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Sh. Yusupov, D. Diniqulov and M. Mamutov

Modeling method for optimizing the regulation of physiological processes in the cultivation of sweet pepper seedlings

Sh. Yusupov[1, a)], D. Diniqulov[2] and M. Mamutov[3]

[1]*Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, Tashkent, Uzbekistan,*
[2]*Tashkent State Agrarian University, Tashkent, Uzbekistan*
[3]*Karakalpak State University named after Berdakh, Nukus, Uzbekistan*

[a)] Corresponding author: yu.sh2003@mail.ru

Abstract. Several different methods are used to grow agricultural foods to increase their productivity. In particular, with the help of electro-technological methods, it is possible to influence the physiological processes occurring in the process of plant growth. Through these processes, high quality early maturing varieties of agricultural food can be grown. Saving energy and resources in the process of growing food leads to lower prices for the product. Therefore, it is possible to optimize and simulate the measures taken until the plant reaches the seedling state for plant growth and row spacing in the field or greenhouses and then is planted and yielded. By studying the physiology of a plant's growth period, the regulation of the physiology of its growth cycle can then be optimized [1-3].

INTRODUCTION

The vegetable sector of the agricultural sector also plays an important role in providing the population with food throughout the year and increasing the export potential. Today, to improve the population's living conditions, to meet the need for vegetables rich in vitamins throughout the year, it is necessary to use advanced foreign and resource-saving technologies in this area. Tasks and tasks have been set to grow and improve the quality of vegetables, increase exports, and develop vegetable growing in open and greenhouses. Greenhouses grow vegetable seedlings for a larger open space. About 70-80% of sweet peppers are grown from seedlings. The only promising way to increase the yield of vegetable crops and improve the quality of fruits is vegetative grafting. In recent years, there has been a growing interest in this method, which vegetable growers widely use in Western Europe, Southeast Asia, and the USA. One of the methods of electrophysical influence on plants is their intensification with the help of intense ultraviolet and infrared radiation and acceleration of the process of getting into the crop [2-14].

Depending on the qualitative sensitivity of technological processes, changes in the structure or reaction of the plant organism must be regulated following external irradiators of the wine. Due to many interacting environmental factors, exposure to plants provides insight into the behavior of the entire plant rather than a detailed study of the parameters of each factor. Consequently, the process that is regulated in plants during observation is abstracted from the ideas about the processes in the plant, its composition, an approach that makes it possible to understand how the function of systemic use is organized. Research based on a systematic approach, which contributed to the introduction of the need to perform multiparametric ecophysiological processes, leads to the biology of the ideas of cybernetics and phytotronics [4-17].

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FIGURE 1. Cabinet (phytotron) where sweet pepper seedlings grow.

MATERIALS AND METHODS

When using a growing cabinet, the process involves the interaction of radiation intensity, ambient temperature and CO_2 concentration for gas exchange and plant biomass in the early stages of ontogeny and economic productivity and reproductive process in plants during greenhouse carbon dioxide gas exchange. A multifactorial method is used to process the data. Studies have shown that the range of temperatures that change in nature is divided into five ranges depending on their effect on plants, and their values increase and decrease in the background and in the two areas of hardening and damage [6]. To ensure accuracy, the movement of factors, taking into account the zoning of the impact and the distance between the measurement points, must be in the same zone. This is done by installing a phytotron to grow plants of the same, different and the same age in the greenhouse, as shown in Figure 2 [5-9].

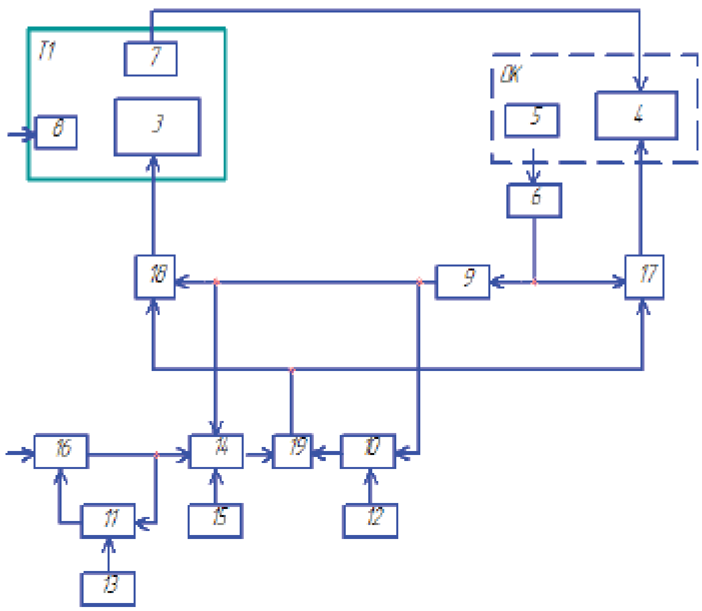

FIGURE 2. The system of optimization of methods for the development of technological processes for growing plants in greenhouses: T1 is greenhouse, OK is optimization of the room (phytotron), 3 and 4 are T1 and OK, 5 is block criteria of the physiological state of plants, devices for regulating technological parameters, 6 is block optimization, 7 are sensors of non-optimization factors, 8 are sensors of shock control, 9 are filters, 10 and 11 are sensors for setting the time function, 12 and 13 are detection functions, 14 is special abbreviation correction device, 15 is regulator, 16 is correction block, 19 are adders.

This system measures the optimized parameters of the external environment and, as a result, the growth in the phytotron. This system measures the optimized parameters of the external environment and, based on the results, forms a mathematical model of planting, taking into account the current and a priori data of the values of the physiological processes of plants in the phytotron, and also calculates the value of the optimization criteria for external conditions. Optimization criteria and control signals are generated to regulate the optimal modes calculated for the desired forecast period for the environmental parameters of the phytotron and the greenhouse. Based on optimisation results through a feedback system, a mathematical model is developed. The current values of the non-optimized parameters in the phytotron and the greenhouse and the deviations of the non-optimized parameters in the phytotron are compared and equated. Phytotron with plants, uniform environment, variety and age, with plants installed by measuring devices located inside the greenhouse; devices that stimulate the behavior of plants during the forecast period, connected to the input of the automatic optimizer by calculation, are the same[6-19].

Aeroponics is a high-tech method of growing plants using special nutrient solutions to increase their development and productivity. The method of apical meristems of experimental plants is used, which is used for the good growth of aeroponic plants. Technological progress, microprocessor technology, energy-saving LED sources of artificial radiation have made aeroponic technology at the enterprise economically profitable, and today the demand for it is greater than ever. Because the technology of growing aeroponic plants allows rationally filling the volume of buildings, it is possible to place additional plants in layers, thereby saving and increasing the working area, increasing productivity. The absence of a soil substrate and the fight against diseases of the joints does not negate the need for sterilization and facilitates plants' care [10-20].

An important method of growing plants in aeroponics is the use of LED radiation sources of these plants, the parameters of which drastically reduce energy costs due to high light output, long service life and the ability to regulate the radiation spectrum. When growing plants, the effectiveness of any technology is determined by its ability to regulate each stage of their growth and development. The aeroponic method allows better regulation of the environmental conditions, the illumination of the grown plants than traditional methods and technologies of the greenhouse. One of the most important advantages of aeroponics is the rapid regulation of environmental factors. With the help of optimally selected factors of the spectral composition of light, mineral nutrition, temperature (both around the leaf surface and inside the root zone of plants), it is possible to repeatedly control the growth of plants from mini-root form to yield to increase quality and quantity[6-9].

The growing conditions of everything depend on the growing season, optical illumination. Currently, the cost of one mini-tuber tape (5 meters long) is about 100,000-115,000 soums; the price depends on the scale and level of production automation. When studying the effect of the LED on the sweet pepper meristem, a light source and the most convenient blue-white-red spectral composition were found. Blue, red and white LEDs can improve the quality of the meristem of plants by 20 ... 25% and save energy by 60-70% compared to other lamps [1-5].

RESULTS AND DISCUSSION

The distribution of dry biomass over the plant body has a different nature and, as noted, depends on the spectral composition of light. Dry biomass accumulation increases under fluorescent lamps and white light LEDs. There is more of this substance in the leaves than in the roots and stems. When plants are irradiated with red LEDs, more dry biomass is accumulated in the roots. Under the influence of white and blue spectra, it is known that the accumulation of dry matter changes over time, accelerating the process of photosynthesis in plants.

TABLE 1. Results of the sprouting process of sweet pepper seedlings.

Days of the month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Growth of treated seedlings	0	0	0	0	0	0.5	1.5	3.5	4.2	5.1	5.9	6	6.2	7	7.2
Growth of untreated seedlings	0	0	0	0	0	0	0	2.2	4	4.5	5	4.5	4.8	5	5

Table 1. Results of the sprouting process of sweet pepper seedlings (continuation).

Days of the month	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Growth of treated seedlings	7.2	7.2	7.2	7.2	7.2	7.2	7.4	7,4	7.4	7.6	7.6	7.6	8	8	8.1
Growth of untreated seedlings	5.3	5.3	5.3	5.3	5.5	5.8	5.8	6	6	6	6	6	6	6	6.1

In the process of growing seedlings of the Tashkent sweet pepper variety, we have achieved the following results. The 1st and 2nd stages of the three-stage germination period of sweet pepper seedlings were taken into account. We have a graph of the time dependence of the process of growing sweet pepper seedlings.

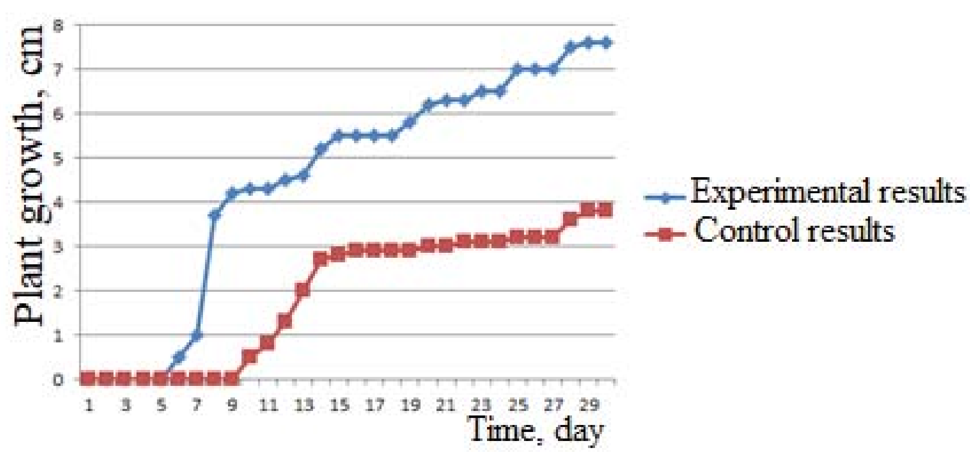

FIGURE 3. Graph of the dependence of the growth of sweet pepper seedlings on time.

FIGURE 4. Grown sweet pepper seedlings.

CONCLUSION

Optical radiation has a very significant effect on photosynthesis and other biological processes in plants; therefore, it is assumed that radiation's spectral radiation or spectral intensity is in the range from 400 to 700 nm of the radiation wavelength that activates photosynthesis. Most blue and red rays are well absorbed by plants.

The maximum uptake of useful biomass is not always the main factor in the process of photosynthesis; optical irradiation is the result of maximum photosynthesis of the green leaf; therefore, the accumulation of new biomass is an illumination of the actual process of plant growth.

As a spectrally controlled parameter, it is necessary to determine radiation's composition and spectral intensity during growth.

Corresponding factors obtained using aeroponic devices can control the spectral composition of light, mineral nutrition, temperature depending on plant growth and can also increase plant quality and yield several times.

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