

Technology & Product Reports

Control of Humidity in Small Controlled-environment Chambers using Glycerol-Water Solutions

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Additional index words: relative humidity, specific gravity

Summary: Solutions of glycerol and water provide a convenient and inexpensive system to control the relative humidity (RH) in small controlled-environment chambers. The relationship between the specific gravity (SG) of a glycerol-water solution and its equilibrium RH is described by the equation $SG = [-0.189(RH) + 19.9]^{1.000}$. Gas can be humidified by bubbling it through jars containing solutions of glycerol-water with the desired equilibrium RH. The effects of flow rate, volume of solution, temperature, and pressure on the equilibrium RH are discussed.

Humidity is an important environmental factor that influences rates of water loss from whole plants or excised plant organs. Rates of water loss from plant cells

affect many physiological processes such as cell expansion, growth, photosynthesis, and senescence. The role of humidity on the physiology of plants often has been ignored, possibly due to a lack of convenient methods to control humidity at desired levels or because of difficulty in measuring humidity accurately (Gaffney, 1978). Equilibrium atmospheres over saturated solutions of different salts can be used to control humidity (ASTM, 1983; Solomon, 1951; Winston and Bates, 1960; Young, 1967). Disadvantages of this system are that a different salt is needed for each humidity, a salt for a specific humidity may not be available, many of the salts are corrosive, and the equilibrium relative humidity (RH) formed over many solutions varies widely with temperature. Nonsaturated solutions also can be used to produce various equilibrium RHs, depending on the concentration of the solute. This method allows for the creation of a precise and evenly graded series of RHs. Solutions of sulfuric acid (ASTM, 1983; Solomon, 1951), potassium hydroxide (Solomon, 1951), and glycerol (ASTM, 1983; Braun and Braun, 1958; Solomon, 1951) can be used in this manner to control RH.

Glycerol and water solutions have several advantages for use in RH control. Solutions of 0% to 100% glycerol can be mixed easily, and their exact composition can be determined by specific gravity (SG) (Braun and Braun, 1958) or by refractive index (ASTM, 1983) measurements. Glycerol solutions are less corrosive than salt or sulfuric acid solutions, and glycerol is relatively inexpensive. This paper discusses the use of glycerol and water solutions to control humidity in controlled-environment chambers. The

effects of temperature, pressure, flow rate, and volume of solution on maintaining constant, desired RH in chambers also are examined.

The relationship between glycerol concentration, measured as SG, and the equilibrium RH that forms at 24°C in a closed system was described by Braun and Braun (1958), and their original data are shown in Fig. 1. To aid in determining equilibrium RH from solutions not tested by Braun and Braun, we derived an equation to fit their data (Fig. 1). The equilibrium RH decreases slowly as the glycerol content increases, but changes more rapidly as glycerol content exceeds ~70%. The slower change in RH when glycerol content is < 70% allows for more accurate control of RH > 60%. To aid in the determination of a solution needed to produce a desired RH, the formula in Fig. 1 can be solved for SG:

$$SG = [-0.189(RH) + 19.9]^{1.000} \quad [1]$$

where RH is the desired percent RH and SG is the specific gravity of the glycerol-water solution needed to produce this RH. Ratios of water and glycerol needed to produce a desired SG can be estimated from Fig. 1 or calculated from Eq. [2]:

$$G_w = 383(SG) - 383 \quad [2]$$

where G_w is the percent glycerol by weight in the solution. The volumes of glycerol and water needed to prepare solutions can be calculated using Eqs. [3] and [4]:



Fig. 1. The relationship of specific gravity (SG) and glycerol content of glycerol-water solutions and equilibrium relative humidities (RH) at 24°C. Points represent actual data from Braun and Braun (1958), and the line represents a model derived using these points.

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Control Of Humidity In Small Controlled Environment

Léo Pomar



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Controlled Environment Guidelines for Plant Research T.W. Tibbitts, 2012-12-02 Controlled Environment Guidelines for Plant Research contains the proceedings of the Controlled Environments Working Conference held in Madison Wisconsin on March 12 14 1979 The papers propose guidelines for measuring and reporting environmental conditions in controlled environment facilities that affect plant growth including temperature radiation carbon dioxide soil moisture atmospheric moisture and air movement They also suggest how to perform measurements accurately and in ways that can be repeated by other investigators Organized into 34 chapters this volume begins with an overview of measurement instrumentation and procedures for growing plants in controlled environments It then turns to a discussion of radiation measurements for plant growth studies in controlled environments principles of heat transfer plant response to increased humidity humidification and dehumidification carbon dioxide variations within plant growth chambers and watering of plants in controlled environments The reader is also introduced to precision and replication of measurements along with interactions among environmental factors such as water light intensity mineral supply temperature air pollution and nutritional preconditioning Biologists and engineers as well as plant physiologists and physicists will find this book extremely useful

Controlled Environment Horticulture: Where Plant Biotechnology Meets Sustainable Future Hemant Bagul, Nikita Patel, T. R. Ahlawat, R. Krishnamurthy, Stephen Oyedeki, 2025-09-16 A comprehensive exploration into the convergence of advanced plant science engineering and biotechnology to revolutionize food production in controlled environments As global challenges such as climate change population growth and resource scarcity intensify this book highlights the transformative potential of controlled environment horticulture CEH in building a more resilient and sustainable food future The volume covers a wide range of topics including smart greenhouse technologies precision agriculture vertical farming bioreactor based plant production and gene edited crops optimized for indoor systems It integrates biological advances with technological innovations to improve yield quality and resource efficiency in horticultural practices By blending plant biotechnology with environmental control strategies the book serves as a roadmap for sustainable intensification in horticulture Key features Explores integration of genomics phenotyping and controlled environments Demonstrates the use of sensors AI and automation in smart horticultural systems Addresses energy efficient lighting water use and nutrient management Highlights sustainability metrics and circular economy practices Provides case studies on commercial CEA models and innovation pathways

Handbook of Cannabis Production in Controlled Environments Youbin Zheng, 2022-06-29 For thousands of years Cannabis sativa commonly called cannabis or marijuana has been used for many different purposes Due to its enormous medicinal values increasing numbers of countries and regions have started to legalise the cultivation of this plant When grown commercially cannabis is most often produced in controlled environments including greenhouse and indoor growing rooms to ensure consistent growth and high quality Even for field production propagation is frequently conducted in

controlled environments Commercial operations and individual growers who cultivate cannabis for personal consumption require scientific information on how to cultivate cannabis most effectively and efficiently To meet these needs scientists have been conducting research on how to optimize cannabis cultivation both in small and large scales Handbook of Cannabis Production in Controlled Environments is the result of collaborations between some leading cannabis scientists and highly experienced practitioners Featuring full color illustrations and photographs throughout this book covers a broad range of topics include cannabis biology science and techniques for breeding and propagation management and optimization of both aerial and rootzone environments plant nutrition and nutrient disorder diagnosis crop training and pest management harvesting and post harvest processing Along with the basic aspects of controlled environment cannabis production this book summarises developments in these areas that may challenge old beliefs and improve production Led by Editor Youbin Zheng President of the Canadian Society for Horticultural Science La Soci t Canadienne de Science Horticole this book is a practical guide for cultivators consultants and researchers a reference for students and an information source for individuals who grow cannabis for personal consumption

ARS-S. ,1974 Bibliography of Agriculture ,1993 **Powders and Grains 2005, Two Volume Set** R. Garcia-Rojo,H.J. Herrmann,Sean McNamara,2005-07-01 This volume contains the proceedings of the Fifth International Conference on the Micromechanics of Granular Media Powders and Grains 2005 Powders and Grains is an international scientific conference held every 4 years that brings together engineers and physicists interested in the micromechanics of granular media The book is a guide to the hotte *Engineering Applications of Composites* Bryan R. Noton,1974 **Sand and Water Culture Methods Used in the Study of Plant Nutrition** Eric John Hewitt,1966 Plant containers Drainage Undrained containers Drained containers Capacity Sand culture Water culture Relation of solution renewal and aeration Shape of containers Covers for containers Exclusion of light and heat Exclusion of dust Support of culture plants Composition of containers Metal Cement Wood and paper Plastic Unglazed clay Glazed clay Glass Cleaning containers Multiple compartment containers and Split root methods Solid rooting media Particle size of sand Mechanical analysis Choice of particle size Chemical analysis and purity of sand Macronutrients Micronutrients Relation to grading Toxic constituents Sand purification Use of unpurified sand Methods and results using purified sand Mixzed solid media Base exchange materials Zeolites and synthetic resins Colloidal clays Other materials Solid nutrient compounds Water Sources of water Rain water Tap water Distilled water Demineralised water Nutrient impurities and purification methods Impurities in nutrient salts and raw materials Experiments using unpurified salts Methods of purifying nutrient reagents Composition of the nutrient solution Source of nitrogen in nutrient solutions Influence and control of pH of the nutrient solution Supply and utilization of iron in nutrient solutions Micronutrients supplied in nutrient solutions Methods for the renewal and application of culture solutions Aeration of culture solutions and study of root atmosphere Composite Materials: Engineering applications of composites Lawrence J. Broutman,Richard H. Krock,1974 *Controlled Environment Production System for*

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Whispering the Strategies of Language: An Mental Quest through **Control Of Humidity In Small Controlled Environment**

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