

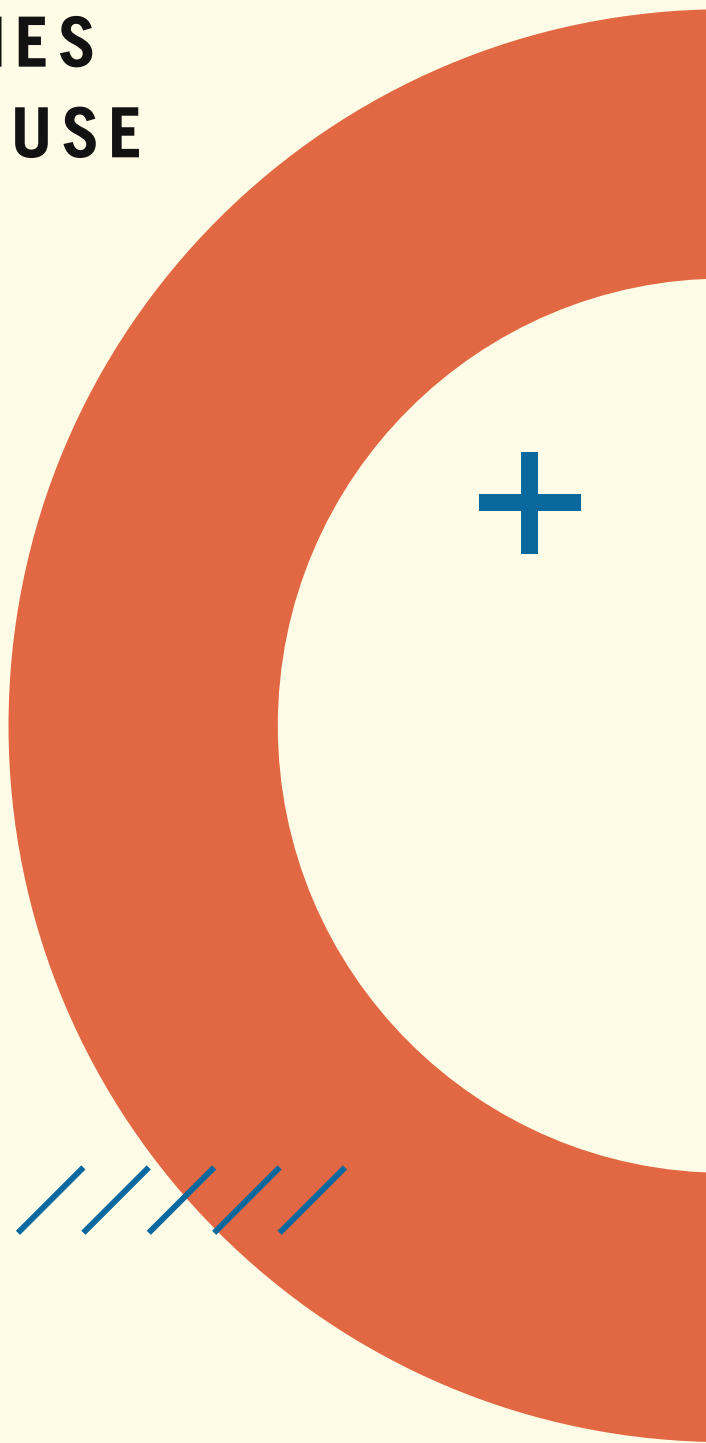
# CONVERSION TABLES, FORMULAS, AND SUGGESTED GUIDELINES FOR HORTICULTURAL USE

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**EXTENSION**



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Pesticide and fertilizer recommendations often are made on a pounds-per-acre or tons-per-acre basis for field production. However, greenhouse and nursery operators, landscape professionals and orchardists often must convert these recommendations to smaller areas, such as row feet or square feet per tree or per pot. Pints, cups, ounces, tablespoons and teaspoons often are the common units of measure. Metric units of measure can further complicate conversion.

This publication is designed to help growers make these calculations and conversions and to provide other data useful in the management, planning and operation of horticultural enterprises. A number of formulas for calculating fertilizer application rates on a parts-per-million basis are given. Tables for fertilizer injector calibration using a conductivity meter, as well as pre-plant application rates for various soil mix components and amendments, also are provided. A brief explanation of how each table is used is provided.

**Tables 1 through 3** help determine equivalent measures for liquid (volume) or dry (weight) chemical substances and also converting metric to English units.

Table 1. Equivalentents for liquid measure (volume)								
Gallons	Quarts	Pints	Fluid Ounces	Cupfuls	Tablespoonful	Teaspoonful	Milliliters	Liters
1	4	8	128	16	256	768	3785	3.785
-	1	2	32	4	64	192	946	0.946
-	-	1	16	2	32	96	473	0.473
-	-	-	1	1/8	2	6	30	0.030
-	-	-	-	1	16	48	236	0.236
-	-	-	-	-	1	3	15	0.015
-	-	-	-	-	-	1	5	0.005
-	-	-	-	-	-	-	1	0.001

<b>Table 2. Equivalents for dry measure and weight</b>	
<b>This amount</b>	<b>Converts to</b>
<b>Dry measure</b>	
3 level teaspoonfuls	= 1 level tablespoonful
16 level tablespoonfuls	= 1 cupful
2 cupfuls	= 1 pint
2 pints	= 1 quart
<b>Weight</b>	
<b>Pounds/Ounces</b>	<b>Metric</b>
220.46 lb	100 kilograms (kg)
100 lb	45.349 kg
2.204 lb	1 kg
1.102 lb	500 grams (g)
1 lb/16 oz	453.5900 g
8 oz	226.78 g
4 oz	113.39 g
3.527 oz	110 g
2 oz	56.70 g
1 oz	28.35 g
3/4 oz	21.25 g
1/2 oz	14.17 g
1/4 oz	7.08 g
1/8 oz	3.54 g
1/16 oz	1.77 g
1/32 oz	885 milligrams (mg)
1/64 oz	442 mg
1/128 oz	221 mg
<b>Ounces to Grams</b>	
<b>Ounces</b>	<b>Grams</b>
3/8	10.631
1/2	14.75
5/8	17.718
3/4	21.162
7/8	24.805
1	28.349
2	56.698
1/256	0.111
1/128	0.221
1/64	0.443
1/32	0.886
1/16	1.772
1/8	3.544
1/4	7.087

<b>Table 3. Metric system conversion table</b>	
<b>This amount</b>	<b>Converts to</b>
<b>Liquid capacity</b>	
1 fluid ounce (fl oz)	30 milliliters (ml)
1 pint (pt) = 16 fl oz	473 ml
1 quart (qt)	946 ml
1 gallon (gal)	3,785 ml
1 liter (L)	1,000 ml
1 milliliter (ml)	1 cubic centimeter (cc)
<b>Dry material capacity</b>	
1 ounce (avoirdupois)	28.4 grams (g)
1 pound (lb)	453.6 g
1 kilogram (kg)	1,000 g = 2.2 lb
<b>Volume</b>	
1 cubic inch (in <sup>3</sup> )	16.4 milliliters (ml)
1 cubic foot (ft <sup>3</sup> )	7.48 gallons = 28.3 liters (l)
1 bushel (bu)	1.24 ft <sup>3</sup> = 35.2 liters
1 cubic yard (yd <sup>3</sup> )	21.7 bu = 765 liters
<b>Linear</b>	
1 inch (in)	2.54 centimeters (cm)
1 foot (ft)	30.48 cm
1 yard (yd)	91.44 cm
1 meter (m)	100 cm
<b>Area</b>	
1 square inch (in <sup>2</sup> )	6.45 square centimeters (cm <sup>2</sup> )
1 square foot (ft <sup>2</sup> )	0.09 square meter (m <sup>2</sup> )
1 square yard (yd <sup>2</sup> )	0.84 square meter (m <sup>2</sup> )
1 acre (a)	0.40 hectare (ha)
1 square mile (M <sup>2</sup> )	2.59 square kilometer (km <sup>2</sup> )

Tables 4 through 7 help determine correct application rates for various pesticides.

**Table 4. Dilution of liquid pesticides at various concentrations**

Dilution	Amount Desired			
	1 Gal	3 Gal	Gal	5 Gal
1:100	2 Tbs + 2 tsp	½ cup	¾ cup + 5 tsp	1 cup + 3 Tbs
1:200	4 tsp	¼ cup	6½ Tbs	½ cup + 2 Tbs
1:400	2 tsp	2 Tbs	3 Tbs	4 Tbs + 2½ tsp
1:800	1 tsp	1 Tbs	1 Tbs + 2 tsp	3 Tbs + 2½ tsp
1:1000	¾ tsp	2¼ tsp	1 Tbs + 1 tsp	1 pint + ½ cup

Example: Directions call for a 1:200 dilution. To prepare 3 gallons of finished product, you would need to add ¼ cup.

**Table 5. Equivalent quantities of dry materials (wetable powders) for various volumes of water based on recommended pounds per 100 gallons**

Water	Recommended Rate					
	1 lb	2 lb	3 lb	4 lb	5 lb	6 lb
50 gal	½ lb	1 lb	1½ lb	2 lb	2½ lb	3 lb
25 gal	4 oz	8 oz	12 oz	1 lb	1¼ lb	1½ lb
12.5 gal	2 oz	4 oz	6 oz	8 oz	10 oz	¾ lb
5 gal	3 Tbs	1½ oz	2½ oz	3¼ oz	4 oz	5 oz
1 gal	1 tsp	2 tsp	1 Tbs	4 tsp	5 tsp	2 Tbs

Example: Directions for use specify a rate of 4 lb per 100 gallons of water. To prepare 1 gallon of solution would require 4 tsp of material.

**Table 6. Equivalent quantities of liquid materials (emulsion concentrates, etc.) for various volumes of water based on pints per 100 gallons**

Water 100 gal	Recommended Rate					
	½ pt	1 pt	2 pt	3 pt	4 pt	5 pt
50 gal	4 fl oz	8 fl oz	1 pt	1½ pt	2 pt	2½ pt
25 gal	2 fl oz	4 fl oz	8 fl oz	12 fl oz	1 pt	1¼ pt
12.5 gal	1 fl oz	2 fl oz	4 fl oz	6 fl oz	8 fl oz	10 fl oz
5 gal	1 Tbs	1 fl oz	2 fl oz	2½ fl oz	3 fl oz	4 fl oz
1 gal	½ tsp	1 tsp	2 tsp	3 tsp	4 tsp	5 tsp

Example: Directions for use specify a rate of 4 pt per 100 gallons of water. To prepare 5 gallons of solution would require 3 fl oz of material.

**Table 7. Rate of application equivalent table**

Rate per Acre	Rate per 1000 sq ft	Rate per 100 sq ft
<b>Liquid Materials</b>		
1 pint	$\frac{3}{4}$ Tbs	$\frac{1}{4}$ tsp
1 quart	$1\frac{1}{2}$ Tbs	$\frac{1}{2}$ tsp
1 gallon	6 Tbs	2 tsp
25 gallons	4 $\frac{2}{3}$ pints	$\frac{1}{2}$ pint
50 gallons	4 $\frac{2}{3}$ quarts	1 pint
100 gallons	2 $\frac{1}{3}$ gallons	1 quart
200 gallons	4 $\frac{2}{3}$ gallons	2 quarts
300 gallons	7 gallons	3 quarts
400 gallons	$9\frac{1}{4}$ gallons	1 gallon
500 gallons	$11\frac{1}{2}$ gallons	$1\frac{1}{4}$ gallon
<b>Dry Materials</b>		
1 lb	$2\frac{1}{2}$ tsp	$\frac{1}{4}$ tsp
3 lb	$2\frac{1}{4}$ Tbs	$\frac{3}{4}$ tsp
4 lb	3 Tbs	1 tsp
5 lb	4 Tbs	$1\frac{1}{4}$ tsp
10 lb	$\frac{1}{2}$ cup	2 tsp
100 lb	$2\frac{1}{4}$ lb	$\frac{1}{4}$ lb
200 lb	4 $\frac{2}{3}$ lb	$\frac{1}{2}$ lb
300 lb	7 lb	$\frac{3}{4}$ lb
400 lb	$9\frac{1}{4}$ lb	1 lb
500 lb	$11\frac{1}{2}$ lb	$1\frac{1}{4}$ lb

Examples: For liquid materials, 100 gallons per acre is equivalent to 2  $\frac{1}{3}$  gallons per 1000 ft<sup>2</sup> or 1 quart per 100 ft<sup>2</sup>. For dry materials, 4 lb per acre is equivalent to 3 Tbs per 1000 ft<sup>2</sup> or 1 tsp per 100 ft<sup>2</sup>.



Tables 8 through 9 help determine the correct application rates for fertilizers when nutrition recommendations are based on fertilizer weight.

Table 8. Fertilizer conversions for specified square feet and row area								
Material grouped by approximate weight per pint	Fertilizer rate for specific areas							
						Per 10 feet of row spaced**		
	Recommended rate per acre* lb	100 sq ft lb	1000 sq lb	10 sq ft Tbs	100 sq ft pt	1 ft Tbs	2 ft Tbs	3 ft cup
10 oz per pint Sulfur or Dried Blood	100	0.2	2.3	1.2	0.4	1.2	2.4	0.2
	500	1.2	11.5	6.0	1.9	6.0	12.0	1.1
	1000	2.3	23.0	12.0	3.7	-	-	-
13 oz per pint Urea or Ammonium Nitrate or Ammonium Chloride	100	0.2	2.3	0.9	0.3	0.9	1.8	0.2
	500	1.2	11.5	4.5	1.4	4.5	9.0	0.8
	1000	2.3	23.0	9.0	2.8	-	-	-
16 oz per pint Ammonium Phosphate or Potassium Chloride or Gypsum or Mixed Fertilizers	100	0.2	2.3	0.7	0.2	0.7	1.4	0.1
	500	1.2	11.5	3.5	1.2	3.5	7.0	0.7
	1000	2.3	23.0	7.0	2.3	-	-	-
19 oz per pint Calcium Nitrate or Ammonium Sulfate or Superphosphate	100	0.2	2.3	0.6	0.2	0.6	1.2	0.1
	500	1.2	11.5	3.0	1.0	3.0	6.0	0.6
	1000	2.3	23.0	6.0	2.0	-	-	-
23 oz per pint Ground Limestone or Potassium Sulfate	100	0.2	2.3	0.5	0.2	0.5	1.0	0.1
	500	1.2	11.5	2.5	0.8	2.5	5.0	0.5
	1000	2.3	23.0	5.0	1.6	-	-	-
	2000	4.6	46.0	10.0	3.2	-	-	-

\* Any of the materials listed in the first column can be used at the rates shown below. \*\*High Rates, not desirable in row fertilization, are omitted in the table. **Example:** You wish to apply calcium nitrate at the rate of 500 lb per acre. It weighs approximately 19 oz per pint. For application to 100 ft<sup>2</sup>, you need 1.2 lb or 1.0 pint.

**Table 9. Fertilizer weight as measured by standard pot size**

Fertilizer	Pot Size					
	2¼ in.	3 in.	3½ in.	4 in.	5 in.	6 in.
Ammonium nitrate	2 oz	5½ oz	9 oz	15 oz	1 lb 12 oz	2 lb 15 oz
Urea, 45-0-0	2½ oz	6 oz	9 oz	1 lb	1 lb 13 oz	3 lb
Superphosphate	2½ oz	6 oz	9½ oz	1 lb	1 lb 14 oz	3 lb 2 oz
Dusting sulfur	2½ oz	6 oz	10 oz	1 lb	1 lb 14 oz	3 lb 3 oz
Peters, 20-5-30	2½ oz	6 oz	10 oz	1 lb 1 oz	1 lb 15 oz	3 lb 3 oz
Ammonium sulfate	3 oz	7 oz	11 oz	1 lb 3 oz	2 lb 3 oz	3 lb 11 oz
Osmocote, 14-14-14	3 oz	7½ oz	12 oz	1 lb 4 oz	2 lb 5 oz	3 lb 13 oz
MagAmp, 12-62-0	3 oz	7½ oz	12 oz	1 lb 4 oz	2 lb 5 oz	3 lb 14 oz
Gypsum, CaSO <sub>4</sub>	3 oz	8 oz	12½ oz	1 lb 5 oz	2 lb 7 oz	4 lb 1 oz
Calcium nitrate	3 oz	8 oz	12½ oz	1 lb 6 oz	2 lb 8 oz	4 lb 2 oz
Peters, 15-0-15	3½ oz	8 oz	13 oz	1 lb 6 oz	2 lb 9 oz	4 lb 5 oz
Potassium chloride	3½ oz	9 oz	14 oz	1 lb 8 oz	2 lb 12 oz	4 lb 9 oz
Sodium nitrate	4 oz	9 oz	15 oz	1 lb 9 oz	2 lb 14 oz	4 lb 13 oz
Dolomitic limestone	5½ oz	13 oz	1 lb 5 oz	2 lb 4 oz	4 lb 2 oz	6 lb 14 oz

Clay flower pots are frequently used for fertilizer measurement by greenhouse operators. The above shows average weights of several representative fertilizers as measured by standard clay pots when level full. The 3-in. standard is considered to contain 8 fl oz or 1 cup. Since the actual pot size varies with the manufacturer and the volume of a given weight of fertilizer varies with moisture and compaction, deviations of 10% may be expected but up to 40% may occur.

Tables 10 through 14 help determine the correct application rates for fertilizers with various analysis when nutrition recommendations are based on parts per million and fertilizer injectors are used to deliver liquid plant fertilizer. Table 12 is designed to help growers calibrate their injectors.

Table 10. Element concentrations for pounds soluble fertilizer in 1000 gallons (U.S.) water													
Pounds of Fertilizer Needed													
Desired ppm	% Nitrogen (N)					% Phosphate (P <sub>2</sub> O <sub>5</sub> )				% Potash (K <sub>2</sub> O)			
	30	25	20	15	10	20	15	10	5	25	20	15	10
300	8.3	10.0	12.5	16.7	23.0	--	--	--	--	12.0	15.0	20.0	30.0
275	7.8	9.2	11.4	15.3	23.0	--	--	--	--	11.0	13.7	18.2	27.5
250	7.3	8.4	10.2	13.9	21.8	--	--	--	--	10.0	12.5	16.7	26.2
225	6.2	7.5	9.3	12.5	18.7	--	--	--	--	9.0	11.3	15.0	22.5
200	5.6	6.7	8.4	11.1	16.7	19.2	--	--	--	8.0	10.0	13.3	20.0
175	4.9	5.8	7.3	9.7	14.6	16.8	22.4	--	--	7.0	8.8	10.7	17.5
150	4.2	5.0	6.3	8.3	12.5	14.4	19.2	28.8	--	6.0	7.6	10.0	15.0
125	3.5	4.2	5.3	7.0	10.2	12.0	16.0	24.0	48.0	5.0	6.2	8.4	12.5
100	2.8	3.4	4.2	5.6	8.3	9.6	12.6	19.2	38.4	4.0	5.0	6.7	10.0
75	2.1	2.5	3.1	4.2	6.2	7.2	9.6	14.4	28.8	3.0	3.8	5.0	7.5
50	1.4	1.7	2.1	2.8	4.2	4.8	6.4	9.6	19.2	2.0	2.5	3.4	5.0
25	0.7	0.9	1.1	1.4	2.1	2.4	3.2	4.8	9.6	1.0	1.3	1.7	2.5

**Example:** You wish to apply 200 ppm N using a 20-10-20 soluble fertilizer. Reading across from 200 ppm under the 20 percent N column, you find 8.4 lb are needed for 1000 gallons water.

**NOTES:** 1 oz/2 gallons is about 30 lb/1000 gallons; 1 oz/3 gallons is about 20 lb/100 gallons; 1 oz/5 gallons is about 12 lb/1000 gallons; 1 oz/gallon = 7490 ppm; 1 oz/100 gallons = 75 ppm.

To determine parts per million (ppm) of an element in a fertilizer, simply multiply the percent of that element by 75. The answer will be the ppm of the element per oz of the fertilizer in 100 gallons of water. As an example, ammonium sulfate contains approximately 20% nitrogen. Twenty percent multiplied by 75 is 15, which is the ppm of nitrogen in 1 oz of ammonium sulfate per 100 gallons of water.

**Table 11. Injection ratios and nitrogen concentrations for constant fertilization**

oz fertilizer per gallon concentrate				oz fertilizer per gallon concentrate			
	100 ppm N	150 ppm N	200 ppm N		100 ppm N	150 ppm N	200 ppm N
Ratio	30% N formula <sup>a</sup>			Ratio	20% N formula <sup>c</sup>		
1:300	13.5	20.2	27.0	1:300	20.2	30.3	40.5
1:200	9.0	13.5	18.0	1:200	13.5	20.2	27.0
1:150	6.7	10.1	13.5	1:150	10.1	15.1	20.2
1:128	5.7	8.6	11.5	1:128	8.6	12.9	17.2
1:100	4.5	6.7	9.0	1:100	6.7	10.1	13.5
1:50	2.2	3.3	4.5	1:50	3.3	5.0	6.7
1:30	1.3	2.0	2.7	1:30	2.0	3.0	4.0
1:24	1.0	1.6	2.1	1:24	1.6	2.4	3.2
1:15	0.67	1.0	1.3	1:15	1.0	1.5	2.0
	25% N formula <sup>b</sup>				15% N formula <sup>d</sup>		
1:300	16.5	24.7	33.0	1:300	27.0	40.5	54.0
1:200	11.0	16.5	22.0	1:200	18.0	27.0	36.0
1:150	8.2	12.3	16.5	1:150	13.5	20.2	27.0
1:128	7.0	10.5	14.0	1:128	11.5	17.2	23.0
1:100	5.5	8.2	11.0	1:100	9.0	13.5	18.0
1:50	2.7	4.1	5.5	1:50	4.5	6.7	9.0
1:30	1.6	2.4	3.3	1:30	2.7	4.0	5.4
1:24	1.3	1.9	2.6	1:24	2.1	3.2	4.3
1:15	0.82	1.2	1.6	1:15	1.3	2.0	2.7

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<sup>a</sup>e.g., 30-10-10

<sup>b</sup>e.g., 25-5-20, 25-10-10, 25-0-25

<sup>c</sup>e.g., 20-20-20, 20-5-30, 21-7-7

<sup>d</sup>e.g., 15-15-15, 15-30-15, 16-4-12

**Table 12. Injector calibration with a conductivity meter**

**A. Peters Single Element Fertilizer Components**

ppm Nitrogen	Ammonium Nitrate $\text{NH}_4\text{NO}_3$ 34% N	Ammonium Sulfate $(\text{NH}_4)_2\text{SO}_4$ 21% N	Sodium Nitrate $\text{NaNO}_3$ 16% N	Potassium Nitrate $\text{KNO}_3$ 14% N	Calcium Nitrate $\text{Ca}(\text{NO}_3)_2$ 15.5% N	Epsom Salt $\text{MgSO}_4$ 10% Mg
50	0.23	0.45	0.43	0.48	0.37	0.38
75	0.35	0.68	0.65	0.71	0.55	0.56
100	0.46	0.90	0.86	0.95	0.74	0.75
125	0.58	1.13	1.08	1.18	0.92	0.94
150	0.69	1.35	1.29	1.42	1.11	1.13
175	0.81	1.58	1.51	1.66	1.30	1.31
200	0.92	1.90	1.72	1.90	1.48	1.50
225	1.04	2.03	1.94	2.14	1.66	1.69
250	1.15	2.25	2.15	2.37	1.85	1.88
275	1.27	2.48	2.37	2.61	2.04	2.06
300	1.38	2.70	2.58	2.85	2.22	2.25
350	1.61	3.15	3.01	3.32	2.59	2.63
400	1.84	3.60	3.44	3.80	2.96	3.00
450	2.07	4.05	3.87	4.27	3.33	3.38
500	2.30	4.50	4.30	4.75	3.70	3.75
550	2.53	4.95	4.73	5.22	4.07	4.13
600	2.76	5.40	5.16	5.70	4.44	4.50
650	2.99	5.85	5.59	6.17	4.81	4.88
700	3.22	6.30	6.02	6.65	5.18	5.25
750	3.45	6.75	6.45	7.12	5.50	5.63
800	3.68	7.20	6.88	7.60	5.92	6.00
850	3.91	7.65	7.31	8.07	6.29	6.38
900	4.14	8.10	7.74	8.55	6.66	6.75
950	4.37	8.55	8.17	9.02	7.03	7.13
1000	4.60	9.00	8.60	9.50	7.40	7.50

Adapted from Grace Horticultural Products. W.R. Grace & Co. Cambridge, Massachusetts 02140.

**NOTES:**

- 1) For use with meters in millimhos with Peters® Single Element Fertilizer Components.
- 2) These are readings made with distilled water.
- 3) Test your plain irrigation water first and subtract that reading from the fertilizer-injected water. For example, your water test indicates 0.5 mmhos and you are applying 500 ppm N with calcium nitrate. Your calibration reading is  $3.70 - 0.5 = 3.20$  mmhos.

B. Peters Mixed Soluble Fertilizer Analysis														
ppm N	20-20-20 20-19-18	20-10-15	20-5-30	25-5-20	25-10-10 30-10-10	5-11-26 Hydrosol	15-16-17 15-11-29 15-20-25	15-15-15	15-10-30	15-30-15	15-0-15	16-4-12	21-7-7 Acid	21-7-7 Neutral
50	0.23	0.31	0.22	0.12	0.09	1.00	0.32	0.30	0.32	0.31	0.36	0.32	0.28	0.21
75	0.34	0.47	0.33	0.18	0.14	1.50	0.48	0.46	0.51	0.47	0.55	0.48	0.42	0.32
100	0.45	0.62	0.44	0.24	0.18	2.00	0.65	0.62	0.70	0.62	0.74	0.64	0.56	0.42
125	0.56	0.78	0.56	0.30	0.23	2.50	0.82	0.79	0.87	0.78	0.94	0.81	0.70	0.53
150	0.68	0.93	0.69	0.36	0.27	3.00	1.00	0.96	1.50	0.93	1.15	0.98	0.84	0.63
175	0.79	1.09	0.81	0.43	0.32	3.50	1.20	1.13	1.23	1.09	1.35	1.14	0.98	0.74
200	0.90	1.24	0.94	0.51	0.36	4.00	1.40	1.30	1.41	1.24	1.55	1.31	1.12	0.84
225	1.01	1.40	1.07	0.57	0.41	4.50	1.56	1.47	1.59	1.40	1.72	1.47	1.26	0.95
250	1.13	1.55	1.20	0.62	0.47	5.00	1.72	1.65	1.78	1.55	1.90	1.62	1.40	1.05
275	1.24	1.71	1.32	0.71	0.51	5.50	1.91	1.82	1.95	1.71	2.09	1.81	1.54	1.16
300	1.35	1.86	1.43	0.80	0.54	6.00	2.10	1.98	2.12	1.86	2.28	2.00	1.68	1.26
350	1.58	2.17	1.66	0.92	0.64	6.50	2.45	2.31	2.45	2.17	2.64	2.29	1.96	1.47
400	1.80	2.48	1.90	1.04	0.74	7.00	2.80	2.65	2.78	2.48	3.00	2.58	2.24	1.68
450	2.03	2.79	2.15	1.18	0.85	7.50	3.15	2.98	3.12	2.79	3.34	2.93	2.52	1.89
500	2.25	3.10	2.40	1.32	0.96	8.00	3.50	3.25	3.46	3.10	3.68	3.28	2.80	2.10
550	2.48	3.41	2.61	1.45	1.06	-	3.84	3.55	3.76	3.41	3.98	3.57	3.08	2.31
600	2.70	3.72	2.82	1.58	1.16	-	4.18	3.85	4.06	3.72	4.28	3.86	3.36	2.52
650	2.93	4.03	3.03	1.71	1.26	-	4.52	4.15	4.36	4.03	4.58	4.15	3.64	2.73
700	3.15	4.34	3.24	1.84	1.36	-	4.80	4.45	4.66	4.34	4.88	4.44	3.92	2.94
750	3.38	4.65	3.45	1.98	1.46	-	5.20	4.75	4.95	4.65	5.20	4.72	4.20	3.15
800	3.60	4.96	3.66	2.11	1.56	-	5.54	5.05	5.25	4.96	5.50	4.98	4.48	3.36
850	3.83	5.27	3.87	2.24	1.66	-	5.88	5.35	5.55	5.27	5.80	5.24	4.76	3.57
900	4.05	5.58	4.08	2.37	1.76	-	6.22	5.65	5.85	5.58	6.10	5.50	5.04	3.78
950	4.28	5.89	4.29	2.50	1.86	-	6.56	5.95	6.15	5.89	6.40	5.76	5.32	3.99
1000	4.50	6.20	4.5	2.63	1.96	-	6.90	6.25	6.45	6.20	6.70	6.00	5.60	4.20

**NOTES:** 1) For use with meters in millimhos with Peters® Fertilizer formulations. 2) These readings are made with distilled water. 3) Test your plain irrigation water first and subtract that reading from the fertilizer-injected water. For example, your water test indicates 0.2 mmhos and you are applying 200 ppm N with 15-15-15 fertilizer. Your calibration reading is 1.30 - 0.2 = 1.10 mmhos.

**Table 13. Parts per million of desired nutrient to ounces of fertilizer carrier in 100 gallons of water (or grams in 1 liter) and vice versa**

Ounces of Fertilizer Carrier in 100 Gallons	Percentage of Desired Nutrient in Fertilizer Carrier													
	12	13	14	15.5	16	20	20.5	21	33	44	45	53	60	62
1	9	9.7	10.5	11.6	12.0	15.0	15.3	15.7	24.7	32.9	33.7	39.7	44.9	46.4
2	18	19.5	21.0	23.2	24.0	29.9	30.7	31.4	49.4	65.9	67.4	79.3	89.8	92.0
3	27	29.3	31.4	35.0	35.9	44.9	46.0	47.2	74.1	98.8	101.0	117.0	134.7	139.2
4	36	38.9	41.9	46.4	47.9	59.9	61.4	62.9	98.8	131.7	134.7	158.7	179.6	185.6
6	54	58.4	62.9	70.0	71.9	89.9	92.1	94.3	148.2	197.6	202.1	238.0	269.4	278.4
8	72	77.8	83.8	92.8	95.8	119.7	122.7	125.7	197.6	263.4	269.4	317.3	359.2	371.2
16	144	155.7	167.7	185.6	191.7	239.5	245.5	251.5	395.2	526.9	538.9	634.6	718.5	742.4
24	216	233.5	251.5	278.4	287.5	359.2	368.2	377.2	592.7	790.3	808.3	952.0	1077.7	1113.6
32	288	311.4	335.4	371.3	383.4	479.0	490.9	502.9	790.3	1053.7	1077.7	1269.3	1436.9	1484.8
40	359	389.2	419.2	464.0	479.2	598.7	613.7	628.6	987.9	1317.2	1347.1	1586.6	1796.2	1856.1
48	431	467.0	503.0	556.8	575.0	718.5	736.4	754.4	1185.5	1580.6	1616.5	1903.9	2155.4	2227.2
56	503	544.7	586.9	649.7	670.9	838.2	859.2	880.1	1383.0	1844.0	1886.0	2221.2	2514.6	2598.4
64	575	622.7	670.7	742.4	766.7	958.0	981.9	1005.8	1580.6	2107.5	2155.4	2538.6	2873.9	2969.7

Grams of Fertilizer Carrier in 1 Liter	ppm													
0.1	12	13	14	16	16	20	20.5	21	33	44	45	53	60	62
0.2	24	26	28	31	3	40	41.0	42	66	88	90	106	120	124
0.3	36	39	42	47	48	60	61.5	63	99	132	135	159	180	186
0.4	48	52	56	62	64	80	82.0	84	132	176	180	212	240	248
0.6	72	78	84	93	96	120	123.0	126	198	264	270	318	360	372
0.8	96	104	112	124	128	160	164.0	168	264	352	360	424	480	496
1.0	120	130	140	155	160	200	205.0	210	330	440	450	530	600	620
1.5	180	195	210	233	240	300	307.0	315	495	660	675	795	900	930
2.0	240	260	280	310	320	400	410.0	420	660	880	900	1060	1200	1240
2.5	300	325	350	388	400	500	512.5	525	825	1100	1125	1325	1500	1550
3.0	360	390	420	465	480	600	615.0	630	990	1320	1350	1590	1800	1860
3.5	420	455	490	543	560	700	717.5	735	1155	1540	1575	1855	2100	2170
4.0	480	520	560	620	640	800	820.0	840	1320	1760	1800	2120	2400	2480

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**Table 14. Conversion factors among electrical conductivity (EC) units**

From	To	Multiply by:
mmhos/cm or mS/cm or dS/cm	mhos x 10 <sup>-5</sup> /cm	100
mhos x 10 <sup>-5</sup> /cm	mmhos/cm or mS/cm or dS/cm	0.01
mmhos/cm or mS/cm or dS/cm	µmhos or mhos x 10 <sup>-6</sup>	1000
µmhos or mhos x 10 <sup>-6</sup>	mmhos/cm or mS/cm or dS/cm	0.001
mmhos/cm or mS/cm or dS/cm	ppm	670*
ppm	mmhos/cm or mS/cm or dS/cm	0.0014925*
mhos x 10 <sup>-5</sup> /cm	ppm	6.70*
ppm	mhos x 10 <sup>-5</sup> /cm	0.14925*
µmhos or mhos x 10 <sup>-6</sup>	ppm	0.670*
ppm	µmhos or mhos x 10 <sup>-6</sup>	1.4925*

Adapted from T.J. Cavins, et al., 2000.

\* Some labs report EC in terms of ppm or convert EC to ppm. Although 670 is the basis used in this example, the conversion factor can vary between 640 and 700. This conversion factor is an average due to the variability in the type of fertilizer salts that contribute to the substrate EC in each sample, and it should be considered a broad approximation. Expressing EC in terms of mS/cm or mhos/cm is the preferred method.



**Table 15** is designed to help growers decide which acid to add and in what quantities to acidify their irrigation water.

<b>Table 15. Various acids to add to irrigation water for acidification</b>						
<b>Alternative Acids to Add to Irrigation Water</b>						
<b>Amounts</b>	<b>Phosphoric Acid (75%)</b>	<b>Phosphoric Acid (85%)</b>	<b>Sulfuric Acid (35%)</b>	<b>Sulfuric Acid (93%)</b>	<b>Nitric Acid (61.4%)</b>	<b>Nitric Acid (67%)</b>
<b><i>For Small Volumes</i></b>						
ml per liter	0.253	0.207	0.348	0.087	0.234	0.209
fl oz per gallon	0.032	0.027	0.044	0.011	0.030	0.027
ml per gallon	0.956	0.785	1.316	0.330	0.884	0.793
<b><i>For a 1:100 Injector</i></b>						
fl oz per gallon (conc.)	3.23	2.65	4.45	1.12	2.99	2.68
ml per gallon (conc.)	95.63	78.47	131.59	32.98	88.40	79.28
<b><i>For a 1:128 Injector</i></b>						
fl oz per gallon (conc.)	4.14	3.40	5.70	1.43	3.83	3.43
ml per gallon (conc.)	122.41	100.44	168.44	42.22	113.16	101.48
<b><i>For a 1:200 Injector</i></b>						
fl oz per gallon (conc.)	6.47	5.31	8.90	2.23	5.98	5.36
ml per gallon (conc.)	191.27	156.94	263.19	65.97	176.81	158.56
<b>Nutrients Added by Each Type of Acid</b>						
Nutrients Added	Phosphorus	Phosphorus	Sulfur	Sulfur	Nitrogen	Nitrogen
Amount Added (ppm)	94.6	94.6	50.3	50.3	43.7	43.7
<p><b>Note:</b> The table is an example from software called <i>Alkalinity Calculator</i>. It is an acidification analysis done on a water sample with a starting pH of 8.0 and alkalinity of 200 ppm CaCO<sub>3</sub> acidified to an end point pH of 5.8. For your specific water sample, visit the <i>Alkalinity Calculator</i> and follow the directions. You will need to obtain a water report on your irrigation water <b>prior to</b> running the software. You will need to know the water pH and alkalinity of your sample and have an idea about what end-point pH you want to obtain after acidification. The software also gives you information about the cost of the acidification treatment. Visit the <i>AlkCalc</i>: <a href="https://extension.unh.edu/agric/AGGHFL/alk_calc.cfm">https://extension.unh.edu/agric/AGGHFL/alk_calc.cfm</a></p> <p><i>Use the information above for modifying your fertility program.</i></p>						

**Tables 16 through 20** help determine which fertilizers to use based on chemical analysis, reaction in substrate, longevity in substrate (slow release fertilizers), and incorporation rates for some popular slow release fertilizers. Tables 17 and 18 are specifically designed to provide detailed information on fertilizer calculations, which also aid determine correct application rates.

**Table 16. Amounts of nutrient sources to combine in making various fertilizer formulas**

Fertilizer Name	Analysis	Nutrient Sources <sup>a</sup>									% of N as NH <sub>4</sub> + Urea	Reaction in Substrate*
		33-0-0	13-0-44	15.5-0-0	16-0-0	21-0-0	45-0-0	0-0-60	12-62-0	21-53-0		
Ammonium nitrate	33-0-0	X									50	A
Potassium nitrate	13-0-44		X								0	N
Calcium nitrate	15.5-0-0			X							6	B
Sodium nitrate	16-0-0				X						0	B
Ammonium sulfate	21-0-0					X					100	A
Urea	45-0-0						X				100	SA
Potassium chloride	0-0-60							X			-	N
Monoammonium phosphate	12-62-0								X		100	A
Diammonium phosphate <sup>b</sup>	21-53-0									X	100	SA
Magnesium nitrate	10-0-0										0	B
Chrysanthemum green	18-0-22	1	2			1					47	A
General Summer	20-10-24	1					1	2		1	83	A
General low phosphate	21-4-20	7						4		1	55	A
General summer	21-17-20	1					2	3		3	90	A
General	17-6-27	4						4		1	57	A
UConn Mix	19-5-24		6	2			2		1		49	N
Editor's favorite	20-5-30		13				4			2	57	SA
20-20-20 substitute	20-20-22		4				1			3	67	SA
Starter and pink hydrangea	12-41-15		1						2		65	SA
Starter and pink hydrangea	17-35-16						1	4		10	100	SA
N-K only	16-0-24	2			1			2			40	SA
N-K only	20-0-30	1	2								28	SA
Blue hydrangea	13-0-22					2		1			100	VA
Blue hydrangea	15-0-15					3		1			100	VA
Acid	21-9-9	3	1			7		1		2	79	VA
Spring carnation	10-0-17				5			2			0	B
Winter nitrate	15-0-15		1	2							5	B
Winter potash	15-0-22		1	1							4	B
Lily substitute	16-4-12	1	4	6						1	22	N
High K	15-10-30		7	1						2	28	N

<sup>a</sup> For names of nutrient sources, see the first nine entries in the Name column.

<sup>b</sup> Diammonium phosphate may be pelletized and coated. To dissolve, use very hot water and stir vigorously. Sediment formation should not cause concern. Use crystalline potassium chloride if possible.

\* B = basic; N = neutral; SA = slightly acid; A = acid; VA = very acid.

**NOTE:** For example, an 18-0-22 formula fertilizer can be formulated by blending together 1 lb of ammonium nitrate plus 2 lb of potassium nitrate plus 1 lb of ammonium sulfate. This formulation is determined by locating the 18-0-22 formula in the Analysis column. Then the three numbers 1, 2 and 1 are located in the row after this formula. Each of the three numbers is traced to the X above it and then to the nutrient source to the left of the X.

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**Table 17. Formulas for additional fertilizer calculations**

<b>Compound</b>	<b>Formula</b>	<b>Formula Weight</b>
Ammonium Nitrate	$\text{NH}_4\text{NO}_3$	80.8
Ammonium Sulfate	$(\text{NH}_4)_2\text{SO}_4$	132.0
Calcium Nitrate	$\text{Ca}(\text{NO}_3)_2$	164.0
Potassium Nitrate	$\text{KNO}_3$	101.1
Potassium Chloride	KCl	74.6
Potassium Sulfate	$\text{K}_2\text{SO}_4$	174.2
Urea	$\text{CO}(\text{NH}_2)_2$	60.0
<b>Element</b>	<b>Symbol</b>	<b>Atomic Weight</b>
Calcium	Ca	40.1
Carbon	C	12.0
Chlorine	Cl	35.5
Hydrogen	H	1.0
Nitrogen	N	14.0
Oxygen	O	16.0
Phosphorus	P	31.0
Potassium	K	39.1

# Using Chemicals

To calculate	Use this formula
1) mg of fertilizer source/liter of water =	$\frac{(\text{ppm})(\text{formula weight})}{(\text{atomic weight of element})(\text{number of units in formula of fertilizer source})}$
2) ppm =	$\frac{(\text{mg of fertilizer/liter of water})(\text{atomic weight of element})}{(\text{number of units of element in formula of fertilizer source})}$ $(\text{formula weight of fertilizer source})$
3) to convert mg/l to lb/100 gallon, multiply mg by 0.0008344	
4) to convert lb/100 gallons to mg/l, divide lb by 0.0008344	
EXAMPLE:	How many pounds of potassium sulfate ( $\text{K}_2\text{SO}_4$ ) need to be dissolved in 100 gallons of water to make 100 ppm K solution.
	Get the formula weight of potassium sulfate ( $\text{K}_2\text{SO}_4$ ) and the atomic weight of potassium from Table 14 (page 15).
	Then:
	1) mg of $\text{K}_2\text{SO}_4$ / liter of water = $(100 \times 174.2) \div (39.1 \times 2) = 222.8 \text{ mg/L}$
	2) $222.8 \text{ mg/L} \times 0.0008344 = 0.186 \text{ lb potassium sulfate/100 gal}$

# Using Premixed Fertilizers

To calculate	Use this formula
1) mg of mixed fertilizer/liter of water =	$\frac{(\text{ppm of N desired})(100)}{(\% \text{ N in fertilizer})}$
2) ppm of P =	$\frac{(\text{mg of mixed fertilizer/liter of water})(\% \text{ P}_2\text{O}_5)(0.4366)}{100}$
3) ppm of K =	$\frac{(\text{mg of mixed fertilizer/liter of water})(\% \text{ K}_2\text{O})(0.8301)}{100}$
4) mg of mixed fertilizer/liter of water =	$\frac{(\text{ppm of P desired})(100)}{(\% \text{ P}_2\text{O}_5)(0.4366)}$
5) mg of mixed fertilizer/liter of water =	$\frac{(\text{ppm of K desired})(100)}{(\% \text{ K}_2\text{O})(0.8301)}$
6) mg of mixed fertilizer/liter of water =	$\frac{(\text{mg of mixed fertilizer/liter of water})(\% \text{ N})}{10}$

**Table 18. Miscellaneous conversions used in fertilizer calculations**

1 millimeter or cubic centimeter of water weighs 1 gram			
1 liter of water weighs 1 kilogram			
1 gallon of water weighs 8.34 lb			
1 part per million (ppm)		= 0.0001 percent	
1 part per million		= 1 mg per L	
1 part per million		= 0.013 oz in 100 gallons of water	
1 percent		= 10,000 ppm	
1 percent		10 g per L	
1 percent		10,000 g per kg	
1 percent		1.33 oz by weight per gallon of water	
1 percent		8.34 lb per 100 gallons of water	
0.1 percent	= 1000 ppm	= 1000 mg per L	
0.01 percent	= 100 ppm	= 100 mg per L	
0.001 percent	= 100 ppm	= 10 mg per L	
0.0001 percent	= 100 ppm	= 1 mg per L	
<b>Approximate weight-volume measurements for making small volumes of water soluble fertilizers</b>			
1 cup	= 8 oz or ½ lb of fertilizer	1 tablespoon	= 0.5 oz of fertilizer
2 cups	= 1 lb of fertilizer	2 tablespoons	= 1 oz of fertilizer
<b>Useful conversions</b>			
1 ton/acre	= 20.8 grams/square foot	100 lb/acre	= 0.2296 lb/100 square feet
1 ton/acre	= 1 lb/21.78 square feet	grams/square foot x 96	= lb/acre
1 gram/square foot	= 96 lb/acre	lb/square foot x 43,560	= lb/acre
1 lb/acre	= 0.0104 g/square foot	100 square feet	= 1/435.6 or 0.002296 acres
100 lb/acre	= 0.2296 lb/100 square feet		
<b>Weight conversions from lb/acre to weight/100 square feet</b>			
lb/acre	amount applied/100 square feet	lb/acre	amount applied/100 square feet
100	3.7 oz	700	1 lb 10 oz
200	7.4 oz	800	1 lb 13 oz
300	11.1 oz	900	2 lb 1 oz
400	14.8 oz	1000	2 lb 5 oz
500	1 lb 2½ oz	2000	4 lb 10 oz
600	1 lb 6 oz		
<b>Percent to Ratio Conversion</b>			
2.0% = 1:50	0.6% = 1:167		
1.5% = 1:67	0.5% = 1:200		
1.0% = 1:100	0.4% = 1:250		
0.9% = 1:111	0.3% = 1:333		
0.8% = 1:128	0.2% = 1:500		
0.7% = 1:143			

**Table 19. Osmocote® controlled-release fertilizers and their release periods**

Analysis	Longevity* (months)	Product Name
14-14-14	3-4	Osmocote®
19-6-12	3-4	Osmocote®
13-13-13	8-9	Osmocote®
18-6-12	8-9	Osmocote® Fast Start
18-6-12	8-9	Osmocote®
17-7-12	12-14	Osmocote®
15-9-12	3-4	Osmocote® Plus
15-9-12	5-6	Osmocote® Plus
15-9-12	8-9	Osmocote® Plus
15-9-12	12-14	Osmocote® Plus
15-9-12	14-16	Osmocote® Plus
16-8-12	8-9	Osmocote® Plus Minors Tablets
19-5-8 + Minors	8-9	Osmocote® Pro with Poly-S
19-5-9 + Minors	12-14	Osmocote® Pro with Poly-S
20-5-8 + Minors	8-9	Osmocote® Pro with Poly-S
24-4-8	8-9	Osmocote® Pro with Resin Coated Urea
24-4-7	12-14	Osmocote® Pro with Resin Coated Urea
24-4-6	14-16	Osmocote® Pro with Resin Coated Urea
21-4-7w/Mg & Fe	8-9	Osmocote® Pro with Resin Coated Urea
21-3-7w/Mg & Fe	12-14	Osmocote® Pro with Resin Coated Urea
22-4-9 + Minors	5-6	Osmocote® Pro with Resin Coated Urea
22-4-8 + Minors	8-9	Osmocote® Pro with Resin Coated Urea
22-4-7 + Minors	12-14	Osmocote® Pro with Resin Coated Urea
22-4-6 + Minors	14-16	Osmocote® Pro with Resin Coated Urea
20-4-9	8-9	Osmocote® Pro with Methylene Urea and Ureaform
20-4-8	12-14	Osmocote® Pro with Methylene Urea and Ureaform
23-4-8 + Minors	14-16	Osmocote® Pro + ScottKote™
19-7-10 + Fe	3-4	Osmocote® Pro with Uncoated NPK and Iron
18-7-10 + Fe	8-9	Osmocote® Pro with Uncoated NPK and Iron
17-7-10 + Fe	12-14	Osmocote® Pro with Uncoated NPK and Iron
13-10-13	5-6	Osmocote® Pro with IBDU and Minors
15-10-10	8-9	Osmocote® Pro with IBDU and Minors
18-8-8	8-9	Osmocote® Pro with IBDU and Minors
20-4-8	8-9	Osmocote® Pro with IBDU and Minors
18-5-9	12-14	Osmocote® Pro with IBDU and Minors
17-6-12 + Minors	3-4	Sierra® Tablets
17-6-10 + Minors	8-9	Sierra® Tablets

\* At an average root substrate temperature of 70 °F (21 °C).

Osmocote® and Osmocote® Fast Start include six trace elements plus magnesium.

From the Scotts Company and Subsidiaries, Marysville, OH 43041

**Table 20. Rates in lb/yd<sup>3</sup> (kg/m<sup>3</sup>) for incorporation of three of the most popular formulations of Nutricote into greenhouse root substrates**

Release Type (days)	Sensitive Crops		Medium-Feeding Crops		Heavy-Feeding Crops	
	<b>13-13-13</b>					
70	2.5	(1.5)	5	(3.0)	8.5	(5.1)
100	3.5	(2.1)				
140	5	(3.0)	9	(5.4)	13	(7.8)
180	6	(3.6)	11	(6.6)	17	(10.2)
270	8	(4.8)	13	(7.8)	21	(12.6)
360	11	(6.6)	<b>15</b>	<b>(9.0)</b>	25	(15.0)
	<b>14-14-14</b>					
40	2	(1.2)	5	(3.0)	8	(4.7)
70	4	(2.4)	9	(5.4)	14	(8.3)
100	5	(3.0)	12	(7.1)	20	(11.9)
140	8	(4.7)	15	(9.0)	22	(13.0)
180	12	(7.1)	20	(11.9)	28	(16.6)
270	16	(9.5)	24	(14.2)	32	(19.0)
360	20	(11.9)	28	(16.6)	36	(21.3)
	<b>18-6-8</b>					
70	2	(1.2)	4.5	(2.7)	7.5	(4.5)
100	3	(1.8)	6.5	(3.9)	11	(6.6)
140	4.5	(2.7)	8	(4.8)	12	(7.2)
180	6	(3.6)	11	(6.6)	14	(8.4)
270	8	(4.8)	13	(7.8)	16	(12.0)
360	11	(6.6)	15	(9.0)	18	(13.8)

From Nelson, P.V. 1998. Greenhouse Operations and Management, 5<sup>th</sup> ed. Published by Prentice Hall, Inc. Reprinted with permission.

Tables 21 through 22 are designed to assist growers in correcting the pH of the growing substrate.

**Table 21. Materials and rates necessary to lower the pH level of greenhouse potting substrate 0.5 to 1.0 units**

Material	Pounds to incorporate in lb/yd <sup>3</sup>	Pounds to dissolve in 100 gallons of water <sup>a</sup>	Rate of change in pH
Aluminum sulfate	1.5	6.0	Rapid
Iron sulfate	1.5	6.0	Moderate
Finely-ground elemental sulfur	0.75	-	Slow

<sup>a</sup> Apply this drench as a normal watering, about 1 quart per square foot or 8 fluid ounces per 6-in. pot.

Adapted from Bailey, D.A. 1996.

**Table 22. Approximate amount of materials required to change pH of peat-based potting mixes**

Pounds per cubic yard to change acidity to pH 5.7 for:		
Beginning pH	50% Peat 50% Bark	100% Peat
7.5 <sup>2</sup>	2.0	3.4
7.0	1.5	2.5
6.5	1.0	2.0
<b>5.0<sup>3</sup></b>	<b>2.5</b>	<b>3.5</b>
<b>4.5</b>	<b>5.6</b>	<b>7.4</b>
<b>4.0</b>	<b>7.9</b>	<b>11.5*</b>
<b>3.5</b>	<b>10.5*</b>	<b>15.58</b>

<sup>2</sup> Add sulfur or acidifying mixture to lower pH to 5.7.  
<sup>3</sup> **Add dolomitic lime or equivalent amount of calcium to raise pH to 5.7.**  
\* Addition of more than 10 lb of dolomitic per yd<sup>3</sup> can cause micronutrient deficiencies.

Adapted from Conover, C.A., and R.T. Poole. 1984.

Table 23 will help when applying various plant growth regulators.

Table 23. Dilution/conversion chart for various plant growth regulators						
A-REST (0.0264% active ingredient)						
Spray	Spray Solution (ppm)	Fluid Ounces per Gallon of Final Solution		Milliliters per Gallon of Final Solution	Milliliters per Liter of Final Solution	
	1	48		14.34	3.79	
	3	1.45		43.02	11.36	
	10	4.85		143.39	37.88	
	25	12.12		358.47	94.70	
	50	24.24		716.93	189.39	
	75	36.36		1075.40	284.09	
	100	48.48		1433.87	378.79	
Drench	Dose (Milligrams per 6-in. Pot)	Drench Volume per 6-in. Pot <sup>a</sup> (Fluid Ounces)	ppm solution	Fluid Ounces per Gallon of Final Solution	Milliliters per Gallon of Final Solution	Milliliters per Liter of Final Solution
	0.125	4	1.06	0.51	15.15	4.0
	0.25	4	2.11	1.02	30.30	8.01
	0.50	4	4.23	2.05	60.61	16.01
	0.75	4	6.34	3.07	90.91	24.02
	1.00	4	8.45	4.10	121.21	32.02

<sup>a</sup> 2 fl oz/4-in. pot; 3 fl oz/5-in. pot; 10 fl oz/8-in. pot



**Table 23. (Continued)**

<b>CYCOCEL (11.8% active ingredient)</b>						
<b>Spray</b>	<b>Spray Solution (ppm)</b>	<b>Fluid Ounces per Gallon of Final Solution</b>	<b>Milliliters per Gallon of Final Solution</b>	<b>Milliliters per Liter of Final Solution</b>		
	1,000	1.08	32.08	8.47		
	1,500 <sup>b</sup>	1.63	48.12	12.71		
	2,000	2.17	64.16	16.95		
	2,500	2.71	80.20	21.19		
	3,000 <sup>c</sup>	3.25	96.24	25.42		
	5,000	5.42	160.40	42.37		
<sup>b</sup> Commonly referred to as 1:80. <sup>c</sup> Commonly referred to as 1:40.						
<b>Drench</b>	<b>Dose (Milligrams per 6-in. Pot)</b>	<b>Drench Volume per 6-in. Pot<sup>d</sup> (Fluid Ounces)</b>	<b>ppm</b>	<b>Fluid Ounces per Gallon of Final Solution</b>	<b>Milliliters per Gallon of Final Solution</b>	<b>Milliliters per Liter of Final Solution</b>
	355	6	2,000	2.17	64.18	16.95
	532	6	3,000 <sup>e</sup>	3.25	96.18	25.42
	710	6	4,000	4.34	128.36	33.90
<sup>d</sup> 2 fl oz/2¼- to 3-in. pot; 3 fl oz/4-in. pot; 4 fl oz/5-in. pot; 8 fl oz/8-in. pot.						
<sup>e</sup> Commonly referred to as 1:40.						

<b>B-NINE WSG (85% active ingredient)</b>				
<b>Spray</b>	<b>Spray Solution (ppm)</b>	<b>Ounces per Gallon of Final Solution</b>	<b>Grams per Gallon of Final Solution</b>	<b>Grams per Liter of Final Solution</b>
	1,000	0.16	4.45	1.18
	2,500	0.39	11.13	2.94
	5,000	0.79	22.26	5.88
	7,500	1.18	33.40	8.82
<b>BONZI (0.4% active ingredient)</b>				
<b>Spray</b>	<b>Spray Solution (ppm)</b>	<b>Fluid Ounces per Gallon of Final Solution</b>	<b>Milliliters per Gallon of Final Solution</b>	<b>Milliliters per Liter of Final Solution</b>
	1	0.032	0.95	0.25
	3	0.096	2.84	0.75
	5	0.160	4.73	1.25
	10	0.320	9.46	2.50
	15	0.480	14.20	3.75
	25	0.800	23.66	6.25
	45	1.440	42.59	11.25
	60	1.920	56.78	15.00
	90	2.880	85.17	22.50

**Table 23. (Continued)**

<b>BONZI (cont.)</b>						
<b>Drench</b>	<b>Dose (Milligrams per 6-in. Pot)</b>	<b>Drench Volume per 6-in. Pot<sup>f</sup> (Fluid Ounces)</b>	<b>ppm</b>	<b>Fluid Ounces per Gallon of Final Solution</b>	<b>Milliliters per Gallon of Final Solution</b>	<b>Milliliters per Liter of Final Solution</b>
	0.1	4	0.85	0.03	0.8	0.21
	0.2	4	1.69	0.05	1.6	0.42
	0.5	4	4.23	0.14	4.0	1.06
	1.0	4	8.45	0.27	8.0	2.11
	1.9	4	16.06	0.51	15.2	4.02
<sup>f</sup> 2 fl oz/4-in. pot; 3 fl oz/5-in. pot; 10 fl oz/8-in. pot.						
<b>SUMAGIC (0.055% active ingredient)</b>						
<b>Spray</b>	<b>Spray Solution (ppm)</b>	<b>Fluid Ounces per Gallon of Final Solution</b>		<b>Milliliters per Gallon of Final Solution</b>		<b>Milliliters per Liter of Final Solution</b>
	1	0.26		7.57		2
	3	0.77		22.71		6
	5	1.28		37.85		10
	10	2.56		75.71		20
	15	3.84		113.56		30
	25	6.40		189.27		50
	30	7.68		227.12		60
	50	12.80		378.54		100
<b>Drench</b>	<b>Dose (Milligrams per 6-in. Pot)</b>	<b>Drench Volume per 6-in. Pot<sup>g</sup> (Fluid Ounces)</b>	<b>ppm</b>	<b>Fluid Ounces per Gallon of Final Solution</b>	<b>Milliliters per Gallon of Final Solution</b>	<b>Milliliters per Liter of Final Solution</b>
	0.02	4	0.17	0.04	1.28	0.34
	0.03	4	0.25	0.06	1.92	0.51
	0.04	4	0.34	0.09	2.56	0.68
	0.05	4	0.42	0.11	3.20	0.85
	0.06	4	0.51	0.13	3.84	1.01
	0.09	4	0.76	0.19	5.76	1.52
	0.12	4	1.01	0.26	7.68	2.03
	0.20	4	1.69	0.43	12.80	3.38
<sup>g</sup> 2 fl oz/4-in. pot; 3 fl oz/5-in. pot; 10 fl oz/8-in. pot.						

**Table 23. (Continued)**

<b>FLOREL (3.9% active ingredient)</b>				
<b>Spray</b>	<b>Spray Solution (ppm)</b>	<b>Fluid Ounces per Gallon of Final Solution</b>	<b>Milliliters per Gallon of Final Solution</b>	<b>Milliliters per Liter of Final Solution</b>
	300	0.97	28.72	7.59
	325	1.05	331.11	8.22
	500	1.62	47.86	12.64
	750	2.43	28.89	18.97
	975	3.16	93.34	24.66
	1,000	3.24	95.73	25.29
<b>PRO-GIBB (4% active ingredient)</b>				
<b>Spray</b>	<b>Spray Solution (ppm)</b>	<b>Fluid Ounces per Gallon of Final Solution</b>	<b>Milliliters per Gallon of Final Solution</b>	<b>Milliliters per Liter of Final Solution</b>
	2.5	0.008	0.24	0.06
	5.0	0.016	0.47	0.13
	100.0	0.320	9.46	2.50
	250.0	0.800	23.66	6.25
	300.0	0.960	28.39	7.50
	500.0	1.600	47.31	12.50
<b>FASCINATION</b>				
<b>Spray</b>	<b>ppm BA/GA</b>	<b>Fluid Ounces per Gallon of Final Solution</b>	<b>Milliliters per Gallon of Final Solution</b>	<b>Milliliters per Liter of Final Solution</b>
	1/1	0.007	0.2	0.06
	5/5	0.04	1.1	0.3
	10/10	0.07	2.1	0.6
	25/25	0.18	5.3	1.4
	50/50	0.36	10.5	2.8
	75/75	0.53	15.8	4.2
	100/100	0.71	21.0	5.5

Adapted from Hammer, P.A. 1992.

Tables 24 through 25 are designed to assist growers who desire to prepare their own substrate mix.

<b>Table 24. Pre-plant fertilizer sources and rates of application<sup>1,2</sup></b>		
	<b>Rate per cubic yard (per m<sup>3</sup>)</b>	
<b>Nutrient source</b>	<b>Soil-based media</b>	<b>Soiless media</b>
<b>To provide calcium and magnesium</b>		
When a pH rise is desired:		
Dolomitic limestone	0–10 lb (0–6 kg)	10 lb (6 kg)
When no pH shift is desired:		
Gypsum for calcium	0–5 lb (0–3 kg)	0–5 lb (0–3 kg)
Epsom salt for magnesium	0–1 lb (0–0.6 kg)	0–1 lb (0–0.6 kg)
<b>To provide phosphorus<sup>3</sup></b>		
Superphosphate (0-45-0), or	1.5 lb (0.9 kg)	2.25 lb (1.3 kg)
<b>To provide sulfur</b>		
Gypsum (calcium sulfate)	1.5 lb (0.9 kg)	1.5 lb (0.9 kg)
<b>To provide micronutrients: iron, manganese, zinc, copper, boron, molybdenum</b>		
Esmigran	3–6 lb (1.8–3.6 kg)	3–6 lb (1.8–3.6 kg)
Micromax	1–1.5 lb (0.6–0.9 kg)	1–1.5 lb (0.6–0.9 kg)
Promax	1–1.5 lb (0.6–0.9 kg)	1–1.5 lb (0.6–0.9 kg)
F-555HF	3 oz (112 g)	3 oz (112 g)
F-111HR	1 lb (0.6 kg)	1 lb (0.6 kg)
<b>To provide nitrogen and potassium (optional)</b>		
Calcium nitrate, or	1 lb (0.6 kg)	1 lb (0.6 kg)
Potassium nitrate	1 lb (0.6 kg)	1 lb (0.6 kg)

<sup>1</sup> From Nelson, P.V. 1998. Greenhouse Operations and Management, 5th ed. Published by Prentice Hall, Inc. Reprinted with permission.

<sup>2</sup> Rates in this table are for crops other than seedlings. Only limestone is necessary in seedling substrates. Optional nutrient sources for seedling substrate include up to 1 lb (0.6 kg) each of superphosphate, gypsum, and calcium nitrate; no potassium nitrate; and the low end of the rate range for micronutrients.

<sup>3</sup> These are maximum rates designed to supply phosphorus for 3 to 4 months if pH is maintained in a desirable range for the crop and the leaching percentage is at or below 20%.

**Table 25. Cornell Peat-Lite Mix A for seedlings, bedding plants and potted plants\***

Materials Used	Amount per Cubic Yard <sup>1</sup>	Amount per Bushel
Spagnum peat moss	0.5 cubic yard (13 bushels)	0.5 bushel
Horticultural grade vermiculite #2 size for seed germination #2 or 3 for transplanting	0.5 cubic yard (13 bushels)	0.5 bushel
Superphosphate, or	1 to 2 lb	20.5 to 41.0 grams (1 to 2 tablespoons)
Treble superphosphate <sup>2</sup>	0.5 to 1 lb	10.3 to 20.5 grams (0.6 to 1.2 tablespoons)
Ground dolomitic limestone <sup>2</sup>	5 to 10 lb	103 to 206 grams (5.2 to 10.4 tablespoons)
Gypsum <sup>2</sup>	2.0 lb	41 grams (2.5 tablespoons)
Calcium nitrate	0.5 lb	10 grams (1.2 tablespoons)
Potassium nitrate	0.5 lb	10 grams (1.2 tablespoons)
<b>Trace element material (Use Only One)</b>		
Esmigran, or	4.0 lb	81 grams (4.0 tablespoons)
Micromax	1.5 lb	31 grams (1.7 tablespoons)
<b>Wetting agent (Use Only One<sup>3</sup>)</b>		
Aqua-Gro 2000 granular or	1.0 lb	----
Aqua-Gro 2000-L liquid <sup>4</sup>	3-5 fluid ounces	0.5 level teaspoon
PsiMatric liquid <sup>5</sup>	2-4 fluid ounces	0.5 level teaspoon

<sup>1</sup> A cubic yard equals 27 cubic feet or approximately 22 bushels. A 15% to 20% shrink occurs in mixing. Therefore, an additional 5 cubic feet or 4 bushels are used to obtain a full cubic yard.

<sup>2</sup> If treble superphosphate is used, gypsum is added to supply sulphur. If only 5 lb of limestone are used for pH control, then add the gypsum that supplied calcium and sulphur.

<sup>3</sup> The granular Aqua-Grow is preferred.

<sup>4</sup> 3 oz/yard for germination/seedlings, 5 oz/yard for bedding plants and pot plants.

<sup>5</sup> 2 oz/yard for germination/seedlings, 4 oz/yard for bedding plants and pot plants.

\* Adapted from Fonteno. W.C. 1994

**Table 26. Number of pots and flats that can be filled from 1 ft<sup>3</sup> of soil mix**

Pot Size (in.)	Approximate Dimension Top x Depth x Bottom (in.)	Number of Pots/ft <sup>3</sup>	Type	Approximate Dimension Top x Depth x Bottom (in.)	Units/ft <sup>3</sup>
<b>Standard Round Pots</b>			<b>Flats</b>		
2¼	2¼ x 2 1/16 x 1¾	256	Germination tray	11½ x 21¼ x 1 1/8	7.0
2½	2 3/8 x 2¼ x 2	208	20-row Seeding tray	11½ x 21¼ x 1 1/8	11.0
3	3 x 2 13/16 x 2¼	120	<b>Standard Cell-Packs</b>		
3½	3 3/8 x 3 3/10 x 2 3/8	80	8-4 cell packs per tray		5.4
4	4 x 3 7/8 x 2¾	48	8-6 cell packs per tray		5.9
4½	4 3/8 x 4 3/8 x 3	40	10-4 cell packs per tray		6.2
5	5 x 3½ x 4	28	10-6 cell packs per tray		6.7
5½	5½ x 5 3/8 x 3 13/16	20	12-4 cell packs per tray		6.0
6	6 x 5¾ x 4 1/16	16	12-6 cell packs per tray		7.0
7	6¾ x 7¾ x 4 11/16	10	Standard size 11¼ x 21¼ x 2½		
8	7 5/8 x 7¾ x 5 3/8	6	<b>Plug Flats</b>		
10	9 7/8 x 9¾ x 6 7/8	3	50 sq. flat	1 7/8 x 2¼	6.3
<b>Azalea Pots</b>			72 rd. flat	1 7/16 x 1¾	12.8
4	4 x 21 3/16 x 3	56	72 sq. flat	1 9/16 x 2 3/16	7.3
4½	4½ x 3 3/8 x 3¼	44	98 sq. flat	1 5/16 x 2	7.9
5	5 x 3 13/16 x 3 9/16	28	128 sq. flat	1 3/16 x 1 13/16	9.0
5½	5½ x 4¼ x 3 7/8	24	162 sq. flat	1 x 1½	9.2
6	6 x 4 5/8 x 4¼	18	200 sq. flat	5/16 x 1½	10.7
6½	6½ x 5 x 4 9/16	16	273 sq. flat	¾ x 1 1/8	18.6
7	7/8 x 5 3/8 x 51/16	12	288 rd. flat	13/16 x 1	19.1
7½	7 3/8 x 5 11/16 x 5 3/8	10	288 sq. flat	13/16 x 1¼	15.0
8	8 1/8 x 5 7/8 x 6	7	392 sq. flat	5/8 x 7/8	23.1
8½	8 1/8 x 6¼ x 6¼	6	406 sq. flat	5/8 x 7/8	22.2
10	9 7/8 x 7 3/8 x 7¼	4	512 sq. flat	9/16 x ¾	24.7
<b>Square Pots</b>			<b>Nursery Containers (plastic)</b>		
2¼	15/16 x 1 7/8 x 1½	357	1 gal	6½ x 6½	10.0
2½	2 3/8 x 1 15/16 x 1 7/8	224	2 gal	8½ x 8½	4.5
3	2¾ x 2¼ x 2 1/8		3 gal	10¼ x 9 5/8	3.3
3½	3¼ x 2¾ x 2½		<b>Saucerless</b>		
4	3 5/8 x 3 1/8 x 2 7/8		8		9.7
4½	4 1/8 x 3 5/8 x 3¼		0		5.3
			2		3.1

Table 26. Number of pots and flats that can be filled from 1 ft <sup>3</sup> of soil mix					
Pot Size (in.)	Approximate Dimension Top x Depth x Bottom (in)	Number of Pots/ft <sup>3</sup>	Type	Approximate Dimension Top x Depth x Bottom (in)	Units/ft <sup>3</sup>
<b>Bulb Pans</b>			<b>Hanging Baskets</b>		
6	6 1/16 x 3 9/16 x 4 9/16	24	6	6 x 4 1/2 x 3 1/4	29
7	7 1/16 x 3 13/16 x 5 9/16	16	8	7 1/2 x 4 7/8 x 4 1/16	11
10	10 1/4 x 4 15/16 x 8 1/8	5	10	10 x 6 1/8 x 4	5
12	12 1/8 x 6 x 9 3/4	3	<b>NOTES:</b> Sources – Eason Horticultural Resources, Inc., Crestview Hills, KY, and Hummert's Helpful Hints, 1999-2000 edition. These figures have to be treated as approximations. Actual pot dimensions will vary from one manufacturer to another. Based on volume of pots when filled level to rim with loose, unpacked soil mix.		
<b>Geranium Pots</b>					
3½	3 1/4 x 3 x 2 3/8	96			
4	3 15/16 x 3 7/16 x 2 7/8	56			
4¼	4 1/4 x 3 9/16 x 3 1/8	50			
4½	4 3/8 x 3 7/8 x 3	44			

Table 27. Number of nursery containers that can be filled from 1 yd <sup>3</sup> of soil mix	
Size	# / per yd <sup>3</sup>
Trade 1	300
Full 1	200
2	140
3	80
5	50
7	35
10	20
15	14
25	8
45	4

Source: Ruter, J. (personal communication)

### Soil Mix Volumes

1 bushel = 1¼ cu ft

1 cubic yard = 27 cu ft

1 cu yard = 22 bushels

100 sq ft of bench area (at 6 in. soil depth) = 50 cu ft or 40 bushels of soil mix.

Table 28. Coverage estimates for perlite, peat, topsoil and straw					
Thickness	4 cu ft Perlite	6 cu ft Canadian Peat (12 cu ft loose)	1 cu yd* Peat Mulches, Topsoil, etc.	1 Bale	
				Pinestraw	Wheatstraw
2 in.	28 sq ft	72 sq ft	162 sq ft	90 sq ft	180 sq ft
1 in.	48 sq ft	144 sq ft	324 sq ft	180 sq ft	360 sq ft
½ in.	96 sq ft	288 sq ft	648 sq ft	360 sq ft	720 sq ft
¼ in.	192 sq ft	576 sq ft	1296 sq ft	720 sq ft	1440 sq ft

\* cubic yard (yd<sup>3</sup>) = 27 cubic feet (ft<sup>3</sup>)

Tables 29 through 30 help determine correct spacing and number of plants at each spacing for both greenhouse and field situations.

Table 29. Plant spacing guide (greenhouse)			
Spacing	Plants/sq ft	Plants/acre of production area	Plants/acre of ground covered*
8" x 9"	2.0	87,000	58,000
8" x 8"	2.3	98,000	65,000
8" x 7"	2.6	114,000	76,000
8" x 6"	3.0	30,000	87,000
6" x 7"	3.4	147,000	98,000
6" x 6"	4.0	174,000	116,000
6" x 5"	4.8	208,000	139,000
5" x 5"	5.8	252,000	168,000
5" x 4"	7.2	313,000	209,000
5" x 3"	9.6	418,000	279,000
4" x 3"	12.0	522,000	348,000

\*Assuming 1/3 of production area devoted to aisles, etc.

Table 30. Plant spacing guide (field/orchard)												
	Spacing Between Plants Within the Row											
	Feet	6	8	10	12	14	16	18	20	22	24	26
Spacing Between Rows of Plants	4	1815	1361	1089	907	777	680	605	544	495	453	418
	6	1218	907	726	605	518	453	403	363	330	302	279
	8	907	680	544	453	388	339	302	272	247	226	209
	10	726	544	435	362	311	272	242	218	207	181	167
	12	605	453	362	302	259	226	201	181	165	151	139
	14	518	388	311	259	222	194	172	155	141	129	119
	16	453	339	272	226	194	169	151	136	123	113	104
	18	403	302	242	201	172	151	134	121	110	100	93
	20	363	272	218	181	155	136	121	108	99	90	83
	22	330	247	207	165	141	123	110	99	90	82	76
	24	302	226	181	151	129	113	100	90	82	75	69
26	279	209	167	139	119	104	93	83	76	69	64	

**Number of Plants per Acre**  
To determine the number of plants per acre for spacing not given in the table, multiply the distance in the row by the distance between rows and divide that number into 43,560.



# Landscape

Tables 31 through 36 are designed to aid landscape professionals and homeowners in determining number of plants at various spacings, cubic yards of soil needed at various depths and areas, areas covered in square feet at various depths, time needed to trim lawns, and the volume of water delivered as affected by the size of irrigation hose.

**Table 31. Estimated number of plants to fill 100 ft<sup>2</sup> of bed area for square (row) and triangular (equilateral) planting patterns using 4- to 14-in. spacing distances**

Planting Pattern		Inches between rows of plants (Y)	Inches between plants (X) within rows	Estimated number of plants per 100 ft <sup>2</sup>
<b>Square</b>				
For square spacing, the distance between plants within rows (x) equals the distance between rows (Y)		4	4	900
		6	6	400
		8	8	225
		10	10	144
		12	12	100
		14	14	74
<b>Triangular</b>				
For triangular spacing, the distance between plants within rows and between rows both equal X, and the distance between rows (Y) equals 0.886 X.		3.46	4	1039
		5.20	6	462
		6.93	8	260
		8.66	10	166
		10.39	12	115
		12.12	14	85

Adapted from Bailey, D.A., and M.A. Powell. 1999.

**Table 32. Volume of water delivered – by size of hose (in gallons per minute)**

Water Pressure (lb)	Hose Diameter						
	3/8 in.	13/32 in.	7/16 in.	1/2 in.	9/16 in.	3/4 in.	5/8 in.
<b>30</b>	2.6	3.2	3.8	5.3	7.2	9.3	14.5
<b>40</b>	3.5	4.2	5.0	7.0	9.4	12.2	19.0
<b>50</b>	4.3	5.2	6.3	8.8	11.8	15.3	24.0
<b>60</b>	5.2	6.2	7.5	10.5	14.1	18.3	28.5
<b>70</b>	6.0	7.3	8.7	12.2	16.2	21.0	32.7
<b>80</b>	6.8	8.3	9.9	13.9	18.5	24.0	37.3

NOTE: Table based on 50-ft hose length; for 25 ft, multiply by 1.40; for 75 ft, multiply by 0.80.

**Table 33. Number of plants per acre at various spacing**

Distance Apart	No. of Plants	Distance Apart	No. of Plants	Distance Apart	No. of Plants
<b>3 x 3 in.</b>	696,690	<b>4 x 4 ft</b>	2,722	<b>13 x 13 ft</b>	257
<b>4 x 4 in.</b>	392,040	<b>4½ x 4½ ft</b>	2,151	<b>14 x 14 ft</b>	222
<b>6 x 6 in.</b>	174,240	<b>5 x 1 ft</b>	8,712	<b>15 x 15 ft</b>	193
<b>9 x 9 in.</b>	77,440	<b>5 x 2 ft</b>	4,356	<b>16 x 16 ft</b>	170
<b>1 x 1 ft</b>	43,560	<b>5 x 3 ft</b>	2,904	<b>16½ x 16½ ft</b>	160
<b>1½ x 1½ ft</b>	19,360	<b>5 x 4 ft</b>	2,178	<b>17 x 17 ft</b>	150
<b>2 x 1 ft</b>	21,780	<b>5 x 5 ft</b>	1,742	<b>18 x 18 ft</b>	134
<b>2 x 2 ft</b>	10,890	<b>5½ x 5½ ft</b>	1,417	<b>19 x 19 ft</b>	120
<b>2½ x 2½ ft</b>	6,960	<b>6 x 6 ft</b>	1,210	<b>20 x 20 ft</b>	108
<b>3 x 1 ft</b>	14,620	<b>6½ x 6½ ft</b>	1,031	<b>25 x 25 ft</b>	69
<b>3 x 2 ft</b>	7,260	<b>7 x 7 ft</b>	881	<b>30 x 30 ft</b>	48
<b>3 x 3 ft</b>	4,840	<b>8 x 8 ft</b>	680	<b>33 x 33 ft</b>	40
<b>3½ x 3½ ft</b>	3,555	<b>9 x 9 ft</b>	537	<b>40 x 40 ft</b>	27
<b>4 x 1 ft</b>	10,890	<b>10 x 10 ft</b>	435	<b>50 x 50 ft</b>	17
<b>4 x 2 ft</b>	5,445	<b>11 x 11 ft</b>	360	<b>60 x 60 ft</b>	12
<b>4 x 3 ft</b>	3,630	<b>12 x 12 ft</b>	302	<b>66 x 66 ft</b>	10

**Table 34. Times required to mow or trim lawn areas**

		In Minutes Per 1000 Square Feet or Minutes Per Acre (Numbers Rounded Up To The Nearest Minute)							
Speed Is		And Width of Cut** is (inches)							
Miles Per Hour	Feet Per Hour	6	12	18	24	36	48	60	72
.25	22	91	46	31	23	16	12	10	8
.5	44	46	23	16	12	8	6	5	4
1.0	88	23	12	8	6	4	3	3	2
1.25	110	19	10	7	5	4	3	2	66
1.50	132	16	8	6	4	3	2	66	55
1.75	154	13	7	5	4	3	71	57	48
2.0	176	12	6	4	3	2	62	50	42
2.5	220	10	5	3	3	66	50	40	33
3.0	264	8	4	3	83	55	42	33	28
3.5	308	7	4	95	71	48	36	29	24
4.0	352	6	3	83	62	42	31	25	21
4.5	396	6	110	74	55	37	28	22	19
5.0	440	198	99	66	50	33	25	20	17
5.5	484	180	90	60	45	30	23	18	15
6.0	528	165	83	55	42	28	21	17	14
8.0	704	124	62	42	31	21	16	13	11

\*Time = min/1000 sq ft above this line

\*Time = min/acre below this line

\*\*These figures are for effective width of cut—that is, width of blade less operational overlap averages = 4 in. to 10 in.

**Some Average Speeds**

- Slow Walk – Pushing Mower . . . . . 150 ft/min
- Slow Walk . . . . . 200 ft/min
- Fast Pushing Mower .. . . . 250 ft/min
- Modest Riding Yard Mower . . . . . 275 ft/min
- Fast Brisk Walk .. . . . 300 ft/min
- Good Riding Yard Mower . . . . . 300–350 ft/min
- Tractor-Towed Riding Mower . . . . . 6–7 mph

1 acre = 43,560 sq ft; 1 mile = 5,280 lin ft

**Table 35. Cubic yards of soil needed at various depths and areas**

		Areas in 1,000 sq ft and acres													
		½	1	2	3	4	5	6	7	8	9	10	½A	1A	2A
Depth in Inches	1	2	3	6	9	12	15	17	22	25	28	31	67	134	269
	2	3	6	12	19	25	31	37	43	49	56	62	134	269	538
	3	5	9	19	28	37	46	56	65	74	83	93	202	403	807
	4	6	12	25	37	49	62	74	86	99	111	124	269	538	1076
	5	8	15	31	46	62	77	93	108	124	139	154	336	672	1344
	6	9	19	37	56	74	93	111	130	148	167	185	403	807	1613
	7	11	22	43	65	86	108	130	151	173	194	216	471	941	1882
	8	12	25	49	71	99	124	148	173	198	222	247	538	1076	2151
	9	14	28	56	83	111	139	167	194	222	250	278	605	1210	2420
	10	15	31	62	93	124	154	185	216	247	278	309	672	1344	2688
	11	17	34	68	102	136	170	203	238	272	306	340	739	1479	2858
	12	19	37	74	111	148	185	222	259	296	333	370	807	1613	3227

**Table 36. Areas covered in square feet at various depths**

		Depth in Inches					
		1	2	3	4	5	6
Depth in Inches	1	324	162	108	81	65	54
	2	648	324	216	162	130	108
	3	972	486	324	243	195	162
	4	1296	648	432	324	260	216
	5	1620	810	540	405	324	270
	6	1944	972	648	486	390	324
	7	2268	1134	756	567	455	378
	8	2592	1296	864	648	520	432

Table 37 deals with temperature conversion.

Table 37. Temperature conversion			
from Fahrenheit	to Centigrade (Celsius)		
		from Centigrade (Celsius)	to Fahrenheit
0	-17.8	-30	-22.0
5	-15.0	-25	-13.0
10	-12.2	-20	-4.0
15	-9.4	-15	5.0
20	-6.7	-10	14.0
25	-3.9	-5	23.0
30	-1.1	0	32.0
35	1.7	5	41.0
40	4.4	10	50.0
45	7.2	15	59.0
50	10.0	20	68.0
55	12.8	25	77.0
60	15.6	30	86.0
65	18.3	35	95.0
70	21.1	40	104.4
75	23.9	45	113.0
80	26.7	50	122.0
85	29.4	55	131.0
90	32.2	60	140.0
95	35.0	80	176.0
100	37.8	100	212.0

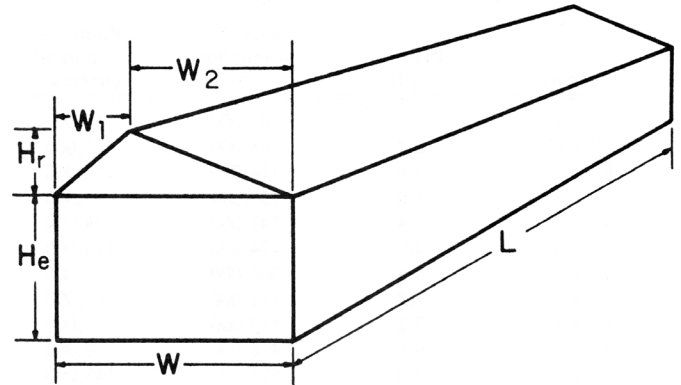
**NOTES:** 1) To convert temperature in degrees from Centigrade (Celsius) to temperature in degrees Fahrenheit: multiply Centigrade temperature by **1.8** and add **32**. 2) To convert temperature in degrees Fahrenheit to temperature in degrees Centigrade (Celsius): subtract **32** and multiply by **0.55**.

# Formulas for calculating greenhouse volumes

These formulas are helpful in determining heating and cooling costs for greenhouses.

Figure 1-A. Formula for calculating uneven-span greenhouse volume.

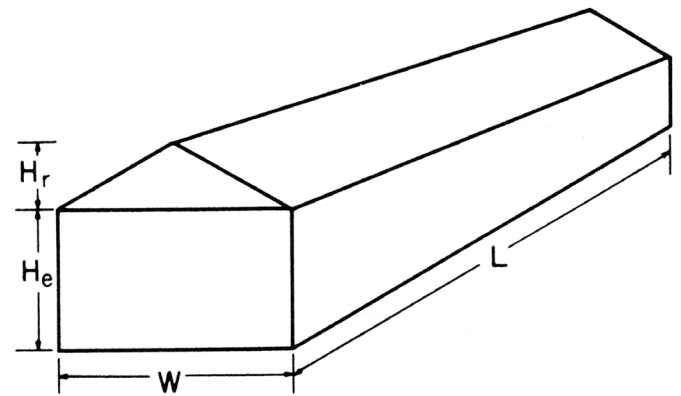
- L = length
- W = width
- $W_1$  = width of short span
- $W_2$  = width of long span
- $H_e$  = height from floor to eave
- $H_r$  = height from eave to top



$$\text{Greenhouse volume in cubic feet} = [(H_e \times W) + (W_1 \times H_r)/2 + (W_2 \times H_r)/2] \times L$$

Figure 1-B. Formula for calculating even-span greenhouse volume.

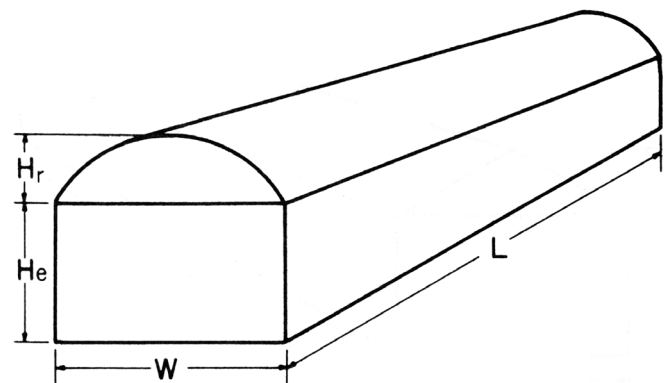
- L = length
- W = width
- $H_e$  = height from floor to eave
- $H_r$  = height from eave to top



$$\text{Greenhouse volume in cubic feet} = [(H_e \times W) + (W \times H_r)/2] \times L$$

Figure 1-C. Formula for calculating quonset greenhouse volume.

- L = length
- W = width
- $H_e$  = height from floor to eave
- $H_r$  = height from eave to top



Formula for calculating the surface area of the gable end, which is an arc segment.

A = arc length of the roof

R = radius of circle of which a is the arc segment

$\alpha$  = the angle forming the arc segment

$R = c$

$c = b + H_r$

$a^2 + b^2 = c^2$

$\tan A = a/b$

Examples:  $H_r = 4$  ft,  $W = 20$  ft

$R = c$

$c = b + 4$

$a = 10$  ft

$(10)^2 + b^2 = (b + 4)^2$

$b = 10.5$

$c = 10.5 + 4 = 14.5 = R$

$A = (\pi \times R \times \alpha) / 180^\circ$

$\tan A = 10 / 10.5$

$\tan A = 0.9524$

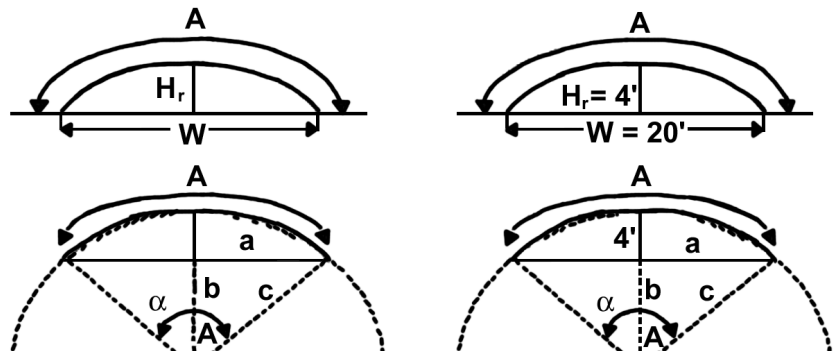
$\arctan 0.9524 = 43.6^\circ$

$\alpha = 2 \times A = 2 \times 43.6^\circ = 87.2^\circ$

$A = (\pi \times R \times \alpha) / 180$

$A = (3.14159 \times 14.5 \times 887.2) / 180$

$A = 22$  ft 6 in.



Area of an arc segment =  $(A \times R) / 2$

Area =  $(22.6 \times 14.5) / 2 = 164$  ft<sup>2</sup>

But we do not need the area of the entire arc segment, only the area actually present on the greenhouse; so we need to SUBTRACT OFF the bottom triangles:

Area of a triangle =  $1/2$  (width  $\times$  height) =  $a \times b = 10 \times 10.5 = 105$  ft<sup>2</sup>

So the area of one gable end =  $164$  ft<sup>2</sup> -  $105$  ft<sup>2</sup> =  $59$  ft<sup>2</sup>

Volume (above eaves) is area of gable multiplied by the length of the greenhouse.  
Greenhouse volume in cubic feet =  $(H_e \times W \times L) +$  (Volume above eaves).

## Formulas for calculating variously shaped areas

These formulas are helpful in determining application rates for areas with specific shapes. Knowledge of the areas is also helpful in estimating amounts of various soil amendments and number of plants needed.

Figure 2-A. Square or rectangle

Area = Length  $\times$  Width

Area =  $L \times W$

Area =  $(50$  ft)  $\times$   $(50$  ft)

Area =  $2,500$  sq ft

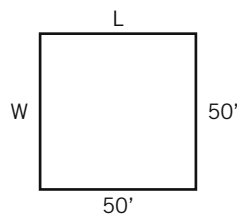


Figure 2-B. Triangle

Area =  $1/2 \times$  Base  $\times$  Height

Area =  $1/2 \times B \times H$

Area =  $1/2 \times (50$  ft)  $\times$   $(75$  ft)

Area =  $1,875$  sq ft

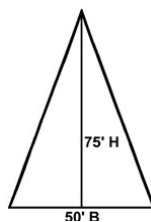


Figure 2-C. Circle

Area =  $\pi \times \text{Radius} \times \text{Radius}$

Area =  $\pi \times R^2 = 22/7 (3.14)$

Area =  $3.14 \times 20 \text{ ft} \times 20 \text{ ft}$

Area = 1,256 sq ft

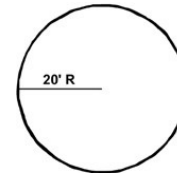


Figure 2-D. Circle (within 5% accuracy)

Area = Diameter x Diameter x 0.8

Area =  $0.8 \times D^2$

Area =  $0.8 \times 40 \text{ ft} \times 40 \text{ ft}$

Area = 1,280 sq ft

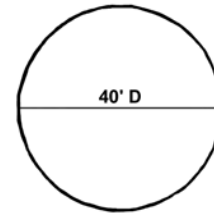


Figure 2-E. Ovals or egg-shaped (within 5% accuracy)

Area = Length x Width at midpoint x 0.8

Area =  $0.8 \times LW$

Area =  $0.8 \times 20 \text{ ft} \times 50 \text{ ft}$

Area = 800 sq ft

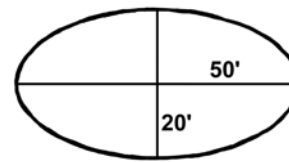


Figure 2-F. Irregular shapes (within 5% accuracy)

- Measure the longest axis of the area (length line).
- At every 10 ft on the length line, measure the width at right angles to the length line.
- Total all widths and multiply by 10.

Area =  $(A + B + C + D + E + F) \times 10$

Area =  $(50 \text{ ft} + 75 \text{ ft} + 125 \text{ ft} + 150 \text{ ft} + 75 \text{ ft} + 25 \text{ ft}) \times 10$

Area =  $500 \times 10$

Area = 5,000 sq ft

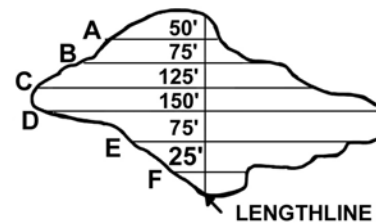


Figure 2-G. Unusual-shaped areas

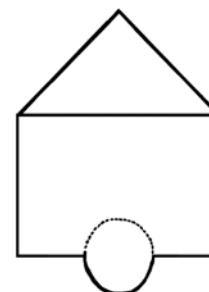
Calculation should be made for various sections. In this case, calculate and add together:

Area of triangle

Area of rectangle

½ Area of circle

Total area = total sq ft of area





## Acknowledgments

The authors wish to acknowledge the following sources, certain tables from which were adapted to use in this publication.

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