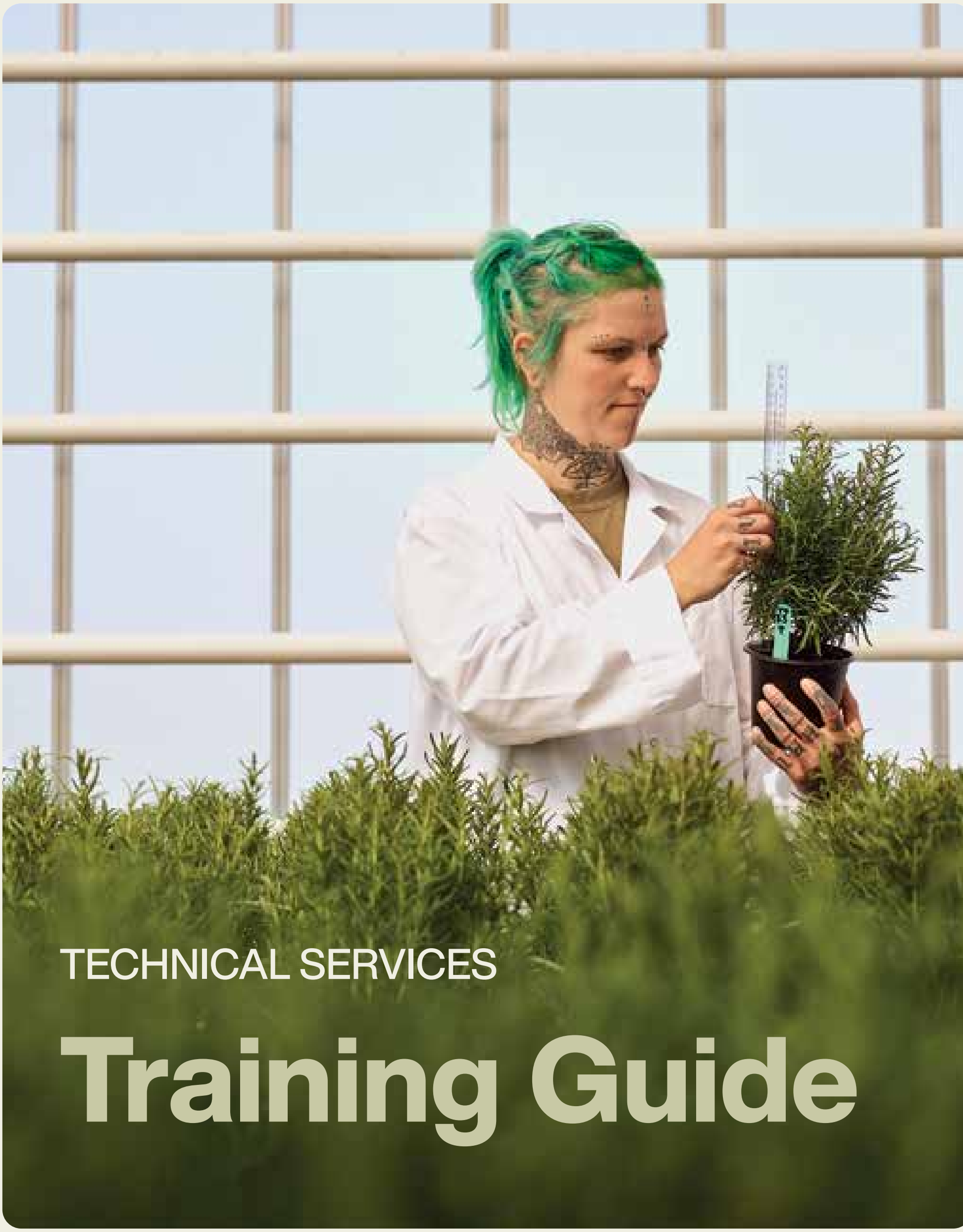

TECHNICAL SERVICES

Training Guide

A collection of technical tools
as practical as they are profitable
for your operations

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Berger Toolbox

Your Comprehensive Resource for Technical and Agronomic Excellence

We are thrilled to unveil the Berger Toolbox, a curated collection of invaluable technical and agronomic information designed exclusively for you, esteemed professional growers. This cutting-edge document library serves as your go-to resource, centralizing a wealth of knowledge and insights to enhance your day-to-day operations.

With a commitment to your success, we have meticulously compiled a wide range of resources in the Berger Toolbox. From expert guides and best practices to innovative techniques and industry trends, this comprehensive toolkit empowers you to make informed decisions, optimize your greenhouse practices, and achieve exceptional results.

Navigate through the pages of the Berger Toolbox to unlock a treasure trove of technical know-how, unrivaled expertise, and practical solutions tailored to your specific needs. As your trusted partner, we understand the challenges you face and are dedicated to providing the support you require to thrive in the ever-evolving world of greenhouse cultivation.

We invite you to explore the Berger Toolbox and leverage this powerful resource to elevate your greenhouse operations to new heights. Together, let us cultivate success and drive the future of professional greenhouse growing.

Potting Chart

	CONTAINER TYPE	HEIGHT (in)	VOLUME (cu.in.)	NUMBER OF CONTAINERS (per 1 cu.ft.)
ROUND POT	**3 1/2 in.**	3 11/32 in.	21	73
	4 in. Azalea	2 29/32 in.	25	63.5
	4 in. Standard	3 17/32 in.	29	53
	4 1/2 in. Geranium	3 27/32 in.	38	41
	5 in. Azalea	3 21/32 in.	50	31
	5 in. Standard	4 11/16 in.	63	25
	5 1/2 in. Azalea	4 25/32 in.	77	20
	6 in. Azalea	4 5/16 in.	81	19
	6 in. Standard	5 5/16 in.	106	14.5
	6 1/2 in. Azalea	4 7/8 in.	113	14
	6 1/2 in. Standard	6 3/8 in.	137	11.5
	7 in. Azalea	5 1/16 in.	128	12
	7 1/2 in. Azalea	5 9/32 in.	156	10
	8 in. Azalea	5 9/16 in.	188	8
	9 in. Mum pan	6 1/2 in.	287	5.5
	10 in. Azalea	7 1/2 in.	391	4
	12 in. Azalea	10 in.	845	2
	14 in. Planter	10 11/16 in.	947	1.5
	16 in. Planter	12 in.	1220	1
SQUARE POT	**2 1/4 in.**	2 in.	7	222
	2 1/2 in.	2 25/32 in.	13	116.5
	3 in.	2 1/4 in.	16	97
	3 1/2 in.	3 13/32 in.	28	55.5
	4 in.	3 9/16 in.	39	40
	4 1/2 in.	3 15/16 in.	47	33
	5 in.	4 3/4 in.	83	18.5
	5 1/2 in.	5 21/32 in.	111	14
	12 3/4 in.	11 1/8 in.	975	1.5
SEEDLING TRAYS	**21 cavities**	4 in.	324	5
	24 cavities	2 15/32 in.	220	7
	32 cavities	3 1/16 in.	374	4
	36 cavities	2 23/32 in.	319	5
	38 cavities	3 1/32 in.	296	5
	40 cavities	2 3/4 in.	282	5.5
	50 cavities	2 11/32 in.	268	6
	58 cavities	2 5/16 in.	160	9.5
	60 cavities	2 27/32 in.	259	6
	72 cavities	2 5/16 in.	222	7
	84 cavities	1 5/32 in.	129	12
	98 cavities	1 9/16 in.	166	9.5
	102 cavities	1 11/16 in.	135	11.5
	105 cavities	1 1/2 in.	151	10.5
	128 cavities	2 in.	218	7
	144 cavities	1 9/16 in.	138	11
	162 cavities	1 21/32 in.	175	9
	200 cavities	1 21/32 in.	166	9.5
	288 cavities	1 3/32 in.	132	11.5
	512 cavities	31/32 in.	127	12

	CONTAINER TYPE	HEIGHT (in)	VOLUME (cu.in.)	NUMBER OF CONTAINERS (per 1 cu.ft.)
HANGING BASKET	**6 in.**	4 9/32 in.	93	16.5
	8 in.	5 17/32 in.	194	8
	10 in.	5 31/32 in.	318	5
	11 in.	6 21/32 in.	405	4
	12 in.	7 17/32 in.	573	2.5
	14 in.	8 7/8 in.	1001	1.5
CELL PACKS (INSERTS)	**601**	2 5/16 in.	397	4
	606	3 7/32 in.	341	4.5
	612	2 1/4 in.	256	6
	801	2 9/32 in.	382	4
	804	2 3/8 in.	325	4.5
	806	2 3/8 in.	296	5
	809	2 1/4 in.	272	5.5
	812	2 7/32 in.	255	6
	906	3 7/8 in.	452	3.5
	1001	2 9/32 in.	366	4
	1004	2 9/32 in.	310	5
	1006	2 7/32 in.	284	5.5
	1201	1 11/32 in.	361	4.5
	1202	2 5/16 in.	324	4.5
	1203	2 11/32 in.	297	5
	1204	2 1/2 in.	288	5.5
	1206	2 5/16 in.	264	6
	1801	2 9/32 in.	318	5
	1802	2 7/32 in.	288	5.5
	1803	2 1/2 in.	259	6
	1804	2 1/4 in.	317	5
	2401	2 5/16 in.	292	5.5
	3601	2 9/32 in.	267	6
NURSERY	**1/2 gal.**	6 11/32 in.	139	11
	3/4 gal.	6 5/8 in.	184	8.5
	1 gal.	7 13/16 in.	262	6
	1 1/2 gal.	8 7/32 in.	391	4
	2 gal.	8 3/4 in.	537	3
	2 1/2 gal.	9 13/16 in.	660	2.5
	3 gal.	11 3/32 in.	832	2
	4 gal.	9 13/16 in.	1008	1.5
	5 gal.	12 11/16 in.	1356	1
	6 gal.	13 1/8 in.	1595	1
	7 1/2 gal.	13 3/8 in.	2050	0.5
	10 gal.	15 15/16 in.	2629	0.5

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Acidifying/basifying Potential of the Main Fertilizers

Whether to compensate for water quality issues, rectify a problematic situation or simply to adapt to the needs of the crop, here is a comparative table of the acidifying or basifying potential of several common fertilizers.

Definition of acidity potential

Estimated number of pounds of calcium carbonate (CaCO3) needed to neutralize one ton of acidifying fertilizer. The higher the value, the greater the potential to lower the pH of the substrate.

Definition of basicity potential

The number of pounds of calcium carbonate (CaCO3) estimated to be equal to one ton of basifying fertilizer. The higher the value, the greater the potential to increase the pH of the substrate.

FERTILIZER*	ACIDITY OR BASICITY POTENTIAL	NH_4 (%)
21-7-7	1 700 A	90
21-7-7	1 560 A	100
20-2-20	800 A	69
20-18-18	710 A	73
24-8-16	667 A	80
24-7-15	612 A	58
20-18-20	610 A	69
20-20-20	583 A	69
20-9-20	510 A	42
20-20-20	474 A	69
16-17-17	440 A	44
20-10-20	422 A	40
21-5-20	418 A	40
20-10-20	393 A	38
21-7-7	369 A	100
15-15-15	261 A	52
17-17-17	218 A	51
15-16-17	215 A	47
15-16-17	165 A	30

FERTILIZER*	ACIDITY OR BASICITY POTENTIAL	NH_4 (%)
20-5-30	153 A	56
17-5-24	125 A	31
20-5-30	118 A	54
20-5-30	100 A	54
15-11-29	91 A	43
15-5-25	76 A	28
15-10-30	76 A	39
20-0-20	40 A	25
21-0-20	15 A	48
20-0-20	0	69
16-4-12	73 B	38
17-0-17	75 B	20
15-5-15	135 B	28
13-2-13	200 B	11
14-0-14	220 B	8
15-0-15	319 B	13
15.5-0-0	400 B	6
15-0-15	420 B	13
13-0-44	460 B	0

*According to the manufacturer, identical analyses may have different acidity and basicity potentials as well as NH_4 percentages.

Adapted from: Bailey, Douglas A., William C. Fonteno, and Paul V. Nelson. 1995. Greenhouse Substrates and Fertilization. North Carolina State University, Department of Horticultural Science: Raleigh, North Carolina.

Sampling Methods

Summary

Here are the best practices that will allow Berger to perform rigorous analyzes for any or all of these types of samples and get you the most representative results. Proper sample identification is very important to ensure the adequate traceability of the results.

Growing media

- Sample approximately one hour after the last water/fertilizer application;
- Remove a wedged-shaped sample from top to bottom excluding the upper and lower ½-1 inch OR a handful of mix from the middle (vertically) portion of the container;
- Ideally, combine 8-10 subsamples, thoroughly mixed together;
- Plug flats: exclude the top 1/8 inch and use the rest of the media;
- Follow the same procedure every time;
- Package the sample in a clearly labelled plastic bag.

	ANALYSYS	TYPE OF SAMPLE	VOLUME OF MEDIA NEEDED
QUANTITY NEEDED	SME	Used or unused growing media	1 L (approx. 4 cups)
	Density	Unused growing media	2 L (1/2 gallon)
	Particle size	Unused growing media	1 L(1/4 gallon)
	Complete characterization	Unused growing media	15 L (1/2 pi3)
	Mehlich-3	Mineral soil	500 mL (approx. 2 cups)
	Porosity	Unused growing media	8 L (2 gallons)
	Incubated pH	Unused growing media	1.5 L (6 cups)

For more information, contact your sales representative or our laboratory at **labsupport@berger.ca**.

TO DOWNLOAD OUR ANALYSIS REQUEST FORMS, SCAN THE QR CODE!

Plant Tissue

- Sample should be representative of the crop or nutritional issue you wish to analyze;
- Select the most recently fully extended leaves or leaves with the nutritional issue;
- Sample several plants of the same variety or with the same issue and combine them;
- Unless it is for diagnostic purposes (sampled separately) avoid ill or odd looking leaves;
- Avoid tissue that is contaminated by pesticides or foliar sprays;
- Ship sample at the beginning of the week as much as possible;
- Do not allow tissue samples to freeze;
- Ship in clearly labeled paper bags;
- Quantity needed: 1-2 cups of plant material (about 30 to 50 medium-sized leaves).

Irrigation Water/Fertilizer Solution

- Use a clean, hermetic bottle (no traces of soap or other chemicals);
- Run the water or fertilizer solution for 5 min before sampling to clean the pipes;
- Rinse the bottle 2-3 times with the liquid you want to test;
- Fill the bottle and cap it quickly to avoid prolonged exposure to air;
- Different water sources or fertilizer solutions should be analyzed separately;
- Fertilizer solutions should be collected at the nozzle or the dripper;
- Label each bottle properly;
- Quantity needed: approximately 250 mL (1 cup).

Investigation and Troubleshooting

- Send entire plants in their pots;
- Select plants that display evident symptoms;
- Include healthy and unhealthy plants for comparison;
- Send as much information as possible about the situation (ask your sales representative about our troubleshooting form);
- Send pictures of the problem;
- Ship in a well-packaged cardboard box;
- Quantity needed: at least two plants (one healthy and one unhealthy).

Excess Symptoms

Copper (Cu)
Lead often to iron deficiency and poor lateral root growth.

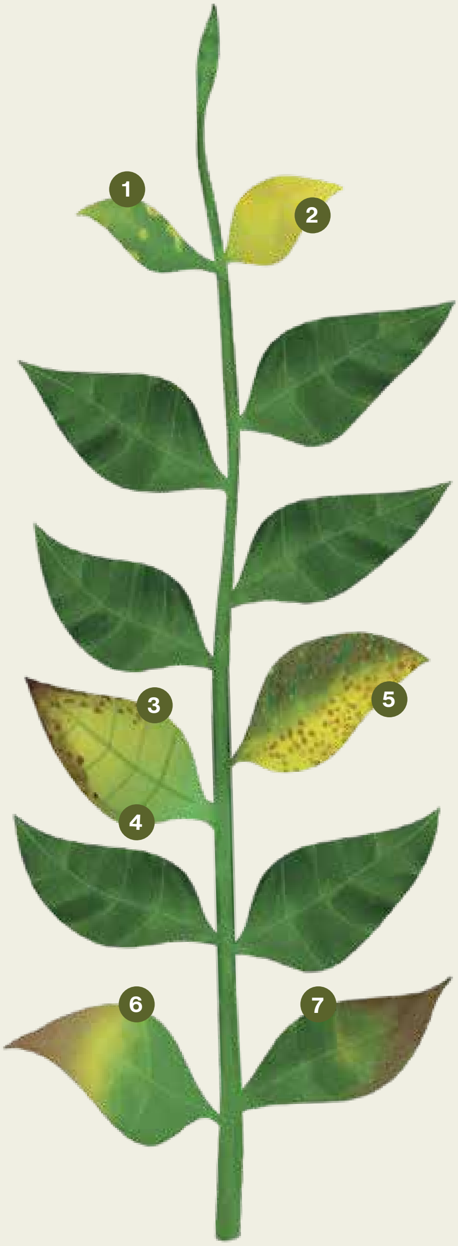
Calcium (Ca)
Does not generally lead to any toxicity but can prevent seed germination. Mostly lead to magnesium or potassium deficiencies.

Molybdenum (Mo)
So rare that only a few symptoms are known. Most crops can tolerate more than 1000ppm (on a dry basis).

Potassium (K)
Induces calcium and magnesium deficiencies, especially when these two elements are present in their minimum required amount.

Magnesium (Mg)
Does not usually cause toxicity, but rather calcium, potassium and sometimes manganese deficiencies.

Phosphorus (P)
Growth slow down mainly by limiting the absorption of zinc, iron, and copper.



❶ Sulfur (S)
Very uncommon, but most crops are sensitive to sulfur dioxide gas when close to a pollution area. The usual symptom is dry, white, and well-defined necrotic spots, mainly on the underside of the leaves. Can also lead to boron and molybdenum deficiencies.

❷ Zinc (Zn)
Most crops are tolerant to excesses. However, high concentrations can result in uniform chlorosis of the leaves. Induces iron, manganese, or phosphorus deficiencies.

❸ Manganese (Mn)
Brown spots surrounded by chlorotic tissue, or blackish/purplish spotting on older leaves. Marginal or interveinal chlorosis, and marginal or spots necrosis on new leaves. Induces iron deficiency.

❹ Iron (Fe)
Results in a bronzing of the leaves, followed by tiny brown/black spots.

❺ Boron (B)
Chlorosis and subsequent reddish-brown necrosis first of the tips and margins, then of the whole leaf.

❻ Chloride (Cl-)
Leaf spotting, chlorosis, and necrosis of the leaf margins of older leaves. High chloride levels in the substrate can lowers nitrate uptake and vice versa.

❼ Nitrogen (N)
Generally due to excess of ammonium. May inhibit calcium, potassium, and magnesium absorption. Wilting and marginal leaf necrosis in older leaves epinasty, stem lesions, and root tips necrosis (orange-brown).

Deficiency Symptoms

1 Boron (B)

Transpiration reduction and high pH lead to boron deficiency. Deformed, wrinkled, thicker and darker colored leaves. Leaves and stems may become brittle. Necrosis of leaves and other parts of the plant. Vein splitting. The roots are slimy, thick, and bumpy, and the tips are necrotic.

3 Sulfur (S)

Overall chlorosis, more uniform than nitrogen deficiency symptoms. Veins and petiole can show a reddish color on the underside of the leaves.

5 Manganese (Mn)

Interveinal chlorosis of young leaves, sometimes followed by brown specks in the chlorotic areas.

8 Zinc (Zn)

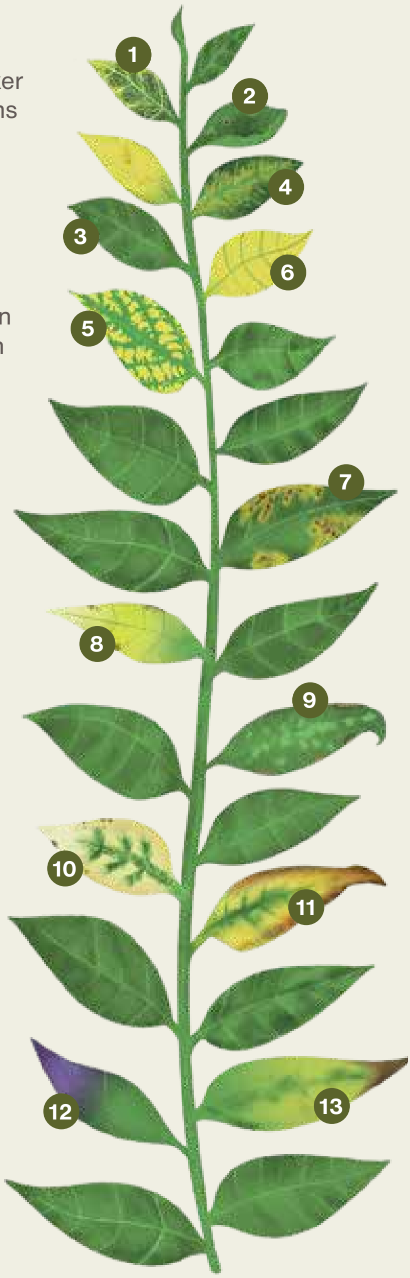
Interveinal chlorosis (first pale green, then yellow, and even white) and then necrotic spots. Internodes reduction giving the appearance of a rosette.

10 Magnesium (Mg)

Interveinal chlorosis, the veins remaining green. A severe deficiency leads to tissue death (indistinguishable from potassium deficiency).

12 Phosphorus (P)

Often caused by low temperatures. Darker green, then purplish coloration of the leaves (extremities first) which extends into the stems. Slower root growth.



2 Calcium (Ca)

More often physiological than visual and resulting from a decrease in transpiration. Could still result in deformation, poor root growth, chlorosis, or leaf edge necrosis. Too many nitrates can reduce the calcium content of plants.

4 Chloride (Cl-)

Interveinal chlorosis young leaves (yes, even if chloride is mobile in the plant!). Severe deficiency can result in curling, wilting and necrosis of the margins of the youngest leaves.

6 Iron (Fe)

Interveinal chlorosis of the youngest leaves, then global chlorosis ending with a bleached leaf.

7 Copper (Cu)

Most often interveinal chlorosis but the tips and lobes stay green. Symptoms are reduced growth with distortion of young leaves and necrosis of the apical meristem.

9 Molybdenum (Mo)

Mottled (as nitrogen) or uniform chlorosis (as sulfur) of central leaves first. May show leaf margin curling then necrosis. Induces nitrogen deficiency.

11 Potassium (K)

Leaf edge turn light green or yellow while veins stay green. Severe deficiency causes leaf edge burns and then total necrosis.

13 Nitrogen (N)

Slow growth, chlorosis from light green to yellow, old leaves fall prematurely, and in severe cases, leaf necrosis. High chloride levels lower nitrate uptake.

Guide to Identifying the Symptoms or Consequences of Nutrients Deficiency or Excess

We have all been told at one time or another that proactivity must prevail over reactivity. This is even more true when you have the responsibility of working with living material. Because a bad diagnosis can be just as damaging to your crops as it is to your budget, this guide should help you get started with your diagnosis.

Classification	Elements
Macronutrients - Major	N, P, K
Macronutrients - Minors	Ca, Mg, S
Micronutrients - Essentials	Fe, Mn, Zn, Cu, B, Mo, Cl, Ni
Micronutrients - Beneficials	Na, Si, Co, Se

A first step in diagnosing a fertilizer deficiency or excess is usually to locate where the symptoms are on the plant: on the upper, youngest parts, or on the lower, oldest parts. This characteristic depends on the mobility of the elements within the plant (and not within the substrate!).

Except for some cases, when an element is **mobile in the plant, deficiency symptoms will appear on the upper parts, and excess symptoms on the lower part**. You can imagine that it is exactly the opposite when an element is immobile.

As we will not be detailing all the elements in this guide, the following table only reports the mobility of those we have selected.

Elements	Mobility	Elements	Mobility
N	Mobile	Fe	Immobile
P	Mobile	Mn	Immobile
K	Mobile	Zn	Immobile
Ca	Immobile	Cu	Immobile
Mg	Mobile	Cl^-	Mobile
S	Immobile	Mo	Mobile
B	Immobile		

Essential Roles of the Main Elements

Element	Role
Nitrogen	Helps plants grow by forming important components like amino acids, vitamins, and proteins. It also aids in the formation of new cells, which is necessary for overall plant growth.
Phosphorus	Plays a vital role in the energy transfer and storage within the plant, as well as root and seed growth. It also helps to increase the hardiness of plants and make them more drought resistant.
Potassium	Helps plants use water more efficiently (controls stomata opening) and aids in the production of fruits. It also promotes winter hardiness and helps plants resist disease.
Calcium	Essential for cell formation and division, which is necessary for root growth and overall plant development. It also helps with nitrogen metabolism and fruit set.
Magnesium	Necessary for chlorophyll production (no substitute possible!), which is necessary for photosynthesis. It also helps with the utilization of other nutrients like phosphorus and iron, and it aids in fruit maturation.
Sulfur	Helps to form amino acids, in plant defense mechanisms, and aids in the formation of vitamins and enzymes. It is also important for seed production, legume nodule formation, and for the characteristic smell synthesis of onions and brassicas.
Iron	Necessary for chlorophyll formation and in oxidation-reduction states changes. It also aids in the transportation of oxygen within the plant and promotes cell growth and division.

Element	Role
Manganese	Helps with enzyme systems and chlorophyll synthesis. It also makes phosphorus and calcium more available to plants.
Zinc	Important for the formation of hormones and enzymes, as well as the production of chlorophyll. It aids in carbohydrate, starch, and seed formation. Zinc is important for water absorption and utilization by plants.
Copper	Acts as a metabolic catalyst and aids in photosynthesis and reproduction. It also intensifies plant color and flavor and increases sugar production.
Boron	Necessary for the growth of pollen tube. It also aids in cell wall formation, sugar translocation and promotes maturity in plants. Boron also has an indirect control on germination.
Molybdenum	Helps to form nitrate reductase and nitrogenase, which is important for nitrogen metabolism and fixation. It also helps to convert inorganic phosphates to organic forms that can be used by plants.
Chlorure	Its role in plant growth is not yet fully understood, but it may play a role in plant metabolism and osmoregulation.

Best Potting Practices

Storage

Rotate you inventory (1st in - 1st out).

Ideally, bales/bags should be stored in a cool area out of direct sunlight.

Prevents degradation of the wetting agent.

To facilitate handling, skids should be placed on 2X4s to preserve the wooden pallets.

Prevents them from sinking in the mud or freezing on the ground.

Maintain some space between the skids to allow air movement.

For frozen product, it will accelerate the thawing process. You still need to bring skids inside several days/weeks before processing.

During the summer, it will help keep the product cool.

Handling

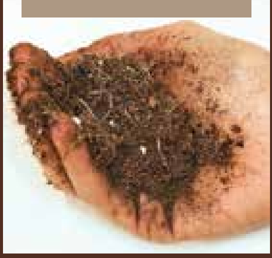
Avoid damaging the components.

Select your equipment carefully.

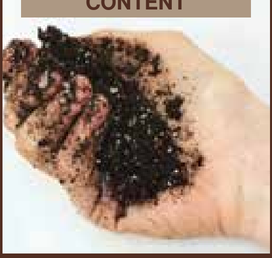
Damage to the product will decrease the particle size which directly impacts the porosity and water retention.

Adjust the moisture content prior to potting or tray-filling. Because our compressed products are delivered with a lower humidity than recommended for optimal use, here is an indicative table of the approximate quantity of water to add to our products before potting.

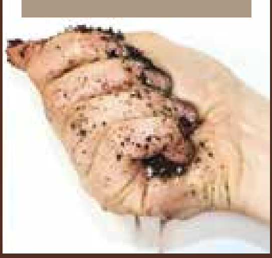
Add approximately ½ gallon of water per cubic foot of mix (67L of water per cubic meter of mix).



TOO DRY



OPTIMUM WATER CONTENT



TOO WET

Benefits of Proper Handling Methods

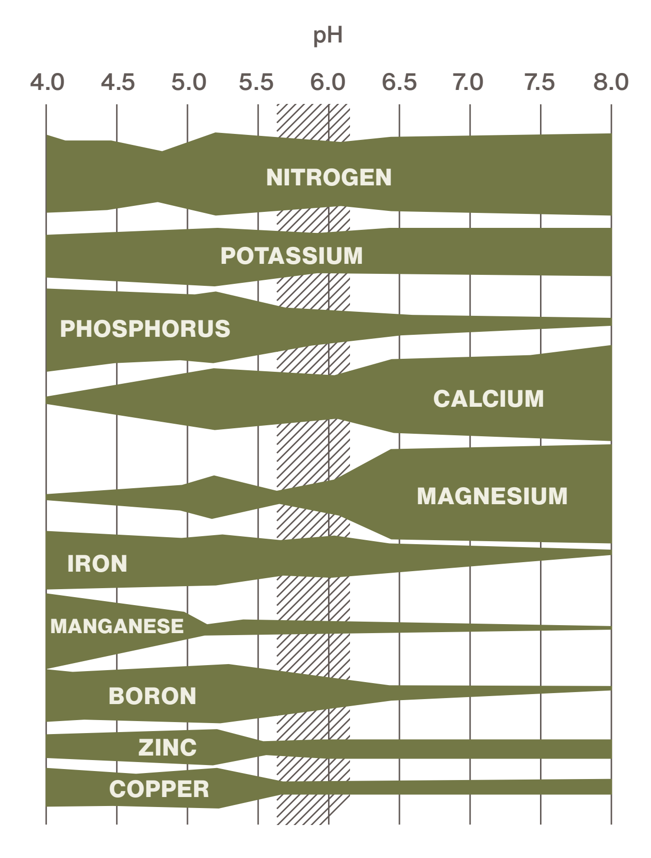
- ✓ Increases the useable volume (yield).
- ✓ High-quality sphagnum peat moss swells when rehydrated. Reduces the presence of dust.
- ✓ Fine particles will cluster together, which creates a cleaner environment for workers.
- ✓ Increases porosity.
- ✓ Expanded peat moss will lock in the porous structure.
- ✓ Improves water distribution.
- ✓ Reduces the surface tension of peat moss, improves the wettability and prevents water channeling.
- ✓ Prevent compaction.
- ✓ Compressed mixes allow less oxygen back into the mix, hold more water and dry-down slower.
- ✓ Potting equipment and process shouldn’t cause excessive compaction.
- ✓ Stacked pre-filled containers and trays should not be nested into each other.
- ✓ Promote “uniform” practices.
- ✓ Standard operating practices (SOP) should be established for all potting activities to ensure uniform, consistent and predictable results.

FORMAT	NUMBER OF LITERS OF WATER TO ADD (per unit)	NUMBER OF GALLONS OF WATER TO ADD (per unit)
3.0 ft^3 loose*	3 L	0.75 gal
3.8 pi^3 compressed**	15 L	4 gal
75 ft^3 loose*	75 L	19 gal
Skyscrape compressed**	424 L	112 gal

*Could be used as is, but adjusting moisture content is preferable.
**Since the volume per format depends on the components of our products, the values in the table are an overall average. If you need more information, please contact your sales representative.

Nutrient Availability in Organic Soils is Influenced by Soil pH

This figure is valid for organic soils such as those based on sphagnum peat moss, bark, compost, perlite, vermiculite, etc. As the strip gets thicker, the availability of the element to the plant increases. Be careful, an element that is too available can be toxic for some crops, it is therefore important to respect the recommended pH for each of them. The pH range recommended for most greenhouse crops is highlighted in black.



Adapted from: Peterson, J. C. 1982. Effects of pH upon nutrient availability in a commercial soilless root medium utilized for floral crop production. Ohio Agr. Res. And Devel. Center, Res. Cir. 268, pp. 16-19.

Interpretation of the Electrical Conductivity Values According to the Extraction Method

1:2	SME	POURTHRU	CE	INDICATION
0 - 0.25	0 - 0.75	0 - 1.0	Very low	Nutrient levels may not be sufficient.
0.26 - 0.75	0.76 - 2.0	1.0 - 2.6	Low	Suitable for seedlings, bedding plants and salt sensitive plants.
0.76 - 1.25	2.0 - 3.5	2.6 - 4.6	Normal	Standard root zone range for most established plants. Upper range for salt sensitive plants.
1.26 - 1.75	3.5 - 5.0	4.6 - 6.5	High	Reduced vigor and growth may occur, particularly during hot weather.
1.76 - 2.25	5.0 - 6.0	6.6 - 7.8	Very high	May result in salt injury due to reduced water uptake. Reduced growth rates are likely.
>2.25	>6.0	>7.8	Extreme	Most crops will suffer salt injury at these levels. Immediate leaching required.

Adapted from: Cavins, T. J., Whipker, B. E., & Fonteno, W. C. (2005, September). Pourthru: A method for monitoring nutrition in the greenhouse. In International Symposium on Growing Media 779 (pp. 289-298).

Most laboratories use the SME extraction method. However, many growers use the PourThru method because it is much simpler and faster to set up. Here are two formulas that allow you to go from an EC value measured by SME to an estimated PourThru value, and vice versa.

$$\text{SME EC value*} = 0.74 \times \text{PourThru EC value} - 0.05$$

$$\text{PourThru EC value*} = \frac{\text{SME EC value} + 0.05}{0.74}$$

*Source: Cavins, T. J., Whipker, B. E., Fonteno, W. C., Harden, B., McCall, I., & Gibson, J. L. (2000). Monitoring and managing pH and EC using the PourThru extraction method. Horticulture Information Leaflet, 590(1), 1-17.

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