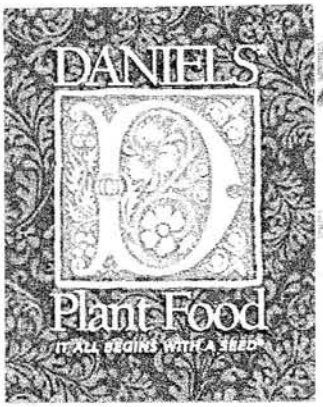


Daniels® Plant Food for The Professional Grower

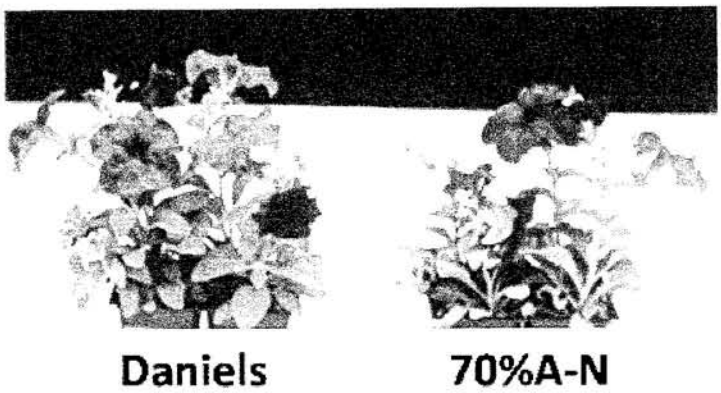
By: Paul Nelson, Carl Niedziela, and Dharma Pitchay

Daniels Plant Food, a complete liquid fertilizer with a $10N:4P_2O_5:3K_2O$ analysis, was introduced by Agrotech (Sherman, TX) and is now manufactured and marketed by D P Foods, LLC (Sherman, TX). The technology for producing Daniels soybean-base liquid fertilizer was developed in 1982 by Ralph Daniels. Beginning in 1986, grower and university trials were conducted on cut flowers, perennials, woody ornamentals, bedding plants, and potted flowering plants as well as fruit and vegetable plants. Marketing of the product began in 1996. The American Association of Plant Food Control Officials (AAPFCO) recognized "oilseed-extract", the base for Daniels Plant Food, as a source of plant nutrients in 1998.

Although Daniels Plant Food is not classified as an organic fertilizer, it does contain sufficient biodegradable carbon to give it organic properties. The base for this fertilizer is produced from soybean seed (Daniels, 1996). After roasting and crushing, oils are extracted from the seeds to yield a crude oil. Following this process, additional oils are extracted using potassium hydroxide or sodium hydroxide to yield high value cooking (edible) oil. The remaining material is divided into two fractions, solid material containing fiber and protein used for animal feed and oilseed-extract. Oilseed-extract is the water soluble portion of the seeds. It contains minerals and water soluble compounds such as amino acids, organic acids, and sugars. Unless converted to fertilizer, oilseed-extract constitutes a disposal challenge requiring waste treatment to eliminate carbon and lower N content and ultimate discharge of remaining minerals, particularly phosphorus, into the environment.

For fertilizer production purposes, potassium hydroxide, rather than sodium hydroxide, is used for oil extraction from the seeds and additional inorganic nutrients are added to the resulting oilseed-extract to bring it to the guaranteed analysis of Daniels Plant Food. Its final nitrogen (N) composition includes 3.70% ammoniacal-N (A-N), 1.90% nitrate-N, 3.65% urea-N and 0.75% organic-N for a total of 81% of the N in the reduced forms of ammonium, urea, and organic N. This fertilizer could also be produced from other types of oilseeds such as sunflower, corn, and canola. An estimated 325,000 metric tons of oilseed-extract are available in the United States per year (Daniels, R., D P Foods, LLC, Sherman, TX, personal communication). In addition to relieving the environmental burden caused by discharge of nutrients from oilseed-extract, less phosphate and K minerals would be mined from world reserves and less natural gas burned to produce ammonia, the base N stock in fertilizers.

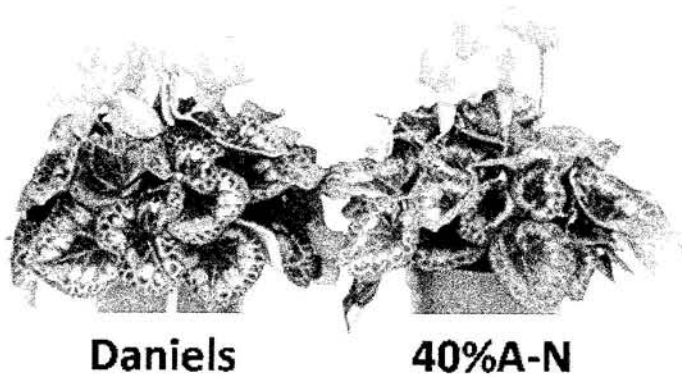
When we were first asked to test this nutrient source, three issues caused us to hesitate. Could its sole, unusual 10:4:3 analysis meet the nutritional requirements of crops in general? Would it supply adequate potassium (K) with its $10N:3K_2O$ ratio? And, would this fertilizer, which contains 81% of its N in reduced forms including ammonium, urea, and organic-nitrogen, result in ammonium toxicity? Although recent acceptance by commercial growers of this product suggested that these issues were not a problem, scientific verification was lacking. We conducted three experiments to examine our concerns. Conventional production materials and practices were used in each experiment unless noted.



'Dreams Midnight' fertigated with Daniels Plant Food and a 70% ammoniacal nitrogen fertilizer at 100 ppm.

In the first experiment, Petunia 'Dreams Midnight' was grown in bedding plant flats using three fertilizer formulations (Daniels, 40% A-N, and 70%A-N) at three constant fertilizer rates (50, 100, and 200 ppm). The 40%A-N fertilizer was the same as commercial 20-10-20 while the 70%A-N fertilizer differed from 20-10-20 only in its higher proportion of N (70%) in the ammoniacal form. Although plant size increased with increasing Daniels fertilization rate, the visual quality rating was highest at 100 ppm N. Adverse plant size for the available plant container space and etiolated stems on the larger plants which did not adequately support those plants occurred at 200 ppm N. Number of days to flower was lowest at 100 and 200 ppm N. Taking into consideration all of the variables measured, the best rate of application for Daniels fertilizer was 100 ppm N.

Plants fertilized at 50 ppm N were lighter green and smaller than desired regardless of fertilizer type. Within this 50 ppm N group, plants fertilized with Daniels were deeper green, taller, rated higher, and flowered earlier than those fertilized with the other two sources. Within the 100 ppm N group, the Daniels fertilized plants flowered in 4.5% less time than plants fertilized with the 40%A-N formulation and rated higher than the other two treatments. Plants in the 200 ppm N group grew too large for the container, resulting in thin stems and a problem with plant toppling. No differences occurred in plant size or days to flower across fertilizer types. Ratings were best for Daniels and 70%A-N fertilized plants. Across all fertilizer types and rates, the most commercially desirable plants were those fertilized with 100 ppm N from Daniels fertilizer.



'Laser Rose' fertigated with Daniels Plant Food and a 40% ammoniacal nitrogen fertilizer.

In the second experiment, Cyclamen 'Laser Rose' were grown in 5.5 inch pots, one plant per pot. Cyclamen was selected as the test crop because it has been reported to have one of the highest K requirements of greenhouse crops with a 1N:2K_2O ratio recommended. Daniels and the 40%A-N fertilizers were applied with each irrigation. During the first six weeks, all fertilizers were applied at an N rate of 126 ppm. After six weeks, the two fertilizers were increased to an N rate of 175 ppm, as is customary in commercial practice. Growth in the forms of canopy height, flower height above the canopy, plant diameter, plant fresh weight, corm fresh weight, and numbers of shoots, leaves, and buds did not differ between Daniels and 40%A-N fertilizer. For these growth parameters Daniels fertilizer performance was equal to the commercial fertilizer (40%A-N).

Twelve weeks after potting, Daniels fertilized plants had an average of 9.7 open flowers compared to 6.6 flowers for the 40%A-N plants. This was an increase of 47% attributed to Daniels. The 47% increase in number of flowers in plants fertilized with Daniels at the same N concentrations as the inorganic 40%A-N would allow a grower to market a showier plant or market the plants about one week earlier than normal with the standard number of flowers.

In the third experiment, Dianthus 'Floral Lace', pansy 'Crystal Bowl Orange', petunia 'Dreams Red', salvia 'Victoria Blue', snapdragon 'Bell Mix', verbena 'Quartz Mix', and vinca ' Grape Cooler' plug seedlings were grown in bedding plant flats at two pH levels (standard and low) established using the standard and one-third of the standard lime rates. Three fertilizers (Daniels, 25%A-N, and 75% A-N) were applied during each irrigation at rates of 100 or 200 ppm N. Once again, the latter two fertilizers were based on the 20-10-20 formulation and differed only in the proportion of N in the ammoniacal form. Flowering was similar in the seven bedding plant species when fertilized with Daniels compared to the conventional fertilizers. Daniels fertilizer resulted in deeper green color in all species except dianthus where color was similar. Generally speaking, high ammonium 75%A-N treated plants were more compact (shorter and less leaf area) in all species except verbena where there was no difference from the low ammonium 25%A-N plants. Plants treated with Daniels were equivalent to 75%A-N treated plants in all comparisons except height in petunia where they were similar to the taller 25%A-N plants. The compact Daniels and 75%A-N plants were more desirable for the tight space constraints of bedding plant flats.

The potassium (K) content of Daniels was adequate to meet the requirements of the eight species tested across the three experiments, including cyclamen, which has one of the highest K requirements for greenhouse crops. No symptoms of K deficiency or suppression of growth occurred in plants treated with Daniels. Although leaf tissue K concentrations were lower than in plants treated with the conventional formulations, K levels were still above the minimum concentrations reported by Gipson et al. 2008. Nutrient Deficiencies in Bedding Plants. Ball Publishing, Batavia, Ill.

There was no ammonia toxicity in the first two experiments. In the third experiment, Daniels did not cause ammonium toxicity in any of the bedding plant species when applied at normal fertilizer rates (100 ppm) using the standard limestone rate (10 lbs/yd^3). When the Daniels rate applied to the seven bedding plant species was doubled to 200 ppm, ammonium toxicity still did not develop. However, when the lime rate was decreased to one-third (3.3 lbs/yd^3) resulting in excessively low substrate pH levels, a slight ammonium toxicity occurred in only one species (pansy) at both Daniels rates (100 and 200 ppm). The low ammonium 25%A-N fertilizer at low line rate caused slight symptoms in pansy and petunia while the high ammonium 75%A-N fertilizer caused moderate symptoms in dianthus, petunia, salvia, and snapdragon and heavy symptoms in pansy, verbena, and vinca. Although it was anticipated that applying Daniels under extreme conditions of high concentration and low substrate pH would lead to ammonium toxicity, for the most part this did not occur. This indicates that, unlike conventional fertilizers, Daniels is very resistant to ammonium toxicity.

The lack of ammonium toxicity from Daniels may be due to pH buffering capacity since high pH protects against ammonium toxicity. Daniels has 81% of the N in reduced form (ammonium, organic-N and urea) resulting in a potential acidity of 327. Consequently, we expected the pH in the Daniels treatments to be low as expected from the high ammoniacal fertilizers (70 and 75%A-N). Surprisingly, substrate pH in the Daniels treatments was buffered at a higher pH similar to or higher than that in the low ammoniacal fertilizers (25 and 40%A-N) in all but two species (verbena and vinca).

Substrate salt levels were 50-75% lower in plants treated with Daniels. Only when Daniels was applied at a N level double that of the conventional formulations, were the substrate salt levels equivalent. This is due to the high percentage of N in urea (36.5%) and organic-N (7.5%). Growers who normally use substrate EC as a guide for fertilization will need to factor in the lower EC of the Daniels.

When all experiments are taken into consideration, Daniels, compared to the 25%A-N and 40%A-N fertilizers, generally resulted in lower tissue concentrations of K, Ca, Mg, and Zn and a higher Fe concentration. Less frequently, P and Cu concentrations were found to be higher.

Daniels Plant Food proved to be a very effective fertilizer for seven species of bedding plants and cyclamen. Plants tended to be desirably more compact for most species while for the others, growth was similar to the conventional 20-10-20 fertilized plants. Plant color with Daniels was deeper green in all but two species. Earlier (more) flowers formed in petunia and cyclamen plants. Tissue K levels were lower but in all cases adequate. Ammonium toxicity was not a problem with Daniels. It was more resistant to ammonium toxicity than conventional fertilizers. Substrate EC levels were lower with Daniels. Daniels also provided substrate pH buffering against decline.

Daniels Plant Food is a 10-4-3 liquid formulation. When a 100:1 fertilizer proportioner draws fertilizer concentrate straight from the Daniels container, the resulting final concentration is 250 ppm N. Since this avoids any pre-dilution of the concentrate, the manufacturer recommends twice weekly applications of Daniels at 250 ppm N for bedding plants. Clear water should be used for Irrigations between fertilizer applications.

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