Investigation of Drainage and Plant Growth from Nursery Container Substrate

Over eighty percent of water from sprinkler systems may be lost through runoff, drainage, and evaporation during a growing season. Similarly, fertilizers are often over-applied without knowing the amount of nutrient loss through drainage. This is complicated due to the wide range of species grown in a typical nursery, as species-specific water and fertilizer management practices would be too expensive. This results in the common practice of using the same substrate and water-fertilizer management practices for different species. These irrigation and fertilization practices have raised concerns over efficient use of water and fertilizer because of water loss through the containers and the extent of nutrient and chemical leaching with drainage water to the soil and ground water. Knowledge of water and nutrient holding capacity of a substrate can improve irrigation and nutrition application management.

A substrate composed of 55% aged pine bark, 3% sharp silica sand, 5% expanded shale Haydite soil conditioner, 20% steamed composted nursery trimmings and left over potting material (predominantly peat moss and pine bark), 12% fibrous light Sphagnum peat, and 5% composted municipal sewage sludge was selected for testing. The experiment consisted of fifty pots; forty containing the substrate and a transplanted bare-root butterfly bush and ten containing just the substrate. The pots were then divided into ten groups of five, each group consisting of four pots with plants and one with just the substrate. The pot without a plant was included as a way to determine the effect of substrate type with fertilizer rate without the influence of a plant. Group 1 received no fertilizer, while groups 2 through 10 received increasing amounts of fertilizer. Pots were set up so that a collection dish for each pot would catch the drainage water. The butterfly bush plants were grown for four weeks in a double-polyethylene plastic-coated greenhouse.

Table 1.Percentage of NO_3-N, P, and K lost through drainage from substrate with plants or no plants with different amounts of fertilizer initially applied to the substrate during the 28 day test.

	Rate of Fertilizer Lost Through Drainage					
	NO_3-N		P		K	
Group No.	With Plant	Without Plant	With Plant	Without Plant	With Plant	Without Plant
1	30.6	45.0	19.4	25.8	21.4	25.7
2	12.2	22.7	12.3	21.5	19.0	31.8
3	9.8	39.8	7.0	13.9	13.5	29.5
4	42.1	42.5	7.1	9.2	23.8	29.8
5	44.5	48.0	7.7	11.7	24.2	27.7
6	48.4	65.5	6.3	11.3	26.3	38.7
7	44.3	51.2	5.7	10.2	22.8	34.8
8	42.2	90.3	6.7	9.5	20.9	32.9
9	50.7	57.2	7.4	11.6	24.4	46.1
10	76.4	46.3	19.7	11.8	58.5	35.9

Table 2.Average weekly relative plant height with increasing levels of nitrogen (N), phosphate (P), and potassium (K) applied to the substrate.

	Average Weekly Relative Plant Height Increase (%)			
Group No.	Week 1	Week 2	Week 3	Week 4
1	42.5	25.8	16.0	8.8
2	39.9	39.9	19.7	16..8
3	47.1	46.0	16.1	11.0
4	29.8	42.5	14.6	18.1
5	23.0	31.4	17.4	17.7
6	30.5	33.8	26.1	17.9
7	31.4	25.5	17.5	5.7
8	27.1	26.2	23.4	14.2
9	16.0	22.9	19.6	17.4
10	13.5	4.8	4.5	13.0

As expected, the amount of nutrients that leached from the pots increased as the amount of supply increased. Based on leaf area, plant height, and chlorophyll content, the optimum fertilizer supply to the plants was between 1.0 to 3.0 g of fertilizer per pot (0.8 g N, 0.3 g P, and 1.8 g K), including the fertilizer within the substrate. The 3.0 g rate is close to the rate that is commonly used in this production system.

The results of this research provide information on how to improve the use of water and nutrients for a nursery production substrate. When the commonly used fertilizer rates of 0.8g of NO_3-N and 0.4g of P were applied, 48.4% of the NO_3-N and 6.3% of the P were lost through drainage. Plants treated with the higher rates of fertilizers began to show symptoms of stress with in a week of the initial treatments and plants in the higher groups died within the first 10 days. There are potential plant growth and environmental benefits from reducing the current fertilizer rates. When between 0.4 to 0.8 g of nitrogen (N) and 0.1 to 0.2 g of phosphate (P) were applied, the plant growth was optimized and nutrient loss from drainage was minimized.

For more information, contact: Heping Zhu, heping.zhu@ars.usda.gov USDA-ARS-ATRU, OARDC,1680 Madison Ave, Ag Eng. Bldg., Wooster, OH 44691

Zhu, H., J. Frantz, R.C. Derksen, C. Krause. 2007. Investigation of drainage and plant growth from nursery container substrate. J. Ag. Eng. Hort. 23:289-297.