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RESEARCH ON THE BIOLOGY AND PRODUCTIVITY OF THE *Phacelia tanacetifolia* Benth. SPECIES IN THE CLIMATE CONDITIONS OF CENTRAL MOLDOVA

Oana MÎRZAN[1], Margareta NAIE[1], Andreea ENEA[1], Diana BATÎR RUSU[2], Adriana MUSCALU[3], Milica DIMA[4], Nina BĂRĂSCU[5]

[1]Agricultural Research Development Station Secuieni, 377 Principala Street, 617415, Secuieni, Neamt County, Romania
[2]Plant Genetic Resources Bank Suceava, Romania
[3]National Institute of Research Development for Machines and Installations Designed to Agriculture and Food Industry - INMA, 6 Ion Ionescu de la Brad Blvd, District 1, 013183, Bucharest, Romania
[4]Research and Development Station for Plant Culture on Sands, Dabuleni, Dolj County, Romania
[5]National Institute of Research and Development for Potato and Sugar Beet Brasov, Romania

Corresponding author email: naie.marieta@yahoo.com

Abstract

Phacelia is used in several climatic regions, and this illustrates its adaptability to different climates and soil types. This species is an annual herbaceous, non-leguminous, flowering plant of the Hydrophyllaceae family. It is also a versatile crop, widely used in the USA and Europe, both in crop rotation and as a source of nectar for bees. The main objective of the present research was to study the biology and productivity of the species Phacelia tanacetifolia Benth. with the aim of understanding its adaptability to the climatic conditions in Central Moldova in the period 2023-2024. Phacelia, depending on the sowing season, reaches maturity between 85-97 days from sowing, and the optimal time for harvesting is when the inflorescences have dried and the seeds have a brown color. Under the conditions at A.R.D.S. Secuieni the highest seed production was obtained with the variant sown in the first decade of April of 415 kg/ha and at a distance of 50 cm between plants/row (395 kg/ha).

Key words*: phacelia, epoch of sowing, seed.*

INTRODUCTION

Lacy phacelia (*Phacelia tanacetifolia* Benth.), a versatile plant of North and Central American origin, is now widely cultivated in many regions around the world (Kirk, 2000).

It is among the world's top twenty melliferous plants, providing monofloral honey with excellent quality for human consumption (Farkas and Zajacz, 2007; Kus et al., 2018; Stanek et al., 2019). It also supports wild pollinators and some biological control agents with pollen and nectar (Williams and Christian, 1991; Hickman and Wraten, 1996; Petanidou, 2003; Sprague et al., 2016; Owayss et al., 2020). As a cover crop and green manure, it is beneficial for soil structure (Bacq-Labreuil et al., 2019) and soil microorganisms (Patkowska and Konopinski, 2013); nevertheless, its effect on weed infestation has been assessed with different outcomes. In Switzerland, the experiments of Büchi et al. (2020) indicated that previous use of phacelia as a cover crop reduced weed abundances in the subsequent planting of maize; however, in Poland, the trials of Gaweda et al. (2014) and Kolodziejczyk (2015) suggested that phacelia cover crop caused higher weed infestations in the subsequently grown cereals, and that it also resulted in yield loss in potato, when it was sown for living mulch between rows. Phacelia is potentially used in various agricultural practices. It is used as forage and silage in livestock feeding and as a source of pollen and nectar in beekeeping. It has significant contributions to ecosystem balance by improving the habitats of beneficial insects and supporting biological control activities. Phacelia is known as a great nectar source by beekeepers worldwide and is listed among the top 20 nectar plants of the world (Lermi and Palta, 2017). Currently, in many countries, agriculture is required to use non-chemical

methods to control diseases, pests, and weeds (Kubiac et al., 2022). Many studies indicate that phacelia is exceptionally resistant to diseases and pests. Moreover, after harvesting, it constitutes a valuable preceding crop for most crop species. Its species specifity combined with its allelopathic properties, has gained recognition among both proponents of high-volume technologies and those seeking low-volume technologies (Kosolapov et al., 2021).

All these data indicate the high potential of phacelia in both economic and ecological dimensions, particularly in providing various ecosystem services such as pollination support, erosion control, and carbon sequestration. In light of recent assumptions, agricultural production should pursue several goals at the same time. In addition to producing healthy food, sustainable agriculture should mitigate climate change, positively affect soil fertility, and provide renewable energy (Zarczynski et al., 2023; Mackiewicz-Walec et al., 2024; Sienkiewicz et al., 2024). Lacy phacelia is drought-resistant (Schappert et al., 2019) and grows well even in areas with annual precipitations of approximately 200-500 mm. It prefers lighter, well - aerated soils with a good supply of nutrients. The influence of sowing period on plant development has been studied, for example in winter wheat (Fazily, 2021), where a reduction in grain yield was observed with later sowing periods (Ali et al., 2010). The influence of sowing period on the growth and development of agricultural crops has also been studied for soybeans (Bastidas et al., 2008) and cotton (Khan et al., 2017). The effect of sowing period on the vegetation period was also described by Bowie et al. (1995), Thrasyvoulou and Tsirakoglou (1998), or Lermi and Palta (2017). Karadağ and Büyükburç (2001) determined that the highest plant height, fresh and dried hay yield, seed yield and biological yield were obtained at a row spacing of 40 cm. Karadağ and Büyükburç (2003) investigated the effects of four different sowing periods (March 5, March 20, April 5 and April 20) on hay yield in fiddleneck as well as on various other agricultural properties thus showing that sowing periods have significant effects on fresh and dried hay yields while also stating that the highest values were obtained for March 5 sowing period.

This study was conducted to determine the effects of sowing period on the growth parameters of the phacelia plant, taking into account the influence of cultivation techniques on plant development.

The purpose of the research carried out during the 2023-2024 period was to determine the influence of meteorological conditions on the biology, yield and quality of phacelia seeds in the center of Moldova region.

MATERIALS AND METHODS

The Agricultural Research and Development Station (A.R.D.S.) Secuieni is located in the southeastern part of Neamț County, between the geographical coordinates of 26°51'00" east longitude and 46°51'15" north latitude. From an agro - ecosystem point of view, the territory belongs to the Central Moldavian Plateau, and from a morphostructural point of view, most of it is part of the Moldavian Platform. The area where the unit is located has a temperate continental climate (D.f.b.x. Köppen), characterized by short springs, cool summers and harsh winters, with an average annual temperature of 10.1°C and average annual precipitation of 537 mm (Trotuş et al., 2020). Under the conditions of A.R.D.S. Secuieni three sowing periods were tested: V1 (control) - sown in the first decade of April; V2 - sown in the second decade of April; V3 - sown in the third decade of April.

To establish the optimal planting space, a bifactorial experiment was set up using a split - plot design with the following factors: A - row spacing, with the following distances: a1 - 25 cm, a2 - 50 cm and a3 - 70 cm and B - plant spacing with the following distances: b1 - 15 cm, b2 - 25 cm and b3 - 35 cm.

During the phacelia vegetation period, phenological observations were conducted, and the thermal sum requirements for growth and development of the studied species were also determinated. From a thermal point of view during the lacy phacelia growing season, in 2023 there were monthly deviations from the multiannual average between -1.5°C (April) and 2.2°C (July). The spring was cool and the summer months were very warm (June and August). In 2024, the lacy phacelia growing season was warm, with monthly deviations from

the multiannual average ranging from 3.6°C (April) to 4.3°C (August) (Figure 1).

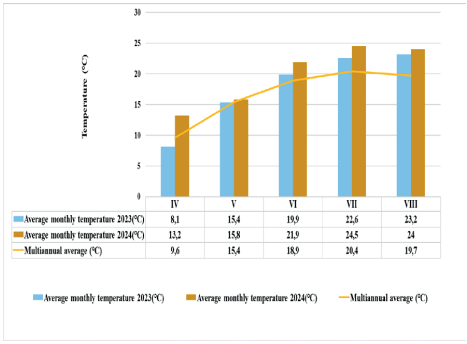

Figure 1. Temperatures recorded during the lacy phacelia growing season in the 2023-2024 period

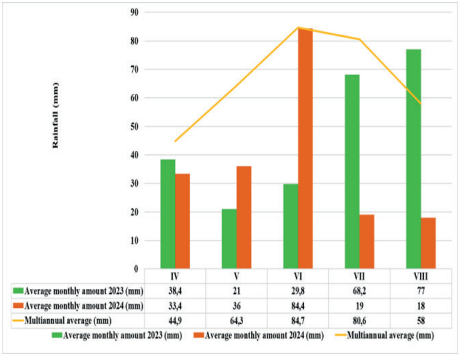

Figure 2. Precipitation recorded during the lacy phacelia growing season in the 2023-2024 period

With regard to the rainfail recorded during the lacy phacelia growing season, in 2023 there were monthly deviations from the multi-annual monthly amount between -54.9 mm (July) and 19.0 mm (August). The lacy phacelia growing season in 2024 was characterized as dry. The recorded precipitation had deviations from the multiannual average between -61.6 mm (July) and -11.5 mm (April). In June, precipitation values close to the multiannual average were recorded (Figure 2). Overall, the precipitation recording in 2023 characterized the phacelia growing season as dry (Naie et al., 2024). Meteorological data were obtained from the unit's own weather station, located in the experimental field of A.R.D.S. Secuieni.

RESULTS AND DISCUSSIONS

In the case of the species *Phacelia tanacetifolia* Benth. sown in first decade of April, on average over two years, the plants emerged after 14 days from sowing, accumulating a thermal sum of 138.5°C and a total precipitation of 15.6 mm. From emergence to the appearance of the flowering stem, 29 days were recorded, requiring a thermal sum of 462.4°C and 26.6 mm of precipitation (Table 1).

From the appearance of the flowering stem to the beginning of flowering, 12 days were required, with a recorded of thermal sum of 554.7°C and 27.2 mm of precipitation (Table 1).

Figure 3. *Phacelia tanacetifolia* in A.R.D.S. field

The seeds were harvested 20 days after the beginning of fruiting, accumulating 798.7°C and 22.4 mm of precipitation (Table 1).

From sowing to harvest, plants sown in the first period required an average of 97 days, with a thermal sum of 2532.6 °C and 146.1 mm of precipitation.

Due to the higher temperatures during the vegetation period, the plants sown in the second and third periods showed a faster development.

In the second sowing period, from sowing to seed harvesting, 95 days were required, the thermal sum was 2312.6°C and the precipitation amounted to 139 mm (Table 1).

During the third sowing period, the plants had a vegetation period of 87 days to reach maturity. The thermal sum recorded for this period (2023-2024) was 2268.1°C and the precipitation amounted to 121.4 mm (Table 1).

Table 1. Growth phenophases of the species *Phacelia tanacetifolia* Benth. under the conditions of A.R.D.S. Secuieni during the 2023-2024 period

Phenological observations	Average growing season duration during the 2023-2024 period (days)	Σ average temperature (^{0}C)	Σ average precipitation (mm)
	Sowing period I		
Sowing	-	-	-
Emergence	14	138.5	15.6
The appearance of flowering rods	29	462.4	28.6
The beginning of blooming	12	554.7	27.2
The beginning of fructification	22	578.3	52.3
Harvesting for seeds	20	798.7	22.4
TOTAL	97	2532,6	146.1
	Sowing period II		
Sowing	-	-	-
Emergence	11	101.3	20.2
The appearance of flowering rods	36	506.6	28.8
The beginning of blooming	8	509.1	36.9
The beginning of fructification	21	601.8	25.4
Harvesting for seeds	17	593.8	26.7
TOTAL	95	2312.6	139.0
	Sowing period III		
Sowing	-	-	-
Emergence	10	135.4	13.2
The appearance of flowering rods	33	512.1	30.4
The beginning of blooming	15	477.9	29.4
The beginning of fructification	17	606.1	23.4
Harvesting for seeds	10	536.6	25.0
TOTAL	85	2268.1	121.4

Table 2. Influence of the interaction between row spacing and plant spacing on average seed yield of *Phacelia tanacetifolia* Benth. (phacelia) during the 2023-2024 period

Row spacing (A)	Plant spacing (B)	Yield (kg/ha)	%	Diff.	Significance
a1-25 cm	b1-15 cm	313	90,46	-33	oo
	b2-25 cm	338	97,69	-8	
	b3-35 cm	354	102,31	8	
a2-50 cm	b1-15 cm	341	98,55	-5	
	b2-25 cm	395	114,16	49	***
	b3-35 cm	373	107,80	27	**
a3-70 cm	b1-15 cm	358	103,47	12	
	b2-25 cm	340	98,27	-6	
	b3-35 cm	300	86,71	-46	ooo
Average		346	100	Ct.	
LSD 1% 16.4 kg/ha LSD 0,1% 26.1 kg/ha LSD 5 % 43.2 kg/ha					

Under the conditions at A.R.D.S. Secuieni, the interaction of the studied factors influenced the average seed yield of the lacy phacelia species. Compared to experimental average (346 kg/ha), yield increases ranging from 27 to 49 kg/ha were recorded, being statistically significant and interpreted as distinctly and highly significant positive effects. The interaction a2xb2 (50 cm row spacing and 25 cm between plants within the row) with an average yield of 395 kg/ha was noted (Table 2).

The average seed yield ranged from 353 kg/ha for the variant sown in the IIIrd decade of April to 415 kg/ha for the variant sown in the Ist

decade of April (control). Compared to the control variant, yield reductions were statistically confirmed and interpreted as distinctly and highly significant negative effects, and were obtained for the variants sown in the second period (33 kg/ha) and the third period (62 kg/ha) (Table 3).

Tabel 3. Average seed yield of lacy phacelia depending on the sowing period at A.R.D.S. Secuieni during the 2023-2024 period

Variant	Yield			
	kg/ha	%	Diff.	Sign.
V1-Ist decade of April	415	100	Ct.	
V2-IInd decade of April	382	92.04	-33	oo
V3-IIIrd decade of April	353	85.06	-62	ooo
	LSD 5% 12.5 kg/ha LSD 1% 24.6 kg/ha LSD 0.1% 38.7 kg/ha			

CONCLUSIONS

In Central Europe, *Phacelia tanacetifolia* is more appreciated as a honey plant and as a source of valuable biomass for soil regeneration. The above-average nutritional value of phacelia pollen prompts researchers to identify an easy and effective way to support not only the honeybee breeding but also a number of other pollinators. The average yield of lacy phacelia varies widely depending on climatic conditions, the sowing period and the cultivated varieties.
It is recommended to sow lacy phacelia in the first decade of April with a row spacing of 50 cm. Ensuring the nutrition space is very important for obtaining high yields in lacy phacelia. Seed yields of lacy phacelia are strongly influenced by the experimental sowing periods.

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