AGRONOMIC SPOTLIGHT

Seminis® grow forward

ONION PLANTING DENSITY

- Total marketable yield of onions often increases with increasing planting density.
- As planting densities increase, average bulb size and per-bulb weight may decrease.
- High-density onion plantings may mature faster than less dense plantings.

PLANTING DENSITY AND YIELD

There are many planting methods and configurations of plant spacing used for onion production in North America. Onions can be direct-seeded, transplanted with field-grown or greenhouse-grown transplants, or planted using onion sets, and onions are planted on flat-ground and raised beds (Figure 1). The between-row and within-row plant spacings vary considerably depending on the region, soil type, type of onion, and target market. Within each of these systems, the plant density can be adjusted to manipulate the final bulb size, plant structure, time to maturity, and severity of foliar diseases.

Figure 1. Onions planted in two double-rows per bed. Lindsey du Toit, Washington State University.

Total yield (tons per acre) and marketable yields of onion usually increase with increasing plant density.[1,2] A study on the effect of planting density of long-day, globe-shaped onions in eastern Oregon looked at densities from 75,000 to 150,000 plants per acre.[2] In this study the total marketable yields increased with increasing plant density. A similar study on short-day, flat, sweet onions in Georgia evaluated the effect of plant spacings from 31,680 plants per acre to 110,800 plants per acre.[1] The standard plant density used in this area is 63,360 plants per acre. As in the Oregon study, total yields were highest in the standard and high-density plantings in most cases. However, other factors can influence the effect of plant density on yield. In the Georgia study, not all the varieties used in the study responded to plant density in the same way, and yield differences between treatments varied from year to year. The Oregon study also showed some variation in yield responses to density from year to year.[2] Other studies have found that varieties can differ in their yield response to plant density and that the effects of planting density can vary with planting date or show an effect some years but not others.[3,4,5]

Table 1. United States standards for grades of onions.[2,6]

Size Classification	Bulb Diameter (inches)
Super Colossal	4 to 4½ and up
Colossal	3¾ and up
Large or Jumbo	3 to 3¾
Medium	2 to 3¼
Small	1 to 2½

Total marketable yield is not the only yield criterion that should be considered when determining the planting density that will result in the largest profit per acre. Onion bulbs fall into size classes from small to super colossal (Table 1).[6] Desired bulb sizes and marketable classes vary by region, but generally marketable onions are those that fall in the medium to super colossal size classes, with the larger bulbs being the most valuable.[2]

Larger sized onion bulbs often command a price premium over smaller bulbs, and the ratio of bulb size classes within the total marketable yield needs to be factored into the calculations for obtaining the highest gross return from a planting.[1,2] However, some markets may require a uniform, medium-size distribution.

While total marketable yield usually increases with increasing plant density, bulb size tends to decrease with increasing density. In the Oregon study, the production of medium to jumbo sized bulbs increased with increasing density, but the production of colossal and super colossal bulbs decreased with increasing density. The gross returns were found to be lower at the highest density because of the reduced production of the more valuable colossal and super colossal sized bubs.[2] In some regions, such as Texas, growers are

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Table 2. Some common planting densities used for onions in various regions of North America.

Region	Day Length Type	Row Arrangement Between-row Spacing	In-Row Spacing	Target Bulb Sizes	Density (Plants/Acre)
California	short- to mid-day	2 double rows/bed	4 to 5 inches	medium to jumbo	156,000 to 210,000
Northeast US and Canada	long-day	4 rows/bed 16-inch spacing	1.5 to 2 inches	medium to jumbo	210,000 to 280,000
Eastern North America	long-day	4 rows/bed 24-inch spacing	1 to 2 inches	medium	120,000 to 160,000
			4 to 6 inches	jumbo	60,000 to 100,000
Pacific North West	long-day	2 double rows/bed	3 to 4.5 inches	medium to colossal	120,000 to 246,000
Southern US	short-day	4 rows/bed 12 to 14 inches	4 to 12 inches	medium to jumbo	63,360 to 110,800
Texas	short-day mid-day	4 rows/bed 10-inch spacing	4 to 4.5 inches	jumbo	130,000 to 157,000
Mexico - Bajío market	short-day	2 or 4 rows/bed		large/jumbo	101,000 to 122,000
Mexico – northern seedbed production	short-day mid-day	4 to 8 rows/bed		large to colossal	162,000 to 182,000

paid not by the tons of onions produced per acre, but by the number of bags of onions produced. In this situation, higher returns are seen with larger bulbs because fewer numbers of larger bulbs are needed to fill a bag.

High planting densities can result in bulbs with narrower necks and fewer double bulbs.[7] However, extremely high densities can result in the production of a large number of small, non-marketable bulbs, and overcrowding can result in misshapen bulbs with flat sides.[8]

Some commonly used spacings by region are shown in Table 2. Plant densities at the lower end of the specified range will likely result in lower total marketable yields but a larger proportion of larger-sized bulbs.

Density effects on growth

Plant density not only affects bulb size but also impacts other growth parameters. At lower densities, onions often produce an increased number of leaves per plant and have increased leaf lengths.[2] Plant density can also have an effect on the rate of maturation. Higher plant densities often result in earlier maturity dates.[1] One study found that leaf-fall on onions planted at 13 plants per square foot (140 plants per m^2) occurred 8 to 10 days earlier than on onions planted at a density of 2 plants per square foot (20 plants per m^2).[9] However, the increased canopy density at higher planting rates can also result in higher levels of foliar disease due to reduced air circulation and longer periods of leaf wetness.

Sources:

[1] Brewster, J.L. 2008. Onions and Other Vegetable Alliums 2nd Edition. Cabi Publishing.
[2] Shock, C., Feibert, E., and Saunders, L. 2004. Plant population and nitro-gen fertilization for subsurface drip-irrigated onion. HortScience 39:1722–1727.
[3] Dawar N., Wazir, F., Dawar, M., and Dawar, S. 2007. Effect of planting density on growth and yield of onion varieties under climatic conditions of Peshawar. Sarhad J. Agric. Vol. 23, 911-918.
[4] Carusoa,G., Contia, S., Villarib, G., Borrellia, C., Melchionnaa, G., Minutoloa, M., Russoa, G., and Amalfitano, C. 2014. Effects of transplanting time and plant density on yield, quality and antioxidant content of onion (*Allium cepa* L.) in southern Italy. Scientia Horticulturae 166: 111–120.
[5] Boyhan, G., Torrance, R., Cook, J., Riner, C., Hill, C., 2009a. Plant population, transplant size, and variety effect on transplanted short-day onion production. HortTechnology 19: 145–151.
[6] United States standards for grades of onions (other than bermuda-granex-grano and creole type). Effective November 24, 2014.
[7] Gupta, R. and Sharma, V. 2000. Effect of different spacing and levels of nitrogen for production of export quality onion bulbs planted on raised bed. Nwsl. Natl. Hort. Res. Dev. Found. 20, 13–16.
[8] 2010. Vegetable Production Guides. Oregon State University Department of Horticulture. https://horticulture.oregonstate.edu/vegetable-production-guides.
[9] Rumpel, J. and Felczynski, K. 1998. Effect of plant density on yield and bulb size of direct sown onions. Acta Hort. 533, 179-185.

Other regional production guides
Orzolek, M., Kime, L., Harsh,R., and Harper, J. 2013. Onion production. Penn State Extension: Agricultural Alternatives.
Boyhan, G. and Coolong, T. 2017. Transplant production and direct seeding. In "Onion Production Guide". University of Georgia Athens Extension. Bulletin 1198.
Wyenandt, A., Kuhar, T., Hamilton, G., VenGessel, M., and Arancibia, R. 2019. Mid-Atlantic commercial vegetable production recommendations.

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