Proc. Fla. State Hort. Soc. 102:346-348. 1989.

NITROGEN NUTRITION OF CABBAGE SEEDLINGS GROWN IN A PINE BARK MEDIUM IN POLYSTYRENE TRAYS

G. J. WRIGHT
University of Florida, IFAS
Ornamental Horticulture Department
Gainesville, FL 32611

I. E. SMITH
Department Horticultural Science
University of Natal
Pietermaritzburg, South Africa

Additional index words. Cabbage, *Brasica oleracea* var. *capitata*, pine bark, nutrition.

Abstract. **Cabbage seeds (*Brassica oleracea* var. *capitata* f. *alba* 'Green Coronet') were sown in a composted pine bark medium to which different forms of N had been added at different rates as a pre-enrichment application. After germination, the seedlings were supplied with a nutrient solution containing different concentrations of N ranging from 0 to 200 mg liter^{-1} to test whether nutrient solutions were necessary in addition to the pre-enrichment N sources. Germination percentage was severely inhibited by high levels of urea pre-enrichment. Pre-enrichment alone did not supply sufficient N to meet the demands of the seedlings and as a result, the solution N concentration was found to be important in determining the growth rate and quality of the seedlings. Optimum results were obtained using a pre-enrichment of 300-600 g N m^{-3} and a solution N concentration of 50-70 mg N liter^{-1}.**

Vegetable, ornamental and tree seedling production in South Africa is primarily based on a compartmentalized polystyrene tray system (Speedling). Increasing costs of imported peat for use as a component for seedling growing media, and a lack of good quality local deposits, have increased the emphasis on alternative components for seedling media. A large timber industry has provided the necessary raw materials for the development of composted, milled pine bark as a suitable growing medium.

While the importance of medium preparation must be stressed, the correct choice of fertilizers, application rates, and timing are of critical importance in the production of healthy seedlings. Initially the practice involved the application of a dilute liquid fertilization containing low concentrations of all elements required by the plants for healthy growth. Calcium, Mg and micronutrients were then added to the bark prior to planting and supplemented with a dilute application of N, P and K. Hiron and Symonds (1) have shown that it is possible to supply the total P requirement as a pre-enrichment, with manipulation of the growth by the application of N and K in a nutrient solution. Roberts (2) and Wright (3) have shown that composted pine bark may supply the total plant K requirement for cucumbers and cabbage seedlings, respectively.

The aim of this research was to establish whether or not it was possible to supple sufficient N in the form of pre-enrichment, or whether a supplemental dilute feed was necessary to supply seedlings with their total N requirement.

Florida Agricultural Experiment Station Journal No. 00118. This research was financed by the organic waste program of the CSIR, Pretoria, South Africa; the South African Pulp and Paper Industry, and the Seedling Growers Association of South Africa. Growing medium was supplied by Gromed, Cramond, Natal.

Materials and Methods

Cabbage seedlings were grown in 128 cavity polystyrene seedling trays under 25% shade cloth. The cavities were inverted pyramids 30 mm square at the top and 60 mm deep. Each tray was divided into quarters each with 8x4 cavities. These 32 units constituted a plot with the outer row serving as a border row and the inner 2x6 plants used for data.

A commercially available medium was used from a local source consisting of a mixture of bark from *Pinus patula*, *P. elliottii* and *P. taeda*. The medium was prepared by first milling through a 25 mm screen in a tub grinder and then composted with 5 kg urea m^{-3} with regular turning for aeration, until the temperature had stablized after roughly 30 days. The bark was then sieved through a 10 mm screen giving the final product.

The medium was pre-enriched with 1327 g single superphosphate, 4000 g dolomitic limestone, 500 g K_2SO_4, 300 g micronutrient mix (FRIT 504) and 300 g $FeSO_4$ per cubic meter. In addition to this calcitic limestone and Mg as MgO were added to ensure the correct totals of these elements.

The experimental design used was a 6x3x5 split plot factorial. The N pre-enrichment rates were 0, 150, 300, 600, 1200 and 2400 g N m^{-3} from 3 N sources, $Ca(NO_3)_2$, LAN (limestone ammomium nitrate) and urea, constituting the sub-plot factor. Superimposed on this were 5 rates of dilute N feed (0, 25, 50, 100, and 200 mg N liter^{-1}) with a constant concentration of 25 mg P liter^{-1} and 150 mg K liter^{-1}. The rates of dilute application were the whole plot factor. This resulted in a total of 90 treatment combinations with 2 replications. Twelve plants from each replication were used as data plants. The nutrient solutions were stored in 80 liter containers and were applied by hand 3 times daily.

Seeds were sown into the medium on 5 June 1986 and grown until 14 July when the best treatments were considered ready for transplanting. At this stage the seedlings were removed from the trays and data collected. The shoot portion was dried and analyzed for macro-elements. Samples of the growing medium were stored in plastic bags and analyzed 6 weeks later using a 1:1 media:water extract.

Results and Discussion

As would be expected from the treatments, ranging from zero N for the entire growth period to 2400 g N m^{-3} with 200 mg N liter^{-1}, a dramatic difference in growth response was noted.

Germination percentage. The highest rate of urea (2400 g N m^{-3}) used in a pre-enrichment prevented any germination from occurring, while 1200 g N m^{-3} reduced the germination percentage to 70%. No significant reduction in germination percentage was noted with LAN or $Ca(NO_3)_2$.

Top fresh mass increased linearly with solution concentration (Fig. 1). It must be noted that the largest seedlings may not be the most desired. Evaluation by growers indicated an optimum mass of 3.2 g, obtained using a liquid application of approximately 100 mg N $liter^{-1}$ or pre-enrichment of 450 g N m^{-3} and an application of 60 mg N $liter^{-1}$. The latter treatment combination would be most cost effective. Pre-enrichment levels did influence plant mass although not to the same degree as the solution application. Optimum was found to be 600 g N m^{-3}. Urea produced the highest mean plant mass, followed by LAN and $Ca(NO_3)_2$.

Percentage moisture content in the upper plant portion increased from 80.5% to 92% as rates of N in the dilute feed rose from 0 to 200 mg N $liter^{-1}$ (Table 1).

Dry root mass. Increasing concentrations of N in the liquid led to a quadratic response, while for pre-enrichment a negative linear trend was detected. Root to shoot ratio decreased signifcantly with increasing solution concentration (Table 1).

Substrate analysis. a) Calcium nitrate. Electrical conductivity of the medium increased linearly with increasing N pre-enrichment. The NO_3^- N concentration, however, remained relatively low while the concentration of NH_4^+ N increased with increasing pre-enrichment. The levels of Na, Mg and Ca also increased.

b) LAN. Trends similar to $Ca(NO_3)_2$ were evident with an increase in all cations including the NH_4^+, while a relatively low level of NO_3^- was recorded. Once again the NH_4^+ was the major contributin ion in the increase in the EC.

c) Urea. Increased cation concentration with the major contributing ion being the NH_4^+ cation. Ca and Mg levels increased with increased N pre-enrichment.

Plant analysis. Plant N content showed a strong positive correlation with increased rate of dilute N application, while pre-enrichment level appeared to have little effect on plant N content (Fig. 2).

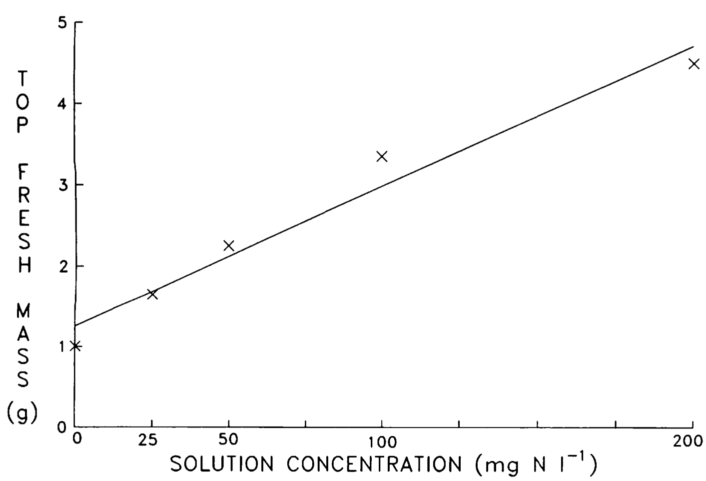

Fig. 1. Effect of increasing concentrations of N in the dilute nutrient solution on cabbage seedling fresh mass.

Table 1. The effects of increasing rates of dilute N appliccation on the % moisture in the upper plant portion, and the root to shoot ratio.

N concn (mg $liter^{-1}$)	Moisture (%)	*Root:Shoot*
0	80.63	1:22.0
25	84.69	1:21.6
50	86.37	1:19.2
100	89.89	1:17.4
200	91.97	1:13.2

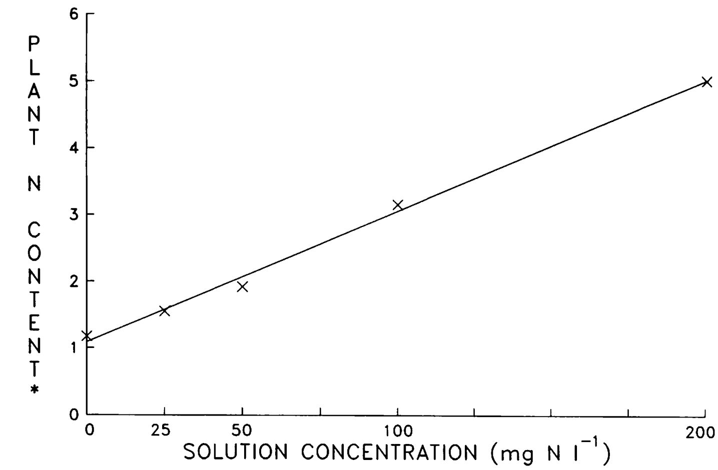

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Fig. 2. Effect of increasing concentrations of N in the dilute nutrient solution on the N content of cabbage seedlings.

There was a significant positive correlation between the N and P content of the seedlings. While the amount of P supplied to the plant was constant, an increase in plant N uptake resulted in a simultaneous increase in P uptake (Fig. 3). Rates of N fertilization appeared to have little effect on plant K levels.

Nitrogen, although supplied in relatively large quantities in the form of pre-enrichment, did not appear to remain available to the plant. Nitrogen is known to leach rapidly from bark media as well as the drain created by microbes and the complexing of the N to the bark itself. This reduces N availibility to plants which only receive a

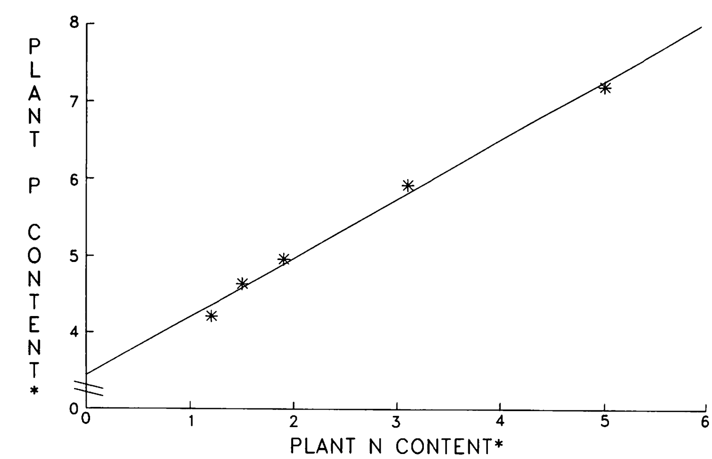

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Fig. 3. Correlation between increasing concentrations of N in the cabbage seedlings and coprresponding increases in P content.

pre-enrichment, and hence necessitates the application of a dilute nutrient solution.

The solution itself appeared to be the controlling factor, far more so than the rate of pre-enrichment applied. The highest rate of N supplied as a pre-enrichment was not sufficient to meet the plants needs. It was essential to gauge the seedling's N requirements in order to correctly supply the required N without supplying excessive quantities leading to waste and the production of soft seedlings.

The actual N source used was important. Seedlings which were grown with 450 g N m^{-3} with urea pre-enrichment and a dilute feed of 75 mg N $liter^{-1}$ had a good overall shape and a thick stem which allowed the plants to hold themselves upright in the field following transplanting. Ammonium may play an important role in the medium. The possibility exists that some form of ionic substitution on the bark complex occurs with the subsequent release of other cations, increasing the demand for N, whether supplied by pre-enrichment or dilute nutrient solutions.

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Proc. Fla. State Hort. Soc. 102:348-351. 1989.

EFFECT OF CONTROLLED (SLOW) RELEASE NITROGEN SOURCES ON TOMATO, *LYCOPERSICON ESCULENTUM* MILL. CV. SOLAR SET

A. A. CSIZINSZKY
IFAS, University of Florida
Gulf Coast Research & Education Center
Bradenton, FL 34203

Additional index words. isobutylidene diurea, methylene urea, oxamide, sulfur coated urea, full-bed mulch.

Abstract. **Several slow-release N fertilizer sources were evaluated for their effect on tomato, *Lycopersicon esculentum* Mill. cv. Solar Set, yields in 1989 spring. Isobutylidene diurea (IBDU), methylene urea (MU), oxamide (OA), and sulfur coated urea (SCU) N sources, alone or in combination, were applied pre-plant in polyethylene mulched beds. Early and total fruit yields were similar with slow-release-N and with a 70% NO_3-N:30% NH_4-N treatment. Nitrogen concentrations in leaves and in fruits and the proportion of cull fruits and fruits with blossom-end rot (BER) were similar with all N-sources. Post-harvest soil NO_3-N concentrations were highest with the 25% IBDU:75% SCU at 60 ppm, and with the 100% MU treatments at 51 ppm, and lowest with the 75% OA:25% MU, 13 ppm, 50% MU:50% IBDU, 14 ppm, and with the 25% OA:75% MU, 18 ppm, treatments. The post-harvest concentrations of soil NH_4-N were similar with all N-treatments.**

Slow-release (or controlled release) N sources have been developed to overcome the problems of N loss from soil due to leaching, volatilization and nitrification when soluble N-source is applied for te crop (1, 8, 10). In earlier studies on the effect of slow-release N sources on vegetables, yields were comparable with slow-release and with soluble N sources. Lorenz et al. (6) reported similar tomato yields with $(NH_4)_2SO_4$ and urea-N sources and lower yields with urea-formaldehyde-N (Nitroform). The researchers attributed the lower tomato yields with the urea-formaldehyde-N to the slow rate of N-mineralization compared with N availability from $(NH_4)_2SO_4$ and from urea. In Florida, Locascio et al. reported higher early and total yields of extra large size tomatoes with 66% NO_3-N + 33% NH_4-N source than with 100% IBDU or combinations of IBDU with SCU (5). Marketable yields for all fruit sizes were similar with the 2 N sources. Also in Florida, Graetz et al. (4) found higher marketable tomato yields with NH_4NO_3 than with 50% SCU:50% NH_4NO_3-N source. In Texas, bell pepper and cantaloupe yields were similar with soluble N, methylene-urea (MU) and with SCU fertilizers (11). Soil N concentrations, however, remained high for 20 weeks in the 0 to 6 inch soil depth which indicated slow N transformation from the SCU N source. In Maryland on sandy loam, a combination of 75% SCU with 25% AN provided no additional yield benefit over 100% AN fertilizer for processing tomatoes (6). In trickle-irrigated cauliflower, Csizinszky and Stanley (3) reported reduced yields when 15% of the total N was provided from a pre-plant applied IBDU source compared with a 100% NO_3-N source.

The study reported here was conducted to evaluate several controlled-release N sources for polyethylene mulched fresh-market tomato.

Florida Agricultural Experiment Station Journal Series No. N-00119.

Materials and Methods

Studies were conducted during the spring (Mar.-June) of 1989 at the Gulf Coast Research and Education Center on an EauGallie fine sand (sandy, silicaceous hypothermic Alfic haplaquod). Six raised beds, each 32 inches wide and 9 inches high, were formed on 5 ft centers between irrigation furrows 40.5 ft apart. Soil tests prior to land preparation indicated low concentrations of available plant nutrients, except for Ca and Mg. Nitrogen, from sources listed on Table 1, was applied at 305 lb./acre (1 acre = 8712 linear bed ft) in 3-inch deep and 2-inch wide furrows formed 12 inches from the bed center on each half of the bed, then covered with soil. The 34-ft long N treatment plots were arranged in a randomized complete block de-