LED RADIATION WITH DIFFERENT SPECTRA INFLUENCE ON PLANTS DEVELOPMENT AT DIFFERENT STAGES OF VEGETATION

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Introduction

In spite of numerous research, concerning the influence of radiation with different spectra on photosynthesis [1,2,3,4,5,6], the narrow-band radiation influence on plants at different stages of vegetation is studied insufficiently. The research is topical due to the absence of systematic data on condition of the plant photosynthetic system under LED radiation. At the same time resource efficiency acquires a special place in competitiveness and development of agricultural enterprises.

The aim of the research is to study the influence of radiation spectrum and intensity on lettuce crop growth and development.

Materials and methods

The experiment was held in the period from May 22 to June 6, 2013. Lettuce «Moscow greenhouse» was chosen as an object of research. Duration of daily photoperiod was 12 h continuously during the experiment. A mechanical timer-plug was used for turning on and off the lighting system. Experimental samples were grown in 3 phytotron models (Fig. 1).

Fig. 1. Physical configuration of phytotron models

The front wall of phytotron model was converted to the audit window (Fig.2). The thermometer was fixed on the inner wall for temperature control (3). The radiation source (5) was fixed on the top (6). Lettuce seeds were sowed into the containers (4) with universal nutritious soil «Terra Vita» placed on the bottom of a phytotron model.

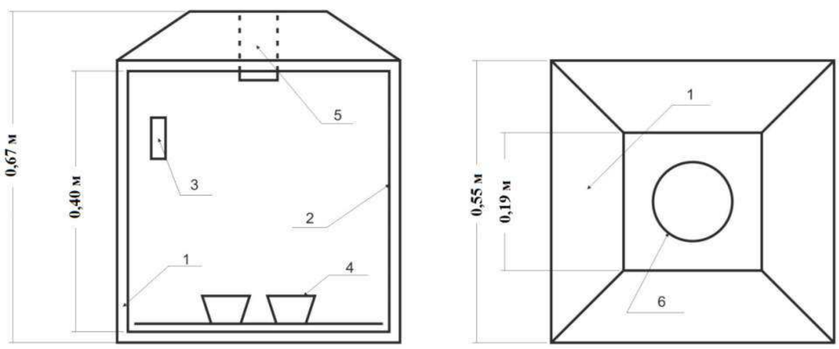

Fig. 2. Phytotron model scheme
1 – shell; 2 – audit window; 3 – thermometer; 4 – containers with soil; 5 – radiation source; 6 – top-holder of radiation source.

Different LED modules were used for irradiation of the plants in each phytotron: red LED module with dominating wavelength λ_d= 620–630 nm, green LED module (λ_d= 520–535 nm), blue LED module (λ_d= 450–465 nm).

LED modules based on RGBW LED Cree XLamp MC-E (pic.3) 3×4 sm were used. A power supply was provided by the driver IPS 30-350T in nominal conditions (I=0,35A).

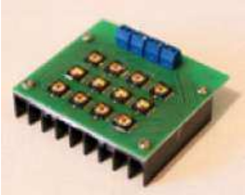

Fig.3. LED module:
1 – PCB; 2 – LED; 3 – radiator;
4 –power connector.

Specification of the radiation sources is shown in Table 1.

Table 1 – Characteristics and nomenclature of the radiation sources.

Source	Power capacity, W	Luminous flux, lm	Dominant wavelength λ_d, nm / Color temperature, K
LED module (red)	10,5	529,2	620–630 nm
LED module (green)	15,4	651	520–535 nm
LED module (blue)	14,7	310,53	450–465 nm

Radiation spectra of sources were measured with the spectrophotometer AvaSpec-2048 USB2, the monochromator MDR-206. Luminous flux of the sources was determined, using a photometric integrating sphere.

The following parameters were measured: number of leaves, height of sprout, width of leaf.

Results

Values of measured parameters are presented in pictures 4–6.

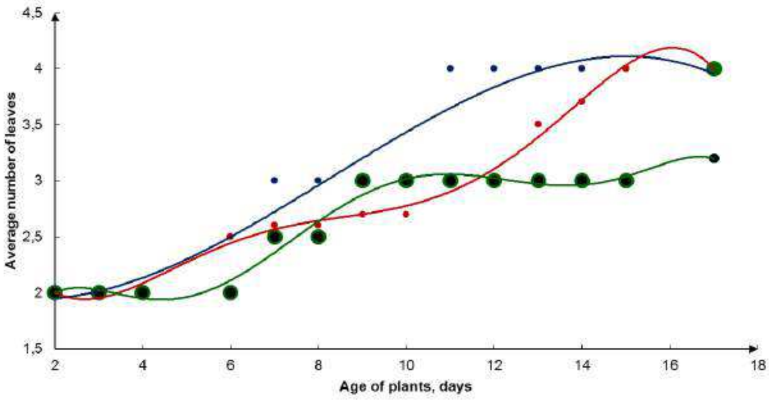

Fig. 4. Average number of lettuce leaves variations

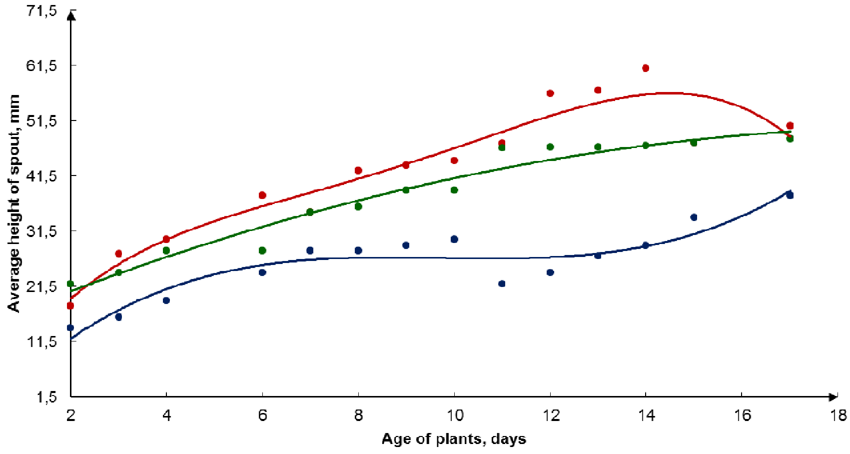

Fig. 5. Height of lettuce sprout variations

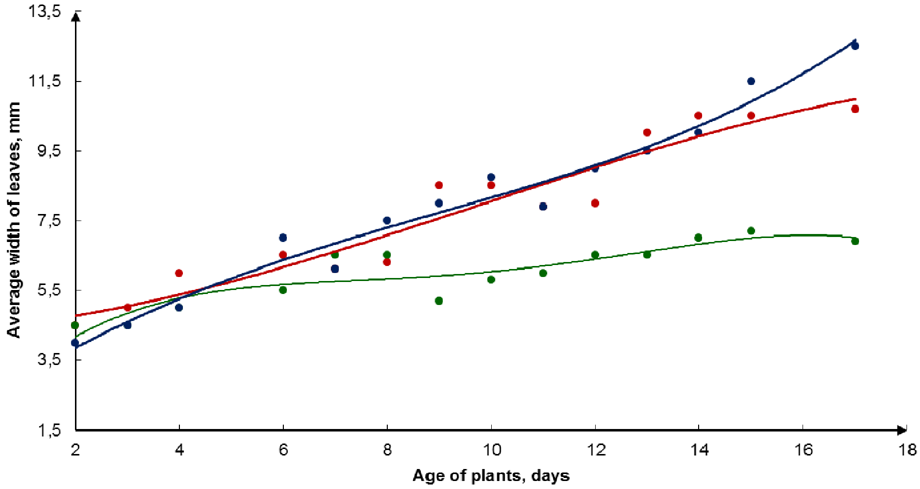

Fig. 6. Width of lettuce leaves variations

Most of the plants had 4 leaves after 17 days of experiment. In 11 days the fourth leaf was found in phytotrone with the blue LED module (the first among other phytotrones), as average time of the fourth leaf growth was 15 days. So, the conclusion can be made that the blue part of the spectrum facilitates development of crown. Samples that grew under the green LED module radiation had the maximum height of a sprout; samples under the blue LED module had the minimum height. So, we can conclude that green spectrum promotes growth in height.

Lettuce that grew under the blue LED module radiation had the maximum width of a leaf. These leaves developed more actively, they were deep green colored and carved at the end of experiment. The samples in other phytotrones did not have these features. The sample under the green LED module had leaves of the untypical form and pale green color, in spite of their large width.

Conclusion

The results of the study confirm topicality of the questions of spectrum regulation as far as its influence on plants growth and development is great. Required processes can be activated by radiation with different spectra at every stage of vegetation.

Usage of LED based modules is very prospective due to the possibility of their spectrum control. Methods of control are the following:

- variation amperage of RGBW LED components;
- turning off same parts of the LED module;
- spectrum correction by remote phosphor.

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IMPROVING THE MANAGEMENT SYSTEM BASED ON THE PROCESS APPROACH

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Since contemporary business environment has become more dynamic and uncertainty, most companies are experiencing a fundamental shift in the rules of competition. The old, dominant business logic focusing on stability seeking and uncertainty avoidance may be inadequate for firms to respond to this rapidly changing environment [1]. Indeed, this fast growing economics calls for a strategy based on three intertwined elements: low cost, high quality and fast and flexible response to customer needs [2]. Thus, only firms possessing the capability of being aligned and efficient in their management of today's business demands while simultaneously adaptive to changes in the environment are more likely to success [3].

As enterprises are increasingly recognizing the strategic importance of quality management [4] and information technology [5], process-based management practice has become very popular throughout these years [6]. Consequently, a number of studies interesting in process's role in business value creation have appeared - especially in the con text of IT-enabled business value [7].It has been widely accepted that business process management (BPM) can contribute a lot to improve manufacturing efficiency [8] and much of literatures on BPR also embraced this “seek efficiency” view to achieve the value of BPM [2]. However, as business competitive environment has become more intensive, the need for dual capabilities also arises in the context of focusing on BPM.

Business process management (BPM) has been referred to as a "holistic management" approach to aligning an organization's business processes with the wants and needs of clients. BPM uses a systematic approach in an attempt to continuously improve business effectiveness and efficiency while striving for innovation, flexibility, and integration with technology. Process management is the application of knowledge, skills, tools, techniques and systems to define, visualize, measure, control, report and improve processes with the goal to meet customer requirements profitably.

So, the article is aimed to provide analysis of Process Management in organizations nowadays. The issue of Process Management presented in articles by M. Kohlbacher, R. Xie, H. Ling and Ch. Zhang and our Russian authors O.L. Vishnyakov and N.E. Rybchenko.

M. Kohlbacher writes about process-orientated organizations. A process-oriented organization is also often referred to as “horizontal organization”, “process centered organization” [9], “process enterprise” [10],