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Impact of light source on distribution of greenhouse whiteflies *Trialeurodes* spp. (Hemiptera: Aleyrodidae) on tomatoes in greenhouses

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Abstract: Nowadays to ensure better plant production various artificial light sources are used in greenhouses. Light in terms of photoperiod length, wavelength and temperatures is one of the most important factors in the insect life. Whiteflies *Trialeurodes* spp. are known to feed on many plant species, including agriculturally important ones, and in favourable conditions can rapidly reproduce and cause vast plant damage. During our monitoring the significant increase of whitefly numbers was observed under high-pressure sodium vapor lamps Helle Magna compared to LED and induction lamps.

Key words: pests, control, monitoring, yellow sticky traps, artificial light

Introduction

Nowadays, to provide fresh vegetables, all year-round growing in greenhouses during the cold and dark autumn-spring seasons is a fundamental part of agriculture. Various artificial light sources are used to ensure better plant growth, development and flowering during the short-day periods. Plant growth and reproduction are influenced by light intensity and photoperiod. The light in greenhouses may be that of natural sunlight, artificially provided, or both. Lately, beside the other light sources, light emitting diodes are introduced in greenhouse systems, as they are safer, easier to control digitally and are cooler than high-pressure sodium vapor lamps.

In greenhouses, not only plants can flourish under favourable living conditions, but various pests also thrive. As for plants light, and especially ultraviolet light, is one of the most important factors in insect life. Light can stimulate or supress insect development, their feeding habits and life cycles. Insects can suffer mortality from collisions with hot lamps, exhaustion, or increased predation due to the attraction of predators and/or increased visibility (Donners et al., 2018). Light may influence insect

activity, orientation, and dispersal. On the other hand, the degree to which insects are attracted to light is influenced by its intensity, polarisation and the spectral composition of the light.

Whiteflies *Trialeurodes* spp. (Insecta: Hemiptera: Aleyrodidae) are known to feed on many plant species, including agriculturally important ones. In favourable conditions, whiteflies can rapidly reproduce as their life cycle takes about three weeks to develop and cause vast plant damage (White, 2013). They do not have dormant stages and in greenhouse conditions develop year-round and are year-round pests (van der Ent et al., 2017). *Trialeurodes* spp. feed on plant fluids and sap and infested leaves may lose vigour, become yellow and may drop prematurely. In case of severe infestation, plants can be destroyed. Whiteflies must eat large quantities of dilute sap to obtain the necessary nutrients. The liquid and excess sugar ends up being excreted as shiny, sticky, sugary honeydew on a plant's surface that may lead to black sooty mould starting to appear on the foliage. Still, what harms plants the most is a whitefly's ability to transfer plant viruses. They can transmit over a hundred different plant viruses, like begomoviruses (Geminiviridae), criniviruses (Closteroviridae), and torradoviruses (Secoviridae). The viruses are taken by whiteflies during the feeding on an infected plant. Then whiteflies move to new plants and start feeding, and viral particles enter new plants. Whitefly transmitted viruses are more frequently associated with vegetables than ornamental crops in greenhouses.

Materials and methods

The study was performed in the polycarbonate greenhouse of Faculty of Agriculture of the University of Life Sciences and Technologies of Latvia in Jelgava. The investigation was performed during the winter season 2020/2021. Three additional light sources were used: LED COB Helle Top LED 280 luminary, induction lamps and high-pressure sodium vapor lamps Helle Magna (HPS) (Fig. 1).

Figure 1. LED COB Helle Top LED 280 luminary, induction lamps and high-pressure sodium vapor lamps Helle Magna (from left to right)

These three light sources differ by light wavelength (Fig. 2). Tomatoes were grown under a 16-hour photoperiod.

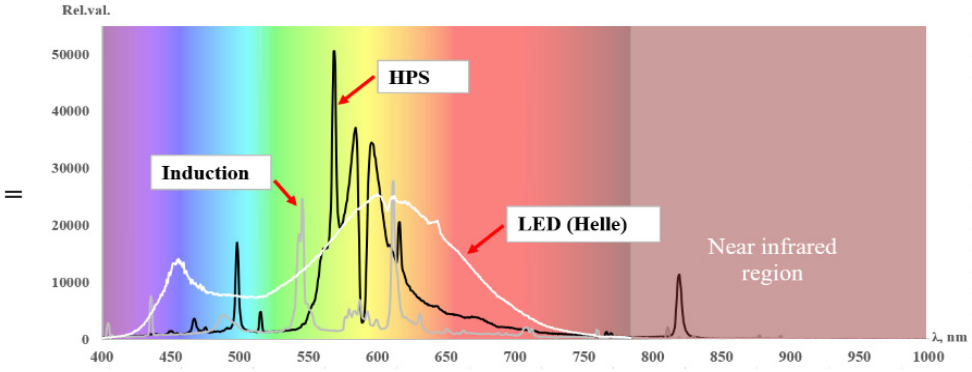

Figure 2. Spectral distribution of investigated light sources

Adult whiteflies were collected by means of yellow sticky traps placed about 50 cm below the light source (Fig. 3). One sticky trap was placed for each tomato plant. These traps were monitored every 2 weeks during the ten-week period. Traps were changed and whiteflies were counted by means of reflected light microscope. The air temperature was measured hourly 50, 100 and 150 cm below the light source. Afterwards average day temperatures were calculated.

Figure 3. Yellow sticky traps exposed for whiteflies control

Results and discussion

During the whitefly monitoring, we observed temperature differences under the investigated light sources (Fig. 4). Temperature was measured 50, 100 and 150 cm under the lamps. The highest temperature was observed under HPS lamps, and this difference remained even 150 cm down from the lamps.

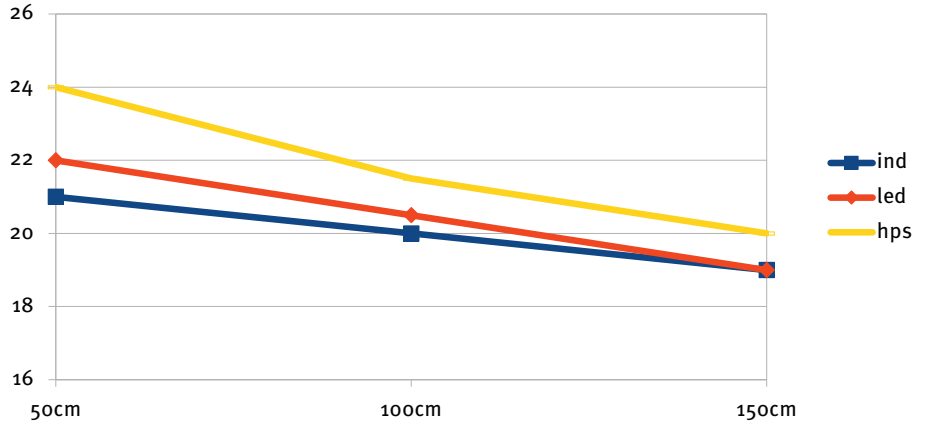

Figure 4. Temperature (°C) changes with distance from light source (blue-induction, green-LED, yellow-HPS lamps)

Obviously, adult whitefly distribution was affected by two factors: environmental temperature in greenhouse and spectral properties of lamps. HPS lamps emitted higher temperatures in comparison to the other light sources throughout the investigation period. This difference is retained also with the increase of distance from the lamps (Fig. 4). Gammara's (et al., 2020) investigation demonstrated that optimal temperature for whitefly development is 22–24 °C. Typical wavelength of HPS lamps (Fig. 2) was observed to be as the most attractive to whiteflies since some authors (Zhang et al., 2020) found the peak sensitivity of greenhouse whitefly optical receptors occurring at 525 nm wavelength which corresponds with green light.

During the ten weeks period, numbers of whiteflies increased, and their distribution was observed variable under the investigated light sources. The least pronounced increase was recorded under induction lamps (Fig. 5). Increase of whitefly numbers under LED lamps was also similar. The comparatively dramatic increase of adult whiteflies was observed under high-pressure sodium vapor lamps (Fig. 5). There were recorded 300 000 individuals/m^2 during the last observation, e.g., about six times the number under LED and induction lamps at the same time.

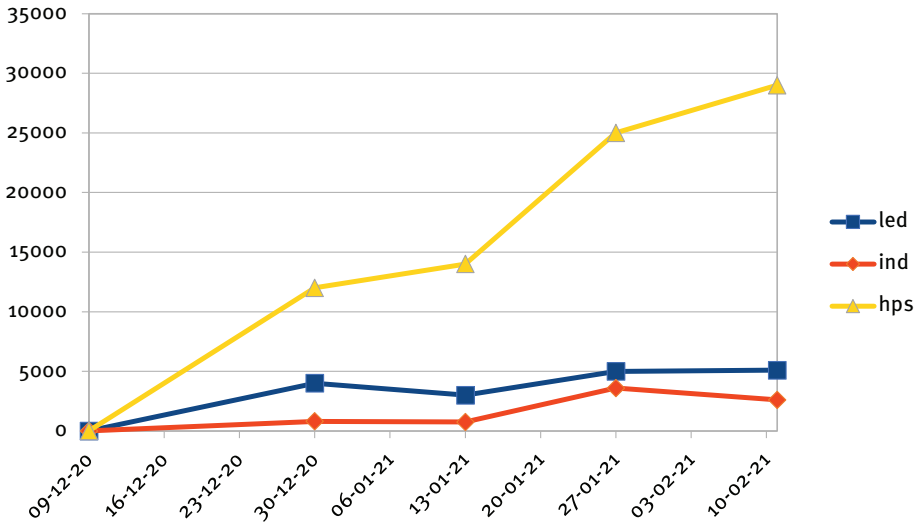

Figure 5. Increase of greenhouse whitefly numbers during the ten-weeks period under LED COB Helle Top LED 280 luminary (LED), induction (IND) and high-pressure sodium vapor lamps Helle Magna (NA)

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