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Development of new elements to automatized greenhouses

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Abstract. Development of new elements to automatized of greenhouses is always needed and be it is to improve the current situation because of the increase effectivity in greenhouses or their control. Czech University of Life Sciences Prague was to increase efficiency in greenhouses and therefore, devices designed to improve the automation in greenhouses have been designed and patented. The aim was to propose new improvements for automated greenhouses based on demand. This is primarily about solving the problem of lack of daylight and regularly occurring moss on the roof. This research and development are guided primarily because it is a agriculture branch in the stage of expansion, and it is essential that there is a continuous innovation and research in this field of science. New automatic features or upgrades to existing features in greenhouses, was solved on the basis of the current state of development curent technology. When designet new technologies also help us grants, personal experience with a real installation and cooperation with manufacturers (or with distributors) greenhouses systems. Designs for a light routing system and a system for removing moss from the roof were made.

Key words: greenhouses, light panel, applicator, inhibitor, development, roof

INTRODUCTION

Nowadays, when we place great emphasis on automation in greenhouses, there is a need for constant development. It is also very important to increase the quality and system efficiency of these greenhouses systems. There are many of these simple systems on the market today and many more are being added. Their differences are usually very small, and they frequently vary in terms of cost and reliability. These systems are fully utilized by many companies where the efficiency of the system is not addressed. The design of new low-cost greenhouse systems is therefore highly sought after. It is intended primarily for use in companies where it is necessary to modify the conditions of the greenhouse at a particular moment (Morisse et al., 1997; Hassan et al., 2015; Bradna & Malaťák, 2016; Hart & Hartová, 2016).

Technology focus, which is the constant need for increasing efficiency, is to modify the lighting conditions of greenhouses and protect the roof of greenhouses against unwanted mosses. The most common technology used today to improve the lighting in greenhouses are specific reflectors, whose operation is costly. Removal of the moss also produces recurrent costs. At present, only manual spraying is used. Copper sulfate is most often used to remove mosses. Another is a slaked lime mixed with water. Or, there are combinations of copper sulfate with sodium carbonate or other similar combinations. The aim of our development was therefore to design systems that would eliminate these problems and were not financially unattainable (Gao et al., 2015; Xia et al., 2015).

MATERIALS AND METHODS

Editing of lighting conditions in greenhouses is associated with a number of aspects. Among the most important is the routing sunlight and classical or IR light beams. All of these options are associated with light conditions in the greenhouse. Therefore, a variant has been devised where light can be directed through an automatically light panel (see Fig. 1) or similarly adapted roof (Lee et al., 2015; Liu et al., 2017).

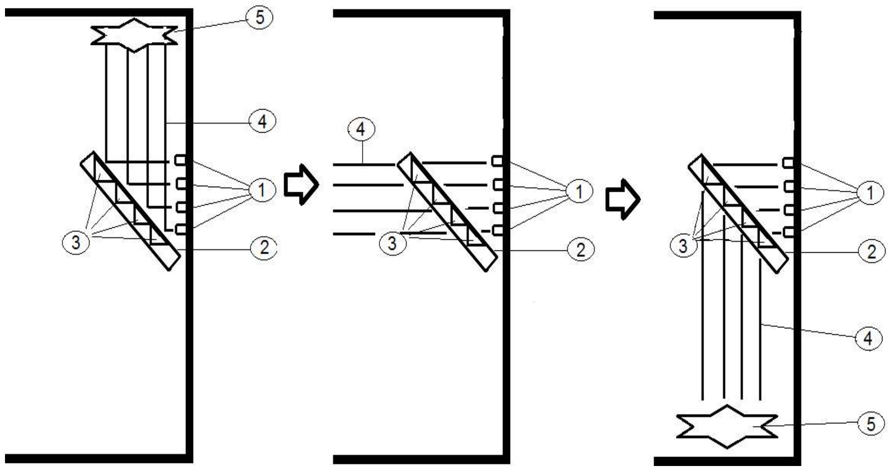

Figure 1. Principle of the automatically light panel: 1 – reflectors or sunlight; 2 – light panel body with rotating mechanism; 3 – light permeable triangles; 4 – light beams; 5 – lighting center. Please refer to the reference if this is not your own drawing.

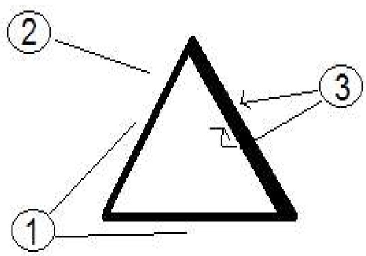

Figure 2. Principle of the light permeable triangle: 1 – light permeable sides; 2 – light permeable triangle; 3 – reflective sides.

The light panel consists of permeable triangles (Fig. 2), which together with the light source provide different illumination intensity, the body of the panel with the rotating mechanism and the reflectors. Forward triangles are rotated by the rotating mechanism inside the body of the light panel according to the setting. Light panel can be set a lower light intensity when turning the permeable triangles downwards.

Average daily light diffusion light was measured by the measurements. The measurement was carried out on the DT-8809A. It was measured 5 days in October for diffuse lighting. These values were surveyed at the Czech University of Life Sciences

Pargue. Mathematically, the efficiency of light routing into specific points within the greenhouse was derived.

The design of the system for adjusting the lighting conditions of the greenhouse is an easy matter compared to the moss elimination system (Fig. 3). It was necessary to carefully evaluate which substances are suitable for elimination and then select the 'economical (or cost-effective)' option.

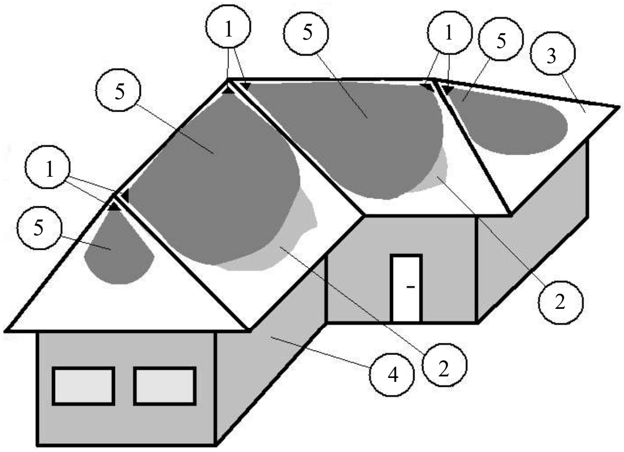

Figure 3. Applicator of inhibitors for protection of roofing: 1 – Sprayers; 2 – Plants of the order Porellales; 3 – Roof; 4 – Greenhouse; 5 – A copper sulphate mixture.

The applicator of inhibitors for protection of roofing consists of a tank containing an integrated refill tank for special inhibitors and mixed chambers, and then from sprayers connected by piping to the mixed chamber. The mixing chamber is then connected to the classical water supply system (Fig. 4).

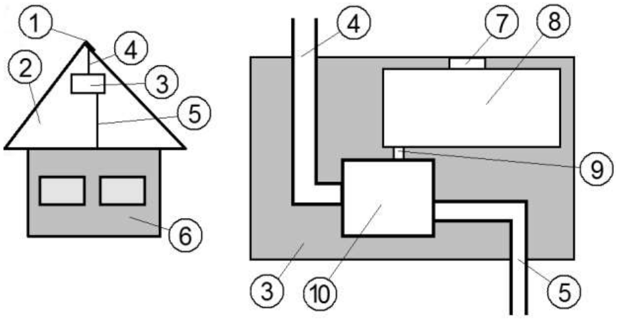

Figure 4. Distribution system: 1 – Sprayers; 2 – Roof; 3 – Tank; 4 – Mixed piping; 5 – Water supply system; 6 – Greenhouse; 7 – refilling opening; 8 – Integrated refilling tank; 9 – Dispenser; 10 – Mixing chamber.

One of the most effective and affordable formulations is copper sulfate ($CuSO4$), which has to be diluted with water. When the applicator starts running, water is introduced into the mixing chamber and a dispenser is opened, which dispenses special inhibitors from the filling tank to the mixing chamber. The mixture that is formed in the mixing chamber is then distributed via a pipe to the sprayers which was fed through the distribution node. From the distribution node, the mixture is led through the distribution system to the nozzle heads which apply the mixture to the roofing.

The applicator of inhibitors periodically and removes roof coverings of Porellales plants. Repetition is based on the location of the greenhouse and the outdoor climate in the area. In humid environments, there are two applications per year. Cleaning is important because there is sufficient light access to greenhouses. A special mixture (most commonly cuprous sulphate) can be added to the refilling tank by means of a lockable opening. When using this technology, it is important to have the gutter lead in the pit. The economic appreciation was based on several basic price calculations, see Table 1.

Table 1. Price review of the system for the application of inhibitors and periodic cleaning by the company

Service/system price	Price per piece	Price per year
Removal of moss by spraying	300 €	600 €
System price (applicator)	3,200 €	x
The price of chemicals in the applicator	x	80 €

RESULTS AND DISCUSSION

It can be seen from the graph in Fig. 5 that the direction of light leads to improvement of the growing process due to the improvement of the lighting conditions. The plant is able to provide the maximum level of photosynthesis at 35,000 lux. Diffuse light provides about 25,000 luxes. Thanks to light routing, it is possible to stretch the lighting time of a plant to increase its productivity.

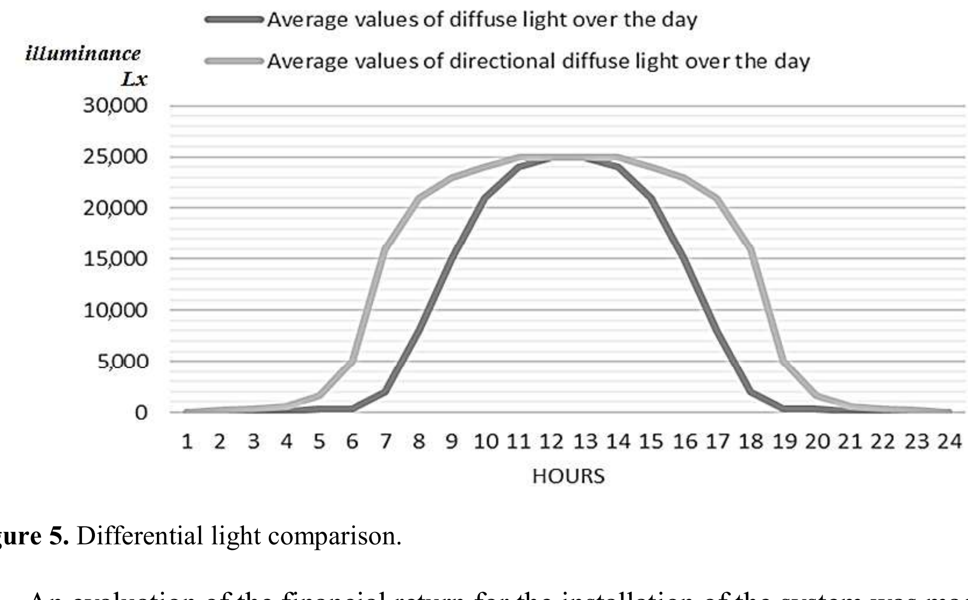

Figure 5. Differential light comparison.

An evaluation of the financial return for the installation of the system was made to compare the costs of the applicator with regular maintenance work of a specialized company. It was found that the applicator would pay back after the sixth year of installation (Fig. 6).

The resulting system is more expensive than spraying, but in the long run, the cost is returned, since there is no need for an intermediary to apply the active substance to the roof. Based on the fixed costs of installing the applicator of inhibitors for the protection of roofing and the periodic maintenance costs performed by an expert firm, a conversion of the return on investment was created.

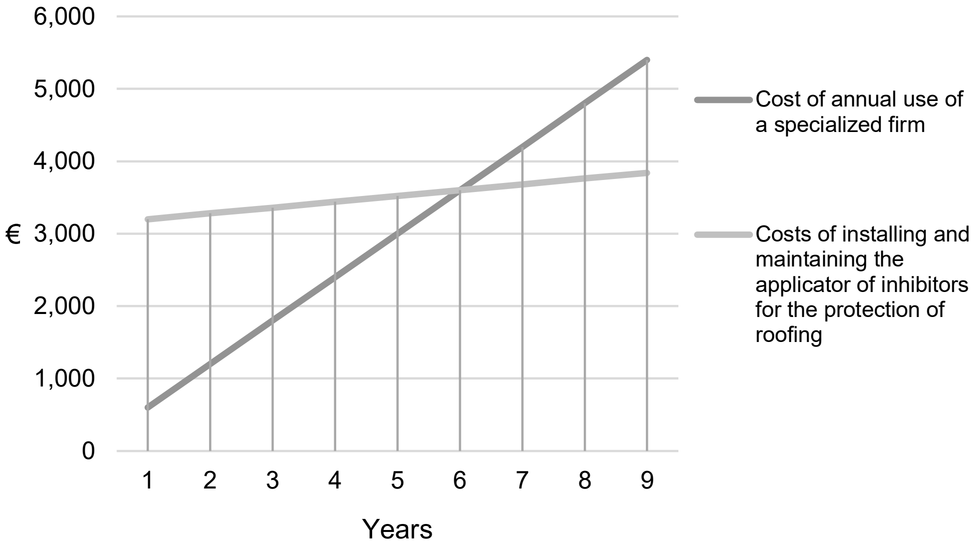

Figure 6. Financial returns using the application of inhibitors for protection of roofing.

Until all the invented systems are real tested, it is possible only to ask whether they will work according to assumptions. The present state of development of systems for greenhouses is at a point of expansion.

The development of light routers follows the research published in the article 'A Solar Automatic Tracking System that Generates Power for Lighting Greenhouses' (Zhang et al., 2015), but the research plan has been viewed from a different point of view. In the same way as in the articles 'Research on Automatic Control System of Greenhouse' (Wen, 2016), 'Design of an intelligent greenhouse automation system based on C language' (Wen, 2016) and 'An Automatic Monitoring and Control System Inside Greenhouse' (Liu at al., 2017), the research was viewed from a fully automatic viewpoint not only for light routing but also for moss removal. Contrary to the above examples, this research was aimed at going in a new direction and making available a financially viable variant of substantial improvements.

CONCLUSIONS

Testing and improving the existing technologies is very important. Due to the continuous development in the field of automated technology research in greenhouses, techniques is always important to continue to develop new and better systems, modules, switchboards and all components. The overall solution of designed system is advantageous for several reasons. Systems should be affordable and should improve the quality of automation in greenhouses.

The resulting design has its selected hardware construction. Thanks to the created system it was demonstrated as well that it enables financial returns on implementation. As long as the future manufacturer has not commenced full cooperation with the other variants of automatization, the system's greenhouse automatization use will remain limited, even when meeting the condition of being a technology which fully conforms to automatic demands.

Light conditions affect plant growth and this is especially true of diffuse light. By bringing daylight to the entire greenhouse and effectively targeting plants, their yields will also increase. This is the basis for a new direction of research to improve lighting and its sustainability.

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REFERENCES

Bradna, J. & Malaťák, J. 2016. Flue gases thermal emission concentration during waste biomass combustion in small combustion device with manual fuel supply. *Research in Agricultural Engineering* **62**(1), 1–7.

Gao, J., Zhao, L. & Sun, Y. 2015. The Design of Automatic Circulating Temperature Control System of SCM-based Greenhouse. In: *Proceedings of The 2015 International Conference on Applied Science and Engineering Innovation*, vol. **12**, pp. 2019–2026.

Hart, J. & Hartová, V. 2016. Development of new testers to improve quality for data transmissions in intrusion and hold-up alarm systems. In: *15th International Scientific Conference on Engineering for Rural Development,* LUA, Jelgava, pp. 523–528.

Hassan, N., Abdullah, S.I., Noor, A.S. & Alam, M. 2015. An Automatic Monitoring and Control System Inside Greenhouse. In: *2015 3rd International Conference on Green Energy and Technology (ICGET*), art. num. 7315084.

Morisse, J.P., Huonnic, D., Cotte, J.P. & Martrenchar, A. 1997. Relation between mixing solid foods and wellfare into the feed of calves. Study on three groups of 21 calves, *POINT VETERINAIRE*, Volume: **28**, Issue: 184, pp. 71–73.

Lee, Y.J., Park, K.W. & Kim, E.K. 2015, Automatic Dehumidifier Control System for Greenhouse Using Smart Phone. In: *Advanced Multimedia and Ubiquitous Engineering: Future Information Technology*, vol. **352**, pp. 257–264

Liu, Y., Qi, G.Y., Li, Z.Y., Wu, Q.N. & Meng, Y.P. 2017. Research on Automatic Control System of Greenhouse. In: *Advances In Materials, Machinery, Electronics* I, vol. 1820, art. num. 070011.

Wen, J.X. 2016. Design of intelligent greenhouse automatic control system based on C language. In: *Proceedings of the 2016 2nd workshop on advanced research and technology in industry applications*, vol. **81**, pp 1635–1641.

Xia, C.L., Chon, T.S., Ren, Z.M. & Lee, J.M. 2015. Automatic identification and counting of small size pests in greenhouse conditions with low computational cost. *Ecological informatics* **29**, 139–146.

Zhang, Q.X., Yu, H.Y., Zhang, Q.Y., Zhang, Z.Y., Shao, C.H. & Yang, D. 2015. A Solar Automatic Tracking System that Generates Power for Lighting Greenhouses. *Energies* **8**, 7367–7380.