Colorado Flower Growers Association

IN COOPERATION WITH COLORADO A AND M COLLEGE

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Nutrition Control for Carnations

by W. D. Holley

Greenhouse crops are grown in soils with high fertility. It is our purpose in growing these crops to keep every environmental factor within our control at the absolute optimum. In spite of this high purpose we will slip up on occasion even though we may know better. This summary of carnation nutrition is presented with the thought of bringing together all the checks we have on carnation feeding. These are plant symptoms, optimum levels by soil tests and quantitative checks with known amounts of fertilizers required by healthy carnations.

Much has been written and spoken about feeding greenhouse plants. Even with all the information available, certain human frailties enter the picture at times when growing problems arise. Too often we are inclined to diagnose the cause of thin, weak plants as overfeeding or underfeeding when, if we study all the facts and possible causes, we can arrive at a much clearer diagnosis and solution.

Just one example should suffice. A grower's plants are thin and weak in January. His flowers are soft. Someone immediately blames him for overfeeding with nitrogen. Missed completely are the real causes. This plant condition is most often brought about by:

1. Higher than optimum night and dry temperatures.
2. The low light and short days of November and December.
3. An extremely heavy crop on his plants.
4. Poor soil aeration and an abundance of water, and
5. Inadequate soil nutrients.

It is probably never caused by overfeeding as such, without some or all the above contributing factors. To put it another way, if other environmental factors are kept optimum, overfeeding can only stunt or harden plants.

Let us examine the several essential plant nutrients and nutritional factors, summarizing what we know about them as we go.

Soil Aeration

Adequate soil aeration is the key to successful feeding and successful growing of any greenhouse crop. When a soil is irrigated most of the oxygen is driven out. When the soil is loose and porous, air is quickly replaced. If the soil is packed or its structure has melted, air comes back slowly. Even relatively dry soil in this condition may be poorly aerated.

An insufficient supply of oxygen in the soil causes death of roots. The more severe the oxygen deficit, the more roots are killed. Following loss of roots the tops of the plants become succeedingly thinner and wilt readily on sunny days. With more extreme cases of poor soil aeration and root loss, the tops become chlorotic and hard. Without adequate roots the plants cannot take in enough water or mineral nutrients.

Our first objective then in the proper feeding of all greenhouse crops should be to provide a porous, well aerated medium for the plant roots. There are several ways to work toward this kind of soil. Organic matter such as peat and plant residues is beneficial to soil structure, especially if it is applied in a partially rotted condition. The use of too much organic matter at one time can lead to trouble from poor aeration, since the water holding capacity of a soil is altered greatly by adding organic matter. Watering frequencies must be altered when organic matter is added.

In extreme cases of tight or melted soil structure, synthetic resins or soil conditioners may be necessary. The application of these chemicals is still much cheaper than changing the soil. When applied according to directions, usually before planting, a good soil structure can be insured for two or more years. Healthy carnation root growth following this treatment will do much to maintain the structure once it has been accomplished.

Nitrogen

There are a lot of misconceptions among greenhouse growers when nitrogen feeding is discussed. Many growers will say that overfeeding with nitrogen causes soft plants. Actually the reverse is most nearly true. As the amount of nitrogen available to plants is raised they become successively harder. With exceptionally high amounts the plants become chlorotic, with burned spots on the foliage.

A low nitrogen supply also hardens carnation plants. The leaves become thin and narrow and lose their curl. The development of side branches is retarded. The color of plants becomes dull to yellow-green. When such hungry plants are again fed adequate nitrogen the growth gradually becomes normal. The condition of "soft growth" or "soft flowers" as we think of them in the florist trade, is caused by poor light, higher than optimum temperatures or an over abundance of soil moisture, or a combination of these factors. High nitrogen will contribute to this "softness" only when the other major factors are not right for carnation growth.

Nitrogen is most often the limiting nutrient in greenhouse soils, since plants use relatively large amounts of this nutrient. Nitrogen is usually present in a water soluble form, hence is readily leached from the soil. Plants require water and nitrogen in direct relation to the amount of growth they make. Growth is pretty well determined by the amount of light available to the plants. Hence plants require nitrogen in direct relation to the amount of light (time of the year).

The yield and grade of William Sim carnations was best at nitrate levels from 40 to 100 ppm (Spurway). The work from which these results were taken was described in detail in Colo. Flower Growers Assn. Buls. 26 and 27. Since soil testing varies between systems and between individuals doing the testing knowing a quantitative amount of nitrogen required each year by actively growing carnations is of some help. In the previously mentioned experiments 3 to 4 pounds of actual nitrogen per 100 square feet per year gave the best yield and grade of carnations. To calculate the pounds of actual nitrogen being applied, multiply the pounds per 100 square feet by the percentage of actual nitrogen in the fertilizer being used. Nine to 12 pounds of ammonium nitrate (33%) should be adequate for carnations in Colorado. Heavy leaching during irrigation will increase this amount. Whether the fertilizer is applied dry or liquid makes little difference in the amount of nitrogen required. The source of nitrogen (kind of fertilizer used) probably is of little consequence either, so long as it does not contain toxic impurities. Price per pound of nitrogen and residue left by the fertilizer are the two most important considerations in buying nitrogen.

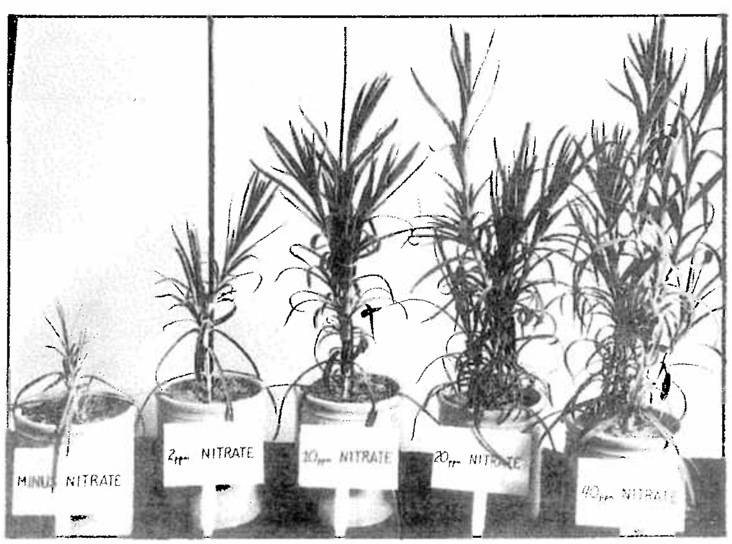

Fig. 1 - Response of carnations to different levels of nitrogen in sand culture.

Potassium

Carnation plants use potassium in amounts second only to nitrogen. When potassium is lacking, carnations become thin and weak. Lower foliage burns or ripens prematurely and necrotic spots appear in middle aged leaves. The top leaves under the flower are often scorched or have dead spots on them. The yield, grade and keeping quality of flowers is greatly reduced (Colo. Flower Growers Assn. Bul. 60). Excess potash in the soil causes similar foliar symptoms, especially premature ripening of the older foliage. Instead of thin plants, however, they are more often the opposite in appearance. Internodes are shortened and plants are hard.

The three principal potassium fertilizer sources are muriate of potash (potassium chloride) which contains 60% available potash, potassium sulfate (50% potash) and potassium nitrate which contains 44% potash as well as 13% nitrogen. Due to the cost potassium nitrate is used primarily in liquid fertilizer starter solutions. A normal dry application of any of these potash fertilizers is one pound per 100 square feet of bench area.

Quick tests for soil potassium are the least reliable of any tests now in use. If done carefully, they are still an excellent guide to potash fertilization. With Spurway's system of testing 25 to 40 ppm is an optimum level for carnations in Colorado. Hunger symptoms become apparent at 20 ppm or less with resulting detriment to quality and yield. As a quantitative check on these levels, $2\frac{1}{2}$ to 3 pounds of actual potash per 100 sq. ft. per year is the minimum required for actively growing carnations in Colorado. To calculate the actual potash (K_2O), multiply the pounds fertilizer applied per 100 sq. ft. by the percentage of potash in the fertilizer. In muriate of potash (KCl) this percentage is 60. In a complete fertilizer the percentage of potash is the third figure in the formula, i. e. in a 5-8-7 fertilizer there is 7% potash or 7 pounds per 100.

Fig. 2 - Potash hunger.

Phosphorus

Phosphorus is used in lesser quantities than either nitrogen or potassium, but it is no less essential. Due to the nature of phosphorus it is easily tied up or made non available to plants when the pH of the soil is highly alkaline. In extremely acid soils phosphorus may become so soluble that it is readily leached. The availability of phosphorus in greenhouse soils is not usually a problem, if adequate phosphate fertilizers are applied.

Phosphate hunger results in stunted or thin carnation plants. The color of the foliage is not usually changed from the normal, but leaves are narrow and the flowers are small. Growth is greatly reduced. No symptoms of injury have been observed from extremely high phosphorus either to yield, quality or outward appearance of the plants (Colo. Flw. Gr. Assn. Bul. 70).

The main fertilizer sources of phosphorus are superphosphate (20%), treble super (44%) and diammonium phosphate (21% nitrogen and 53% P_2O_5). Phosphorus may be applied at any time that it is found to be low in the soil. It is most easily applied as treblesuperphosphate before planting.

A level of 2 ppm (Spurway) was found adequate for carnations in Colorado. Increasing the phosphorus above this level did not improve yield, grade or keeping quality of Pink Sim carnations (Bul. 70). This optimum level can be maintained in most greenhouse soils by yearly applications of $2\frac{1}{2}$ pounds of treblesuper per 100 square feet of bench area.

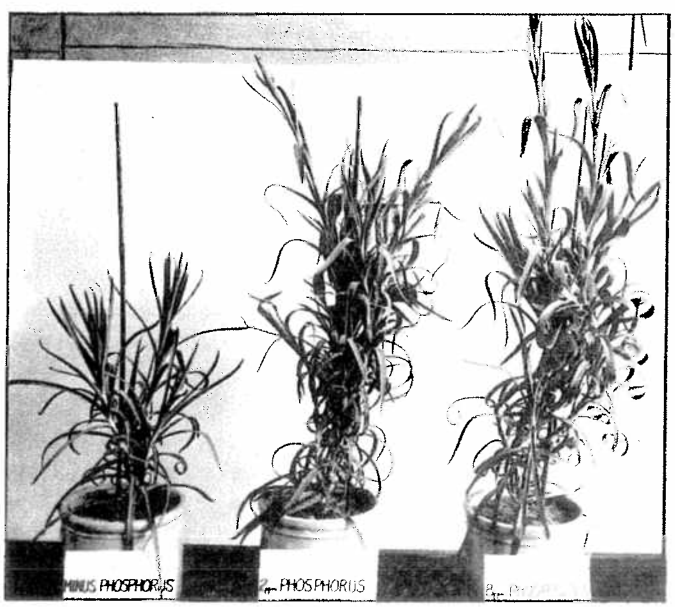

Fig. 3 - Response to different levels of phosphorus in sand culture.

Calcium

Calcium hunger signs which can be seen are extremely rare. In order to produce these symptoms, plants must be grown in acid washed quartz sand and glazed or metal containers. Messing described calcium deficiency symptoms, which he produced in England, in Carnation Craft No. 32. Tip burn on young leaves is very characteristic, having a constriction a certain distance from the tip. The whole leaf became narrow and often bent upwards at right angles to the rest of the leaf blade. The growing point of each shoot died, stimulating side branches which were light green in color and thin.

The chances of observing calcium hunger in Colorado greenhouses are remote. Calcium does play an important role in carnation nutrition, however. Low calcium reduced the average cut flower life on Red Sim carnations but did not affect yield and grade (Colo. Flw. Gro. Assn. Bul. 60).

Our present knowledge on calcium nutrition indicates 150 ppm (Spurway) as an adequate level. Higher calcium has not been shown to be detrimental to carnations. In many greenhouse soils this level can be maintained with 5 pounds of limestone or gypsum per 100 square feet per year, or less. If a grower uses well water, he may not need to apply calcium at all.

Calcium is leached from the soil mostly as calcium nitrate. Other fertilizers used may have a direct bearing on the amount of calcium which is lost through leaching. Calcium in the form of limestone is commonly used to regulate the pH, hence any acid fertilizer used will raise the limestone requirement of the soil (Colo. Flw. Gro. Assn. Bul. 37).

Trace Elements

Iron, magnesium, manganese, copper, zinc, boron, sodium, molybdenum, and several other elements have been shown to be essential to healthy plant growth. Most of these elements occur as impurities in fertilizers. Many of them are also present in adequate amounts in most water supplies. As we use purer forms of fertilizer chemicals and use our soil longer, we may experience deficiencies of some of these trace elements.

It is possible for trace elements to be present in the soil and not available. Extremes of acidity or alkalinity are to be avoided since most essential elements are most available in the middle range. Severe root injury to plants may reduce their ability to take in the nutrients. In general, however, hunger signs due to deficiencies of trace elements are rare. Methods of quick testing for most of these trace elements either do not exist or they are unsatisfactory. Should a particular trace element be suspected of being deficient, it may be applied to small plots for observation of possible stimulation. Most trace elements are toxic except in extremely small amounts.

Mixtures of trace elements such as Es-min-el may be applied to greenhouse soils once each year as insurance against deficiencies. Be sure that the mixture you apply is of value for many so-called minor element mixtures are worthless. The trace elements most likely to become limiting in Colorado greenhouse soils are boron, sodium and possibly iron.

Boron: -- Early deficiency symptoms of boron can be shown in gravel culture in about six months. A healthy cutting may have enough boron stored to last the new plant about this long. Apparently most of our commonly used fertilizer chemicals have no boron impurities nor is boron present in most water.

The early symptoms of boron hunger in carnations are a shortening of the internodes and a slight clubbiness or thickening of the upper portion of stems. There is also an extreme thinning of the stems just under the flower buds or death of the stem tips. Some flower buds may completely stop development at any stage, or they may be poorly formed. Coupled with all this is a tendency toward many stubby lateral branches high on the stem. In the more advanced stages of boron hunger,

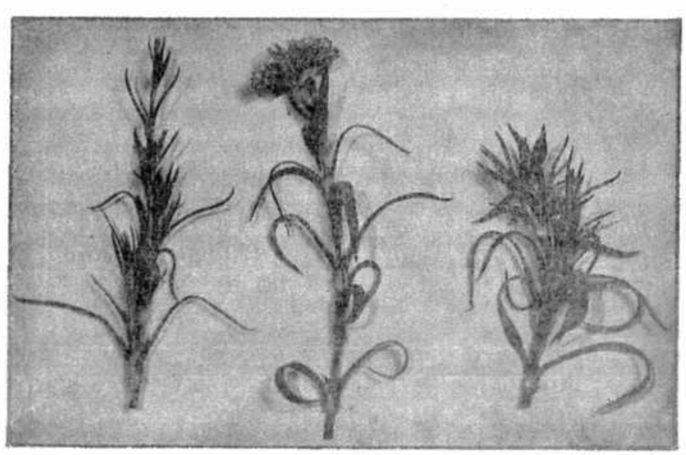

Fig. 4 -- Boron hunger signs.

older leaves take on distinct white margins.

Boron may be supplied as borax at $\frac{1}{2}$ ounce per 100 square feet. Borax is highly toxic at rates normally used for fertilizers. ***Sodium*** : -- The only hunger sign we have been able to produce by withholding sodium has been a lighter, yellow-green color of the stems and leaves. This very much resembles the earliest symptom of nitrogen hunger. Plants are not the desirable lush blue color. Sodium can replace a part of the potassium requirement of some plants.

The inclusion of sodium in the fertilizer program on Colorado greenhouse soils improved the grade and yield of Red Sim carnations but did not affect the keeping quality of the flowers (Colo. Flw. Gro. Assn. Bul. 60). At present we are applying 10% of our nitrogen as sodium nitrate to supply this sodium requirement. Soils in some areas contain sufficient sodium. The flame photometer test is quite reliable for this element.

Total Soluble Salts

The term soluble salts refers to all chemical substances in the soil which are soluble in water. Together they will determine the strength of the soil solution. The stronger the salt solution in the soil, the more water these salts will hold away from plants. If this solution becomes too strong, it will burn plant roots, thereby causing premature loss of leaves, stunting or hardening of the tops of plants.

The total salts are determined by passing electric current through a water extract of soil. A soluble salt level that is toxic in a sandy soil may not be toxic in a heavier one. The reading obtained is influenced by many chemical compounds, some of which can be more toxic than others. Since these chemicals can be in the soil in all possible combinations, no reading can be taken as being the point at which toxicity begins.

From the experience of many research workers, it is possible to view high total salts readings with caution. When the total soluble salts approach an excess range, thorough leaching is the best corrective measure. With one part of soil to five of distilled water, a specific conductance reading of 90-100 is usually considered a danger signal. The grower should proceed with caution or even leach, depending upon the appearance of his plants.

Basic soluble salt work is now being done at Colorado A & M by John White. More information is needed about the levels of salts at which toxicity can be expected. Also we need.to know how much a crop is impaired by high salts before we can see the damage by visual symptoms.

Other Toxic Compounds

Nitrites and ammonia, the most commonly occurring toxic materials in greenhouse soils, are brought about by poor soil aeration. Nitrate nitrogen is reduced to the nitrite or ammonia forms by the removal of oxygen by soil bacteria. When adequate air is present in the soil, toxic amounts of either of these forms do not accumulate. Accumulations of nitrites or ammonia are often brought about by overwatering a tight soil or one made highly retentive of moisture by the addition of large quantities of organic matter.

There are good quick tests for nitrites and ammonia. For greatest reliance on these tests, however, the soil should be sampled and tested immediately. If the sample is allowed to aerate, much of the nitrite and ammonia will be changed to nitrate.

Chlorides are toxic in amounts that would not give a high soluble salt reading. High chlorides have been observed to cause extremely thin plants and to produce symptoms similar to those of potash deficiency. Water supplies high in chlorides should be avoided. The small amount of chloride residue from muriate of potash would probably never accumulate to the toxic level.

Certain organic toxins may develop just following steaming of soils. More toxins usually develop when there is an abundance of partially decomposed organic matter in the soil. Poor soil aeration also increases the amount of toxins produced by steaming.

pH

The acidity or alkalinity of a soil affects plants in several ways, most of these being indirect. The pH influences the solubility of nutrients and toxic substances. When soils become too acid several of the fertilizer elements are more readily leached. When soils are too alkaline, nutrients such as phosphorus and iron may change forms and become unavailable. The pH also affects the activity of beneficial soil microorganisms thereby affecting the soil structure.

The pH scale used for measuring acidity or alkalinity is a scale from 1 to 14. 7 is neutral, below 7 is acid and above is alkaline. The divisions are not equal. Ten times as much lime is required to raise the pH from 5 to 6 as that required to raise the pH from 6 to 7.

There is no one pH for carnations. They have been grown successfully in soils with pH's ranging all the way from 5.0 to 7.8 or higher. Soils are very complex. When the pH of any soil is changed sharply, many factors are so changed that plants may no longer grow well in that soil. The pH of soils should be altered gradually, if good plant growth is expected. No attempt should be made to make an acid soil strongly alkaline in a short time, or vice versa.

Most of the fertilizers which we use in the greenhouse leave slightly acid residues. Ammonium sulfate and diammonium phosphate are relatively strong acidifers. Some agricultural limestone or dolomitic limestone is required yearly to counteract this acidity, if the pH is maintained. Most Colorado soils require a minimum of 5 to 10 pounds of limestone per 100 square feet to prevent the pH from dropping. Limestone works slowly and over a long period.

Miscellaneous

The balance of nutrients in soils has been investigated to some extent for a few greenhouse crops. It is known that the presence of greater than optimum quantities of certain nutrients interferes with the uptake of others. It is also known that some nutrients can partially substitute for others. Much more research should be done on these phases of carnation nutrition.

Carnation plants take in much more of most nutrients than their immediate requirements. There is some evidence that carnations store potash freely during their first six months in the bench, or during the late summer and fall. This may explain why it is sometimes difficult to maintain a desired potash level in the soil during the fall and early winter. It may also explain why nutrient deficiency symptoms are not always obvious even when soil tests show low levels.

Any one essential element may limit plant growth even when all others are in plentiful supply. We cannot afford to have hunger signs develop. Regular soil tests and a knowledge of the nutrient requirements of our crops will help prevent this.

Your editor, W D Holley

COLORADO STATE FLOWER GROWERS ASSOCIATION
OFFICE OF EDITOR
W. D. HOLLEY
Colorado A and M College
Fort Collins, Colorado

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Prof. H. Kamemoto
University of Hawaii
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