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SMALL GRAIN PRODUCTION MANUAL PART 3

Seedbed Preparation, Sowing, and Residue Management

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This publication is the third in a fourteen-part series of University of California Cooperative Extension online publications that comprise the *Small Grain Production Manual*. The other parts cover specific aspects of small grain production practices in California:

- *Part 1: Importance of Small Grain Crops in California Agriculture*, Publication 8164
- *Part 2: Growth and Development*, Publication 8165
- *Part 4: Fertilization*, Publication 8167
- *Part 5: Irrigation and Water Relations*, Publication 8168
- *Part 6: Pest Management—Diseases*, Publication 8169
- *Part 7: Pest Management—Insects*, Publication 8170
- *Part 8: Pest Management—Vertebrates*, Publication 8171
- *Part 9: Pest Management—Weeds*, Publication 8172
- *Part 10: Small Grain Forages*, Publication 8173
- *Part 11: Small Grain Cover Crops*, Publication 8174
- *Part 12: Small Grains in Crop Rotations*, Publication 8175
- *Part 13: Harvesting and Storage*, Publication 8176
- *Part 14: Troubleshooting Small Grain Production*, Publication 8177

The main objective of seedbed preparation in small grains is to produce a firm, debris-free, weed-free seedbed for rapid germination and emergence. Good contact between the seed and the soil is necessary for quick imbibition and germination. Seedbed preparation varies among regions according to crop rotation, soil type, need for soil and moisture conservation, residue management, and growers' approach to tillage.

SEEDBED PREPARATION

Conventional Systems

Soil type and previous cropping pattern dictate the amount of tillage necessary to prepare the seedbed. A field with a large amount of residue from the previous crop, such as a crop produced on irrigated soil, requires deep plowing or deep tillage to help decompose the residue and to keep the surface soil free of debris. Soil should be plowed or disked as deeply as possible to help break up compaction and reduce the risk of herbicide carryover. Deep plowing, or at least two diskings, may be necessary. Disking and harrowing follow plowing or chiseling to complete seedbed preparation.



Soils should not be tilled when wet since this contributes to soil compaction, large clods, and other physical conditions unfavorable for growth of small grains.

The seedbed should be several inches deep, and the soil clods should be small enough so that they do not interfere with grain drilling, such as by getting caught between disc openers. Seedbeds with large clods and heavy crop residue that do not pass freely through the conventional 6- to 7-inch drill spacing of grain drills produce a weak stand with uneven germination. Conversely, an overprepared seedbed creates a powdery surface soil that is prone to crusting, which can delay or prevent emergence. Seedbed preparation for broadcast seeding is less critical because the broadcasting equipment does not drag clods and residue.

Summer fallowing preceded by deep plowing or deep tillage is one system used in rainfed production areas. With summer fallowing, seedbed preparation can be completed well before the normal fall planting period, allowing seed to be planted before the onset of the rainy season. Seedbed preparation for summer fallowing begins with plowing or chiseling in spring followed by disking or harrowing. This process starts after volunteer cereals and weeds have made some growth but before weeds have produced seed and while there is ample moisture available for tilling. Soil can then be disked in early fall to break up large clods and harrowed after the first rain to help control germinating weeds.

Annual cropping is also used in rainfed areas. Seedbed preparation for annual rainfed cropping begins with disking or chiseling dry soil in early summer. The seedbed is prepared after fall rains begin and is completed with shallow disking or harrowing. There is more risk of crop failure with annual cropping than with summer fallowing because inadequate moisture conditions and increased weed and disease pressure are more likely under annual cropping.

Minimum-Till and No-Till

Minimum-till and no-till seedbed preparation can be very beneficial in rainfed cropping systems because the crop residue that remains on the soil surface helps retain moisture and prevent soil erosion. In addition, reduced-tillage systems generally have lower input costs than conventional systems. Seedbed preparation usually consists of applying chemical weed control if weeds are present and drilling seed directly through the residue of the previous crop. The amount of disking and harrowing needed to bury surface crop debris, kill emerging weeds, and incorporate seed or fertilizer is limited. Straw and chaff must be thoroughly chopped and spread during harvest of the previous crop in order for sowing to be successful. Also, care must be taken in setting up sowing equipment so that the drill is able to cut through surface residue. "Hairpinning" occurs when residue is not cut but stuffed into the seed slot by the openers, preventing the soil-seed contact necessary for optimal germination.

Mulching

Mulch may be used in irrigated production in the Southern California Desert Region or other regions where rain is not expected before stand establishment. Fields are prepared, leveled, fertilized, and irrigated approximately 2 to 4 weeks before sowing to allow enough time for the fields to dry sufficiently for mulching and seeding. A mulch layer of dry soil 2 to 3 inches (5 to 7.5 cm) thick is created and seed is drilled into the moist soil beneath the mulch layer. This system of mulching can provide excellent weed control.

SOWING

Sowing Flat Versus Sowing on Beds

Small grains grown under well-drained conditions can be successfully sown flat or on raised beds. Soil type and surface drainage determine the best method for a given field. If border-check irrigation is planned, border levees should be prepared before sowing, and seed should be drilled through or across the levees. Heavy winter rains can flood fields prepared in this manner, so drainage must be provided. In the Sacramento–San Joaquin Delta, small grains are sown flat and spud ditches are dug every 100 feet (30 m). Spud ditches are the smallest ditches in the drainage system used in peat soils, about 12 inches (30 cm) wide and 24 inches (60 cm) deep, and are connected to larger 4-foot (1.2-m) ditches. They provide both drainage and subirrigation.

Many small grain growers use raised beds to allow for better winter drainage and to provide for spring irrigation. Raised beds can be especially effective on heavy soils that hold moisture for long periods. They improve drainage, keeping the root system and plant crown aerated and reducing the chance of root rot, and they can also reduce nitrogen loss due to denitrification and leaching. The beds are spaced up to 60 inches (1.5 m) apart; the width of beds depends on the equipment used, rotation crops planted in the same field, soil type, and how well the soil moves water laterally to the center of the bed, or “subs,” during irrigation. The tops of raised beds should be flat or rounded so that water does not accumulate around plant crowns, where it can cause waterlogging. Beds can be formed with listing shovels on a tool bar. Furrows should run with the field's slope, and drainage should be provided at the end of the field. Planting systems for raised beds include

- bedding and shaping the bed top followed by drilling the seed parallel or diagonally to the beds (the preferred method)
- bedding and shaping the bed top followed by broadcast seeding and harrowing to cover the seed
- broadcast or drilling the seed followed by harrowing and furrowing (which saves time)

Drilling Versus Broadcast Seeding

Most sowings on irrigated soils are drilled. The advantages of drilling over broadcasting include a more uniform depth, some reduction (up to 20%) of seeding rate, more uniform emergence, and the ability to place a starter fertilizer (a low-nitrogen, high-phosphorus fertilizer) with the seed. The advantage of broadcast seeding is that it permits large acreages to be sown in less time; the disadvantages are poor soil to seed contact, uneven planting depths (some seed too shallow for proper emergence of permanent root systems, and other seed too deep for germination), and, often, poor plant distribution. Broadcast seeding is successful when soil conditions are optimal, the seedbed is prepared properly, and rainfall or irrigation follows broadcasting and harrowing.

Seeding into Moisture from Irrigation or Rainfall

Some growers, particularly in the San Joaquin Valley and in the desert valleys of Southern California, preirrigate then sow into moist soil. Preirrigation of fine-textured soils such as clay loams and clays should be done early enough in the fall to allow time for the topsoil to dry sufficiently to permit seedbed preparation and sowing before rain begins in mid to late November. Preirrigation can be done later on loam and fine sandy loam soils that drain more quickly. One advantage of preirrigation is that weeds germinate before seeding and can be removed by tillage during seedbed preparation. Preirrigation can also provide ideal soil-water content in the seedbed so that uniform germination begins soon after seeding.

Seeding into a dry seedbed and then irrigating to germinate the seed is a second option. In the Central Valley, early seedings, in mid-November to early December, are more successfully germinated by irrigation. Irrigating early seedings assures warm soil temperatures at germination, while the risk of rainfall immediately after irrigating is relatively low. Significant rainfall after irrigating prolongs standing water and creates poor aeration around the seed, retards seedling growth, and may lead to seedling disease. Irrigating for germination is more successful on fine sandy loam and loam than on silt loam, clay loam, and clay. The advantage of irrigating to germinate seed rather than waiting for rainfall is that rainfall is unpredictable. However, in years when rainfall during December is insufficient for germination and the field is not irrigated to germinate the seed, emergence will be late, the production season will be shorter, and yields will be lower.

Seeding into a dry seedbed and waiting for rain is a third alternative. Seed retains its viability in dry soil for an extended time (several months), and stands will generally be adequate once rainfall induces germination. In California's Central Valley production region and similar areas, as long as seed germinates by the end of December, losses in yield potential will be minimal. This alternative is cost-effective in areas where surface water is unavailable and groundwater is expensive to pump or is of undesirable quality.

Sowing Depth

The recommended sowing depth is 1 to 1½ inches (2.5 to 4 cm) for wheat and triticale and 1 to 2 inches (2.5 to 5 cm) for barley and oat. If small grains are sown deeper than 2 inches, germination is delayed, emergence is impeded, and stands may be reduced. The sheath that surrounds and protects the embryonic plant as it emerges from the seed (the coleoptile) is only about 2 to 2½ (5 to 6.5 cm) inches long, and it can be buried at deep seedings.

Sowing Date

Most of California's small grain crop is sown in the fall (October through December) (see table 1) and harvested in late spring to early summer (May through July). One exception is in the Intermountain Region of Northern California, where both winter and spring cereals are produced. True winter cereals are seeded in this area in mid-October through November and harvested in July. Spring cereals are sown in the spring (early April to mid-

May) and harvested in late summer (late August through mid-September). Choosing the correct sowing date can reduce the likelihood of damage by frost and certain diseases, make weeds easier to control, and increase yield. Sowing too early in the fall increases the risk of frost injury at flowering, damage by barley yellow dwarf virus (wheat, barley, oat), *Septoria tritici* leaf blotch (wheat), and net blotch and leaf scald (barley). Later-emerging crops are less likely to be damaged by frosts; the crop should be sown late enough to minimize the risk that the crop will be flowering when there is a significant chance of frost.

Table 1. Recommended sowing dates for small grain crops in California

Growing region	Wheat, triticale, and oats	Barley
Intermountain (winter grain)	mid-Oct. to early Nov.	mid-Oct. to early Nov.
Intermountain (spring grain)	early April to early May	early April to early May
Northern Sacramento Valley	early Oct. to mid-Nov.	mid-Nov to Feb. 1
Sacramento Valley, Delta, Northern San Joaquin Valley	late Oct. to Jan. 1	mid-Nov. to Feb. 1
Southern San Joaquin Valley, Southern Desert Valleys	mid-Nov. to mid-Jan.	Dec. to Feb.
Coastal, irrigated	mid-Nov. to mid-Dec.	mid-Nov. to mid-Dec.
Coastal, dryland	early Nov. to mid-Dec.	early Nov. to mid-Jan.

If soil type and weather permit, field preparation should be delayed until fall rains stimulate weed seed germination so that weed seedlings can be destroyed before or during sowing. Sowing should not be delayed too long, however, or fields may be too wet to sow and excessive soil compaction may occur. The highest yield of irrigated small grains in the Central Valley is obtained by sowing from late October through mid-December. Yields progressively decrease with sowing after January 1. Late-sown

grain produces fewer tillers and shorter plants; it is also likely to be damaged by barley yellow dwarf virus. In rainfed systems where growers must make maximum use of winter rainfall, sowing usually starts in mid to late October, early enough so that sowing can be finished before winter rains saturate the soil and prevent operation of equipment.

Replanting is necessary if stand establishment is poor. A good plant density for an irrigated field averages about 25 plants per square foot (270 per square meter). Consider replanting if the stand is less than half of that density.

Seeding Rate

The optimal seeding rate is determined by sowing method and growing conditions (see [table 2](#)). For wheat it ranges from about 1 million seeds per acre (2.5 million per ha) for rainfed crops to 1.2 to 1.5 million seeds per acre (3.0 to 3.7 million per ha) for irrigated crops.

Higher rates are used for broadcast sowing since a smaller proportion of broadcast seed emerges. Higher rates and narrower row spacing are recommended for late sowing to compensate for the fewer tillers that will form and because higher sowing densities tend to shorten the time to flowering. Higher rates are also recommended if poor growing conditions (e.g., competition from weeds) are anticipated. High seeding rates help control johnsongrass and swamp smartweed in the Sacramento–San Joaquin Delta. Lower seeding rates can help avoid lodging, especially with barley and oat, when optimal growing conditions are expected.

Seeding rates for barley are not as critical as for wheat because barley has a greater ability to compensate for a thin stand through increased tiller production. Cultivars can vary widely in seed size, as can different seed lots of the same cultivar, so the metering system of the grain drill must be calibrated before use. Certified seed tags may specify a thousand kernel weight (in grams), which can be converted to seeds per pound and seeds per acre. A seeding rate of 1.2 million seeds per acre equals about 28 seeds per square foot (300 per square meter), which equals about 106 pounds per acre (119 kg/ha) for a cultivar that has a thousand kernel weight of 40 grams.

Table 2. Recommended seeding rates for small grain crops in California

Crop	Seeding rate*	
	lb/acre	kg/ha
irrigated wheat	100–150	112–168
irrigated wheat, Delta	180–250	202–280
rainfed wheat	60–100	67–112
irrigated barley	80–120	90–134
rainfed barley	60–100	67–112
oat [†]	80–120	90–134
irrigated triticale	100–150	112–168
Cover Crops		
barley	90	101
cereal rye	60	67

Notes:

*Increase rate by 20 to 30 pounds per acre (22 to 34 kg/ha) for broadcast plantings. Increase rate by 25 to 50 pounds per acre (28 to 56 kg/ha) and use narrower row spacing for late plantings.

[†]Use higher rates for forage production, lower rates for grain production.

RESIDUE MANAGEMENT

When crop residues interfere with planting operations, management practices must remove or reduce them. These practices include baling and removing straw, grazing, plowing, or burning, alone or in combination. Choppers or spreaders should be attached to the combine unless the straw is to be baled. Removing, deep plowing, or burning residue may help reduce the buildup of disease-causing organisms that survive on crop residue, such as those that cause *Septoria tritici* leaf blotch (wheat) and net blotch and scald (barley). Incorporating crop residue improves soil structure and in many instances is a major benefit of a small grain crop.

Small grain crops are often followed by corn or summer vegetable crops such as beans or tomatoes in some parts of the Central Valley and similar areas. In these situations, open-field burning of small grain residue, where permitted, may expedite preparation of the field for the following crop. Agricultural burning is controlled by state and local agencies, which impose restrictions on the time of burning, acreage burned, and burning procedures. Before burning, permits must be obtained from county air pollution control districts, the agricultural commissioner, or other designated agencies.

Conservation tillage, defined as a tillage program that keeps at least 30 percent of the soil surface covered by crop residue at all times, is appropriate for many rainfed small grain production areas. Maintaining a surface cover of crop residue to reduce

soil erosion is an important part of conservation tillage operations. Straw chopper and spreader attachments should be used on the combine to spread crop residue uniformly. This helps control erosion and improves distribution of the straw. Areas of straw accumulation may tie up nitrogen fertilizer during the following crop season. In no-till operations, uniform distribution of crop residue is critical to providing favorable planting conditions for the next crop.

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