W1368

Dispensing with Fertilization Labor: An Inexpensive Labor-Saving Fertilizer Applicator

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Nursery crops production is labor intensive. Consider pruning, potting, staking, fertilizing, labeling, harvesting and grading—nearly every production task requires workers to handle, transport or otherwise manipulate plants. Much of this work can be physically demanding, seasonal and takes place outdoors, subjecting workers to hot and cold temperature extremes. Industries competing for this limited manual labor workforce often offer higher wages, more comfortable working conditions and benefits, including health insurance, paid time off and retirement benefits. For example, a regional mega gas station and country store is currently advertising entry-level restroom attendant, food service and car wash positions at $20-$21/ hour and other hourly positions up to $42/hour. This business has also increased wages for entry level cashier positions by 13 percent since July 2022. That's pretty stiff competition!

Mechanized and automated solutions that can help nurseries get the most from the scarce labor force exist in all price ranges and can help with simple, tedious tasks. These labor-saving technologies are also a wonderful way to improve worker happiness and well-being by making the same job easier and reducing discomfort when completing repetitive tasks. During a recent nursery tour, when a nursery employee was asked, "What is your least favorite task and why?" he responded, "Fertilizing," because of discomfort due to bending over for long durations of time to spoon fertilizer manually. A recent national nursery survey revealed that just 45 percent of field nurseries and 51 percent of container nurseries are applying fertilizer using mechanization or automation (Fulcher et al. 2023). Fertilizer dispensers are a type of inexpensive labor-saving technology, making them suitable for nurseries of all sizes.

Labor scarcity is a serious problem for nurseries across the country. In Tennessee, nursery operators have shared their frustrations regarding recruiting and retaining laborers:

- "100 percent H-2A (workers), plus one guy in the winter. Prior to H-2A one person at work but eight people on payroll."
- "Terrible. We can't get no help. We've got about half done what we should have by this time of year. Have five guys; I need 10 or 15. It's been really tough this year."
- "Don't have everyone I need. It is begging. There are no workers. It doesn't matter what you pay them, no one wants to work."
- "Terrible. Using H-2A (workers) next year."

The Pro-35 (Fertileeze, Hendersonville, North Carolina) is one type of fertilizer dispenser that can replace manual fertilizer application (Figure 1). The dispenser has a wand that consists of nested inner and outer PVC pipes (Figure 1A) that allow the user to pump the outer pipe. The pump action pushes a measured amount of fertilizer from the hopper at the top of the wand through a rubber valve and out the other end into a targeted area. A clip under the hopper can be moved up and down to specified positions to change the amount of fertilizer released making it easily adaptable to different plant needs (Figure 1B). After being set and filled with fertilizer, the Pro-35 requires only a small pump to dispense fertilizer and can apply up to 35g per pump.

Figure 1. *The Fertileeze Pro-35 dispenser showing (A) how the Pro-35 dispenses fertilizer by pumping the outer PVC pipe to release fertilizer into a pot and (B) the clip at the top of the pipe which can be adjusted to change the amount of fertilizer dispensed with each pump.*

The objective of this publication is to familiarize the nursery industry and those who advise them with the benefits of using a fertilizer dispenser and specifically to investigate the properties and advantages and disadvantages of the Fertileeze Pro-35 fertilizer dispenser when compared with the industry standard of manually applying fertilizer from a 5-gallon bucket (Figure 2A, B). In this publication, we share our results from testing how uniformly the Pro-35 dispenses a range of fertilizer doses and formulations. We also share our experiences regarding time to apply, worker perceptions and placement accuracy in tests using a range of plants, pot sizes and row block configurations.

Figure 2. *A worker (A) applies fertilizer using the Pro-35 while another worker (B) applies fertilizer manually.*

We tested a total of four granular fertilizers from two different brands, Polyon's and Osmocote, including a specialty Osmocote blend designed to adhere to the substrate surface. The four fertilizers were Polyon 19-4-8, Osmocote Blend 17-5-11, Osmocote 18-6-12 and Osmocote Blend 19-6-9 with Fusion technology (Figure 3, Table 1).

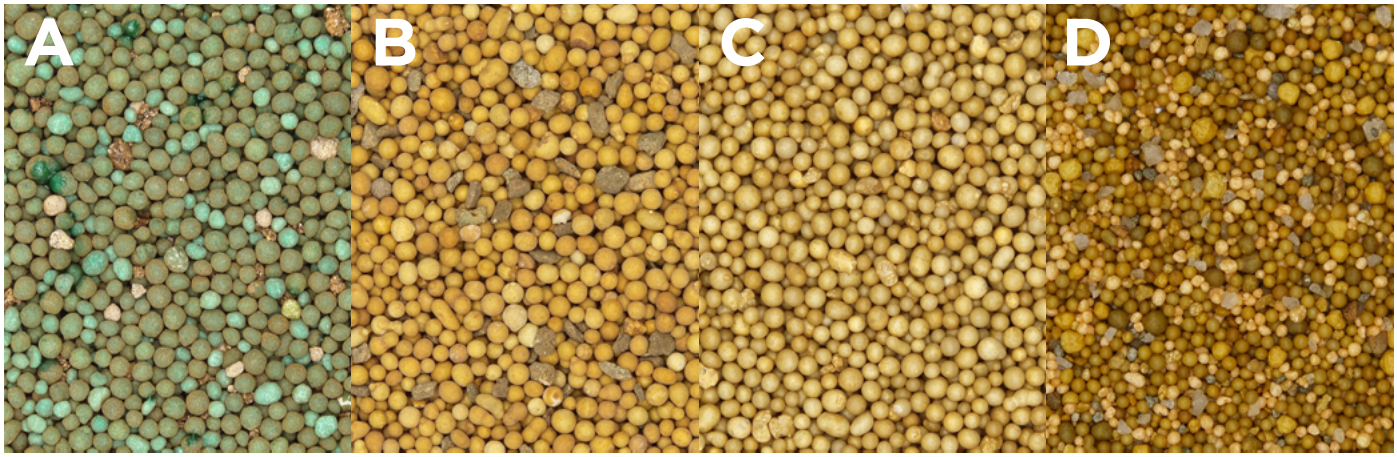

Figure 3. *Fertilizers used for calibrating the Pro-35. (A) Polyon 19-4-8, (B) Osmocote Blend 17-5-11, (C) Osmocote 18-6-12, (D) Osmocote Blend 19-6-9 (Fusion technology). The same level of magnification was used for each image.*

Table 1. Comparison of the fertilizers used in the fertilizer dispenser tests.

Brand, Manufacturer	Analysis	Longevity (months)	Description of Fertilizer and Coating	Weight of 1 teaspoon (grams)
Polyon, Harrell's	19-4-8 (Figure 3A)	5-6	N, P, K + micronutrients. Some nutrients are polymer-coated Designed to release nutrients regardless of substrate type, pH, or moisture level	7.1
Osmocote Blend, ICL	17-5-11 (Figure 3B)	5-6	N, P, K + micronutrients Some nutrients are polymer-coated	5
Osmocote, ICL	18-6-12 (Figure 3C)	8-9	N, P, K Lo-Start formulation All nutrients are polymer-coated	5
Osmocote Blend, ICL	19-6-9 (Figure 3D)	5-6	N, P, K + micronutrients Fusion technology Some nutrients are polymer-coated	5

Calibrating the Pro-35 and Assessing Manual Scoops

Because the amount of product dispensed may vary with the type of fertilizer used, the Pro-35 should be calibrated for each fertilizer prior to use. We conducted a simple test to calibrate the dispenser and assessed differences between commonly used and specialty fertilizers. To calibrate the Pro-35, we used ten 6-inch saucers, set the Pro-35 at the first setting (a half step below the mark labeled "01") and pumped one time into each saucer. The amount of fertilizer dispensed was weighed and recorded. We repeated this process for each of the six settings. We also tested the conventional measurements used in manual applications (1 tsp, 1 tbsp, and ¼ cup or 2 oz) from the fertilizer labels to see how close the manual "spoon" measurements were to the recommended labeled volumes. To do this, we scooped a level teaspoon, weighed it and recorded the weight. This was repeated ten times for a total of ten weights. We repeated this process with a tablespoon and ¼ cup. It is important to note these were very intentional level measurements, not representative of the rapid scoops a worker would potentially make when fertilizing in a production system. These measurements were made to determine how true and consistent the fertilizer's labeled weight was per volume measurement.

Results: Calibrating the Pro-35 and Assessing Manual Scoops

When using the automatic fertilizer applicator, Osmocote 18-6-12 released the highest amount (by weight) of fertilizer at each setting, generally 2-2.5 g more than the other fertilizers (Figure 4). However, it also was the most consistently dispensed product as indicated by the small **standard deviation** bars. Across all fertilizers, the Pro-35 had a 2-36 percent **coefficient of variation**; the standard deviation was approximately ≤1 g of fertilizer. The coefficient of variation was 2-36 percent for settings 0.5-1.0, which dispense <10g of fertilizer, 2-8 percent for 1.5 setting and ≤5 percent for setting 2 and higher settings. These results suggest that the Pro-35 may be ideally suited to applications of >10g, which often correspond with #1 or larger container sizes. Smaller containers are often pot-to-pot and may be more efficiently top-dressed with a hand-crank broadcast spreader.

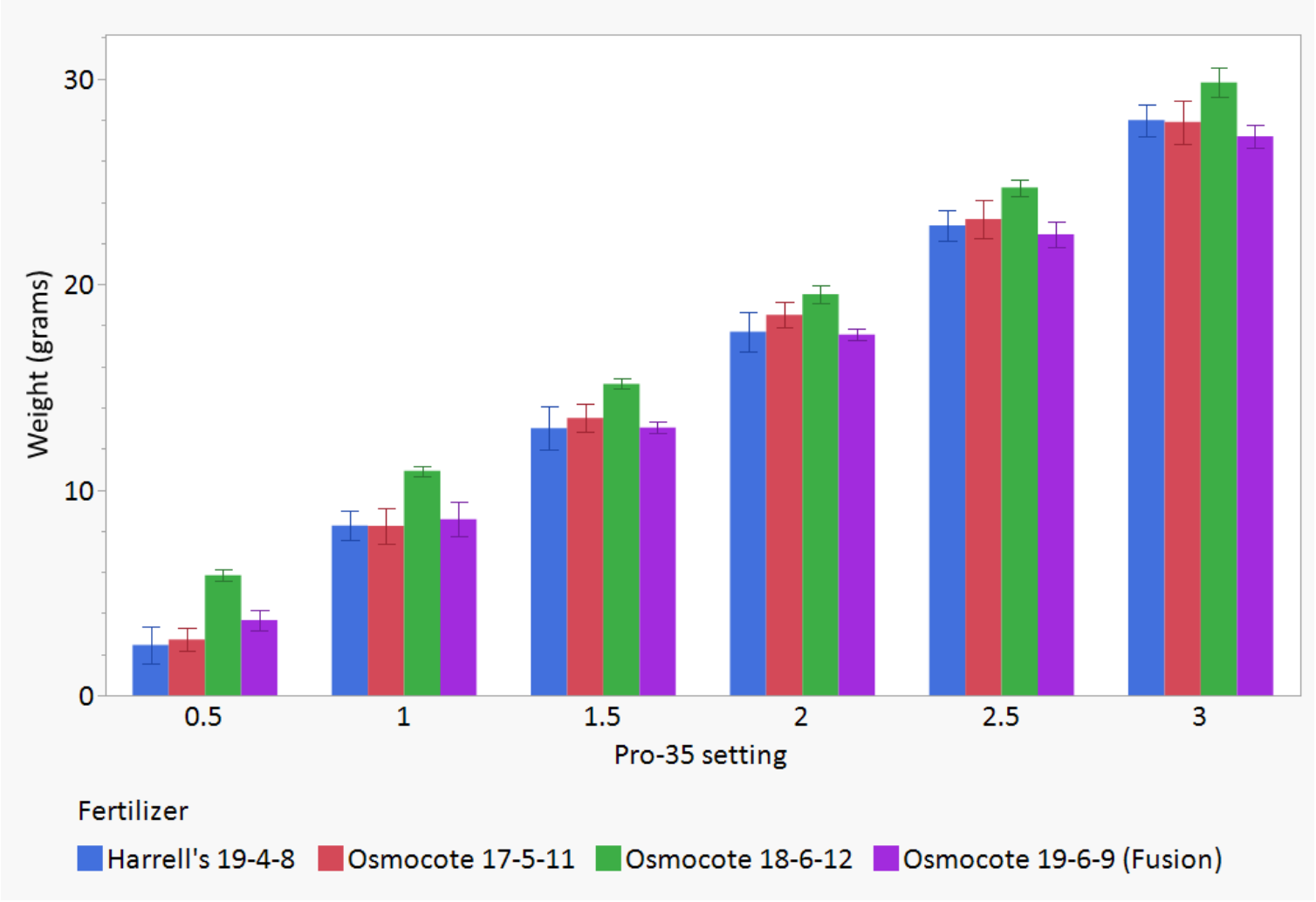

Figure 4. *Comparison of the precision (repeatability) with which the Pro-35 dispenses four different fertilizers. Each setting was repeated 10 times for each fertilizer with weight reported in grams. Bars represent standard deviation.*

Weights recorded from manually scooping Osmocote fertilizer were generally similar to what was reported on the labels and were consistent across the ten replications as indicated by the small standard deviation bars (Figure 5). For Polyon fertilizer, our measurements were lower than the labeled amount and more similar to the Osmocote fertilizer. In general, there was 2-6 percent coefficient of variation for all fertilizers, with the larger volume measurement having the greatest standard deviation, approximately 2 grams. In a replicated companion test with the 19-4-8 fertilizer, a nursery worker scooped a mounded teaspoon, tablespoon and ¼ cup. The average weights were 6.3, 19.4 and 67.2 grams, which were 19 percent, 13 percent and 4 percent more, respectively, than the level measures. This disparity demonstrates the variation possible when quickly scooping fertilizer compared with carefully measuring a level spoonful.

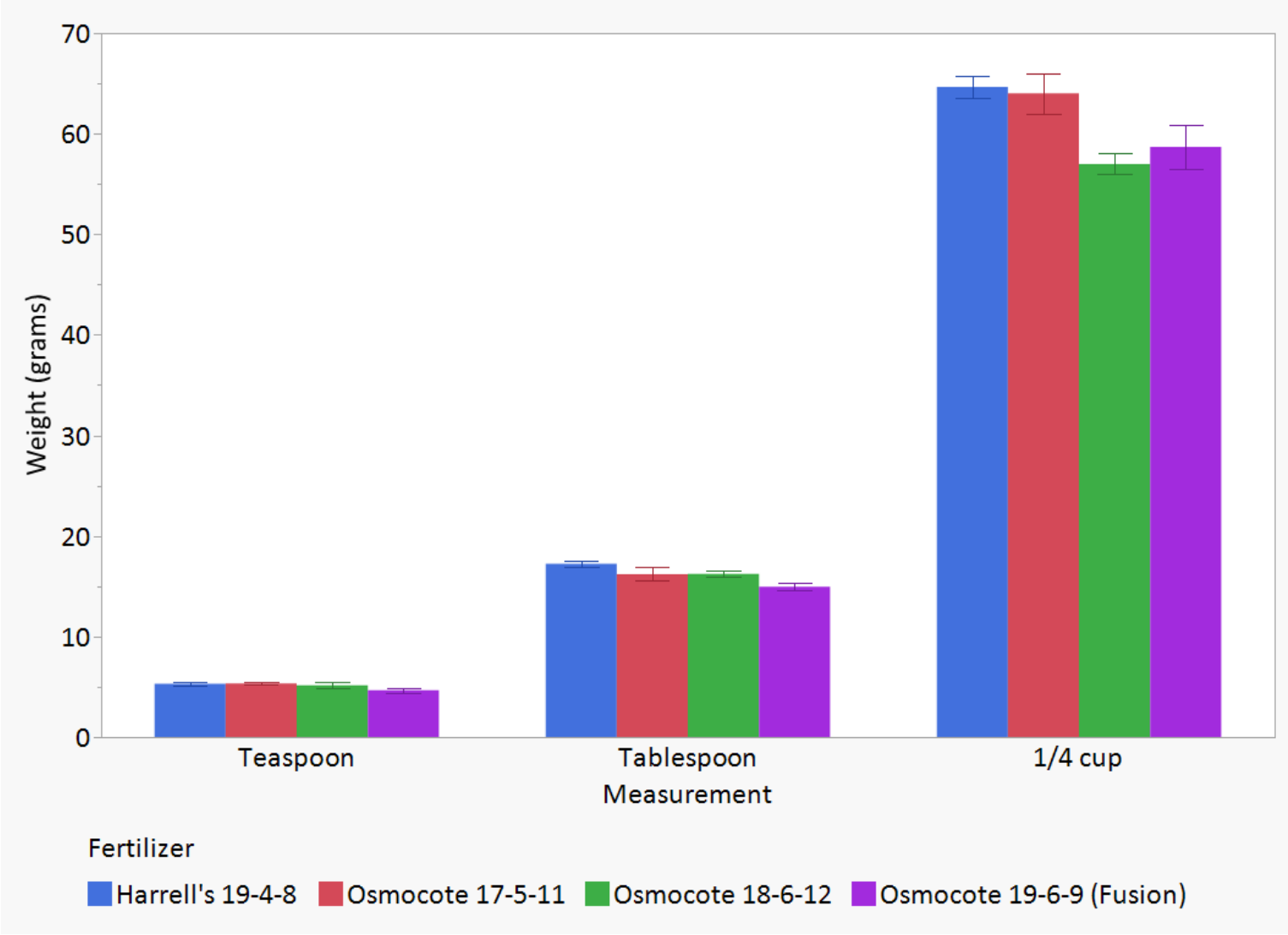

Figure 5. *Fertilizer weight associated with manually measuring a level teaspoon, tablespoon, and ¼ cup of fertilizer when weighed ten times. Bars represent the standard deviation.*

In these tests, the Fertileeze Pro-35 applied fertilizer consistently, which means once a grower establishes the amount of a particular fertilizer that is dispensed at a given setting, they do not need to worry about over- or under-fertilizing plants.

Material Input Cost of Over-Fertilizing

Applying the medium rate of 48 grams of fertilizer to a crop of 500,000 3-gallon plants would require 1,058 bags of fertilizer and have an approximate cost of $58,202 (@ $55 per bag). However, a mounded tablespoon of fertilizer can apply 13 percent more than the intended amount and would require 1,196 bags of fertilizer at an approximate cost of $65,768, nearly $7,600 more per top dress application.

Note: A dose of 48 grams requires more than 1 tablespoon; this example is for illustrative purposes only.

Evaluating Fertilizer Applications Made with the Pro-35

The Pro-35 allows a person to stand while fertilizing; whereas, manual application requires a worker to bend over or kneel, which can be uncomfortable and increase worker strain. The dispenser also has the potential to decrease the amount of time it takes to apply fertilizer. We conducted three experiments to compare the Pro-35 against manual applications for different sized plants and those in a different block configuration or spacing. For each experiment, we looked at

- Weight of dispensed product
- Time to apply
- Change in worker energy level
- Change in worker mobility
- Perceived accuracy of placement
- Perceived ability to spread fertilizer

How to Determine the Correct Setting for the Pro-35

Calibrate as described above to determine how much fertilizer is dispensed at each setting. Check the fertilizer label for the container size that will be fertilized and select the desired dose. Check the results from your calibration to determine which setting would get the closest to the correct dosage. For example, if you want to fertilize a three-gallon container with the high rate of Osmocote 18-6-12 (97g), it would require dispensing the Pro-35 four times on the 2.5 setting (24.7g × 4 pumps).

The results are the average from two applicators who each applied the fertilizer manually and with the Pro-35 for each experiment. The amount of fertilizer applied in each test was based on the labeled rate for the container size for each crop.

Methods and Results: Evaluating Fertilizer Applications Made with the Pro-35

Experiment 1: Trees, #7 containers, pot-to-pot spacing

In the first experiment, oak trees in seven-gallon pots were spaced pot-to-pot in three rows. Each person fertilized 34 trees using the Pro-35 and a second set of 34 trees using manual application. Trees were fertilized with Osmocote Blend 19-6-9, and rates were determined by using a medium rate for a #7 pot (104g). Each person independently calculated how much fertilizer would be needed and started timing how long the process took from when they weighed out the fertilizer needed to completion of application. This experiment was conducted on a large group of trees that were all the same size and provides a good comparison of the time to complete the task and difficulty of the task between the two application methods.

Results:
Both methods dispensed more fertilizer than desired based on labeled rate for the product, but the amount dispensed by the Pro-35 was much closer to the desired amount (Table 2). Manually applying fertilizer applied an additional 487g (approximately 14g per plant), 14 percent more than the labeled rate. The Pro-35 took 48 percent less time and less energy to use and also impacted mobility less than the manual application. However, worker perceptions of placement accuracy and their ability to spread fertilizer around the container surface were greater for the manual application.

Table 2. Comparison of fertilizer application and worker perceptions when applied with a dispenser and manually applied to #7 oak trees spaced pot-to-pot.

	Pro-35 dispenser	Manual application
Weight of dispensed product (grams) Desired amount 3,536g[1]	3,563	4,023
Time to apply (minutes)	8.5	16.5
Change in worker energy level at the end of the task[2]	0	0.25
Change in worker mobility at the end of the task[2]	0.25	1
Perceived accuracy of placement (1-5)[3]	4.25	5
Perceived ability to spread fertilizer (1-5)[3]	3.38	5

[1] Expected amount based on 34 #7 pots at 104g per pot
[2] Worker energy and worker mobility based on a Likert scale of 1-5 with 1 being low energy or mobility and 5 being high energy or mobility. The difference was calculated as the beginning score minus the ending score.
[3] Worker perceived accuracy of fertilizer placement and ability to spread fertilizer based on a Likert scale of 1-5 with 1 being low accuracy or ability and 5 being high accuracy or ability.

Experiment 2: Shrubs and trees, #2, #3 and #5 containers

The second experiment was set up with hydrangeas in #3 containers that were fertilized with Polyon 19-4-8 and red oak trees in #2 and #5 containers that were fertilized with Osmocote Blend 19-6-9 with Fusion technology and spaced pot-to-pot. The medium rate was used for both pot sizes and types of fertilizer. Because this experiment requires the applicator to change fertilizer from one group of plants to the next and requires the applicator to change application rate based on pot size, it requires more adjustments and attention to detail. The time to apply fertilizer includes measuring out both fertilizers to start with, applying one fertilizer, switching out to the second fertilizer and applying the second fertilizer. The change between plant types and fertilizer types reflects real world nursery conditions.

Table 3. Characteristics of fertilizer application and worker perceptions when applied by dispenser and manually to hydrangeas grown in #3 containers and red oak trees in #2 and #5 containers and spaced pot-to-pot.

		Pro-35 dispenser	Manual application
Weight of dispensed product (grams) Desired amount: Polyon's 816g, Osmocote 1,550g[1]	Polyon's 19-4-8: Osmocote 19-6-9:	785 1,538	840 1,440
Time to apply (minutes)		9.5	11
Change in worker energy level at the end of the task[2]		0	0
Change in worker mobility at the end of the task[2]		0	0.75
Perceived accuracy of placement (1-5)[3]		4.75	4.5
Perceived ability to spread fertilizer (1-5)[3]		3.5	4.5

[1] Expected amount for Polyon's based on 17 #3 containers at 48g per pot, Osmocote based on ten #2 containers at 36g per pot plus 17 #5 containers at 70g per pot

[2] Worker energy and worker mobility based on a Likert scale of 1-5 with 1 being low energy/mobility and 5 being high energy/mobility. The difference was calculated as the beginning score minus the ending score

[3] Worker perceived accuracy of fertilizer placement and ability to spread fertilizer based on a Likert scale of 1-5 with 1 being low accuracy or ability and 5 being high accuracy or ability.

Results:

In this experiment, two different fertilizers were used, which meant the applicator had to switch from one to the other. These results showed that for Polyon 19-4-8, the Pro-35 dispensed 4 percent less fertilizer than desired, while manual application dispensed 3 percent more (Table 3). Both methods applied less than the desired amount of Osmocote Blend 19-6-9 fertilizer with Fusion technology. The Pro-35 applied <1 percent from the desired application, while the manual application was 7 percent less than intended. Application time was somewhat faster for the dispenser, with the Pro-35 taking 14 percent less time. This may be because the hopper and wand needed to be completely emptied before they could be filled with a different fertilizer. The applicators did not notice a change in energy for either method, but they reported slightly better mobility after using the Pro-35. The Pro-35 was perceived to apply fertilizer with better accuracy but with less ability to spread than the manual application.

Experiment 3: Trees, tall forestry containers, four rows, spaced pot-to-pot

In the final experiment, fertilizer was applied to red oak trees in tall tree pots, which are equivalent to a #3 pot. Pots were spaced pot-to-pot with four rows of 11 or 12 pots in each group. This pot configuration tests the ability to reach pots that are in inner rows for each method.

Table 4. Characteristics of fertilizer application and worker perceptions when applied by dispenser and manually to red oak trees grown in tall pots.

	Pro-35 dispenser	Manual application
Weight of dispensed product (grams) Desired amount 2,340g[1]	2,435	2,535
Time to apply (minutes)	4.5	10
Change in worker energy level at the end of the task[2]	0	0
Change in worker mobility at the end of the task[2]	0	1
Perceived accuracy of placement (1-5)[3]	4	4.5
Perceived ability to spread fertilizer (1-5)[3]	3.5	5

[1] Expected amount based on 45 #3 pots at 52g per pot
[2] Worker energy and worker mobility based on a Likert scale of 1-5 with 1 being low energy or mobility and 5 being high energy or mobility. The difference was calculated as the beginning score minus the ending score
[3] Worker perceived accuracy of fertilizer placement and ability to spread fertilizer based on a Likert scale of 1-5 with 1 being low accuracy or ability and 5 being high accuracy or ability.

Results:

Both application methods dispensed more fertilizer than the desired amount, with manual application dispensing 8 percent more and the Pro-35 dispensing 4 percent more (Table 4). Manual application of fertilizer took approximately twice as long as the Pro-35. The applicators did not notice a difference in energy level after using the Pro-35, but reported a slight decrease following the manual application. Mobility was reduced more by the manual application than by the Pro-35. The workers' perception of their ability to place and spread the fertilizer was better when the manual application method was used.

Economic Considerations of Using the Fertileeze Pro-35

There are potential labor and fertilizer input savings associated with the use of the Fertileeze Pro-35.

Labor: We documented approximately a 50 percent reduction in application time in both experiments in which the fertilizer type was not changed during the test (experiments 1 and 3), which implies labor savings. For example, in experiment 1, there would be a reduction of 13.3 hours going from manual application to Fertileeze Pro-35 dispenser when scaling up this experiment to 3,400 #7 pots, assuming there are no gains in worker efficiency when scaling up this experiment. Assuming an hourly wage rate of $15.14 (2024 Tennessee adverse effect wage rate), this is equivalent to a $200 labor cost savings for 3,400 #7 containers. These labor savings also suggest that 13.3 hours of workers' time can be allocated to other tasks.

Fertilizer: Given the general increase in accuracy of each dose and the related reduction in fertilizer use, input savings will be associated with using the Fertileeze Pro-35, but those savings will vary depending on the type of fertilizer applied. A nursery operator would need to compare potential savings associated with the use of the Fertileeze Pro-35 to its cost, which is approximately $155 per unit (the operator would need to buy one for each worker involved in fertilization), to evaluate the economic benefits associated with purchasing this tool. The cost of the Pro-35 reported is for 2025.

Other Considerations and Limitations of This Assessment

Our experiments were with small numbers of plants and did not take into account long periods of time fertilizing, but, even with these small trials, workers noticed a difference in mobility using the Pro-35 compared to manual applications. With our first experiment using larger containers, we had to refill the Pro-35 once to fertilize all the plants. In a larger nursery, a supply of fertilizer would need to be readily available to efficiently refill the hopper, as much more fertilizer would be required to complete the task. Plants grown in large containers may benefit from multiple smaller applications in order to disperse the fertilizer evenly over the surface of the container. A dispenser may be particularly valued by workers when fertilizing thorny plants, such as roses, and evergreens and grasses with sharp foliage. One of the disadvantages of the Pro-35 that we noticed was that when the hopper was full it was top heavy and difficult to handle. As the fertilizer was dispensed, the Pro-35 became easier to use.

Although we have determined some advantages and disadvantages to the Pro-35, there are many questions yet to be answered about its performance and utility. For example, the Pro-35 is easy to use and the PVC pipes slide easily when pumping, but over time, how well will it continue to work? If fertilizer dust or prills get between the two sections of PVC, will its performance be affected? How does the Pro-35 compare to other commercially available fertilizer dispensers? Our experiment was conducted on a very small scale, and there are questions to answer about how to utilize the Pro-35 efficiently on a large scale. Resupplying dispensers may require a dedicated vehicle with a bulk supply of fertilizer. Alternatively, empty hoppers may be replaced by full hoppers. It is unknown how many workers it would require to refill and maintain maximum efficiency, thus making it difficult to estimate the difference in labor between using a dispenser and hand-spooning fertilizer on a larger scale. This estimation of efficiency is further complicated when considering that a worker may need to make multiple smaller pumps to evenly distribute fertilizer or to supply the labeled amount of fertilizer in a large pot-in-pot system. We did not assess how this compares to fertilizing a pot using a single, manual scoop. In our experiments, we asked applicators to provide their perception of their ability to place fertilizer where intended and their ability to spread fertilizer but did not measure either of these. Considering applicator perceived limitations for placement accuracy and ability to spread fertilizer, these should be investigated. Similarly, the effects of foliage density and canopy structure should be explored. The applicators in our experiments felt that oak trees were easier to fertilize than hydrangeas, which had denser canopies. It is unknown whether plants such as boxwood, which have an even denser canopy than hydrangea, would be more difficult to fertilize using these dispensers.

Take Home Message for Nursery Producers

- Pro-35 applied fertilizer approximately 50 percent faster when the same fertilizer was used
- Worker energy level was modestly affected by the manual application method
- Worker mobility was negatively affected more when using manual application
- Applicators rated their ability to accurately place fertilizer 15 percent lower when using the Pro-35
- Applicators rated their ability to spread fertilizer 33 percent lower when using the Pro-35
- The Pro-35 is very affordable, $155 USD (2025 prices)

One Nursery's Experience with the Pro-35 Fertilizer Applicator

Willoway Nurseries in Avon, Ohio, tried the Pro-35 to see if it improved their fertilizer application efficiency while also making the job more enjoyable for their employees. They began by measuring the doses of their normal fertilizer (Harrell's CRF product) to see how the equipment handled their typical fertilizer. They found that the Pro-35 applied a repeatable, consistent dose at a given setting. Willoway employees were concerned about their ability to spread fertilizer across larger containers since the Pro-35 delivers a single dose in one location. After some experimenting, they found that they could split the application into multiple, smaller doses, which was especially relevant for trade 5 gallon and larger containers. For example, on a trade 15, they applied three shots of fertilizer at a lower setting (2.5) rather than one large dose that delivers the entire amount of fertilizer for that container. For a trade 20 gallon, they applied four shots. This smaller-but-more-doses strategy spreads the fertilizer over the surface while still being considerably faster and easier to apply than when manually applying fertilizer. Growers at Willoway also found the Pro-35 to be more accurate when delivering the target fertilizer weight than a manual application process.

Conclusion

As a labor-intensive form of agriculture operating during a significant worker deficit, the nursery industry can benefit from technology that allows workers to complete tasks in less time. The Pro-35 allows employees to fertilize nearly twice as quickly when the same fertilizer product is used, making them available for other tasks. Labor-saving technology like the Pro-35 that also reduces physical strain can help retain workers by making tasks more pleasant. Remember the nursery employee who said fertilizing was his least favorite task? Labor-saving technology cuts down on the time and effort that it takes to carry out a task and keeps employees more comfortable while saving your nursery money. If simple tasks such as fertilizing can be made easier by technology, then what will be next in the nursery industry's future? Remember that an evaluation of savings versus costs will help producers make an economically sound decision when considering the purchase of labor-saving technologies.

Glossary

Standard deviation is the amount of variation around the average measurement from a group of measurements. A low standard deviation means the values are close to the average. A high standard deviation means that the values have a wider range from the average. The unit is the same as the data.

Coefficient of variation (CV) is the standard deviation divided by the average. A small CV means low variation and a large CV means greater variation. The CV is unitless, so it can be used to compare variation across experiments.

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Disclaimer statement

The authors did not receive any compensation from Fertileeze nor were the tests done in consultation with Fertileeze. No statistical analyses were conducted to determine the results and conclusions. The authors made judgments based on the averages, standard deviation and coefficient of variation.

Acknowledgements

The authors gratefully acknowledge Natalie Bumgarner, Karl McKim, Tyson Raper and Alicia Rihn for their careful review of this publication. The authors also thank Ben Averitt and Willoway Nurseries for sharing their experience, Kyle Creamer and Harrell's Co. for providing fertilizer, Dr. Bill Klingeman for use of plants and fertilizer and Dr. Bob Trigiano for use of fertilizer. The authors also acknowledge USDA NIFA 2024-51181-43291 for financial support.

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