Chapter 9
Energy-Efficient Lighting System for Greenhouse Plants

Leonid Yuferev
Federal Scientific Agroengineering Center VIM, Russia

Alexander Sokolov
Federal Scientific Agroengineering Center VIM, Russia

ABSTRACT

This chapter describes how with the artificial cultivation of plants lamps are required with a certain spectrum of radiation. For lighting plants have developed a special lamp. Industry produces special gas discharge lamp. In these lamps a fixed range of radiation. Recently, there were light sources for plants on LEDs. LEDs can create light with any spectrum range from 360 to 800 nm. The authors of the article give a technique for modeling the spectrum of luminaires and calculating LED lamps for plants. The tests of the developed lamps for plants in dark chambers are given. A description of a resonant regulated power supply system for LED luminaires is given. In the proposed system when the frequency changes radiation power.

INTRODUCTION

Most greenhouses use high and low pressure efficient sodium lamps high and low pressure as light sources, but their range replaces the natural spectrum needed for plant growth and development only partially. Previous studies show that the most favorable for plants is sunlight - a continuous spectrum. The UV radiation range A contains up to 8% in the natural solar spectrum.

Expanding the range of artificial light sources in the UV radiation and the possibility of changing the spectral composition allows increasing yield and improve the quality characteristics of the product. Metal halide high-pressure mercurial lamps have the closest spectral composition, but these lamps have a fixed range and their service life isn’t long.

Powerful LEDs cover the entire desired spectrum needed for the development of the plant from 380 to 700 nm.

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Modern LEDs partially applied in the greenhouse with existing lighting systems. The use of LEDs as light sources will create artificial matrix illuminator with variable spectrum.

Lighting systems by using LED light sources get a high efficiency in 1.5 ... 2 times higher than sodium lamps used in greenhouses. One of the advantages is the absence of heat radiation, in which there is increased consumption of water by plants.

Known solutions of lighting systems require the installation of LED power supply (driver) in each lamp. An adjustable lighting system will require a digital control system. Another option of adjustable lighting system can be power supply system based on the resonance of the transmission system. In such system one voltage converter can be used to enable the LEDs for transmitting a large number of fixtures, in which the inverters are installed with a simplified rectifier circuit. And the adjustment is performed by changing the frequency and therefore movement from the resonance.

The Effect of Artificial Lighting on Plants

The most important group of physical factors affecting the growth and development of plants is the light regime.

The management of photosynthesis is the most effective way of influencing the productivity and yield of plants. As a result of the research, it was shown that the most favorable for growing light-loving plants are the intensity within the range of 150-220 W / m², and the optimum composition of radiation has the following ratio of energies over the spectrum: 30% in the blue region (380-490 nm), 20% in the green (490-590 nm) and 50% in the red region (600-700 nm). There were obtained in several times higher yields by using such artificial lighting than in normal illumination and it took shorter (in 1.5-2 times) periods.

The intensity of irradiation is the most important vital component in the conditions of artificial cultivation of greenhouse plants, and different parts of the spectrum have different effects on the growth and development of plants, so the spectrum of an artificial light source must have certain characteristics.

Literature Review

The first systematic experiments on the effect of artificial radiation on plants were carried out in 1865 by Russian botanists A.S. Famintsin and I.P. Borodin (Moshkov, 1966). The source of radiation was kerosene lamps mounted in a special device, which has a reflector and a lens. The alga (Spirogyra) was exposed to the light, and the formation of starch was observed in its chloroplasts.

In 1882 at a special lecture, K.A. Timiryazev demonstrated the effect of electric lighting on the process of decomposition of carbon dioxide by water plants. (Moshkov, 1966)

Somewhat later, in 1895, the electric arc was successfully used by the famous French botanist Bonnier. (Moshkov, 1966) He sprouted seeds, rhizomes and tubers of herbaceous plants. He managed to show, not only the presence of growths of plant mass under the influence of electric light, but also their dependence on the duration of the daily illumination period.

The first attempt of using the light of an incandescent lamp was made in 1895 by R.W. Rane (Moshkov, 1966). However, due to the imperfection of electric lighting, it was preferred to use other lighting sources and, in particular, the Auer gas burner.

For the first time, the American researcher Harvey experimentally possible proved the possibility of growing plants completely on artificial light in 1922. And in response to the appearance of powerful