Colorado Flower Growers Association Inc.

Bulletin 171

IN COOPERATION WITH COLORADO STATE UNIVERSITY
Doris Fleischer, Executive Secretary
901 Sherman St., Denver, Colorado 80203

June 1964

LOW TEMPERATURE STEAM

Joe J. Hanan

Work at CSU on steaming soils at different temperatures has shown that failure to steam reduces yield, quality and delays flowering of carnations. Steaming at temperatures less than 200°F is more beneficial in increasing vigor. However, the increased growth resulting from steaming will increase splitting unless temperature control is good. With clean cuttings and good growth, symptoms of infection by Fusarium roseum and oxysporum may not be found during the first six months of growth even when steamed or unsteamed soil is deliberately infested.

Procedure

By mixing air from a 30 CFM blower with steam in a stovepipe arrangement, the temperature of the steam was controlled at will. Variations in boiler pressure (4 to 8 psi) caused an approximate six degree fluctuation in steam temperature. Fifty boxes were filled with Fort Collins loam and divided into the following treatments, 10 boxes per treatment; no steaming, steamed to a soil temperature of 132-140°F, steamed to 154-158°F, 170-174° and 202-208° The boxes were placed on two benches, 25 per bench. In November, 1963, Red Gayety rooted cuttings were planted, four plants per box, and later single pinched. On October 28, boxes on one bench were infested by D. J. Phillips with a heavy spore suspension of Fusarium roseum and F. oxysporum. This suspension was poured on the soil at one end of each box.

Results

In both infested and noninfested treatments, plants grown in steamed soil came into flowering one to two weeks before the nonsteamed treatments. At the end of 3 to 4 weeks after first flowering, plants in steamed soil, on the average, had produced twice as many flowers as those grown in nonsteamed soil. It was observed that steamed soil settled less and dried out quicker. Figure 1 compares - typical "no steam" and "202-208" treatments. Plants in unsteamed soil were lighter in color, thinner, had fewer breaks, and usually had shorter stems.

Symptoms usually caused by F. roseum and F. oxysporum were not evident. At the end of the experiment, D. J. Phillips cultured all plants in the infested treatments and one plant in each box of the noninfested soil. The results were negative. There was no sign of F. roseum, or F. oxysporum in the plants.

Soil cores were taken from the boxes and the results are shown in Table 1. Steaming had the effect of reducing compaction as indicated by bulk density, increasing total pore space and air content and reducing slightly the amount of water retained. It was noted that using steam direct from the boiler (202-208°F) seemed to have a detrimental effect in comparison to lower steam temperatures.

Considerable splitting occurred. The temperature control, particularly admission of cool outside air, was poor. There was a definite relationship between temperature, treatment, and splitting. Figure 2 shows results when the benches were divided into fifths and the boxes located according to position in the bench in relation to the cold air inlet. Yield increased the further the plants were removed from the padend except on the 1/5th furthest removed from the pad. This indicated a shading effect by the padend or that day temperatures were too cool. With the exception of the first 2/5ths near the padend, grade increased to its highest value at the warm end. The reduction in grade shown by the plants located toward the center of the bench was caused by calyx splitting. Splitting was least at the extreme ends of the benches.

On the other hand, comparing yield, grade, splitting, fresh weight of entire plant, and number of visible buds showing on May 25, 1964, (end of experiment) on the basis of steam treatment, showed that practices resulting in more vigorous growth could lead to more splitting (Figures 3 and 4). In considering all factors, the 154-158 treatment was considered best although it reduced mean grade as the result of splitting. The use of steam above 180°F apparently did not result in a commensurate increase in growth.

Discussion

Increasing vigor of carnations makes them more susceptible to splitting. Temperature control is critical. If yield is to be maximum, steaming should be practiced with the realization that temperature control correspondingly becomes more important. There is no compromise. It also appears that our usual practice of steaming at temperatures above 200°F is slightly detrimental. Aside from disease control, steaming at lower temperatures results in maximum yield - provided all other factors are provided at the proper levels. If clean cuttings are employed, and allowed to grow without check, symptoms of F. roseum and F. oxysporum may not be evident during the first 6 months regardless of steam temperature or no steaming at all.

At present, the use of aerated steam on long benches has not been studied. The equipment used here is simple, consisting of a 5-foot length of 6-inch stovepipe with one end fashioned into a "Y". Air from a 30 CFM centrifugal blower is blown through one branch of the "Y", and steam from the boiler is directed in opposition to the air flow through another leg. For small plots, the air and steam flow must be considerably reduced. A PRV valve should be installed in the steam line to maintain constant steam pressure. This arrangement works well on low pressure boilers and should work on high pressure systems. At pressures above 40 psi, a venturi can be used, dispensing with the blower[1]. However, temperature is not as easily regulated. Steaming soils at temperatures below 200°F increased the time required to bring the soil up to the desired temperature. It is suggested that 180°F steam be used with a minimum temperature of 150°F at the coldest part of the bench.

Literature cited

1. Baker, K. F. 1957. The U. C. System., Calif. Agric. Expt. Sta.-Ext. Service Manual 23., p 148.

Table 1: Effect of steaming soil at different temperatures on soil characteristics.

Treatment	Water (% Volume)	Air (% Volume)	Total pores (% Volume)	Bulk density (g/cc)
No steaming	24	29	53	1.22
132-140°F	24	31	55	1.19
154-158°F	22	35	57	1.14
170-174°F	20	40	60	1.06
202-208°F	22	35	58	1.12

Figure 1: Comparison of Red Gayety carnations grown in unsteamed soil (right), with those grown in soil steamed to 202-208°F.

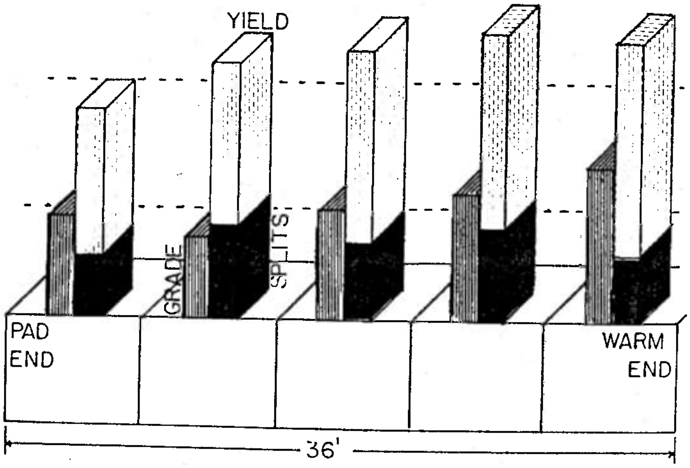

Figure 2: Effect of location in bench on yield, grade, and splitting of Red Gayety carnations. Cool air entered at padend.

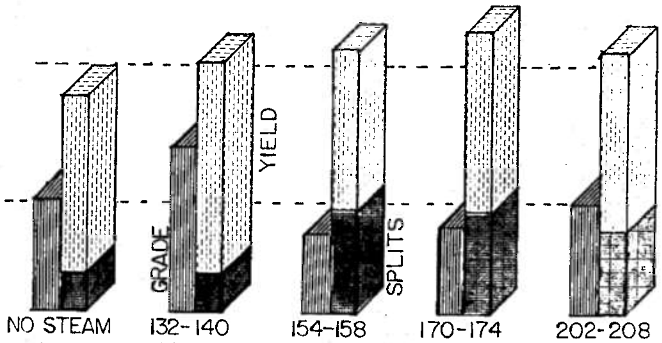

Figure 3: Effect of steaming at different temperatures on yield, quality, and splitting of Red Gayety carnations.

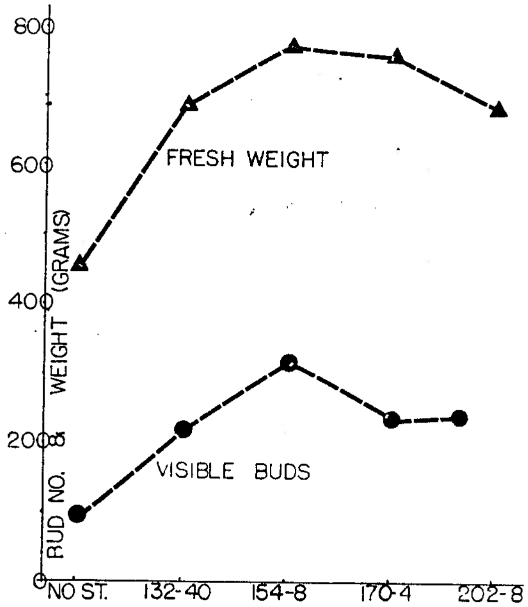

Figure 4: Effect of steaming at different temperatures on fresh weight of whole plants and number of visible buds showing at termination of experiment of Red Gayety carnations.

Interest in Greenhouses from Engineers

While England, Holland, and Germany have had well-developed research divisions on greenhouse engineering for several years, research engineers in this country are beginning to show group interest in this fertile field for the first time. One morning session was devoted to greenhouse environment and design at the 57th Annual Meeting of the American Society of Agricultural Engineers at Colorado State University, June 21-24, 1964. A copy of the program for that session follows with numbers of the papers included:

Theme: Greenhouse Environment and Design

9:00 Environment Control in Greenhouses 64-427
W. A. Bailey, Agr. Engr., H. M. Cathey, Plant Physiol., R. J. Downs, Plant Physiol., and H. H. Klueter, Agr. Engr., ARS, USDA

9:20 New Commercial Greenhouse Developments Oral-NPA
H. E. Gray, Sales Mgr., Lord & Burnham Div. of Burnham Corp.

9:40 New Plastic Greenhouse Designs Improve Appearance, Lower Costs, and Provide Good Plant Environment 64-429
McNeil Marshall, Assoc. Agr. Engr., and P. H. Massey, Jr., Horticulturist, Virginia Polytechnic Inst.

10:00 Temperatures in Heated or Ventilated Greenhouses 64-430
J. N. Walker, Assoc. Prof., Agr. Eng. Dept., Univ. of Kentucky

10:40 Plastics for Greenhouse Design 64-431
J. C. Couturier, Western Reg. Mgr., Construction and Agr. Sales, E. I. DuPont deNemours & Co.

11:00 Light Transmission of Rigid Plastics 64-432
J. H. Baker, Tectrol Serv. Engr.; and R. A. Aldrich, Assoc. Prof., Agr. Eng. Dept., Pennsylvania State Univ.

11:20 Artificial Lighting in Greenhouses 64-433
H. H. Klueter, Agr. Engr., H. M. Cathey, Plant Physiol., R. J. Downs, Plant Physiol., and W. A. Bailey, Agr. Engr., ARS, USDA

11:40 Some Solar Considerations Affecting Greenhouses 64-434
W. J. Roberts, Asst. Spec., and C. H. Reed, Prof., Agr. Eng. Dept., Rutgers - The State Univ.

It is amazing what can be done in one field and not be known to the workers in another. Considerable duplication of effort and lack of knowledge of the plant culture field was obvious from some of the reports. Costs of construction was emphasized by some of the engineers while others were dreaming about construction that could only be used by highly subsidized experiments.

The summary of paper 64-427 follows to illustrate the thinking of the research team at the USDA Research Center in Beltsville, Maryland.

Environmental Control in Greenhouses. Bailey, W. A. et al.

The greenhouse of today is almost the same as those used by our great grandfathers. Research on this structure has been sadly lacking in the United States. Almost 5% of the total value of all crops is grown in greenhouses or other controlled environment facilities (1959 census). Research is needed on greenhouses for this growing industry. According to an article in the March 27, 1964 issue of Time Magazine, the suburban home owner is buying small greenhouses at an increasing rate. The new greenhouse owner can have automatic environment control even to watering of the plants. More research is needed to make these automatic features better and more economical so that they can be used by large commercial growers, also. Research on the structure should include minimum shading from super structure, glass size and quality, heat conservation, temperature distribution in the growing area during heating and cooling, roof slopes and shapes. The orientation of the whole house is the first problem encountered in greenhouse design and although some orientation studies have been made the problem needs to be thoroughly reevaluated.

Future. The greenhouse of the future may be an entirely different creation than the present one. It could be hemispherical in shape, rotating with one side toward the sun to give the plant maximum radiation. Since it rotates, only half the structure need be glass or other light transmitting material, whereas the other half of the shell could be solid insulated material to cut down on heat losses. At night the insulated shell would rotate from the back part of the house to cover the glass front thereby reducing heat losses and make it possible to control the photoperiod.

The structure would be almost self-supporting because of its shape and therefore more economical to build.

We plant growers are constantly in need of help from engineers, individually and collectively. We welcome this stirring of interest. We should do what we can to encourage these workers. Mimeographed copies of the individual papers should be available from the respective authors.

Your editor,

W D Holley

COLORADO FLOWER GROWERS ASSOCIATION, INC.
OFFICE OF EDITOR
W. D. HOLLEY
Colorado State University
Fort Collins, Colorado 80521

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