SEED PRODUCTION OF NATIVE FORBS SHOWS LITTLE RESPONSE TO IRRIGATION IN A WET YEAR

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Introduction

Native forb seed is needed to restore rangelands of the Intermountain West. Commercial seed production is necessary to provide the quantity of seed needed for restoration efforts. A major limitation to economically viable commercial production of native forb seed is stable and consistent seed productivity over years. Variations in spring rainfall and soil moisture result in highly unpredictable water stress at seed set and development. Excessive water stress during seed set and development is known to compromise yield and quality of other seed crops.

Native forbs are not competitive with crop weeds. Both sprinkler and furrow irrigation promote seed production, but risk encouraging weeds. Furthermore, sprinkler and furrow irrigation can lead to the loss of plant stand and seed production to fungal pathogens. By burying drip tapes at 12-inch depth, and avoiding wetting of the soil surface, we hope to assure flowering and seed set without encouraging weeds or opportunistic diseases. This trial tested the effect of three irrigation intensities on the seed yield of seven native forb species.

Materials and Methods

Plant Establishment

Seed of seven Intermountain West forb species (Table 1) was received in late November in 2004 from the Rocky Mountain Research Station (Boise, ID). The plan was to plant the seed in the fall of 2004, but due to excessive rainfall in October, the ground preparation was not completed and planting was postponed to 2005. To ensure germination the seed was submitted to a cold stratification treatment. The seed was soaked overnight in distilled water on January 26, 2005. After soaking, the water was drained and the seed soaked for 20 minutes in a 10 percent by volume solution of 13 percent bleach in distilled water. The water was drained and the seed placed in a thin layer in plastic containers. The plastic containers had lids with holes drilled to allow air movement. The seed containers were placed in a cooler set at approximately 34°F.

Every few days the seed was mixed and, if necessary, distilled water added to maintain the seed moisture. In late February, seed of *Lomatium grayi* and *L. triternatum* had started sprouting.

Table 1. Forb species planted at the Malheur Experiment Station, Oregon State University, Ontario, OR, and their origins.

Species	Common name	Origin	Year
Eriogonum umbellatum	Sulfur buckwheat	Shoofly Road	2004
Penstemon acuminatum	Sand penstemon	Bliss Dam	2004
Penstemon deustus	Hotrock penstemon	Black Cr. Rd.	2003
Penstemon speciosus	Royal or sagebrush penstemon	Leslie Gulch	2003
Lomatium dissectum	Fernleaf biscuitroot	Mann Creek	2003
Lomatium triternatum	Nineleaf desert parsley	Hwy 395	2004
Lomatium grayi	Gray's lomatium	Weiser R. Road	2004

In late February, 2005, drip tape (T-Tape TSX 515-16-340) was buried at 12-inch depth between two rows (30-inch rows) of a Nyssa silt loam. The drip tape was buried on alternating inter-row spaces (5 ft apart). The flow rate for the drip tape was 0.34 gal/min/100 ft at 8 PSI with emitters spaced 16 inches apart, resulting in a water application rate of 0.066 inch/hour.

The trial was conducted in a field of Nyssa silt loam with a pH of 8.3 and 1.1 percent organic matter. On March 3, seed of all species was planted in 30-inch rows using a custom-made plot grain drill with disk openers. All seed was planted at 20-30 seeds/ft of row. The *Eriogonum umbellatum* and the *Penstemon* spp. were planted at 0.25-inch depth and the *Lomatium* spp. at 0.5-inch depth. The trial was irrigated with a minisprinkler system (R10 Turbo Rotator, Nelson Irrigation Corp., Walla Walla, WA) for even stand establishment from March 4 to April 29. Risers were spaced 25 ft apart along the flexible polyethylene hose laterals that were spaced 30 ft apart and the water application rate was 0.10 inch/hour. A total of 1.72 inches of water was applied with the minisprinkler system. *Eriogonum umbellatum*, *Lomatium triternatum*, and *L. grayi* started emerging on March 29. All other species, except *L. dissectum*, emerged by late April. Starting June 24, the field was irrigated using the drip system. A total of 3.73 inches of water was applied with the drip system from June 24 to July 7. Thereafter the field was not irrigated.

Plant stands for *Eriogonum umbellatum*, *Penstemon* spp., *Lomatium triternatum*, and *L. grayi* were uneven. *L. dissectum* did not emerge. None of the species flowered in 2005. In early October, 2005, more seed was received from the Rocky Mountain Research Station for replanting. In the *Eriogonum umbellatum* and *Penstemon* spp. plots the blank lengths of row were replanted by hand. The *Lomatium* spp. plots had the entire row lengths replanted using the planter. The seed was replanted on October 26, 2005. In the spring of 2006, plant stand of the replanted species was excellent, except for *Penstemon deustus*.

Irrigation for Seed Production

In April, 2006, the field was divided into plots 30 ft long. Each plot contained four rows of each of the seven forb species. The experimental design was a randomized complete block with four replicates. The three irrigation treatments were: a nonirrigated check, 1 inch per irrigation for a total of 4.8 inches, and 2 inches per irrigation for a total of 8.7 inches. Four irrigations were applied approximately every 2 weeks starting on May 19. The amount of water applied to each plot was measured by a water meter for each plot and recorded after each irrigation (Table 2). At the first irrigation on May 19, *Penstemon acuminatum* had ended flowering, *P. deustus* and *P. speciosus* were flowering, and *Eriogonum umbellatum* was just starting to flower.

Soil volumetric water content was measured by neutron probe. The neutron probe was calibrated by taking soil samples and probe readings at 8-, 20-, and 32-inch depths during installation of the access tubes. The soil water content was determined volumetrically from the soil samples and regressed against the neutron probe readings, separately for each soil depth. The regression equations were then used to transform the neutron probe readings during the season into volumetric soil water content.

Eriogonum umbellatum flowering started on May 19, peaked on June 24, and ended on July 28. *Penstemon acuminatum* flowering started on May 2, peaked on May 10, and ended on May 19. *P. speciosus* flowering started on May 10 and peaked on May 19. *P. deustus* flowering started on May 10, and peaked on May 22.

The *Eriogonum umbellatum* and *Penstemon* spp. plots produced seed in 2006, probably because they had emerged in the spring of 2005. In these plots, only the lengths of row that had consistent stand and seed production were harvested. The plant stand for *Penstemon deustus* was too poor to result in reliable seed yield estimates. The middle two rows of each plot were harvested using a Wintersteiger Nurserymaster small plot combine. *P. acuminatum* was harvested on July 7, *P. speciosus* was harvested on July 13, *E. umbellatum* was harvested on August 3, and *P. deustus* was harvested on August 4.

Eriogonum umbellatum seeds did not separate from the flowering structures in the combine. *E. umbellatum* unthreshed seed was taken to the U.S. Forest Service Lucky Peak Nursery and run through a dewinger to separate seed. The seed was further cleaned in a small clipper seed cleaner.

Penstemon deustus seed pods were too hard to be opened in the combine; the unthreshed seed was precleaned in a small clipper seed cleaner and then seed pods were broken manually by rubbing the pods on a ribbed rubber mat. The seed was then cleaned again in the small clipper seed cleaner.

Penstemon acuminatum and *P. speciosus* seeds were threshed in the combine and the seed was further cleaned using a small clipper seed cleaner.

Results and Discussion

Precipitation in 2005 and 2006 was higher than normal at the Malheur Experiment Station (Fig. 1). Precipitation from October 2004 through June 2005 totaled 11.1 inches and from October 2005 through June 2006 totaled 15.9 inches. The 62-year average precipitation for October through June is 9.2 inches. The wet weather could have attenuated the effects of the irrigation treatments. The actual amount of water applied for each irrigation treatment was relatively close to the planned amounts (Tables 2 and 3). The soil volumetric water content responded to the irrigation treatments (Figs. 2-4 and Table 4).

There was no significant difference in seed yield between irrigation treatments for *Penstemon acuminatum*, *P. deustus,* and *P. speciosus* (Table 3). *Eriogonum umbellatum* showed a trend for increasing seed yield with increasing irrigation, with the 2-inch irrigation rate resulting in higher seed yield than the 1-inch irrigation rate or the non-irrigated check. Compared to the *Penstemon* spp., *E. umbellatum* started flowering later, at about the same time as the start of the irrigation treatments. *P. acuminatum* had ended flowering at the start of the irrigation treatments. *P. speciosus* and *P. deustus* were in mid flowering at the start of the irrigation treatments. The later reproductive stage of *E. umbellatum* might explain the response to the irrigation treatments.

The lack of seed yield response to irrigation of the *Penstemon* spp. in this trial is consistent with substantial rainfall over the winter and spring of 2006 and consistent with the rangelands showing vigorous growth of native plants in the spring of 2006.

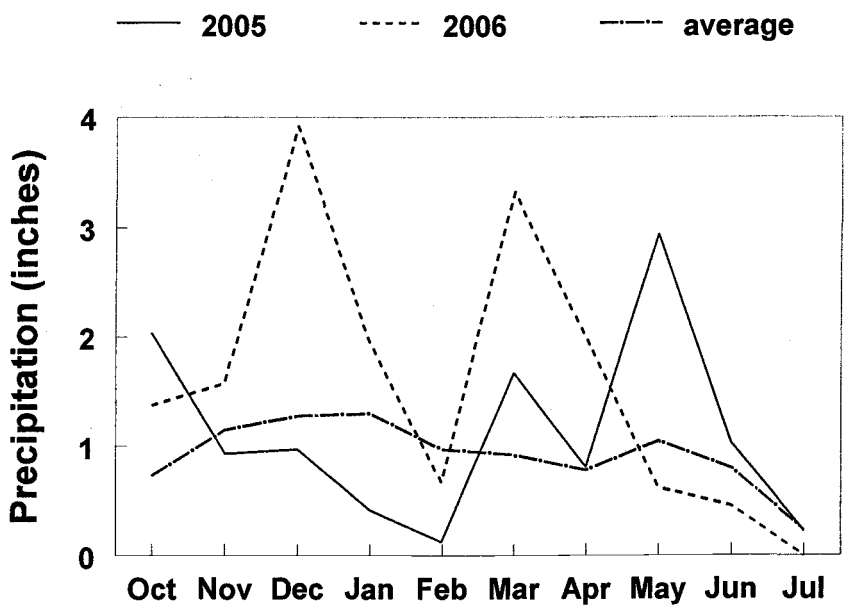

Figure 1. Monthly precipitation from October of the previous year through July for the displayed years. Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

Table 2. Irrigation treatments and actual amounts of water applied to native forbs. Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

	Irrigation rates (inches per irrigation)	
Date	Planned	Actual
May 19	2	2.2
	1	1.3
June 2	2	2.2
	1	1.2
June 20	2	2
	1	1.2
June 30	2	2.3
	1	1.1
Total	8	8.7
	4	4.8

Table 3. Native forb seed yield response to irrigation rate. Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

Total irrigation applied	*Eriogonum umbellatum*	*Penstemon acuminatum*	*Penstemon deustus*[a]	*Penstemon speciosus*
inches	---------- lb/acre ----------			
8.7	371.6	544.0	1,068.6	213.6
4.8	214.4	611.1	1,200.8	285.4
0	155.3	538.4	1,246.4	163.5
LSD (0.05)	92.9	NS	NS	NS

[a]Yields might overestimate potential commercial yields due to small areas harvested.

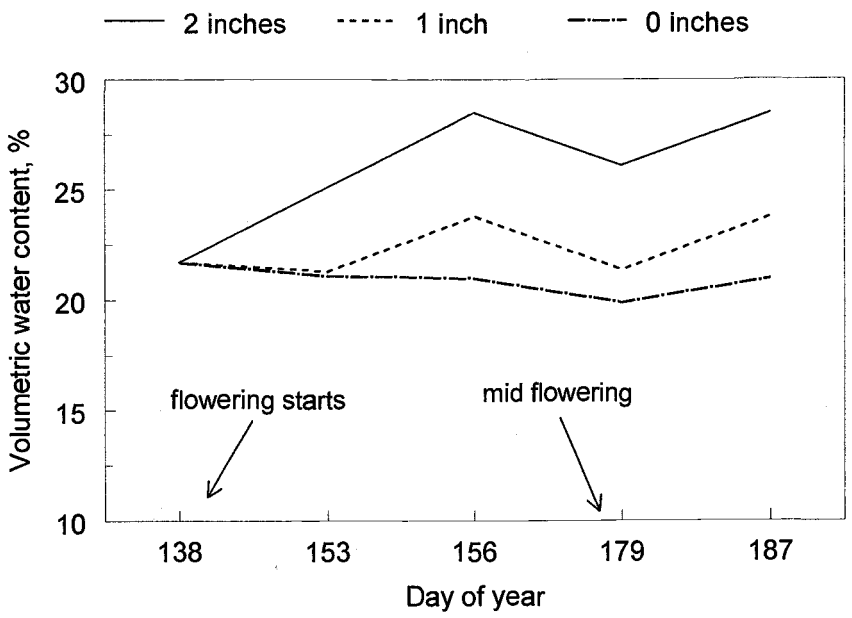

Figure 2. Soil volumetric water content for *Eriogonum umbellatum* over time. Soil volumetric water content is the combined average at the 8-, 20-, and 32-inch depths. *E. umbellatum* was harvested on August 3 (day 215). Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

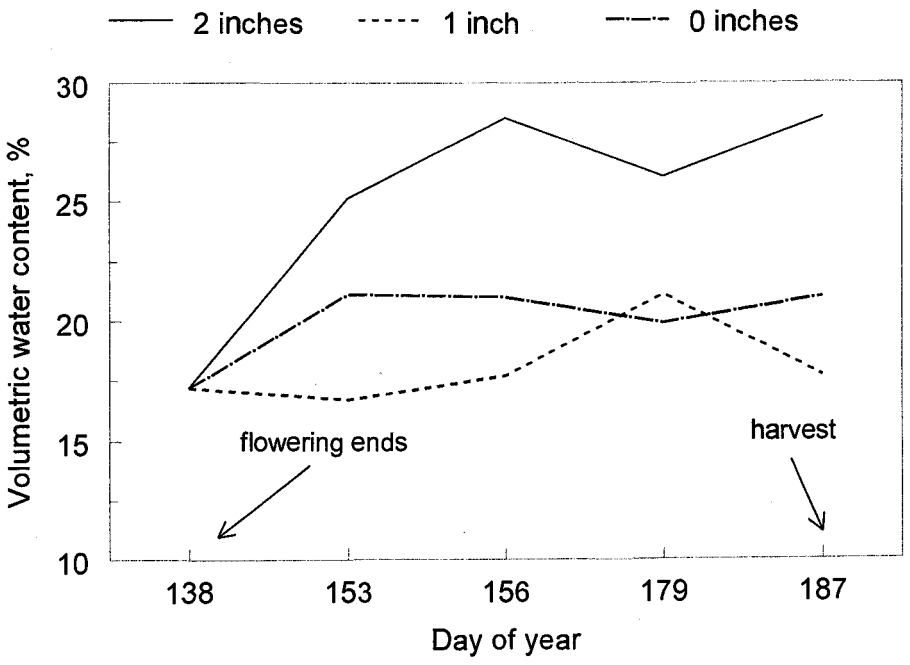

Figure 3. Soil volumetric water content for *Penstemon acuminatum* over time. Soil volumetric water content is the combined average at the 8-, 20-, and 32-inch depths. Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

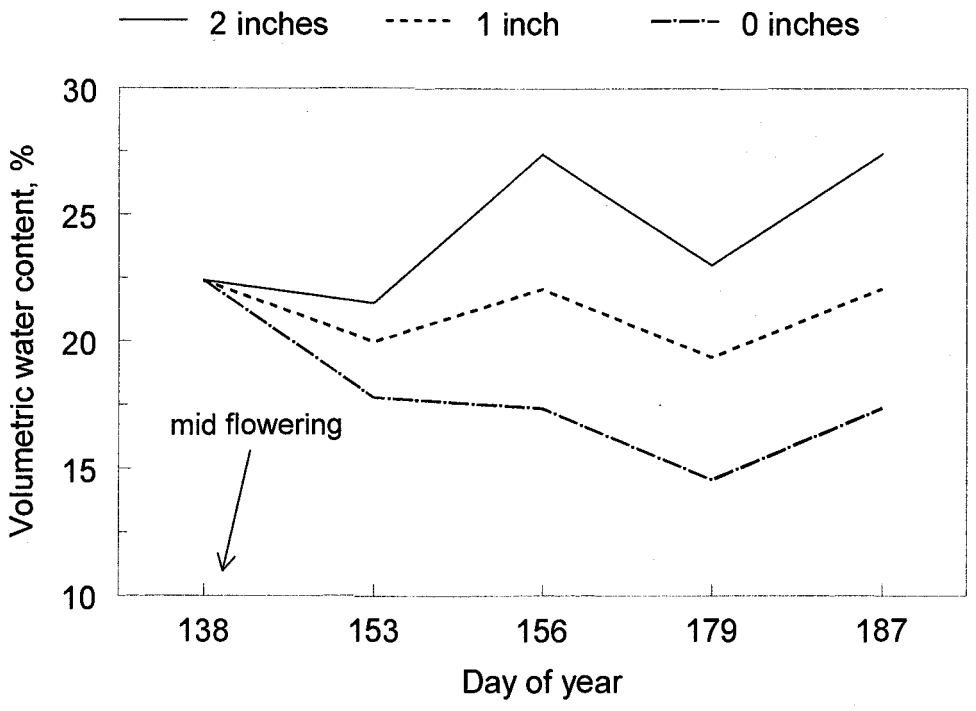

Figure 4. Soil volumetric water content for *Penstemon speciosus* over time. Soil volumetric water content is the combined average at the 8-, 20-, and 32-inch depths. *P. speciosus* was harvested on July 13 (day 194). Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

Table 4. Soil volumetric water content for native forb species submitted to three irrigation intensities, Malheur Experiment Station, Oregon State University, Ontario, OR.

	18-May			2-Jun			5-Jun			28-Jun			6-Jul		
Depth	2 inches[a]	1 inch	0 inches	2 inches	1 inch	0 inches	2 inches	1 inch	0 inches	2 inches	1 inch	0 inches	2 inches	1 inch	0 inches
							Eriogonum umbellatum								
0.2 m	16.4	16.4	16.4	17.9	15.6	14.1	22.3	19.1	14.0	19.8	13.6	12.4	21.0	14.7	5.1
0.5 m	24.5	24.5	24.5	28.7	24.2	25.4	32.1	26.6	25.3	29.7	22.8	24.1	30.1	24.2	16.4
0.8 m	24.2	24.2	24.2	28.6	24.1	23.7	31.1	25.6	23.7	28.8	27.7	23.1	29.3	26.2	22.5
Average	21.7	21.7	21.7	25.1	21.3	21.1	28.5	23.8	21.0	26.1	21.4	19.9	28.5	23.8	21.0
							Penstemon acuminatum								
0.2 m	11.2	11.2	11.2	17.9	10.7	14.1	22.3	11.7	14.0	19.6	16.1	12.4	21.5	12.8	7.0
0.5 m	19.0	19.0	19.0	28.7	18.7	25.4	32.1	20.5	25.3	30.5	23.7	24.1	32.2	22.5	17.2
0.8 m	21.3	21.3	21.3	28.6	20.7	23.7	31.1	20.8	23.7	27.9	23.6	23.1	28.6	21.8	21.0
Average	17.2	17.2	17.2	25.1	16.7	21.1	28.5	17.7	21.0	26.0	21.1	19.9	28.5	17.7	21.0
							Penstemon speciosus								
0.2 m	13.1	13.1	13.1	12.1	13.7	9.8	18.0	17.0	9.5	13.6	13.2	7.3	17.3	14.6	7.1
0.5 m	30.3	30.3	30.3	25.2	22.6	22.1	32.4	25.1	21.5	26.8	22.4	18.1	29.5	23.2	17.4
0.8 m	23.9	23.9	23.9	27.4	23.6	21.6	31.8	24.1	21.2	28.7	22.8	18.4	29.8	23.1	17.8
Average	22.4	22.4	22.4	21.5	20.0	17.8	27.4	22.1	17.4	23.0	19.4	14.6	27.4	22.1	17.4

[a]Inches of water per irrigation.