IRRIGATION REQUIREMENTS FOR NOVEL NATIVE WILDFLOWER SEED PRODUCTION

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Introduction

Native wildflower 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 wildflower (forb) seed is stable and consistent seed productivity over years.

In natural rangelands, the natural variations in spring rainfall and soil moisture result in highly unpredictable water stress at flowering, seed set, and seed development, which for other seed crops is known to compromise seed yield and quality.

Native wildflower plants are not adapted to croplands. Native plants are often not competitive with crop weeds in cultivated fields. Poor competition with weeds could also limit wildflower seed production. Both sprinkler and furrow irrigation could provide supplemental water for seed production, but these irrigation systems risk further encouraging weeds. Also, sprinkler and furrow irrigation can lead to the loss of plant stand and seed production due to fungal pathogens. By burying drip tapes at 12-inch depth and avoiding wetting the soil surface, we hoped to assure flowering and seed set without undue encouragement of weeds or opportunistic diseases. The trials reported here tested the effects of three low rates of irrigation on the seed yield of 10 native forb species (Table 1) planted in 2009.

Materials and Methods

Plant Establishment

In November 2009, drip tape (T-Tape TSX 515-16-340) was buried at 12-inch depth between 2 30-inch rows of a Nyssa silt loam with a pH of 8.3 and 1.1 percent organic matter. The drip tape was buried in 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.

On November 25, 2009 seed of all species was planted in 30-inch rows using a custom-made plot grain drill with disk openers. All seed was planted on the soil surface at 20-30 seeds/ft of row. After planting, sawdust was applied in a narrow band over the seed row at 0.26 oz/ft of row (558

lb/acre). Following planting and sawdust application, the beds were covered with row cover. The row cover (N-sulate, DeWitt Co., Inc., Sikeston, MO) covered four rows (two beds) and was applied with a mechanical plastic mulch layer. The field was irrigated for 24 hours on December 2, 2009 due to very dry soil conditions.

After the newly planted forbs had emerged, the row cover was removed in April. The irrigation treatments were not applied to these forbs in 2010. Stands of *Penstemon cyaneus*, *Penstemon pachyphyllus*, and *Eriogonum heraculeoides* were not adequate for an irrigation trial. Gaps in the rows were replanted by hand on November 5. The replanted seed was covered with a thin layer of a mixture of 50 percent sawdust and 50 percent hydro seeding mulch (Hydrostraw LLC, Manteno, IL) by volume. The mulch mixture was sprayed with water using a backpack sprayer.

Table 1. Forb species planted in the drip irrigation trials in 2009 at the Malheur Experiment Station, Oregon State University, Ontario, OR.

Species	Common names
Penstemon deustus	Scabland penstemon, hotrock penstemon
Penstemon cyaneus	Blue penstemon
Penstemon pachyphyllus	Thickleaf beardtongue
Eriogonum heracleoides	Parsnip-flowered buckwheat
Dalea searlsiae	Searls' prairie clover
Dalea ornata	Western prairie clover, Blue Mountain prairie clover
Astragalus filipes	Basalt milkvetch
Cleome serrulata	Rocky mountain beeplant
Lomatium nudicaule	Bare-stem desert parsley, Barestem lomatium
Cymopterus bipinnatus	Hayden's cymopterus

Irrigation for Seed Production

In April, 2011, each plot strip of each forb species was divided into plots 30 ft long. Each plot contained four rows of each species. The experimental design for each species was a randomized complete block with four replicates. The three irrigation treatments were a nonirrigated check, 1 inch per irrigation, and 2 inches per irrigation. Each treatment received 4 irrigations that were applied approximately every 2 weeks starting with flowering of the forbs. The amount of water applied to each treatment was calculated by the length of time necessary to deliver 1 or 2 inches through the drip system; the amount was measured by a water meter and recorded after each irrigation to ensure correct water applications. Irrigations were controlled with a controller and solenoid valves.

The drip-irrigation system was designed to allow separate irrigation of the species due to different timings of flowering and seed formation. The three *Penstemon* spp. were irrigated together and the two *Dalea* spp. were irrigated together. *Eriogonum heracleoides* and *Astragalus filipes* were irrigated individually. Flowering, irrigation, and harvest dates were recorded (Table 2). *Lomatium nudicaule* and *Cymopterus bipinnatus* have not flowered as of 2011. Irrigation treatments were not applied to *Lomatium nudicaule* and *Cymopterus bipinnatus.*

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, for each soil depth. Regression equations were then used to transform the neutron probe readings during the season into volumetric soil water content.

Table 2. Native forb flowering, irrigation, and seed harvest dates by species in 2011, Malheur Experiment Station, Oregon State University, Ontario, OR.

	Flowering			Irrigation		
Species	Start	Peak	End	Start	End	Harvest
Penstemon cyaneus	23-May	15-Jun	8-Jul	13-May	23-Jun	18-Jul
Penstemon pachyphyllus	10-May	30-May	20-Jun	13-May	23-Jun	15-Jul
Penstemon deustus	23-May	20-Jun	14-Jul	13-May	23-Jun	16-Aug
Eriogonum heracleoides	26-May	10-Jun	8-Jul	27-May	6-Jul	1-Aug
Dalea searlsiae	8-Jun	20-Jun	20-Jul	27-May	6-Jul	21-Jul
Dalea ornata	8-Jun	20-Jun	20-Jul	27-May	6-Jul	22-Jul
Astragalus filipes	20-May	26-May	30-Jun	13-May	23-Jun	18-Jul
Cleome serrulata	25-Jun	30-Jul	15-Aug	21-Jun	2-Aug	26-Sep
Lomatium nudicaule		No flowering				
Cymopterus bipinnatus		No flowering				

Results and Discussion

The spring of 2011 followed considerable snowpack and had higher than average precipitation and lower than average growing degree-days (Figs. 1 and 2).

The soil volumetric water content in the various species in 2011 responded to the irrigation treatments on each species (Figs. 3-7) and remained fairly moist due to winter precipitation and the continued precipitation in 2011. The soil moisture content remained above 20 percent until mid-June for all species and irrigation treatments.

Seed Yields

Seed yield of all species, except *Cleome serrulata*, either had a negative response to irrigation (*Dalea searlsiae* and *Penstemon deustus*) or did not respond to irrigation (*Dalea ornata* and *Astragalus filipes*) (Table 3, Figs. 8 to 13). Seed yield of *Cleome serrulata* was highest with the highest amount of water applied (8 inches). The higher than average winter moisture and precipitation in March and May reduced the effect of the irrigation treatments for the species that flowered in May and June. *Cleome serrulata* started flowering in late June and peaked in August, when precipitation was lower. Seed yields of *Penstemon cyaneus* and *P. pachyphyllus* did not respond to irrigation, but the results might be compromised by the poor stand in many plots.

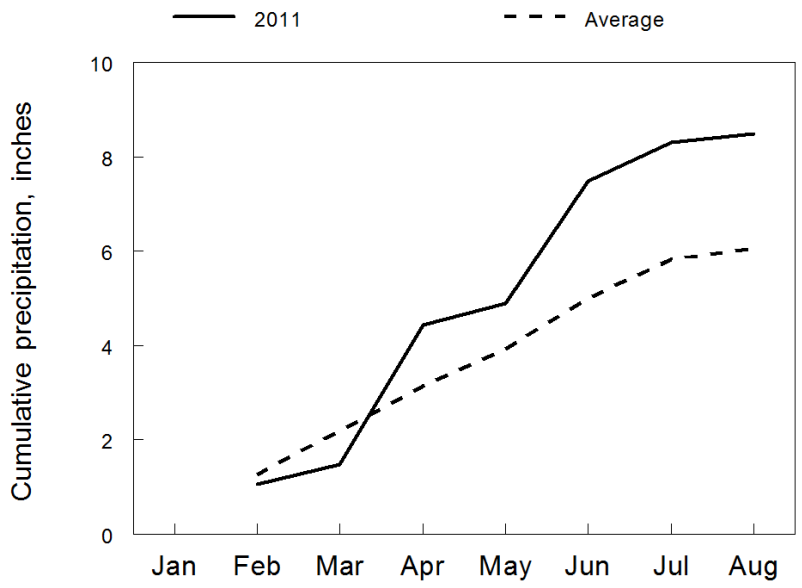

Figure 1. Cumulative annual and 66-year average precipitation from January through July at the Malheur Experiment Station, Oregon State University, Ontario, OR.

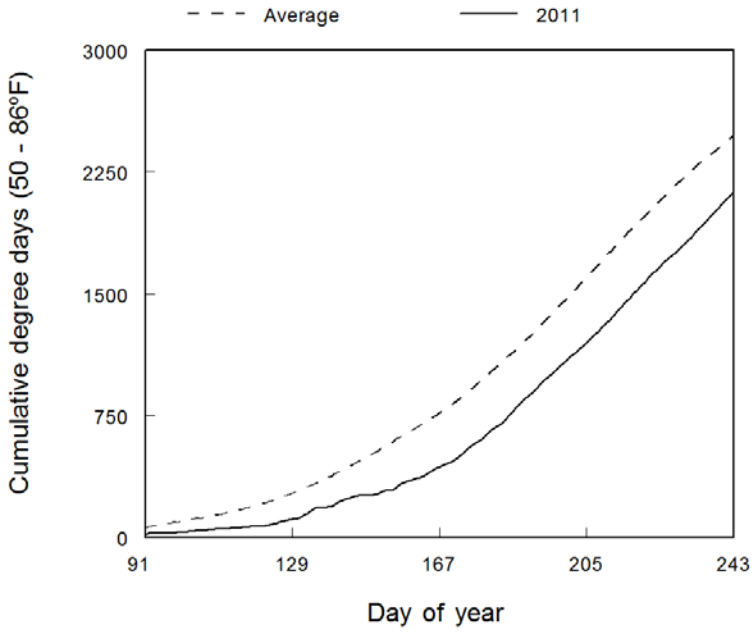

Figure 2. Cumulative 2011 and 20-year average growing degree-days at the Malheur Experiment Station, Oregon State University, Ontario, OR.

Table 3. Native forb seed yield response to irrigation rate (inches/season) in 2011. Malheur Experiment Station, Oregon State University, Ontario, OR.

Species	0 inches	4 inches	8 inches	LSD (0.05)
	---------- lb/acre ----------			
Penstemon cyaneus[a]	857.2	821.4	909.4	NS
Penstemon pachyphyllus[a]	569.9	337.6	482.2	NS
Penstemon deustus	637.6	477.8	452.6	NS
Eriogonum heracleoides	55.2	71.6	49.0	NS
Dalea searlsiae	262.7	231.2	196.3	50.1
Dalea ornata	451.9	410.8	351.7	NS
Astragalus filipes	87.0	98.4	74.0	NS
Cleome serrulata	446.5	499.3	593.6	100.9[b]

[a]poor stand
[b]LSD (0.10)

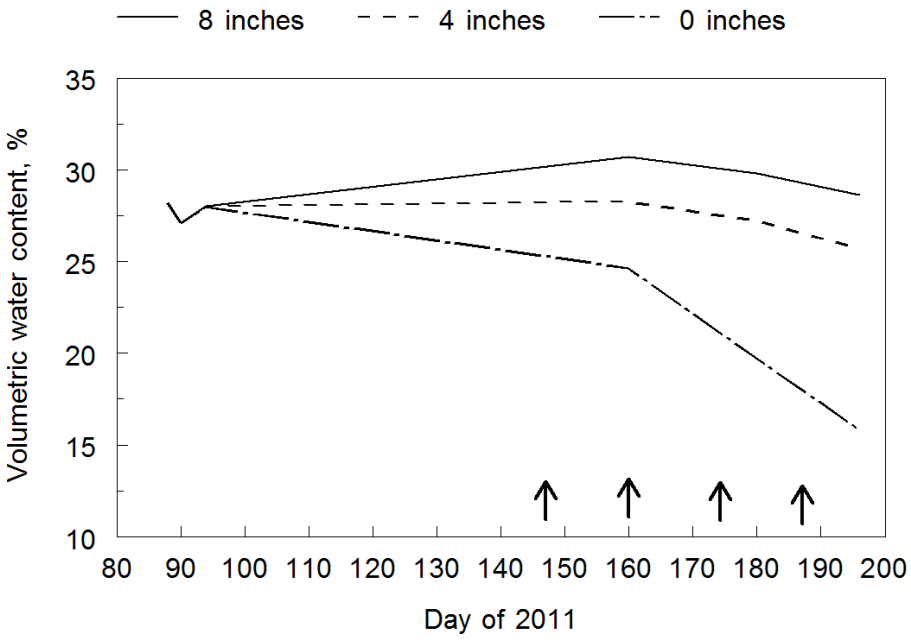

Figure 3. Soil volumetric water content for Eriogonum heracleoides *over time in 2011. Soil volumetric water content is the combined average at the 8-, 20-, and 32-inch depths. Irrigations started on May 27 and ended on July 6. Arrows denote irrigations.* E. heracleoides *was harvested on August 1 (day 213). Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.*

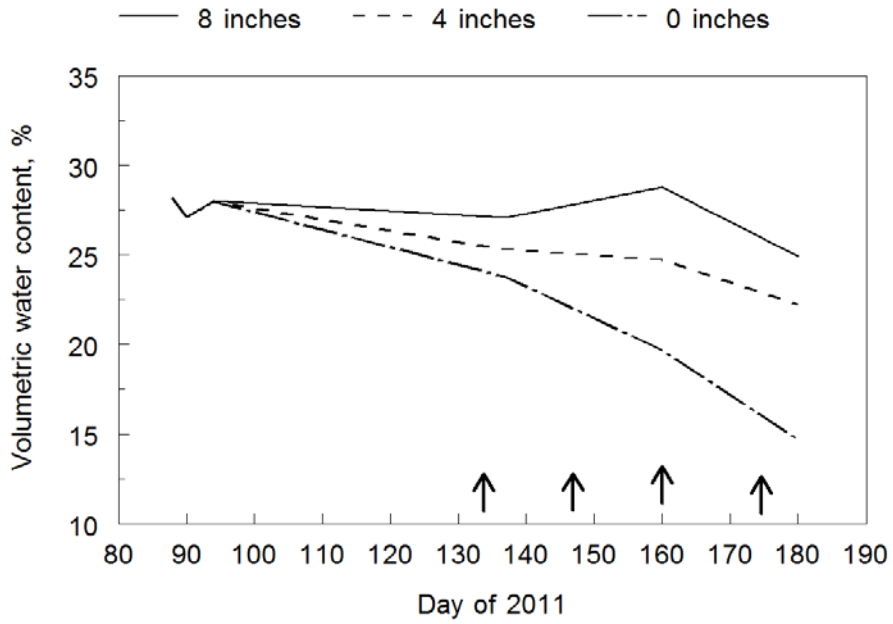

Figure 4. Soil volumetric water content for Penstemon deustus *over time in 2011. Soil volumetric water content is the combined average at the 8-, 20-, and 32-inch depths. Irrigations started on May 13 and ended on June 23. Arrows denote irrigations.* P. deustus *was harvested on August 16 (day 228). Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.*

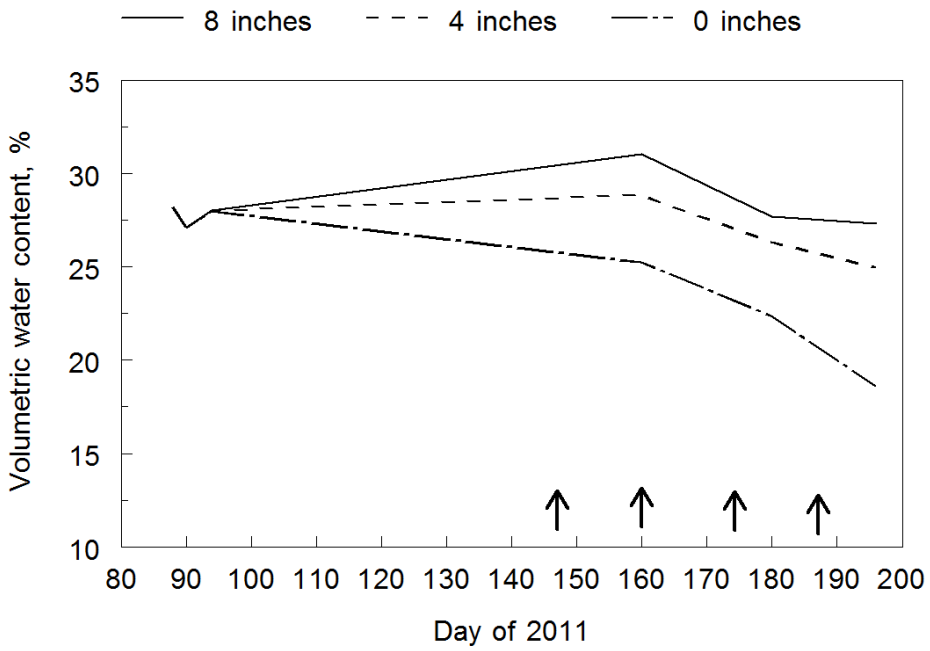

Figure 5. Soil volumetric water content for Dalea searlsiae *over time in 2011. Soil volumetric water content is the combined average at the 8-, 20-, and 32-inch depths. Irrigations started on May 27 and ended on July 6. Arrows denote irrigations.* D. searlsiae *was harvested on July 21 (day 202). Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.*

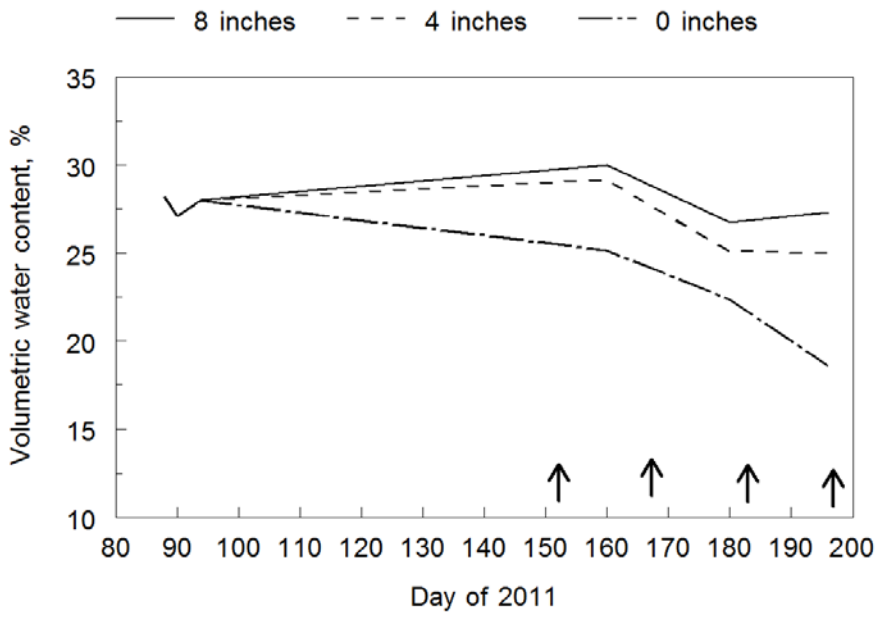

Figure 6. Soil volumetric water content for Dalea ornata *over time in 2011. Soil volumetric water content is the combined average at the 8-, 20-, and 32-inch depths. Irrigations started on May 27 and ended on July 6. Arrows denote irrigations.* D. ornata *was harvested on July 22 (day 203). Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.*

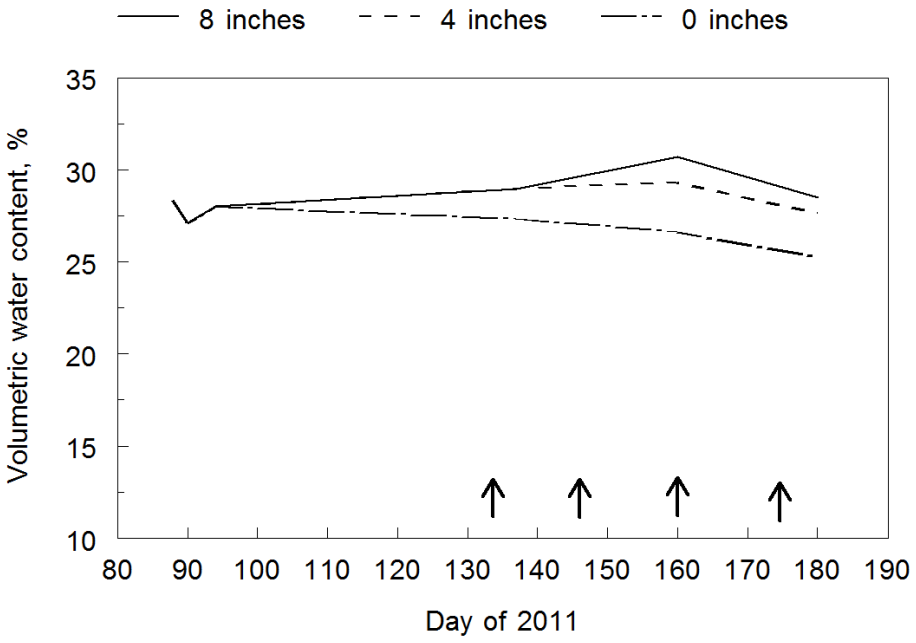

Figure 7. Soil volumetric water content for Astragalus filipes *over time in 2011. Soil volumetric water content is the combined average at the 8-, 20-, and 32-inch depths. Irrigations started on May 13 and ended on June 23. Arrows denote irrigations.* A. filipes *was harvested on July 18 (day 199). Malheur Experiment Station, Oregon State University, Ontario, OR, 2011.*

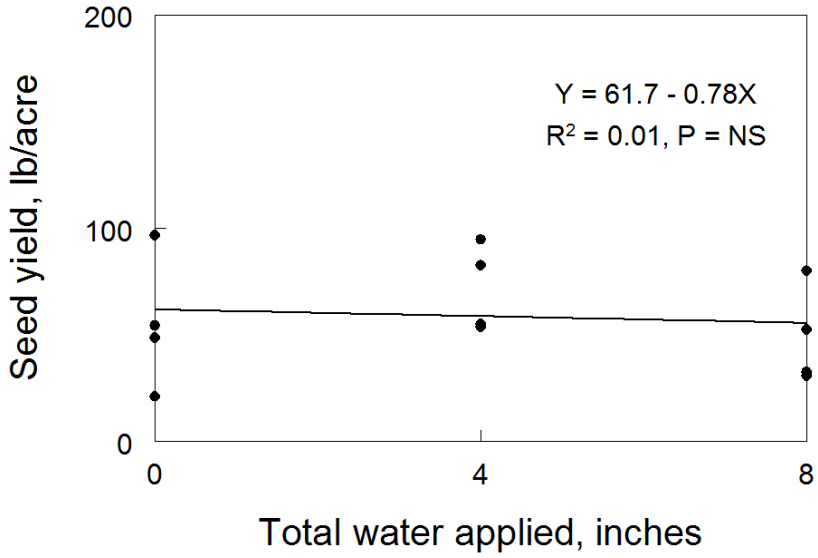

Figure 8. Eriogonum heracleoides *seed yield response to irrigation water applied in 2011, Malheur Experiment Station, Oregon State University, Ontario, OR.*

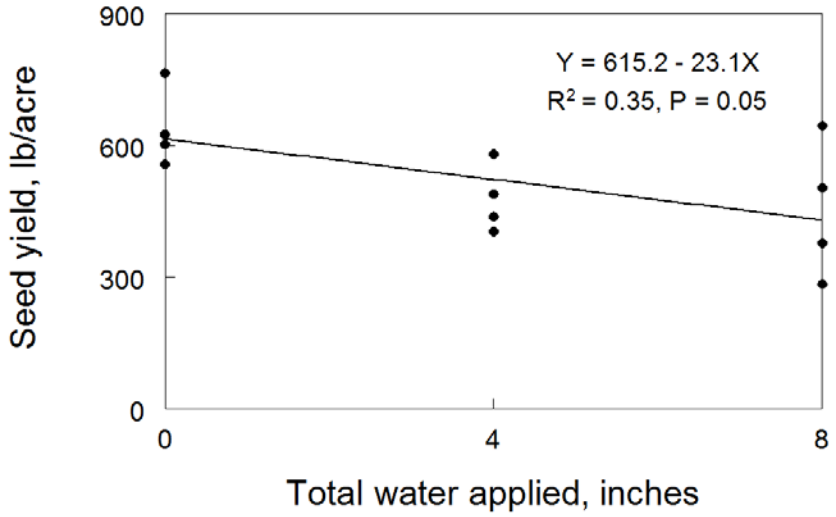

Figure 9. Penstemon deustus *seed yield response to irrigation water applied in 2011. Malheur Experiment Station, Oregon State University, Ontario, OR.*

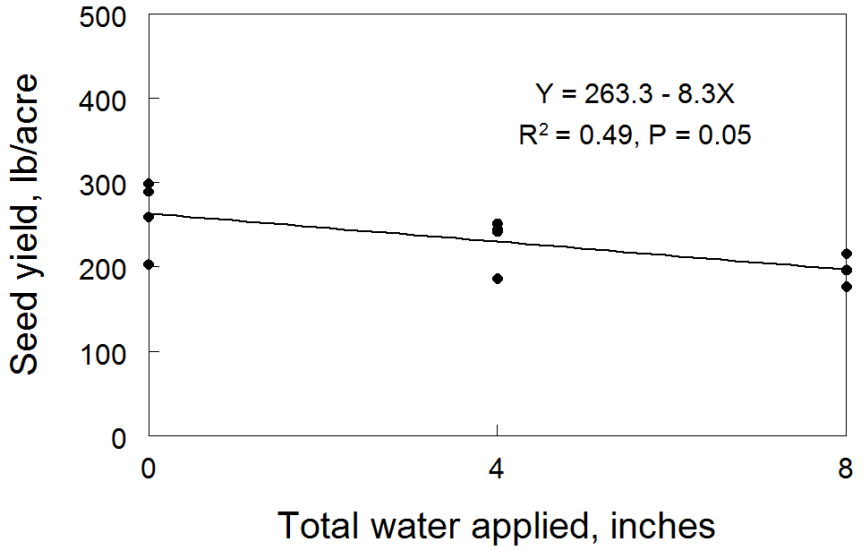

Figure 10. Dalea searlsiae *seed yield response to irrigation water applied in 2011. Malheur Experiment Station, Oregon State University, Ontario, OR.*

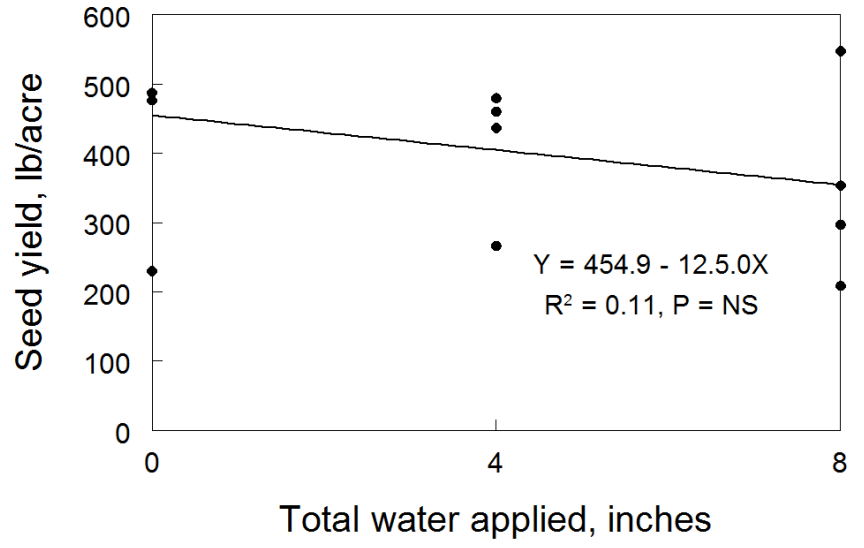

Figure 11. Dalea ornata *seed yield response to irrigation water applied in 2011. Malheur Experiment Station, Oregon State University, Ontario, OR.*

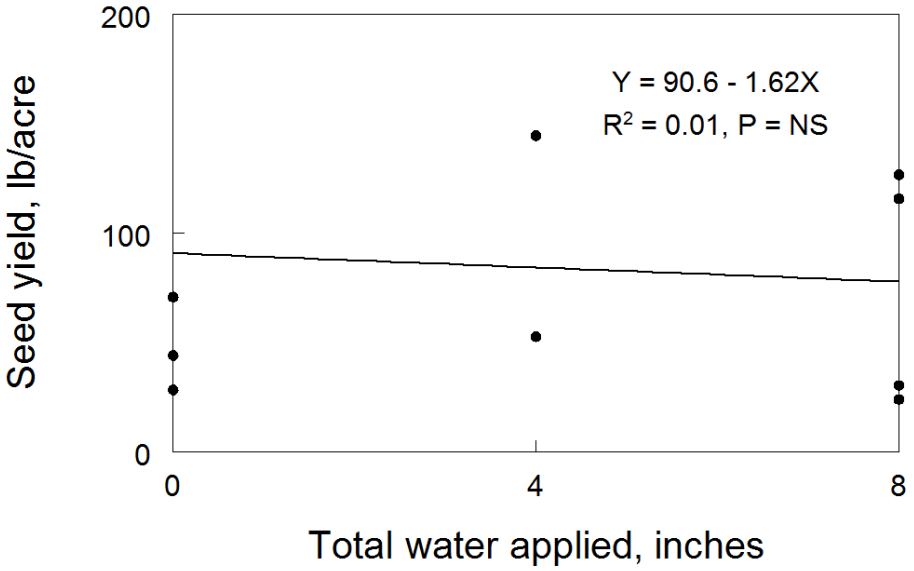

Figure 12. Astragalus filipes *seed yield response to irrigation water applied in 2011. Malheur Experiment Station, Oregon State University, Ontario, OR.*

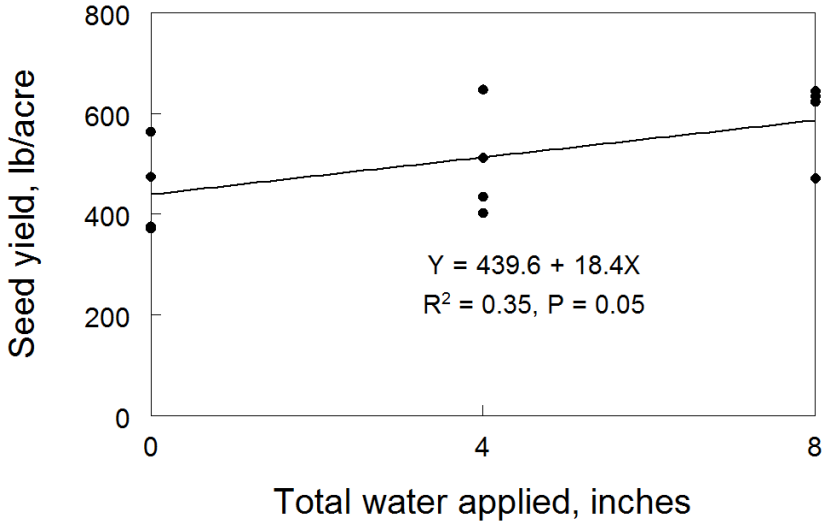

Figure 13. Cleome serrulata *seed yield response to irrigation water applied in 2011. Malheur Experiment Station, Oregon State University, Ontario, OR.*