

Seedling geranium response to nitrogen deprivation and subsequent recovery in hydroponic culture

Nitrogen (N) fertilization recommendations to achieve optimum growth are well established for many floriculture crops. Although it has been shown that plant functions can recover from N deficiency in other crops, little research has investigated the threshold beyond which a bedding plant crop is recoverable. The objective of this research was to determine the effect of N deficiency on geranium chlorophyll content and growth and then to document the degree of recovery and recovery time from N deprivation. This was determined in two experiments by monitoring chlorophyll content and growth of seedlings grown in hydroponic culture in which the N source was removed and then restored after differing lengths of time. Summarizing across both experiments, chlorophyll and

foliar N levels were shown to rebound quickly after N deprivation; however, growth was reduced after just 4 days compared with plants fed constantly. Geraniums grown without N for 4 to 12 days resulted in smaller, more compact plants with lower shoot-to-root ratios. Although foliar chlorophyll and N concentration recovered from longer periods in N growth solution, geranium growth was reduced and failed to completely recover for any plant receiving more than 2 days of N-free solution.



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Table 1. Foliar nitrogen, shoot and root mass, and shoot:root ratio of geranium plants grown in N deficient conditions for different lengths of time and recovered for up to 33 days.

Days N withheld	Foliar nitrogen (%)	Shoot mass (g)	Root mass (g)	Shoot:root ratio
0-control	4.32	1.35	0.22	6.4
2	4.46	1.38	0.21	6.8
4	4.37	1.11 ^{*y}	0.16 [*]	7.2
6	4.43	1.06 [*]	0.16 [*]	7.0
8	4.33	1.25	0.20	6.5
10	4.33	1.03 [*]	0.17 [*]	6.0
12	4.43	0.84 [*]	0.14 [*]	6.2
14	4.28	0.88 [*]	0.16 [*]	5.8
16	4.23	0.80 [*]	0.16 [*]	5.3 [*]
18	4.27	0.61 [*]	0.13 [*]	4.7 [*]
20	3.89 [*]	0.53 [*]	0.12 [*]	4.5 [*]
22	3.90 [*]	0.54 [*]	0.14 [*]	4.2 [*]
24	3.74 [*]	0.44 [*]	0.12 [*]	3.6 [*]
26	3.15 [*]	0.44 [*]	0.12 [*]	3.6 [*]

^xPlants were grown for 7 d with full nutrient solution with 7.5 mM N and then N was withheld for 0 to 26 d, after which selected buckets (n = 6) were returned to full nutrient solution. All plants were harvested and data collected 33 d after initiation of N-free solutions.

^yAsterisk indicates mean is significantly lower than control plants by Dunnett's one-tailed *t* test.

Table 2. Non-destructive estimation of chlorophyll content of geranium plants grown in N deficient conditions for different lengths of time and recovered for up to 33 days.

Days N withheld	SPAD readings 4 to 32 d after treatment ^y							
	4	8	12	16	20	24	28	32
0-control	34.0	33.7	33.4	34.8	41.2	42.4	46.0	44.0
2	33.5	32.0	33.4	37.0	40.6	41.6	45.6	46.5
4		30.3 ^{**}	33.8	34.9	40.2	42.3	44.0	42.5
8			26.6 [*]	34.8	41.7	42.4	42.9	41.1
12				24.7 [*]	37.6 [*]	41.5	43.9	41.1
16					26.6 [*]	39.8	43.0	41.6
20						27.5 [*]	39.4 [*]	40.0 [*]
24							25.4 [*]	34.4 [*]
28								24.6 [*]
Plants in 0 N solution ^w	33.0	31.3 [*]	31.1 [*]	29.4 [*]	27.5 [*]	26.1 [*]	24.3 [*]	

^xPlants were initially grown for 7 d in full nutrient solution with 7.5 mM nitrogen (N) and then N was withheld for 0 to 26 d. Periodically, selected buckets (n = 6) were returned to the full N solution. All plants were harvested 32 d after initiating N-free solutions.

^yExperiment was initiated when non-control plants were switched to N-deficient solution.

^{*}Asterisk indicates mean is significantly lower than control plants by Dunnett's one-tailed *t* test.

^wMeans for plants growing in N-deficient solution were pooled, regardless of their randomly assigned treatment day.