Phenology and growth indicators of honey trees and bushes in Uzbekistan

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Abstract. This article presents the results of research on the study of some bioecological properties of honey-producing trees and shrubs. The flowering period of the main trees and shrubs is March-June and allows to obtain a high amount of honey. During the summer months, *Lycium barbarum*, *Symphoricarpos albus*, *Sophora japonica* species continue to bloom until autumn. According to the data, the growth rates of all trees and shrubs were at the level of demand. In particular, when growing linden trees in the spring, their height increased from 190.5 cm to 230.5 cm in autumn. That was, it grew by 40 cm during one vegetation. The *Ligustrum* bush had the highest growth rate, with seedlings planted in spring averaging 90 cm in height and 155.8 cm in autumn, with an annual growth rate of 65.8 cm. These indicators depicted that the conditions in the experimental fields were suitable for the growth of trees and shrubs.

1 Introduction

Beekeeping is one of the most productive areas in forestry. It is important to establish plantations of trees and shrubs that produce large amounts of nectar and long-flowering in the forestry area. There are more than 1,000 different species of trees and shrubs where bees receive nectar and pollen at the same time. But in beekeeping there are 200-250 species of honey-producing plants with high production quality, which produce large amounts of nectar and grow in large massifs. Among the fruit trees and shrubs, the species, which belong to the family of rhinoceroses, serve as a source of food for the development and reproduction of bees in early spring [1-2]. This will help strengthen beekeeping families. Bees, on the other hand, play a major role in pollination of orchards. Most importantly, during April-May, bees make good use of orchards and shrubs such as cherries, apples, pears, raspberries, currants, plums, apricots, peaches, almonds, which are made up of different species. Once the bees have used the orchards, they will need other honey-producing tree and shrub species or grasses. Therefore, in order to provide bees with nectar throughout the year, it is important to develop a scientific basis for the establishment of plantations of flowering trees and shrubs that alternate throughout the growing season [3, 6, 8].

In the registration of morphological changes associated with the development process of plants are usually divided into five phenophases: awakening, budding, flowering, fruiting

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and transition to dormancy. Each of these phenophases is subdivided into smaller phases. Accurate data on the flowering period of honey-producing plants allow timely planning and implementation of the correct placement of bee families during the beekeeping season [3-4]. *Lycium barbarum* flowers are more attractive to bees, especially in the morning and evening when they collect nectar and pollen. In traditional Chinese medicine, dried fruits are used to treat pollutants, lower body pain, dizziness, and amblyopia. For centuries, the fruit has been used in traditional Asian medicine as a general tonic enhancer. In Japan and China, alcoholic beverages are made from them [5, 7-8]. Typically, when phenological observations are made in a particular area, observation sites are designated to record the phenological phases of the plant species studied. In addition to visiting the designated places, it is important to note that the routes that cross and connect the points and that the plant species have entered a certain stage of development. This makes it possible to compare the phenological development time of plants in and out of the field. The beginning of the vegetative phase in trees and shrubs is marked by the beginning of the sap movement - the appearance of the first drops of sap. In advance, holes are made in several trees with a beak or burr [8]. On the south side of the tree, a hole is drilled at the height of a man's chest and covered with mud or plasticine. During the observation, the mud is removed and again carefully sealed. When the buds open, the outflow of juice is not noticeable. The plant has three and side buds. In some cases, the bud begins to grow and very soon the rod is formed. Sometimes the bud does not begin to grow for a long time and is called a dormant or dormant period. The lowest shoots can turn into bud buds, such buds are called closed. If the bud does not have special leaves, then it is called open. The flower buds are slightly larger than the leaf buds and are in the leaf axils [7]. When these buds begin to open, it can be said that the plant has entered the budding phase. The opening of more than half of the flower buds on a plant is considered a mass budding.

The full opening of the flower bud is the beginning of flowering. Flowering in wind-pollinated plants (birch, plum, pine, spruce) is noted when the flowers are shed by the wind or when the branch is shaken. In plants pollinated by insects, the onset of flowering is mainly determined by the expansion of pollinators [7-9]. For plants, the beginning of flowering should be considered as the time when the first fully opened flowers appear. When most of the flowers are in bloom, the trees are considered to be in full bloom. In many flowers, the drying of the petals is considered the day when the flowering phase is over. In the second part of the summer, second flowers appear on some plants. This event should be recorded. In some trees, the flowers appear before the leaves are written (beech, almond, peach, cherry, goat willow, etc.), in some plants they bloom after the leaves are written. Fruit ripening, just like flowering, occurs in a certain sequence. The partial fall of the petals on individual flowers is an indication that the fruits are formed in them; the complete shedding of the petals indicates the formation of a large number of fruits. First dried fruits, then - wet fruits, and finally - hard-shelled fruits (nuts) [8, 9]. And later - the buds and seeds of a number of conifers ripen. The ripening of dried fruits is determined by their discoloration and shedding. Wet fruits are considered ripe when they have a distinctive color and soften. First of all, the first day when the leaves of trees and shrubs begin to change color is determined. Then the day is recorded when the plant leaves completely take on the color of autumn (yellow, red) [8]. Leaf shedding continues differently in different species: in some slow (birch, oak), in others fast (poplar, hazelnut) [8]. The following dates should be noted: when the first leaves begin to turn yellow, their mass falls off, and the plant is completely leafless. In many trees, new shoots are formed during this period. The last date of leaf fall indicates that the plant has entered a dormant period.

2 Materials and methods

In this research, the territory of Burchmulla State Forestry, Tashkent province was selected as study site. In field experiments, several observations were made during the growing season to monitor plant development and determine external quality indicators. It was also possible to study not only plant development in practice, but also external general factors and other unexpected effects. Seasonal changes in trees and shrubs took place mainly in the territory of Burchmulla State Forestry, Tashkent province. Phenological phases such as flowering of trees and shrubs, duration of flowering, fruit formation and ripening, yellowing and shedding of leaves in autumn are of great importance, they are selected according to the timing and duration of flowering. To do this, it was necessary to accurately determine the flowering phases of honey-bearing tree and shrub species. The morphological characteristics of the studied plants were analyzed before the observations When planting bee-giving tree and shrub plantations, they should be arranged in terms of their flowering periods, duration, so that for bees there should always be flowers to collect nectar. In addition, trees and shrubs should be able to grow together in proportion to each other in terms of bioecological properties. Seedlings that meet the standard were selected for planting. The method of transplanting can be vary depending on the soil reclamation conditions of each place. Seedlings of trees and shrubs were planted in March when the soil temperature was 4-5 °C and above.

3 Results and discussion

The results of the study of the main phenophases of honey-producing trees and bats were given in Table 1. Accordingly, budding in the species Salix caprea was begun in the third decade of March and serves as the first food source for bees. Salix caprea continued to bloom in April along with Pyracantha coccinea species. The longest-flowering species were Lycium barbarum (160 days), Symphoricarpus albus (120 days), Sophora japonica (100 days) that ensured the use of bees throughout the summer without relocation. Furthermore, the longest-budding species was *Tilia cordata,* accounted for 70 days, whereas the shortest-budding species was *Sali caprea* with 10 days. The longest fruit repining period was referenced to *Pyracantha coccinea, Robinia Pseudoacacia, and Ligustrum vulgaris,* which took 200, 130 and 120 days, respectively (Table 1).

The study of the relationship of honey-producing trees and shrubs to seasonal changes was of great practical importance. Because it was impossible to know their biological, ecological and other characteristics without knowing the seasonal changes of tree plants. In order to study seasonal changes, observations were made on the developmental stages of trees and shrubs in different seasons. These observations provide information on the main periods of change in the life of trees and shrubs, their onset, rapid transition, and completion times. Evidently, the most of trees were blossomed in early-late spring and in summer, however, only three of them were blossomed in autumn, especially *Sophora japonica, Lycium barbarum* and *Symphoricarpus albus* (Table 2). In the construction of beehives, the planting scheme was set at 6.0-3.0 m, with trees in each row at 6 meters and bushes at 3 meters between them. As a result, 520 trees would be planted on 1 hectare (Table 3). Accordingly, there were main trees and shrubs: *Tilia cordata, Robinia pseudoacacia, Sophora japonica* were taken as main trees, and *Ligustrum vulgaris, Lycium barbarum* were shrub. It was planned to plant *Rosa canima* and *Salix caprea*, which blossoms in the spring, in the experimental fields (Figure 1).

Table 1. The main phenophases of honey-producing trees and shrubs

№	Type of trees and shrubs	January			February			March			April			May			June			July			August			September			October			November		
		I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
1.	*Salix caprea*																																		
2.	*Pyracantha coccinea*																																		
3.	*Lycium barbarum*																																		
4.	*Rosa canina*																																		
5.	*Robinia Pseudoacacia*																																		
6.	*Ligustrum vulgaris*																																		
7.	*Symphoricarpus albus*																																		
8.	*Tilia cordata*																																		
9.	*Sophora japonica*																																		

1 Budding, opening, leaf phyllotaxy
2 The growth of leaves and stems is the beginning and end
3 Budding
4 Flowering - the beginning, gross and end
5 Fruit ripening - beginning, gross, end
6 The fall of autumn leaves is the beginning, the end

Table 2. Grouping of trees and shrubs in the experiment by phenological phases

№	Groups	Name of the species	Duration
1	**Blooms in early spring**	• *Salix caprea* • *Pyracantha coccinea*	1st decade of March
2	**Blooms in late spring**	• *Robinia Pseudoacacia* • *Ligustrum vulgaris* • *Lycium barbarum* • *Rosa canina* • *Symphoricarpus albus*	3rd decade of April
3	**Blooms in summer**	• *Tilia cordata* • *Sophora japonica* • *Ligustrum vulgaris* • *Lycium barbarum* • *Symphoricarpus albus*	1st decade of June
4	**Blooms in autumn**	• *Sophora japonica* • *Lycium barbarum* • *Symphoricarpus albus*	1st decade of September

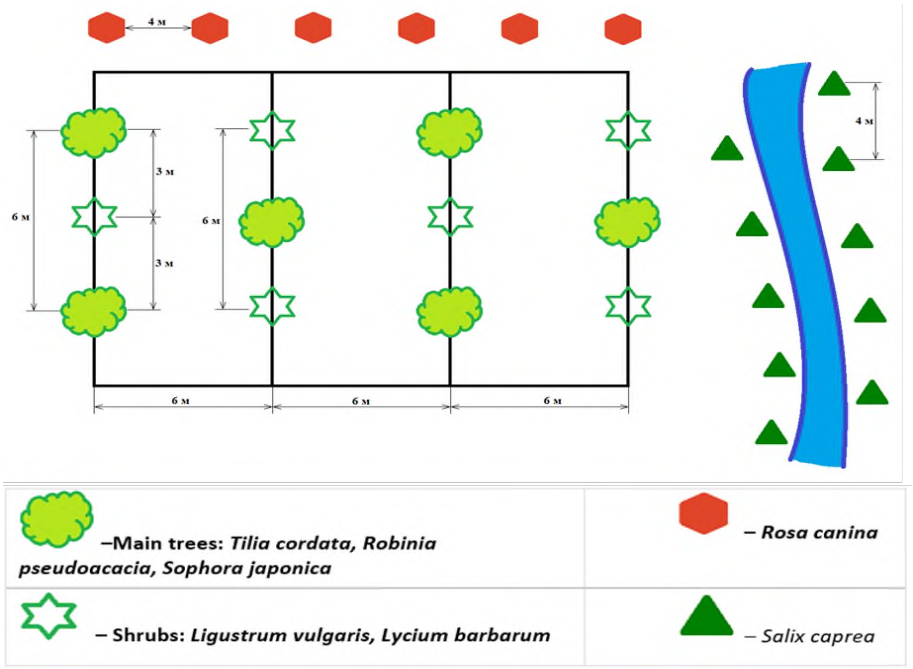

Fig. 1. Scheme of placement of cultivated forests of trees and shrubs producing honey

Table 3. Scheme of placement of honey-bearing trees and shrubs

Type of tree	Sowing scheme		Number of seedlings per 1 ha, pcs
	Distance between rows, m	Distance between trees, m	
1st experiment field			
Tilia cordata	6.0	6.0	130
Sophora japonica		6.0	130
Ligustrum vulgaris		6.0	260
Total			520
2nd experiment field			
Robinia pseudoacacia	6.0	6.0	130
Sophora japonica		6.0	130
Lycium barbarum		6.0	260
Total			520

Protective rows were built around the plantation from *Rosa canina* bushes, which provide honey. Around 100 *Salix caprea* seedlings were planted around the water source. These tree and shrub species are an additional crop type that bloom in early spring and are the primary food source for beehives. According to the data in Table 4, the growth rates of all trees and shrubs were at the level of demand. In particular, *Tilia cordata* trees grew from 190.5 cm in spring to 230.5 cm in autumn. That was, it grew by 40 cm during one

vegetation (Figure 2). The Ligustrum vulgaris shrub had the highest growth rate, with an average height of 90 cm in spring and 155.8 cm in autumn, with an annual growth rate of 65.8 cm. These indicators represented that the conditions in the experimental fields were suitable for the growth of trees and shrubs.

Table 4. Growth rates of trees and shrubs in the first experimental field

№	Type of trees and shrubs	Indicators	Value	Statistical indicators		
				Mean square deviation	Coefficient of variation	Relative error, %
Spring						
1.	*Tilia cordata*	Height, cm	190.5±0.01	0.1	3.3	0.5
		Diameter, mm	12.7±0.02	0.2	12.2	1.7
2.	*Sophora japonica*	Height, cm	105.2±0.01	0.0	3.5	0.5
		Diameter, mm	10.5±0.02	0.1	14.2	2.0
3.	*Ligustrum vulgaris*	Height, cm	90.0±0.01	0.1	9.3	1.3
		Diameter, mm	7.76±0.03	0.2	23.4	3.3
4.	*Salix caprea*	Height, cm	125.1±0.01	0.0	2.8	0.5
		Diameter, mm	22.2±0.02	0.1	3.7	0.7
Autumn						
1.	*Tilia cordata*	Height, cm	230.5±0.06	0.4	17.5	2.5
		Diameter, mm	21.64±0.61	4.3	20.0	2.8
2.	*Sophora japonica*	Height, cm	134.4±0.08	0.3	22.7	6.1
		Diameter, mm	17.75±1.46	5.5	30.7	8.2
3.	*Ligustrum vulgaris*	Height, cm	155.8±0.05	0.4	23.7	3.4
		Diameter, mm	8.94±0.50	3.5	39.4	5.6
4.	*Salix caprea*	Height, cm	169.5±0.07	0.3	19.8	4.2
		Diameter, mm	22.9±0.66	3.1	13.5	2.9

Robinia pseudoacacia, Lycium barbarum species planted in the second experimental field were slow-growing species, growing to 7.7 and 4.2 cm in height in the first year the seedlings were planted. However, *Sophora japonica and Salix caprea* species were also well-adapted to the conditions as they were fast-growing trees and grew by 39.0 and 43.2 cm in height during the growing season (Table 5). Discrepancy in diameters of the plants during spring and autumn were around 6 mm in *Robinia pseudoacacia,* followed by *Lycium barbarum* with 0.9 mm, *Sophora japonica* with 7.7 mm and *Salix caprea* with 0.3 mm.

Table 5. Growth rates of trees and shrubs in the second experimental field

№	Type of trees and shrubs	Indicators	Value	Statistical indicators		
				Mean square deviation	Вариация коэффициенти	Нисбий хато, %
Spring						
1.	*Robinia pseudoacacia*	Height, cm	183.2±0.01	0.1	2.8	0.4
		Diameter, mm	12.9±0.03	0.2	14.6	2.1
2.	*Lycium barbarum*	Height, cm	74.0±0.02	0.1	15.0	2.1
		Diameter, mm	4.6±0.01	0.1	12.4	1.8
3.	*Sophora japonica*	Height, cm	135.5±0.00	0.0	2.5	0.4
		Diameter, mm	12.2±0.03	0.2	15.5	2.2
4.	*Salix caprea*	Height, cm	127.1±0.00	0.0	2.0	0.4
		Diameter, mm	22.6±0.03	0.2	8.1	1.5
Autumn						
1.	*Robinia pseudoacacia*	Height, cm	190.9±0.16	0.6	32.2	8.3
		Diameter, mm	19.62±1.66	6.4	32.9	8.5
2.	*Lycium barbarum*	Height, cm	78.2±0.05	0.3	32.5	5.9
		Diameter, mm	5.51±0.30	1.6	29.3	5.4
3.	*Sophora japonica*	Height, cm	174.5±0.05	0.3	14.5	2.9
		Diameter, mm	19.90±0.55	2.8	13.9	2.8
4.	*Salix caprea*	Height, cm	170.3±0.09	0.3	16.8	5.1
		Diameter, mm	22.97±0.57	1.9	8.2	2.5

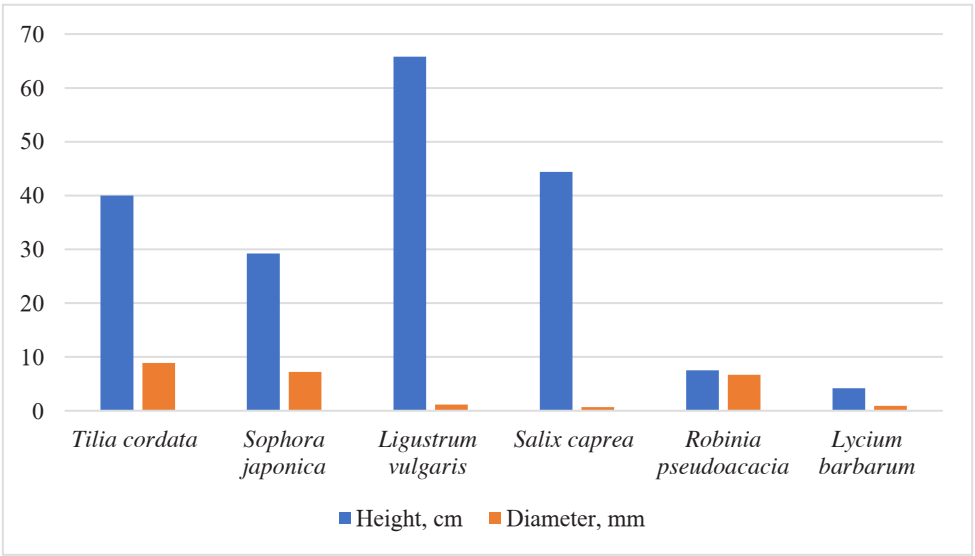

Fig. 2. Annual growth rates of trees and shrubs in the experimental field

4 Conclusion

Honey-bearing trees and shrubs in early spring flowering (*Salix caprea, Pyracantha coccinea*), late spring flowering (*Robinia Pseudoacacia, Ligustrum vulgaris, Lycium barbarum, Rosa canina, Symphoricarpus albus*), and summer flowering (*Tilia cordata, Sopho, Sopho*, *Lycium barbarum, Symphoricarpus albus*), were divided into groups of autumn flowering (Sophora japonica, Lycium barbarum, Symphoricarpus albus). Honey from these tree and shrub species can be placed in a mixture in the establishment of forest plantations.The planting scheme was as follows: 6 m between rows, 3 m between trees in a row, bushes every 3 m between trees.

The growth rates of all trees and shrubs were at the level of demand. In particular, *Tilia cordata* trees grew from 190.5 cm in spring to 230.5 cm in autumn. That was, it grew by 40 cm during one vegetation. The Ligustrum vulgaris shrub had the highest growth rate, with an average height of 90 cm in spring and 155.8 cm in autumn, with an annual growth rate of 65.8 cm. These indicators represented that the conditions in the experimental fields were suitable for the growth of trees and shrubs.

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