USDA United States Department of Agriculture

FINAL STUDY REPORT

Los Lunas Plant Materials Center, Los Lunas, New Mexico

Establishment of Pollinator Plants by Direct Seeding In Flood Irrigated Fields at the Los Lunas Plant Materials Center

David R. Dreesen, Ph.D, Agronomist/Horticulturist, Keith L. White, Bio-Technician

ABSTRACT

Both NRCS and the Xerces Society have emphasized conservation practices to establish pollinator habitat by the direct sowing of seed mixes with diverse blooming dates. The feasibility of establishing pollinator plants under flood irrigation was evaluated at the Los Lunas Plant Materials Center (LLPMC) in 2014. Two seed mixes (LLPMC mix of superior species and Applewood High Plains Pollinator Mix) were broadcast sown on May 8th at three seeding rates. The field used for the study had been fallow the previous year and had been in native grass seed production in prior years so the expected weed competition would be typical of a crop production landscape. To help overcome the possibility of flood irrigation flows displacing shallowly planted seed, the seeding trials were installed on beds approximately 18" wide and 7" high to allow the beds to be watered by capillary movement from the flooded furrows. When extreme desiccating conditions were encountered (i.e., hot and/or windy), the seedbeds were spray irrigated using a water trailer once a week (3 to 4 days after flood irrigation) to keep the surface soil moist. The plots were evaluated in mid-August. Due to an inability to hire seasonal labor, Palmer pigweed (*Amaranthus palmeri*) and stinkgrass (*Eragrostis cilianensis*) overwhelmed the seeded species; however, it was possible to identify some of the seeded species. The species most frequently encountered in the test plots of each mix are listed in the text.

INTRODUCTION

Previous studies at the LLPMC have demonstrated a substantial number of native plant species capable of attracting pollinators including honey bees, native bees, wasps, and flies (New Mexico Plant Materials Technical Note PM-71 (rev.)). These demonstrations have relied on species evaluations established using greenhouse-grown seedlings transplanted into fields irrigated with drip systems. Conservation practices to establish pollinator habitat by direct sowing of seed mixes with diverse blooming dates.

In the arid and semi-arid Southwest, seeding done by broadcasting or drilling on non-irrigated sites are fraught with difficulty due to the low likelihood of precipitation patterns that allow the establishment of native species. The high likelihood of seeding failures precludes recommending this practice under non-irrigated conditions because of the high cost of both native wildflower seed and seeding operations.

Sites with reliable irrigation supplies offer a better opportunity for establishing pollinator habitat plantings by seeding. However, there are still significant obstacles that can substantially impede the establishment of pollinator habitat under irrigated conditions. Some of these difficulties include:

David R. Dreesen, Agronomist, Los Lunas Plant Materials Center, 1036 Miller Road, Los Lunas, NM 87031
david.dreesen@nm.usda.gov

1. Competition from weeds common in agricultural settings can significantly reduce the chances of obtaining a good stand of pollinator plants from seeding. Unless special care has been taken to reduce the weed seed bank in the surface soil well in advance of planting, this weed competition can result in little or no establishment of the desired wildflower species.
2. Spring seeding is recommended in most situations because many of the desired species are summer annuals. In addition, the availability of irrigation water is typically in the spring in most surface water irrigation districts. Dormant seeding in late fall or winter is required for certain species requiring cold stratification unless the aim is to have these species persist in the seed bank from a spring seeding and germinate the following spring. Weather conditions during the spring in the Southwest can pose many impediments to direct seeding including: hot, dry, low humidity, and windy conditions which desiccate the surface soil very rapidly; windblown sand abrading newly germinating seedlings; wind erosion causing either the uncovering of seed or the buildup of eolian deposits burying the seed. Extreme temperature fluctuations and late hard frosts can also reduce establishment prospects. These difficulties suggest that seeding after spring winds have subsided might increase establishment probabilities despite the higher temperatures that would generally be encountered. However, seeding in late June or later will necessarily restrict blooming to the late summer and fall during the first growing season.
3. Irrigation, whether by flood flows or overhead sprinklers, can displace surface-applied or slightly buried seed from the seedbed. If broadcast or drilled seed is placed near the soil surface, care should be taken to prevent such seed loss and the subsequent, possible concentrated deposition of seed.
4. Soil properties including texture, organic matter, and sodium content can enhance the chances of soil crusts forming which can restrict emergence, especially of smaller and less vigorous seedlings. These crusts can also reduce infiltration and air exchange between the soil and atmosphere (*USDA-NRCS Soil Quality Indicators: Soil Crusts*). Soil crusting is more common on fine-textured soils, such as silts, loams, and clays.

The consequence of these obstacles is that even with reliable irrigation, wildflower seeding should be considered a practice with a fairly high likelihood of failure under the weather and soil conditions as found at the LLPMC in the spring of 2014. With the costs involved for seeding large areas, every precaution should be implemented before and after seeding to ameliorate these potential impediments. The goal of this study was to determine the feasibility of establishing pollinator plants under flood irrigated field conditions by direct seeding mixes that contained native herbaceous annual and perennial species.

MATERIALS AND METHODS

The field provided for the planting had been fallow in 2013, and had been in native grass seed production in prior years. Until 2014, weeds in this field were well-controlled and not allowed to disperse seed. However, a field at the LLPMC just west of pollinator habitat seeding trial had substantial populations of mature weeds which likely had been the source of weed seed, especially resulting from the predominant westerly winds in the spring. In addition, there could have been significant amounts of weed seed present in irrigation water or persisting in the soil seed bank for many years.

David R. Dreesen, Agronomist, Los Lunas Plant Materials Center, 1036 Miller Road, Los Lunas, NM 87031
david.dreesen@nm.usda.gov

To help overcome the possibility of flood irrigation flows displacing shallowly planted seed, the seeding trials were installed on beds formed in the following manner:

1. The beds were rototilled and fertilized with 50 lb/acre P and K as well as 10 lb/ac N using a side dresser
2. The beds were rototilled again
3. A soil berm was created using a border disc
4. The planting beds were formed using a bed maker
5. We ripped the beds deeply with a straight shank subsoiler down the middle of each bed, and firmed and indented the beds with a narrow cultipacker
6. The beds were approximately 18" wide (top width) and 7" high to allow the beds to be watered by capillary movement from the flooded furrows

Two seed mixes were included in the trial: Applewood High Plains Pollinator Mix and a LLPMC mix which was based on species found to be the better pollinator attractors and to have longer flowering seasons based on the results of evaluations performed at the LLPMC from 2010 to 2013. The contents of these mixes are presented in Tables 1 and 2, respectively. Three approximate rates of seed application were tested: 30, 60, and 100 seed/ft^2.

Table 1. Applewood High Plains Pollinator Mixture labelled composition and seeding rates applied (Code XSHP, Lot - XSHP014, Germination 41%, Dormant 37%, Hard 2%, Pure 94.51%, Other Crop 0.03%, Inert 5.31%, Weed Seed 0.15%, Test Date 1/27/14)

Species Name	Common Name	Weight %
Cleome serrulata	Rocky Mountain beeplant	16.36
Bouteloua curtipendula	sideoats grama	11.69
Linum lewisii	Lewis flax	10.93
Liatris punctata	dotted blazing star (dotted gayfeather)	10.93
Thelesperma filifolium	stiff greenthread	10.93
Dalea purpurea	purple prairie clover	8.26
Helianthus petiolaris	prairie sunflower	5.47
Penstemon angustifolius	broadbeard beardtongue (narrow leaved beardtongue)	5.47
Tradescantia occidentalis	prairie spiderwort	5.47
Verbesina encelioides	golden crownbeard	5.47
Bouteloua gracilis	blue grama	2.79
Engelmannia peristenia	Engelmann's daisy	2.43
Koeleria macrantha	prairie Junegrass	1.34
Ratibida columnifera	upright prairie coneflower	1.34
Coreopsis tinctoria	golden tickseed (plains coreopsis)	1.09

Seeding Rate (approximate seed per ft^2)	Percentage of Mix Treated by Ten Weeks Cold Stratification	Percentage of Mix Treated by Six Weeks Cold Stratification	No Pre-Treatment	Grams of Seed per Square Foot
Low Rate (30)	26%	26%	48%	0.20
Medium Rate (60)	26%	26%	48%	0.39
High Rate (100)	26%	26%	48%	0.64

David R. Dreesen, Agronomist, Los Lunas Plant Materials Center, 1036 Miller Road, Los Lunas, NM 87031
david.dreesen@nm.usda.gov

Table 2. LLPMC seed mix composition at three application rates per square foot (30, 60 and 100 seed per square foot).

Species Name	Common Name	Vendor*	Seed Mix Dry and (Stratified) grams of seed per 450 ft^2 at 100 seed/ft^2	grams of seed per 450 ft^2 at 60 seed/ft^2	grams of seed per 450 ft^2 at 30 seed/ft^2	Number of seed per ft^2 for each species at a mix rate of 100 seed/ft^2	Notes
Achillea millefolium	common yarrow	WNS	0.52	0.31	0.16	7	
Baileya multiradiata	desert marigold	AW	1.09	0.66	0.33	5	
Cleome serrulata	Rocky Mountain beeplant	WNS	6.38 (6.38)	3.83 (3.83)	1.91 (1.91)	2	most germ. in 10w cold
Dalea candida	white prairie clover	WNS	2.45	1.47	0.73	3	
Erigeron speciosus	aspen fleabane	WNS	3.06	1.84	0.92	7	
Gaillardia aristata	blanketflower	WNS	2.98	1.79	0.89	2	
Gaillardia pinnatifida	red dome blanketflower	WNS	5.61	3.37	1.68	2.7	
Gaillardia pulchella	indian blanket	WNS	3.81	2.29	1.14	3	
Gilia capitata	bluehead gilia	EF	1.11	0.67	0.33	5	
Helenium autumnale	common sneezeweed	EF	0.85	0.51	0.25	5	
Helianthus annus	common subflower	WNS	13.35	8.01	4.01	2	
Heliomeris multiflora var. multiflora	showy goldeneye	WNS	0.91 (0.91)	0.54 (0.54)	0.27 (0.27)	5	most germ. in cold 6w
Machaeranthera tanacetifolia	tanseyleaf tansyaster	AW	4.25	2.55	1.27	4	
Monarda citriodora	lemon beebalm	EF	1.60	0.96	0.48	5	
Monarda fistulosa	wild bergamot	AW	1.22	0.73	0.37	7	
Oligoneuron rigidum	stiff goldenrod	EF	1.66	1.00	0.50	5	
Phacelia tanaceifolia	lacy phacelia	EF	2.63	1.58	0.79	3	
Ratibida columnifera	upright prairie coneflower (yellow)	EF	1.57	0.94	0.47	5	
Ratibida columnifera	upright prairie coneflower (brown)	WNS	0.91	0.54	0.27	5	

David R. Dreesen, Agronomist, Los Lunas Plant Materials Center, 1036 Miller Road, Los Lunas, NM 87031
david.dreesen@nm.usda.gov

Table 2. LLPMC seed mix composition at three application rates per square foot (30, 60 and 100 seed per square foot).

Species Name	Common Name	Vendor*	Seed Mix Dry and (Stratified) grams of seed per 450 ft^2 at 100 seed/ft^2	grams of seed per 450 ft^2 at 60 seed/ft^2	grams of seed per 450 ft^2 at 30 seed/ft^2	Number of seed per ft^2 for each species at a mix rate of 100 seed/ft^2	Notes
Solidago nemoralis	gray goldenrod	EF	1.89	1.13	0.57	7	
Symphyotrichum laeve var. geyeri	Geyer's aster	WNS	1.14	0.68	0.34	5	
Thelesperma filifolium	stiff greenthread	WNS (older seedlot)	6.01 (1.28)	3.61 (0.77)	1.80 (0.38)	1	some germ. in cold 6w
Thelesperma filifolium	stiff greenthread	WNS (newer seedlot)	(8.36)	(5.02)	(2.51)	2	some germ. in cold 6w
Zizia aurea	golden zizia	EF	2.82	1.69	0.85	2	some germ. in cold 10w
Totals			**87.58**	**52.55**	**26.27**	**99.7 seed /ft^2**	

* WNS = Western Native Seed, AW = Applewood Seed, EF = Everwilde Farms

Fractions of the Applewood Mix were cold stratified at 40° F for either 6 or 10 weeks in moist sphagnum peat/perlite potting media as noted in the bottom section of Table 1. Those fractionated species in the LLPMC Mix which required cold stratification for germination were exposed to 6 or 10 weeks of cold stratification in moist potting media; the seed weights in parentheses represent the cold stratified fractions.

The seed mix (including the moist stratification media) for each plot was diluted with 3 gallons of parboiled rice hulls to facilitate spreading. The rice hulls absorbed sufficient moisture from the LLPMC Mix to allow the use of a hand-cranked spreader. A stiff plastic apron was constructed below the spreader to confine the seed to the top of the bed and limit the amount of seed displaced by wind. The Applewood Mix with rice hulls was still too wet from mixing with the stratified seed media to allow the use of the spreader, so this mix was broadcast by hand. The seeded area for each plot was approximately 450 ft^2. Each plot was 150 feet long, and the plot width was assumed to be 3 feet because of seed spread or broadcast beyond the top of the bed.

The seeding was conducted on May 8, 2014 after the last expected date of a hard freeze. After the seed was spread, a tractor-pulled lawn roller (no water weight added) was used to press the seed into seedbed. The seeding was flood irrigated on a weekly basis throughout May, June, July, and August except during a period of heavy rains in July. When extreme desiccating conditions were encountered (i.e., hot and/or windy), the seedbeds were spray irrigated using a water trailer once a week (3 to 4 days after flood irrigation) to keep the surface soil moist.

David R. Dreesen, Agronomist, Los Lunas Plant Materials Center, 1036 Miller Road, Los Lunas, NM 87031
david.dreesen@nm.usda.gov

RESULTS AND DISCUSSION

The plots were evaluated in mid-August by randomly tossing a one square foot frame onto the bed 13 times per plot and recording the number of seedlings other than the ubiquitous Palmer pigweed (*Amaranthus palmeri*) and stinkgrass (*Eragrostis cilianensis*) (Figure 1). The plots were mown in July to reduce canopy competition. Species identification was possible for some of the seeded species, but many seedlings were still too young to distinguish among species.

The tally information was so variable among individual square foot samples that it was obvious that no meaningful statistical results could be developed between mixes or among seeding rates. Individual tallies ranged from 0 to 15 seedlings per square foot. It was also clear that the only potentially useful information gleaned from the sampling was an indication of which species seem to have emerged best under these conditions. Some seedlings were easy to identify to species (Figure 2), yet there were substantial numbers that were unidentifiable. Table 3 lists the identifiable species which were most commonly counted in the sampling of each seed mix plot.

Table 3. Identifiable pollinator plant species which were counted in the sampling frame for each seed mix (pooling the data from the 3 rate plots) in approximate order of frequency (high to low)

LLPMC Seed Mix		**Applewood Seed Mix**	
Species Name	**Common Name**	***Species Name***	**Common Name**
Dalea candida	white prairie clover	*Thelesperma filifolium*	stiff greenthread
Baileya multiradiata	desert marigold	*Bouteloua curtipendula*	sideoats grama
Gaillardia pulchella	indian blanket	*Linum lewisii*	Lewis flax
Thelesperma filifolium	stiff greenthread	*Dalea purpurea*	purple prairie clover
Machaeranthera tanacetifolia	tanseyleaf tansyaster	*Penstemon angustifolius*	broadbeard beardtongue (narrow leaved beardtongue)
Ratibida columnifera	upright prairie coneflower	*Verbesina encelioides*	golden crownbeard
Monarda sp.	Beebalm sp.		
Achillea millefolium	common yarrow		
Gaillardia pinnatifida	red dome blanketflower		
Heliomeris multiflora var. multiflora	showy goldeneye		

Solarization of the beds a year before seeding might have resulted in the control of weed seed in the surface soil and improved the success of the seeded species. A more drastic approach would be to fumigate, hot water sterilize, or steam sterilize the plots to kill weed seed. It is highly doubtful that any selective post-emergent herbicide would have controlled the pigweed without major damage to the seeded species. A post-emergent herbicide selective for grasses could have helped control the stinkgrass infestation, but with unknown effects on the seeded forbs. The extent of weed seed introduction from irrigation water is a significant unknown. One proactive recommendation would be to enclose pollinator habitat planting sites with windbreaks or wind screening fence to limit the wind transport of seed onto the sites.

David R. Dreesen, Agronomist, Los Lunas Plant Materials Center, 1036 Miller Road, Los Lunas, NM 87031
david.dreesen@nm.usda.gov

CONCLUSION

Even with reliable irrigation, wildflower seeding should be considered a practice with a fairly high likelihood of failure under the weather, weed, and soil conditions as found at the LLPMC in the spring and summer of 2014. With the high costs involved for seeding large areas, every precaution should be implemented before and after seeding to ameliorate potential impediments to establishment, especially from weed competition.

Until a more successful methodology is identified for direct seeding, it is still our recommendation that small, very diverse habitats be established from planted seedlings on irrigated sites.

Figure 1. Palmer pigweed (*Amaranthus palmeri*) and stinkgrass (*Eragrostis cilianensis*) infestation on pollinator plant seeding plot on July 13, 2014.

David R. Dreesen, Agronomist, Los Lunas Plant Materials Center, 1036 Miller Road, Los Lunas, NM 87031
david.dreesen@nm.usda.gov

Figure 2. Pollinator plant seeding on October 3, 2014 showing one of the LLPMC mix plots. *Baileya multiradiata*, *Gaillardia pulchella*, *Machaeranthera tanacetifolia*, and *Monarda citriodora* in bloom as well as *Thelesperma filifolium* with seedheads.

LITERATURE CITED

Dreesen, D. R. and T. Grasswitz. 2013. Revised Pollinator Plant Recommendations for New Mexico. Plant Materials Technical Note No. 71 (Rev.), U.S. Department Of Agriculture Natural Resources Conservation Service, Albuquerque, New Mexico. Revised January, 2013.

USDA Natural Resources Conservation Service. 1996. Soil Quality Indicators: Soil Crusts. Soil Quality Information Sheet, April 1996. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051593.pdf

David R. Dreesen, Agronomist, Los Lunas Plant Materials Center, 1036 Miller Road, Los Lunas, NM 87031
david.dreesen@nm.usda.gov