NATIVE BEEPLANT SEED PRODUCTION IN RESPONSE TO IRRIGATION IN A SEMI-ARID ENVIRONMENT

Clinton C. Shock, Erik B. G. Feibert, Alicia Rivera, and Lamont D. Saunders, Malheur Experiment Station, Oregon State University, Ontario, OR, 2015

Nancy Shaw and Francis Kilkenny, U.S. Forest Service, Rocky Mountain Research Station, Boise, ID

Summary

Beeplants (*Cleome* spp.) are annual species that favor pollinators in the Intermountain West. Beeplant seed is desired for rangeland restoration activities, but little cultural practice information is known for its seed production. The seed yield response of *Cleome serrulata* (Rocky Mountain beeplant) and *C. lutea* (yellow spiderflower or yellow beeplant) to four biweekly irrigations applying either 0, 1, or 2 inches of water (total of 0, 4 inches, or 8 inches/season) was evaluated over multiple years. *Cleome serrulata* seed yield was maximized by 8 inches of water applied per season in 2011, but did not respond to irrigation in 2012, 2014, or 2015. *Cleome lutea* seed yield did not respond to irrigation in 2012, 2014, or 2015. Cleome stands were lost to flea beetles in 2013.

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 annual variation in spring rainfall and soil moisture results 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 well adapted to croplands; they do not compete well with crop weeds in cultivated fields, which could also limit their 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 designed experiments 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 *Cleome serrulata* (Rocky Mountain beeplant) and *C. lutea* (yellow beeplant).

Materials and Methods

Plant establishment

Each species was planted in separate strips containing 4 rows 30 inches apart (a 10-ft-wide strip) and about 450 ft long on Nyssa silt loam at the Malheur Experiment Station, Ontario, Oregon. The soil had a pH of 8.3 and 1.1% organic matter. In October 2010, 2 drip tapes 5 ft apart (T-Tape TSX 515-16-340) were buried at 12-inch depth to irrigate the four rows in the plot. Each drip tape irrigated two rows of plants. 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.

Starting in 2010, seed of *Cleome serrulata* was planted each year in 30-inch rows using a custom-made plot grain drill with disc openers in mid-November. All seed was planted on the soil surface at 20-30 seeds/ft of row in the same location each year. 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. Starting in 2011, seed of *C. lutea* was also planted each year. After the newly planted wildflowers had emerged, the row cover was removed in April each year.

Starting in 2013, each spring after the row cover was removed, bird netting was placed over the *Cleome serrulata* and *C. lutea* plots to protect seedlings from bird feeding. The bird netting was placed over No. 9 galvanized wire hoops.

Flea beetle control

Flea beetles were observed feeding on leaves of *Cleome serrulata* and *C. lutea* in April of 2012. On April 29, 2012, all plots of *C. serrulata* and *C. lutea* were sprayed with Capture® at 5 oz/acre to control flea beetles. On June 11, 2012, *C. serrulata* was again sprayed with Capture at 5 oz/acre to control a reinfestation of flea beetles.

Flea beetle feeding occurred earlier in 2013 than in 2012. Upon removal of the row cover in March of 2013, the flea beetle damage for both species at seedling emergence was extensive and resulted in full stand loss. Flea beetles were not observed on either *Cleome* species in 2014.

On March 20, 2015, after removal of the row cover, all plots of *C. serrulata* and *C. lutea* were sprayed with Capture at 5 oz/acre to control flea beetles. On April 3, 2015, all plots of *C. serrulata* and *C. lutea* were sprayed with Entrust® at 2 oz/acre (0.03 lb ai/acre) to control flea beetles.

Weeds were controlled by hand weeding as necessary.

Irrigation for seed production

In April, 2011, each strip of each wildflower species was divided into 12 30-ft plots. Each plot contained four rows of each species. The experimental design for each species was a randomized complete block with four replicates. The three treatments were a non-irrigated check, 1 inch of water applied per irrigation, and 2 inches of water applied per irrigation. Each treatment received 4 irrigations that were applied approximately every 2 weeks starting with bud formation and flowering. 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. Irrigations were regulated with a controller and solenoid valves.

The drip-irrigation system was designed to allow separate irrigation of each species due to different timings of flowering and seed formation. Flowering, irrigation, and harvest dates were recorded (Table 1). In 2014, after the four bi-weekly irrigations ended, *Cleome serrulata* and *C. lutea* received three additional bi-weekly irrigations starting on August 12 in an attempt to extend the flowering and seed production period. On August 12, 50 lb nitrogen/acre, 30 lb phosphorus/acre, and 0.2 lb iron/acre were applied through the drip tape to all plots of *Cleome serrulata* and *C. lutea.*

Flowering and harvest

The two species have a long flowering and seed set period (Table 1), making mechanical harvesting difficult. Mature seed pods were harvested manually 2 to 4 times each year.

Table 1. *Cleome serrulata* and *Cleome lutea* flowering, irrigation, and seed harvest dates by species. Malheur Experiment Station, Oregon State University, Ontario, OR.

		Flowering dates			Irrigation dates		
Species	Year	Start	Peak	End	Start	End	Harvest
Cleome serrulata	2011	25-Jun	30-Jul	15-Aug	21-Jun	2-Aug	26-Sep
	2012	12-Jun	30-Jun	30-Jul	13-Jun	25-Jul	24-Jul to 30-Aug
	2013	Full stand loss					
	2014	4-Jun	24-Jun	22-Jul	20-May	1-Jul	11-Jul to 30-Jul
	2015	20-May	24-Jun	15-Sep	20-May	30-Jun	1-Jul to 15-Aug
Cleome lutea	2012	16-May	15-Jun	30-Jul	2-May	13-Jun	12-Jul to 30-Aug
	2013	Full stand loss, fleabeetle damage					
	2014	29-Apr	4-Jun	22-Jul	23-Apr	3-Jun	23-Jun to 30-Jul
	2015	8-Apr	13-May	6-Jul	17-Apr	27-May	4-Jun to 30-Jul

Results and Discussion

Precipitation from January through June in 2012 and 2014 was close to the average of 5.8 inches (Table 2). Precipitation from January through June in 2013 and 2015 was lower than the average of 5.8 inches. Precipitation from January through June in 2011 was higher than the average of 5.8 inches. The accumulated growing degree-days (50-86°F) from January through June in 2013-2015 were higher than average (Table 2) and were associated with early flowering and seed harvest.

Cleome serrulata, Rocky Mountain beeplant

In 2011, seed yields increased with increasing irrigation up to the highest tested of 8 inches (Tables 3 and 4). Seed yields did not respond to irrigation in 2012, 2014, or 2015. There was no plant stand in 2013 due to early, severe flea beetle damage. The additional irrigations starting on

August 12, 2014 did result in an extension/resumption of flowering, but seed harvested in mid-October was not mature.

The winter and spring of 2011 were wetter and this annual plant developed much better in 2011, responded to irrigation, and had higher seed yield. Our results over years suggest that *Cleome spp*. may need early irrigation in drier years in addition to irrigation during flowering and seed set.

Cleome lutea, **yellow spiderflower or yellow beeplant**

Seed yields did not respond to irrigation in 2012, 2014, or 2015 (Tables 3 and 4). There was no plant stand in 2013. Early attention to flea beetle control is essential for *Cleome lutea* seed production. The additional irrigations starting on August 12, 2014 did not result in an extension or resumption of flowering.

Acknowledgements

This project was funded by the U.S. Forest Service, U.S. Bureau of Land Management, Oregon State University, Malheur County Education Service District, and supported by Formula Grant Nos. 2015-31100-06041 and 2015-31200-06041 from the USDA National Institute of Food and Agriculture.

Table 2. Early season precipitation and growing degree-days at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2011-2015.

	Precipitation (inches)		Growing degree-days (50-86°F)
Year	Jan-Jun	Apr-Jun	Jan-Jun
2011	8.3	3.9	856
2012	5.8	2.3	1,228
2013	2.6	1.4	1,319
2014	5.1	1.6	1,333
2015	4.8	2.7	1,610
72-year average	5.8	2.7	1,178[a]

[a]22-year average.

Table 3. *Cleome serrulata* and *Cleome lutea* seed yield in response to irrigation rate (inches/season). Malheur Experiment Station, Oregon State University, Ontario, OR.

Species	Year	Irrigation rate: 0 inches	4 inches	8 inches	LSD (0.05)
		------------- lb/acre		--------------	
Cleome serrulata	2011	446.5	499.3	593.6	100.9[a]
	2012	184.3	162.9	194.7	NS[b]
	2013	No stand, fleabeetle damage			
	2014	66.3	80	91.3	NS
	2015	54.0	41.0	37.9	NS
	Average	150.8	157.1	183.7	NS
Cleome lutea	2012	111.7	83.7	111.4	NS
	2013	No stand, fleabeetle damage			
	2014	207.1	221.7	181.7	NS
	2015	136.9	80.5	113.0	NS
	Average	151.9	128.6	135.4	NS

[a]LSD (0.10).
[b]Not significant: There was no statistically significant trend in seed yield in response to the amount of irrigation.

Table 4. Regression analysis for *Cleome serrulata* and *Cleome lutea* seed yield (y) in response to irrigation (x) (inches/season) using the equation $y = a + bx + cx^2$. Malheur Experiment Station, Oregon State University, Ontario, OR.

Cleome serrulata Year	Intercept	Linear	Quadratic	R^2	*P*	Maximum seed yield	Water applied for maximum yield
						lb/acre	inches/season
2011	439.6	18.4		0.35	0.05	587	8
2012	175.4	1.3		0.01	NS[a]		
2014	66.7	3.1		0.16	NS		
2015	52.4	-2.0		0.08	NS		
Average	206	6.5		0.33	NS		

Cleome lutea Year	Intercept	Linear	Quadratic	R^2	*P*	Maximum seed yield	Water applied for maximum yield
						lb/acre	inches/season
2012	102.4	-0.031		0.01	NS		
2014	207.1	10.4	-1.7	0.2	NS		
2015	122.0	-3.0		0.08	NS		
Average	159.3	-1.6		0.04	NS		

[a]Not significant.