The Influence of a Dynamic Climate on Pests©

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The influence of a dynamic climate on pests is at present not well investigated. During the last years, some Danish growers have observed that problems with pests have diminished when they shifted from the traditional rigid climate control to a dynamic regime. This tendency was also observed in experiments where different dynamic climate strategies were tested. A recent experiment has shown that the influx of thrips from outside was diminished when a dynamic climate regime was compared to a traditional rigid climate regime. Another experiment revealed that the development time of *Myzus persicae* was longer under a simulated dynamic climate compared to a static climate. Knowledge of how the development of a pest is influenced by a temperature regime makes it possible to use climate management as a tool for pest control.

INTRODUCTION

Pests are exposed to and react to the present greenhouse climate, which depends on the crop-specific climate regime. Greenhouse climate regimes were originally designed to serve the crop optimally, and pests or their biocontrol agents were not taken into account. Commonly the greenhouse temperature is rigidly controlled to constantly attain the crop-specific optimum temperature. However, dynamic temperature regimes have been developed. Within those dynamic climate regimes, initially developed for energy-saving purposes, the greenhouse climate is allowed to fluctuate more within days, weeks, and seasons.

Recently the influence of dynamic climate regimes on pests and beneficial organisms has come into focus as some growers in Denmark have observed that, by changing the traditional rigid climate control to a dynamic regime, pest problems decreased and consequently the need for treatments, both chemical and biological. The growers claim that their use of pesticides has diminished after they have changed to a dynamic climate regime. This tendency of fewer pests has also been reported from scientific experiments where different dynamic climate strategies were investigated (Jakobsen et al., 2003).

IntelliGrow is a Danish-designed dynamic-climate control concept in which the climate is controlled according to the outside irradiance and the microclimate of the plants within the greenhouse. Heat and CO_2 are supplied only when the plants can make optimal use of it, i.e., when the light intensity is sufficient for a high photosynthesis rate. Set points for CO_2 and temperature are calculated using a leaf photosynthesis model (Aaslyng et al., 2003) from which the system generates a two-dimensional array of photosynthesis rates as a function of a range of selected temperatures and CO_2 concentrations at the measured photosynthetic photon flux density (PPFD). The maximum photosynthesis rate is determined from this array. The magnitude of production can be controlled by reducing the photosynthesis optimization level.

To find some explanations for the decrease in pests observed by growers, two experiments were carried out: one looking at the influx of pests into the greenhouse from outside and the other to compare the development time of the peach aphid *Myzus persicae* (Sulzer) (Hem: *Aphididae*) under static and fluctuating temperatures.

INFLUX OF THRIPS

This experiment, which is described in detail in Jakobsen et al. (2006), showed that the choice of climate strategy influences the level of pest influx into a greenhouse from outdoors. The experiment was conducted during the natural flying period of the thrips (Thysanoptera), from late March to the middle of September 2004, in which time the influx of the pest in small greenhouse compartments (25 m^2) was monitored by use of sticky traps. The experiment compared the effect of two climate regimes on pest influx: a dynamic regime (simulated IntelliGrow) and a traditional climate regime with fixed set points for heating and ventilation of 18 °C and 20 °C, respectively.

The two different climate regimes resulted in differences in the degree of vent opening. Over the entire 25-week period, the vents opened on the average 6.9% under the dynamic regime and 33.4% in the traditional climate. When calculated on a weekly basis, this difference was highly significant ($P<0.0001$). The influx of thrips into the greenhouse was found to be linearly correlated to the density of pests outside the greenhouse ($P<0.0001$), as well as with the degree of opening of the greenhouse vents ($P = 0.0038$). Due to the smaller degree of vent opening in the dynamic climate, significantly ($P = 0.0026$) fewer thrips were monitored on sticky traps in the dynamic climate compared to the traditional climate (except during week 32) (fig. 1). The average weekly differences (counts on traps from the dynamic climate minus counts on traps from the traditional climate) varied from -0.1 to 9.4 thrips per sticky trap. These results thus confirm tendencies seen in earlier experiments and in commercial greenhouses of fewer problems with pests under a dynamic climate strategy.

DEVELOPMENT TIME OF PEACH APHID

This experiment examined the effect of a dynamic climate regime on the development of the peach aphid, *Myzus persicae*. The experiment was conducted in climate cabinets under a simulated dynamic climate (8 h at 20 °C followed by 8 h at 15 °C followed by 8 h at 25 °C) and a constant climate regime (24 h at 20 °C), respectively, with a photo/darkness period of 16 : 8 and a humidity of 40%–70%.

Adult aphids were placed for progeny production on a hibiscus leaf positioned with the underside up on non-nutrient agar in a Petri dish. After 24 h at 20 °C adult aphids were removed and Petri dishes placed in the climate chambers. Each Petri dish was checked once a day for recording of number of adult aphids; adults and new offspring were removed. The experiment lasted 18 days and three repetitions were carried out.

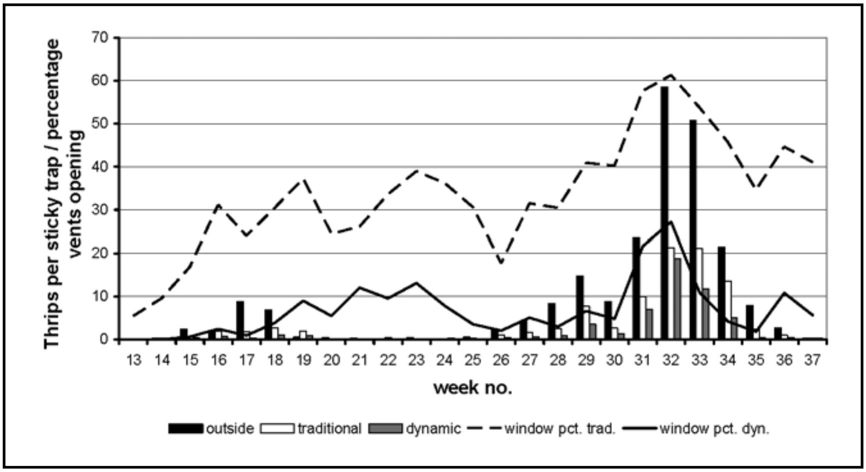

Figure 1. Average number of thrips per sticky trap in a dynamic climate regime, a traditional climate regime, and outside the greenhouse, as well as the percentage vent opening in the two climate regimes between Weeks 13 and 37, 2004.

The experiment showed that the development time of *M. persicae* was longer ($p<0.0001$) under a dynamic climate compared to a constant climate (Table 1) even though the average temperature was the same.

Table 1. Development time for *Myzus persicae*.

Climate regime	Average temperature (°C)	Maximum temperature (°C)	Minimum temperature (°C)	Development time (days)
Constant climate	20	20	20	9.094±0.033a (53)
Dynamic climate	20	25	15	10.367±0.041b (49)

Note: Values followed by different letters are significantly different. Round brackets are the number of individuals in the experiment.

Other experiments have shown that fluctuating temperatures compared to static temperatures can have varying effects on development of pests and beneficials. Studies revealed that the development of *Anthocoris sibiricus* Reuter (Het.: *Anthocoridae*) was significantly faster at fluctuating temperatures compared to a constant climate (Hofsvang, 1976). Likewise Tommasini & Benuzzi (1996) showed that the development time of *Orius laevigatus* (Het.: *Anthocoridae*) was shorter at fluctuating temperatures (29 °C /5 °C) compared to a constant temperature of 14 °C. In contrast to the above-mentioned studies, Petitt et al. (1991) found that the development time for *Liriomyza sativae* Blanchard (Dip.: *Agromyzidae*) was not significantly influenced by fluctuating temperatures. Yet another study showed that the influence of fluctuating temperatures on development time of *Heliothis zea* (Boddie) (Lep.: *Noctuidae*) egg depended on the mean temperature, because at low temperatures (21.1 °C) the development time was decreased by fluctuating temperatures and at high temperatures (35 °C) the development time was longer at fluctuating temperatures compared to static temperatures (Eubank et al., 1973).

The current study indicates that not only the average temperature is important to consider when estimating the development time for a pest. The effect of fluctuating temperatures on the development time of a pest or beneficial depends on the optimum temperature and the upper and lower threshold of the pest or beneficial in question. Knowledge of how the development of a pest is influenced by a temperature regime makes it possible to use climate management as a tool for pest control. Similarly biological control might be improved by selecting beneficial most optimally adapted to a certain climate regime.

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