COLORADO CARNATIONS

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PRODUCING SIDE BREAKS ON CARNATIONS

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Side breaks on a carnation plant directly influence eventual flower production. Any factor, particularly in the first year, which reduces the number of breaks resulting from a pinch or cut, will reduce flowers. Growers often complain about lack of breaks at various times. In our visits to growers, and discussions with them, we often conclude that lack of breaks frequently results from cultural conditions. To point out some of these factors, we have reviewed the Colorado Flower Growers' Association Beuletins published over the last 28 years.

The most important factors controlling side breaks on carnations are:

1. Total solar energy.
2. Water availability.
3. Water demand, or dryness of the air.
4. Nutrition, including salinity.
5. CO_2 concentration.
6. Temperature.
7. Photoperiod, or length of the light and dark periods.

There are other factors which can influence break number: such as heredity, planting density, air pollution, disease, insects, herbicides, and type of cutting. Years of work by Holley, Melquist, Thompson, and others has shown carnations to have relatively high mutation rates. Without constant reselection, reduced yield is a common occurrence. Planting density has always been known to influence flower production. Heins (CFGS Bul. 296) showed outside rows to produce the greatest number of cut flowers due to higher light. Over a two year period, Hanan and Heins (CFGS Bul. 302) showed carnations at 2 plants per sq. ft. produced 67.6 flowers as contrasted to 111.0 flowers per sq. ft. at 6 plants per sq. ft. As density increased, yield per plant decreased with a loss of quality. The effect of higher density was less in the second year, and we suspect that differences between densities would disappear beyond the third year in production. In a major research project, Altstadt (Bulletins 177, 178, and 181) covered the effects of how the cutting was produced on eventual yield. He found that cuttings should have 6 to 8 expanded leaf pairs with a weight of 10 to 15 grams. Smaller cuttings produced fewer flowers, with cuttings from young stock plants producing better than those from old stock plants. Similarly, several bulletins (120, 280, 288, 290, 316, etc.) have dealt with pesticide misuse and problems from pollution, particularly in the form of unwanted herbicides. We mention these so-called "minor" factors in passing, for their occurrence is often too frequent. We wish to discuss largely those factors which seem to have the greatest effect, year-in and year-out, on breaking and flower yield.

Total solar energy

Plants use sunlight to produce food. The fact is so true as to be trite. If no other factors are limiting, growth follows the solar energy pattern with season. In Bulletin 146, Korns showed, with young plants, that growth decreased 15% when light intensity decreased 45%. Hanan (Bul. 96) also showed this fact, and interaction with temperature. We are limited in total yield by available energy. If, through improper practices, we fail to provide the proper environment commensurate with the available sunlight, we will limit production even more. High sunlight requires higher temperatures, and so temperature should be programmed to follow seasonal variations (Bul. 107). Attempts to increase breaks by application of chemical growth regulators during low light periods is limited by energy. It is also limited if other factors are limiting. We may produce more breaks, but the result is trash as there is insufficient energy to grow them on. In Bulletin 240, Behrens and Holley point out that carnations with CO_2, under fiberglass, and in inert media, can be ventilated at 72°F. in the spring, reducing to 65°F. in the summer and early fall months. In soil, temperatures must be dropped one to two degrees, and without CO_2, another reduction is required. Cultural conditions imposed on carnations must be built around available light and the particular practices of the grower.

Water availability

We can make a statement to the effect that any withholding of water will reduce side breaks on carnations. The classical example is Jasper's Fig. 2 in Bulletin 194. He showed a direct relationship between stress, imposed by allowing the soil to dry out, and yield. Excessive water stress is probably the single most important factor in regulating breaks, which means that the demand for water, or dryness of the atmosphere, must also be considered. However, the ability to apply water is limited by the root medium. Excessive watering in most soils can cause root damage, resulting in a worse problem. In an early Bulletin (130), Holley indicated that most Colorado bench soils should be watered at 300 to 500 cm water suction (30 to 50 reading on a tensiometer). Based upon Hanan and Jasper's work (Bul. 204) irrigation frequencies for good bench soils in the winter should never be more than 14 days apart, decreasing to as few as 3 days in the summer with large plants. In ground beds, it may be necessary to allow drying to 700 to 800 cm water suction before watering, or perhaps as long as three weeks. This obviously increases stress on the plant and yield will be reduced. A watering record should always be kept on each bench as an aid to proper scheduling unless inert medium is used.

The basic limitations of soils led Holley and others (Bulletins 205, 215, and 256) to consider inert media such as scoria or gravel. In such a medium, excess water can be applied without danger of root damage. Holley and Novovesky stated that, over a 3 year period, yield was increased 15%. Unfortunately, inert media require more stringent attention to irrigation systems, disease control, and fertilizer application. There is less room for mistakes as several growers have found to their misfortune. Nevertheless, a 15% higher yield, and a possible 30% higher quality is not to be sneezed at.

Water demand

Water demand, or the transpiration rate, or the rate of water loss from carnations, is directly influenced by light and humidity. In innumerable articles dealing with internal plant water stress on carnations (e.g. 233, 234, and 214) Hanan, Holley, Jasper, and others showed that high stress imposed by rapidly moving, dry air can reduce side breaks regardless of the water supply. (The introduction of fan-and-pad cooling saved the Colorado industry.) Such situations are commonly imposed when warm winter days require fan operation, but no effort is made to humidify the air by turning on the pads. Not much attention has been paid to humidification for carnations, although CSU has installed and tested a system for regulating air flow and maximum humidification under such conditions. Late spring and early fall months are particularly crucial as this is our best time for growing.

Water demand and water availability are probably the single most important factors in regulating break production. Hardening young plants seriously reduces side breaks for the first crop, with worse results for the second crop.

Fiberglass installation in Colorado has probably done more to improve break production by reducing water stress than any other single factor. Starting with Briggs in the late 1950's and continuing down to the present (e.g. Bulletins 189, 148, and 135), it has been shown that a clear fiberglass will provide 10% higher yields when compared to glass, with commensurate increases in quality. Briggs found that heat transmission was reduced, resulting in less cooling fan times, and Hanan showed that water loss under fiberglass was less as compared to glass. The situation in regard to double polyethylene is presently being tested. Problems with glass under Colorado conditions has been recently reinforced for us at CSU where we have attempted to produce cut flowers under glass. The results have not been particularly edifying.

Nutrition

For years, effects of nutrition and salinity on carnation production has been investigated at CSU (e.g. Bulletins 221, 222, 224, 229, 249, and 305). There has been shown to be an interaction between concentrations of individual elements and environment. Ammonium nutrition changes with season, and nutrition in general must be modified in accordance with water quality. In early work, White (Bul. 95) showed that increasing salinity in soils resulted in a gradual reduction of carnation yield. Again, in the 1960's, Schekel (Bul. 229) showed that any increase in nutrient solution concentration beyond that absolutely necessary would decrease yield, and if the proper ratios and proportions of ions were not maintained, yield reduction would be greater. In 1975, Hanan (Bul. 313) showed that increasing salinity reduced calcium concentration in carnations. Culminating more than 20 years of work, Hartman and Holley (Bul. 221) proposed an ideal fertilizer solution for carnations in Colorado; consisting of 50 pounds potassium nitrate, 30 pounds of calcium nitrate, 20 pounds of magnesium sulfate, 15 pounds of phosphoric acid, and 10 pounds of ammonium nitrate in 50 gallons of water, injected at a rate of 1:200. This recommendation was for good water, — as good as or better than Denver municipal supplies. Where water already contained salts, the recommendations must be modified — but regardless of the modification, yield cannot be as high as in pure water. Hartman and Holley also pointed out that when chlorine concentration exceeded 39 ppm (1 meq/l), growth was reduced, and a concentration of 117 ppm (3 meq/l) would reduce growth 20%. In Bulletin 122 (1960) Holley asked if we could afford not to use potassium nitrate instead of potassium chloride?

These facts are interesting, for in an attempt to reduce costs or strengthen weak stems, many growers have shifted from potassium nitrate to potash or potassium chloride as a major fertilizer. We feel this is false economy. Rates of CKl injection often exceed 40 pounds per 50 gallons (1:200), with the rest of the nitrogen coming from ammonium nitrate at rates up to 40 pounds per 50 gallons. Thus, ratio and proportions are thrown out the window, and chloride concentration is increased sufficiently to significantly reduce growth. Nutrition becomes a limiting factor so that solar energy, good temperatures, and CO_2 injection cannot be used to advantage. We have recently grown two good sized plots of carnations, using these different feeds — and the differences are striking. We don't think potash is worth a 20% yield reduction. The effect of potash is greater under glass or where stress is high.

CO_2 concentration

Goldsberry began this first investigation in Colorado on benefits of CO_2 injection, and this was quickly followed by many articles on CO_2 use (Bulletins 151, 164, 162, 172, 174, 149, 139, and 138). According to Holley, Korns, and Goldsberry, the use of CO_2 on carnations can provide a 10% increase in yield. However, we have noticed many growers no longer make the effort to inject CO_2, and accordingly quality is much lower during winter seasons. Regulation of peak flowering periods with lights is more difficult without CO_2, and maximum use of high light during winter, fall, and spring periods is limited without CO_2. CO_2 should be injected from dawn to dusk to maintain 600 ppm on clear days with no ventilation up through March, and starting as soon as possible in the fall.

Temperature

Temperature is one factor most susceptible to control by greenhouse operators. However, it requires close attention to accuracy, proper location and mounting of thermostats, and good balance with the actual heating and control system. Schmidt (Bulletins 83 and 93), Hanan (Bul. 106), and others (Bulletins 107 and 128) have studied effects of temperatures on carnations. We have been able to show that optimum temperatures for carnations vary with sunlight, fertilizer practice, CO_2 concentration, root medium, water supply, water demand, and variety. In a relatively recent article, Holley (Bul. 254) presented data from California showing the very slow rates of carnation growth when night temperatures are 50°F. or lower, and day temperatures range between 55° to 60°F. At temperatures much below 52°F, reds turn bricky, whites are likely to be flushed. If night temperatures are only one degree too high for a sufficiently long period, stem strength and flower size will suffer drastically. High day temperatures, depending upon available sunlight, will cause sleepiness in pink, and small flowers with hollow centers. The problem will be compounded where no CO_2 is injected and the fertilizer practice causes an increase in salinity. Many growers do not bother to raise day temperatures above night temperatures, depending upon the sun to raise them. If the day is dark and cloudy, night temperatures are maintained. There has been no proof to show that this will provide good quality or maximum yield. Generally, with such practices, we observe increased slabs and splits, poorer color and reduced breaks. Results are modified by the particular season experienced. Proper temperature manipulation will allow growers to compensate for other limiting factors — within limits. Temperatures should be raised at least to 58 or 60°F. during the day, regardless of sunshine. Obviously this will increase fuel consumption, but this must be balanced against more flowers with higher quality. Fifty-four degrees F. probably represents the maximum winter night temperature for carnations in Colorado under good growing conditions. With old plants, an attempt should be made to prevent temperatures above 70°F., or 72 to 74°F. with young plants. With good temperature control, splitting can be pulled to very low levels (Bul. 144).

Photoperiod

Publications by Koon, Holley, Novovesky, Rudolph, and others (CFGA Bulletins 224 and 209) have shown that dusk-to-dawn lighting of carnations will hasten flowering. This is a regular practice for many Colorado growers. However, long days reduce side breaks, and thus it is not often recommended for new plantings. The first crop will flower heavily, but the second crop will be seriously delayed. Short days enhance break production. Lighting must be programmed with future crops in mind, and the status of side breaks on the plant.

Summary

We have attempted to show that break production on carnations requires good growing. We know that CO_2 will increase production 10%, inert media another 15%, fiberglass 10%, and excessive salinity (particularly chlorine) will reduce yield 20%. These cultural operations probably represent the difference between yields of less than 40 flowers per sq. ft. per year — what we had 20 years ago — and at least 50 or perhaps 70 flowers per sq. ft. per year.