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THE CLIMATE FACTORS IMPACT ON THE NECTARIFEROUS QUALITIES OF *Phacelia tanacetifolia* Benth

Tsvetelina NIKOLOVA, Vera PETROVA

University of Forestry-Sofia, Faculty of Agronomy, 10 Kliment Ochridsky Blvd., 1756 Sofia, Bulgaria

Corresponding author email: c.alipieva@abv.bg

Abstract

An analysis of the influence of climatic factors on the honey qualities of Phacelia tanacetifolia Benth was carried out by conducting the field experiments. The main objective is to study the influence of air temperature and humidity on the formation and extraction of nectar from plants flowers. Determine the impact of climatic factors on the flowering duration, the number of plant blooms, the amount of nectar, and the composition of sugars in the nectar.

Key words: *special honey plants, honey production, Phacelia tanacetifolia, climatic factors, nectar sugar content.*

INTRODUCTION

Additions to the climate system are signify-cantly faster than those in the past millennium. They cause variations in the amount and distribution of precipitation in many regions, leading to a strong occurrence of very high temperatures, drought or floods. Due to the nonlinear nature of climatic influences and ecosystem sensitivity, even minor temperature fluctuations can have serious consequences.

The higher temperatures can, induce shifts in plant phenology and change the interaction networks between plants and pollinators (Takkis et al., 2015; Schweiger et al., 2010; Petanidou et al., 2014). Most of plants species have an optimum temperatures range for proper development- around 35^{o}C. The temperature also directly affects a nectar production and the amount of sugar produced per flower. A number of studies from have found decreased nectar volumes and nectar production rates at higher temperatures under both experimental and natural conditions (Jakobsen and Kristjánsson, 1994; Petanidou and Smets, 1996; Keasar et al., 2008). At the other hand, nectar sugar concentration is usually less dependent on external factors and more constant throughout the flowering season. In relation to this, evaluation of the climate parameters is a very important in the context of global warming. Agro-meteorological and phenological observations are a valuable source of information about the relationship between climate and development of plants during the growing season.

“Special honey plants" are not a large group that is used in some area in case of lack of bee grazing. In beekeeping, they are known as special honey plants, they release a large amount of nectar and pollen. To prevent periods without any harvesting, sowing of special honey plants is very importance.

The *Phacelia* takes the first place in the production of nectar and pollen among honey plants (Bijev, 2003). It is used for green fertilization as an intermediate crop, such as a decorative plant, for fodder and honeybee pasture. The phacelia is an annual dicotyledonous plant of the family *Hydrophilaceae*. Originally from North America, individual species occur in Asia, Africa and Hawaii.

In Bulgaria, the phacelial occurs only as a cultural species. And it is one of the best honey plants with a long flowering period and a large amount of nectar (Talevnina, 2016).

The stem is erect and highly branched, is 50-80 cm high. The leaves are consecutive, pinnate cuties, with short handles, bristly glared. Flowers are normal, two-poles, forming multi-colour thick inflorescences, which are twisted in a spiral (Petkov, 1989).

They have a characteristic aroma that strongly attracts bees (Naumkin, 2001). The *Phacelia* is characterized by a rapid initial development, a very high degree of coverage and shading of the soil surface, thereby greatly suppressing the growth of weeds. She has a very good tolerance to drought, a strong root with a moderate share of fine roots mainly in the upper soil layer (up to 20 cm). The phacelia is very suitable as a roofing culture. It can be sown by direct sowing (Naumkin, 2001; Lembacher, 2009).

The *phacelia* flowers give a significant amount of nectar of varying intensity during the flowering of each individual flower (Carreck, 1997; Williams, 1991). It can be said that this is an excellent honey plant, emitting large amounts of nectar and pollen. According to Petkov (1989), for the Vidin region of 1 da it was produced from 33 to 36 kg of honey, and for the Sofia region - from 21 to 37 kg.

The global studies give evidence of more than 50-60 kg of honey obtained by 1 da.

These positive characteristic of the phacelia plant have led us to an in-depth study and observe the influence of climatic factors on honey qualities.

According to Tsankov (2004), the extricate of nectar from plants depends on many factors.

One of the main and important factors which directly affect the nectar productiveness is air temperature.

Plants nectar extraction begins above 10-12˚C and increases with increasing of temperature. The most favourable temperature for the release of nectar in plants is 16-25˚C. When the temperature decreases at night, nectar secretion decreases sharply. The optimal temperature is different for a different plants species and is closely related to a number of other factors.

Another important factor is air humidity. The optimal air humidity for most plants is around 60-80%. It has been found that higher humidity increases the amount of nectar but reduces the sugar content in it. Prolonged rainfall reduces photosynthesis and less nectar is formed. The rains stimulate the growth of the green parts of the plants and thus retain the blossom development, on the other hand prolonged rainfall wash the nectar from flowers.

Dry winds, combined with high temperature and low relative humidity, drastically reduce the amount of nectar compartment and even the deformation of nectarines (Petkov, 1989).

In Bulgaria, there are not sufficiently studies related to the impact of climate factor on honey plants and its productivity.

MATERIALS AND METHODS

The studies were conducted in the experimental field of Vrajdebna - University of Forestry, Sofia, in 2018 on an alluvial meadow soil with an area of 150 m^2. The experiment is based on the standard method and scheme in 6 variants as fallow:

I-Control

II-Control + Biochar

III - Manure

IV- Manure + Biochar

V- Compost

VI - Compost + Biochar

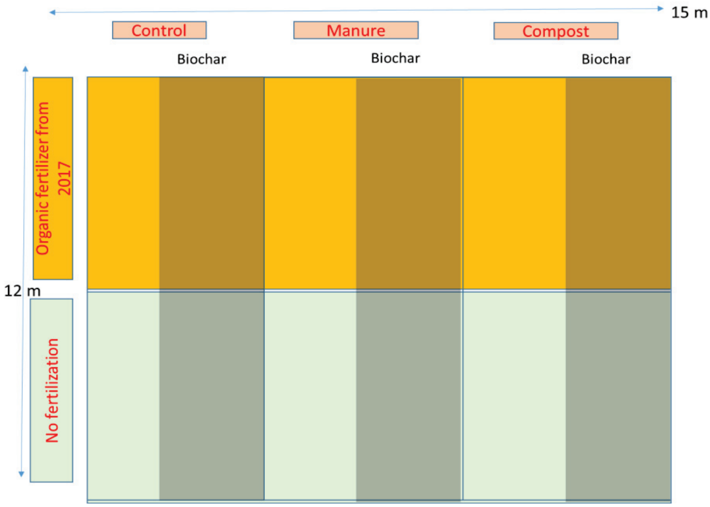

Figure 1. Experimental scheme

The imported BC is 15 kg/da in all variants. The norm is selected based on our previous BC studies conducted on the same field.
The single variants, which are as control, have optimal amounts of used ameliorants. This amounts were determined by literature data. In combine variants, the main point is on the ability of BC to improve soil fertility when is combined with different organic fertilizer types and compositions.
The biochar for the experiment is provided by a licensed manufacturer and is fragmented into a finer fraction before its being introduced into the soil. In order to determine the influence of BC on the soil properties, field experiments with *Phacelia tanacetifolia* Benth were carried out. The sowing data is 20.04.2018.
The followed parameter is: start and duration of flowering; Flowering duration of a separate blossom; Number of blossoms per plant; Amount of nectar of 1 blossom in mg; Percentage of sugar content in nectar (Brix%);

RESULTS AND DISCUSSIONS

For the purpose of the experiment, information on climatic conditions and changes has been collected. An analysis of the meteorological conditions for the last 31 years was carried out in order to track the climate change for the Sofia field (Fig. 2). Information about the annual rainfall in the Sofia region was also collected.

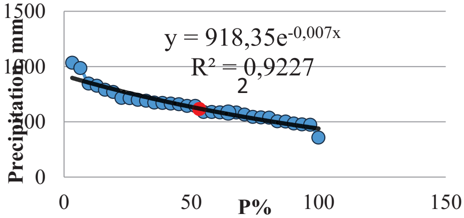

Figure 2. The precipitation provision curve for the period 1987-2018

Information on annual rainfall in the Sofia region is 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 2018 it is characterized by secure close to 53%, which determines it as a mean dry year.
The weather conditions during the experimental period (April-September), is presented on Figure 3.

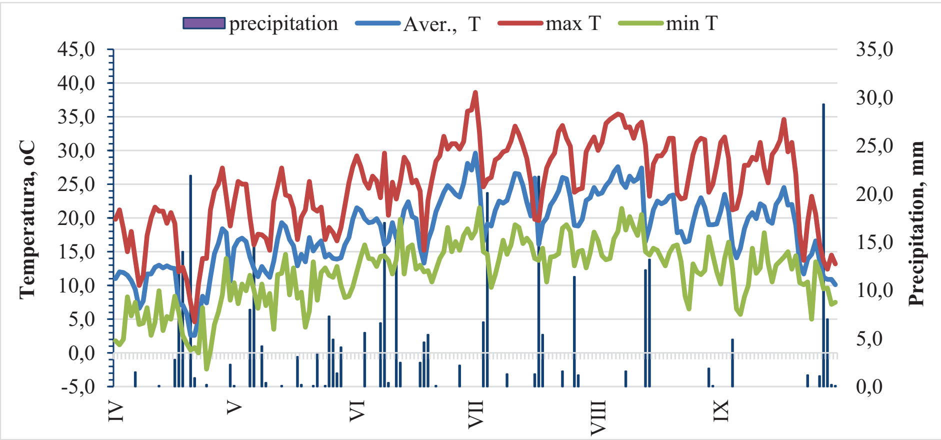

Figure 3. Temperatures and rainfall during the vegetation of phacelia 2018

Higher temperature values are observed, and at the beginning of July, the maximum reading is 38.6°C. The reported temperatures are on average by +1.2°C, higher than the data published by the National Institute of Hydrology and Meteorology, compared to the norms for the period 1961-1990.
Precipitation are relatively uniform, but their amount in most case exceeds 10 mm, this indicating that the plants is under water stress conditions. High temperatures in July and August and water stress alter many physiological processes during the plant life cycle and affect plants at the molecular, cellular, and

organismal level. Water stress leads to stomatal closure, reducing water potential and CO_2 uptake, thus leading to inhibition of photosynthesis (Descamps et al., 2018).

Rainfall in April and May is below the average for a long time in the region of Sofia - 54 mm and 72 mm. The average monthly air temperature does not exceed 30°C. At the end of September, there is a sharp drop in temperature (from 16°C to 9°C) and the minimum values are -2.5°C.

The data shown in Figure 4 clearly demonstrates the presence of water deficiency during the growth of the *Phacelia*. The line indicating the average monthly precipitation values is permanently reduced below the average temperature line. This clearly indicates the need for irrigation during the period.

The environmental factors also have a significant impact on the quantity and quality of the nectar produced by the flower. Temperature, solar radiation, vapour pressure, and soil moisture all may affect nectar production (Corbet, 1990; Michaud, 1990).

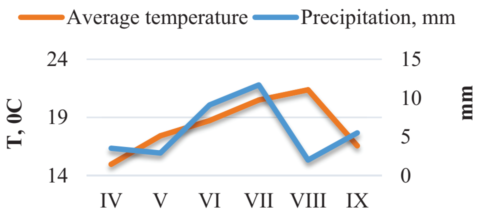

Figure 4. Average temperature and precipitation in failed experiment-2018

The figure 5 represents the average values of relative humidity. The solar radiation and the relative humidity have a direct impact on honey productivity of plants.

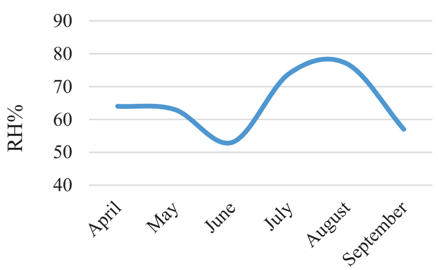

Figure 5. Monthly relative humidity during the failed experiment-2018

The high temperatures during the study period combined with low atmospheric humidity and water deficiency dramatically reduce the separation of nectar. Under these conditions, deformation of the nectarines of the plants is possible; it is not accounted for in this experience.

The amount of nectar increases and the bees find it difficult him collect.

There is a close relationship between solar radiation and relative humidity. The lowest values are in June and the highest first ten days August.

Phase start flowering was recorded one month after sowing the seeds end of May.

Table 1. Number of flower in one inflorescence

Variant	Number of flowers in initial flowering	Number of flowers in oneplant
I-Control	1–2	159
II-Control + Biochar	2	162
III - Manure	3–4	200
IV- Manure + Biochar	6	300
V- Compost	4–5	254
VI - Compost + Biochar	5	265

Table 1 shows the results obtained for the number of flowers in the beginning and mass flowering phases. Initially, flowering began with variants III and IV with fertilizer and biochar. In these variants, there was a vigorous growth and increased development of the generative organs of the plants. In the initial flowering phase, we observed the blossoming of 1 to 6 of flowers in inflorescence, gradually increasing their number and reaching from 250 to 300 of flowers in one plant. We observed similar results with other variants. In version I and II (Control and Control + Biochar), flowering started later with a smaller number of flowers (1-2). The blossoming of the flowers in the inflorescence occurs from the bottom up.

The long flowering period of this species is because the individual flowers blossom in succession from the base to the top of the inflorescence.

Figure 6 shows the results for the sugar content in the nectar.

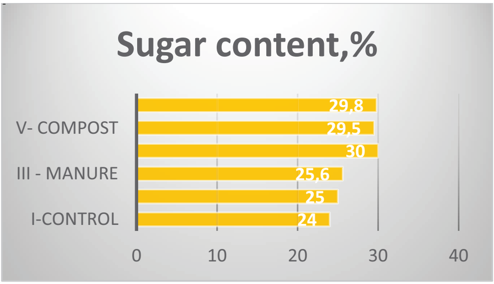

Figure 6. Sugar content, %

Sugar content is higher in variants, III – Manure, IV- Manure + Biochar,V- Compost, VI - Compost + Biochar, from 25.6% to 30.0% and lower in control variants 24-25%.
The presence of manure and biocharis a good solution for improving the soil properties and for honey productivity plants despite the unfavorable climatic conditions.

CONCLUSIONS

The weather conditions during flowering 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 that most plants begin to produce nectar is about 10-12°C. During the development of Phacelia tanacetifolia weather conditions were not suitable for optimal amounts of nectar, reported a water deficit and dry periods.
The high temperatures during the study period combined with low atmospheric humidity and water deficiency dramatically reduce the separation of nectar. The concentration of nectar increases and bees find it difficult him collect.

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REFERENCE

Descamps, C., Quinet, M., Baijot, A., Jacquemart, A.L. (2018).Temperature and water stress affect plant–pollinator interactions in *Borago officinalis* (Boraginaceae). *EcolEvol*., 8(6), 3443–3456.

Corbet, S.A. (1990). Pollination and the weather. *Isreal J. Bot*., 39, 13-30.

Williams, I.H., Christian, D.G. (1991). Observations on *Phacelia tanacetifolia* Bentham 1991 (Hydrophyllaceae) as a food plant for honey bees and bumble bees, *Journal of Apicultural Research* , 30 (1), 3-12

Jakobsen, H.B., Kristjánsson, K. (1994). Influence of temperature and floret age on nectar secretion in *Trifolium repens* L. *Annals of Botany*, 74, 327–334.

Keasar, T., Sadeh, A, Shmida, A. (2008). Variability in nectar production and standing crop, and their relation to pollinator visits in a Mediterranean shrub. *Arthropod-Plant Interactions*, 2, 117–123.

Lembacher, F., Wasner, J. (2009). *Technology for growing Phacelia*, United States Department of Agriculture, Natural resources conservation service Plant Materials Technical Note No.MT-113.

Michaud, J.P. (1990). Observations on nectar secretion in fi reweed, *Epilobium angustifolium* L. (Onagraceae). *J. Apicult. Res*., 29, 132–137.

Naumkin, V.P. (2001). *Recommendations for conveyor-based phacelia (Phacelia tanacetifolia Benth.)* In the near-site - Eagle, 16 p.

Carreck, N.L., Williams, I.H., Little, D.J. (1997). Observations on *Phacelia tanacetifolia* Benth am (Hydrophyllaceae) as a food plant for honey bees and bumble bees. *Bee World*, 78.

Petanidou, T., Kallimanis, A.S., Sgardelis, S.P., Mazaris, A.D., Pantis, J.D., Waser, N.M. (2014). Variable flowering phenology and pollinator use in a community suggest future phenological mismatch. *Acta Oecologica*, 59, 104–111.

Petanidou, T., Smets, E. (1995). The potential of marginal lands for bees and apiculture: nectar secretion in Mediterranean shrublands. *Apidologie*, 26, 39–52.

Petkov, V. (1989). *Bee pasta and ways to improve her*. Zemizdat, 127 p.

Polishchuk, V.P. (1962). *Nectar production and the use of phacelia to improve the food supply of beekeeping in the conditions of the Polesia* USSR: author. Cand. S.-H. sciences. – Kharkov

Schweiger, O., Biesmeijer, J.C., Bommarco, R., Hickler, T., Hulme, P.E., Klotz, S., Kühn, I., Moora, M., Nielsen, A., Ohlemüller, R., Petanidou, T., Potts, S.G., Pyšek, P., Stout, J.C., Sykes, M.T., Tscheulin, T, Vilà, M, Walther, G.R, Westphal, C., Winter, M., Zobel, M., Settele, J. (2010). Multiple stressors on biotic interactions: how climate change and alien species interact to affect pollination. *Biological Reviews*, 85, 777–795.

Takkis, K., Tscheulin, T., Tsalkatis, P., Petanidou, T. (2015). Climate change reduces nectar secretion in two common Mediterranean plants. *AoB PLANTS*, 7, 111.

Tsankov, G. (2004). What does the separation of nectar depend on? *Bee Journal*, 5, 45-51.

Williams, I.H., Christian, D.G. (1991). Observations on *Phacelia tanacetifolia Bentham* (Hydrophyllaceae) as a food plant for honeybees and bumble bees. *J. Apicult. Res*., 30, 3-12.