Problems of the Influence of Light on Workers in Greenhouses

Z R Abdrakhmanova¹, A L Laukmanis², C V Pshenichnaya³

¹Peter the Great St.Petersburg Polytechnic University, St.Petersburg, Russia, st. Polytechnicheskaya, 29, 195251
²Peter the Great St.Petersburg Polytechnic University, St.Petersburg, Russia, st. Polytechnicheskaya, 29, 195251
³State Marine Technical University of Saint-Petersburg, St.Petersburg, Russia, st. Lotsmanskaya, 3, 190008

E-mail: abdrakhmanova.zu@gmail.com, Laukmanisanna@mail.ru, pshenichnaya@mail.ru

Abstract. No living person can do without vegetables and fruits, food grown in the fields, kitchen gardens or in greenhouses. Those crops that are less whimsical to their surrounding nature and the conditions of growth and fruit formation are grown in open ground, and those that are more demanding, but at the same time not less necessary are grown in protected ground, or greenhouse. In this article, an analysis was conducted of the influence of the main harmful and dangerous production factors on the organism of workers in the greenhouse complex. When working in greenhouses, employees complain of discomfort from exposure to bright light and ultraviolet radiation during artificial irradiation and lighting up of plants. In the work, a comparison of frequently used types of lamps in greenhouses was made and it was revealed among them that it is safer for workers. Recommendations for improving working conditions are given.

1. Introduction

Over the past decade, fruit and vegetable products have acquired great importance for humans. The desire to improve and balance their diet, the desire to abandon unnatural products has led to a huge modernization of agricultural production and an increase in the number of enterprises for the cultivation of greenhouse crops. But despite the improvement of technological processes, the problem of the influence of illumination on the workers of greenhouse complexes remains relevant today [1].

The success of plant growth is ensured by the optimal selection of microclimatic conditions. Light is the main factor in the formation of the microclimate in the greenhouse. Its amount affects the intensity of photosynthesis, the spectral composition affects the phases of development, growth, flowering and fruiting of plants, and the duration of the light period affects the phases of flowering and fruiting[2].

Therefore, insufficient or excessive lighting can lead to a decrease in yield. That is why it is necessary to maintain the values of certain parameters at the intervals provided for the respective crops[3].
2. Methods
To identify the causes of the negative impact of greenhouse lighting on human health, it is necessary to study various factors of the working environment. Of all the major hazards (increased (up to 100%) air humidity and lack of mobility, moving machines and mechanisms, unprotected moving parts of production equipment, high (more than 45°C) surface temperature of process equipment, low (less than 10°C) and high (more than 25°C) air temperature, a sharp change in barometric pressure, increased noise level in the workplace) workers of greenhouse complexes emit increased brightness of light and the level of ultraviolet radiation with artificial irradiation and illumination of plants [4-5].

The spectrum perceived by humans is different from that absorbed by plants. The human eye, for all its perfection, catches only a small part of the entire spectral range of electromagnetic radiation. Plants are much more sensitive. For proper growth and development requires a much wider range than can be perceived by human vision. For example, the most optimal perception of light flux in humans occurs in the range of 380-780 nm[6]. The sensitivity of flora is determined by a wider spectrum:

- Light with a wavelength shorter than 380 nm is detrimental to plants. They can burn, the leaves turn yellow and curl.
- Waves 380-430 nm contribute to the production of vitamins, the trunk becomes more massive, and the plants become cold-resistant.
- Waves with a length of 430-490 nm increase the size of the leaves, which allows us to accelerate photosynthesis, this leads to the rapid growth of plants.
- The range of 490-570 nm is green, the leaves reflect it.
- The range 570-600 is yellow-green, the plants are drawn out.
- Waves in the range of 600-780 nm contribute to rapid growth, intensification the formation of carbohydrates that promote good fruit development.
- Waves from 780 nm and longer can increase the temperature of the plant, which leads to death.

To clarify the problem of discomfort among the working staff, it is necessary to consider the regulations and the values normalized in them.

Figure 1. Human eye and plant response.
Therefore, optimal conditions for plants are not always comfortable for humans. To clarify the problem of discomfort among the working staff, it is necessary to consider the regulations and the values normalized in them.

The following units of measurement are used to assess the characteristics of light useful for plants:

- **Photosynthetic Active Radiation (PAR).** It characterizes the radiation power in the range of 400-700 nm per 1 m$^2$, which falls on the plant. Measured in W/m$^2$.

- **Photosynthetic Photon Flux (PPF).** This parameter is used to express the flux of light (PAR) in the number of photons per second in the range 400-700 nm. Measured in µmol/s.

- **Photosynthetic Photon Flux Density (PPFD).** This parameter characterizes the number of photons falling per second per square meter in the range of 400-700 nm. Measured in µmol/s·m$^2$ [7].

Basic data on the regulation of illumination of agro-industrial complexes in Russia are presented in OSN-APK 2.10.24.001-04 "Standards of illumination of agricultural enterprises, buildings and structures".

### 3. Results

Human exposure depends entirely on the type of light source and its characteristics. Today, there are a wide variety of fitolamp both the old and new generation. The most effective sources of artificial lighting for growing plants are sodium gas-discharge lamps such as DNAT (Sodium arc Tube) — in a cylindrical flask [8]. They are widely used for the cultivation of crops and flowers. The composition of sodium lighting devices includes a mixture of sodium vapor and mercury. They emit a favorable spectral composition of light (red-yellow) for growing plants. Sodium fitolampy produce large amounts of ultraviolet radiation, whose excess effect on the retina of the eye leading to corneal burn, cataract, conjunctivitis and even blindness. The property of the cornea to accumulate the resulting ultraviolet contributes to a tangible deterioration of visual functions.

The blue spectrum (440-480 nm) is visible to the eye and is located near the ultraviolet. Phytolamp, in the emission spectrum of which the blue color predominates, stimulates the growth of plantations. However, the possible consequences of a regular exposure to such a fitolamp may be: lens and retina damage (which occurs gradually, since UV radiation has a cumulative effect), cataracts, muscle degeneration, and damage to the long-term light source [9].

Led bulb a number of parameters are the most suitable fitolamp. Their main advantage is a low ripple coefficient (within 1%), due to which the intensity of the negative impact on the human body is significantly reduced. Another distinguishing feature is the combinatoricity of such light sources: the possibility of using combinations of different light sources (with red, blue LEDs), which allows you to get all kinds of shades. LEDs are characterized by low UV radiation, which minimizes the negative impact on humans. However, radiation with such a spectrum can affect the state of health, in particular, on the organs of vision in the form of deterioration of concentration, tension in the eyes, fatigue. At the same time, led lamps are referred to groups with low and moderate risk of developing diseases. Therefore, from all available led fitolampy are the least hazardous to health.

In the case of combining the light environment of a person and a plant, light is preferred, providing not only the needs of the plant, but also the visual comfort of a person, that is, white light of high color rendering [10-11].

### 4. Conclusion

The difference in the perception of the light environment by man and plant causes discomfort, which responds to a large number of employees of greenhouse complexes[12]. Full optimization of the light environment is almost impossible, because the plants are extremely sensitive, which means that even the slightest deviation of the lighting parameters entails a change in the growth of vegetative and generative parts of fruit and vegetable products. However, it is possible to implement other measures to ensure more comfortable working conditions [13]. For example, replacement of low-pressure discharge lamps with stroboscopic effect by high-pressure discharge lamps or led lamps[14]. It is also
necessary to conduct regular medical examinations and monitor the statistics of complaints or diseases of the visual apparatus of greenhouse workers, depending on their experience. According to the results of the analysis of statistics, it is possible to change the mode of work or the time spent by employees in the high-light zone.

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