

Propagation and Irrigation Regime Affect the Development of Catnip

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Abstract

Historically, catnip (*Nepeta cataria*) has been used as a cat toy filler and medicinal tea, but recent research has shown catnip was 10 times more effective at repelling mosquitoes than the compound used in most commercial bug repellents. We determined propagation strategies and irrigation regimes for the production of catnip. Adventitious root formation and the subsequent development of rooted cuttings were determined for terminal and single-node cuttings of catnip treated with indole-3-butyric acid (IBA) and rooted and grown for different time intervals. After eight-week production period and averaged over all IBA treatments, terminal cuttings propagated for 2 or 3 weeks had more dry weight (DW) allocated to shoots than roots compared to cuttings propagated for 4 weeks. Single-node cuttings propagated for two or three weeks had more and longer roots than those propagated for three weeks. Also, we determined whether irrigating plants every 2, 5, and 10 d for 12 weeks influenced physiological, anatomical, and growth traits of catnip. Plants irrigated every 10 d had the lowest root and shoot DW which averaged 142 and 19 g/plant, respectively. Plants irrigated every 10 d had the lowest leaf area (934 cm²), while leaves watered every 2 and 5 d had the thickest leaves. In another experiment, plants were irrigated every 2, 5, and 10 d for 6 weeks. Stomatal conductance of plants irrigated every 10 days was reduced to as little as 82 % of plants watered every 2 d. Biomass production was similar in plants watered every 2 or 5 d. In conclusion, irrigating catnip every 10 d reduces dry mass, but irrigating every 5 d might conserve water without compromising biomass production.

INTRODUCTION

Currently, catnip (*Nepeta cataria*) is propagated mainly from seed. This propagation method is a challenge because catnip seeds are small and difficult to handle, seed germination rates average only 50 %, and it requires at least three months for successful field establishment of transplants (Hockman et al., 2001). Thus, additional propagation techniques, such as rooting of stem cuttings need to be evaluated for catnip.

Besides the lack of information on rooting stem cuttings, there also is limited information about the impacts of irrigation regime biomass yield, growth, and physiology of catnip. Previous horticultural research on catnip has focused on ways to optimize biomass yields under nonstressed conditions (Butterfield, 1997), but not on its response to environmental factors.

Traditionally, catnip has been used as a cat toy filler and herbal tea (Ferguson et al., 1988). Recently, nepetalactones found in catnip was 10 times more effective at repelling mosquitoes than DEET (*N,N*-diethyl-3-methylbenzamide) the compound used in most mosquito repellents (Peterson et al., 2002). Catnip is becoming increasingly popular as a specialty field-grown crop (Butterfield, 1997).

The objectives of this research were to 1) evaluate rooting and subsequent development rooted cuttings, and 2) compare development of catnip plants irrigated every two, five or 10 days.

MATERIALS AND METHODS

Propagation Experiments

In the first experiment, terminal cuttings (9 cm long and 0.3 cm thick) were selected from greenhouse-grown catnip plants. Proximal ends were treated with 0, 1000, 3000 or 8000 mg kg⁻¹ IBA (0, 1000, 3000, or 8000 ppm) (distilled water, Hormodin® #1, #2, or #3; E.C. Geiger, Harleysville, PA) in the talc form. Using a completely randomized design, 28 cuttings in each of four IBA treatments were inserted in plastic flats (Dyna-flat, A. H. Hummert, Earth City, Missouri) filled with Metromix 360, (Scotts-Sierra, Marysville, Ohio) and misted for 10 sec every 7 min in a mist chamber.

Rooting and the development of seven cuttings in each IBA treatment were assessed nondestructively after two, three, and four weeks in the mist chamber. Immediately after measurement, each rooted cutting was repotted singly into #1 plastic pots filled with Metromix 360 (Scotts-Sierra) and allowed to continue growth in a greenhouse. Plants were irrigated as needed and fertilized weekly with 150 ppm N. At four weeks, both nondestructive and destructive methods were used to assess rooting and plant development of the remaining seven cuttings in each of the four IBA treatments.

Eight weeks after cuttings were first placed in the mist chamber, four plants (out of seven) from each IBA/week combination were harvested randomly. This harvest resulted in plants that were in the greenhouse for six, five, and four weeks after having been propagated for two, three, and four weeks, respectively. Dry weights of roots, stems, and leaves and leaf areas were determined.

A second experiment was started using similar experimental procedures as the first study. However, subterminal, single-node cuttings were used. Secondly, cuttings and rooting and plant development were determined one, two, and three weeks after cuttings were placed in the mist bench.

Irrigation Experiments

In one experiment, nine 3L, greenhouse-grown plants of catnip were watered by using three irrigation schedules: irrigated every two, five, or 10 days. After 12 weeks of irrigation treatment, all plants were destructively harvested. Total lamina area of five plants in each treatment was determined. Leaf discs were taken from five plants and processed for light microscopy. Oven dry weights of stems, leaves, and roots were determined.

In the second irrigation experiment, plants were irrigated every two, five, or 10 days for six weeks. For the first four weeks of the experiment, plant stomatal conductance was measured every 5 days with a LI-COR steady state porometer (LI-1600, LI-COR, Lincoln, Nebraska) two hours (midday) before plants were irrigated. All plants were destructively harvested at the end of six weeks. For both experiments, the experimental design was a completely randomized design with nine replications in each of three moisture regimes.

RESULTS AND DISCUSSION

Propagation Experiments

Regardless of the concentration of IBA, terminal cuttings rooted for four weeks had longer shoots (Fig. 1A) and roots (Fig. 1B), and less shoot dry weight (Fig. 1C) than cuttings propagated for two or three weeks. Extended periods in the low radiation levels of mist will reduce carbohydrate synthesis and this might have contributed to reduced biomass production in cuttings rooted for four weeks. Cuttings rooted for four weeks and allowed to grow in the greenhouse for four weeks had less biomass partitioned into shoots than those propagated for two or three weeks and allowed to grow for six and five weeks, respectively (Fig. 1D). Cuttings rooted for four weeks and treated with 3000 mg kg⁻¹ IBA had the most root dry weight (Fig. 2). While root biomass may not be part of the economically important yield, a relatively large root mass would help to maintain long-term growth (Smalley and Dirr, 1987).

Single-node cuttings propagated for two or three weeks had more and longer roots

than those propagated for one week (Table 1). The length of the longest primary root was longer in cuttings that received IBA (Table 1). Root to shoot dry weight ratio was lowest in cuttings propagated for one or two weeks and grown in the greenhouse for seven or six weeks, respectively (Table 1). The lower allocation of biomass to roots in single-node cuttings propagated for one or two weeks suggests that nursery producers could consider propagating plants for one or two weeks if shoot dry mass production is the objective. Cuttings treated with 8000 mg kg⁻¹ IBA had the most dry mass partitioned into roots (Table 1).

Irrigation Experiments

In the first irrigation experiment, root dry weight (Fig. 3A), shoot dry weight (Fig. 3B), and total leaf area (Fig. 3C) were lowest in plants irrigated every 10 days. This suggests that plants irrigated every 10 days accumulated the least dry mass. Catnip essential oils are extracted from leaves, stems, and flowers (Chalchat and Lamy, 1997). Irrigation treatments that do not curtail above-ground dry mass production could be advantageous for essential oil production. Plants irrigated every 10 days had the thinnest leaves (Fig. 3D), and irrigation treatment did not affect specific leaf weight (data not shown). Taken together, these data suggest that irrigating plants every 10 days might have caused a decrease in cell size while maintaining the density of the cellular contents.

In the second experiment, stomatal conductance of plants irrigated every 10 days was reduced to as little as 82 % of plants watered every two days (Fig. 4). Stomatal closure under short-term drought might allow the plant to maintain turgor and conserve moisture. However, prolonged stomatal closure curtails CO₂ uptake and thus reduces dry matter production (Jones, 1998). This can be surmised by our data which indicated that although plants irrigated every 2 or 5 days had similar biomass (264 and 298 g, respectively; Least Significant Difference= 7), this dry matter production was less than that of plants watered every 10 days (194 g).

CONCLUSION

Within the eight-week production period, terminal cuttings of catnip propagated for two or three weeks and grown for six or five weeks, respectively, accumulated more shoot dry weight than cuttings rooted for four weeks and grown for four weeks. Catnip growers might value this result when using terminal cuttings to propagate the plants because the economic yield of the plants is obtained from shoots and flowers. If single-node cuttings are the propagule of choice, then nursery producers could maximize shoot biomass accumulation by rooting cuttings for one or two weeks instead of three weeks.

While irrigating catnip plants every 10 days clearly reduced dry matter accumulation, plants receiving water every 2 or 5 days had similar dry matter production. This result might be significant to catnip producers growing the plant on a restricted water budget. Irrigating plants every 5 days might conserve water resources without reducing the economic yield of the plant.

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Tables

Table 1. Rooting and developmental traits of single-node cuttings treated with IBA, rooted and allow to grow for different intervals but harvested at 8 weeks.

Rooting and growth traits	Weeks of Propagation ¹			IBA (mg kg ⁻¹)			
	1	2	3	0	1000	3000	8000
Number of primary roots	5a ²	24b	18b	5a	14ab	18b	34c
Length of longest primary root (cm)	1a	6b	7b	3a	5b	5b	5b
Root to shoot dry weight ratio	0.2a	0.2a	0.4b	0.2a	0.2a	0.2a	0.3a

¹ Cuttings propagated for 1, 2, or 3 weeks grew in the greenhouse for 7, 6, and 5 weeks, respectively.

² Within each row for weeks of propagation or IBA level, numbers with a letter in common are not significantly different at p=0.05 %.

Figures

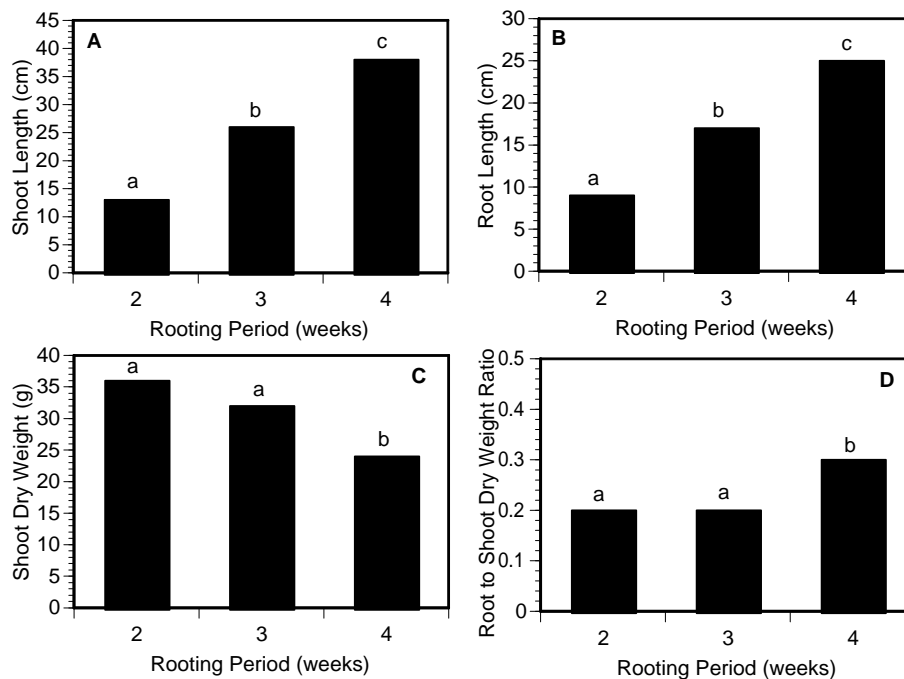


Fig. 1. Influence of propagation time on (A) length of the longest shoot (shoot length), (B) root length (length of the longest root), (C) shoot dry weight, and (D) root to shoot dry weight ratio on catnip terminal cuttings. There was no interaction between propagation time and IBA for these parameters. Columns with the same letter are not significantly different at $p=0.05$ %.

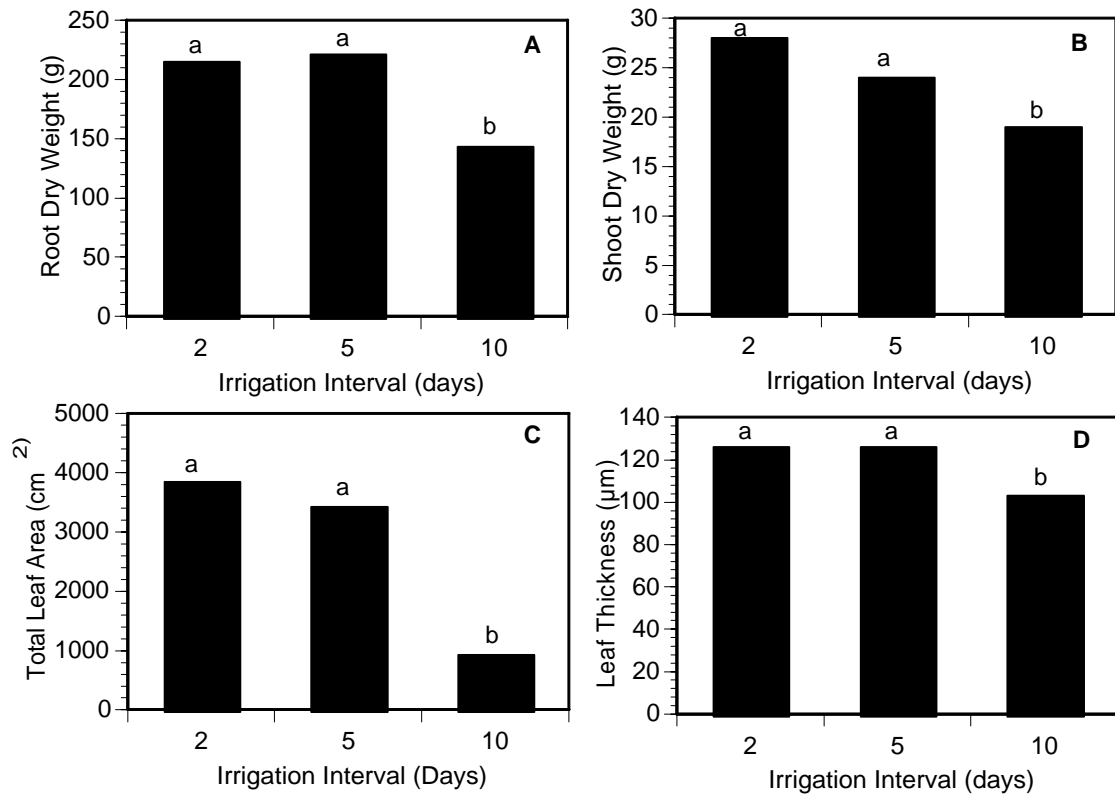


Fig. 2. Root dry weight of terminal cuttings of catnip in response to propagation period and concentration of IBA. Columns with the same letter are not significantly different at $p=0.05$ %.

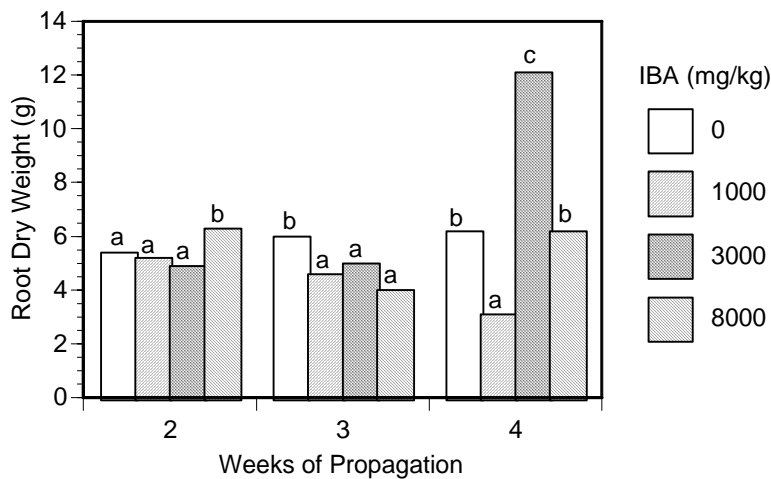


Fig. 3. Root dry weight (A), shoot dry weight (B), average total leaf area per plant (C), and average leaf thickness of catnip plants irrigated every 2, 5, or 10 days. Columns with the same letter are not significantly different at $p=0.05$ %

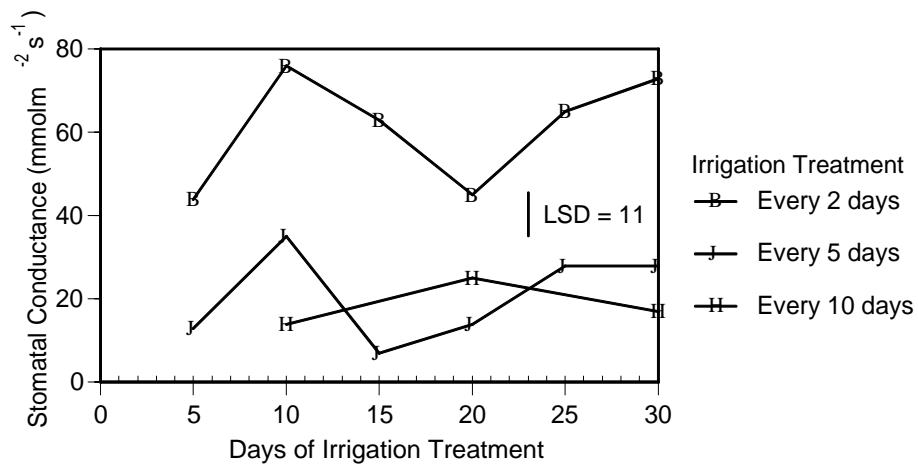


Fig. 4. Stomatal conductance of catnip plants irrigated every 2, 5, or 10 days. Each point represents the mean of 5 values.