Effect of Trickle Irrigation, Nitrogen Rate, and Method of Application on Field-grown 'Compacta' Japanese Holly[1]

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Abstract

Three methods of N application and 4 N rates of 34, 67, 134, and 268 kg/ha (30, 60 120, and 240 lbs/A) were evaluated on field-grown 'Compacta' Japanese holly (*Ilex crenata* Thunb. 'Compacta'). Fertilizer application methods consisted of NH_4NO_3 broadcast over trickle irrigated and non-irrigated plants, and injection of NH_4NO_3 through the trickle irrigation system. Irrigation regardless of whether N was surface applied or injected through the system, increased root and shoot dry weights, plant size, visual ratings, and percent survival. Irrigated plants had a more fibrous root system. N rate had no affect on root or shoot dry weights, root distribution, visual ratings, or percent survival.

Index words: fertilizer injection, *Ilex crenata*, root distribution, root growth, shoot growth

Significance to the Nursery Industry

Use of trickle irrigation in the nursery industry should increase due to lower water usage than overhead irrigation systems. This work demonstrates that trickle irrigation can also serve as a medium for application of water soluble fertilizers reducing total amount of fertilizer used and labor requirements for fertilization of field-grown nursery stock over conventional broadcast application methods. Trickle irrigation may also improve transplantability of field-grown nursery stock by concentrating roots around the base of the plant and reducing root loss during transplanting.

Introduction

Trickle irrigation of field-grown nursery crops is becoming a more widespread component of nursery irrigation practices in the U.S., especially in the southeast U.S. (2, 4, 7, 12). Previous research has shown that trickle irrigation improves root growth (9, 11, 13) and shoot growth (9, 11, 13, 17), while using water more efficiently than conventional overhead irrigation (4, 15, 16). Trickle irrigation may also be used as a medium for injection of fertilizers, systemic pesticides, and pre-emergence herbicides. Coston et al. (3) reported no reduction in trunk caliper growth or leaf N of 'Redhaven' peaches when half the recommended rates of surface applied N were injected into the trickle irrigation system. Hairston et al. (6) suggest that N application through a trickle irrigation system may be more efficient, reducing the amount of N fertilizer needed for plant growth. The objectives of this experiment were to determine the effects of trickle irrigation, N rate, and method of application on growth of field-grown 'Compacta' Japanese holly.

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Materials and Methods

On April 30, 1982, 'Compacta' Japanese Holly were planted in a fine-loamy siliceous, thermic Typic Hapudult soil at Auburn, Alabama. Plants were fertilized at planting according to soil test recommendations, except for N, and thereafter maintained according to standard nursery practices. Trickle irrigation was installed on May 25, 1982, for two-thirds (192) of the plants. One 3.78 l/hr (1 gal/hr) Rain Bird EM-J10 series pressure compensating emitter was inserted into a 1.27 cm (½ in) black polyethylene pipe adjacent to each plant. On the lateral lines of half (96) of the irrigated plants, a hydraulic displacement fertilizer injection system was installed (8).

NH_4NO_3 broadcast over plants with and without trickle irrigation, and injection of NH_4NO_3 through the trickle system were compared. The 4 annual N rates applied by each method of application were 34, 67, 134, and 268 kg/ha (30, 60, 120, and 240 lbs/A) split equally among 4 applications made in June, August, September, and October of 1982, and May, July, September, and October of 1983. Rainfall and net evaporation from a class A evaporation pan (14) were recorded daily throughout the experimental period. Irrigation rates were applied based on 50% replacement of net evaporation when cumulative daily net evaporation reached or exceeded 1.25 cm (½ in) from May through October of each growing season. Irrigation outside these months was not necessary due to adequate rainfall and lower daily temperatures. Daily water replacement requirements were determined using 929 cm^2 (1 ft^2) as the space occupied by each plant based on earlier work of Ponder et al. (11). The experimental design was a 3 × 4 factorial with 4 replications of 6 plants each (288 plants).

Percent survival was determined at 6 week intervals during the 2 growing seasons. Foliar samples for nutrient analysis were collected on August 18, 1982, and September 24, 1983. Plants were rated on a scale of 1–8, where 1 = dead plant, 3 = stem dieback, 5 = foliar chlorosis, and 8 = green plant with excellent growth, on November 2, 1982, and October 17, 1983. On November 12, 1982, one plant per treatment was dug from each replication to determine root and shoot dry weights. On October 27, 1983, 2 plants/

Table 1. Effects of method of N application and rate on total root and shoot dry weight, and root distribution of 'Compacta' Japanese holly.

Treatment	Root dry wt (g)		Shoot dry wt (g)		1983 Root dry wt (g)			
	1982	1983	1982	1983	Primary 0–20 cm	Fibrous 0–20 cm	Primary 20+ cm	Fibrous 20+ cm
Method of application								
Surface applied/no irrigation	8.4b[z]	62.4b	14.4b	128.6b	28.4b	6.8b	10.8b	16.4b
Surface applied/irrigation	19.2a	126.8a	32.2a	202.0a	38.5a	20.7a	13.4ab	54.2a
Injected/irrigation	17.7a	125.2a	30.1a	182.8a	40.1a	18.6a	16.2a	50.3a
N rate (kg ha⁻¹)								
34	15.2[y]	112.5	24.4	174.5	36.4	16.3	15.6	44.1
67	15.4	112.5	24.4	174.5	36.4	16.3	15.6	44.1
134	14.3	100.7	25.8	163.7	35.9	14.9	11.6	38.3
268	15.7	108.5	25.4	181.9	37.5	13.3	14.4	43.3

[z]Treatment means within each column followed by the same letter or letters are not significantly different at the 5% level as determined by Duncan's new multiple range test.

[y]There was no significant effect as a result of N rate or method of application × N rate as determined by F-test.

treatment were dug from each of the 4 replications. The root system was washed and divided into 2 sections: (a) roots 0–20 cm (0–8 in) from the plant base, and (b) roots beyond 20 cm (8 in) from the plant base. The 40 cm (16 in) root ball conforms to the American Association of Nurserymen standards for this size plant (1). Roots were further divided into fibrous (less than 2 mm diameter) and primary (greater than 2 mm diameter) roots for each of the 2 rootball sections. Root dry weights were determined for each root classification plus total root dry weights.

Results and Discussion

Root and shoot dry weights for hollies receiving irrigation, regardless of whether N was surface applied or injected into the trickle irrigation system, were nearly double those of non-irrigated hollies after each of the 2 growing seasons (Table 1). Both primary and fibrous roots were increased by trickle irrigation within a 20 cm (8 in) root ball. These data concur with results obtained by Ponder and Kenworthy (10), and Ponder et al. (11). In the 20 cm (8 in) root ball, fibrous roots were almost 3 times greater for irrigated hollies compared to non-irrigated hollies. Since a major problem with balled and burlapped nursery stock is the loss of roots at transplanting, use of trickle irrigation on 'Compacta' Japanese holly will produce a plant that should transplant more successfully due to enhanced root numbers, especially fibrous roots.

Regardless of whether N was surface applied or injected, irrigated hollies had higher survival rates than non-irrigated plants (Table 2). By the end of the first growing season non-irrigated hollies had 24% fewer plants surviving than hollies receiving irrigation with surface applied N and 21.9% fewer than hollies receiving irrigation with injected N. By the end of the second growing season, 13.5% of the remaining non-irrigated hollies had died while only 2% of the irrigated hollies with surface applied N did not survive. Visual inspection in the fall of the first year showed that non-irrigated plants had more chlorosis and twig dieback than irrigated hollies (Table 2). This suggests non-irrigated plants that died the second season were already under stress due to conditions in the first growing season. These data emphasize the importance of irrigating young liners through the first growing season, and agree with the work of Ponder et al. (11).

The absence of differences in root and shoot dry weights, percent survival, and visual rating between hollies receiving surface applied and injected N applications demonstrates that injection of fertilizer into a trickle irrigation system can

Table 2. Effects of method of N application and rate on percent survival and visual rating of 'Compacta' Japanese holly.

Treatment	% Survival							Visual rating[z]	
	1982			1983					
	July 15	Aug. 31	Oct. 19	June 19	July 18	Sept. 23	Oct. 17	1982	1983
Method of application									
Surface applied/no irrigation	95.8a[y]	94.8a	76.0b	71.9b	71.9b	70.8b	62.5b	3.8b	3.6b
Surface applied/irrigation	100.0a	100.0a	100.0a	100.0a	100.0a	97.9a	97.9a	7.4b	7.2a
Injected/irrigation	99.0a	97.9a	97.9a	97.9a	97.9a	97.9a	97.9a	7.3a	7.9a
N rate (kg ha⁻¹)									
34	93.7[x]	93.7	91.7	91.7	91.7	91.7	87.5	6.3	6.2
67	100.0	97.9	93.8	87.5	87.5	87.5	79.2	6.2	7.3
134	97.9	97.9	81.2	81.2	81.2	81.2	81.2	6.1	6.2
268	100.0	100.0	83.3	83.3	83.3	81.2	81.2	6.2	5.6

[z]Visual rating on a scale of 1 to 8 where 1 is dead and 8 is green foliage with excellent growth.

[y]Treatment means within each column followed by the same letter or letters are not significantly different at the 5% level as determined by Duncan's new multiple range test.

[x]There was no significant effect as a result of N rate or method of application × N rate as determined by F-test.

produce quality plants while minimizing water and fertilizer usage, and reducing labor compared to conventional field nursery practices.

Foliar nutrient content was similar for all hollies regardless of method of N application (data not shown). Foliar N levels increased in the hollies with increasing N application rates (data not shown). Foliar N levels were in the sufficiency range for all N rates (5). Increasing N rate did not increase plant quality indicating current N recommendations for the production of nursery crops may be too high. This agrees with work by Coston et al. (3) on peaches where ½ the recommended N rate produced similar yields to higher rates.

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