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RESEARCH AND DEVELOPMENT OF SEEDLING GERMINATION GREENHOUSE AND ANCILLARY EQUIPMENT

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ABSTRACT Based on market requirements, a seedling germination greenhouse and its ancillary technology and equipment were researched. The seedling germination greenhouse environmental control technology and its control system were developed based on the new materials and new application techniques. The control system consisted of an advanced low-pressure spray mist humidification technology, a solar supplementary facility, an air-condition system and a multi-layer shelf. Furthermore, the full use of solar energy can further reduce the germination greenhouse production costs and improve their synthesized performance. Problems such as bad environment control capability, low-control accuracy and inconvenience of use can be solved efficiently in factory seedling germination greenhouse, thus a higher benefit can be achieved with a lower overall investment. Meanwhile high quality seedling can be obtained and this helps seed producers increase their production, income and efficiency.

Keywords: seedling germination, germination greenhouse, facility agriculture, low-pressure spray mist

INTRODUCTION

Advanced cultivation technology is the important component of factory agriculture, and high quality seedling is one of key factors on successful cultivation technology. Traditional greenhouse germination is not a perfect factory seedling nursing method, its indoor environment is susceptible to outdoor environment change□this leads to non-uniform distributing in the space, at the same time because of the large room in greenhouse, this causes the sharply change of environment, the cost of environment control energy and consumption is large, and it is easy to give birth to plant diseases and insect pests such as propagation of microbial pathogens, the germination and uniform rate of seedling is difficult to ensure. Therefore using factorial vegetable and flower automatic control germination greenhouse and comprehensive ancillary

equipment can provide uniform and dependable germination environment and high quality, vigorous, and good root growth seedling for factory agriculture, integrate seedling quality, shorten the time of seedling, and further reduce breeding cost.

Through research and development of breeding germination greenhouse and ancillary technology and equipment, this paper solved problems existed in factory seedling germination greenhouses such as poor environmental control ability, low-control accuracy, inconvenient use and so on, with a view of using the smallest input to get the best cost-effective, efficient production, and ensure the seed producers to increase production, income and efficiency.

KEY TECHNOLOGY OF BREEDING GERMINATION GREENHOUSE AND ANCILLARY EQUIPMENT

Breeding Germination Greenhouse Multiple Factors Environmental Control System Based on the utilization of natural resource, by changing environmental factors such as temperature, humidity, light intensity and so on gradually, to realize optimal growth condition for plants, and achieve the objective of increasing plant production, regulating plant growth period and improving economic benefit.

The system that is based on the requirement of seed germination and utilizes environmental comprehensive modulation measure, can maintain several environmental factors such as temperature, humidity, oxygen concentration, air velocity at relative optimal combination, with a view of using the least environmental control equipment to get the best seed germination environment condition. The principle diagram of breeding germination greenhouse environmental monitoring system is shown in Figure 1:

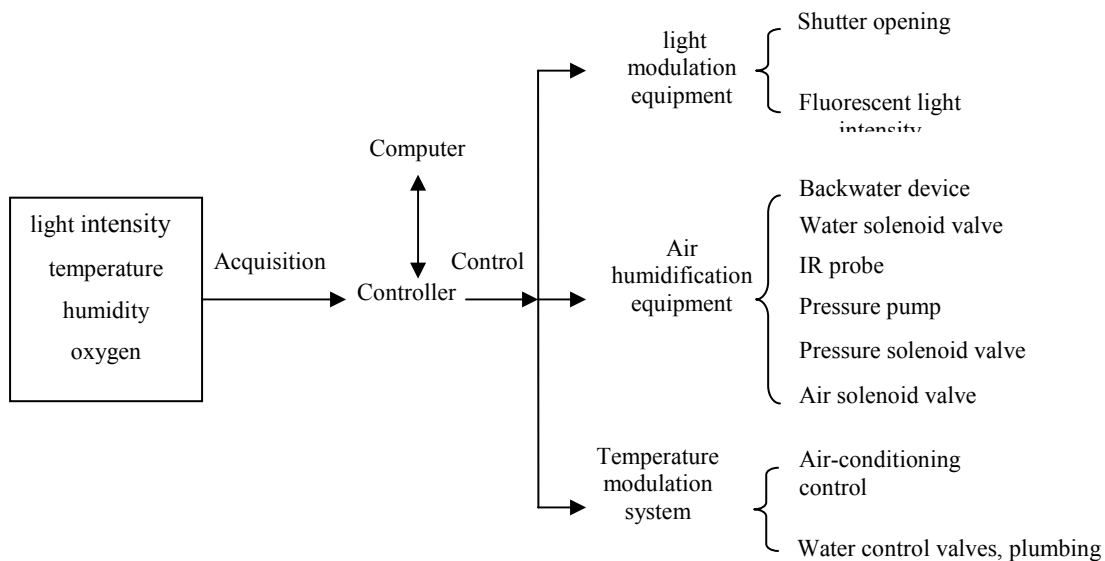


Fig1. Principle diagram of breeding germination greenhouse environmental monitoring system

Breeding germination greenhouse environmental monitoring system software control interface is as follows:



Fig 2. Breeding germination greenhouse environmental monitoring system interface

On the computer control software interface, germinant seed can be chosen by user on one's own circumstance, this computer control diagram can run automatically, and regulate environment in greenhouse so as to suit seed germination.

The working principle of breeding germination greenhouse environmental monitoring system is as followings: the system has several types of common seed's germination conditions in greenhouse and characteristic parameters at different stages, new seeds characteristic such as optimal temperature and humidity in the day and night, light requirement, optimal oxygen content, different characteristics of growth phase can be added by users. Based on seed germination characteristic parameters in the day and night, based on external climate condition tested by weather station and real-time day-night segmentation offered by weather department, this system figures out a suit of control strategy which includes the change of temperature, humidity, light and oxygen content during seed germination period. These parameters change which is analyzed and calculated automatically by this system will reflect to parameters that need set by computer program, so as to realize control parameter's real-time change with seed germination progression and external environment, and make seed germination environment according with theory.

The working principle of the controller is as followings: controller collects parameters of temperature, humidity, light and oxygen content and then compare them with parameters output through controller, and examines if it fits seed germination conditions, if not corresponding measures should be taken. For example, if temperature doesn't satisfy the requirement, the air can be cooled by air-condition in summer and be heated by heating system which can adjust indoor temperature by controlling import water quantity in winter; if humidity doesn't satisfy the requirement, low-pressure spray mist import water solenoid valve, pneumatic solenoid valve and solenoid pump will be turned on, after definite humidify time, the rest water in the pipeline was drawn and cleaned out by using backwater equipment pump. If oxygen content is not enough in the greenhouse or fresh air need to be supplemented, Air solenoid valve can be activated and compressed air can enter the greenhouse; infra-red probe need to be used. Fig.3 is humidity and air supplement system.

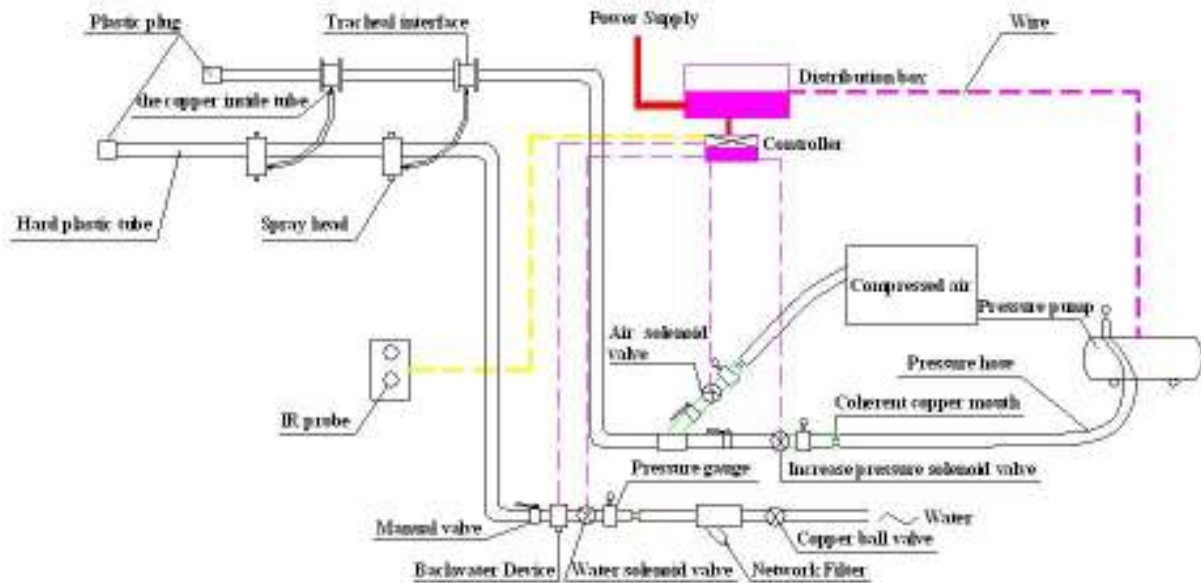


Fig3. Humidity and air supplement system

Structures of Breeding Germination Greenhouse and The Application of New Materials

Breeding germination greenhouse takes heat insulation, burn resistant, clean-proof new type light-gauge building material (purified color armor plate) as main material. The ceiling of breeding germination greenhouse uses 8mm PC plate and 100mm color armor plate, its span is 9.6m and the bay is 8m. Color armor plate is made by doing chemical treatments on surface of cold-roll steel sheets and galvanized sheet, painting (roller painting) or sticking organic film (pvc film etc.) and then baking. Color armor plate not only has the qualities of mechanical intensity and easily molding, but also has the qualities of decoration and causticity-proof. Color armor plate has the advantages of light-gauge, high strength, waterproof, heat preservation, heat insulation, easy to use, earthquake resistant, universal placement and so on.

Low-pressure Spray Mist Humidification Technology Greenhouse spray mist system is an irrigation system with an average diameter of droplet size below $20\mu\text{m}$, these mist can vapor quickly in the air. In fact, the aim of spray mist system is not used for irrigation, but mainly for reducing the temperature in high temperature months. The air temperature in greenhouse can be reduced rapidly by using spray mist system together with ventilator.

Low-pressure spray mist system is composed of infra-red probe, gas-liquid two phase atomizer, water pipe control device and windpipe control device. This spray mist system offers pressure to the spray nozzle system, and need an air pressure pump whose air pressure should reach $2.8\text{kg}/\text{m}^2$, a water pump or booster pump is needed when hydraulic pressure is deficiency. This system doesn't need special ductwork, large atomizer aperture preventing from jamming, and export water quantity of this atomizer is more than high-pressure atomizer, this means the quantity of atomizer in breeding germination greenhouse is less, and commonly every 10-15 square meters needs only one atomizer. The atomization effect of this atomizer is also good, the whole greenhouse can be full of mirage, and no dripping drops in the plug trays to influence seed germination and seedling growth. The spray mist system is either controlled by infra-red probe, or by the main controller program. The breeding germination greenhouse needs to maintain oxygen

and air motion velocity, a compressed air control device is equipped on the import windpipe, which can send compressed air into greenhouse and supplement the needed air.

Light Supplement of Breeding Germination Greenhouse If using light to prolong the growth time in breeding germination greenhouse for better germination or increasing the germination rate of some photosensitive plants, it is best to choose cold white fluorescent lamp. Fluorescent lamp using low-pressure mercury vapor radiate ultraviolet radiation on the discharge process, thereby make fluorescence emit visible light, therefore it belongs to low-pressure arc discharge lamp. Fluorescence emits visible light after absorbing ultraviolet radiation. Because fluorescent lamp converts most of electric energy into ultraviolet radiation, so its efficiency is higher than incandescent lamp and halogen lamp, and it is the most energy saving. Fluorescent lamps can be installed up through the germination chamber, or vertically along the wall, or between two planting frames. Double type lamp whose spacing is 1.8m to 2.4m can offer approximately 1076lx light intensity. The lamp distant from plug tray is at least 20cm to 25cm to prevent dry-wet non-uniform and light distributing non-uniform [1]. Breeding germination greenhouse commonly chooses low-pressure double type fluorescent lamp located vertical along the wall. Fluorescent lamp can regulate light intensity by fluorescent lamp supply current, satisfying light requirement for seed germination.

Moreover, breeding germination greenhouse can use solar absorbing belt and shading system reasonably. At present large & medium type breeding germination greenhouse commonly adopt enclosing structure, and wholly using artificial light as supplemental light for intolerant seeds germination. A special controlled lighting belt was set on the breeding germination greenhouse for fully taking advantage of natural light resource and reducing breeding germination greenhouse environment control energy consumption.

Pregermination Shelf of Breeding Germination Greenhouse According to plug tray specification, pregermination shelf designed for 1400mm by 540mm, efficient size should be 1460mm by 545mm. It is a layer-frame structure, and every layer can accommodate five plug trays with 540mm long, 280mm wide and 48mm high. The four sides of pregermination shelf is an open frame structure, four locking device were set at the bottom with truckles. After galvanization, pregermination shelf need to be plastic sprayed or hot dip galvanized. The plug chamber must have enough intensity, no absolute distortion occurs when loading trays full of media. Above the bottom of plug chamber is assembly structure, which is assembled at building site.

Cooling and Heating System of Breeding Germination Greenhouse Breeding germination greenhouse can modulate temperature by air-condition in summer, ensure the temperature in greenhouse is satisfied for seeds germination, and in winter will use heating unit, which can regulate indoor temperature by electrical import water control valve. The length of circulating pipes for radiator is equal, to ensure the temperature uniform in greenhouse.

WORKING ENVIRONMENT TEST ON BREEDING GERMINATION GREENHOUSE

Two experimental breeding germination greenhouses were built by research team, one is positioned at Farming-pastoral academy of science in Lasa city of Tibet in China, another is in Liannong seed & seedling demonstration farm in Wenzhou of Zhejiang province in China. The seedling productivity and quality can be improved by using breeding germination greenhouse.

The temperature and humidity of breeding germination greenhouse were tested on Liannong seed & seedling demonstration Farm from the 7:00am on 28 November to 7:00am on 29 November in 2007. Temperature and humidity in the environmental control system were set at 20°C and 66%RH separately. In order to test temperature and humidity accuracy in breeding germination greenhouse, three 8829 automatic temperature/humidity data-loggers made by AZ Instrument Corp were set, the test time spacing is 1 hour. According to experiment, test results of temperature and humidity are shown in figure 4 and figure 5. (note: points two, three, four are three uniform distributing testing points).

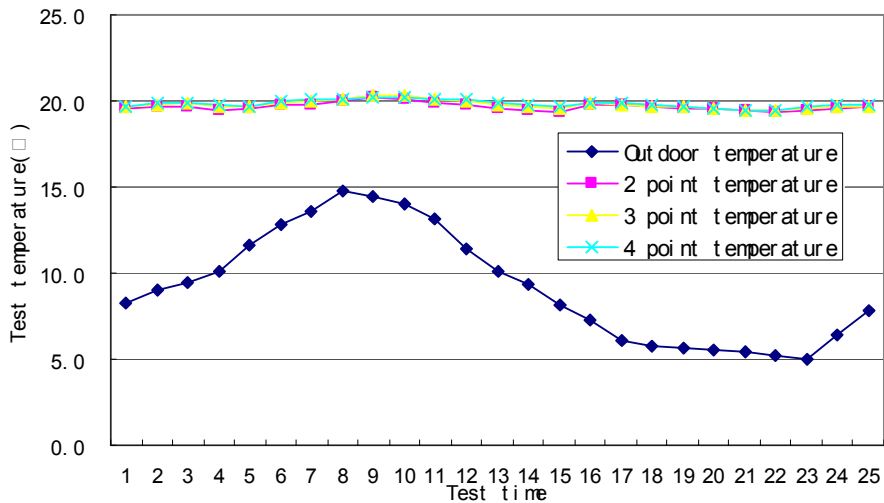


Fig4. Temperature comparison indoor and outdoor breeding germination greenhouse

According to test, the temperature in the breeding germination greenhouse can be controlled at a constant temperature, and accuracy is $\pm 0.5^\circ\text{C}$, the humidity in greenhouse is between 64.6%RH and 70.2%RH when outside humidity is 60.3%RH and 77.5%RH, and accuracy is below $\pm 3\%$.

The above data is totally fit the seed germination environment requirement which the temperature and humidity should be between 10°C and 30°C, 40% RH and 90%RH separately, and accuracy is $\pm 0.5^\circ\text{C}$ and $\pm 3\%RH$. Under such relative constant temperature and humidity environment, the rate of germination is above 95%.

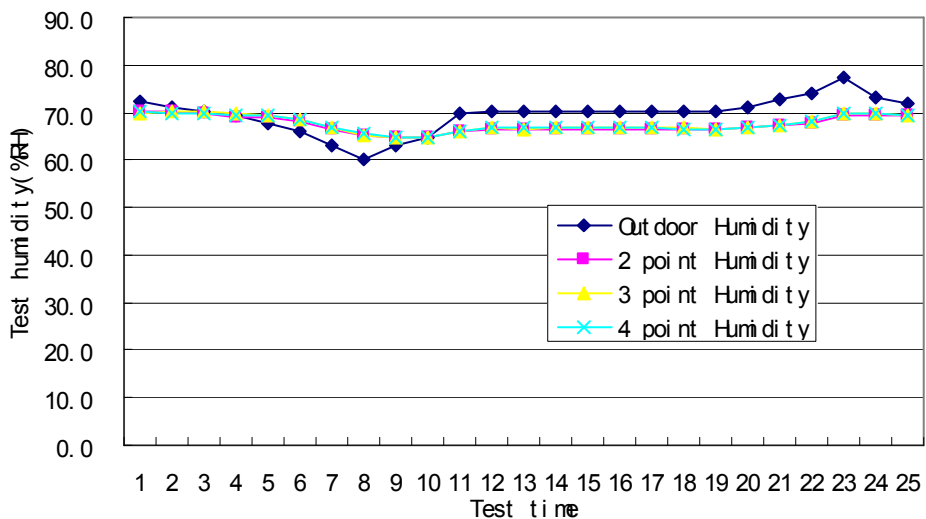


Fig5. Humidity comparison indoor and outdoor breeding germination greenhouse

CONCLUSION The research and development of breeding germination greenhouse and ancillary technology & equipment conform to the China climate conditions and market requirement, it can greatly enhance the plug seedling germination technology in China, and provide perfect technology support and guarantee for the development of Chinese facility agriculture.

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