Scientific Papers. Series A. Agronomy, Vol. LXVII, No. 2, 2024
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

# BRASSICACEAE SPECIES (Brassicaceae Burnett) IN THE COLLECTION OF "ALEXANDRU CIUBOTARU" NATIONAL BOTANICAL GARDEN (INSTITUTE) AS POTENTIAL HONEY PLANTS

**Natalia CÎRLIG**

"Alexandru Ciubotaru" National Botanical Garden (Institute), 18 Padurii Street, Moldova State University, 60 Alexei Mateevici Street, Chisinau, Republic of Moldova

Corresponding author email: nataliacirlig86@gmail.com

***Abstract***

*The collection of honey plants of the "Alexandru Ciubotaru" National Botanical Garden (Institute) includes species of different position in the taxonomic system. Thus, 5 species of the Brassicaceae Burnett family have been researched - flowering herbaceous annual and perennial plants. These species belong to 5 genera. The genus Brassica is represented in the collection by: B. napus L. subsp. oleifera DC. (rapeseed); Sinapis L. - Sinapis alba L. (white mustard); Isatis L. - Isatis tinctoria L. (woad); Bunias L.- Bunias orientalis L. (the Turkish wartycabbage, warty-cabbage, hill mustard); Crambe L. - Crambe cordifolia Steven. (greater sea-kale, colewort). All of these species start the growing season early and the flowering stage occurs in May-June, providing honey-producing and pollinating insects with food. Flowering is staggered, abundant, lasting about 20-30 days. The flowers are attractive for a wide range of insects, the most common belong to the order Hymenoptera: Apidae; Diptera: Syrphidae. Both cultivated and wild Brassicaceae can bring a significant contribution to the diversification and use of the potential sources of nectar and pollen in the Republic of Moldova.*

***Key words****: Brassicaceae Burnett, diversity, honey plants, insects.*

## INTRODUCTION

The representatives of the Brassicaceae Burnett family (Cruciferae Adans.), both cultivated species and those from the wild flora, contribute significantly to making use of the nectar-pollen producing potential in the Republic of Moldova. Considering that they are valuable plant species, used in different fields of the national agro-economy, their research is of topical interest. Brassicaceae are distributed in various geographical areas, and their centers of diversity include the Irano-Turanian and the Mediterranean floristic regions, as well as the Himalayas, the Cape, the Andes, Western USA, Australia and New Zealend (Appel & Al-Shehbaz, 2003; Nikolov et al., 2019). The Brassicaceae Burnett. family is very large, comprising about 3000-4000 herbaceous species of annual or perennial plants, rarely suffrutescent and woody, glabrous or with diverse indumentum. In the spontaneous flora of Bessarabia, Brassicaceae are represented by 48 genera and 97 species. Plants with alternate leaves, simple, entire or variously divided, actinomorphic flowers grouped in racemose inflorescences, without bracts. At the base of the stamens there are 4 or 2 nectariferous glands of various shapes. Fruits glabrous or pubescent, smooth or reticulate-rough. Seeds relatively small, different in shape and color (Comanici & Palancean, 2002; Flora Bassarabiei, vol. 3, 2020). Due to the position of nectar secreting glands, floral insect visitors collecting nectar often inadvertently pick up and disperse pollen. Floral nectaries of crucifers vary in their morphology, size and distribution. There are four nectary types based on number and distribution of the organs: (1) annular, a continuous zone of nectarial tissue around the receptacle; (2) two nectary type - two opposing nectaries at the flower base; (3) four-nectary type - made up of two pairs of nectaries classified as lateral and median; (4) eight-nectary type - two pairs of lateral and two pairs of median nectaries (Davis et al., 1996; Davis et al., 1998).

Brassicaceae flowers are tetramerous, with four sepals arranged in medial and lateral positions, alternating with four petals in diagonal position (Ronse de Craene, 2010). The androceium consists of six stamens, two outer and four

inner stamens with longer filaments opposite the medial sepals and shifted toward the median line. The gynoecium consists of two carpels and has a false septum dividing the ovary into two compartments (Appel & Al-Shehbaz, 2003).

Rapeseed inflorescences are umbelliform racemes with hermaphrodite flowers, with long pedicel, regular corolla, bright yellow, with 4 oblong ovate petals that reach 10-15 mm long, 4 sepals, 6 stamens, of which 4 long and 2 short, fused unicarpellate genioceum. Pollination is predominantly allogamous, entomophilous, honey potential productivity – 50-80 kg/ha honey (Țîței & Roșca, 2021).

White mustard has raceme inflorescences with flowers of 8-14 mm in diameter, attached to long, pubescent petiole. The length of the sepals is 4-6 mm, when blooming - patent, later retracted. Petals yellow, obovate, 7-9 mm long, tapering into a 6-8 mm long unguicule (Ghendov, 2020). Honey bees, solitary bees, bumblebees, flies etc. frequently visit the flowers of *Sinapis alba* to collect nectar and pollen, and serve as agents of cross pollination. Expert beekeepers could manage to get about 10-50 kg honey per hive during a season or 50-60 kg/ha (Ion et al., 2018).

Tatarican colewort is known for its voluminous, multi-branched inflorescences. The flowers are numerous, 7-8 mm in diameter, glabrous sepals 2.5 x 1.5 mm, elongated white petals, staminal filaments 2.8-3.0 mm. This species is researched for its honey, medicinal, fodder and food qualities (Vergum et al., 2019).

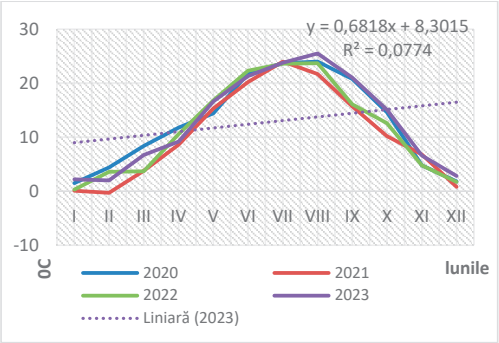
Woad is distinguished by the abundance of yellow flowers, gathered in raceme inflorescences, it has tetradynamous androecium, consisting of six stamens with two shorter filaments, actinomorphic, hermaphrodite. Honey potential productivity is around 70-100 kg/ha and fresh mass productivity reaches 20-35 t/ha and 50-800 kg/ha fruits (Țîței & Roșca, 2021). In the specialized literature these plants are described as useful plants of high economic importance. They are used in food, as valuable sources of oil, spices, as ornamental plants etc. (Al-Shehbaz, 2011; Warwick, 2011). According to the data obtained by Țîței (2022) regarding the evaluation of the quality of silage prepared from plants of the Brassicaceae family, the researched species are of interest in diversifying the assortment of agricultural crops of high potential as forage and energy biomass. The harvested biomass mixed with other traditional crops can be ensiled and fed to domestic ruminants, but also can be used as a substrate to produce biomethane. The biochemical biomethane potential from plant substrate of Brassicaceae species varied from 349 to 379 L/kg of organic matter (Ababii et al., 2023).

## MATERIALS AND METHODS

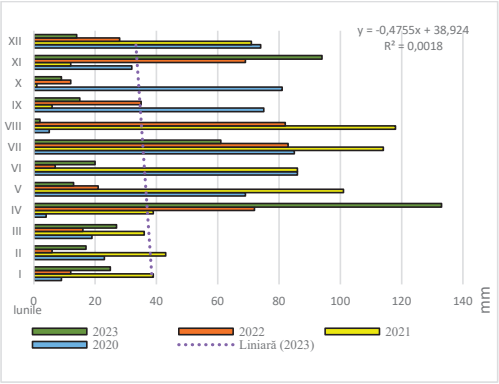
Research activities on potential honey plants have been conducted over the years at the "Alexandru Ciubotaru" National Botanical Garden (Institute), State University of Moldova, based on plants of different taxonomical position included in the families: Asteraceae, Brassicáceae, Fabaceae, Hydrophylaceae, Lamiaceae, Linaceae, Malvaceae, Papaveraceae, Pedaliaceae, Polygonaceae, Salicaceae, Rutaceae (Cîrlig et al., 2020). The National Botanical Garden is located in the South-Eastern area of the city of Chisinau, Republic of Moldova, on an area of 104 ha, divided into sectors, based on ecological-systemic principles. The climatic conditions are favorable for the growth and development of plants, with some exceptions, when high temperatures and extended periods of drought are recorded, a fact that has been proven by the systematization of the data provided by the State Hydrometeorological Service (Figure 1 A, B) (meteo.md).

The year 2022 was characterized by high temperatures and deficiency in precipitation (inconsistent weather temperatures in spring in terms of temperatures, hot summer). As compared with 2021, the air temperature was higher by 1.0-1.5 C and the amount of precipitation – lower, and compared with 2020, the air temperature was lower by 0.5-1.5°C and there was more precipitation. The year 2023 was characterized by higher temperatures and a significant precipitation deficit in the August-October period. The years 2023 and 2020 were ranked 1st among the years with high average annual temperature. The spring of the previous year was characterized by inconsistent weather.

The average temperature during the growing season was 9.7-11.2°C, 0.5-1.1°C higher than the norm. But in April, the highest amount was recorded (amount of 85-175 mm). The summer was hot and dry. The average temperature of the season was 21.3-23.9°C, by 2.1-2.7°C higher than the norm.




A




B

Figure 1. Main meteorological indices during the research period 2020-2023: A - average monthly temperature; B - monthly precipitation total

The research described in this article refers to 5 species of plants in the family Brassicaceae Burnett – *B. napus* L. subsp. *oleifera* DC., (rapeseed); *Sinapis alba* L. (white mustard); *Isatis tinctoria* L. (woad); *Bunias orientalis* L. (the Turkish wartycabbage, warty-cabbage, hill mustard); *Crambe cordifolia* Steven (greater sea-kale, colewort). The plants are native to various geographical areas, being received by us through international seed exchange from abroad (Humboldt-Universitat zu Berlin, Germany; Botanical Garden, Marie Curie-Sklodowska University; Botanical Garden of the University of Medicine and Pharmacy of Târgul Mureș, Romania) and from research institutes of our country (Institute of Genetics, Physiology and Plant Protection).

The study was carried out in the period 2020-2023, during the active growth season of the plants, with special attention focused on the generative periods. The methodical indications in force were used to research the biological peculiarities of plant growth and development and phenological observations (Beideman, 1974; Metodiceskie ucazania po semenovedeniu introduțentov, 1980). The seed material of the researched taxa was tested, under laboratory conditions, to determine the germination capacity. The experiments were made according to the recommendations form Metodiceskie ucazania po semenovedeniiu introduțentov (Методические указания по семеноведению интродуцентов) (1980). To determine the spectrum of entomofauna associated with brassicaceae plants, surveys were conducted during the growing season, with intervals of 2-4 days, direct observations in the field were made, specimens were collected and pictures of the insects were taken. Later, under laboratory conditions, the insects were subjected to taxonomic determination with the help of entomological species determination guides (Talmaciu & Talmaciu, 2014; Plavilsciov, 1994; Mamaev, 1985).

The goal of the current study has been to highlight the species of useful plants of the Brassicaceae family with high potential for honey production; to achieve it, the following objectives were set: determining the germination capacity of the seeds, obtaining the vegetative material for multiplication as necessary, establishing the phenological stages, determining the spectrum of associated entomofauna.

## RESULTS AND DISCUSSIONS

The research on the resources of plants with high melliferous potential started at the "Alexandru Ciubotaru" National Botanical Garden has been aimed at expanding the range of useful plants, in order to make use of the available potential honey crops and introduce new crops from other geographical areas, organizing an uninterrupted conveyor of

blooming honey plants that will serve as a source of nectar and pollen for useful entomofauna. In this context, plant species from the Brassicaceae family were also included in the research. The germination capacity of the seeds was tested, obtaining the following values: *I. tictoria* - 57.57±4.88%; *S. alba* - 94.7±9.98%; *B. napus* - 66±1.92%; *C. cordifolia* - 1.67±0.52%; *B. orientalis* - 2±0.82%. The seeds of *B. orientalis* and *C. cordifolia* that germinated were incorporated into the soil in cell trays and stored under greenhouse conditions. As a result, planting material was obtained, which was later transplanted in open ground. The seedlings were moved to the experimental plots, when they reached 12-16 cm in height and developed 4-5 true leaves, they had a healthy appearance and were not affected by diseases or parasites.

*Brassica napus* L. subsp. *oleifera* DC. - rapeseed (Figure 2 A) is a plant with many uses, particularly in the food industry, cosmetics, medicine, animal feed, biofuel production, all parts of the plant being useful - flowers, seeds, leaves, stem and roots.

A B

Figure 2. A - *Brassica napus* L.;
B - *Bunias orientalis* L.

In the Republic of Moldova, rapeseed is a profitable crop and undemanding to pedoclimatic conditions. According to the National Bureau of Statistics, the agricultural production of rapeseed in 2021 was 92.4 thousand tons, and in 2022 it was 77.3 thousand tons (Statistica.md). Rapeseed flowers can be used to prepare herbal teas (Lim et al., 2017), and the consumption of pollen helps strengthening the immune system, due to the presence of steroids (Feng et al., 2011).

Rapeseed culture, in general terms, provides nectar and pollen to bees at a time when the few other melliferous plants are blooming; therefore, it contributes to the strong development of bee families in the early spring period. In the experimental sectors in the Botanical Garden, the flowering period of rapeseed depends on the period of incorporation of the seeds into the soil. Its productivity reaches 35-100 kg of honey per hectare. Honey has yellow color, specific taste, crystallizes fast (Heroica, 1986).

Pollinating insects, especially the honey bee, are attracted to the light yellow pollen of rapeseed, available for a period of about 15-25 days. Insects are active on flowers since the morning hours (7:30-8:00), when the air temperature reaches values of 8-12°C. Bees are active all day, but the maximum intensity was recorded between 12:00 and 14:00. The amount of nectar generated by a rapeseed flower is 0.3-0.8 mg, and the daily honey production is 2-3 kg (lumeasatului.ro).

*Bunias orientalis* L., the Turkish wartycabbage, is a biennial or perennial plant, with an erect, branched stem, the leaves on branches attached to long petioles, and those from the stem – to short petioles. The flowers are small, yellow, produced in multifloral raceme inflorescences. It is a common species for the Republic of Moldova (Figure 2 B), widespread in the Atlantic, Central and Eastern Europe, the Mediterranean Region, Asia Minor, Caucasus, Western Siberia, Central Asia, where it is used as a food, honeydew and medicinal plant (Flora Basarabiei, 2020). Total nectar carbohydrate production per ten *B. orientalis* flowers averaged 0.3 mg, sugar concentration of nectar, which was 28%, was in the range reported for other crucifers (Denisov et al., 2016). Nectar production in *B. orientalis* flowers is relatively low, but as a result of extremely high flower display, this species may be a valuable food source for visiting insects and hence compete for pollinators with native flora and depress the visits of pollinators to other plants (Hochkirch et al., 2012.)

*Sinapis alba* L. (=*Brassica hirta* Moench, *Brassica alba* (L.) Rabenh.), white mustard, is an annual plant, with a short growing season, cultivated for seeds and green mass, recommended in beekeeping as a honey plant.

The yellow flowers, opening in sequence, attract pollinators and honeybees throughout the flowering stage. Honey productivity reaches 50-100 kg/honey/ha (Burmistrov, 1990).

A B

Figure 3. *Sinapis alba* L.: A - inflorescences developed on a shoot; B - the total number of fruits, flowers and floral buds in an inflorescence

The biometric study of mustard plants revealed that by the end of May - mid-June (flowering stage) the plants reach a height of 68-85 cm, there can be about 8-18 inflorescences on one shoot (Figure 3 A). In one inflorescence, there can be 6-15 buds, 8-18 flowers and 4-6 developing fruits at a time (Figure 3 B). Leaf size varies between 18-20 cm long and 8-11 cm wide. There are usually 10-12 leaves per shoot.

*Crambe cordifolia* Steven (=*Crambe glabrata* DC.) - the greater sea-kale. Under the climatic conditions of the Republic of Moldova, it reaches up to 180 cm in height. The stem is glabrous with basal leaves - petiolate, entire and with irregularly toothed margin. The inflorescences are very branched, with numerous, small, white flowers. It has gained popularity as a fodder, medicinal and food plant, and its abundant flowers attract many pollinating insects. The number of seeds depends on the pollination process. Bulk seed density is 273.75±0.73, and weight of 1000 seeds is 4.30±0.12 g (Ababii et al., 2023).

*Isatis tinctoria* L. - woad - perennial plant, with simple, erect stems, the basal leaves are petiolate, and those in the middle and apical area of the stem are sessile. The growing season starts early (in March) and the plants grow rapidly and abundantly. It is a source of food for insects in May-June (Figure 4). Honey productivity is about 60 kg/honey/ha (Burmistrov, 1990). Flowering and fruiting are staggered and last 25-30 days. In May, there can be simultaneously 7-8 flower buds, 148 flowers and 192 fruits on a shoot. The weight of 1000 seeds is 5.4±0.19, bulk seed density is 88.3±0.13 g (Ababii et al., 2023).

Figure 4. *Isatis tictoria* L. in the collection of the National Botanical Garden

Brassicaceae species are plants with a relatively short growing season. They bloom among the first in the collection of forage-honey plants. The flowering stage occurs in May-June. Forecasting the flowering period of honey plants is based on the flowering stage of each plant species, from the accumulation of the effective amount of temperature during the period from the beginning of active growth to the full flowering of each crop. Determining the honey base, classifying plants according to phenological criteria - the length of the flowering stage and the period when it occurs - spring, summer or autumn, are essential data to be taken into account while building a honey conveyor. The phenological study of the researched species allowed the identification of the vegetative and generative phenological phases (Table 1), as well as their duration in correlation with the climatic conditions recorded in the Republic of Moldova.

The researched Brassicaceae have been able to complete the entire biological cycle, producing viable seeds. The species *I. tinctoria, B. orientalis* and *C. cordifolia*, being perennial plants, in the first year form only plant mass (rosette of leaves) and do not go through the cycle of generative phases. Starting with the second year of vegetation, the rate of growth and development of the shoots intensifies, the plants develop generative organs, bloom and bear fruit.

Table 1. The phenological spectrum of Brassicaceae species with high potential for honey production

| Species | Month | March | | April | | | May | | | June | | | July | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year | II | III | I | II | III | I | II | III | I | II | III | I | II | III |
| *Isatis tinctoria* | 2020 | - | v | v | B | B | B F | F | F | F | x | x | x | x | x |
| | 2021 | - | v | v | B | B | B F | B F | F | F | F | x | x | x | x |
| | 2022 | v | v | v | B | B | B | B F | F | F | x | x | x | x | x |
| | 2023 | - | v | v | B | B F | B F | B F | F | F | x | x | x | x | x |
| *Sinapis alba* | 2020 | - | - | - | - | - v | v | v | v | B F | B F | B F | F | x | x | x |
| | 2021 | - | - | - | - | - v | v | v | B | B | B F | F | F | F | x | x |
| | 2022 | - | - | - | v | v | v B | B | | B F | F | F | x | x | x | x |
| | 2023 | - | - | - | v | v | v | B | | B F | F | F | x | x | x | x |
| *Bunias orientalis* | 2021 | - | - | - | v | v | B | B F | | F | F | x | x | x | x | x |
| | 2022 | - | - | v | v | v | B | B F | | F | F | x | x | x | x | x |
| | 2023 | - | v | v | v | v | v B | B | | B F | F | F | x | x | x | x |
| *Brassica napus* | 2020 | - | - | - | v | v | v | B | | B | B F | F | F | F | x | x |
| | 2021 | | - | - | v | v | v | B | | B | B F | F | F | F | x | x |
| *Crambe cordifolia* | 2022 | - | - | - | v | v | v | B | | B | B F | F | F | F | x | x |
| | 2023 | - | - | | v | v | v | B | | B | B F | F | F | F | x | x |

NOTE: V –vegetative phases; B – bud development; F – flowering; X – fruiting/seed ripening; "-" – dormancy

The studied species begin the growing season in early spring - usually in the middle of March (*I. tinctoria* came out of dormancy on 12. 03. 2022). Starting with the middle of April, Brassicaceae progress through the generative stages: bud development, flowering, fruiting, which can be staggered or overlapping (bud development, flowering and fruiting occurring at the same time). In the experimental sectors of the Botanical Garden, the flowering period of the annual species (*S. alba, B. napus*) depends on the period of incorporation of the seeds into the soil. The seeds were incorporated into the soil later than usual, depending on the weather conditions, by the end of March – the middle of April, a reason for that was to create diversified and successive sources of food for beneficial insects, available throughout the growing season.

One of the objectives of the current study was to research, determine and compile the list of useful entomofauna detected on the flowers of Brassicaceae plants, being known as high-potential honey plants and providing food for insects starting in May. The insects were monitored during the flowering stage, throughout the day. Nectar composition, concentration and accessibility are important in determining pollinators. In Brassicaceae species, the nectar is produced by the glands located at the base of the androecium, between the sepals and the petals. The structure of nectar in these plant species, which is hexose-dominated, makes it accessible and easily collected by butterflies and short-tongued bees (Davis et al., 1998; Baker & Baker, 1983). The optimal temperature for nectar secretion in most honey crops is considered to be 16-25°C, with air humidity of 60-80% (Cerevko, 2001).

The spectrum of insects visiting the generative organs of the studied plants was determined, as well as their classification according to the systematic position. Woad, being among the first species in the collection to bloom, was visited by a larger number of insects - 14 species (*Apis mellifera, Lasioglossum malachurus, Arge ustulate, Eristalis tenax, Epicometis hirta, Chrysomela limbate, Oedemera mobilis, Cantharis pellucida, Trichodes alvearius, Entomoscelis adonidis, Coccinella septempunctata, Eurydema dominulus, Cercopis arcuate, Polyommatus icarus*), which belong to 6 orders (Hymenoptera, Diptera, Coleoptera, Hemiptera, Homoptera, Lepidoptera), 14 families (Apidae, Holictidae, Argidae, Syrphidae, Scarabaeidae, Chrysomelidae, Oedemiridae, Cantharidae, Cleridae, Chrysomelidae, Coccinellidae, Pentatomidae, Cercopidae, Lycaenidae) and 14 genera.

The white mustard flowers were visited by 11 insect species (*Apis mellifera, Bombus lapidaries, Lasioglossum malachurus, Lasius niger, Scolia maculata, Eristalis tenax, Epicometis hirta, Coccinella septempunctata, Eurydema oleracea, Dolycoris baccarum, Pieris brassicae*) of 5 orders (Hymenoptera, Diptera, Coleoptera, Hemiptera, Lepidoptera),

9 families (Apidae, Holictidae, Formicidae, Scoliidae, Syrphidae, Scarabaeidae, Coccinellidae, Pentatomidae, Pieridae) and 11 genera.

On *B. orientalis* plants, 6 insect species were detected (*Apis mellifera, Lasioglossum malachurus, Arge ustulata, Lasius niger, Eristalis tenax, Epicometis hirta*) of 3 orders (Hymenoptera, Diptera, Coleoptera) and 6 families (Apidae, Holictidae, Argidae, Formicidae, Syrphidae, Scarabaeidae), these species play a major role in the plant pollination process by visiting the flowers where they find their source of food during the flowering period, which occurs in May.

The flowering stage of rapeseed, under the conditions of the Botanical Garden, was recorded in June, nectar and pollen serving as food for the 6 insect species identified during this period (*Apis mellifera, Lasioglossum malachurus, Lasius niger, Eristalis tenax, Epicometis hirta, Coccinella septempunctata*), belonging to 3 orders (Hymenoptera, Diptera, Coleoptera), 6 families (Apidae, Holictidae, Formicidae, Syrphidae, Scarabaeidae, Coccinellidae).

The species *Apis mellifera* and *Eristalis tenax* were most frequently detected on the flowers of the researched brassicaceae plants. A bee collects nectar for 6-8 seconds on a flower, actively participating in the pollination process.

## CONCLUSIONS

The research carried out in the "Alexandru Ciubotaru" National Botanical Garden (Institute) on plants of the family Brassicaceae Burnett (*B. napus* L. subsp. *oleifera* DC.*; Sinapis alba* L.*; Isatis tinctoria* L.*; Bunias orientalis* L.*; Crambe cordifolia* Steven) highlighted their melliferous potential, proved by the interest exhibited by pollinating insects, especially *Apis mellifera*, towards these plant species. The researched species have been recognized as economically important plants, as valuable honey and fodder crops. All of these species start the growing season early and the flowering stage occurs in May-June, providing honey-producing and pollinating insects with food. Flowering is staggered, abundant, lasting about 20-30 days. The flowers are attractive for a wide range of insects, the most common belong to the order Hymenoptera: Apidae; Diptera: Syrphidae. Both cultivated and wild Brassicaceae can bring a significant contribution to the diversification and use of the potential sources of nectar and pollen in the Republic of Moldova.

Making use of the available plant resources with high-potential for honey production and expanding the assortment of valuable plants could significantly contribute to the diversification and creation of an uninterrupted chain of nectar and pollen sources for honey production, besides, it would help beekeepers to preventively plan their activities throughout the entire season.

## REFERENCES


Ababii, A. et al. (2023) Some seeds characteristic and biomass quality of some Brassicaceae and Fabaceae species in Moldova. *Scientific Paper, Series A. Agronomy. Vol. LXVI, No. 1*. pp. 645–654.

Al-Shehbaz, I.A. (2011). Brassicaceae (Mustard Family). eLS; Wiley: Hoboken, NJ, USA. pp. 482–486.

Appel, O., Al-Shehbaz, IA. (2003). Cruciferae. In: Kubitzki K, Bayer C. eds. *The families and genera of vascular plants. Vol. 5.* Berlin: Springer Verlag. 75–174.

Baker, H., Baker I. (1983). A brief historical review of the chemistry of floral nectar, In: *Bentley B., Elias T. (eds). The biology of nectariei.* Columbia University Press, New York, pp. 126–152.

Cerevko, U. (2001). *Priusadebnye hozeaistva*. Pcelovodstvo. Moskva. EKSMO Press. 368 s.

Cîrlig, N., Lupat, A, Țîței, V., Guțu, A. & Iurcu-Străistaru, E. (2020). Inițierea fondării colecției de plante melifere în cadrul Grădinii Botanice Naționale (Institut) „Alexandru Ciubotaru.” *Journal of Botany, Vol. XII, Nr. 2(21),* Chișinău, pp. 169–170.

Comanici, I., Palancean, A. (2002). *Botanică agricolă și forestieră.* Chișinău, Tipografia Centrală, 456 p.

Davis, A., Pylatuik, D., Paradis, J., Low, N. (1998). Nectar-carbohydrite production and composition vary in relation to nectar anatomy and location within individual flowers of several species of Brassicaceae. *Planta 205*. 306–318.

Davis, A., Sawlney, V., Frowke, L., Low, N. (1996). Floral nectar secretion and ploidy in Brassica rapa and Brassica napus (Brassicaceae). II. Quantified variability of nectar structure and linetion in rapid cycling lines. *Ann. Bd.77*. 223–234.

Denisow, B., Maslerowska, M., Anton, S. (2016) Floral nectar production and carbohydrate composition and the structure of receptacular nectaries in the invasive plant *Bunias orientalis* L. (Brassicaceae). *Protoplasma, 253*. 1489–1501

Feng, H., Jiao, S., Tang, Y., Tang, P. & Liu, J. (2011). Advance studying of rape pollen. *Food Ind., 9* pp. 108–111.Flora Basarabiei (plante superioare spontane) în 6 vol./sub red. Andrei Negru; vol. III: Magnoliophyta. (2020). Chișinău: Universul, 623 p.

Ghendov, V. (2020). Genus Sinapis L. In. *Flora Basarabiei, 3.* 30–31.

Heroica, A. (1986). Ce ştim despre Rapiţă. *In: Apicultura în România*, *8.* 17.

Hochkirch, A., Mertes, T., Rautenburg, J. (2012). Conspecific flowers of Sinapsis arvensis are stronger competitors for pollinators than those if the invasive weed *Bunias orientalis*. *Naturwissensechafen, 99*. 217–224.

Ion, N., Odoux, J.F., Vaissiere, B.E. (2018). Melliferous potential of weedy herbaceous plants in the crop fields of Romania from 1949 to 2012. *Journal of Apicultural Science, 62*(2). 1–17.

Lim, Y., Chun, J., Lee, K., Horg, S., Lee, Y., & Kim, S. (2017). Changes in Composition and Content of flavonoids by processing type in rapeseed (Brassica napus) flower. *Korean Soc. Environ. Agric., 36.* 7–16.

Nikolov, L., et al. (2019). Resolving the backbone of the Brassicaceae phylogeny for investigaiting trait diversity. *New Phytologist*., 222. 638–1651.

Ronse De Craene, L.P. (2010). *Floral diagrams: an aid to understanding floral morphology and evolution. Cambridge:* Cambridge University Press. 459 p.

Tălmaciu, M., Tălmaciu, N. (2014). *Entomologia Agricolă ID*. USAMV "Ion Ionescu De La Brad" Iaşi, 181 p.

Ţîţei, V. (2022). Calitatea silosului din unele specii din familia Brassicaceae și posibilități de valorificare în Republica Moldova. *În : Știința în Nordul Republicii Moldova : realizări, probleme, perspective. Ed. 6*, Bălți, Republica Moldova, pp. 287–291.

Ţîţei, V., Roșca, I. (2021). *Bunele practici de utilizare a terenurilor degradate în cultivarea culturilor cu potenţial de biomasă energetică: Ghid practic pentru producătorii agricoli.* - Chișinău: S. n., 80p.

Vergun, O., Shymanska, O., Rakhmetov, D., Fishchenko, V., Bondarchuk, O., Rakhmetova, S. (2019). Accumulation of nutrients in the raw of Crambe L. species. In: *Agrobiodiversity for Improving Nutrition, Health and Life Quality, 3.* 323–332.

Warwick, S.I. (2011). Brassicaceae in Agriculture. *Genetics and Genomics of the Brassicaceae*; Schmidt, R., Bancroft, I., Eds.; Springer: New York, NY, USA, pp. 33–65.

Бейдеман, И. (1974). Методика изучения фенологии растений и растительных сообществ, Новосибирск. 161с. Metodica izucenia fenologhii rastenii i rastitelinîh soobschestv.

Бурмистров, А., Никитина, В. (1990). Медоносные растения и их пыльца. Москва: Росагропромиздат. 195 с. Burmistrov A., Nichitina V. Medonosnîe rastenia i ih pâliţa.

Мамаев Б. (1985). Школьный атлас – определитель насекомых. Москва: Просвещение.160 с. Mamaev B. Şcolinîi atlas – opredeliteli nasecomîh.

Методические указания по семеноведению интродуцентов. Москва: Наука, 1980. Metodiceskie ucazania po semenovedeniu introduţentov.

Плавильщиков, Н. (1994). *Определитель насекомых*. Москва: Топикал, 543 с. Opredeliteli nasecomâh.

https://www.lumeasatului.ro/#google_vignette

Meteo.md

Statistica.md