Scientific Bulletin. Series F. Biotechnologies, Vol. XXVIII, No. 2, 2024
ISSN 2285-1364, CD-ROM ISSN 2285-5521, ISSN Online 2285-1372, ISSN-L 2285-1364

RESEARCH INTO INCREASE BEE PRODUCTIVITY USING COVER CROPS

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Abstract

The general objective of the research work was to identify species of plant crops with honeydew potential during the July-October period when bee food is reduced, and it is necessary to supplement the bee family with artificial food. After harvesting the main commercial crops (barley, oats, wheat), honey plants were cultivated on the respective plots: buckwheat, mustard, phacelia, peas and camelina, which bloom during this period. After flowering, all these crops were incorporated into the soil by mechanized plowing in order to increase the amount of humus and keep the soil green, thus ensuring an ecological method of sustainability (cover crops). To determine the honeydew capacity of the selected crops, the capillary method was applied throughout the flowering period: or 3 repetitions were performed for each crop during the period of maximum nectar accumulation capacity, indicated by the specialized literature.

Key words*: cover crops, rural area, agricultural ecosystem, honey base, soil enrichment.*

INTRODUCTION

Cover crops play a crucial role in improving the humus content of the soil, contributing to its health and fertility, under the conditions of climate change (Pisante et al., 2015; Harrison et al., 1995), under which there are also Romania (Râșnoveanu et al., 2023; Drăgan et al., 2022a).
Several studies have determined the influence of cover crops on soil properties in a wide range of soil types and climates. Islam & Sherma (2021), showed that management practices that integrate soil conservation works with cover crops could help recover, preserve and build soil quality (SQ) to address food security issues. Furthermore, Farmaha et al., (2021) analyzed soil nutrients in 196 fields in the southeastern United States and reported improved soil health in no-till and cover cropping systems compared to the tillage system.
Cover crops such as legumes, crucifers and grasses add organic matter to the soil through their biomass (Drăgan et al., 2022a; Drăgan et al., 2022b).
According to Sharma et al. (2018), cover crops help to reduce soil water evaporation, thereby conserving soil moisture for the next crop. Through plowing incorporation technologies, cover crops are allowed to decompose in the soil, the plant material turns into humus, enriching the soil with essential nutrients.
Through tillage technologies, cover crops are allowed to decompose in the soil, the plant material turns into humus, enriching the soil with essential nutrients.
Cover crops stimulate microbial activity in the soil (Drăgan et al., 2022b). Microorganisms are responsible for breaking down organic matter and turning it into humus. Cover crop roots and residues provide food for these microorganisms, encouraging healthier soil (Islam & Sherman (Eds.), 2021; Farmaha et al., 2021).
Cover crops protect the soil from erosion caused by wind and water (Drăgoi et. al., 2020). By reducing erosion, they prevent the loss of the upper soil layer, which is rich in organic matter and humus (Stănilă et al., 2011)
Cover crops can suppress weed growth, reducing the need for herbicides and soil disturbance (Bîscoveanu et al., 2023). According to the studies developed by Drăgoi et al. (2020), this was found to allow the soil to remain more stable and able to support humus-forming processes.

Cover crops, especially low-diversity mixtures that include buckwheat and *Phacelia* spp., provide a high abundance of flowers throughout the summer, resulting in excessive bee visitation rates, with *Phacelia* spp. being more attractive to honeybees and bumblebees, while sunflowers and local wildflowers are more attractive to solitary bees (Khalifa et al., 2021).

Phacelia crops (*Phacelia* spp.) have become increasingly popular due to their ecological and agricultural benefits (Râșnoveanu et al., 2023; Bîscoveanu et al., 2023; Lee-Mäder et al., 2018). These plants with attractive flowers are known for their ability to attract pollinators such as bees and other beneficial insects. Thus, they contribute to the promotion of biodiversity and the pollination of other agricultural crops. Phacelia crops are also remarkable for their ability to fix atmospheric nitrogen, thereby providing organic fertilizers to the soil and improving its fertility.

White mustard (*Sinapis alba* L.) is originally from the Mediterranean region, but due to its phenotypic plasticity, it is currently cultivated on all continents. This oilseed crop has numerous agronomic advantages over canola, including greater tolerance to drought, moisture, heat, frost, and pests (Jankowski, et al., 2020).

Bees are surrounded by several variables that affect their role as pollinators, such as pathogens, nutritional deficiencies, climate change and deforestation (Pătruică et al., 2017). Spraying of agrochemicals such as fungicides, insecticides and pesticides causes contamination, toxicity and decrease in the quality and quantity of nutrients in pollen and nectar, leading to poor colony health and therefore threatening bee survival (Khalifa et al., 2021).

The present study is based on the achievement of objectives pursued, during the years 2021 - 2024, of the implementation of the project financed by the Agency for the Financing of Rural Investments - Romania, and the Regional Center for the Financing of Rural Investments 8 Bucharest - Ilfov and the completion of doctoral research studies, experimental mellifer potential cultures were established in the basic apiary from Cornetu (Călărași county, Romania),using nectar taken from staggered blooming flowers over 2-3 weeks.

MATERIALS AND METHODS

The experiments were carried out in locations located in the S-E of Romania, during 3 years of cultivation respectively: 2021-2022, 2022-2023, 2023-2024 in the following farms: Moara Domnească Didactic Farm from Găneasa, Ilfov county (area 1,000 sq m/m for each crop), Stupina Cornetu from Ilfov county (area 500 sq/m), Scurtu Mare commune, from Teleorman county (5,000 sq/m for each crop), and Ștefan cel Mare commune from Călărași county (5,000 sq/m each culture).

The cover crops selected in this research were represented by the following species: white mustard (*Sinapis alba* L. variety Myria), phacelia (*Phacelia tanacetifolia* L.), buckwheat (*Fagopyrum esculentum* L. Zita variety), spring peas (*Vicia sativa* L.) and camelina (*Camelina sativa* - Mădălina variety), by the fact that they demonstrated a good ability to fix atmospheric nitrogen in the soil as a result of symbiosis with rhizobial bacteria. For the establishment of camelina crops, the recommendations published by Dobre et al. (2014), as a result of the research carried out by them at Moara Domnească, on the use as a second effective crop on the same land area, were taken into account.

To measure nectar secretion, the capillary method was used (Ion et al., 2007) which involved the following steps:

- collection of nectar directly from flowers in the field at 9, 12 and 17 hours, the flowers being isolated 24 hours before starting the collection procedure using graduated capillaries;
- measuring the volume of nectar collected to determine the amount of nectar produced per flower;
- the comparative analysis of the data obtained to evaluate the performance of each crop in terms of nectar secretion.

The calculation of the carbohydrate index (mg/flower) needed to assess the honeydew value was carried out using the formula recommended by Ion et al. (2007):

Carbohydrate index (mg/flower) = [Nectar secretion (mg/flower) x sugar concentration (%)] / 100

RESULTS AND DISCUSSIONS

From the experiments carried out, the following was found:
- the plots sown with buckwheat, offered the highest floral coverage, total bee visitation rates increased for all cover crops during the flowering period, an important result noted by the beekeepers in the project was the elimination of the addition of bee families with artificial food.

The values recorded at the level of the samples collected from the cover crops of the Moara Domnească Didactic Farm, for the assessment of honeydew potential in the 2021 research year, were the following:

For buckwheat (*Fagopyrum esculentum* L. 'Zita') culture:
- the amount of nectar was 0.1-0.2 mg/flower
- honey production of 20 kg/ha

For white mustard (*Sinapis alba* L. variety 'Maryna') culture:
- the amount of nectar 0.04 - 0.1 mg/flower
- honey production 15 kg/ha

For camelina (*Camelina sativa* L. 'Mădălina') culture:
- the amount of nectar was below 0.02 mg/flower
- honey production below 8 kg/ha

Phacelia (*Phacelia tanacetifolia* L. 'Stala'), the culture did not emerge uniformly and due to the weather conditions of November 2021, the plant did not bloom, the collection of samples for nectar determinations were not sufficient and edifying.

The autumn pea (*Vicia villosa* L.) crop did not emerge uniformly and due to the weather conditions of November 2021, the plant did not bloom, the collection of samples for nectar determinations were not sufficient and edifying.

The values recorded at the level of the samples collected from the cover crops located in the Cornetu Commune and from the Moara Domnească Didactic Farm, for the assessment of the potential of the honeydew in the 2022 research year, were the following:

For buckwheat (*Fagopyrum esculentum* L. 'Zita') culture, the amount of nectar was 0.2-0.25 mg/flower, honey production 25 kg/ha.

And for white mustard (*Sinapis alba* L. variety 'Maryna') culture, the nectar quantity 0.1 - 0.15 mg/flower, honey production 20 kg/ha.

The cover crops camelina, phacelia, autumn pea did not withstand the water stress of July 2022.

Buckwheat and mustard crops have shown a good ability to develop under severe drought conditions.

Among the 5 crops of honey plants established to cover the ground at the basic apiary in Cornetu commune, only buckwheat (*Fagopyrum esculentum* L.) and white mustard (*Sinapis alba* L.) yielded quantifiable results, comparable to the data from the specialized literature.

The 2023 research year took place in the basic apiary in Cornetu commune, Moara Domnească Didactic Farm, Scurtu Mare commune, Teleorman county and Ștefan cel Mare commune in Călărași county.

In the experiments initiated with buckwheat culture (*Fagopyrum esculentum* L.), the results of which are presented in Table 1, the establishment of plant cultures was carried out in July 2023, for the purpose of testing for cover crops, and for this reason the determined values are different from the cultivation conditions of a main crop.

Plots sown with buckwheat provided the highest floral covers compared to the other crops studied. This suggests that buckwheat may be an excellent option for attracting pollinators due to its high flower density.

So, for mounth August and September of the year 2023 for the buckwheat crop (*Fagopyrum esculentum* L.), a production in the amount of approx. 40 kg/ha-honey, this value being located very close to the one in the specialized literature for buckwheat, through the average results recorded in the 3 series of determinations of honey collection/evaluation of honey potential (kg/ha), carried out at the 4 farms of the project.

Table 1. The values calculated in BRIEF between the hours of 9-12.30-16.30 at the level of the samples collected from the buckwheat crop, for the estimation of the honeydew harvest/evaluation of the honeydew potential (kg/ha) on Average duration of flowering = 26 days from 14 September 2023

BUCKWHEAT SERIES	Average number of flowers/ha	Glycemic index	The entire flowering period	Daily honeydew potential	Honeybee/culture potential
		(mg/flower)	(number of days)	(kg/ha/days)	(kg/ha)
SERIES 1 (9.00 a.m. (14.09.2023, Scurtu Mare)	475,200,000	0.0028	26	1.6333	42.4650
SERIES 2 (12.30 p.m. (14.09.2023, Scurtu Mare)	475,200,000	0.0029	26	1.7084	44.4177
SERIES 3 (4.30pm (14.09.2023, Scurtu Mare)	475,200,000	0.0011	26	0.6383	16.5956
Average values Scurtu Mare		0.0023		1.3267	34.4928

(with variation limits between 230,400,000 and 720,000,000)

For the months of August of the year 2023 for the white mustard crop (*Sinapis alba* L.), a production in the amount of approx. 32 kg/ha-honey, a quantity of nectar of 0.03-0.1 mg/flower, this value being very close to the one in the specialized literature for white mustard (*Sinapis alba* L.), through the average results recorded at the 3 series of determinations of honey which are presented in Table 2. The collection/evaluation of honey potential (kg/ha), are carried out at the 2 farms of the project.

Table 2. Values calculated in Ștefan cel Mare for the 9-12.30-17 hours interval, for the samples collected from the white mustard crop (*Sinapis alba* L.), for the estimation of the honey collection/evaluation of the honey potential (kg/ha) on Average duration of flowering = 26 days from 05 August 2023

WHITE MUSTARD SERIES	Average number of flowers / ha	Glycemic index	The entire flowering period	Daily honeydew potential	Honeybee/culture potential
		(mg/flowers)	(number of days)	(kg/ha/days)	(kg/ha)
SERIES 1 (9.00 a.m. (15.09.2023, Ștefan cel Mare)	475,200,000	0.0027	26	1.5939	41.4403
SERIES 2 (12.30 p.m. (15.09.2023, Ștefan cel Mare)	475,200,000	0.0019	26	1.1001	28.6031
SERIES 3 (4.30pm (15.09.2023, Ștefan cel Mare)	475,200,000	0.0016	26	0.9537	24.7958
Average values Ștefan cel Mare		0.0021		1.2159	31.6131

(with variation limits between 230,400,000 and 720,000,000)

In 2022, soil analyzes were carried out in the S.C. ALCHIMEX laboratory in Herești, Giurgiu county. The amount of humus determined from the Cornetu apiary was 2.70% (Figure 1).

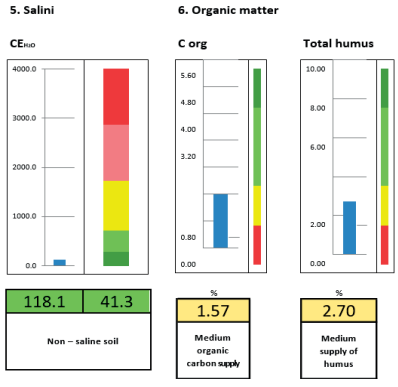

Figure 1. Soil analysis bulletin 2022, Cornetu, Ilfov county

The 2023 cover crop with humus-rich soil benefited from very good nutritional conditions. The analyzes were repeated in 2024, in March, the amount of humus increased to 4.27%. (Figure 2).

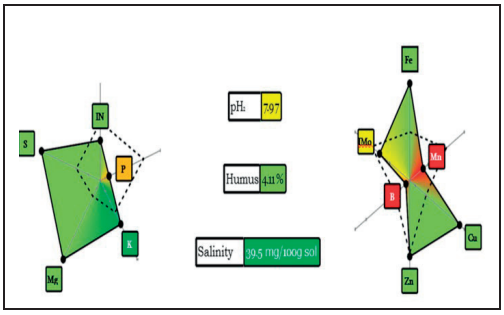

Figure 2. Soil analysis bulletin 2024, Cornetu, Ilfov county

The 2023 cover crop with humus-rich soil benefited from very good nutritional conditions. The amount of humus in the course of 2 years of research has doubled through the use of technologies for incorporating the plant mass resulting from the cultivation of "cover-crops" plants, proving indicators of soil fertility and the formation in the soil of humus mineralization (its destruction), a process through which it reproduces varying amounts of nutrients to the soil.

CONCLUSIONS

Due to the severe drought in the last 3 years on the territory of Romania, the local honey base has been seriously affected.

This research helps the specific area of beekeeping to prevent effective economic measures. Thus, the study carried out during the 3 years had the role of extending the honey and pollen harvesting period and supporting the beekeeping sector after the spring and summer periods, by increasing the values of the hive products, by using agricultural crops beneficial to bees and pollinators in accordance with the agro-environmental conditions, as well as increasing the annual production of honey and pollen.

Thus, from the observations made, it was found that bees visit mustard flowers intensively, especially in the morning when nectar secretion is abundant. Throughout September and until October 18 of the year 2023, the bees had a source of collecting nectar and pollen.

Results obtained within the framework of the research thesis and the development of the AGROAPIS project have resulted in the creation of a database accessible for free online https://agroapis.polenizare.ro. by using the APIA database, where farmers report all the agricultural crops established in the current year, it is possible to see in real time all the honey-bearing agricultural crops from the entire territory of Romania, evaluating the honey-bearing potential of the location of any apiary.

The information found on the online database will be updated periodically and will thus provide beekeepers with a method to protect their bees and the production of bee products by avoiding the loss caused by bee colonies with reduced health that are at risk of not surviving. the winters.

Reducing the expenses generated by the need to use artificial sources of food to maintain their own beehive, will motivate farmers to inform themselves in order to obtain economically advantageous methods of increasing crop productivity.

ACKNOWLEDGEMENTS

This publication was made with the support of the Doctoral School - Plant and Animal Resource Engineering and Management, Biotechnology field, from the Biotechnology Faculty of the University of Agronomic Sciences and Veterinary Medicine of Bucharest. At the same time, the present research study of the doctoral thesis was carried out within the Project financed by the Agency for the Financing of Rural Investments - Romania, and the Regional Center for Financing Rural Investments 8 Bucharest-Ilfov, Project code: CRFIR-BUCURESTI-ILFOV, no: 16100000011884200019, with the title "Project for raising the value of beekeeping production by using agricultural crops beneficial to bees and pollinators in compliance with agroenvironmental conditions" (acronym AGROAPIS, https://agroapis.polenizare.ro/).

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