Appendix

WORKSHEET 1. TOTAL MAXIMUM DAILY WATER APPLIED

This worksheet explains how to estimate peak water use to irrigate your entire production area in one day. A peak use day is a day with high solar radiation, low relative humidity, moderate-high winds and high temperatures. The same calculation can be used to determine Average Daily Water Applied. It is important to know the total maximum daily water use when:

- designing an irrigation system
- designing an irrigation/storm water recycling pond
- recording and estimating daily water use for reporting

To calculate total maximum daily water applied, you need to know:

- output of irrigation nozzles (volume per minute)
- number of nozzles in one acre/hectare of container production (including driveways)
- total time to irrigate one acre/hectare on peak use day (can give low-med-high or take an average of all crops)
- total number acres/hectares to be irrigated on peak use day
- to convert 1 acre to hectares → multiply by 0.40
- to convert 1 US gallon to litres → multiply by 3.785
- 1 acre = 209 feet x 209 feet (43,560 ft^2)
- 1 hectare = 100 metres x 100 metres (10,000 m^2)

Example

Based on a typical operation with nozzle spacing of 30 feet, we can fit about 33 nozzles in one acre of container production polyhouses (including driveways and walkways).

Each nozzle output is about 3.7 US gpm (gallons per minute) = 14 lpm (litres per minute)

At the most, we would irrigate for a total of 60 minutes per day.

33 nozzles/acre x 14 lpm/nozzle x 60 minutes = 27,720 litres/acre

Max Water Applied per Area = 27,720 L/acre <u>OR</u> 69,300 L/ha

To convert litres/acre to litres per hectare: L/ac ÷ 0.4 = L/ha

To calculate the *Total Max Water Applied* for your farm, multiply this water volume by the total number of acres/hectares under container production with overhead i sprinkler irrigation.

Note: when calculating the volume required for an irrigation/storm water collection pond, take into consideration the average annual precipitation and historical storm events in your area.

Gallons referenced in this document are US gallons.

WORKSHEET 2. LEACHING FRACTION FOR CONTAINER NURSERY PRODUCTION

Percent leaching fraction (or %LF) is commonly used to assess the irrigation efficiency of container crop production. Specifically, it helps to measure whether too much or not enough irrigation water is being applied to the crop. The lower the number, the lower the volume of water being lost out the bottom of the pot.

Periodically, growers may need to leach their crops (e.g. high heat in the spring/early summer causing accumulation of fertilizer salts in the media). But on average, growers are working towards minimizing % leaching fraction.

Several unrelated factors can affect the leaching fraction data. For instance, media that is not evenly or regularly moistened tends to have dry "cracks" that channel irrigation water rapidly through the pot, exaggerating the leachate volume. Container crops with dense or tall canopy architectures can deflect irrigation water, preventing it from landing on the surface of the media of some of the pots within the irrigation zone. Proximity and direction from the nearest sprinkler, as well as wind speed, can have a significant effect on % leaching fraction throughout the bed.

By knowing and paying attention to these limitations, growers can use % leaching fraction to help make decisions about irrigation scheduling in order to help conserve water and nutrients lost through leaching.

Example

For this exercise, try to choose overhead sprinkler-irrigated container beds that have crops that are similar in age, size and canopy architecture. Use 10–20 pots each for both the "interception" and the "leachate" pots in each bed. Larger beds (>300 feet) may require more than 20 pots to accurately assess average leaching fraction %.

You will need the following for each bed:

- 40–60 clean, empty pots identical to those used to grow crops in each bed
- 40–60 small plastic bags (e.g. small garbage bags)
- 40–60 large elastic bands
- 20–30 medium-sized stones (5–10 cm in diameter) or pieces of 2x4 wood (e.g. 5x15 cm)
- wide-mouth 1–2 L jug, graduated cylinder, flagging tape, clip board with chart paper, mechanical pencil and eraser.

Step 1

Place 10–20 empty pots lined with an impermeable barrier (e.g. plastic bag) throughout the container bed at different distances and directions from the irrigation nozzles. These empty, lined pots are the "interception" pots. Only use pots identical to those used in the crop you are testing. The "interception" pot approximates how much of the overhead irrigation water actually makes it onto the surface of the media. (*Tip:* Use elastic bands to secure the impermeable barrier to the top rim of the pot.)

WORKSHEET 2. LEACHING FRACTION FOR CONTAINER NURSERY PRODUCTION (cont'd)

Step 2

Place 10–20 empty, lined pots directly underneath the crop plant pots. Place a 5 cm stone inside to give room for drainage. These pots are the "leachate" pots, and will catch the volume of water that drains from the crop pots. The "leachate" pots are identical to the crop pots and fit tightly under the crop pot. Place these crop plant + "leachate" pots beside the empty "interception" pots. (*Tip:* Attach flagging tape to the plants and number them so you can find them more easily after the irrigation event.)

Step 3

After an average irrigation event, collect and measure all "leachate" and "interception" pot water volumes, and record them in a chart so you can refer back to individual pot volumes and their location in the bed, in relation to the sprinklers. A quick sketch of the Leaching Fraction pot layout in the bed will be valuable for interpreting results later. (*Tip:* Hold the plastic liner to allow water to drain smoothly. Collect water into a wide-mouthed vessel before pouring into the graduated cylinder for measurement.)

Record temperature, wind speed, wind direction and relative humidity at the time of the irrigation event (e.g. at the beginning and at the end).

Step 4

Use the water volumes collected to calculate % leaching fraction.

$$\text{\% Leaching Fraction} = \frac{\text{“leachate” pot volumes}}{\text{“interception” pot volume}} \times 100$$

$$\text{Average \% Leaching Fraction for the Bed} = \frac{\text{Avg (“leachate” pot volumes)}}{\text{Avg (“interception” pot volumes)}} \times 100$$

Interpreting the results

Review the individual %LF for various pots throughout the bed. Do they differ in relation to distance and direction from sprinkler? Does wind speed play a role in Leaching Fraction? Does canopy architecture play a role in deflecting water off the plant foliage? Can you think of any other factors that could affect the results?

Guidelines for Interpreting Average Leaching Fraction:

%LF = 0–15%	%LF = 16–25%	%LF = 26-40%	%LF = >40%
Very Good	Good	Inefficient	Excessive
This indicates a conservative use of irrigation water.	Review crop quality, wetting front in the media and any other factors that could be exaggerating %LF. Then consider reducing the length of the irrigation cycle.	Review crop quality, wetting front in the media and any other factors that could be exaggerating %LF. Then consider reducing the length of the irrigation cycle.	Review crop quality, wetting front in the media and any other factors that could be exaggerating %LF. Most likely there is an error in the procedure somehow. Try evaluating the volume of water with alternative devices (e.g. rain gauges) placed at the top of the canopy. Strongly consider reducing the length of the irrigation cycle.

WORKSHEET 3. INTERCEPTION EFFICIENCY

Percent interception efficiency (%IE) is commonly used to describe the spacing and configuration of container crops. It indicates the pot surface area in relation to the area of bed they are growing on. However, the true value of this measurement is to quantify the effective use of the production area and the efficient use of overhead-applied irrigation water. The higher the % interception efficiency, the lower the volume of water being lost between the pots.

%IE is a simple calculation based on container spacing in two directions. Container crop spacing will depend on several key crop and management factors.

Container crops with tall or wide canopy architectures will deflect irrigation water and prevent it from landing on the surface of the media, and may require pots to be placed farther away from each other to achieve adequate wetting of the media. Many nursery crops are susceptible to foliar diseases that can be reduced by using wider pot spacing patterns. Some growers space pots in the spring at the maximum spacing distance they will require months later to allow for seasonal canopy growth. Other growers prefer to space the crop multiple times throughout the growing season, incrementally larger as the crop canopy expands.

By measuring %IE throughout the growing season for various types of nursery container crops, growers can use the data to help make decisions about irrigation systems and scheduling in order to help conserve water and nutrients lost through leaching. Also, crops that are grown with a low %IE (e.g. <40%), and that require a moderate to high amount of fertilizer and irrigation volumes, may be placed farther from environmentally sensitive areas and surface or ground water sources.

What you will need:

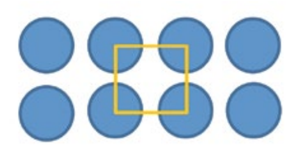
- a 30-cm ruler, a measuring tape
- clipboard with chart paper, mechanical pencil and eraser.

Step 1. Pick your sites.

For this exercise, try to choose overhead sprinkler-irrigated container beds that have crops that are similar in pot size, age and canopy architecture. By organizing %IE data into groups, growers can gain more meaningful data to help manage their different crops. Many growers prefer to organize their groups by pot size and canopy architecture (e.g. 1 gallon upright evergreens).

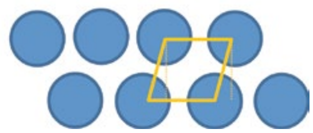
Step 2. Calculate your areas.

Start by envisioning a rectangle or square that includes one quarter of each of 4 containers (see Fig. A). Measure the length and width of the rectangle that intersects with the centres of the 4 containers and record it as ground area.



A. Rectangular pot spacing

In staggered pot spacing, you will need to draw an imaginary vertical line to make the parallelogram into a rectangle and measure length and width (see Fig. B). These length and width dimensions will be used to calculate the area of the rectangle that reaches the centre of 4 pots.



B. Staggered pot spacing

There are 4 quarters of a container surface in each rectangle, which adds up to one full container surface area. Calculate surface area (A) of one container ($A= \pi$ r2) by measuring the diameter of the pot. The radius is one-half of the diameter and is used to calculate the pot surface area. If the container is square or a rectangle, simply calculate the area of the container using length x width.

WORKSHEET 3. INTERCEPTION EFFICIENCY (CONT'D)

Step 3. Do the calculations.

$$\%IE = \frac{\text{Surface area of 1 container}}{\text{Rectangle area}} \times 100$$

Sample calculation:

1 gallon container (pot)
(Container diameter = 15.24 cm) (Radius = ½ diameter = 7.62 cm)
Container area: $A = \pi r^2 = \pi (7.62)^2 = 182.41\ cm^2$

$$\%IE = \frac{182\ cm^2}{19.2 \times 18\ cm} \times 100 = \frac{182\ cm^2}{346\ cm^2} \times 100 = 53\%$$

Table 1. Sample Calculations for Actual % Interception Efficiency in a Typical Nursery

Pot Size, Diameter	Pot/Tray Surface Area	Ground Area (Measured)	Calculated %IE
Liner tray (26.7 x 49.5 cm)	1321 cm^2	26.7 cm x 54.6 cm = 1457.8 cm^2	91%
1 gallon (15 cm)	182 cm^2	19.2 cm x 18 cm = 346 cm^2	53%
2 gallon (20 cm)	314 cm^2	28.2 cm x 21.1 cm = 595 cm^2	53%
3 gallon (25.4 cm)	508 cm^2		

Because nursery containers are round, there is already a significant loss in interception, even when the crop is grown 'pot-to-pot' tight. The following table lists the maximum %IE when a crop is grown in round containers that placed out pot-pot tight in all four directions.

Table 2. Maximum % Interception Efficiency Possible for Typical Round Containers used in Commercial Nursery Production

Pot Size, Diameter	Pot/Tray Surface Area	Rectangle Area (pot–pot tight)	Maximum Potential %IE
1 gallon (15 cm)	182 cm^2	15 cm x 15 cm = 225 cm^2	81
2 gallon (20 cm)	314 cm^2	20 cm x 20 cm = 400 cm^2	79
3 gallon (25.4 cm)	508 cm^2	25.4 cm x 25.4 cm = 645 cm^2	79

Step 4. Complete this several times during the growing season for several different production zones and crops. Use the data to optimize irrigation interception efficiency.

WORKSHEET 4. NUTRIENT TESTING FOR CONTAINER MEDIA

Most growers these days are using controlled-release fertilizers (CRFs) because they release quantities of nitrogen, phosphorus, potassium and other nutrients over the growing season. The nutrient release is dependent on media temperature and to a lesser extent, moisture. As we all know, temperature and moisture are highly variable from growing season to growing season. How do we know if there are enough nutrients to supply the plant through its entire growth period?

Some growers measure the electrical conductivity (EC) of the media to get a quick and reasonably good indication of media fertility. However, EC determination only gives the total salts content and not the concentrations of individual nutrients in the media solution. Without further analysis, you don't know if the EC reading reflects the necessary N, P, K, or the less essential ions (e.g. sulphates). This can lead to a false impression of media fertility, especially later in the growing season. In addition, the N supplied in some CRF productions is provided as urea, which does not register a charge and therefore does not contribute to the EC.

To test media fertility, samples can be sent to an OMAFRA-accredited laboratory[a] monthly throughout the growing season. **Complete analysis packages should include: pH, EC, nitrogen (nitrate and ammonium), phosphorus, potassium, calcium, magnesium, iron, manganese, zinc, copper, boron, molybdenum, sodium, chloride, and sulphates.** The results will give not only the EC and pH of the media, but all of the necessary macro and micronutrients – everything needed to determine if your crop is being fertilized correctly. To save money, you may want to get a complete test done monthly and a basic test (pH, EC, nitrate nitrogen, phosphorus, potassium, calcium, magnesium) during the two weeks in between.

If a decline in an essential nutrient is detected, growers have the ability to correct the problem by supplemental fertilizer application. This can include topdressing or subsurface placement with a reduced amount of a CRF to the affected plants. Costs for a complete nutrient analysis of your growing media are modest and a small price to pay compared to the possible losses in plant sales due to nutrient deficiencies or toxicities. Here's what you can do to make the most out of your container growing nutrient status:

Table 1. Sampling Procedures for Soilless Media Fertility

Sampling Technique	Procedure	Notes	Comparison of Results
Soilless Media Core Sample	Use a small-diameter probe to extract a core of media from each pot. Sample midway between top and bottom, halfway between stem and pot edge. Sample 10 pots and mix samples to get one pooled sample of media (about 2 cups). Refrigerate sample until delivered to lab.	Avoid breaking CRF prills when sampling. Procedure may disturb roots. Most labs will conduct a "saturated paste" analysis on media.	Compare results to Table 2 (based on saturated paste analysis).
Pour-Through Technique for Leachate	Sample 30 minutes after irrigation has finished. Pour 200 ml deionized water over media surface (or enough water to collect 50 ml leachate). Let pot drain long enough to collect 50 ml leachate. Repeat for at least 10 pots and mix sample (roughly 500 ml). Refrigerate sample until delivered to lab.	Does not disturb roots. Try testing pH and EC with your own equipment and compare with lab results.	Compare results to Table 3 (based on Virginia Tech Extraction Method).

[a] See OMAFRA Publication 841, *Guide to Nursery & Landscape Plant Production and IPM* for a list of OMAFRA-accredited labs as well as more information on nutrition for nursery production. www.omafra.gov.on.ca/english/crops/pub841.pdf

WORKSHEET 4. NUTRIENT TESTING FOR CONTAINER MEDIA (CONT'D)

Always sample from at least 10 pots for a good representation of your containers. Sample from an entire block – from centre to outside edge. For media samples, take small amounts from numerous pots to give a better representative sample with less impact on the root system. Mix the sample well.

You should test your media and/or pour-through leachate at least monthly. It would be useful to send a corresponding sample of irrigation source water, since it has a huge impact on soilless media. Compare these test results with previous samples and to the ranges in Table 2, to determine trends in pH, EC and nutrient status. Analysis results can then be correlated with plant growth and health symptoms to help establish your own thresholds for irrigation water and media properties. We guarantee that the results will help you gain more insight into growing better container crops.

Table 2. Media Nutrient Levels for Most Container Crops[b]

Nutrient	Low	Moderate	Excessive
pH	<5.0	5.0–6.5	>7.0
Electrical Conductivity (mS/cm), (mmho/cm), (dS/m)	<0.75	1.0–3.5	>3.5
Ammonium nitrogen (NH_4-N, ppm)	Generally, NH_4-N should not exceed NO_3-N		
Nitrate nitrogen (NO_3-N, ppm)	0–39	100–199	>250
Phosphorus (P, ppm)	0–2	6–9	>50
Potassium (K, ppm)	0–59	150–250	>350
Calcium (Ca, ppm)	0–79	200–300	>400
Magnesium (Mg, ppm)	0–29	70–200	>200
Chloride (Cl, ppm)	–	0–50	>50
Copper (Cu, ppm)	–	0.3–3.0	–
Iron (Fe, ppm)	–	0.3–3.0	–
Manganese (Mn, ppm)	–	0.3–3.0	–
Sodium (Na, ppm)	–	0–50	–
Sulphate (SO_4, ppm)	–	–	>300
Zinc (Zn, ppm)	–	0.3–3.0	–

[b] See OMAFRA Publication 841, *Guide to Nursery and Landscape Plant Production and IPM*. www.omafra.gov.on.ca/english/crops/pub841/pub841.pdf

Use a soil probe to sample media cores from container production crops.

WORKSHEET 4. NUTRIENT TESTING FOR CONTAINER MEDIA (cont'd)

Table 3. Pour-through Leachate Nutrient Levels for Most Container Crops[c]

Nutrient	Liquid Fertilizer or CRF and Liquid	CRF Fertilizer Only
pH	5.0–6.0	5.0–6.0
Electrical Conductivity (mS/cm), (mmho/cm), (dS/m)	0.5–1.0	0.2–0.5
Ammonium nitrogen (NH_4-N, ppm)	Generally, NH_4-N should not exceed NO_3-N	
Nitrate nitrogen (NO_3-N, ppm)	50–100	15–25
Phosphorus (P, ppm)	10–15	5–10
Potassium (K, ppm)	30–50	10–20
Calcium (Ca, ppm)	20–40	20–40
Magnesium (Mg, ppm)	15–20	15–20
Chloride (Cl, ppm)	–	–
Copper (Cu, ppm)	0.02	0.02
Iron (Fe, ppm)	0.5	0.5
Manganese (Mn, ppm)	0.3	0.3
Sodium (Na, ppm)	–	–
Sulphate (SO_4, ppm)	–	–
Zinc (Zn, ppm)	0.2	0.2
Boron (B, ppm)	0.05	0.05

[c] Southern Nurseryman's Assoc. 2013. *Best Management Practices; Guide for Producing Container-Grown Plants*. S.N.A., Marietta, GA.

Other references: Davidson, H., R. Mecklenburg and C. Peterson. 2000. *Nursery Management Administration and Culture.* Prentice-Hall Inc. NJ.

This infosheet was authored by Jen Llewellyn, OMAFRA Nursery Crops Specialist and Peter Purvis, Nursery Technician, University of Guelph.

Use a soil probe to sample media cores from container production crops.

Apply enough water to the surface of media to collect a known quantity of leachate for sampling.

WORKSHEET 5. TOTAL NITROGEN, PHOSPHORUS AND POTASSIUM APPLIED PER AREA

This worksheet explains how to calculate annual nitrogen (N), phosphorus (P) and potassium (K) application per production area unit (e.g. hectares) for each crop type or container size.

Knowing the actual amount applied per area will be helpful when decisions are being made regarding where to grow certain crops in relation to distance to natural surface and ground water sources.

These calculations are relatively easy to complete, and are very important when assessing the impact of fertilizer practices on the environment and on the cost of production.

To calculate total maximum daily water applied, you will need to know the following:

- number of containers per acre/hectare of production, for each container size (including driveways) – see the bottom of this worksheet for examples
- total grams of fertilizer product(s) applied to each plant per year, for each container size or crop type
- N-P-K analysis of all fertilizer products applied in a season
- 1 acre = 209 feet x 209 feet (43,560 ft^2)
- 1 hectare = 100 metres x 100 metres (10,000 m^2)
- 1 acre to hectares → multiply by 0.40
- 1 hectare to acres → multiply by 2.47
- P_20_5 to actual Phosphorus → multiply by 0.44
- K_20 to actual Potassium → multiply by 0.83.

Example

A 3-hectare container nursery produces 1.5 hectares of 1-gallon containers, 1 hectare of 3-gallon containers and 0.5 hectares of 2-gallon containers.

All of the containers are fertilized with a slow release fertilizer product (17-6-12), which is 17% nitrogen (N), 6% phosphorus (as P_20_5) and 12% potassium (as K_20). The 3 gallon containers receive 32 g per pot, the 2 gallon containers receive 18 g per pot, and the 1 gallon containers receive 9 g per pot of the fertilizer product.

Unless you have accurate inventory averages for your operation, you may assume there are:

- 158,080 1-gallon pots per hectare (64,000 1-gallon pots per acre)
- 79,040 2-gallon pots per hectare (32,000 2-gallon pots per acre)
- 59,282 3-gallon pots per hectare (24,000 3-gallon pots per acre)

1-gallon pots take up 1.5 hectares = 158,080 pots/ha. x 1.5 hectares
= 237,120 1-gallon pots per 1.5 hectares x 9 g fertilizer/pot = **2,134 kg fert/1.5 ha**

2-gallon pots take up 0.5 hectares = 79,040 pots/ha. x 0.5 hectares
= 39,520 2-gallon pots per 0.5 hectares x 18 g fertilizer/pot = **711 kg fert/0.5 ha**

3-gallon pots take up 1 hectare = 59,282 pots/ha
= 59,282 3-gallon pots per 1 hectare x 32 g fertilizer/pot = **1,897 kg fert/ha**

How to estimate Nitrogen (N) used per area:

$$\frac{\text{Total weight of fertilizer product}}{\text{Total production area}} \times \text{\% Nitrogen in analysis} = \text{Total N applied per area}$$

1-gallon pots (1.5 ha): 2134 kg x 17% actual nitrogen = **363 kg nitrogen per 1.5 ha**
- N applied per ha = 363 kg N/1.5 ha = 242 kg/ha (1 gallon)

2-gallon pots (0.5 ha): 711 kg x 17% actual nitrogen = **121 kg nitrogen per 0.5 ha**
- N applied per ha = 121 kg N/0.5 ha = 242 kg/ha (2 gallon)

WORKSHEET 5. TOTAL NITROGEN, PHOSPHORUS AND POTASSIUM APPLIED PER AREA (CONT'D)

3-gallon pots (1 ha): 1897 kg x 17% actual nitrogen = **323 kg nitrogen per 1.0 ha**

- N applied per ha = 323 kg N/1 ha = 323 kg/ha (3 gallon)

How to estimate Phosphorus (P) used per area:

$\frac{\text{Total weight of fertilizer product}}{\text{Total production area}}$ x % P_2O_5 in analysis = Total P_2O_5 applied per area

1-gallon pots (for 1.5 ha): 2134 kg x 6% P_2O_5= 128 kg P_2O_5 per 1.5 ha

- P_2O_5 applied per ha = 128 kg P_2O_5/1.5 ha = 85 kg P_2O_5/ha (1 gallon)
  *CONVERT P_2O_5 to actual P: 85 x 0.44 = **37 kg actual P/ha**

2-gallon pots (for 0.5 ha): 711 kg x 6% P_2O_5= 43 kg P_2O_5 per 0.5 ha

- P_2O_5 applied per ha = 43 kg P_2O_5/0.5 ha = 86 kg P_2O_5/ha (2 gallon)
  *CONVERT P_2O_5 to actual P: 86 x 0.44 = **38 kg actual P/ha**

3-gallon pots (for 1.0 ha): 1897 kg x 6% P_2O_5= 114 kg P_2O_5 per 1.0 ha

- P_2O_5 applied per ha = 114 kg P_2O_5/1.0 ha = 114 kg P_2O_5 /ha (3 gallon)
  *CONVERT P_2O_5 to actual P: 114 x 0.44 = **50 kg actual P/ha**

* Phosphorus is represented as %P_2O_5 (phosphorus pentoxide) in fertilizer formulations. P_2O_5 contains phosphorus, but is not 100% phosphorus. To convert P_2O_5 to P, multiply by 0.44.

How to estimate Potassium (K) used per area:

$\frac{\text{Total weight of fertilizer product}}{\text{Total production area}}$ x % K_2O in analysis = Total K_2O applied per area

1-gallon pots (for 1.5 ha): 2134 kg x 12% K_2O = 256 kg K_2O per 1.5 ha

- K_2O applied per ha = 256 kg K_2O /1.5 ha = 170 kg K_2O /ha (1 gallon)
  CONVERT K_2O to actual K: 170 x 0.83 = **141 kg actual K/ha

2-gallon pots (for 0.5 ha): 711 kg x 12% K_2O = 85 kg K_2O per 0.5 ha

- P_2O_5 applied per ha = 85 kg K_2O /0.5 ha = 170 kg K_2O /ha (2 gallon)
  CONVERT K_2O to actual K: 170 x 0.83 = **141 kg actual K/ha

3-gallon pots (for 1.0 ha): 1897 kg x 12% K_2O = 228 kg K_2O per 1.0 ha

- K_2O applied per ha = 228 kg K_2O /1.0 ha = 228 kg K_2O /ha (3 gallon)
  CONVERT K_2O to actual K: 152 x 0.83 = **189 kg actual K/ha

** Potassium is represented as %K_2O (potash) in fertilizer formulations. Potash contains potassium, but is not 100% potassium. In order to reveal the amount of actual potassium, the amount of K_2O needs to be multiplied by 0.83.

Example Results

Container Size	Actual Nitrogen/ha	Actual Phosphorus/ha	Actual Potassium/ha
1 gallon	242	38	141
2 gallon	242	38	141
3 gallon	323	50	189

By comparing the amount of actual N, P and K used per hectare of production for each crop size or type, it is easy to see that in this case, the 3-gallon containers require greater nutrient inputs per unit area than the other container sizes.

These same calculations can be used when selecting fertilizer formulations.