lb/acre for Siberian wheatgrass, and 3lb/acre for forage kochia. Precipitation at the site over the last thirteen years averaged 7.3 inches, predominantly falling in the winter.

Seedling emergence was successful for all grass varieties tested. Table 1 contains seedlings per foot per variety for all three years. Basin wildrye averaged 0.6 seedlings per foot with no significant difference between years or varieties. Thickspike wheatgrass seedlings were more numerous in year 2, with 'Critana' outperforming the other varieties with 2.8 seedlings per foot. 'Vavilov II' Siberian wheatgrass was also more numerous year two and had significantly greater emergence than the native bunch grasses for all three years. 'Snowstorm' kochia had no seedlings counted for any year. A germination test after year 2 found that the seeds had extremely low viability. New seed was obtained for year 3, however the year 3 seedling count was still zero. These forage kochia results are unexpected as they run contrary to the ARS' experience in this same enclosure. The ARS has planted both 'Snowstorm' and 'Immigrant' Kochia within the enclosure with great success in previous years.

Figure 3: A bunchgrass in the enclosure with at least eight Mormon crickets visible in the foliage.

Despite the successful seedling emergence, no seedling of any species survived to maturity in any year. Both basin wildrye and thickspike wheatgrass are known for their drought tolerance. However, the salt desert scrub is on the lower range of their known tolerances and the drier than average years at an already dry site may have contributed to the lack of establishment. Stand failure was also likely influenced by herbivory pressure. Mormon cricket (*Anabrus simples*) pressure was particularly high in the area for all three years (fig 3), and livestock were found in the enclosure repeatedly.

Table 1: Thickspike Wheatgrass and Basin Wildrye Rangeland Adaptation Trial Seedling per foot per variety per year

Species:Variety	Year 1 Seedlings/ft	Year 2 Seedlings/ft	Year 3 Seedlings/ft	Average Seedlings/ft
Basin Wildrye: Continental	0.3	1.3	0.3	0.6
Basin Wildrye: Magnar	0.3	1.0	0.7	0.7
Basin Wildrye: Tetra Germplasm	0.7	0.8	0.7	0.7
Basin Wildrye: Trailhead	0.7	1.0	0.4	0.7
Basin Wildrye: Trailhead II	0.5	1.2	0.6	0.8
Forage Kochia: Snow Storm	0.0	0.0	0.0	0.0
Siberian Wheatgrass: Vavilov II	5.0	8.5	2.5	5.3
Thickspike Wheatgrass: Bannock	0.3	1.1	0.9	0.8
Thickspike Wheatgrass: Bannock II	0.4	1.2	1.3	1.0
Thickspike Wheatgrass: Critana	0.3	2.8	1.3	1.4
Thickspike Wheatgrass: Schwendimar	0.5	1.5	0.4	0.8
Thickspike Wheatgrass: Sodar	0.6	0.9	0.2	0.6

Summer Cover Crop Study: Millet, Sunn Hemp, and Cowpea

Figure 4: 30 Days After Planting photo for Year 1 (left), Year 2 (center), and Year 3 (Right).

The third and final year of the millet (multiple species), sunn hemp (*Crotalaria juncea*), and cowpea (*Vigna unguiculata*) trial was planted this summer. The collaborative study evaluated the performance of some of the best heat and drought tolerant cover crops in irrigation limited plantings in Nevada, California, and Arizona. This is of interest to Nevada due to the variable summer irrigation available to producers. In drought years irrigation may become limited, with zero allocation in the most extreme situations. The GBPMC evaluated cover crop performance after two irrigations within the first 30 days after planting (DAP), with the last irrigation in mid-July. The species list, varieties, and results are in table 2. The study design was a randomized block with four replications, and data collected was emergence, DAP to 50% bloom, and dry biomass at 50% bloom or 90 DAP if the plot didn't reach 50% bloom. A composite biomass sample from each variety per year was sent to Sierra Testing Service for forage quality analysis and nitrate content.

In general, all millets established rapidly, making them useful for erosion control in appropriate situations. There were significant biomass production differences between years, species, and varieties (Table 2). These differences are useful to know as cover crop strategies often benefit from higher or lower biomass production depending on field conditions, resource concerns, and management objectives.

DAP to 50% bloom was variable between the tested millet varieties and may have implications for management. Millets that flower early may require additional termination strategies to prevent contamination/volunteers in subsequent crops. Table 2 lists the date of the earliest plot to reach 50% flower in any year per variety, with the average DAP to 50% flower of the three years per variety in parenthesis. 'White' Proso, 'Dove' Proso, and Browntop Millet flowered early in this study. 'German' foxtail, 'White wonder' foxtail, and Japanese millet had mixed results with some plots reaching 50% flower before the 90 DAP termination date. "Leafy 22" and "Tifleaf 3" pearl millets were the only millets that did not reach 50% flower in any plot for all three years. Pearl millets may be the best option of those tested for crop rotations planning on winter frost for termination.

Figure 5: 90 Days After Planting photo for 2021(left), 2022(center), and 2023(Right).

Sunn hemp performance was mixed. Emergence was slower than the other crops but still good (70-90%). Biomass production was 4,229 lb/acre in 2021 but there were stand failures in 2022 and 2023. While sunn hemp has a reputation for drought tolerance, it may be that it requires more water for establishment than this study provided. In addition, there were signs of stress in between irrigations in the first four weeks of the study, suggesting that irrigation timing may have also been a problem. As such, sunn hemp would likely be better as minor component of a mix or not used at all in irrigation limited scenarios in Nevada.

Cowpea variety performance was similar for the three years. Emergence was excellent by 14 DAP and biomass production ranged from 749 to 2659 lb/acre with no significant differences between the varieties tested. Iron and Clay trended a little better than the other two, but in general any of them would likely perform well in similar scenarios.

Nitrates were analyzed and are reported as a percentage of biomass in table 2. In 2021, samples of all varieties, except for sunn hemp, showed potentially toxic or toxic levels of nitrate. However, in 2022 and 2023 all samples recorded non-lethal trace amounts of nitrate. Nitrate concentration can vary as a plant matures, as it experiences stress, and the type of tissue tested (stem vs leaf). High nitrate concentrations may require adaptive management strategies such as diversity of diet, slow acclimation of animals to the higher nitrate feed, supplements that reduce the nitrates effect, and/or avoiding forage when plants are stressed.

Table 2: Emergence ratings, biomass production, nitrate results and number of days after planting till 50% flower for GBPMC 2021-2023 summer cover crop trial.

Species	Variety	2021, 2022, and 2023 Emergence at 14DAP[1]	2021 Biomass[2] (Dry lb/acre)	2022 Biomass[2] (Dry lb/acre)	2023 Biomass[2] (Dry lb/acre)	2021 Nitrate	2022 and 2023 Nitrate	DAP to 50% flower[3]
Cowpea *(Vigna unguiculata)*	'Chinese Red'	Excellent	1,454	1,535	1,401	0.91%	<0.13%	∞
Cowpea *(Vigna unguiculata)*	Iron and Clay	Excellent	2,391	749	2,659	1.40%	<0.13%	∞
Cowpea *(Vigna unguiculata)*	Red Ripper	Excellent	1,169	1,124	1,499	0.53%	<0.13%	∞
Sunn Hemp *(Crotalaria juncea)*	'Tropic Sun'	Good	4,229	339	687	<0.13%	<0.13%	81(89)
Browntop Millet *(Urochloa ramosum)*	Browntop	Excellent	9,279	4,211	3,569	0.84%	<0.13%	59(64)
Japanese Millet *(Echinochloa esculenta)*	Japanese	Excellent	6,450	1,436	1,713	1.15%	<0.13%	81(89)
Proso Millet *(Panicum miliaceum)*	'Dove'	Excellent	9,957	5,380	3,872	0.96%	<0.13%	59(69)
Proso Millet *(Panicum miliaceum)*	'White'	Excellent	4,853	2,659	2,427	1.70%	<0.13%	38(45)
Foxtail Millet *(Setaria italica)*	'German'	Excellent	7,450	3,283	2,891	0.61%	<0.13%	81(88)
Foxtail Millet *(Setaria italica)*	'White Wonder'	Excellent	9,466	2,659	2,721	1.08%	<0.13%	59(83)
Pearl Millet *(Pennisetum glaucum)*	'Leafy 22'	Excellent	9,332	4,059	4,461	1.40%	<0.13%	∞
Pearl Millet *(Pennisetum glaucum)*	'Tifleaf 3'	Excellent	8,235	4,987	6,459	1.49%	<0.13%	∞

[1]Excellent = >90%; Good =70-90%
[2]Biomass collected at 50% bloom, or at 90 DAP if the plot never reached 50% bloom.
[3]Date recorded is the earliest plot that reached 50% flower out of the three years, with the average of the three years in parenthesis. ∞ is used when no plot reached 50% flower by 90DAP.

Outreach

Outreach for fiscal year 2023 was focused on assisting state specialists with local and regional trainings. In May, the GBPMC assisted with a multi-day regional soil health and sustainability training led by the Nevada state soil scientist and the Soil Health Division. The GBPMC designed and presented on a cover crop guidance table (fig 6) that highlighted the best plant species to use per resource concern. In August, the GBPMC assisted the state resource team with a Conservation Planner training with the objective of providing job approval authority on a variety of topics. Throughout that training the GBPMC was available for consultation and assistance for rangeland inventory and health assessment, plant identification, cover crops, and soil health.

Figure 6: The GBPMC presenting on a cover crop guidance table at a soil health training.

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