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IMPACT OF HONEY BEES ON POLLINATION OF SOME PLUM VATIETIES

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Abstract

Under the project No.31063, which was funded by the Ministry of Education, Science and Technology Development of the Republic of Serbia, a study was conducted on the Experimental Field *Radmilovac* of the Faculty of Agriculture, University of Belgrade. Pollination of different plum varieties was observed, including: *Toper, Lorida, Avalon* and *Čačanska rodna.* The aim of this study was to determine the impact of honey bees on the rate of pollination, fruit setting and yield of the known and new plum varieties.

Three plum trees of each variety were selected, and three budding branches on each tree were isolated. Three types of pollination were planned and executed: by wind - anemophily, where branches were isolated by tulle bags; self-pollination, where branches were isolated by pergament paper; and entomophily by honeybees, where the branches with buds and flowers were naturally pollinated. During the spring, there was a continual counting of flowers, set fruit, fruits remaining after drop and at the time of picking (when ripe). The recorded data were then statistically analyzed.

For *Čačanska rodna*, it was found that in case of self-pollination, the number of fruit on trees just before the June fruit drop was 20% and 10% at the time of picking; when anemophily was applied, 49% remained before the fruit drop and 15% at time of picking; in case of entomophily, the rate of remaining fruit before drop was 44% and 28% were finally picked. For *Toper* variety the results were the following: self-pollination – before fruit drop 20% remained, and 3% were picked; anemophily - 14% before the drop and 8% were picked; entomophily by honeybees - 33% before the drop and 26% at the time of picking. The picking rate for *Avalon* was: 1.2% in case of self-pollination, 7% where anemophily was used, and 28% in case of entomophily. *Lorida* variety showed the following picking rates: self-pollination - 13%, anemophily - 53%, and pollination by bees - 25%.

Key words: plum, pollination, *Čačanska rodna*, new varieties

Introduction

Phylogenetically speaking, a plum belongs to the same genus (*Prunus*) as almond, peach, apricot, sour cherry, cherry, bird cherry and *džanarika*, which all have a hard stone pit. What makes this subgenus *Prunus* different from other subgenera (Mladenović et al., 1996) are solitary terminal and lateral buds as well as smooth pit (Bulatović, 1991). Stone fruits are in the group most commercialized continental fruits, as they account for 65% of total fruit production (Šoškić, 1991). Plum still holds the title of a „queen“ in Serbian fruit growing. The dominant variety used to be *Požegača*, but in the last few decades more and more new varieties have been introduced, *Stenli* and new varieties from Čačak being the commonest (Gvozdenović et al., 1997).

Due to early, fast and explosive blooming, almost all plum varieties need honeybees as pollinators, regardless of the fact that some varieties indicate certain level of self-pollination capacity (Mišić, 1996; Stanković et al., 1990). The main problem represent the different

maturing time of male and female reproductive organs in the same flower and physiological incompatibility between pollen and stigma. The imperative in cross-pollination is not only the transfer of pollen from a different plant, but also pollen from other varieties of the same species. During the evolution process, honeybee developed the highest capacity for transfer of pollen from different sources as on its body hair several million of pollen grains can be found.

In fruit growing today, the participation of honeybee in pollination is steadily increasing, because there is no fertilization without transfer of pollen grain to stigma (Mišić,1996). The honeybee is the most important of all natural pollinators (solitary bees, wasps, bumblebees, some species of ants, etc.), as it accounts for pollination of 80% of fruits, and even 95% in intensive fruit growing (Ćerimagić, 1985). Such a high share of honeybee participation in pollination results from the fact that, due to the use of pesticides in orchards, almost all spontaneous pollinators have been eradicated, while the use of modern agricultural machinery, together with deep winter ploughing and frequent spraying destroys cocoons of other insects and pollinators. The advantage of honeybee over other pollinators lies in multiple visits to the same flower (as long as it has nectar, pollen and etheric oils), that is, until the fertilization becomes certain, after which the flower ceases to be attractive and interesting to a bee. It can be concluded that honeybee is an insect which created the highest level of symbiosis with plants. It is a mutually beneficial state, both for a plant and a honeybee, bas they cannot sustain without each other as well as the present agriculture (Mladenović,1987).

Honeybee, as a polytropic insect, exerts this extremely important role, among other things, thanks to one of its characteristics – it does not mix pollen of various fruit species, but only of varieties (Stanković & Jovanović, 1990).

Honeybee instinctively collects nectar only from one species of fruit and plants (Simić et al., 1995). Different plant species show fluctuations in quantity of nectar secretion during a day, even an hour. When one species stops nectar production, honeybee moves to another one which offers nectar at that moment and with higher content of sugar. Therefore, during a season the honeybee visits several different plant species, which makes it the best and most reliable pollinator.

With some minor number of exceptions, entomophily is most common way of pollination of fruit cultivars. It is absolutely essential for optimum yield of self-sterile species and varieties of fruit, such as is sour cherry (Mladenović & Pešić, 1996), but it also contributes to high and certain yield of self-fertile species and varieties. Presence of honeybee colonies in pollination of cultivars has positive effects on explosive flowering, especially in case of stone fruits such as are the studied varieties. Pollen transfer activity of honeybees is affected mostly by meteorological conditions. During fruit tree flowering, even a day or two without rain are enough for good effects and when the temperature in shade is above 12^{o}C (Mladenović, 2011).

When using honeybees as pollinators in intensive fruit growing, the problem is how to protect them from toxic chemicals which are used for protection of fruit trees from diseases and pests (Mladenović et al., 2013). A special care should be taken not to do spraying during flowering, or not to allow bees to leave the beehive if the spraying is necessary (Ćerimagić,1985).

Depending on the hereditary factors and meteorological conditions, flowering of all varieties of plum takes place in March and April. According to the start period and sequence of flowering, all plum varieties can be divided into: early-blooming, early-mid blooming, mid-late blooming, and late-blooming. The process of flowering of stone fruits is much faster and stronger than in pome fruits, and depending on the variety and weather conditions the flowering lasts between 6 and 12 days. The plum flower is hermaphrodite and complete. It

consists of 5 sepals, 5=7 petals, 16=19 stamens and 1 pistil. Flowers are single or form clusters (Šoškić, 1991).

The objective of our experiment was to compare the impact of honeybee as a pollinator in comparison to anemophily and self-pollination. This was done by counting and recording the number of fruits 60, 80 and 100 days after fertilization and at picking stage (ripe).

Materials and method

The study was conducted at the experimental field Radmilovac of the Faculty of Agriculture, University of Belgrade. The plum orchard included mix of different domestic varieties and newly introduced ones which are actually subject to study presently. The plantation of plums is at the height of 135 m a.s.l. and the basic variety is *džanarika* (Prunus cerasifera). The cultivars' shape is pyramidal.

The soil type was gajnjacas. During the experiment, it was in the state of idle land, with regular application of mineral fertilizers. The soil was treated with agrotechnical measures every year and the protection from diseases and pests was also regular.

The varieties used in the experiment were: *Čačanska rodna, Toper, Lorida* and *Avalon,* and they were monitored from the flowering phenophase to ripening phenophase and fruit picking. For pollination of the selected varieties 50 honeybee colonies located at 300 m distance were used. The beehives were of a modern LR type, the ownership of the Faculty of Agriculture.

Variety *Čačanska rodna* has been exploited in our country since 1965, when it was created as a hybrid resulting from interbreeding between *Stanley* and *Požegača*. It gives high yield and it is suitable for drying, processing and consumption in a raw state. The flesh part varies from 26 to 30 g. Its skin is of blue colour and has ample epicuticular wax coating ("wax gloom"). Its flesh is juicy, yellowish, of superb nutritional quality. The size of its stone is medium to large and it is compact. It can be easily separated from flesh part. It requires regular and severe pruning in order to have quality fruits and avoid alternate bearing. The plum tree is not so dense, which makes it suitable for dense planting. Plum trees are adaptable to a wide range of climates. Picking season is late August. It is susceptible to powdery mildew and plum rust, as well as sharka (plum pox virus).

The other varieties - *Toper, Lorida and Avalon* are still in the phase of studying, so more information about the results will be available in the future.

A study was conducted in order to determine the impact of honeybee as a pollinator of the plum varieties *Čačanska rodna, Toper, Lorida* and *Avalon*, through comparison with anemophily and self-pollination. Three fruit trees of each variety were selected, with budding branches of various types and at different locations in the crown. The number of buds was established by counting, then number of pollinated flowers, number of set fruit, and the fruit drop was recorded 60, 80 and 100 days after fertilization, and finally the number of picked fruits was counted.

Results and discussion

The results are based on a two-year study of the impact of honeybee on transfer of pollen in plum varieties *Čačanska rodna, Toper, Lorida* and *Avalon*. They indicate that the number of set fruit until picking season varies depending on the type of pollination.

Table 1. Rate of set and picked fruits in variety *Čačanska rodna*

Pollination type	Set fruits	After 60	After 80	After 100	Ripe	Percentage
Entomophily	148	68	54	44	41	from 44%
	83	32	21	21	21	up to 28%
	92	42	31	28	28	
Anemophily	77	11	8	5	5	from 49%
	45	45	16	13	13	up to 15%
	52	30	9	9	8	
Self-pollination	28,3	3	2	2	2	from 20%
	23	1	1	1	1	up to10%
	42	15	7	7	6	

The table 1. shows that the number of set fruits until June fruit drop was the largest in case of entomophily by honeybees (44%) and anemophilic pollination (49%). Number of ripe and picked fruits was the biggest in case of entomophily - 28%, where the anemophilic pollination resulted in only 15% and self-pollination in 10%. All three pollination types resulted in the rate of picked fruits over 8%, which is desirable for plantations, but it is evident that entomophily is the most reliable type of pollination for the variety *Čačanska rodna,* and that is two times more in comparison to self-pollination and almost 100% in relation to wind pollination. The obtained data are in line with those found in literature.

Table 2. Rate of set and picked fruits in variety *Toper*

Pollination type	Set fruits	After 60	After 80	After 100	Ripe	Percentage
Entomophily	96	10	10	10	10	from 33%
	86	58	58	58	56	to 26%
	129	34	16	16	16	
Anemophily	88	7	0	0	0	from 14%
	47	10	7	7	7	to 8%
	50	9	9	8	8	
Self-pollination	25	0	0	0	0	from 20%
	51	19	4	4	4	to 3%
	40	4	0	0	0	

Table 2. shows the dynamics of fruit drop until ripening. Entomophilic pollination resulted in the largest number of fruits until fruit drop (26%). Also, the rate of picked fruits was highest in case of pollination by honeybees (26%); for wind pollination that rate was 8% and for self-pollination 3%. It can be concluded that the honeybees are necessary for pollination of the variety *Toper* in order to achieve profitable production.

Table 3. Rate of set and picked fruits in the variety *Lorida*

Pollination type	Set fruits	After 60	After 80	After 100	Ripe	Percentage
Entomophily	31	31	31	27	27	Od 63%
	99	45	26	13	12	Do 25%
	84	58	44	18	15	
Anemophily	32	32	32	30	30	Od 72%
	24	10	5	3	3	Do 53%
	40	27	21	18	18	
Self-pollination	17	O	O	O	o	Od 35
	33	21	8	6	6	Do 13%
	18	3	3	3	3	

Table 3. shows that the rate of survival of set fruits until the June fruit drop depends on type of pollination. In case of anemophilic pollination, this rate was the best (72%), as well as the rate of picked fruits. It could be concluded that the variety *Lorida* is partly self-fertilizing and can be grown with success without involvement of reliable pollinators.

Table 4 – Rate of set and picked fruits in the variety *Avalon*

Pollination type	Set fruits	After 60	After 80	After 100	Ripe	Percentage
Entomophily	109	65	35	31	31	Od 66%
	112	96	42	37	37	Do 28%
	98	47	20	19	19	
Anemophily	79	49	4	3	3	Od 52%
	93	49	16	15	14	Do 7%
	57	31	0	0	0	
Self-pollination	25	11	1	1	1	from 28%
	30	17	0	0	0	to 1.2%
	27	10	0	0	0	

However, Table 4 indicates that for variety *Avalon* the presence of honeybees is necessary, because not only that the number of remaining fruits before drop was the highest (66%), but also the number of picked fruits (28%), as for enemophilic pollination it was 7% and for self-pollination 1.2%.

Conclusion

The results of the study on impact of honeybees on pollination of plum varieties *Toper*, *Lorida*, *Avalon* and *Čačanska rodna* from the aspects of fruit setting, fruit drop and number of picked fruit, the following can be concluded:

1. Honeybee (*Apis mellifera L.*) is the most numerous, most reliable and most complete pollinator of stone fruits.

2. The studied varieties *Toper, Lorida, Avalon* and *Čačanska rodna* have the highest rate of fertilized and picked fruits when entomophilic pollination is present (28%) as shown in comparison to other types of pollination, except for variety *Lorida* (53%).
3. The highest intensity of fruit drop occurs in the first period after flower falling off.
4. Involvement of honeybees in modern fruit growing is the cheapest pomotechnical measure, if compared to other pollinators and types of pollination.

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