

Physiological modifications in *Zinnia elegans* Jacq. As a result of the attack produced by *Erysiphe cichoracearum* DC.

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Abstract The research regarding physiological modifications produced by *Erysiphe cichoracearum* DC. was made at *Zinnia elegans* Jacq. cultivated in Botanical Garden "Al. Buia" of Craiova.

As a result of the action pathogen on the attacked leaves observe that the diurnal dynamics of the photosynthesis and of transpiration presents a minimum in the morning, a maximum at lunch and a minimum toward the evening, with specific variations in the attacked leaves. The diurnal dynamics of the photosynthesis and transpiration in the attacked leaves by pathogen is similar to that in healthy leaves, but the recorded values are lower as a result of the reduction of the assimilation surface, the coverage of the stomata by the mycelium of the fungus and the malfunctioning of the stomatic apparatus. The leaves attacked by the pathogen present a decrease of chlorophyll content as a result of the blockage of its biosynthesis and the deterioration of the chlorophyll and the decrease of the total water content which is manifested by the withering and premature drying of the plants.

Key words

attacked leaves, healthy leaves, pathogen, photosynthesis, transpiration

Powdery mildew produced by *Erysiphe cichoracearum* DC. appears frequently in the cultures of *Zinnia* sp. in dry years and high average temperatures.

Zinnia is a genus of 20 species of annual and perennial plants. *Zinnia elegans* Jacq. is a plant original in Mexico, being the best known plant from the *Zinnia* genus.

Their colors are striking, pleasing and harmonious but all interesting ranging through all the shades and tints of rainbow. *Zinnia elegans* Jacq. belonging to Fam. *Compositae* is half-hardy summer annual available from spring to fall [4].

The net photosynthetic activity is subjected to seasonal changes and to diurnal changes which are mainly influenced by the stage of shoot development, the leaf ageing, the accumulation of hormones and of carbohydrates in the leaves, as well as the by the fluctuations of light, leaf temperature, air temperature and humidity [3].

Intensity of transpiration process commensurate increases with that of photosynthesis, both processes are dependent on solar radiation intensity [1].

Interception of surface solar radiation is correlated with the amount of heat retained by the leaves, and therefore the intensity of transpiration [2].

Material and Method

The research on the physiological changes caused by *Erysiphe cichoracearum* DC. was made at in 2010 in *Zinnia elegans* Jacq. species cultivated in Botanical Garden "Al. Buia" of Craiova.

Zinnia elegans Jacq. presents rigid stems, up to 30-100 cm tall, branched and covered with stiff hairs. The leaves are opposite, sessile, entire, elongated oval. The flowers are grouped in type of inflorescence anthodium and show various colors: yellow, orange, red, pink, purple, cream etc.

The estimation of the attack (the frequency, the intensity and the degree of the attack) was made using the calculation formulae elaborate by Săvescu & Rafailă [5].

The intensity of the photosynthesis and transpiration was established by a non-destructive methods with the analyzer LCI (Ultra Compact Photosynthesis Measurement System) and results obtained were graphically represented and statistically interpreted.

The total water contents and the dry substance content were determined by the help of the gravimetric method. The chlorophyll content were estimated with the help of the Minolta SPAD 502 chlorophyllmeter.

Results

The attack occurs on the leaves and on the stems, on which, starting with August, there is a fine, whitish-gray felt in the shape of spots of different sizes. As the disease progresses the spots increase, unite and have a dusty aspect as a result of the formation of the asexual part of the fungus respectively of the conidiophores with conidia (Fig. 1).

Erysiphe cichoracearum DC. presents ectoparasites mycelium, which develops at the surface of the leaves forming whitish spots, and on the mycelium there are differentiated conidiophores with *Oidium* conidia type.



Fig. 1. *Zinnia elegans* attacked by *Erysiphe cichoracearum* (Original).

The intensity of the physiological processes in *Zinnia elegans* Jacq. was established, according to the climatic conditions (temperature, light intensity), on September 12th 2010.

The estimation of the attack produced by the *Erysiphe cichoracearum* DC. at *Zinnia elegans* Jacq. is presented in Fig. 3.

The photosynthesis of the analyzed plants shows minimum values in the morning due to low light intensity, low temperature and low opening degree of the stomata, maximum values at noon due to the increasing light intensity and temperature, and to the

The conidia are linked, single-celled, hyaline, ellipsoidal, the conidia from the top of the chain being the biggest because it is the first to reach maturity (Fig. 2).

In the mycelium on the leaves there are sometimes formed the spherical cleistothecium, with simple and numerous appendix, brown at the bottom and hyaline at the top. The cleistothecium contains a single asca with 8 hyaline ascospores.

During the vegetation period the pathogens spread through the conidia, and from one year to another they resist in the shape of cleistothecium or of a mycelium resistance in the plant debris.



Fig. 2. *Erysiphe cichoracearum* - conidia (oc. 10 x ob. 20) - Original.

opening degree of the stomata and minimum values towards the evening due to the decreasing light intensity and temperature, and to the decreasing opening degree of the stomata.

The transpiration shows minimum values in the morning due to the low opening degree of the stomata and to the low power of air dehydration, maximum values at noon due to the high opening degree of the stomata as a result of the increasing light intensity and temperature and to the air dehydration power and minimum values in the evening as a result of the decreasing light intensity and temperature.

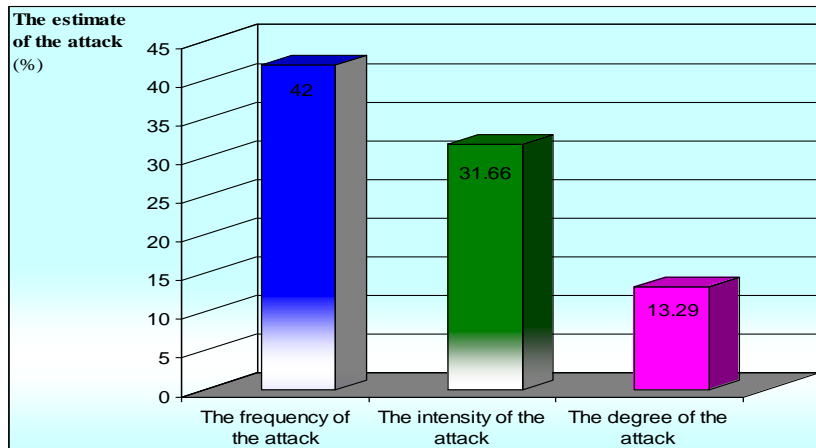


Fig. 3. The estimate of the attack produced by *Erysiphe cichoracearum* DC. at the *Zinnia elegans* Jacq.

The diurnal dynamics of photosynthesis rate and transpiration rate in the attacked leaves is similar to that in healthy leaves but the recorded values are lower as a result of the reduction of the assimilation

surface, the cover of stomata by the mycelium of the fungus, but also by malfunctioning of stomata closing and opening mechanisms (Fig. 4 and Fig. 5).

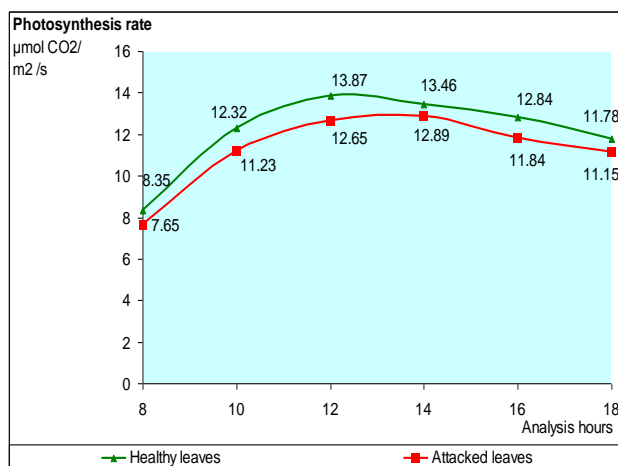


Fig. 4. The diurnal dynamics of photosynthesis at the *Zinnia elegans* Jacq.

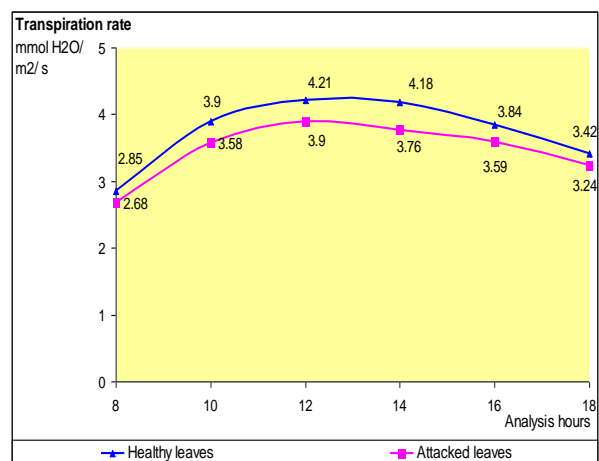


Fig. 5. The diurnal dynamics of transpiration at the *Zinnia elegans* Jacq.

The diurnal dynamics of photosynthesis and transpiration depend on the light radiation received by leaves, which are dependent on the position of the leaves on plants.

In the *Zinnia elegans* Jacq. one can observe an increase of the photosynthetic active radiations presented on the surface of the leaves morning (8 a.m.) when one can record values of 1282 $\mu\text{mol} / \text{m}^2 / \text{s}$ for the healthy leaves and of 1274 $\mu\text{mol} / \text{m}^2 / \text{s}$ for the attacked leaves, their growth up until after lunch (2 p.m.) when one record 1572 $\mu\text{mol} / \text{m}^2 / \text{s}$ for the healthy leaves and 1554 $\mu\text{mol} / \text{m}^2 / \text{s}$ for the attacked leaves, and towards evening (6 p.m.) one can notice a gradual decrease, recording values of 1385 $\mu\text{mol} / \text{m}^2 /$

s for the healthy leaves and of 1372 $\mu\text{mol} / \text{m}^2 / \text{s}$ for the attacked leaves.

In the *Zinnia elegans* Jacq. a strong association was established between the physiological processes (photosynthesis rate and transpiration rate) and photosynthetic active radiations, leaf temperature and stomatal conductance.

Linear regression shows a positive correlation between the photosynthesis rate and photosynthetic active radiations (the coefficient of determination R^2 was 0.85 for the healthy leaves and 0.82 for the attacked leaves) and between the transpiration rate and photosynthetic active radiations (the coefficient of determination R^2 was 0.86 for the healthy leaves and 0.91 for the attacked leaves) - Fig. 6 and Fig. 7.

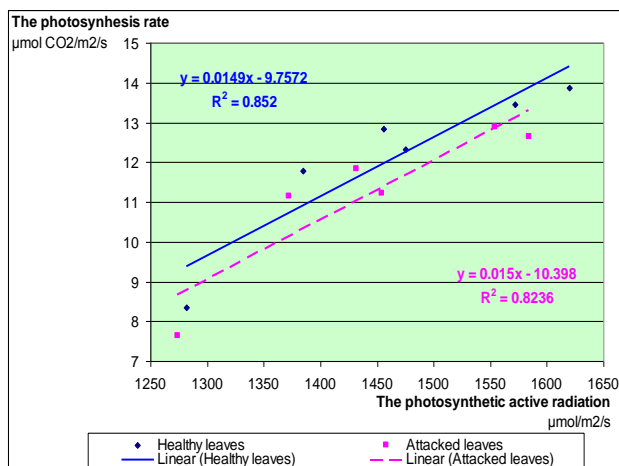


Fig. 6. The correlation between the photosynthesis rate and the photosynthetic active radiation at the *Zinnia elegans* Jacq.

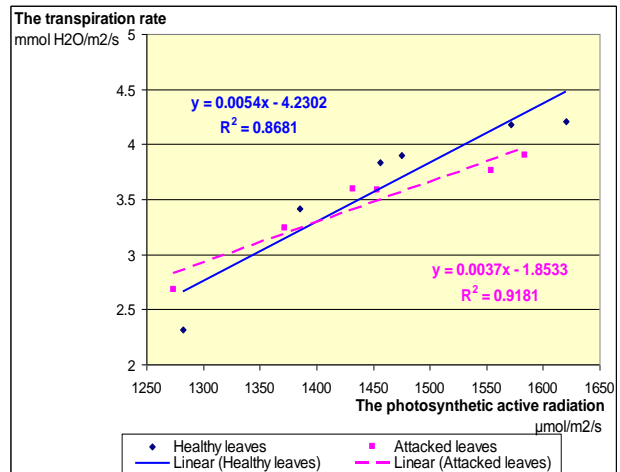


Fig. 7. The correlation between the transpiration rate and the photosynthetic active radiation at the *Zinnia elegans* Jacq.

The photosynthesis and transpiration depend on the temperature. On during the day note increase of leaf temperature in the morning (8 a.m.) when value recorded is 27.8 °C in the healthy leaves and 27.9 °C in the attacked leaves, the increase of the temperature up until after lunch (2 p.m.) when value recorded is 35.0 °C in the healthy leaves and 35.2 °C in the attacked leaves and towards the evening (6 p.m.) temperature decrease when value recorded is 34.1 °C in the healthy leaves and 34.3 °C in the attacked leaves.

Linear regression shows a positive correlation between the photosynthesis rate and of the leaf temperature (the coefficient of determination R^2 was 0.80 for the healthy leaves and 0.87 for the attacked leaves) and between the transpiration rate and of the leaf temperature (the coefficient of determination R^2 was 0.70 for the healthy leaves and 0.65 for the attacked leaves) - Fig. 8 and Fig. 9.

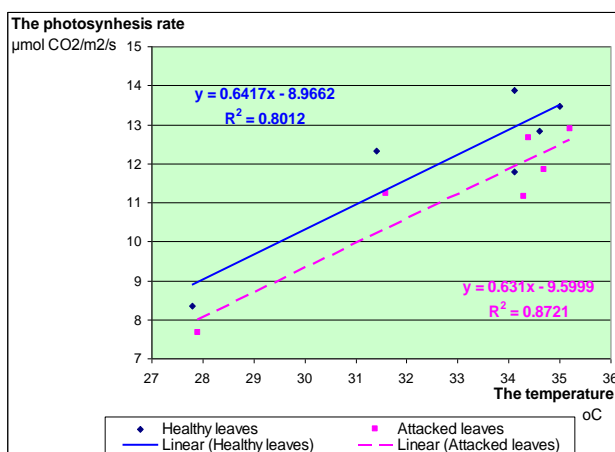


Fig. 8. The correlation between the photosynthesis rate and the leaf temperature at the *Zinnia elegans* Jacq.

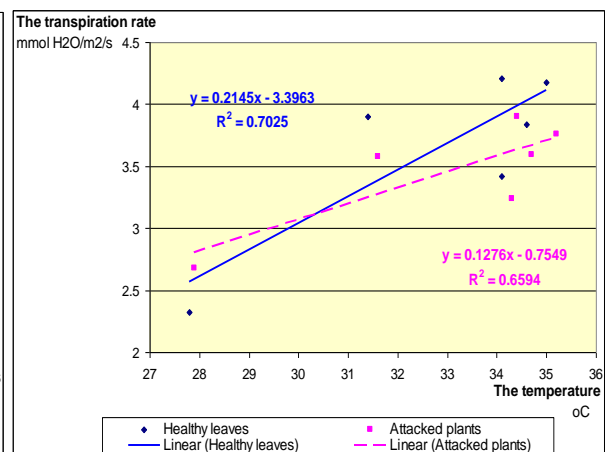


Fig. 9. The correlation between the transpiration rate and the leaf temperature at the *Zinnia elegans* Jacq.

Stomatal conductance varies throughout the day. The conductance of the stomatal increases until after lunch and then decrease as a result of the reducing the stomata opening under the influence of high temperature and low relative humidity of the air.

So during the day one can observe an increase of the stomatal conductance starting with the early hours of the morning (8 a.m.) when one can record values of 0.11 $\mu\text{mol} / \text{m}^2 / \text{s}$ in the healthy leaves and 0.09 $\mu\text{mol} / \text{m}^2 / \text{s}$ in the attacked leaves, the increase

of the stomatal conductance up until after lunch (2 p.m.) when one can record values of $0.19 \mu\text{mol} / \text{m}^2 / \text{s}$ in the healthy leaves and $0.18 \mu\text{mol} / \text{m}^2 / \text{s}$ in the attacked leaves and towards the evening (6 p.m.) the gradual decrease of the stomatal conductance when one can record values of $0.14 \mu\text{mol} / \text{m}^2 / \text{s}$ in the healthy leaves and $0.12 \mu\text{mol} / \text{m}^2 / \text{s}$ in the attacked leaves.

Linear regression shows a positive correlation between the photosynthesis rate and of the stomatal conductance (the coefficient of determination R^2 was 0.83 for the healthy leaves and 0.82 for the attacked leaves) and between the transpiration rate and of the stomatal conductance (the coefficient of determination R^2 was 0.78 for the healthy leaves and 0.76 for the attacked leaves) - Fig. 10 and Fig. 11.

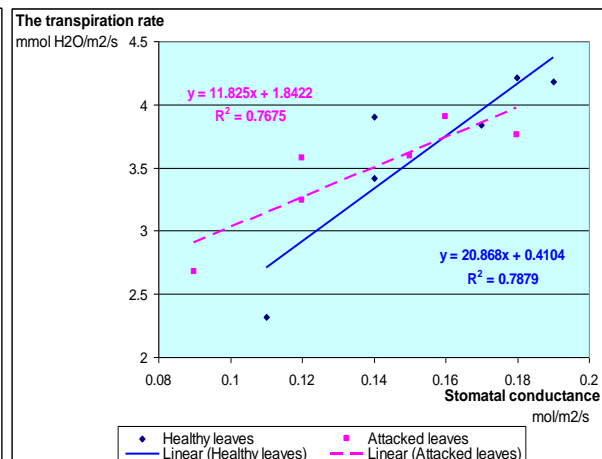
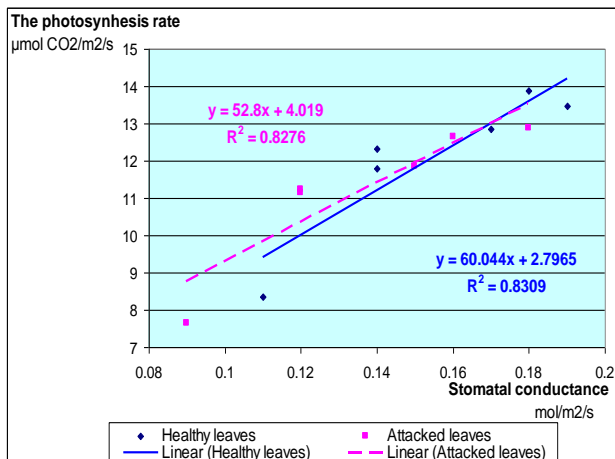


Fig. 10. The correlation between the photosynthesis rate and the conductance stomatal at the *Zinnia elegans* Jacq.

Fig. 11. The correlation between the transpiration rate and the conductance stomatal at the *Zinnia elegans* Jacq.

The attacked leaves present a decrease of the total water content by 1.61 %, which is manifested by the decrease of the cellular turgor, the withering and premature drying of the plants (Fig. 12).

In the attacked leaves the dry substance content present a increase with 6.08 %, in comparison with healthy leaves (Fig. 13).

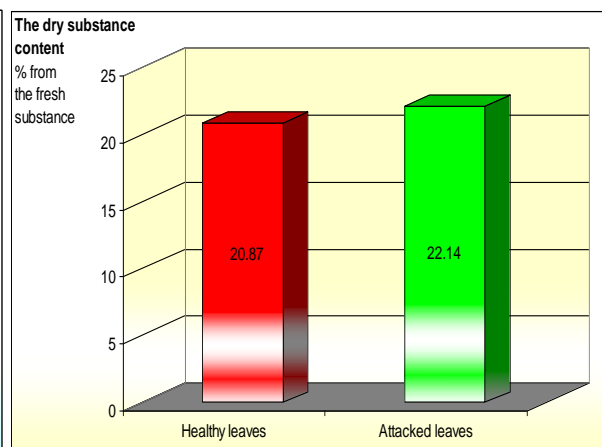
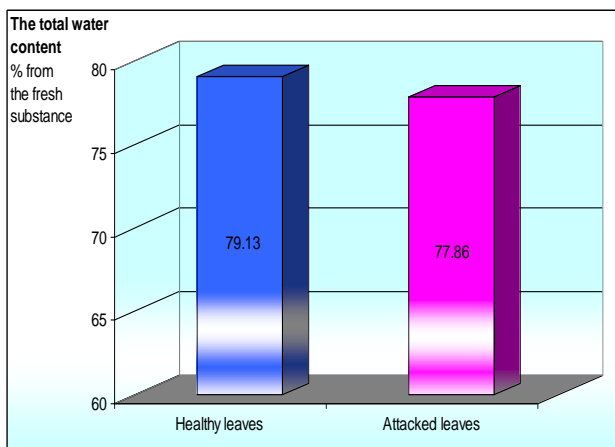


Fig. 12. The water content at the *Zinnia elegans* Jacq.

Fig. 13. The dry substance content at the *Zinnia elegans* Jacq.

The attacked leaves present a decrease of the chlorophyll content by 3.26 % in the young leaves and by 5.65 % in the mature leaves as a result of the

blockage of its biosynthesis and the deterioration of the chlorophyll (Fig. 14).

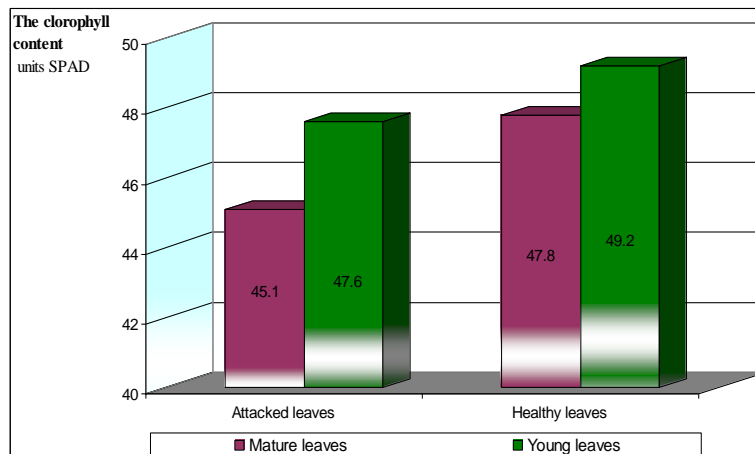


Fig. 14. The chlorophyll content at the *Zinnia elegans* Jacq.

Conclusions

The intensity of the physiological processes in *Zinnia elegans* Jacq. varies according to the frequency, the intensity and the degree of attack, but also by the climatic conditions.

As a result of the action pathogen on the attacked leaves one can observe that intensity of the photosynthesis and of transpiration presents a minimum in the morning, a maximum at lunch and a minimum toward the evening, but the recorded values are small in comparison with healthy leaves.

In the attacked leaves one can observe a decrease of the chlorophyll content because deterioration of the chlorophyll and the decrease of the total water content which determines of the withering and premature drying of the plants.

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