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# IMPACT OF HONEY BEES (*Apis mellifera* L.) ON POLLINATION AND YIELD OF CULTIVATED PLUM VARIETIES

## ABSTRACT

Throughout evolution useful interactions between plants and honey bees have developed which are still very important today. Basically, flowering plants provide nectar and pollen to bees, which in return perform cross-pollination of plants. In the process of cross-pollination, herbal species that are cultivated for human consumption, cattle feed or for other purposes are of particular significance. There are hundreds of such plant species.

Farmers and beekeepers want bees to pollinate agricultural crops as efficiently as possible. Bee colonies were formed particularly for this purpose since most crops are pollinated early in the season when there aren't many worker bees in the hive. Many fruit species are of great importance to bees for the development of their colonies in the early spring (hazel, almond, buckthorn, cherry, plum) as well as for preparation of the main pasture. In our situation, over 85% of the pollination of fruit trees is done by bees, and only 14-15% by other pollinators.

During this two-year research project at two locations in the vicinity of Bijelo Polje, a comparison of pollination efficiency with and without bees was conducted in plum crops, among different varieties of plums. Pollination efficiency with the same agro-technology was drastically increased in the presence of bees, which resulted in a much greater yield.

**Keywords:** honey bee, plum, pollination, yield

## INTRODUCTION

Beginning with the scientifically proven fact that bees should be kept i.e. that beekeeping should be done even in the case where we don't collect bee products (honey, beeswax, propolis, royal jelly, pollen and bee venom). In other words, the indirect benefits from bees are much greater than the direct ones. According to many authors, the indirect benefits gained through bee pollination of cultivated crops are about twenty times bigger than the value of bee products. Bee pollination is as important as proper planting, dissemination, and even the quality of seed (Jevtić et al., 2006; 2009). According to the science, 80 % of crops are pollinated by insects, and bees play major roles in the pollination of

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those crops. Furthermore, bees carry out some 90 % of the pollination of fruits, vegetables and forage (Jaćimović, 2006; Jašmak, 1980).

Logically, the above stated facts regarding bee pollination lead to the conclusion that biological harmony in nature would be endangered if bees disappear. Current unfavourable circumstances warn that bees could actually disappear within a very short period of time. The silence that would come instead of their buzzing would certainly be ominous.

Numerous scientific studies prove bees have a 'crucial impact on pollination and number of fruit sets among various fruit species' (Nedić et al., 2001). In this way, the blueberry pollination experiment (Kulinčević, 2006) led to the conclusion that the yield of blueberry bushes isolated from bees was 0.68 to 1.40 kg per bush, whereas the yield of free, non-isolated bushes was 5 to 14 kg.

Plums, due to their early, fast and explosive blooms, need honey bees to transfer pollen, "pollinators" (Mladenović and Lukić, 2003), and this is true for almost every kind of plum. The bee's most significant role is among self-incompatible or partially self-compatible varieties of plums. It should be noted that bees are excellent pollinators, even on cloudy, gloomy and windless days, as well on the days with poor rain when fertilisation would be impossible due to a lack of breeze, which represents another mode of pollen transfer.

The aim of our paper is to calculate the percentage difference between pollinated fruit sets of cultivated plum types, with or without the presence of bees, as well as to determine their effect on the yield of fruit trees from the examined varieties.

## MATERIALS AND METHODS

The experimental setting was composed of two locations in the vicinity of Bijelo Polje, Mioče and Kostenica, in plantations where several varieties of plums are grown, and where 10 to 20 bee hives were brought.

Before the bloom started, tulle nets were placed on selected branches of trees, which isolated the flowers from contact with bees and other insects, whereby pollination could be done only by anemophily. Near them, branches of similar sizes were marked, and they were within easy reach of insects. The number of closed flowers on both types of branches was counted.

Upon completion of the bloom and pollination, small fruits on the selected branches were counted. Data in this survey represents average values for the years 2010 and 2011.

The percentage of fruit sets was calculated for both isolated and non-isolated branches. Later, comparisons were made and the differences in the number of fruit sets were also determined.

The counting of fruits after they fell off in June, as well as before the harvest, was also done.

Chemical analyses of both types of fruits were performed.

## RESULTS AND DISCUSSION

By counting flowers before the beginning of the bloom and after the fruit set, it was noted (Tables 1 and 2) that the percentage of fruit sets on isolated branches for all varieties of plums was 42.99 %, whereas the percentage on the branches freely accessible to bees was 60.12 %. This leads to the conclusion that the number of fruit sets was higher by almost a third (30 %) in the presence of bees and other insects. Naturally, the number of fruits from the branches pollinated by bees was significantly larger (21.41 %) than the number of those from the isolated branches (15.90 %), and it was higher by some 25 %. If we assume that a tree in its full fertility can bear 80 kg of fruit, using the same agro-technology in crops where bees are brought in, the yield would rise by about 20 kg per tree. Keeping in mind that the number of trees per hectare is 500 (when planting 4x5 m), this would mean that the yield could be increased 10,000 kg of fruit.

Table 1: Plum pollination without bees

| Variety of plum | Number of flowers | Number of fruit sets | % fruit sets | % fruit sets at the end of June | % fruits before harvest |
|---|---|---|---|---|---|
| Čačanska Lepotica | 250 | 146 | 58.40 | 20.80 | 16.55 |
| Stanley | 703 | 193 | 27.45 | 20.44 | 17.20 |
| Čačanska Rodna | 541 | 372 | 68.76 | 19.60 | 16.80 |
| California Blue | 712 | 222 | 31.17 | 15.73 | 10.50 |
| Valjevka | 235 | 145 | 59.18 | 23.66 | 20.33 |
| Čačanska Rana | 113 | 33 | 29.20 | 17.50 | 15.55 |
| Valerija | 65 | 22 | 33.80 | 18.10 | 14.80 |
| Mildora | 52 | 20 | 38.46 | 17.50 | 16.50 |
| Požegača | 88 | 32 | 36.36 | 21.50 | 17.00 |
| *Anna Späth* | 76 | 34 | 44.73 | 14.23 | 14.00 |
| average | 2835 | 1219 | 42.99 | 19.60 | 15.90 |

By observation according to type, it was determined that the number of flowers fertilized by bees was particularly high in the case of Čačanska Rodna (84.79 %) and Čačanska Lepotica (73.56 %). Almost two times more fruit sets, with the bees' assistance, were found in Valerija (33.80 % compared to 62.50 %), whereas their number was more than doubled in Čačanska Rana (67.60 % compared to 29.20 %) and Stanley (62.28 % compared to 27.45 %).

By examining several parameters through chemical analyses, it is concluded that the fruits of both groups were of similar quality. Differences are quite small, but regarding the percentage of dry matter, overall mineral matter, vitamin C and anthocyanin, the fruits pollinated by bees are slightly richer. In

some cases, the content was the same, but in others, such as in Valjevka, the percentage of anthocyanin was higher in fruits from the isolated branches.

Table 2: Plum pollination with bees

| Variety of plum | Number of flowers | Number of fruit sets | % fruit sets | % fruit sets at the end of June | % fruits before harvest |
|---|---|---|---|---|---|
| Čačanska Lepotica | 227 | 167 | 73.56 | 25.33 | 20.50 |
| Stanley | 456 | 284 | 62.28 | 26.30 | 24.40 |
| Čačanska Rodna | 342 | 290 | 84.79 | 24.50 | 22.22 |
| California Blue | 674 | 302 | 44.80 | 22.38 | 23.30 |
| Valjevka | 81 | 52 | 64.19 | 28.78 | 24.00 |
| Čačanska Rana | 71 | 48 | 67.60 | 27.50 | 22.20 |
| Valerija | 48 | 30 | 62.50 | 25.40 | 20.00 |
| Mildora | 44 | 27 | 61.36 | 24.00 | 22.50 |
| Požegača | 112 | 42 | 37.50 | 21.12 | 18.90 |
| *Anna Späth* | 64 | 32 | 50.00 | 17.00 | 16.10 |
| average | 2119 | 1274 | 60.12 | 24.23 | 21.41 |

Table 3: Chemical analyses of fruits of the examined plum varieties (pollinated by bees)

| Variety of Plum | Dry matter % | Dry matter % | Ash % | Cellulose % | Vitamin C mg/100g | Anthocyanins mg/100g |
|---|---|---|---|---|---|---|
| Čačanska Lepotica | 17.00 abc | 17.85 abcd | 0.70 a | 0.30 a | 12.81 a | 0.527 |
| Stanley | 17.97 abc | 20.82 a | 0.78 a | 0.41 a | 12.10 a | 0.665 |
| Čačanska Rodna | 18.10 abc | 18.90 abcd | 0.68 a | 0.39 a | 13.94 a | 0.231 |
| Californi a Blue | 12.60 c | 13.68 d | 0.72 a | 0.34 a | 10.69 a | 0.597 |
| Valjevka | 16.70 abc | 17.60 abcd | 0.70 a | 0.39 a | 13.59 a | 0.734 |
| Čačanska Rana | 13.97 bc | 14.94 bcd | 0.55 a | 0.49 a | 12.80 a | 0.471 |
| Valerija | 12.83 c | 13.98 cd | 0.69 a | 0.33 a | 10.83 a | 0.045 |
| Mildora | 16.60 abc | 17.70 abcd | 0.68 a | 0.41 a | 13.40 a | 0.721 |
| Požegača | 20.40 a | 21.68 a | 0.73 a | 0.48 a | 13.69 a | 0.370 |
| *Anna Späth* | 18.43 abc | 19.22 abc | 0.63 a | 0.40 a | 11.98 a | 0.041 |

*Average values marked with different letters greatly differ statistically at the level P=0.05 (Tukey's test)

During the two-years of research, the largest average amount of soluble dry matter (20.40 %) and overall dry matter (21.68 %) was found in the fruit of the Požegača, whereas California Blue had the smallest amounts (Table 3).

Table 4: Chemical analyses of fruits of the examined plum varieties (without bees)

| Variety of Plum | Dry matter % | Dry matter % | Ash % | Cellulose % | Vitamin C mg/100g | Anthocyanins mg/100g |
|---|---|---|---|---|---|---|
| Čačanska Lepotica | 16.50 abc | 17.64 abcd | 0.68 a | 0.30 a | 12.77 a | 0.555 |
| Stanley | 17.77 abc | 20.85 a | 0.78 a | 0.41 a | 11.50 a | 0.672 |
| Čačanska Rodna | 17.90 abc | 18.75 abcd | 0.65 a | 0.39 a | 13.95 a | 0.228 |
| Californi a Blue | 12.55 c | 13.62 d | 0.70 a | 0.34 a | 10.30 a | 0.586 |
| Valjevka | 16.52 abc | 17.55 abcd | 0.69 a | 0.39 a | 13.44 a | 0.730 |
| Čačanska Rana | 13.85 bc | 14.85 bcd | 0.58 a | 0.49 a | 12.56 a | 0.452 |
| Valerija | 12.80 c | 13.78 cd | 0.72 a | 0.33 a | 10.31 a | 0.154 |
| Mildora | 16.45 abc | 17.40 abcd | 0.61 a | 0.35 a | 12.50 a | 0.701 |
| Požegača | 20.10 a | 21.70 a | 0.75 a | 0.48 a | 13.33 a | 0.343 |
| *Anna Späth* | 18.44 abc | 19.30 abc | 0.62 a | 0.40 a | 11.86 a | 0.042 |

*Average values marked with different letters greatly differ statistically at the level P=0.05 (Tukey's test)

Fruits of the variety Požegača, that are classified by Tukey's test in the first group, with the largest amount of soluble dry matter show statistically significant differences compared to the fruits of the varieties Valerija, Čačanska Rana and California Blue. According to Tukey, Požegača and Stanley also fall into the first group, having the largest amount of dry matter, and statistically they do not differ from the fruits of the Požegača, *Anna Späth*, Čačanska Rodna, Valjevka, Čačanska Najbolja and Čačanska Lepotica.

## CONCLUSION

It is well known that the honey bee *(Apis mellifera L.)* is a major pollinator of both cultivated and uncultivated plant varieties. It is particularly significant in the pollination of fruit trees. In America and Western Europe bees are used almost exclusively for the pollination of cultivated crops. Among the fruit varieties frequently visited by bees we have selected plums and conducted research on these crops.

On the basis of this two-year research project, it has been noted that the percentage of fruit sets in flowers that were freely accessible to bees was significantly higher than in flowers from isolated branches (almost 30%).

Furthermore, the number of fruits just before the harvest on the same branches was larger, which proves that the yield itself increased by about 25%. The yield of cultivated plums increased up to 10 tons per hectare, which points out the enormous value of bees. This brings us to the conclusion that, with the same agro-technology, the yields of fruit growers could be significantly increased by bringing bee colonies to plantations of the examined plum varieties. In this case, bees should be obligatory followers of plum crops, particularly during the blooming period. Although the fruits were of similar quality, those from the group pollinated by bees had a slightly better quality of chemical composition.

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## UTICAJ MEDONOSNE PČELE (*APIS MELLIFERA* L.) NA OPRAŠIVANJE I PRINOS GAJENIH SORTI ŠLJIVA

### SAŽETAK

Poljoprivrednici i pčelari žele da pčele što efikasnije opraše poljoprivredne kulture. U tu svrhu se posebno pripremaju pčelinja društva, jer oprašivanje većine kultura pada rano u sezoni, kada se u košnici ne nalazi obilje pčela radilica. Dosta voćnih vrsta ima ogroman značaj za pčele, za njihov rani razvoj društva u rano proljeće (lijeska, badem, drijen, džanarika...) i pripremu za glavnu pašu. U našim uslovima u oprašivanju voćaka medonosne pčele učestvuju sa preko 85 %, dok na sve ostale oprašivače otpada 14-15 %.

U toku dvogodišnjeg ispitivanja (2010. i 2011. godine) na dvije lokacije u okolini Bijelog Polja (sela Mioče i Kostenica) u zasadima šljiva vršeno je poređenje uspješnosti oprašivanja nekih sorti sa i bez pčela. Naravno uspješnost oprašivanja, uz potpuno istu agrotehniku, u prisustvu pčela je bilo veće oko 30%, što se odražava na značajno prinos, koji može biti veći i za 25 %. Na taj način povećava se prinos i do 10 tona šljiva po hektru, što ukazuje na ogroman značaj najboljeg oprašivača za gajeno bilje na našoj planeti.

**Ključne riječi**: medonosna pčela, šljiva, oprašivanje, prinos