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From Weeds to Flowers: Creating Sustainable Wildflower Meadows in Arid Climates

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Introduction

WILDFLOWER MEADOWS are ecologically sound tools for managing private or public lands. As sustainable management practices become increasingly more accepted, meadows plantings will become more popular. Wildflower meadows have the potential to benefit homeowners, public land managers, and commercial property caretakers in numerous ways. They can beautify landscapes, simplify maintenance, strengthen soil and water conservation efforts, and offer an attractive habitat to pollinators, birds, and small mammals. Meadows also provide habitat and forage for many insects whose presence may help to reduce or eliminate a gardeners' pesticide use.

To take advantage of these potential assets in the arid climates of the West, gardeners should design wildflower meadows according to their ability to provide irrigation. In arid climates, the amount of irrigation supplied will strongly influence a meadow's appearance. A **nonirrigated** meadow produces flowers in the spring and early summer but goes dormant and offers limited aesthetic value thereafter. A **minimally irrigated** meadow shows color through most of the summer with occasional irrigation. A **moderately irrigated** meadow provides significant season-long color but requires larger amounts of applied irrigation water; however, this will allow the introduction of a wider arrangement of less drought-tolerant plant materials. Thus, to create the desired effects and improve their survival rate, it is important to select plant species for each of these meadow types according to their water requirements. Establishment of a **liberally irrigated meadow**, however, is not recommended in the arid West. Such meadows negate one of the main reasons for the meadow in the first place—water conservation.

Regardless of the prospective meadow's irrigation needs, initial establishment is key to creating a sustainable planting. Once a meadow matures and stabilizes, it can

become largely self-sufficient, renewing desirable wildflowers and grasses from seed that outcompete most weeds. However, successfully achieving this stable, climactic phase can be very challenging, especially on lands that have been disturbed or historically cultivated. Unfortunately, heavily used lands are typically infested with numerous species of introduced weeds that can be aggressive and proliferate from accumulated dormant weed seeds. Indeed, disturbing these soils is risky, because it breaks seed dormancy, unleashing a dense crop of weeds anew.

Educational documents and videos about meadows commonly provide a very simplistic approach to establishment. Instructions usually involve five steps: 1) till the soil, 2) smooth the seedbed, 3) scatter seed of appropriate plant species, 4) rake or use some other method to cover the seed, and finally 5) irrigate until seedlings emerge. Theoretically, once you've taken these steps and allowed a little time to pass, an abundance of attractive grasses and flowers emerge. However, where heavy, persistent weed-seed reserves exist in the soil and/or perennial weeds are present, the simplistic approach often results in complete failure. Perennial weeds grow in dense patches, thus stifling floral growth. Annual weeds emerge more quickly, develop faster, and grow taller than most desirable grasses and wildflowers. The result: desirable plants lose out. Outcompeted for light, water, and nutrients before they can become established, they soon die, leaving a flowerless, weedy mess by the end of the first summer.

Along with providing general establishment and management information, this publication imparts a more successful method—an alternate “grass-first” approach that ensures the replacement of a weedy site with a thriving and enduring wildflower meadow. The guidelines that follow target meadows located in the cold arid climates of the Mountain West. They include information about controlling existing perennial weeds, preparing the soil, and selecting appropriate and desirable meadow plant species, as well as provide seeding rates, a planting strategy, weed control during establishment, appropriate irrigation practices, and postestablishment management.

Preparatory Control of Perennial Weeds

Perennial weeds live for three or more years; though they may die back to the ground each fall, they emerge in the spring from roots or a living crown. Because many of them have aggressive underground spreading structures such as rhizomes, they create ultracompetitive weed patches within a meadow. Common perennial weed species in the arid West include field bindweed, Canada thistle, dandelion, quack grass, curly dock, white clover, and nutsedge. Other perennial weeds, including shrubs or sometimes even trees, may also be present.

Once a landowner has planted a meadow that contains both grasses and wildflowers, perennial weeds cannot be eliminated easily without irreparably damaging desirable plants. Therefore, you should implement the majority of perennial weed-control processes prior to meadow establishment. To adequately control sparse infestations of perennial weeds, apply herbicide once during the fall season before planting the meadow. Moderate-to-severe infestations may require two herbicide applications, one in the fall preceding planting and another in the spring just prior to planting or, alternately, two applications in the spring separated by soil tillage and weed regrowth. Prudence suggests it may be best to schedule a full year for eradication in a situation of heavy infestation.

Glyphosate is the primary herbicide to use to control perennial weeds prior to meadow planting. It is nonselective and will kill most plants on contact. For optimal control and avoidance of incidental injury to nontarget plants or animals, follow the herbicide label instructions to determine recommended rates, application methods, and application timing. If opting to use a herbicide other than glyphosate, do not choose a herbicide with a long residual period. If the site is comprised of dense residue of old plant material, it may be helpful to mow off the old weeds a few weeks prior to herbicide application to expose green foliage.

See "Establishing and Caring for a Meadow Using Organic Principles" for organic options for perennial weed control.

Establishing and Caring for a Meadow Using Organic Principles

Most of the protocols described in this paper are applicable to an organically designed meadow, with the exception of using herbicides for weed control and the added need to use approved fertilizer products and organically produced seed. Creating a sustainable wildflower meadow without the use of herbicides produces some unique challenges but can be successfully accomplished. The most significant issue is controlling perennial weeds both before planting and after establishment.

Preparatory Control of Perennial Weeds

Eliminating hard-to-kill perennial weeds prior to planting becomes especially critical in an organically managed meadow. It is not possible to provide rapid control of rhizomatous perennial weeds or those with stolon structures (such as field bindweed, quack grass, and Canada thistle) using organic protocols. If these or other persistent weeds are present on a proposed site, plan for an extended elimination period—two to possibly five years. The site should be deep-tilled every few weeks for the entire control period, with the goal being to deplete the weed root reserves and to prevent any subsequent plant growth. Chances are, even after several years of complete mechanical control, some perennial weeds will still survive and require occasional digging and hand pulling after meadow establishment.

Soil solarization is becoming a common tool employed to control weeds in organic production systems. This technique works well to control annual weeds and shallow-rooted perennial weeds, but it has been shown to be ineffective in controlling deep-rooted perennials species, the deep roots of which act as a survival mechanism that thwarts the shallow heating caused by solarization.

Adding thick compost layers to a meadow can effectively suppress weeds, but it is not a good long-term solution to weed management. The same characteristics that allow mulch to suppress weeds also prevent routine seedling replacement of the flower and grass species in a meadow.

Seed Selection

Certified organic seed of selected species may be difficult to find. However, most native seed is produced with minimal use of herbicides. If organic seed cannot be found, purchase and plant seed from dealers you know and trust.

Fertilization

In lieu of inorganic fertilizers, provide nutrients to the new meadow through application of manures and composts. To minimize problems with salt injury and nutrient tie-up that can occur with applications of manures and composts, complete the application the fall before planting. Supplement as needed with organic fertilizers that provide some of the major plant nutrients. Use the soil testing procedures and nutrient rates provided in the “Soil Preparation” section as a guide to applying nutrients to your organic meadow.

Weed Control during Establishment

Control of weed seedlings after grass species have been planted is limited to mechanical means, specifically hand pulling and mowing. Both procedures are effective in reducing competition from weed seedlings, although these methods require more diligence, time, and work than control with herbicides.

Long-term Maintenance

Consistent annual mowing is important for a meadow managed without herbicides. An additional mowing in early spring, before the flowers are tall enough to be significantly damaged, may also be practical. Otherwise, invading weeds, especially perennials, will need to be removed occasionally by hand pulling or digging.

Soil Preparation

Begin soil preparation by applying a low rate of a complete fertilizer. Alternately, make a lean application of manure. Meadows do not need high levels of soil fertility. After a meadow matures, its

natural system usually recycles adequate nutrients to maintain plant health. However, an initial application encourages early, robust growth. When possible, collect and analyze a soil sample from the proposed site to confirm that you are following, based on the requirements for new pastures, the

appropriate fertilizer recommendations. Otherwise, apply a complete fertilizer equivalent to 40 lbs of nitrogen per acre (0.9 lbs per 1,000 sq ft).

Tillage is critical for preparing a smooth seedbed that provides good seed-to-soil contact. Thus, disk, plow, or rototill the site. For a small site, smooth and pack the soil with a rake; for a larger one, use a harrow or cultipacker (Figure 1). Prior to planting, if the seedbed is dry, pre-irrigate the site.

Selection of Appropriate Plant Species

A successful wildflower meadow will have a complementary combination of grasses and forbs. Thus when choosing what plant species to include, consider the following basic points:

1. Suitable species should have several essential traits, including adaptability to the meadow site and intended irrigation regime, the ability to reproduce easily from seed, the capacity to survive a competitive environment, and the lack of aggressive rhizomes that crowd out neighboring plants.
2. For aesthetic reasons, wildflower species included in a meadow seed mix should also display a variety of plant textures, flower colors, and bloom times.



Figure 1. Soil leveling and packing prior to seeding meadow grass species.

3. It is useful to include some nitrogen-fixing species in the mix to help stabilize long-term soil fertility.
4. Give preference to perennials as meadow components because annuals tend not to persist over time, although some annuals make very good meadow plants.
5. Ultimately, maintaining an appropriate palette of plants for an arid climate depends on the ability of a meadow's manager to provide consistent irrigation.

See Tables 1–3 for specific selection suggestions. Each relates to one of the three suggested meadow types and proposed irrigation strategies. The tables present plants according to their mature height so that you can more easily identify those grasses and forbs whose similar size will allow them to coexist amiably.

Crafting Your Own Meadow Seed Mix

Although many companies sell meadow seed mixes with an array of native plant species (with some of them dominated by species well adapted and appropriate for your proposed site), the best mixture of species is the one whose seeds you blend. However, if you choose to use a commercial seed mix, be sure the included species adapt to onsite climatic, soil, and moisture conditions. Also, purchase a grass mix separately from a wildflower mix. This will allow for flexibility in planting strategy, a factor we clarify later (see “Planting Strategy”).

If you instead prefer to create your own seed mix, plan for variety by purchasing individual seed lots of the selected species. The more species you include in your mix, the more you ensure the display of maximum color during all periods of the growing season. We recommend that you include between two and five different grass species and ten or more wildflower species. Because this publication is directed at meadow establishment in northern arid climates, we also recommend including only drought-tolerant species adapted to cold-winter climates. Indeed, make sure to restrict your choices to species native to the western United States.

Create two separate seed mixes, one that contains grass species, the other wildflowers. The amount of seed of each species to include should be based on

seed size (average seed weight), planting density, and the concept of Pure Live Seed (PLS: % seed purity x % germination/100).

You should be able to find seed purity and germination information on the package; otherwise, request it from the supplier. If the information is not available, you can adequately estimate seed amounts by assuming 90% purity and 50% germination. The goal should be to apply a total of 10 PLS per sq ft for grass seeds and 4 PLS per sq ft for wildflower seeds. Finally, calculate the amount of seed (weight in lbs) needed for each species to plant the entire meadow area by using this formula:

$$\text{weight of seed for a given species} = \frac{\text{PLS per sq ft desired for that species} \times \left(\frac{\text{species PLS}}{\text{overall PLS}} \right) \times \text{sq ft in the meadow}}{\text{number of seeds per lb for the species}}$$

*10/number of grass species selected; or 4/number of wildflower species selected

Ask your seed vendor or do a web search to obtain information on the number of seeds per pound for each species. Measure out the indicated amount of

seeds, place them in a container with measured seed from all included species, and then mix thoroughly. Mix the grass species in one container and the wildflower seed in another. You may want to add some dry, large-particle sand or some cotton meal to help stabilize seed distribution within either blend.

The preceding information is based on your intent to direct-seed the meadow. Blending the seed is unnecessary, however, if you intend to grow plants in pots and for subsequent transplantation. In this case, plant the seeds of each species into flats (black plastic trays that hold multiple seedlings); later, select healthy emerged plants for potting and transplanting.

Species recommendations presented here are far from all-inclusive. Efficacious meadow species come from many plant families and have a multitude of traits. When designing a meadow, don't be afraid to include species that are not on this list. Diversity ensures that at least some of the plants will be adapted to the variable soils and growing conditions within the meadow site, guaranteeing its overall success, regardless of whether some of the species fail.

Table 1. Recommended grass and wildflower species for nonirrigated meadows in the cold, arid regions of the West. Species listed according to mature plant height.

Grass Species	Plant Height	Flower Color
Sandberg bluegrass (<i>Poa sandbergii</i>)	10"	Not applicable
Big bluegrass (<i>Poa secunda</i>)	18"	Not applicable
Blue grama (<i>Bouteloua gracilis</i>)	20"	Not applicable
Snake River wheatgrass (<i>Elymus wawawaiensis</i>)	24"	Not applicable
Mutton grass (<i>Poa fendleriana</i>)	24"	Not applicable
Indian ricegrass (<i>Achnatherum hymenoides</i>)	30"	Not applicable
Thickspike wheatgrass (<i>Elymus lanceolatus</i>)	30"	Not applicable
Prairie dropseed (<i>Sporobolus heterolepis</i>)	30"	Not applicable
Needle-and-thread grass (<i>Hesperostipa comata</i>)	36"	Not applicable
Flower Species	Plant Height	Flower Color
Desert yellow fleabane (<i>Erigeron linearis</i>)	6"	Yellow
Oregon sunshine (<i>Eriophyllum lanatum</i>)	8"	Yellow
Waxleaf penstemon (<i>Penstemon nitidus</i>)	12"	Blue
Bastard sage (<i>Eriogonum wrightii</i>)	12"	Pink

Table 1, continued. Recommended grass and wildflower species for nonirrigated meadows in the cold, arid regions of the West. Species listed according to mature plant height.

Flower Species	Plant Height	Flower Color
Whitest evening primrose (<i>Oenothera albicaulis</i>)	12"	White
James' buckwheat (<i>Eriogonum jamesii</i>)	12"	Buff
Yarrow (<i>Achillea millefolium</i>)	15"	White or pink
Parsnipflower buckwheat (<i>Eriogonum heracleoides</i>)	15"	Cream
Snow buckwheat (<i>Eriogonum niveum</i>)	18"	White
Sulfur buckwheat (<i>Eriogonum umbellatum</i>)	18"	Yellow
Globe mallow (<i>Sphaeralcea munroana</i>)	24"	Orange
Silvery lupine (<i>Lupinus argenteus</i>)	24"	Blue
Pacific aster (<i>Symphyotrichum chilense</i>)	30"	Blue
Blue penstemon (<i>Penstemon cyaneus</i>)	30"	Blue
Prince's plume (<i>Stanleya pinnata</i>)	30"	Yellow
Yellow bee plant (<i>Cleome lutea</i>)	36"	Yellow
Palmer's penstemon (<i>Penstemon palmeri</i>)	40"	Pink

Table 2. Recommended grass and wildflower species for a minimally irrigated meadow (3–5 irrigations amounting to a total of 6"–12" of seasonal supplemental water) in cold, arid regions of the West. Species listed according to mature plant height.

Grass Species	Plant Height	Flower Color
Prairie Junegrass (<i>Koeleria macrantha</i>)	12"	Not applicable
Idaho fescue (<i>Festuca idahoensis</i>)	15"	Not applicable
Spike trisetum (<i>Trisetum spicatum</i>)	15"	Not applicable
Sweetgrass (<i>Heirochloe odorata</i>)	18"	Not applicable
Big bluegrass (<i>Poa secunda</i>)	18"	Not applicable
Bluebunch wheatgrass (<i>Pseudoroegneria spicata</i>)	20"	Not applicable
Blue grama (<i>Bouteloua gracilis</i>)	20"	Not applicable
Snake River wheatgrass (<i>Elymus wawawaiensis</i>)	24"	Not applicable
Blue wildrye (<i>Elymus glaucus</i>)	24"	Not applicable
Thickspike wheatgrass (<i>Elymus lanceolatus</i>)	30"	Not applicable
Mountain brome (<i>Bromus marginatus</i>)	30"	Not applicable
Prairie dropseed (<i>Sporobolus heterolepis</i>)	30"	Not applicable
Little bluestem (<i>Schizachyrium scoparium</i>)	30"	Not applicable
Sand dropseed (<i>Sporobolus cryptandrus</i>)	36"	Not applicable
Needle-and-thread grass (<i>Hesperostipa comata</i>)	36"	Not applicable
Sideoats grama (<i>Bouteloua curtipendula</i>)	36"	Not applicable

Table 2, continued. Recommended grass and wildflower species for a minimally irrigated meadow (3–5 irrigations amounting to a total of 6”–12” of seasonal supplemental water) in cold, arid regions of the West. Species listed according to mature plant height.

Flower Species	Plant Height	Flower Color
Dotted blazingstar (<i>Liatris punctata</i>)	12”	Violet
Pink ladies (<i>Oenothera speciosa</i>)	12”	Pink
Whitest evening primrose (<i>Oenothera albicaulis</i>)	12”	White
Blacksamson echinacea (<i>Echinacea angustifolia</i>)	12”	Pink
Parsnip-flower buckwheat (<i>Eriogonum heracleoides</i>)	15”	Cream
Yarrow (<i>Achillea millefolium</i>)	15”	White or pink
Sidebells penstemon (<i>Penstemon secundiflorus</i>)	15”	Pink
Sulfur buckwheat (<i>Eriogonum umbellatum</i>)	18”	Yellow
Purple prairie clover (<i>Dalea purpurea</i>)	18”	Pink
White sagebrush (<i>Artemisia ludoviciana</i>)	20”	Brown
Rocky Mountain penstemon (<i>Penstemon strictus</i>)	20”	Blue
Blanketflower (<i>Gaillardia aristata</i>)	20”	Orange/yellow
Tall evening primrose (<i>Oenothera elata</i>)	20”	Yellow
Giant red Indian paintbrush (<i>Castilleja miniata</i>)	20”	Red
Sticky geranium (<i>Geranium viscosissimum</i>)	20”	Pink or lavender
Mule-ears (<i>Wyethia amplexicaulis</i>)	20”	Yellow
Northern sweetvetch (<i>Hedysarum boreale</i>)	24”	Pink
Owl’s claws (<i>Helenium hoopesii</i>)	24”	Yellow
Horsemint (<i>Agastache urticifolia</i>)	24”	Purple
Blue flax (<i>Linum lewisii</i>)	24”	Blue
Bee balm (<i>Monarda fistulosa</i>)	24”	Lavender
Firecracker penstemon (<i>Penstemon eatonii</i>)	30”	Red
Richardson’s alumroot (<i>Heuchera richardsonii</i>)	30”	Green
White checkermallow (<i>Sidalcea candida</i>)	30”	White
Showy goldeneye (<i>Heliomeris multiflora</i>)	30”	Yellow
Mexican hat (<i>Ratibida columnifera</i>)	30”	Yellow or maroon
Bigleaf lupine (<i>Lupinus polyphyllus</i>)	30”	Blue
Fireweed (<i>Chamaenerion angustifolium</i>)	30”	Pink
Venus penstemon (<i>Penstemon venustus</i>)	30”	Purple
Rocky Mountain beeplant (<i>Cleome serrulata</i>)	30”	Pink
Hoary vervain (<i>Verbena stricta</i>)	40”	Purple

Table 2, continued. Recommended grass and wildflower species for a minimally irrigated meadow (3–5 irrigations amounting to a total of 6”–12” of seasonal supplemental water) in cold, arid regions of the West. Species listed according to mature plant height.

Flower Species	Plant Height	Flower Color
Blue sage (<i>Salvia azurea</i>)	40”	Blue
Beardlip penstemon (<i>Penstemon barbatus</i>)	50”	Red
Western larkspur (<i>Delphinium occidentale</i>)	60”	Purple

Table 3. Recommended grass and wildflower species for a moderately irrigated meadow (consistent irrigation every 10–14 days during the hottest months of the summer amounting to 12”–24” of seasonal supplemental water) in cold, arid regions of the West. Species listed according to mature plant height.

Grass Species	Plant Height	Flower Color
Big bluegrass (<i>Poa secunda</i>)	18”	Not applicable
Sweetgrass (<i>Hierochloa odorata</i>)	18”	Not applicable
Alkali sacaton (<i>Sporobolus airoides</i>)	24”	Not applicable
Ticklegrass (<i>Agrostis scabra</i>)	24”	Not applicable
Tufted hairgrass (<i>Deschampsia cespitosa</i>)	30”	Not applicable
Slender wheatgrass (<i>Elymus trachycaulus</i>)	30”	Not applicable
Little bluestem (<i>Schizachyrium scoparium</i>)	30”	Not applicable
Mountain brome (<i>Bromus marginatus</i>)	30”	Not applicable
Sideoats grama (<i>Bouteloua curtipendula</i>)	36”	Not applicable
Switchgrass (<i>Panicum virgatum</i>)	50”	Not applicable
Bluejoint grass (<i>Calamagrostis canadensis</i>)	50”	Not applicable
Big bluestem (<i>Andropogon gerardii</i>)	60”	Not applicable

Flower Species	Plant Height	Flower Color
Coulter's daisy (<i>Erigeron coulteri</i>)	12”	White
Pink ladies (<i>Oenothera speciosa</i>)	12”	Pink
Whipple's penstemon (<i>Penstemon whippleanus</i>)	15”	Purple
Blanketflower (<i>Gaillardia aristata</i>)	20”	Orange/yellow
Aspen fleabane (<i>Erigeron speciosus</i>)	20”	Lavender
Rydberg's penstemon (<i>Penstemon rydbergii</i>)	20”	Blue
Giant red Indian paintbrush (<i>Castilleja miniata</i>)	20”	Red
Sticky geranium (<i>Geranium viscosissimum</i>)	20”	Pink or lavender
White sage (<i>Artemisia ludoviciana</i>)	20”	Brown
Owl's claws (<i>Helenium hoopesii</i>)	24”	Yellow
Rocky Mountain iris (<i>Iris missouriensis</i>)	24”	Purple

Table 3, continued. Recommended grass and wildflower species for a moderately irrigated meadow (consistent irrigation every 10–14 days during the hottest months of the summer amounting to 12”–24” of seasonal supplemental water) in cold, arid regions of the West. Species listed according to mature plant height.

Flower Species	Plant Height	Flower Color
Camas (<i>Camassia quamash</i>)	24”	Blue
Bee balm (<i>Monarda fistulosa</i>)	24”	Lavender
Lance leaf coreopsis (<i>Coreopsis lanceolata</i>)	30”	Yellow
Black-eyed Susan (<i>Rudbeckia hirta</i>)	30”	Yellow
Butterfly weed (<i>Asclepias tuberosa</i>)	30”	Orange
Anise hyssop (<i>Agastache aurantiaca</i>)	30”	Orange
White checkermallow (<i>Sidalcea candida</i>)	30”	White
Richardson’s alumroot (<i>Heuchera richardsonii</i>)	30”	Green
Fireweed (<i>Chamaenerion angustifolium</i>)	30”	Pink
Canada goldenrod (<i>Solidago canadensis</i>)	36”	Yellow
Purple coneflower (<i>Echinacea purpurea</i>)	36”	Pink or purple
Tall bluebells (<i>Mertensia paniculata</i>)	36”	Blue
Hoary vervain (<i>Verbena stricta</i>)	40”	Purple
River mallow (<i>Iliamna rivularis</i>)	40”	Pink
Blue sage (<i>Salvia azurea</i>)	40”	Blue
Western larkspur (<i>Delphinium occidentale</i>)	60”	Purple

Seeding Rates

Optimal seeding rates (see Table 4) for a meadow are considerably reduced in comparison with planting a lawn or a pasture. Open ground in a meadow is important because it makes overcompetition less likely, thus allowing existing plants to reseed.

Planting Strategy

The planting strategy described that follows has been vetted experimentally at the University of Idaho Aberdeen Research and Extension Center in southeastern Idaho. This approach involves

a grass-first protocol and takes advantage of the numerous and effective weed-control options available for turf.

In the spring, after completion of prerequisite perennial weed-control measures and appropriate soil preparation, plant the grass components with a drill or scatter the seed over the soil surface and lightly rake it to cover the seeds. At this stage, the soil should be moist but not overly wet. After planting, apply light daily amounts of irrigation water to enhance seedling emergence. During late summer or early fall, after the grass species have become

Table 4. Approximate seeding rates for grass and wildflower meadow components.

Species Type	Up to 8 Species in the Mix	More than 8 species in the Mix
Grasses	10 PLS per sq ft	4 PLS per sq ft
Wildflowers	4 PLS per sq ft	2 PLS per sq ft

well established and annual weeds are adequately controlled, seed the wildflower species among the grass plants. Use a drill seeder or aggressively disturb the soil surface by raking over the top of the grass plants, scatter the wildflower seed, then rake a second time to cover the seed with sufficient

soil to provide protection from predation and to ensure contact with the moist soil. As with the spring planting of grasses, apply daily irrigation soon after seeding until the wildflower seedlings are a few inches tall and well established. Through the remainder of this first growing season, check

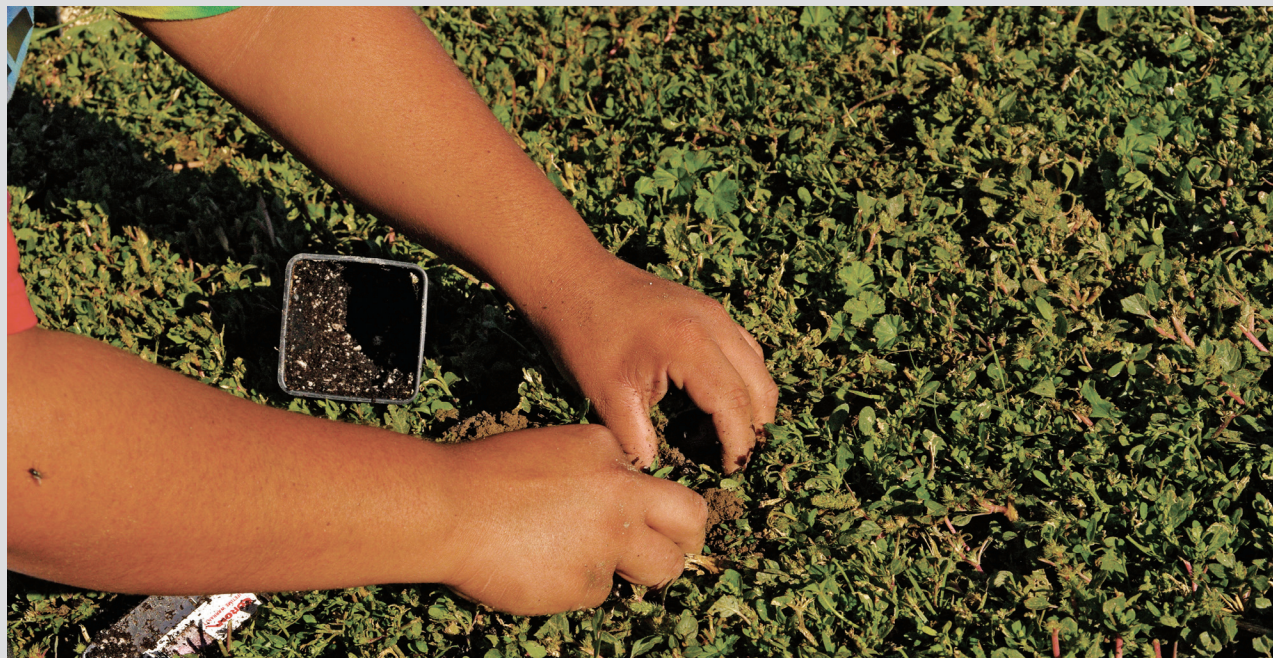


Figure 2. Fall transplantation (as an option to overseeding) of seedlings into a meadow that has been mowed all summer. Weeds are present but short.

Transplanting Wildflowers

As an alternative to fall seeding, wildflower species can be transplanted directly into established grass plants (Figure 2). This method is more expensive than seeding, but it will provide more control over the establishment process. Due to the cost and extra work involved, however, transplanting is more feasible with a relatively small meadow.

Potted plants can be purchased or self-grown. If self-propagation is desired, seed the wildflowers of each species into a separate tray. Be aware that seeds of some wildflower species need cold stratification before they will germinate. Stratification can be done either prior to planting by placing the seeds and damp soil in a plastic bag and storing them in a refrigerator for the allotted 3–8 weeks (depending on the requirements for each species) then planting them in flats.

Alternately, plant seeds into the flats, cover them to prevent drying, and place the flats in a refrigerator. Plan to **begin** stratification about 4–5 months before the intended transplantation date. Schedule it so that you complete stratification about 3 months before your intended planting date to allow for an adequate growth period for the seedlings. After plants emerge and grow a few true leaves, carefully tease them out from the flats with the roots intact and plant them individually into 4-in pots. After transplanting into the meadow area, irrigate daily for a week or two until the wildflower plants begin producing new growth. Then treat them like they are direct-seeded wildflowers.

When transplanting the potted plants, make sure to randomly intersperse the species. Deciding how dense to place transplants in a meadow can be tricky. The more wildflowers initially planted, the more attractive the meadow will ultimately be and the quicker the plants will fill in to create a dense stand. As a rule of thumb, place at least one wildflower transplant into each square yard of meadow.

the soil moisture frequently and make additional applications of water to ensure that the new seedlings are not stressed.

Weed Control during the Establishment

The success of the grass-first planting strategy described in the previous section depends entirely on implementing appropriate weed-control practices after the grasses are planted and before the wildflowers are overseeded. With only grasses present at the beginning of the summer, broadleaf weeds can be controlled by grass-tolerant mechanical or herbicidal treatments that would otherwise injure wildflowers. Lack of adequate weed control during the grass-establishment phase allows dense stands of aggressive weeds to choke out the grass seedlings and make wildflower planting later in the season difficult, if not impossible.

Initiate control measures when the grass seedlings are 2–3 in tall and weed seedlings are less than 2 in tall. Grass plants smaller than 2 in may not be established enough to tolerate weed-control measures; however, weeds larger than 2 in are difficult to control with herbicides. Subsequent timing of weed-control efforts depends on the use of the following methods:

Mechanical Weed Control

Larger weeds can be controlled without herbicides by either hand pulling or mowing. Hand pulling is practical only on a very small scale (Figures 3 and 4). In addition, care must be taken such that young grass seedlings are not damaged or pulled with the weeds. Effective control will require 3 or 4 rounds of weed pulling over the summer.

Mowing is a second mechanical-control option. This strategy works because the growing point of grass plants is close to the ground and therefore not damaged when the upper portion of the plant is removed. In contrast, mowing removes the growing point of nongrass weeds, thus slowing their growth. Mowing will not kill the weeds but will keep them short and diminish competitive advantage (Figure 5). Mowing must be consistent to be effective. A good rule of thumb is to mow every 5–7 days during



Figure 3. Hand weeding a meadow to eliminate weeds while keeping planted grasses.



Figure 4. Established grasses in a hand-weeded meadow, ready for overseeding of wildflowers.



Figure 5. Grasses growing in a mowed meadow surrounded by topped annual weeds, ready for overseeding of wildflowers.

the entire summer. A drawback to mowing is the residual, tough, stubby grass and weed stems that can build up, making overseeding with wildflowers somewhat challenging.

Table 5. Herbicides effective for controlling annuals during the period between planting grasses and planting wildflower species.

Herbicides	Applications
2,4-D	controls broadleaf weeds
Dicamba	controls broadleaf weeds and brush
Trimec (mixture of 2,4-D, mecoprop, and dicamba)	controls a broad range of broadleaf weeds
Clopyralid	effective on Canada thistle
Quinclorac	effective on field bindweed
Aminopyralid	effective on Canada thistle
Halosulfuron	effective on nutsedge
Sulfentrazone	effective on nutsedge

Chemical Weed Control

Read and follow the herbicide label instructions. Utilize herbicides that are selective for broadleaf weeds and will not leave a soil residue that may damage the wildflower seedlings to be planted in late summer/early fall (Table 5). Trimec® products are a mixture of three turf herbicides, 2,4-D, dicamba, and mecoprop. Trimec controls a broader range of weed species and is generally more effective than any of these herbicides applied alone (Figures 6 and 7). At the time of application, weeds should not be stressed for water, so irrigate a few days prior. Some weeds may not be eliminated with one application and some species can germinate and grow late into the summer, so two or more herbicide applications may be necessary.

Appropriate Irrigation Practices

During the establishment phase, follow the irrigation instructions previously provided in the “Planting Strategy” section. Larger amounts of water and more frequent irrigations will be needed the first summer and even into the beginning of the second.

Nonirrigated Meadow

In nature, growth of new seedlings in an arid site is a hit-or-miss proposition. To prevent the mass losses of seedlings that tend to occur naturally, irrigate



Figure 6. Grasses growing in a 2,4-D–treated meadow, ready for overseeding of wildflowers.



Figure 7. Grasses growing in a Trimec®-treated meadow, ready for overseeding of wildflowers.

a nonirrigated meadow during the first summer and into the second just as you would an irrigated meadow. As the plants mature, they will become more tolerant of drought conditions. An established, nonirrigated meadow may be exactly as named, a meadow that does not receive supplemental water. However, if the local annual mean precipitation is less than 10 in and the climate includes very dry summers, as-needed irrigations may enhance the density and health of plants in the meadow. Once the meadow is mature, if you choose to supplement rainfall with irrigation, one or two applications of 2.5–3 in of water in the driest of years should suffice.

Minimally Irrigated Meadow

Once plants in the meadow mature, a minimally irrigated meadow can thrive with 3–5 irrigations at rates of 2–2.5 in per application (Figure 8). Total



Figure 8. A mature low-irrigation meadow, two years after seeding into a site where mowing was used to control weeds during establishment.

summer supplemental irrigation applied to this type of meadow should range from 6 to 12 in.

Moderately Irrigated Meadow

Plants recommended for a moderate-irrigation meadow will require somewhat infrequent but consistent irrigation. Apply 1.5–2 in of water every 10–14 days during the heat of the summer, with less frequent applications during the late spring and early fall. Total annual irrigation amounts for a moderately irrigated meadow should be in the range of 12–24 in.

Postestablishment Management

A wildflower meadow requires two things to remain healthy and attractive. The first is an annual grooming; the second is ongoing weed management.

Annual Grooming

Fall mowing is the best option for removing dead foliage and for keeping the meadow neat. Mow late in the fall when all plants have finished dispersing seed. Mow to a height of 4–6 in.

Ongoing Weed Management

Even if a meadow is relatively free of weeds after establishment, some annual weed species may

continue to germinate and emerge as a result of weed-seed reserves in the soil. Weeds such as prickly lettuce, some mustard species, and downy brome (a.k.a. cheatgrass) can encroach into the meadow from field margins, roads, and ditch banks. Other weeds such as kochia, Russian thistle, or tumble mustard can arrive and be spread into the meadow via tumbleweeds. You can control these annual weeds by occasionally walking the meadow in the late spring and hand pulling invaders. Once both grasses and wildflower species are established, there are no good herbicide choices for spraying across the entire meadow without damaging some desirable meadow species. However, a postemergence herbicide, such as glyphosate or 2,4-D, can be spot sprayed on individual weeds or weedy patches when the need for control outweighs possible damage to meadow species. (NOTE: weeds should be removed/killed before mature seeds are produced. Persistent perennial weeds such as dandelions, Canada thistle, and a few others can reestablish in a meadow over time. It may be possible to eliminate perennials by persistently digging out the invading plants or by spot spraying with glyphosate in early fall when the herbicide translocates to the root structure and kills the weed.)

Additional Reading

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Trade Names—To simplify information, trade names have been used. No endorsement of named products is intended nor is criticism implied of similar products not mentioned.

Groundwater—To protect groundwater, when there is a choice of pesticides, the applicator should use the product least likely to leach.