Grower 101:

Calculations Part IV: Spacing Containers

Learn how to estimate the number of containers to fit in a given area in the final installment of this 4-part series.

Pot spacing is expressed in terms of the distance (in inches) between the centers of adjacent pots when pots are spaced on a square or diagonal spacing pattern in the greenhouse.

By Thomas Boyle

Containers are spaced at certain distances to obtain marketable plants and reasonable profits per square foot of production area. There is a tradeoff between container spacing and plant quality: Closer spacing tends to reduce plant quality (yielding more upright, less bushy plants with thinner branches) but results in a greater number of containers per area of production, whereas greater spacing increases plant quality but yields fewer containers per square foot. Optimum spacing would allow the leaves of one container to slightly overlap the leaves of adjacent containers.

Spacing Pots

Pot spacing is expressed in terms of the distance (in inches) between the centers of adjacent pots. Pots are spaced on a square or diagonal spacing pattern. Square spacing is the most common pattern used for pots, but growers can place more pots in a defined area with diagonal spacing than with square spacing. For example, a grower can fit 400 pots in 100 sq.ft. with 6-inch square spacing and 462 pots in 100 sq.ft. with 6-inch diagonal spacing (see Figure 1, right).

Figure 1 provides information on the amount of space occupied by one pot (in square inches) and the number of pots per 100 sq.ft. of production area using square or diagonal spacing. For example, when pots are spaced on 10-inch centers using a square spacing pattern, each pot occupies 100 sq. inches, and there are 144 pots per 100 sq.ft. (or 1.44 pots per sq.ft.). For pots spaced on 14-inch centers using a diagonal spacing pattern, each pot occupies 170 sq. inches, and there are 85 pots per 100 sq.ft. (or 0.85 pots per sq.ft.).

Minimum pot spacing is determined by pot size. Thus, for 8-inch pots, the closest spacing possible is 8 inches, which is the same as pot-to-pot spacing. As a consequence, you can place 8-inch pots on 10-inch centers, but you cannot place 8-inch pots on 6-inch centers. You can pack more small pots into a given area than large pots using pot-to-pot spacing.

Determining Space

Much of the information in Figure 1, right, can be determined using a calculator. The following examples show how to solve pot-spacing problems.

Example 1. Approximately how many pots are there (per square foot) when pots are spaced in a square pattern on 14-inch centers?

- 14 inch x 14 inch = 196 sq. inches occupied by each pot
- 12 inch x 12 inch = 144 sq. inches, which equals 1 sq.ft.
- $\frac{\text{144 sq. inches per sq.ft.}}{\text{196 sq. inches per pot}}$ = 0.73 pots per sq.ft.
- 0.73 pots per sq.ft. x 100 sq.ft. = 73 pots per 100 sq.ft (same as Figure 1)

Pot spacing calculations are used to determine the number of pots that can be grown in a given area.

Example 2. In a 35x75-ft. greenhouse with 1,838 sq.ft. in benches, a poinsettia crop will be grown with pots spaced on 14-inch centers using a square spacing pattern. Approximately how many pots can be grown in this house?

- Pots on 14-inch centers = 0.73 pots per sq.ft. (from Example 1)
- 1,838 sq.ft. x 0.73 pots per sq.ft. = 1,341 pots

If the bench area could be increased to 2,263 sq.ft., then the number of pots would increase as well:

- 2,263 sq.ft. x 0.73 pots per sq.ft. = 1,652 pots

That is 311 more pots than the greenhouse with 1,838 sq.ft. in benches!

Example 3. You will be growing a crop of geraniums in a 28x100-ft. greenhouse with 1,820 sq.ft. in benches. The geraniums will be grown in 4½-inch pots, and the pots will be spaced on 8-inch centers using a diagonal spacing pattern. Approximately how many pots can be grown in this greenhouse with this pot spacing?

Use a formula for determining the space occupied (square inch) by one pot using diagonal spacing:

- (n) x (n ÷ 2) x (1.732) where n = pot spacing in square inches
- (8) x (8 ÷ 2) x (1.732) ➧

Occupied Pot Space: Square And Diagonal Patterns

	SQUARE SPACING		DIAGONAL SPACING	
Spacing on center (inches)	Space occupied by 1 pot (square inch)	Number of pots per 100 sq.ft.	Space occupied by 1 pot (square inch)	Number of pots per 100 sq.ft.
3	9	1,600	7.8	1,848
4	16	900	13.9	1,039
5	25	576	21.6	665
6	36	400	31.2	462
7	49	294	42.4	339
8	64	225	55.4	260
9	81	178	70.1	205
10	100	144	86.6	166
11	121	119	104	137
12	144	100	125	115
13	169	85	146	98
14	196	73	170	85
15	225	64	195	74
16	256	56	222	65
18	324	44	281	51
20	400	36	346	42
22	484	30	419	34
24	576	25	499	29

Figure 1. This figure provides information on the amount of space occupied by one pot (in square inches) and the number of pots per 100 sq.ft. of production area using square or diagonal spacing. Much of the information can be determined using a calculator.


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Write in 400

- 8 x 4 x 1.732 = 55.4 sq. inches (same as Figure 1, page 60)
- $\frac{\text{144 sq. inches per sq.ft.}}{\text{55.4 sq. inches per pot}}$ = 2.60 pots sq.ft.
- 1,820 sq.ft. x 2.60 pots per sq.ft. = 4,732 pots

Example 4. In another 28x100-ft. greenhouse with 1,820 sq.ft. in benches, a grower wants to grow geraniums on 6-inch centers using a diagonal spacing pattern. Figure 1, page 60, indicates each pot will occupy 31.2 sq. inches. Approximately how many pots can be grown in this greenhouse with this pot spacing?

Use a formula for determining the space occupied (square inch) by one pot using diagonal spacing:

- (n) x (n ÷ 2) x (1.732) where n = pot spacing in square inches
- (6) x (6 ÷ 2) x (1.732)
- 6 x 3 x 1.732 = 31.2 sq. inches (same as Figure 1, page 60)
- $\frac{\text{144 sq. inches per sq.ft.}}{\text{31.2 sq. inches per pot}}$ = 4.62 pots per sq.ft.
- 1,820 sq.ft. x 4.62 pots per sq.ft. = 8,408 pots

With diagonal spacing, 3,676 more pots can be grown on 6-inch centers than on 8-inch centers.

Spacing Trays

Many types of trays are used for producing potted crops. A common spacing situation is encountered with bedding plant trays. Although there are many different sizes, many bedding plant trays are 11½ inches wide and 21¼ inches long; they are commonly called 1020 trays. Bedding plants are usually grown tray to tray, which means there is no space between trays.

Example 5. You have a 35x75-ft. greenhouse and 1,969 sq.ft. of benches. Approximately how many 1020 trays will fit in this greenhouse if there is no space between trays?

- 1020 tray = 11½ inches x 21¼ inches = 244.4 sq. inches
- $\frac{\text{144 sq. inches per sq.ft.}}{\text{244.4 sq. inches per tray}}$ = 0.59 trays per sq.ft.
- 1,969 sq.ft. x 0.59 trays per sq.ft. = 1,162 trays

Example 6. Using the same greenhouse as Example 5, approximately how many 1020 trays will fit into this greenhouse if there is 2-inch spacing between the trays on all sides? (Hint: a 2-inch spacing between the trays is like adding 2 inches to the length and width of each tray.)

- 1020 tray + 2-inch spacing = 13½ inches x 23¼ inches = 313.9 sq. inches
- $\frac{\text{144 sq. inches per sq.ft.}}{\text{313.9 sq. inches per tray}}$ = 0.46 trays per sq.ft.
- 1,969 sq.ft. x 0.46 flats per sq.ft. = 906 trays

With 2-inch spacing between trays, about 250 fewer trays will fit into the 35x75-ft. greenhouse compared with tray-to-tray spacing.

Pot-carrying trays are also commonly used in greenhouse production. Dimensions for pot carrying trays vary among manufacturers. Kord 15-pocket trays (ITML Horticultural Products Inc.) are 20¼ inches long and 12¼ inches wide; each tray holds 15 4-inch square pots. The following example uses the Kord 15-pocket trays.

Example 7. In a 28x100-ft. greenhouse with 1,900 sq.ft. in benches, you want to grow bedding plants in 4-inch square pots. The pots will be placed in Kord 15-pocket trays. Approximately how many 15-pocket trays will fit into this greenhouse if there is no space between trays?

- Kord 15-pocket tray = $20\frac{1}{4}$ inch x $12\frac{1}{4}$ inch = 248.1 sq. inches
- $\frac{\text{144 sq. inches per sq.ft.}}{\text{248.1 sq. inches per tray}}$ = 0.58 trays per sq.ft.
- 1,900 sq.ft. x 0.58 flats per sq.ft. = 1,102 trays

Calculation Accuracy

Usually, the answers from spacing calculations slightly overestimate the number of containers that will actually fit into a given area by about 5 percent. Let's explore this issue further. For instance, take a 5x100-ft. bench (equal to 500 sq.ft. in area) and assume 6-inch pots on 14-inch centers will be placed on it using square spacing. Using the data in Figure 1, page 60, you can determine that 365 pots should fit on the bench. If we fit four 14-inch rows of pots with each row containing 87 pots, that will come to 348 pots — 17 fewer than the answer from the calculation.

Why the difference? The calculations assume that 100 percent of the area is capable of being used, but in most instances 100-percent space utilization is not practical. There's usually some space that growers cannot utilize with 100-percent efficiency. Efficient space utilization becomes more difficult with wider spacing. Closer spacing makes space utilization more efficient.

Although the calculations are slightly inaccurate, they are still useful for a quick estimate. It's important to remember that the answers overestimate the actual number of containers that can fit in a given area. One way to think of these estimates is the maximum number of containers that will fit in a given area. This can be useful if you use these estimates for ordering crop supplies such as pots, labels, growing media, etc. With a slight overestimation of the number of units that can be produced, you should always have enough supplies on hand for your crop.

Another factor affecting the accuracy of spacing calculations is rounding. As in most math problems, it is important not to round off numbers during intermediate steps. In the seven problem examples presented in this article, the number of pots or trays per square foot was rounded to the hundredths place for presentation purposes, but in practice it would be better not to round off until the final answer is obtained. GPN

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