MOJAVE DESERT NATIVE PLANTS: BIOLOGY, ECOLOGY, NATIVE PLANT MATERIALS DEVELOPMENT, AND USE IN RESTORATION

DESERT MILKWEED

Asclepias erosa (Torr.)

Apocynaceae - Dogbane Family

Casey Hensen and Ashlee Wolf | 2023

ORGANIZATION

NOMENCLATURE

Asclepias erosa Torr. (desert milkweed) belongs to the Apocynaceae, or dogbane family (Rosatti and Hoffman 2023, USDA NRCS 2023). It is in the subfamily Asclepiadoideae which has recently undergone taxonomic revisions and was previously categorized as the family Asclepiadaceae (Britannica 2023). Desert milkweed was first described in 1859 by W.H. Emory (PWO 2023).

NRCS Plant Code.

ASER2 (USDA NRCS 2023).

Synonyms.

Asclepias demissa Greene, *Asclepias obtusata* Greene, *Asclepias rothrockii* Greene, *Asclepias erosa* var. *obtusa* (A.Gray) A.Gray, *Asclepias leucophylla* Engelm., *Asclepias leucophylla* var. *obtusa* A.Gray (Kew SID 2022, SEINet 2023, Tropicos 2023)

Common Names.

Desert milkweed. Common names in Spanish include hierba lechosa, yumete, and talayote (SEINet 2023).

Subtaxa.

No subtaxa are currently recognized by the Integrated Taxonomic Information System or other treatments (ITIS 2023).

Chromosome Number.

The chromosome number for desert milkweed is 2n = 22 (Rosatti and Hoffman 2023).

Hybridization.

There is no evidence of hybridization between desert milkweed and other milkweed species.

DESCRIPTION

Desert milkweed is a perennial herb whose surface can range from hairy to completely smooth (Rosatti and Hoffman 2023). It is unbranched and stands erect at 50-180 cm tall with opposite lanceolate and ovate leaves with jagged margins (SEINet 2023). Its leaves are thick, almost succulent, and very large for a species living in the arid portions of the Sonoran and Mojave deserts. Its flower petals are reflexed to spreading and greenish, with green-to-white hoods that become more yellow with age. The horns (small appendages that extend from the hood) are radially flat, sickle shaped, and typically attached in the middle of the hoods (Sundell 1994). The pollinia (condensed packets of pollen) are 1.4-1.5 mm long. Desert milkweed seeds are encapsulated in follicle fruits that stand erect on deflexed pedicels, 7-9 cm long (Sundell 1994). The nectar desert milkweed provides makes its flowers fragrant (SEINet 2023). Desert milkweed is supported by a thick, fleshy taproot.

Figure 1: A desert milkweed individual. Photo: BLM SOS CA930A

Figure 2: The inflorescence of desert milkweed. Photo: Jean Pawek

DISTRIBUTION AND HABITAT

Desert milkweed occurs throughout the Mojave Desert and in the western portions of the Sonoran Desert with more sparse records extending into neighboring ecoregions (Figure 3).

Habitat and Plant Associations.

Desert milkweed habitat generally consists of desert washes and roadsides throughout the Mojave and Sonoran Desert scrub communities. It can be found in abundance in sandy plains, dry slopes, and hummocks near the Lower Colorado River (Rosatti and Hoffman 2023, SEINet 2023).

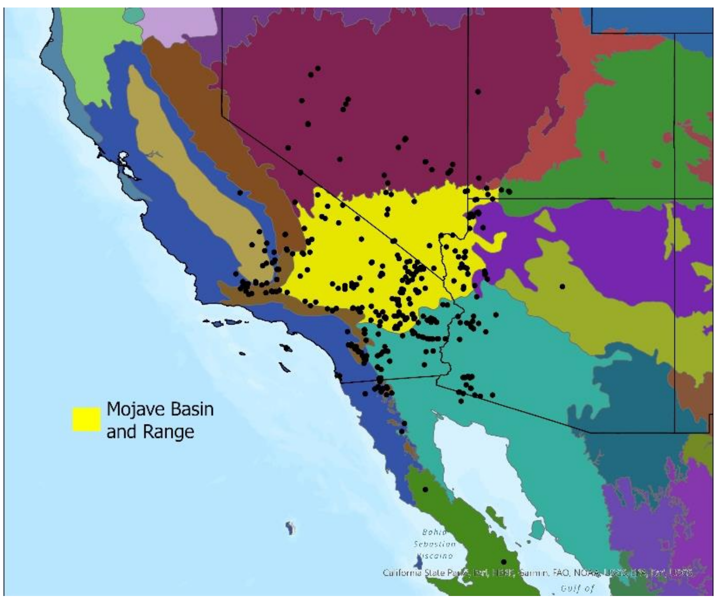

Figure 3: Distribution of desert milkweed based on georeferenced herbarium specimens and verified observations (black circles, SEINet 2022) with EPA Level III Ecoregions (US EPA 2015). The Mojave Basin and Range ecoregion is shown in yellow.

In the Mojave Desert, desert milkweed's associated species include creosote bush (*Larrea tridentata*), burrobush (*Ambrosia dumosa*), Mojave yucca (*Yucca schidigera*), Virgin River brittlebush (*Encelia virginensis*), globemallow (*Sphaeralcea* spp.), low woolygrass (*Dasyochloa puchella*), needle grama (*Bouteloua aristidoides*), Arabian schismus (*Schismus arabicus*), barbwire Russian thistle (*Salsola paulsenii*), brownplume wirelettuce (*Stephanomeria pauciflora*), cheesebush (*Hymenoclea salsola*), wild buckwheat (*Eriogonum deflexum*), and prickly pear (*Opuntia* spp.) (SEINet 2023).

Figure 4: Desert milkweed in a sandy disturbed wash in California. Photo: BLM SOS CA930A

Figure 5: Mature desert milkweed individuals Photo: Jean Pawek

Climate.

The Mojave Desert is characterized by low annual precipitation (5-25 cm or 2-10 inches in valley areas), with most rainfall occurring in the winter and a smaller amount during summer thunderstorms (Randall et al. 2010). Heterogenous climate patterns across the region are influenced by large-scale patterns and regional topography and are important drivers of local adaptation and intraspecific variation (Shryock et al. 2018, Baughman et al. 2019) and phenological events (Beatley 1974). Specifically, the reproductive phenology of many desert plant species is highly responsive to pulses in rainfall over short time scales (Bowers and Dimmitt 1994, Zachmann et al. 2021).

Climate information is derived from the climate-based provisional seed transfer zones (PSZs) where desert milkweed occurs (Shryock et al. 2018; Table 1). According to herbarium specimen locations (SEINET 2022), desert milkweed has been documented in all PSZs in the Mojave Desert ecoregion but is most frequently documented in Zones 20 and 27 and least frequently documented in Zones 22 and 28 (Table 1). The average annual precipitation in the PSZs where desert milkweed occurs in the Mojave Desert ecoregion is 17.8 cm (7.0 inches), with an average of 5.7 cm (2.2 inches) falling in the summer and an average of 12.1 cm (4.7 inches) in the winter. Note, herbarium specimen locations may not represent the full distribution and abundance of desert milkweed due to sampling biases.

Elevation.

Desert milkweed is generally found at elevations between 200-5,000 ft (60-1524 m) (Sundell 1994).

Table 1: Climate of the provisional seed zones (PSZ) where desert milkweed occurs within the Mojave Desert ecoregion (Shryock et al. 2018).#Records = the number of herbarium or verified observations of desert milkweed within the PSZ (SEINet 2022); MAP=mean annual precipitation; SP=summer precipitation, or the mean precipitation that falls in the summer (May-October); WP= winter precipitation, or the mean precipitation that falls in the winter (November-April); MAT=monthly average temperature; Range= Average of the monthly temperature ranges (monthly maximum minus monthly minimum).

PSZ	#	MAP (cm)	SP (cm)	WP (cm)	MAT (C)	Range (C)
20	58	25.5	10.5	14.9	15.3	34.5
27	36	9.6	3.3	6.3	20	36.7
25	25	16.5	6.2	10.3	18.9	34.6
26	25	14.5	2.7	11.8	16.8	34.9
21	19	15.6	6.2	9.4	18.8	38.4
24	18	10.7	2.8	7.9	18.8	38.6
23	15	15.8	5.4	10.4	16.1	35.9
29	14	25.5	4.2	21.4	13.8	31.7
28	6	7.8	2.4	5.3	22.3	41.3
22	2	36.1	13.3	22.8	10	32.4

Soils.

Desert milkweed prefers well-draining, often sandy soils that are generally low in organic matter (BLM SOS 2022, Calscape 2023). No indication of interaction with biological soil crusts was found in the literature.

ECOLOGY AND BIOLOGY

Desert milkweed is highly adapted to drought conditions and tolerates moderate disturbances. It utilizes its trichomes (hairs on the exterior surface of its leaves) and glycosides (waxy substances) to create an herbivore-deterring and sunscreen barrier (Agrawal et al. 2009). Desert milkweed is toxic to domestic livestock but attracts herbivorous insects.

Reproduction.

Breeding System.

The discrete pollen sacs (pollinia) and frequency of floral visitors suggest a high reliance on outcrossing in desert milkweed. Desert milkweed also reproduces clonally from underground rhizomes (Pellissier et al. 2016). No indication of self-compatibility was found in the literature, though most species within Asclepias are self-incompatible (Wyatt et al. 1996).

Reproductive Phenology.

Observations of desert milkweed show that flower budding begins as early as March and can continue throughout the summer (iNaturalist 2023, SEINet 2023). Peak flowering occurs between May and July, but flowering and fruiting individuals are recorded throughout the year (SEINet 2023).

Pollination.

Asclepias species in the desert southwest attract at least 104 native bee species (Nabhan et al. 2015). Desert milkweed has been specifically associated with a diversity of bee species including the genera *Agapostemon*, *Anthophora*, *Bombus*, *Centris*, *Diadasia*, *Halictus*, *Lasioglossum*, *Megachile*, *Melissodes*, *Protandrena*, and *Xylocopa* (Ikerd and Griswold 2014, as cited in Esque et al. 2021). Additionally, its flowers are visited by hairstreak butterflies (subfamily *Theclinae*), monarch butterflies (*Danaus plexippus*), spider and tarantula hawk wasps (genus *Pepsis*), yellow-banded tiphiid wasps (family *Tiphiidae*), milkweed bugs (genus Oncopeltus), and more (Nies 2017, SEINet 2023).

Seed and Seedling Ecology.

Desert milkweed seeds mature within the follicle which splits when ripe. Seeds are transported via the wind, assisted by silky hairs attached to the seed (Beckett et al. 1938). Information on germination and dormancy is limited. However, desert milkweed seeds can germinate readily, and the seeds are assumed to be non-dormant (Everett 2012).

Species Interactions.

Belowground Interactions.

No studies on desert milkweed's belowground interactions were found.

Wildlife and Livestock Use.

Desert milkweed has a particularly high level of steroidal toxins known as cardenolides (Adams et al. 1984) which make this species toxic to livestock. Milkweed poisoning (by many *Asclepias* species) occurs in domestic livestock such as cattle, sheep, and occasionally horses (ARS 2018). Most incidents occur due to milkweed growing in disturbed areas around corrals and pastures (ARS 2018). Because milkweeds are generally bitter and unpalatable, animals will avoid eating them when sufficient forage is available. Poisoning can be avoided when animals are provided with ample forage.

Insect Interactions.

Desert milkweed, like other members of Asclepias, is well known as a primary host plant for the larvae of the monarch butterfly, along with others such as the queen butterfly (*Danaus gilippus*) (Borders et al. 2012, Nabhan et al. 2015). As the larvae feed on milkweed leaves, their bodies sequester the plant's toxic cardenolides which renders the larvae toxic, warding off predators and parasites (Malcolm and Brower 1989, Agrawal et al. 2021).

Desert milkweed can experience infestations of oleander aphids (*Aphis nerii*) that reduce plant health as they consume the plant's sugars (Braman and Latimer 2002). Immature desert milkweed pods may have their moisture drained by milkweed bugs (*Oncopeltus fasciatus*), inhibiting seed development (SEINet 2023).

Disturbance Ecology.

Desert milkweed's habitat preferences along roadsides and washes suggest that it is well adapted to areas with frequent disturbances (Nabhan et al. 2015). No information on desert milkweed's response to fire, invasive species, or other common disturbances in the Mojave Desert was found.

Ethnobotany.

Desert milkweed is used by the Coahuila and Tübatulabal tribes of Southern California as a chewing gum (Voegelin 1938, Barrows 1967). The sap is collected, set aside to solidify, and then roasted over a fire to create its tacky, gum-like form (Voegelin 1938, Barrows 1967).

Horticulture.

Desert milkweed is a great addition to xeriscape butterfly and bird gardens due to its attractive flowers, tolerance to drought, and attractiveness to a variety of pollinators. It may sometimes be available for commercial purchase in limited numbers from a few retail nurseries (Calscape 2023).

DEVELOPING A SEED SUPPLY

A robust and stable supply of genetically appropriate seed is needed to meet restoration demands in response to expanding environmental stressors from land degradation, invasive species, and climate change. Restoration success is, in part, predicated on applying the right seed in the right place, at the right time (PCA 2015). Developing a restoration seed supply involves coordination across many partners in all steps of the process: from conducting wildland collections to propagating materials in nurseries and agricultural fields to eventual seeding or outplanting at restoration sites. Appropriate protocols for preserving genetic diversity and adaptive capacity should be in place (Erickson and Halford 2020) and seed origin should be documented for certification purposes and other seed planning considerations.

Seed Sourcing.

Seed sourcing can influence restoration outcomes due to local adaptation (Custer et al. 2022), landscape genetic patterns (Massatti et al. 2020, Shryock et al. 2021) and differing ability to adapt to current and future climate conditions (Bucharova et al. 2019). However, there has been relatively little research evaluating seed sourcing strategies in actual restoration settings where many additional factors influence performance (Pizza et al. 2023). While non-local sources can perform well in meeting initial restoration goals such as establishment and productivity (Pizza et al. 2023), evidence of local adaptation and its influence on restoration outcomes can take decades to emerge for long-lived species (Germino et al. 2019). Further, plants have coevolved with interacting organisms, such as pollinators and herbivores, that can exhibit preferential behavior for local materials (Bucharova et al. 2016, 2022).

Empirical seed transfer zones have not been developed for desert milkweed. The Desert Southwest Provisional Seed Zones (PSZs) may be used to plan seed sourcing in the absence of species-specific information. The Desert Southwest PSZs use twelve climatic variables that drive local adaptation to define areas within which plant materials may be transferred with higher probability of successful establishment and reduced risk of introducing maladapted ecotypes (Shryock et al. 2018). Overlaying PSZs with Level III ecoregions can serve to further narrow seed transfer by identifying areas of both climate similarity inherent in the PSZs and ecological similarity captured by the ecoregion, namely vegetation and soils. Within the PSZs and ecoregion areas, further site-specific considerations such as soil, land use, species habitat and microclimate affinities, and plant community may be relevant to seed sourcing decisions.

The [USGS Climate Distance Mapper Tool] incorporates the Southwest Deserts Seed Transfer Zones with climate models and can serve to guide seed sourcing according to current and projected climate conditions.

Commercial Seed Availability and Germplasm Releases.

Desert milkweed is sometimes available for purchase from large-scale commercial seed vendors. However, availability may be inconsistent, and sources may be limited to a narrow range of appropriate seed zones. Commercially available seed may not be source identified, and source seed zone information may not be available. There have been no [conservation plant releases] of desert milkweed.

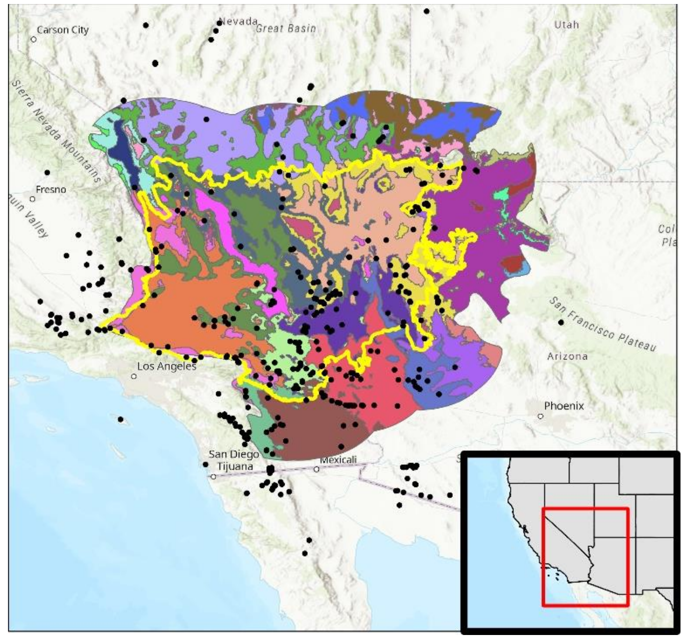

Figure 6: The distribution of desert milkweed across the Desert Southwest Provisional Seed Zones (Shryock et al. 2018). Occurrences (black dots) are based on georeferenced herbarium specimens and verified observations (SEINet 2023). The Mojave Basin and Range Level III ecoregion (yellow outline) is buffered up to 100km in all directions. PSZs do not always extend a full 100km beyond the Mojave ecoregion.

Wildland Seed Collection.

Wildland seed collection involves visiting naturally occurring populations of target species to provide source seed for propagation, restoration, and research. Ethical practices are intended to prevent overharvesting by limiting harvests to no more than 20% of available seed (BLM 2021). However, in arid regions and in drought conditions, it may be best to adapt this guidance to collect no more than 10% of available seed due to limited regeneration and low-density populations (Asbell 2022, personal communication). Several practices are in place to ensure proper genetic diversity is captured from the source population. These include collecting from the entire population uniformly, sampling a diversity of phenotypes and microclimates, and collecting in various time windows to capture phenological and temporal diversity (BLM 2021).

Seed Collection Timing.

According to a limited number of Seeds of Success (SOS) collections, desert milkweed is typically collected between June and August with the majority of collections occurring in June (BLM SOS 2022). Although the plants can bloom throughout the year, fruit formation and seed set may be diminished later in the year (November-December) (Wayman 2023, personal communication). Timing collection to coincide with seed ripening prior to dispersal can be challenging (Wayman 2023, personal communication).

Collection Methods.

Desert milkweed pods are ready for collection when the seeds inside are brown and mature, and the pod is beginning to split, but not fully open (Wayman 2023, personal communication). Fully mature seeds that are ready for collection should be light or dark brown and dry. Collection should be delayed if seeds are green. The entire pod can be hand-collected into dry paper bags (Wayman 2023, personal communication) or seeds can be stripped from the pod and placed into the bag (Borders and Lee-Mader 2014).

Post-Collection Management.

Immediately following collection, seeds should be properly managed to avoid damage or declines in viability during transport and temporary storage. Seed should be dried and ventilated to prevent molding (Pedrini and Dixon 2020). Ventilation can be achieved by collecting and storing seed in breathable containers, such as paper or cloth bags.

To dry material before storage or processing, spread it in a single layer on trays or newspaper indoors in a well-ventilated room, or outdoors in a shaded area (BLM 2021). Collected material should be visually inspected for seed-predating insects (Pedrini and Dixon 2020). If seed predation is observed, consider fumigation with No-Pest Strips. After collection, prevent exposure to excessively hot or cold temperatures during transportation and temporary storage by keeping seed in a dry, insulated container (e.g., a cooler) in a shaded area while in the field (BLM 2021).

Figure 7: Collected pod and seed material from desert milkweed; scale shown in cm. Photo: BLM SOS UT930

Figure 8: Bare cleaned seed of desert milkweed. Photo: BLM SOS CA660

Seed Cleaning.

Seeds can be cleaned by rubbing the mature seed on a rubber mat or shaking seeds in a paper bag to remove the hairs from the seed (Wall and MacDonald 2009). Then the hairs can be separated out using screens, sieves, or a blower. The process can be messy and a dust mask is recommended (Wall and MacDonald 2009). Other milkweed species, all of which have similar fruit morphology, have been cleaned using a brush machine with a #10 mantle and 0.05 mm brush set to a slow speed followed by a blower set to the highest speed or sieve to separate the hairs from the seed (Saidnawey and Cain 2023).

Another method for seed processing involves using a standard shop vacuum ("shop vac") with a cartridge filter. The raw material is fed into the vacuum and the fibers collect around the filter while other materials fall into the bin (Borders and Lee-Mader 2014).

Seed Storage.

Desert milkweed seed is likely orthodox (SER SID 2023). Wildland-collected seed from the Mojave Desert retained viability for at least six years in cold storage (Wayman 2023, personal communication). No further information on optimal storage conditions or longevity for desert milkweed is available.

In general, seeds should be stored in cool and dry conditions, out of direct sunlight, to maintain viability. Optimal conditions for medium-term storage of orthodox seeds (up to 5 years) are 15% relative humidity and 15° C (59° F). For long-term storage (>5 years), completely dried seeds should be stored at -18° C (0° F) (De Vitis et al. 2020, Pedrini and Dixon 2020).

Seed Testing.

After collection, a representative sample of each seed lot must be tested in an appropriate seed lab to ensure purity and germination meet minimum standards defined by the Association of Official Seed Analysts (AOSA 2016) and species standards from state-level certification programs as available. A set of "principles and standards for native seeds in ecological restoration" (Pedrini and Dixon 2020) outlines further guidelines specific to native plants, including procedures for obtaining representative samples of seed lots and incorporation of dormancy measures into seed testing and labels.

The pure seed unit – a combined unit of seed and attached structures that is classified as pure seed as opposed to inert material – for Asclepias species is defined by the AOSA as a "seed, with or without seed coat, with or without wing(s)… piece of a broken seed, with or without seed coat, larger than one-half the original size" (AOSA 2016).

The AOSA does not specify guidelines for testing germination, viability, or purity of desert milkweed. However, another Asclepias (A. tuberosa), can be germinated in a covered petri dish in either 10 or 30°C under a cool white fluorescent or LED light (750-1250 lux, 8-hour photoperiod). Germination can be checked after 14 days. It is also recommended to prechill the seeds at 3-5°C 21 days prior to testing (AOSA 2016).

A tetrazolium testing protocol to assess seed viability in *Asclepias* is available in an International Seed Testing Association handbook (Moore 1985). Methods involve imbibing seeds for 18 hours (temperature not specified) then cutting seed longitudinally down their entire length. Seeds are then placed in a tetrazolium chloride solution (concentration and temperature not specified) for 18 to 24 hours. Viability can then be quantified by assessing the percentage of seeds with embryos completely stained (Moore 1985).

Wildland Seed Yield and Quality.

Wild-collected desert milkweed seed is generally high quality, with an average of 93% fill, 99% purity and 92% viability indicated by tetrazolium tests across 3 Seeds of Success collections (BLM SOS 2022, Table 2). Wild collections contain an average of over 13,000 PLS/lb (BLM SOS 2022, Table 3).

Table 2: Seed yield and quality of desert milkweed collected in the Mojave Basin and Range Ecoregion, cleaned by the Bend Seed Extractory, and tested by the Oregon State Seed Laboratory or the USFS National Seed Laboratory (BLM SOS 2022). Fill (%) was measured using a 100 seed X-ray test. Viability (%) was measured using a tetrazolium chloride test.

	Mean	Range	Samples
Bulk weight (lbs)	1.2	0.09-1.58	3
Clean weight (lbs)	0.66	0.368-0.753	3
Purity (%)	99	99-99	3
Fill (%)	92.66	88-98	3
Viability (%)	92	88-95	3
Pure live seeds/lb	13,220	9,891-14,345	3

Wildland Seed Certification.

The Association of Official Seed Certifying Agencies (AOSCA) sets the standards for seed certification and provides guidance on production, identification, distribution, and promotion of all certified seed, including pre-varietal germplasm. Pre-varietal germplasm (PVG) refers to seed or other propagation materials that have not been released as varieties (AOSCA 2022). Pre-varietal germplasm certification programs for source-identified materials exist in several states encompassing the Mojave Desert ecoregion including California (CCIA 2022), Utah (UTCIA 2015), and Nevada (NDA 2021). Arizona does not have a PVG certification process at this time. Source-Identified (SI) germplasm refers to seed collected directly from naturally occurring stands (G0), or seed grown from wildland-collected seed in agricultural seed increase fields (G1-Gx) that have not undergone any selective breeding or trait testing. These programs facilitate certification and documentation required for wildland-collected seed to be legally eligible for direct sale or seed increase in an agricultural setting. Certified SI seed will receive a yellow tag, also referred to as an SI-label, noting key information about the lot including the species, the generation of seed (G0-Gx), source location, elevation, seed zone, etc. (UTCIA 2015, NDA 2021, CCIA 2022).

Wildland seed collectors should be aware of documentation required for seed certification. The Seeds of Success data form and protocol (BLM 2021) include all appropriate information and procedures for site documentation and species identification verification to meet certification requirements for wildland sourced seed. Seed certifying agencies may also conduct site inspections of collection locations prior to certification—specific requirements for inspections vary by state and are at the discretion of the certifying agency.

AGRICULTURAL SEED PRODUCTION

Desert milkweed will grow best in sandy to granular soils, likely with a neutral soil pH (Calscape 2023, Coxe 2023).

Agricultural Seed Field Certification.

As with wildland source seed (see Wildland Seed Certification section), seed grown in an agricultural seed increase field must also be certified by an official seed certifying agency, where programs exist. Field grown seed is also certified and labeled as Source-Identified (SI), as long as it has not undergone selective breeding or testing. Seed field certification includes field inspection, seed testing for purity and germination (see Seed Testing section), and proof of certification for all source or parent seed used to start the field (AOSCA 2022). The SI-label or "yellow tag" for seed from a seed increase field denotes information about source seed, field location, and generation level (G1-Gx) indicating if there is a species-specific limitation of generations allowed to be grown from the original source (e.g., in a species with a three-generation limit, G1/G3, G2/G3, G3/3) (AOSCA 2022).

There are no specified seed certification standards for desert milkweed crops in the state of California. However, Table 3 outlines the pre-variety germplasm certification standards for a congeneric species, California milkweed (*Asclepias californica*) (CCIA 2022). The Nevada and Arizona Departments of Agriculture do not specify standards for PVG crops. The Utah Crop Improvement Association does not specify standards for PVG crops but may apply standards of similar species or crop groupings (UCIA 2023).

Table 3: Pre-varietal germplasm (PVG) standards for seed analysis results of the related species, California milkweed, in California.

Factor	G1	G2	G3 to G10
Pure Seed (minimum)	80%	80%	80%
Inert Matter (maximum)	20%	20%	20%
Total Other Crop Seed (maximum)	0.1%	0.25%	0.5%
Weed Seed (maximum)	0.2%	0.3%	0.5%
Noxious Weed	None	None	None
Germination and Hard Seed (minimum)	65%	65%	65%

Isolation Distances.

Sufficient isolation distances are required to prevent cross-pollination across seed production crops of desert milkweed from different sources or other *Asclepias* species. Table 4 summarizes the isolation distances required for PVG certification in both Utah and California. Because there are no specified seed certification standards for desert milkweed crops in the state of California, the isolation distances are for the related species, California milkweed. The Utah standards are general for outcrossing perennial species (UCIA 2023). Nevada and Arizona do not specify these standards for Source Identified PVG seed.

Table 4: Crop years and isolation distance requirements for pre-varietal germplasm crops of fringed amaranth. CY= crop years, or the time that must elapse between removal of a species and replanting a different germplasm entity of the same species on the same land. I= isolation distance, or the required distance (in feet) between any potential contaminating sources of pollen.

	G1		G2		G3+	
State	CY	I	CY	I	CY	I
Utah	3	900-600	2	450-300	1	330-165
California	5	60	5	30	2	15

Site Preparation.

Fields should be as weed-free as possible prior to planting. Site preparation to reduce undesirable vegetation should be planned and implemented well in advance of field establishment (USDA NRCS 2004). If fields are uncultivated or fallow and have perennial or annual weeds, one or more years of intensive cultivation (i.e. cover cropping) and herbicide treatment may be necessary (USDA NRCS 2004). After managing undesirable species, final seedbed preparation can include shallow tilling followed by packing to promote a finely granulated, yet firm seedbed that allows soil to seed contact, as well as facilitation of capillary movement of soil moisture to support seedling development (USDA NRCS 2004).

No specific considerations for site preparation for desert milkweed were found in the literature.

Seed Pre-treatments.

While many milkweed species require a cold-moist stratification to induce germination (Borders and Lee-Mader 2014), desert milkweed can readily germinate in absence of seed pre-treatments. In germination tests at the California Botanic Garden, freshly collected desert milkweed exhibited 30%, 66%, and 64% germination across three separate collections when no pre-treatment was applied (CalBG 2023). Some growers in the Mojave Desert suggest soaking or leaching desert milkweed seeds prior to sowing in nursery settings (Plath 2023, personal communication; Johnson 2023, personal communication). Leaching can be accomplished by placing the seeds in a mesh strainer under water with a slow drip for 24 to 48 hours (Johnson 2023, personal communication). Soaking involves placing the seed in water at room temperature for 24 to 72 hours prior to sowing (Plath 2023, personal communication). Following soaking, placing pre-germinating desert milkweed seeds on a moist paper towel and then sowing viable seeds when the radicle emerges can improve propagation success (Plath 2023, personal communication). One grower using local Mojave Desert sources suggests putting desert milkweed seed in a refrigerator at 41-42 ° F prior to sowing (Wayman 2023, personal communication).

Seeding Techniques.

There is no specific information on the best methods of field establishment for desert milkweed. Generally, milkweed species can be established through direct sowing with a seed drill or by hand, or through transplanting containerized stock into a field (Borders and Lee-Mader 2014).

Generally, milkweed seeds should be planted at depths around ½” using a seed drill. Seeds can also be broadcast onto prepared weed-free seedbeds so long as seeds make good contact with the soil. This can be achieved by use of a lawn roller, cultipacker, or the wheels of a vehicle. Planting in the fall allows seeds to overwinter and potentially enhance germination. Seeding rates for milkweed fields generally range from 2-20 live seed per linear foot, depending on seed viability and desired spacing (Borders and Lee-Mader 2014).

Establishment and Growth.

No information on establishment and growth of desert milkweed in agricultural fields was found in the literature or through personal communications.

Weed Control.

Weeds can be manually removed or carefully spot-sprayed with a non-selective herbicide as they emerge. In smaller fields, hand rogueing weeds can be sufficient (Hagman 2023, personal communication).

There are a limited number of herbicides registered and labeled for use on native plant crops. See the Native Seed Production Guide from the Tucson Plant Materials Center (USDA NRCS 2004) for further details on weed management in native seed production fields.

Pest Management.

Oleander aphids are a common pest and can dramatically reduce the health of desert milkweed crops (Braman and Latimer 2002, Borders and Lee-Mader 2014). Five insecticides were tested against the oleander aphids, and all resulted in only a short-term reduction of populations as reinfestation occurred weeks later (Braman and Latimer 2002). It is important to note that with the exception of the oleander aphid, there are many native beneficial insects that interact with milkweed and using insecticides can harm or kill these insects (Borders and Lee-Mader 2014). If insecticides are determined to be necessary to control an infestation, precautions for avoiding or minimizing harm to beneficial insects include: avoiding systemic neonicotinoid insecticides in favor of "contact" insecticides; selecting products with low toxicity or short residual toxicity such as insecticidal soaps; applying insecticide when plants are not flowering; and spot treating infestations as opposed to blanket application over the entire field (Borders and Lee-Mader 2014).

Beneficial insects such as butterfly and moth larvae have the potential to damage milkweed crops, but the caterpillars typically do not occur at high densities that would negatively impact seed production and crop health (Borders and Lee-Mader 2014). If the caterpillars are significantly impacting the crop, they can be collected and transferred to other milkweed plants or adopted by conservation-minded groups or schools. Insecticides should be considered a last resort for managing caterpillar occurrences (Borders and Lee-Mader 2014).

Borders and Lee-Mader (2014) provide an exhaustive overview of insects and other pests that may impact milkweed crops and how to manage them while minimizing harm to beneficial insects.

Pollination Management.

Growing native plants in or near their native range increases the likelihood that compatible pollinators will be able to find and pollinate the crop (Cane 2008). In general, growers can consider implementing pollinator management and stewardship practices to augment and attract existing pollinator communities. Specific practices will depend on the plant species pollination needs, and the biology of the pollinators. For example, if a plant relies on native solitary bees, growers can create nesting opportunities adjacent to or within the field perimeter with downed woody material or crafted bee boxes (Cane 2008, MacIvor 2017). In some cases, there may be a need to supplement with managed pollinators through honeybee or bumble rental services to ensure pollination of wildflower crops for seed increase (Cane 2008).

No suggestions specific to pollinator management for desert milkweed were found in the literature or through personal communications.

Irrigation.

There is little information on techniques specific to irrigating fields of desert milkweed. One example with a field of desert milkweed transplants initially irrigated (methods not specified) once per week for three weeks, then shifted to only once per month for the remainder of the growing season (Beckett et al. 1938).

Many growers apply uniform watering techniques regardless of species due to their set infrastructure and labor resources. For example, at the Tucson Plant Materials Center, all fields are watered with flood irrigation (Dial 2023, personal communication). After seeding, fields are irrigated to maintain a moist soil surface and avoid soil crusting that would interfere with germination. Once seeds are established, fields are flooded approximately every four weeks during the growing season. Irrigation frequently will depend on heat and precipitation levels and may be as frequent as every two weeks during the hottest part of the year to avoid stressing plants and lowering seed yield (Dial 2023, personal communication).

Other growers administer water via drip irrigation and find flood irrigation does not adequately penetrate into soil, resulting in significant evaporation in aridland farm settings (Hagman 2023, personal communication).

Seed Harvesting.

Small-scale seed increase fields may be harvested by hand following similar methods as wildland collections (see Collection Methods). It is estimated to require one acre per person per day to hand-harvest a milkweed seed production field (Borders and Lee-Mader 2014). Since the seeds can quickly disperse in the wind when the pods ripen and split, the window of harvest can be narrow and difficult to time. Hand harvesting allows for multiple harvest events to capture the full range of phenology and genetic diversity as fruits ripen at different times within and across plants in many milkweed species (Borders and Lee-Mader 2014).

A mechanical combine harvester can be used for larger field acreages (Borders and Lee-Mader 2014). The combine harvest should occur when plants are at their peak of fruit maturation to ensure the highest seed yields possible. A combine does not allow for multiple harvest events, meaning only one window of phenology is captured and yields and genetic diversity may be reduced (Borders and Lee-Mader 2014).

Other species of Asclepias have been grown in agricultural settings for milkweed "silk" production, in which many of the fields are hand harvested (Harlow 2018). Some modifications of grain combines have been constructed but can become "gummed up" from sticky latex from the plants. To avoid this, farmers wait until the pods have 30% moisture (greenness) or less (Harlow 2018).

Seed Yields and Stand Life.

No information on seed yields or stand life for desert milkweed seed increase crops was found in the literature or through personal communication.

NURSERY PRACTICE

See Seed Pre-treatments for information on germinating desert milkweed in nursery settings. Some growers in the Mojave Desert have found that desert milkweed is difficult to germinate but that mature plants can be vegetatively propagated by dividing rhizomatous shoots (Sturwold et al. 2022, personal communication). Desert milkweed plants have a slow growth rate and may require a full year in a nursery before being ready for outplanting (Johnson 2023). Using deep-pot plugs helps promote a vigorous root system that contributes to survival and establishment after transplanting (Borders and Lee-Mader 2014). Sowing seeds directly into the final pot size can allow plants to grow more vigorously compared to sowing in smaller containers and "up-potting" which causes root disturbance and reduces growth (Borders and Lee-Mader 2014). If transplanting into larger pots is necessary, root disturbance can be minimized by using a biodegradable pot that can be directly planted into a larger container (Borders and Lee-Mader 2014).

REVEGETATION AND RESTORATION

Desert milkweed can be used to meet a variety of revegetation goals in the Mojave Desert including increasing ground cover in remediation and reclamation settings; establishing early successional plant communities in open habitats; attracting pollinators and beneficial insects for biodiversity enhancement and pest management; and importantly, supporting the monarch butterfly as a larval host plant and nectar source (Borders et al. 2012, Nabhan et al. 2015). Since desert milkweed grows in areas that experience routine surface disturbance and soil movement such as roadsides and washes, it is likely helpful for soil stabilization in these habitats (Nabhan et al. 2015).

Wildland Seeding and Planting.

Wildland Seedings.

Specific information for seeding desert milkweed is not available, but there are recommended practices for milkweeds in general detailed in Borders and Lee-Mader (2014) that may apply.

Generally, milkweed seeds will have higher establishment success when seed-soil contact is established via drill seeding or using a cultipacker or roller following broadcast seeding (Borders and Lee-Mader 2014). Milkweeds can make up 0.1% to 14% of a diverse seed mix that includes other nectar plants and species that are quicker to establish, to compete with invasive species (Borders and Lee-Mader 2014). More research is needed to identify best practices applicable to desert milkweed and the Mojave Desert.

Wildland Plantings.

Outplanting the dormant, tuberous root of desert milkweed may be beneficial to avoid the vulnerable establishment phase (Esque et al. 2021), but no outcomes of this practice have been detailed. When planting entire plugs with actively growing plants, it is best to utilize biodegradable pots to minimize root disturbances (Borders et al. 2012).

A study investigating the rubber content and potential propagation practices of desert milkweed may offer insight for restoration and revegetation plantings in wildlands settings (Beckett et al. 1938). In one component of the study, nine dormant desert milkweeds near Parker, Arizona were collected and relocated by pruning the dormant stalks off within a few inches of the root crown, digging up the root, pruning the roots, and wrapping the entire plant in wet sacks for transport to the site The plants were planted in the site and irrigated every seven days for three weeks and then once a month for the rest of the growing season. Five of the nine plants survived and grew into large, healthy plants (Beckett et al. 1938).

Another component of the rubber content study involved comparing effectiveness of transplanted seedlings versus direct sowing for desert milkweed near Parker, Arizona (Beckett et al. 1938). Two hundred seeds were planted in small tar-paper plots in a sandy soil medium and propagated for seven months prior to transplanting at a field site. The seedlings were irrigated every seven days for three weeks and then once a month for the remainder of the growing season. Mortality was described as "negligible" but not quantified. For the direct sowing, seeds were planted by hand in April in a pre-irrigated seed bed and the field was irrigated twice during the first three weeks after planting and about monthly for the rest of the growing season. Germination rates in plots ranged from 19% to 82%. The seedlings grew rapidly and by July (55 days after sowing) they averaged 42.5" in height. Many seedlings produced flowers in September and mature pods in late October. They found that the direct sowing method resulted in similar establishment and plant height as the transplanting method and concluded that the labor and time involved in transplanting was not justified (Beckett et al. 1938).

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RESOURCES

AOSCA NATIVE PLANT CONNECTION

https://www.aosca.org/wp-content/uploads/Documents/AOSCANativePlantConnectionBrochure_AddressUpdated_27Mar2017.pdf

BLM SEED COLLECTION MANUAL

https://www.blm.gov/sites/default/files/docs/2021-12/SOS%20Technical%20Protocol.pdf

OMERNIK LEVEL III ECOREGIONS

https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states

CLIMATE SMART RESTORATION TOOL

https://climaterestorationtool.org/csrt/

MOJAVE SEED TRANSFER ZONES

https://www.sciencebase.gov/catalog/item/5ea88c8482cefae35a1faf16

MOJAVE SEED MENUS

https://rconnect.usgs.gov/MojaveSeedMenu/

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