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Influence of meteorological conditions on the production of nectar and pollen of *Cucurbita pepo* var. *giromontia*

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Abstract

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The influence of the climatic factors on the honey-producing potential of courgettes *Cucurbita pepo* var. *giromontia* was studied within the framework of the project "Investigation of the impact of biochar on soil fertility and agricultural crops development". By conducting field experiments, the influence of abiotic factors (temperature, air humidity and rainfall) on the development of the plants was studied. The amount of nectar and pollen and the visit of the bees to the plants were determined. Incorporation of biochar in soil has generally been shown to be beneficial for growing crops.

Keywords: Cucurbita pepo var. *giromontia*; meteorological conditions; nectar production; pollen production; bees

Introduction

Light and heat are essential vital factors for vegetable crops. At the optimum temperature growth and development of plants are the most intensive. With deviations of these factors, the life processes stop and the plants die. High temperature is one of the stress factors that significantly reduce photosynthetic activity and plant productivity (Georgieva and Lichtenthaler, 1999; Kaluchiva, 2002; Oukarrorum 2002). Agro-meteorological and phenological observations are a valuable source of information about the relationship between climate and development of plants during the growing season.

The weather conditions before and during the flowering of vegetable crops have a significant impact on the beginning and duration of their flowering. High temperature lowers the pollen's vitality, negatively affects fertilization and reduces the growth of fruit. The negative influence of high temperature is increased when accompanied by drought (Ivanov, 2015). For normal growth and development, courgettes require heat. She is one of the important factors in the process of flowering.

Courgettes (*Cucurbita pepo* L.) are vegetables that quickly reach a generative phase (flowering and fruiting) for about 40-60 days. They prefer sunny areas and well-drained, well-processed, rich in organic matter soils.

According to the literature, the courgettes are sown when they have passed the risk of late spring frosts and the temperature has risen steadily at least 15°C (late April to early May). The optimum germination temperatures for zucchini are 20-30°C and the maximum temperatures for which courgettes can grow are 38°C. The optimal temperatures for the development of courgettes are 18-24°C. They are sensitive to low temperatures below 5°C.

Species of the family Cucurbitaceae depend on the pollination of bees for fruit production. Bees collect nectar from male and female flowers of *Cucurbita pepo*. A special feature of the species is that a large amount of nectar is released from the female flowers and they are more often visited by the bees than the male flowers.

Nepi (1996) establishes the nectar content of parenchyma that stores starch in the presecretory stages, and epidermis. An hour before nectar secretion begins, the starch is hydrolyzed.

Materials and Methods

The experiment was carried out in 2017 on the experimental field of the University of Forestry – Sofia. The soil is fluvisol, slightly stony, slightly acidic. This area came under a continental climatic sub region, in a mountain climatic region.

The study was performed with courgette (*Cucurbita pepo* var. *giromontia*), cv. Izobilna F1, with growing period lasted 55-60 days. Sowing was conducted on May, 03, by scheme 100x60x50. All elements of agro-technical activities (mainly pre-sowing cultivation, irrigation, etc.) are the same for all treatments. Plants are irrigated by a drip irrigation system.

The experiment was set with two meliorants – biochar and manure (used as a background). During the spring cultivation, the two meliorants were incorporated into the soil and were developed six variants: 1) control – no biochar and manure; 2) only with manure – 4 t/ha^{-1}; 3) biochar – 500 kg/ha^{-1}; 4) manure + reduced amount of biochar (250 kg/ha^{-1}); 5) manure + optimal amount of biochar; 6) manure + increased amount of biochar (750 kg/ha^{-1}). The experiment was carried out by randomized complete block design with four replications and protection zones.

The phenological observations were made on ten plants of each replication in the phases: beginning of flowering, mass flowering and ending of flowering, when the characteristics characterizing it show 20% of the plants and the mass at 75%. We examined the following methods according to Simidchiev (1980): amount of nectar from one flower for 12 hours in mg; percentage of sugar content in nectar; pollen count in mg. The nectar productivity of the flower was determined by the capillary method, and the sugar concentration of nectar with laboratory refractometer. The flowers were isolated for 24 hours.

To determine the impact of climatic conditions, daily meteorological observations are conducted.

Results and Discussion

For the purpose of the experiment, information on climatic conditions and changes has been collected. An analysis of the meteorological conditions for the last 30 years was carried out in order to track the climate change for the Sofia field (Fig. 1). Information about the annual rainfall in the Sofia region was also collected.

On the basis of this information curve of probability of precipitation per year has been prepared and according to the results obtained in 2017 it is characterized by secure close to 70% which defines it as an average precipitation rate for the year.

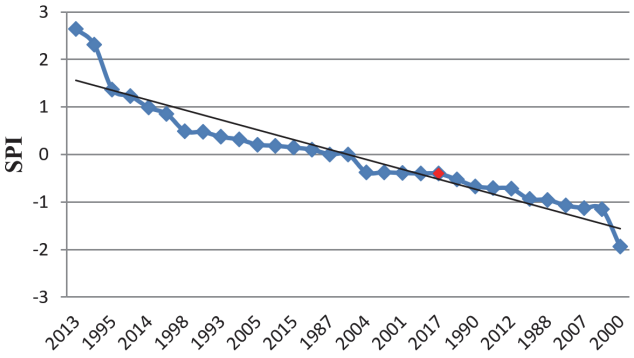

Fig. 1. The precipitation provision curve for the period 1987-2017

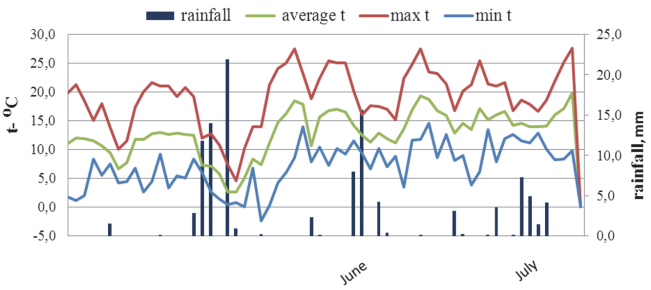

Fig. 2. Temperatures and rainfall during the vegetation of Polish experience with courgettes, 2017

During the experimental period (May-July), weather conditions are favorable for the growth and development of courgettes (Fig. 2).

There were no variations in the minimum and maximum temperatures during this period, which would stop the life processes of plants, and later to their destruction. Only at the beginning and the end of the second decade of May low positive temperatures (3.5°C and 3.8°C) were recorded, but average daily temperatures for those days did not fall below 12°C and no negative impact on vegetative growth of plants were reported.

The courgette is monoecious, separate sexually, cross-pollinating plant and starts to bloom from June, when first bloom the male flowers, and later the females. Male flowers are a source of heavy and sticky pollen that is transported only by insects, including bees. Female flowers emit more nectar that is easily accessible to bees, while male nectar is difficult to access.

The minimum temperature at which most plants begin to produce nectar is about 10-12°C, and the most favorable is from 16 to 25°C. Bees are massively fled from the hive when the temperature is 12-15°C, and the weather is not rainy.

Meteorological conditions in June are favorable for both nectar separation and bee fly. The average daily temperatures

during this period range from 17°C to 24.4°C at the end of the month temperatures begin to rise and the last days of the month are the average daily temperature over 25-27.1°C and 26.5°C.

June is with rainfall 11 days which are evenly distributed – an average of over 2-4 days there is rain, as rainfall periods are from 1 to 3 days. The total amount of rainfall is 63.1, with more than two thirds fall on the precipitation days from the first half of the month. The alternation on wet and dry days is beneficial both for the production of nectar from the flowers and the flow of bees.

The nectar productivity and the amount of sugars in the nectar are directly dependent on the weather conditions. When the soil moisture is sufficient and the air temperature is relatively stable within 21-25°C, nectar content (Fig. 3) and sugar content (Fig. 4) is favorable.

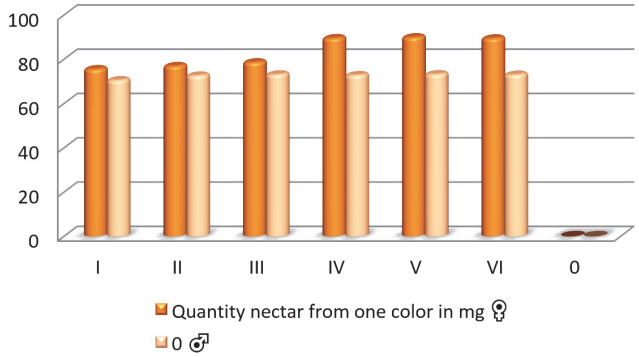

Fig. 3. Amount of nectar from one flower, mg

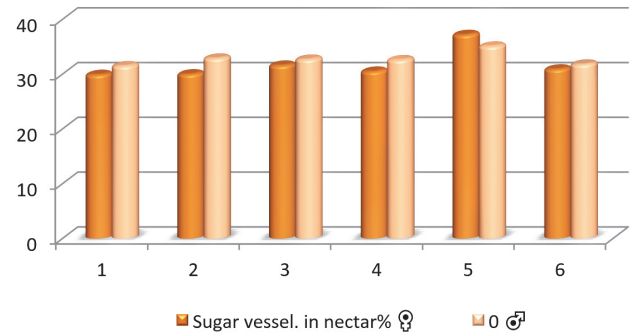

Fig. 4. Sugar content in nectar, %

As a result of the study, we found that female flowers produce a larger amount of nectar in all studied variants with values ranging from 75.5 mg to 89.4 mg, compared to male flowers (70-75 mg), because of the species specificity of *Cucurbita pepo* var. *giromontia*.

Concentration of sugars in nectar depends on external factors and fluctuates widely. Sugar content in the nectar is relatively high from 30% to 37% with a maximum of 40% sugar content.

Our results are similar to those of Massimo (1993, 2001), both sexes were extremely rewarding compared with most bee-pollinated flowers, producing 22-40 mg sugar/flower in 6 h. Female flowers produced significantly more nectar sugar than did males, mainly because of a higher concentration of sugars in nectar (440 vs. 325 mg/mL).

In the variants with imported manure and biochar flowers produce larger quantities of nectar and pollen (Fig. 5). We observed them with strong plant growth and development, which also affected the amount of nectar and sugar content in the nectar.

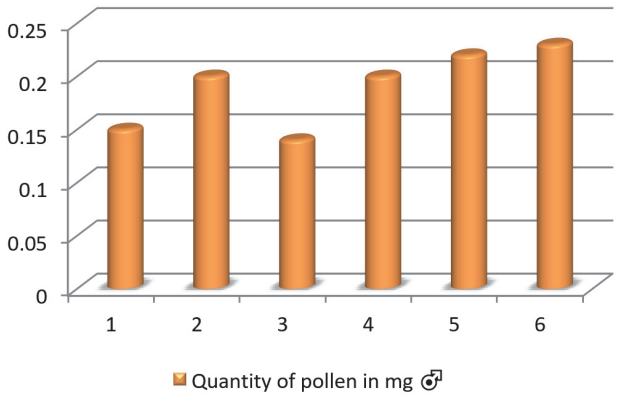

Fig. 5. Amount of pollen, mg

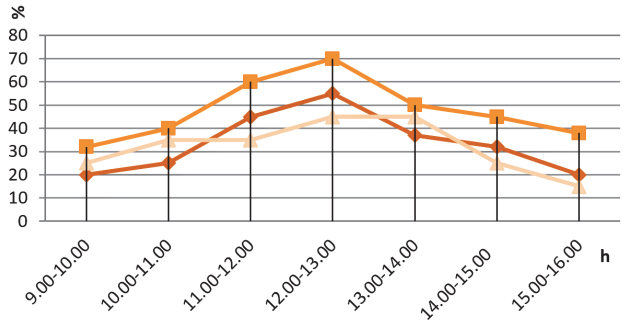

Fig. 6. Visiting of bees on flowers

The best conditions for secretion of a maximum amount of nectar are warm weather without wind and humidity. Under such conditions a mass flight of bees is observed.

The visit of bees to honey plants begins at 9.00 am in the morning with increased temperature and sunshine and reaches a maximum of 12.00 to 13.00 in the afternoon, after which there is a decrease in the visit and stops completely in the hours 15.00-16.00 in the afternoon (Fig. 6). Bees visit

massively plant of the species *Cucurbita pepo* var. *giromontia* and collect both pollen and nectar.

Conclusions

Meteorological conditions have a strong influence on the production of nectar from the flowers of the plants. The most favorable temperature is from 16 to 25°C and the minimum at which most plants begin to produce nectar is about 10-12°C. The meteorological factors during the study period are favorable for the development of *Cucurbita pepo* var. *giromontia* and for the extraction of large amounts of nectar from the flowers.

Manure and biochar to the soil enhances the development of the generative organs and contributes to increasing the production of nectar from the flowers of the plants. The results of this study show that the flowers of the species produce abundance of nectar and pollen which are available in quantities sufficient to maintain bee families in large colonies. Honey bees visit the plants massively during the midday hours of the day.

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