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Title: Pollinator design through forced vibration in tunnel type green houses.

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Introduction

- Pollination is defined as a process in which insects flutter from flower to flower involuntarily involved pollen from the wires of a flower to reach the stigma of that same or another flower, in principle of the same species.

Parts of the flower to be pollinated.

Source: https://generacionverde.com/blog/ambiental/que-es-la-polinizacion

NATURAL POLLINATING AGENTS

- Insects
- Wind
- Water
- Birds

NATURAL POLLINATION BY VIBRATION (BUZZ)

- The vibratory activity of bees ensures a higher degree Pollination.

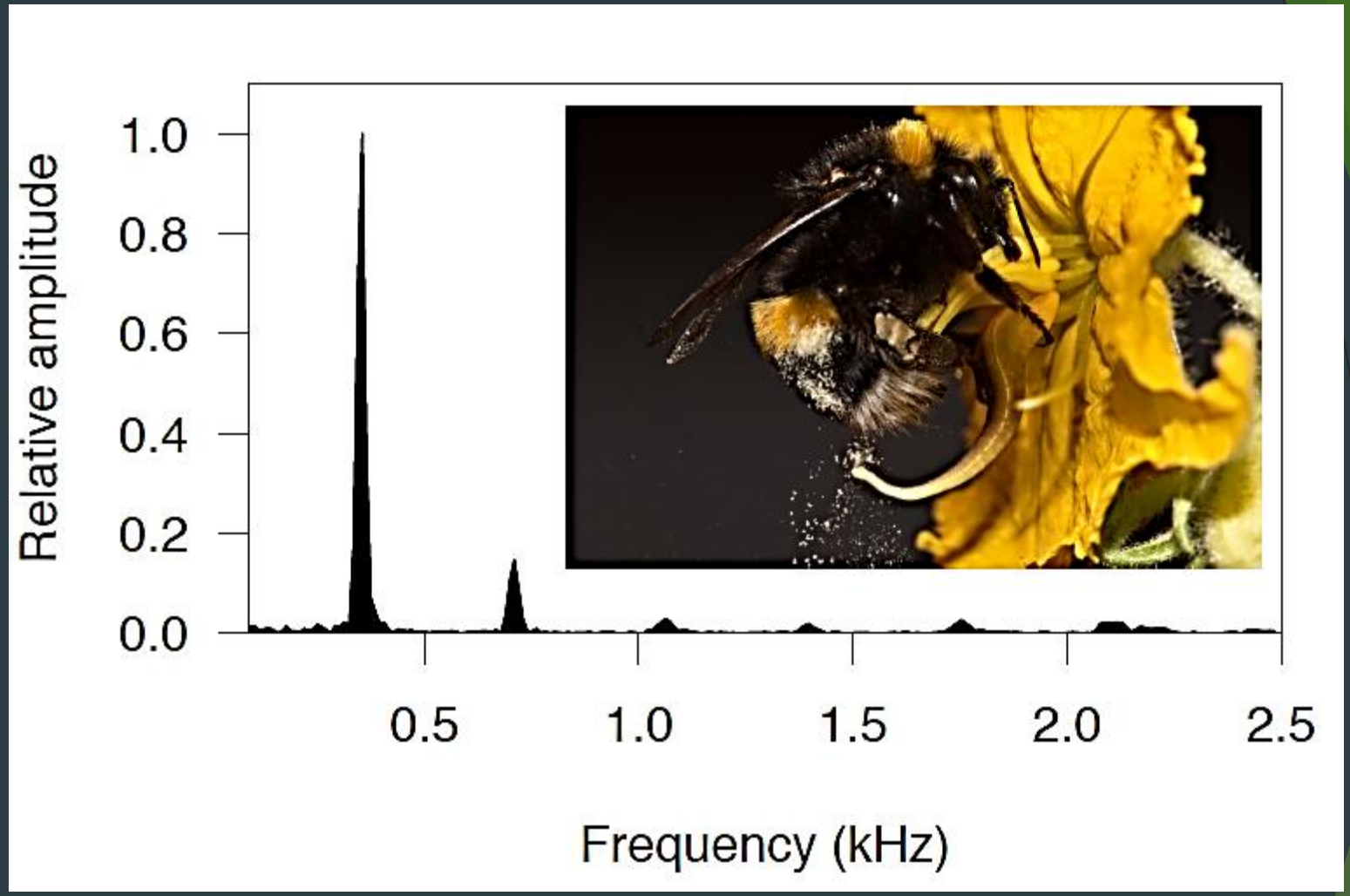
- To release the pollen, the bee clings to the flower and moves quickly your wing muscles, without moving your wings. This produces a hum with a characteristic sound; this vibration loosen the pollen grains and makes them emerge from the anther.

Vibratory bee pollination.

Source: Karl Foord, Universidad de Minessota.

VIBRATORY ARTIFICIAL POLLINATION

- The frequency spectrum of a floral vibration generated by a bee (Bombus audax) is shown, the highest peak represents the highest relative amplitude of 1μm at a dominant frequency that ranges between 300-400 Hz which would be the fundamental frequency of vibration with which the pollen is released from the anthers that is where the pollen is produced.

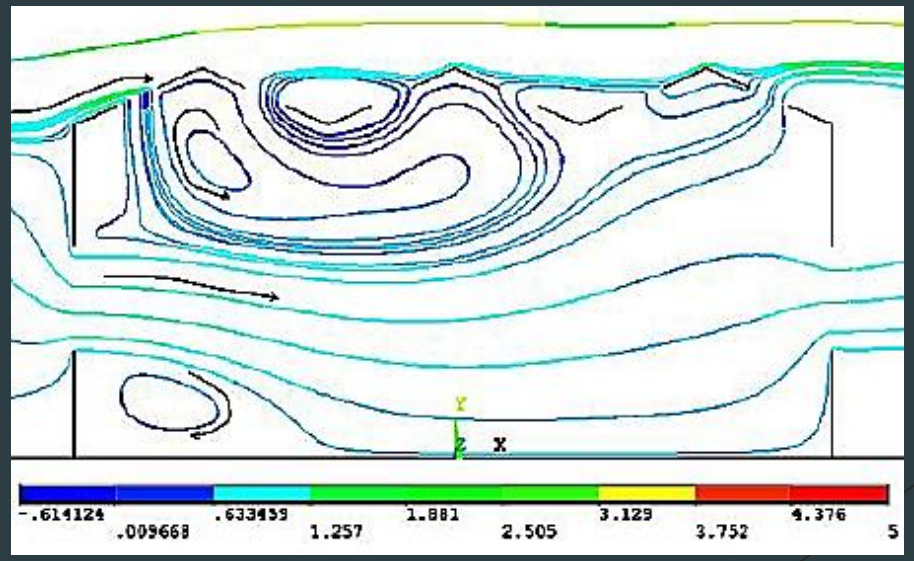


Frequency and amplitude (µm) of vibration generated by the pollinating bee.

Source: Arroyo-Correa (2018). Bee and floral traits affect the characteristics of the vibrations experienced by flowers during buzz-pollination. Recuperado de http: https://www.biorxiv.org/content/biorxiv/early/2018/12/13/494690.full.pdf

Methodology

- The method consists in assimilating the vibratory frequencies that generates a bee when perching on the flower, such frequencies they have to oscillate around 400 Hz and generate a wavelength of about 1 μm.
- It is proposed to transport pollen by air currents in the greenhouse by convective means.



- Regarding the vibration system, a high frequency oscillator is proposed, such as those reached by most bees, which is approximately 400Hz, and it is intended to place the oscillation system in strategic parts of the tensioning wires of the greenhouses.

Swing device at 400 Hz.
Source: the author

SYSTEM MODELING

- Damped forced vibration system where the excitation force and damping coefficient are constant:

$$m\ddot{z} + \gamma\dot{z} + kz = -mg$$

The solution for the stationary case is:

$$m \cdot 0 + \gamma \cdot 0 + kz_s = -mg \qquad \Rightarrow \qquad z_s = -\frac{mg}{k}$$

In this case you have a sinusoidal exciter force then we have:

$$F(t) = F_0 \cos(\omega t)$$

Through the use of phasors, the system has the value of the amplitude:

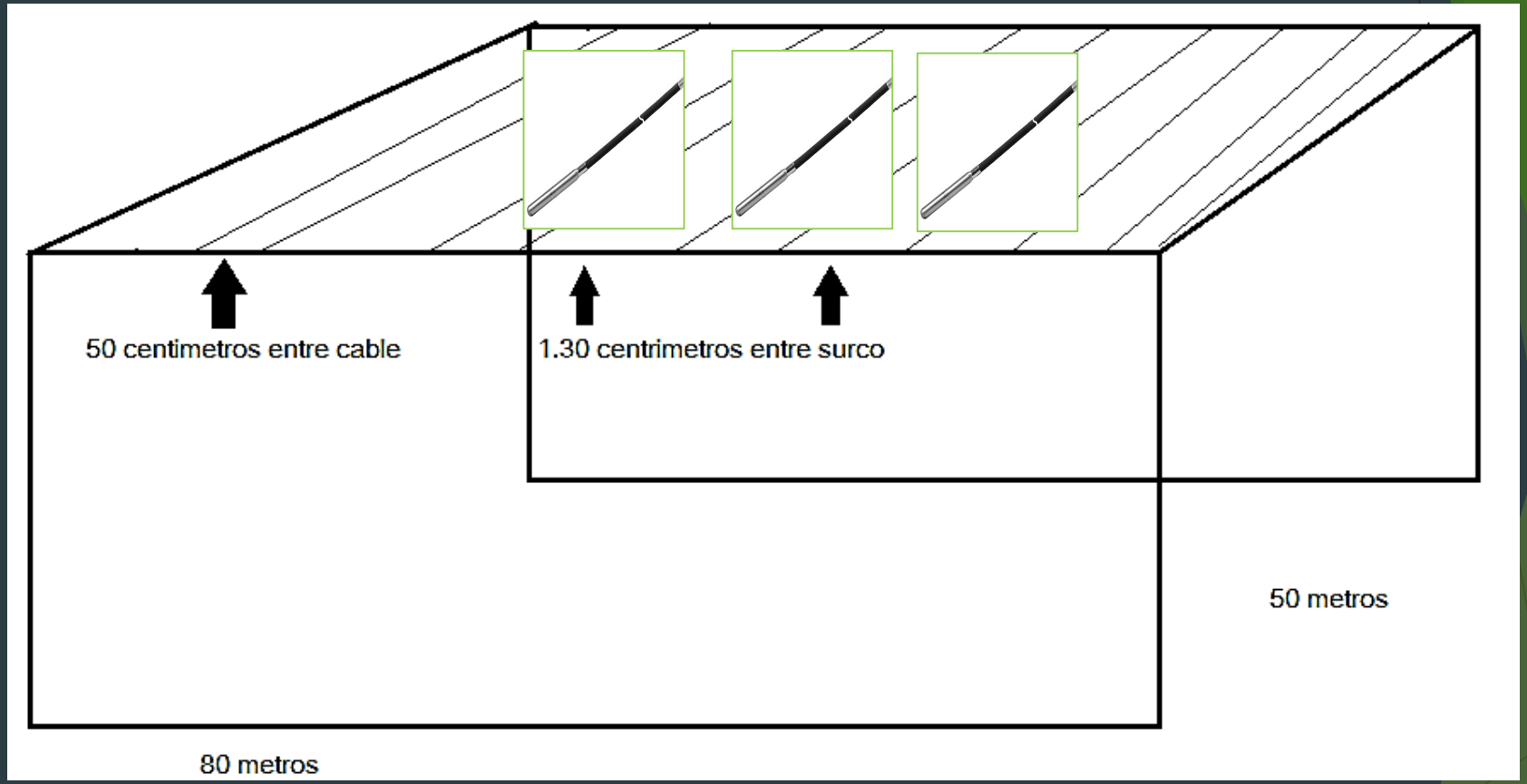
$$A = |\hat{x}| = \frac{F_0/m}{\sqrt{(\omega_0^2 - \omega^2)^2 + 4\beta^2\omega^2)}}$$

Results

Substituting the values in the equation the amplitude A is obtained:

$$A = 1.5 \text{ X } 10^{-6} \text{ m}$$

If we consider that an amplitude of 1µm is required to reach to release the pollen from the anther of the flower, it is necessary that with the initial values proposed in the amplitude equation, they are sufficient to be able to bring to the plant the vibration frequency required to achieve such effect.



Greenhouse configuration with the vibration device.

Source: the autor

Conclusions

- It was intended to provide a contribution as an alternative to pollination systems which retakes to a greater or lesser extent how each of them can be implemented by convection and vibration forced by electro-mechanical means.

- Deepening the analysis of hysteresis losses could yield more data for the improvement of the system and thus reach the expected parameters through theoretical foundations.

- The model needs to be field tested to validate the proposed design.

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