



AGRONOMIC SPOTLIGHT



BEST MANAGEMENT PRACTICES FOR BROCCOLI

- » Broccoli production involves decisions on varieties, planting times and methods, fertilization, irrigation, harvest methods, and post-harvest handling.
- » Variety selection and fertilization can differ with spring and fall broccoli crops.
- » Plant population size impacts head size and rate of development.

VARIETY SELECTION

Broccoli is a cool-season vegetable that is grown as an early spring or fall crop in many parts of the United States. Broccoli varieties differ in their tolerance of heat and cold, so it is important to select varieties that are appropriate for the planting period, location, and type of production.¹ Varieties for fall production will need to be heat tolerant. Varieties for spring production need to be cold tolerant, especially in areas that may experience frosts or freezes after planting.²

Additional selection criteria include the days-to-harvest rating (75 to 140 days), resistance to diseases, yield potential, and head quality. Quality traits include heads with small, uniform beads, a blue-green to bright-green color, a dome shape, and heads that stand above the leaves for ease of harvest. Undesirable traits include a tendency to form hollow stems, brown or yellow beads, bracts within heads, uneven bead size, and excessive branching.^{1,3}

PLANTING METHODS

Broccoli is planted by both direct seeding and transplanting. Direct seeding can result in more weed competition and can add up to 20 days from field planting to harvest, as compared to transplanting. However, labor and supply costs are lower with direct seeding.³ In many cases, the planting method is determined by the equipment available. In the Salinas Valley, most of the broccoli is direct seeded because that planting equipment is also used for planting lettuce. For transplant production, a minimum cell diameter of 1 inch is recommended.³ Four- to five-week-old seedlings with four to five true leaves are best for transplanting, and hardening of seedlings before planting improves stand establishment.

PLANTING TIMES AND CONDITIONS

Broccoli seed can germinate at soil temperatures as low as 40°F, while the optimum range for seed germination is 45° to 85°F. Therefore, the time of direct seeding a spring crop should be based on the average date of soil temperatures reaching 45°F in the local area. Late spring plantings should be avoided in areas where summer temperatures regularly go above 90°F, as plants can bolt and unacceptable levels of head distortion can occur when heads mature during the warmer periods.^{2,3}

Planting of fall crops usually starts in late June and continues through late August. The varieties planted in the summer need to be heat tolerant in order to establish properly. When transplanting into raised beds with plastic mulch, white-on-black plastic should be used for summer plantings to prevent excessively high soil temperatures. There are some areas of the U. S. where broccoli is grown year-round.



Figure 1. Broccoli harvested as large heads and bunched (left) and as a crown cut (right).

PLANT SPACING

Recommendations for plant spacing vary considerably depending on the growing region, intended market, and harvest method (described below). Much of the broccoli produced in California is grown for fresh market sales, with a significant amount of the crop exported to countries such as Japan. This market desires relatively small (4- to 5-inch), crown-cut heads. To produce these heads, broccoli is planted at populations of up to 40,000 plants per acre. Typical plantings are double rows on 38- to 42-inch raised beds with 12 to 14 inches between rows and 5 to 6 inches between plants in the row. Some growers use wide beds, 76 to 80-inches wide with four rows per bed.¹

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In other areas, different growing conditions and a market preference for larger heads require wider plant spacings and lower populations. Recommended planting arrangements in New York are 3 to 4 rows per bed with a 17-inch row spacing and 7- to 10-inch in-row spacing for direct-seeded crops. For transplanted crops, row spacings of 24 to 36 inches with 8- to 12-inch plant spacing is recommended for large head production, and 3 rows on 60-inch beds (20-inch row spacing) for crown-cut heads.³ The Midwest Vegetable Production Guide recommends a 36-inch row spacing with a 12- to 18 inch-in-row plant spacing.⁴

Increased spacing results in larger heads and faster, more uniform development. However, wider spacing also tends to result in higher levels of hollow stem as plants grow more quickly. Reduced plant spacing (higher plant populations) results in smaller heads, slower plant development, and an extended harvest period, but lower levels of hollow stem.⁵

FERTILIZATION

Broccoli is a nutrient-demanding crop, and fertilization rates should be based on soil nutrient tests. Over-fertilization can lead to increased levels of hollow stem and unacceptable nutrient levels in leached and run-off water. Fertilizer applications are usually split into pre-plant and one or more post-plant applications as sidedressings or through drip irrigation systems. Recommendations for total nitrogen (N) amounts range from 80 to 240 lb/acre depending on the region, soil organic matter levels, and cropping season. About half of this is applied as a pre-plant broadcast or banded applications. The remainder is applied in one or two applications starting at 4 weeks after direct seeding (2 to 3 weeks after transplanting).^{1,3,4} Phosphorus (P) and potassium (K) are applied pre-plant with recommended rates of P_2O_5 ranging from 25 to 200 lb/acre and rates of K_2O ranging from 0 to 160 lb/acre depending on the region and soil nutrient test levels. Additions of boron and zinc may be needed in soils that are deficient in these nutrients.^{1,3,4}

IRRIGATION

Broccoli requires an adequate supply of soil moisture to produce maximum yields and quality. However, overwatering can cause the development of watery heads, hollow stems, and root rots. Appropriate moisture levels are the most critical during the period of head formation near the end of the season. Irrigation is applied mostly with overhead sprinkler and drip irrigation systems, and the most common methods used vary by region. Some growers start with sprinklers after planting or transplanting and then switch to drip irrigation once the crop is established. Drip irrigation systems usually provide higher water-use efficiency and they can also reduce the amount of fertilizer needed by as much as 20 or 30%.¹ Overhead irrigation can help spread some fungal and bacterial pathogens, so lower disease

levels may occur where drip systems are used.

HARVEST METHODS

All broccoli harvesting is done by hand, but there are various harvest techniques used depending on the intended market. For all systems, heads should be firm and well developed, but not opening. For fresh market sales, heads are usually harvested two to three times at 3- to 4-day intervals, depending on market price and head quality.^{1,3} Heads harvested for fresh market are typically field packed with 22 to 23 lb per box. For markets that want larger heads, heads are harvested when they are 3 to 8 inches in diameter, and stalks are cut about 8 inches in length. Sometimes two to four heads are banded together in a bunch (Figure 1). Crown-cut heads are usually 4 to 6 inches in diameter and cut approximately 5 inches long. These heads are not bunched. Other harvest/market options are field-cut florets for fresh market and harvest for processing (freezing).^{1,3}

POST HARVEST HANDLING

Field-packed boxes should be kept out of the sun and quickly transported to a packing facility for cooling to preserve quality and shelf life. Standard practice is to use water or ice-based systems (liquid icing) within four hours of harvest to cool the crop to 35°F. Forced-air cooling can also be used, but this takes longer and can dehydrate the heads.^{1,3} After cooling, boxes should be stored at 32°F at 95% RH. This usually allows a shelf life of 21 to 28 days. Storage at 41°F results in a shelf life of 10 to 14 days. Broccoli is very sensitive to exposure to ethylene, which causes heads to yellow, making them unmarketable.

Sources:

¹ LeStrange, M., Cahn, M., Koike, S., Smith, R., Daugovish, O., Fennimore, S., Natwick, E., Dara, S., Takele, E., and Cantwell, M. 2010. Broccoli production in California. UC Vegetable Research and Information Center. Vegetable Production Series. Publication 7211.

² Kaiser, C. and Ernst, M. 2014. Broccoli. University of Kentucky, Center for Crop Diversity Crop Profile.

³ Reiners, S., Bellinder, R., Curtis, P., Helms, M., Landers, A., McGrath, M., Nault, B., and Seaman, A. 2017. Cornell integrated crop and pest management guidelines for commercial vegetable production.

⁴ Egel, D., Foster, R., Maynard, E., Weller, S., Babadoost, M., Nair, A., Rivard, C., Kennelly, M., Hausbeck, M., Hutchinson, B., Eaton, T., Welty, C., and Miller, S. 2017. Midwest vegetable production guide for commercial growers 2017.

⁵ Björkman, T. and Shail, J. 2011. Maximum crown-cut broccoli yield for New York. Eastern Broccoli Project report.

For additional agronomic information, please contact your local seed representative. Developed in partnership with Technology Development & Agronomy by Monsanto.

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