CONSTANT TEMPERATURE WATER BATHS FOR PLANT GROWTH EXPERIMENTS

Previous articles have described construction of relatively inexpensive constant-temperature water baths for pot culture studies. The system described in this report differs from others in two ways: (a) several baths of one replication are maintained at different temperatures using one compressor; and, (b) true replication of treatment is provided, independent of location, by using a separate water bath for each temperature treatment rather than several pot "replications" within a single large water bath.

For our needs a complete replicate required 6 water baths, 2 above and 4 below room temperature. A convenient size was 15 inches wide, 35 inches long and 6.5 inches deep (inside dimensions) and tanks were constructed of 28-gauge galvanized iron. Such a bath accommodates six No. 10 cans (6.2 inches in diameter), six 8-ounce jars (2 inches in diameter) and equipment for temperature control. Each can rests on two 3-inch pieces of 0.5-inch O.D. copper tubing soldered to the galvanized lining, which allows circulation of water under as well as around the cans. A rust inhibitor, commonly used for automotive radiators, effectively checks electrolytic action between the copper cooling coils and galvanized iron, and prevents rusting of the No. 10 cans. Each bath is covered with 1/4-inch tempered pressboard with holes through which the cans and jars are inserted. The glass jars are supported by this cover. An insulating jacket is provided for each bath. The baths are arranged in a randomized block design in a growth chamber.

Water circulation is obtained in each bath with a Goode Pump (model GV30, Little Giant Pump Co.), which delivers 260 gallons per hour. The flow from the pump is divided into two streams by plastic tubing.

Temperature in each bath is controlled by a Cenco 99015 bimetallic thermoregulator suspended in the bath. Thermostatic regulators are suspended, rather than mounted, to eliminate arcing of contact points caused by vibration from the circulation pump. Two of the 6 baths in each replicate are maintained above room temperature with 500-watt Chromolox, divided into two streams by plastic tubing. The glass jars are supported by this cover. An insulating jacket is provided for each bath. The baths are arranged in a randomized block design in a growth chamber.

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Figure 1—Schematic arrangement for controlling 4 water baths at different temperatures, below room temperature, using 1 compressor. Baths 1, 2, 3, and 4 are identical. A is a low-pressure switch for compressor control; B is a filter-drier; C is a moisture indicator; D is a solenoid controlled by a thermostatic expander valve.

Sealed model, a Sporlan See-all moisture and liquid indicator, type SA-12FW, (B and C, respectively), to a Hoke solenoid valve, normally closed 2-way type B90A380C with 3/8-inch orifice (D). It then passes through a Sporlan thermostatic expansion valve, type GFZ2C (E, Figure 1), through 3 loops of 0.5-inch copper tubing immersed in the bath, and returns to the compressor as indicated by the arrows. The 3 loops of tubing, positioned against the inner sides of the tank, provide more than the 16 feet of 0.5-inch tubing necessary for adequate cooling surface. All tubing connections are silver-soldered or use threaded fittings. This system is flexible in that the number of baths that can be controlled with one compressor is dependent only on the cooling requirement, compressor capacity, and space available.

Temperatures in the 4 refrigerated baths are controlled by Cenco thermostatic regulators protected by Sigma 11F2 relays with 90000hms coils and 1-ampere silver contacts. The thermostatic regulators govern action of the solenoids. When cooling in a bath is required, the thermostatic regulators close, thereby opening the solenoid which permits the refrigerant to flow through the cooling coils until the cooling requirement is satisfied. The compressor operates only when the pressure of the refrigerant exceeds that of the differential limit. Consequently, the operation of the compressor is controlled by the pressure of the refrigerant and does not run every time a solenoid opens. In this manner, the baths are individually cooled and continuous operation of the compressor is avoided.

Bath temperatures are controlled within ±0.3°F of the desired temperatures over a range from 45°F to 80°F, with room temperature at 72°F. Only one compressor is used for each replicate, as indicated in Figure 1. This permits a random location of baths and a true replication of treatments. Also, the load on each compressor is equal and if a compressor fails, only one complete replication will be affected. If one compressor were used for all baths of one temperature, each would have a different capacity requirement and if the compressor should fail, that particular temperature treatment of all replicates would be affected.

Cost of all equipment and materials for one complete replicate was $532 in 1961.—W. O. Willis, J. F. Power, G. A. Beichman, and D. L. Grunes, Soil Scientists, USDA Northern Great Plains Field Station, Mandan, N.D.

Notes

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4 Trade names and company names are included for the benefit of the reader and do not imply any endorsement, or preferential treatment by the U. S. Department of Agriculture of the product listed.