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Gardening with Straw Bales

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The use of straw bales as a soilless growth medium in gardens has gained media attention in recent years. While most gardeners raise their crops using soil or raised beds amended with organic matter, it is possible to grow vegetables without soil. Straw bales are an easy-to-obtain material for soilless gardening that will provide compost as a byproduct.

Straw bales have been used as a growing medium for vegetables for at least half a century in Europe. Straw bales continue to be used for growing cucumbers in unheated structures in Poland, where heat and carbon dioxide released from bales undergoing aerobic fermentation aid in plant growth.

Straw bale culture provides a simple means to avoid the disadvantages of growing in poor soils or locations where plant diseases may already be present, but it will require additional water and fertilizer to prepare them for gardening.

Hay versus Straw

Hay is grass or other forage cut from living tissue to be baled. It is intended for animal consumption. It will generally contain leafy tissue as well the plants' reproductive structures. This may include seeds of various species.

Straw is baled from the dry stalks (culms) that remain after seed heads have been harvested from a grass crop such as wheat. They are not intended for consumption by animals. Ideally, straw bales come from a clean, weed-free field and will be free of seeds.

Preparing Bales for Use

Understanding the Process

In order to use straw bales as a growing medium, they must first be prepared for plant use. This preconditioning process is a form of composting. During preconditioning the bales will become hot, and the pH will change as decomposition occurs. It is important to complete the initial compost process prior to planting into the bale or plants may be injured.

Microorganisms will attempt to break down the straw bales as soon as the bales are moistened. During this process nutrients—primarily sources of nitrogen—will be tied up by the microbes as they decompose the straw. As a result, plants growing in root-zone environments high in carbon, such as straw bales, may not have essential nutrients available for growth, even if fertilizer is applied, until the straw has sufficiently decomposed.

Straw bales in midseason. *Photo:* Patricia West, reprinted with permission

Figure 1. Apply fertilizer material across the top of the bale before watering. *Photo:* D. Blakey.

Table 1. Conditioning bales by fertilizing on alternate days

Day	1	2	3	4	5	6	7	8	9	10+
Fertilizer rate	full	0	full	0	full	0	½	½	½	0

Table 2. Conditioning by fertilizing following 3 days of water

Day	1	2	3	4	5	6	7	8	9	10+
Fertilizer rate	0	0	0	full	full	full	½	½	½	0

For optimal composting, a ratio of carbon to nitrogen of 30:1 should be present; however, on their own, straw bales have ratios ranging from 40:1 to 100:1. As a gardener adds fertilizer containing nitrogen, the ratio approaches the ideal. Active composting will then begin. This composting process generates carbon dioxide and a substantial amount of heat. A fresh, 3-string straw bale can exceed 140°F (60°C) during conditioning. Older, seasoned bales may not exceed 100°F (38°C), but should still be preconditioned before use.

Once the preconditioning is complete, nutrients will no longer be sequestered in large amounts and the bale will remain cool enough to plant.

How to Precondition Bales for Planting

Select clean, weed-free straw bales to minimize future weeding. Straw bales are usually available at farm supply dealers or directly from local farms. 2-String or 3-string straw bales may be used. Place bales with the baling twine parallel to the ground. The twine will help to hold the bale together as the season progresses and the bale decomposes (see figs. 1 and 4).

The preconditioning process begins when the bale is moistened. High nitrogen levels are maintained initially by adding fertilizer. Midway through the conditioning process, nitrogen fertilizer inputs are tapered off as the bales continue to compost. Tables 1 and 2 provide two common preconditioning schedules. The process should take approximately 2 weeks to complete for either schedule.

Throughout the conditioning process, bales should be kept wet. A finger inserted in the side of the bale should feel hot and damp. It is best to add water slowly to each bale to minimize runoff and to ensure that the fertilizer applied to the surface is moved into the bale. The first few irrigations on new bales will take substantially more water than subsequent irrigations.

In Europe straw bales were originally preconditioned using solid, granular fertilizers; however, this led to salinity problems in some crops as roots came into direct contact with fertilizer granules. Wilson (1978) found that using water-soluble fertilizer sources eliminated this problem.

Fertilizer should be applied evenly over the top surface followed by a thorough irrigation to move the material into the bale (see fig. 1).

Since nitrogen levels are the limiting factor in the preconditioning process, one should select a water-soluble fertilizer high in nitrogen. As an alternative to the schedules shown in tables 1 and 2, Wilson recommended a constant liquid feed with 250 parts per million (PPM) of nitrogen be used with

Figure 2. Damage to a straw bale treated with fish emulsion during conditioning by a raccoon. *Photo:* D. Blakey.

frequent but small additions until the bales are saturated. At that point the bales are planted and liquid feed continues at every watering; 1.5 teaspoons (7.5 mL) of 24-8-16 in 5 gallons of water (19 L) will approximate his method.

Either organic or synthetic materials will work, but organic materials such as fish emulsion will be more expensive. Products such as fish emulsion produce a strong, disagreeable odor as the bale composts. In urban settings, this odor may be strong enough to be noticed by neighbors. Fish emulsion and other products with a similar odor can attract wildlife—particularly skunks and raccoons—that can damage the bale. Some dogs may be attracted to these bales as well and should be supervised during the conditioning process if fish emulsion is used. Figure 2 shows a bale treated with fish emulsion damaged during the night by a raccoon. Flies may also be attracted to fish emulsion when used in conditioning the bale. If animal damage occurs, replace the loose straw back into the bale firmly as soon as possible.

Table 3. Full- and half-rates of common water-soluble fertilizer products

Product	Full rate	Half rate
urea (46-0-0)	1/2 cup (120 ml)	1/4 cup (60 ml)
ammonium sulfate (21-0-0)	1 cup (240 ml)	1/2 cup (120 ml)
water-soluble blends such as 24-8-16, 20-20-20, and 20-10-20	1 cup (240 ml)	1/2 cup (120 ml)
fish emulsion (4-1-1 or 5-1-1)	3 cups (710 ml)	1 1/2 cup (355 ml)

To prepare the bale for planting, apply either the full rate or half rate of the fertilizer used as determined by the preconditioning schedule you selected. Rates to use of common materials are shown in table 3. Enough variability exists between bales and gardeners' watering practices that exact accuracy is unnecessary.

After the first 9 days of preparing the bales, once they have cooled down internally below 99°F (37°C), the conditioning process has progressed enough to plant; however, bales may not appear visually different than when the process began. A thermometer inserted into the side of the bale can be used to monitor the temperature. It is normal for this process to take 9 to 14 days. Continue to keep bales moist during this time.

Figure 3 shows the recorded temperatures of two bales conditioned with 24-8-16. The composting process continues after the initial 9-day conditioning period but at a slower pace with lower temperatures than during the initial phase. Past studies of intensive wheat straw composting

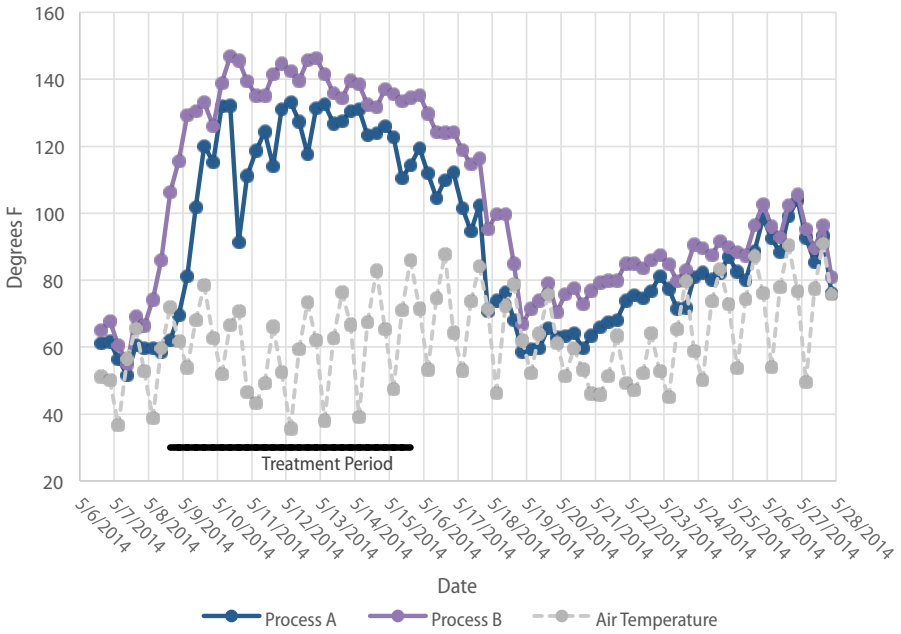

Figure 3. Recorded temperatures of 3-string wheat straw bales conditioned with 24-8-16 fertilizer in Bishop, California. Process A follows the schedule in table 1; process B follows the schedule in table 2.

show this second phase can last from 20 to 37 days, after which temperatures return to ambient (Chang and Hudson 1967).

It is common for mushrooms to emerge from the bale after conditioning. This is normal and is a sign of active decomposition in the bales. These mushrooms should be considered toxic and should not be eaten. Their presence will not affect your plants, but their emergence can disrupt the seed bed, interfering with germination.

In low desert basins with highly saline soils, salts may be drawn upward into the bale when bales are set directly on the ground. An air gap formed by locating bales on coarse gravel or similar material will interrupt this process. Alternatively, bales can placed atop an impermeable surface such as concrete or plastic sheeting.

Once the conditioning process begins, the bales should not be moved.

Growing in Straw Bales

The process of raising crops in straw bales is very similar to that used in raised bed gardening. Gardening guides such as the *California Master Gardener Handbook* (Pittenger 2015) provide cultural information for many crops; however, growing in straw bales deviates from traditional gardening in two important aspects: planting and nutrient management.

Bales are usually good for only one growing season. After that they can be used as mulch or added to a compost pile.

Planting in Straw Bales

For plants usually grown from seeds such as lettuce, squash, and carrots, an effective method of planting is to cover the surface with 2 to 3 inches (5 to 8 cm) of a soilless potting mix or media suitable for growth. This allows seeds to germinate in a finer-textured medium than straw. Seed planted in this prepared surface can be planted in the same manner as one would plant a traditional garden in soil or a raised bed. This method is also suitable for small transplants (fig. 4.)

An alternative to starting seeds in the bale is to remove some of the bale to make a small hole. Fill this hole with a potting mix and plant seeds into the prepared area. This technique is appropriate for vegetables that form large plants, such as squash.

As with any garden, plants should be spaced with enough room for them to grow. Planting suggestions for common warm-season vegetables are provided in table 4. For other crops, follow space recommendations printed on seed packets or consult a garden reference to guide you.

Table 4. Typical quantities of common warm-season vegetables to plant per bale

Plant	Number per bale
winter squash, pumpkins, melons	2
tomatoes	2 or 3
cucumbers, summer squash	2 to 3
peppers	3 to 5
beans	10 to 15

Figure 4. A conditioned bale ready for planting seeds. *Photo:* D. Blakey.

For plants grown as transplants, remove some straw or pry apart the straw "flakes" with a garden trowel and set the transplant and its soil into the opening. Add additional potting soil to fill any gaps. Water immediately after transplanting, ensuring that both the potting soil and bale are well irrigated.

Any trellises or supports should be anchored directly into the ground. As a bale decomposes, its ability to provide support diminishes, and the trellis may fall over. Bales aligned in a row with a single T-post at each end as an anchor are a good option for support and will provide additional support for the bales on the ends as they decompose.

When planting bales, be sure to give consideration to how you will irrigate your crop. Soaker hoses and drip emitters are common methods of providing water slowly to each bale. New transplants set into straw bales may dry out quickly until their roots move into the bale. Expect to water frequently while bales are still fresh. As the bales age and plants' roots spread throughout the bale, the frequency of irrigation will diminish.

Nutrient Management

After their initial conditioning, straw bales lack the nutrient-holding capacity of soil or peat-based growing media, so it is important to watch plants to ensure they are receiving adequate nutrition. Nutrient availability improves as decomposition continues. Furthermore, nutrients that may be present in the soil may not be available in sufficient amounts in bales. Fertilizer is best applied in smaller amounts but more frequently than in soil-based gardening.

Nitrogen deficiency is the most commonly reported nutrient problem in straw bale culture. Plants deficient in nitrogen are stunted and have a yellow color (chlorosis) throughout the plant.

Advantages and Disadvantages to Straw Bale Culture

Advantages

- Ability to garden in locations with contaminated or unsuitable soils, such as in deserts and urban areas; may also be used on paved areas and weed cloth.
- Fewer weeds than with soil-based gardens.
- Elevated beds reduce bending.
- Straw bales may be easier to transport and acquire than bulk compost for some gardeners.
- No construction of beds.
- No tillage required.
- Heat generated can aid seed germination and plant growth.

Disadvantages

- Requires water to condition bales.
- Depending on how bales are arranged, it can be difficult to use organic mulches on the surface of bales, as these loose materials will fall off the edges.
- If organic-approved nitrogen sources are used to condition a bale, it may be expensive to establish a garden.
- Nitrogen deficiency is common, and careful attention to nutrient status of plants is required.
- Emerging mushrooms can disrupt the seedbed.
- Bales may lose their structural integrity as the season progress and collapse or lean over

References

Chang, Y., and H. J. Hudson. 1967. Fungi of wheat straw compost. Transactions of the British Mycological Society. 50(4): 649–666.

Pittenger, D., ed. 2015. California Master Gardener handbook. 2nd ed. Oakland: University of California Agriculture and Natural Resources Publication 3382.

Wilson, G. C. S. 1978. Modified straw bale technique for cucumbers. Acta Horticulturae 82:75–77.

Resources

You can find more information on composting and gardening in these publications and online resources.

- *Compost Production and Utilization: A Grower's Guide*, UC ANR Publication 21514

- *Compost in a Hurry*, UC ANR Publication 8037
- *California Master Gardener Handbook*, Second Edition, UC ANR Publication 3382
- *California Garden Web*, online at http://cagardenweb.ucanr.edu/
- *Straw Bale Gardening*, Washington State University Extension Fact Sheet FS109E, online at http://cru.cahe.wsu.edu/CEPublications/FS109E/FS109E.pdf

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