Impact of Insect Pollination on Fruit Set, Fruit Size and Yield of Three Sweet Cherry Cultivars

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Abstract— *In the present research project, we compare three different pollination types (viz., with insects, without insects, and solely with honeybees) of three widespread sweet cherry cultivars, with the aim of conducting measurements and drawing conclusions pertaining to the impact of pollinators on fruit set, yield, and fruit quality in commercial orchards. It included a total of three treatments: Isolation with anti-insect nets (IS), Isolation with cages and Honeybee Pollination (HB), and Open Pollination (OP). Recent research focuses mostly on the role that different types of pollinator have in sweet cherry pollination; however, they do not provide measurements of final yields. The applied experimental method, was fast, simple, of low labor cost, and yielded robust and valid results based upon statistical analysis that are easily comprehensible by the sweet cherry growers. From the results of the experiment, it is evident that the absence of pollinators is a restrictive factor in fruit production, not only in cross-pollinated but also in self-fertile varieties. The value of open pollination, during which cherry flowers are visited by native pollinators and honeybees is beyond doubt. Wind is not a means of transporting pollen to sweet cherry trees. Honeybees have proved to be effective managed pollinators and thus they represent an efficient approach that can ensure increased yields and large size fruits, when colonies placed in sweet cherry orchards*.

Keywords— Sweet cherry pollination, insect pollination, honeybees, pollination services.

I. INTRODUCTION

Sweet cherry (*Prunus avium L.*) is a valuable fruit tree species of the Rosaceae family, grown worldwide for its exceptionally high-quality fresh fruit. According to their pollination mode, cultivated cherry varieties are classified into self-pollinating, partially self-pollinating and self-incompatible. The genotype (S-alleles, S_aS_b) of a given cultivar determines whether this particular variety is compatible with another so that pollination can be achieved. If the two varieties have the same S-alleles, then they are incompatible with each other, irrespective of whether they bloom at the same time [27], [32].

The range of factors that influence fruit set and quality in different sweet cherry cultivars have been examined and analyzed in the literature, as for example in the paper by Montiel et al. [31]. Such factors are pollen availability and viability, stigmatic receptivity, ovule longevity, pollen vectors such as bees, as well as high and low temperatures during bloom time [5], [34], [41]. Of critical importance also are susceptibility to frost, rootstock type, rate of pollen germination [1], [40] and age of flower at the time of pollen germination [41]. Inadequate insect pollination, low pollen germination, low viable pollen, low pollen tube growth, and rapid ovule senescence, have negative effects on fruit set [35].

Insect pollination of cherry flowers is a core issue as it impacts both fruit set and yields [26], [29]. Both *Apis mellifera L.* (Hymenoptera: Apidae) species and non-apis species are acknowledged as major crop pollinators worldwide [16]. Recent work has demonstrated that pollination services by wild bees in cherry are superior to those offered by honeybees [21]. In fact, the semi-natural habitats that support their diversity and abundance enhance cherry fruit set [12]. Solitary bees such as mason bees (*Osmia cornuta*) achieve high pollination rates after a single visit to cherry flowers [13]. Honeybees, on the other hand, that are bred and maintained by beekeepers in hives, have the great advantage that they can be transported over long distances and offer their precious pollination services in a variety of places. Worldwide, the transportation of honeybee colonies to provide supplemental pollination services remains the defacto approach, for the time being [16]. Honeybees are regarded as exceptionally productive pollinators [38]; as a matter of fact, they are the most economically valuable pollinators of crop monocultures around the world, especially when other pollinators do not visit agricultural fields [26], as for example when agricultural land is cut off from natural or semi-natural areas.

The number of honeybee hives recommended for pollination in commercial cherry orchards is 2 to 5 hives per hectare. Sweet cherry fruits drop in three waves. The first happens 2-2.5 weeks after full bloom, the second 1 week after the first, and the third 3 weeks after the second [7]. The natural formation of pedicel-fruit abscission zone varies by cultivar, and the general molecular basis for its activation is not well characterized [20]. Poor pollen quality gives rise to fruitlet abscission [33]. Several factors, such as variety/rootstock selection, type of pruning, number of fruits, leaf/fruit balance, tree vigor, water adequacy at critical times, and heat stress affect fruit size [30].

The aim of the current research paper was to examine the influence of insect pollination on fruit set, fruit size and yield of three commercial sweet cherry cultivars via a field simulation method. Joint isolation of the cross-pollinated sweet cherry cultivars under examination constitutes a method which has never been applied before in pollination experiments with insects. It is adopted for the first time in the current research paper, with the expectation that it may yield comprehensive results for both farmers and beekeepers on the usefulness of pollinators as a valuable input to sweet cherry production.

II. MATERIALS AND METHODS

2.1 Research area

The current experimental project was implemented between 2020 and 2021 at the premises of the Department of Deciduous Fruit Growing based in the city of Naousa, Greece, (40°37′15”N; 22°07′00”E, altitude: 119 m), which belongs to the Institute of Plant Breeding and Genetic Resources of the Hellenic Agricultural Organization-DIMITRA. The climate in this area is Mediterranean, with a mean annual rainfall of 690 mm. The central farm of the Institute, covering an area of 20 hectares, combines a wide variety of cultivated tree species, several of which bloom at the same period, thus acting competitively in their effort to attract bees and other pollinators. Meteorological data was provided during the experiment by the local meteorological station.

2.2 Plant material

The plant material used consisted of: (i) three open-bowl shaped cherry trees of the ‘Ferrovia’ variety aged 7 years old, grafted on a MaxMa 14 Delbard rootstock; (ii) three open-bowl shaped cherry trees of the ‘Regina’ variety aged 7 years old, grafted on a MaxMa 14 Delbard rootstock (P. mahaleb × P. avium); and (iii) three low-bowl shaped cherry trees of the ‘Lapins’ variety aged 7 years old, grafted on a Mazzard rootstock. The cultivars under investigation as well as the pollinizer varieties planted in the experimental farm are presented in Table 1.

TABLE 1
SWEET CHERRY VARIETIES INCLUDED IN THE POLLINATION EXPERIMENT

Variety	Bloom* (days from B. Burlat)	S-alleles	Pollination group	Pollinizers	Fruit set (OP %)
Ferrovia	+ 5	S_3S_{12} Incompatible	XXII	* ‘Sunburst’, ‘Lapins’, ‘Van’, ‘Kordia’, Regina’, ** ‘Canada Giant’, Giorgia’, ‘Hedelfinger’	*14.30
Regina	+ 7	S_1S_3 Incompatible	II	* ‘Ferrovia’, ‘Cristalina’, ‘Tragana Edessas’, ‘Kordia’, ‘Summit’	*48.00
Lapins	- 2	S_1S_4 Self-fertile*	SC	-	*39.20

Data from Kazantzis [25] **Data from Grandi & Lugli [17]

Tree planting distances were 4.0 m x 5.0 m. Pruning, fertigation, and plant protection practices were carried out in accordance with the principles of integrated management that are widely adopted by cherry growers.

2.3 Experimental treatments

In the present project, we followed the methodology described by Delaplane et al. (2013) concerning fruit set experiments at field level. One target was to exclude all insect pollinators and introduce honey bee colonies in plots, in order to study the influence of honeybee pollination on cross- and self-pollinated cultivars. Another target was to investigate the possibility of wind pollination - without visitors. Pollination in open fields was also investigated, to be compared with the other 2 methods. The experiment consisted of three treatments: Isolation (IS), in which the trees were covered with anti-insect nets; Isolation and Honeybee Pollination (HB), in which in which the trees were caged under anti-insect nets a honeybee hive was placed together with the caged trees; and Open Pollination (OP), in which the trees were completely unprotected. Pollination experiments with honeybees and the use of isolation cages in fruit trees have also been successfully carried out with kiwi [22], plum [6] and sweet cherry [1].

On each experimental tree, ten (10) fruit bearing branches were selected and marked as subjects of each treatment. To carry out the IS treatment, we isolated (Fig. 1A) with the use of insect-proof netting a tree of the 'Regina' and one of the 'Ferrovia' variety together with twenty (20) 0.5 m long blooming branches of the 'Kordia' variety (S_3S_6 group of alleles - pollination group: VI) that were placed in bottles filled with water. With the use of the same net, we also isolated a tree of the 'Lapins' variety, but without any pollinizers (Fig. 1B).

Similarly, for the needs of the HB treatment (Fig. 2A), two trees were jointly isolated by means of insect-proof netting: a tree of the 'Regina' and a tree of the 'Ferrovia' variety together with twenty (20) 0.5 m long blooming 'Kordia' branches. In addition, a tree of the 'Lapins' variety was isolated separately. The difference between treatments (HB) and (IS) is that in the former a honeybee hive was placed inside each cage (Fig. 2B). In the OP treatment, pollination was carried out by both native and honeybee pollinators living in this specific area and, what is more, the transfer of pollen to the flowers of the cultivars under investigation was undertaken by all the pollinizers included in Table 1.

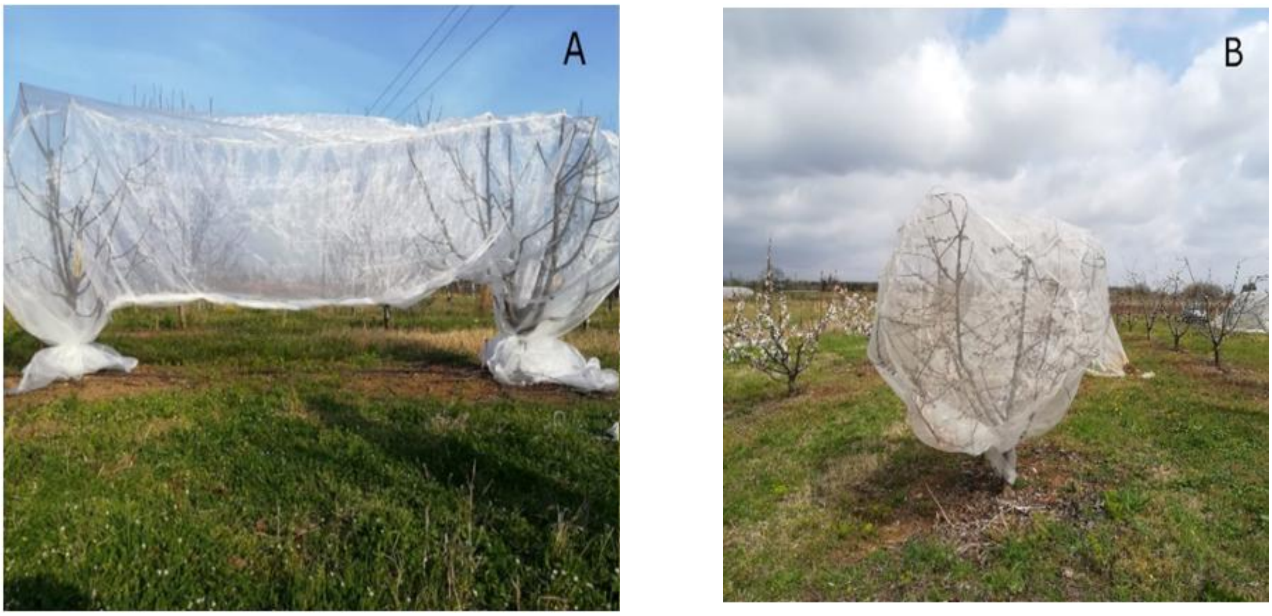

FIGURE 1: Isolation: Ferrovia + Regina (A), Lapins (B)

A great advantage of the method applied is that the measurements conducted concern different branches of the same tree and, consequently, the number of their repetitions can easily be adapted according to the precision that is required each time. In the specific experiment, we assumed that measuring 10 random branches in each treatment, differing in position and orientation was an adequate number for drawing safe conclusions. In addition, the relatively small sample size when combined with homogeneous experimental units, as the ones we selected for our experiment, further ensures valid and robust statistical results. The larger the experiment becomes in terms of the number and/ or size of the individual experimental units deployed, the harder it becomes to either ensure or reasonably assume that these units are all either internally homogeneous or equivalent to each other for the purposes of these comparisons [18].

During the experiment, the following measurements were taken from each selected fruit branch: number of flowers per branch meter, fruit set (%), production (g/m), and fruit diameter (mm).

2.4 Pollinators

For the purposes of the experiment, honeybee hives were used consisting of three bee and brood frames and another two frames of stored pollen and honey (about 6,000 bees). The colonies were introduced under the nets at the onset of bloom. The hives remained inside the HB treatment cages for 8 days, during which they were fed twice with 1:1 sugar syrup to supplement their diet due to lack of nectar.

2.5 Statistical analysis

Statistical analysis was performed with the use of SPSS, Version 21.0 [23] and MS Excel. We used the Kolmogorov-Smirnov test (K-S Test) to examine if our samples are drawn from a population with a normal distribution. For the variables which do not follow a normal distribution, we used nonparametric tests: Kruskal-Wallis median-test, and Mann-Whitney U-test. For normally distributed variables, the differences between two different groups were evaluated with the use of t-test. P-values ≤0.05 (5% significance level) were considered significant.

FIGURE 2: Honeybee pollination: Ferrovia + Regina (A), Lapins (B)

III. RESULTS

The ‘Ferrovia’ fruit set means obtained from treatment IS in 2020 and 2021 (Table 2) were found to be considerably lower than the fruit set means of treatments HB ($P < 0.001$) and OP ($P < 0.001$). The OP treatment conducted in 2020 produced a higher mean fruit set than treatment HB, without this difference being statistically significant ($P = 0.724 > 0.05$); the same occurred in 2021 ($P = 0.153 > 0.05$).

TABLE 2
FERROVIA. RESULTS FOR YEARS 2020 & 2021 (MEAN± S.D)

Treatment	Fruit set (%) 2020	Fruit set (%) 2021	Production (g/m) 2020	Production (g/m) 2021	Size (mm) 2020	Size (mm) 2021
IS	4.30 ± 3.52^{a}	3.60 ± 2.50^{a}	0.00^{a}	0.00^{a}	-	-
HB	22.9 ± 7.54^{b}	15.00 ± 4.26^{b}	229.44 ± 91.93^{b}	177.33 ± 80.00^{b}	27.63 ± 0.51^{a}	28.46 ± 0.49^{a}
OP	24.10 ± 7.40^{b}	19.30 ± 8.05^{b}	263.03 ± 116.87^{b}	253.71 ± 92.85^{b}	27.54 ± 0.83^{a}	26.61 ± 0.83^{b}

The means of each column followed by a different letter are significantly different at the 0.05 significance level

The average production of ‘Ferrovia’ in treatment IS in 2020 and 2021 was equal to zero. The few fruits that were formed turned yellow and dropped in the first wave of fruit drop. The 2020 OP treatment had a higher average yield (263.03 ±

116.87) than treatment HB (229.44 ± 91.93), without the difference being statistically significant ($P = 0.496 > 0.05$); the same also occurred in year 2021 ($P = 0.096 > 0.05$).

In 2020, treatment HB yielded fruit with a nearly equal mean diameter (27.63 ± 0.51) to those resulting from the OP treatment (27.54 ± 0.83). In 2021, mean fruit diameter in treatment HB (28.46 ± 0.49) was significantly greater ($P < 0.001$) than that of the OP treatment (26.61 ± 0.83).

The mean fruit set of the 'Regina' variety obtained from treatment IS in years 2020 and 2021 (Table 3) was significantly lower than the mean fruit set rates of HB ($P < 0.001$) and OP ($P < 0.001$) treatments. In addition, OP treatment had a higher mean fruit set rate than treatment HB in both the years of the experiment, but the difference was not found to be statistically significant (2020: $P = 0.529 > 0.05$; 2021: $P = 0.913 > 0.05$).

The average production obtained from treatment IS in 2020 and 2021 was equal to zero. The few fruits that had been formed turned yellow and dropped in the first wave of fruit drop. The 2020 OP treatment had a higher average production (518.90 ± 111.27) than treatment HB (413.96 ± 139.08), without this difference being statistically significant ($P = 0.105 > 0.05$); the same also happened in 2021 ($P = 0.063 > 0.05$).

TABLE 3
REGINA. RESULTS FOR YEARS 2020 & 2021 (MEAN± S.D)

Treatment	Fruit set (%) 2020	Fruit set (%) 2021	Production (g/m) 2020	Production (g/m) 2021	Size (mm) 2020	Size (mm) 2021
IS	6.30 ± 5.03^{a}	5.10 ± 4.60^{a}	0.00^{a}	0.00^{a}	-	-
HB	56.90 ± 11.14^{b}	37.50 ± 9.03^{b}	413.96 ± 139.08^{b}	178.66 ± 48.21^{b}	23.91 ± 0.64^{a}	24.6 ± 0.50^{a}
OP	59.00 ± 9.34^{b}	38.00 ± 11.00^{b}	518.90 ± 111.27^{b}	251.57 ± 83.95^{b}	23.70 ± 0.85^{a}	23.92 ± 0.78^{b}

The means of each column followed by a different letter are significantly different at the 0.05 significance level.

FIGURE 3: Regina (2020): Open Pollination (A), HB Pollination (B)

Although the difference in fruit set percentages was rather small, in treatment HB a higher rate of fruit drop was recorded, which resulted in fewer fruits remaining on the trees. In particular, after fruit set, some fruits ceased to grow, turned yellow and dropped in the first abscission wave (obviously a result of unsatisfactory pollination). For instance, we compare two repetitions of treatments OP (2nd-2020) and HB (8th-2020), with an almost equal number of immature fruits (91 and 88, respectively), as regards their final yields (Fig. 3 A and 3 B). The weight of the mature fruits in the 2nd repetition of treatment OP was 526 g, whereas their weight in the 8th repetition of treatment HB was 358 g.

Average production was lower than that in 2020 in both treatments (IS & HB). The OP treatment in 2020 yielded fruit with an almost equal diameter (23.91 ± 0.64) to those obtained from treatment HB (23.70 ± 0.85). In 2021, the average fruit diameter (24.63 ± 0.50) from treatment HB was significantly greater (P = 0.031 < 0.05) than the average diameter (23.92 ± 0.78) in the OP treatment.

TABLE 4
LAPINS. RESULTS FOR YEARS 2020 & 2021 (MEAN± S.D)

Treatment	Fruit set (%) 2020	Fruit set (%) 2021	Production (g/m) 2020	Production (g/m) 2021	Size (mm) 2020	Size (mm) 2021
IS	3.10 ± 3.41[a]	24.80 ± 4.63[a]	6.25 ± 14.45[a]	192.09 ± 53.61[a]	26.00 ± 2.00[ac]	25.10 ± 0.73[a]
HB	26.60 ± 9.95[b]	38.90 ± 7.47[b]	76.18 ± 43.87[b]	323.38 ± 70.42[b]	27.53 ± 0.50[ab]	24.64 ± 0.45[a]
OP	33.80 ± 23.07[b]	50.10 ± 8.11[b]	79.74 ± 51.60[b]	456.07 ± 230.02[b]	26.25 ± 0.79[c]	22.78 ± 1.08[b]

The means of each column followed by a different letter are significantly different at the 0.05 significance level

The 2020 mean fruit set rate of ‘Lapins’ in treatment IS (Table 4) was significantly lower than the mean fruit set rates of treatments HB (P < 0.001) and OP (P < 0.001). Also, significant differences were recorded in 2021 between the mean fruit set rate of treatment IS and those of HB (P = 0.001 < 0.05) and OP (P = 0.007 < 0.05). The OP treatment in 2020 yielded a higher mean fruit set than treatment HB, without the difference being statistically significant (P = 0.383 > 0.05), and the same occurred in 2021 (P = 0.059 > 0.05). In 2021 higher fruit set rates were recorded compared to year 2020.

The average production in treatment IS was significantly lower than the yields of treatments HB (P < 0.001) and OP (P < 0.001) in 2020 and 2021 (HB: P = 0.002 < 0.05; OP: P = 0.002 <0.05). The OP treatment in 2020 and 2021 produced a higher average yield (2020: 79.74 ± 51.60; 2021: 456.07 ± 230.02) than that obtained from HB (2020: 76.18 ± 43.87; 2021: 323.38 ± 70.42), but the difference was not statistically significant (2020: P = 0.739 > 0.05; 2021: P = 0.089 > 0.05).

The average fruit diameter in treatment IS did not differ significantly from the fruit sizes yielded in treatments HB (P = 0.314 > 0.05) and OP (P = 0.739 > 0.05) in 2020. However, significantly greater was the average fruit diameter in treatment IS than that obtained from treatment OP (P < 0.001) in year 2021. The average OP treatment diameter in 2020 (26.25 ± 0.79) was significantly smaller than that in treatment HB (P < 0.001). The same result was observed in year 2021 (P < 0.001). Measurements of the variable "number of flowers per branch meter" were carried out both in 2020 and 2021 (table 5).

TABLE 5
FLOWERING (FLOWERS/M)

Variety	*Year 2020 (N = 30)*	*Year 2021 (N = 30)*	*Period 2020-2021*
Ferrovia	163.25 ± 45.29	170.12 ± 35.03	166.68 ± 40.29
Regina	146.31 ± 34.77	136.99 ± 33.54	141.66 ± 34.20
Lapins	45.07 ± 17.67	150.07 ± 41.32	97.57 ± 61.61

‘Ferrovia’ had 166.68 ± 40.3 flowers per meter of fruit bearing branch, ‘Regina’ had 141.66 ± 34.2 flowers and ‘Lapins’ had 97.57 ± 61.61. The latter result can be attributed to the very intense pruning done in the winter of 2020, resulting in trees having a small number of flowers.

IV. DISCUSSION

No statistically significant differences in fruit set between HB and OP treatments were found, a fact that reveals the high efficiency of honeybees in the pollination of the ‘Ferrovia’ cultivar. Differences appear to be due to the following factors: (i) inside the HB treatment cage, there were only two pollinizers, namely a ‘Regina’ tree and twenty blooming ‘Kordia’ branches, a fact that restricts pollen supply in terms of time span, diversity and quantity, in comparison to the open pollination; ii) there are marked differences in bee activity between bees isolated in cages (HB) and those that are involved in open pollination [1]; iii) the presence of various kinds of bumble bees living in the natural environment is likely to have improved the performance of honeybees in this cross-pollinated variety [13]. The variation in the fruit set rates of this variety has also been observed in open pollination by Kazantzis [25], who cites a mean fruit set rate of 14.30%. Generally, in 2021 fruit set rates were lower compared to those in 2020. Treatment HB (15.00 ± 4.26) had the lowest fruit set. The low temperatures recorded in April 2021 (to cite some examples: on 08/04 minimum temperature: 5.5°C, maximum: 12.0°C; on 09/04 minimum: -1.0°C, maximum: 14.0°C; and on 10/04 minimum: 2.5°C, maximum: 17.0°C) appear to have negatively influenced both the flower fertilization process and bee foraging activity. Zhang et al [41] showed that the germination of pollen grains is limited under conditions of low temperatures. What is more, low temperatures slow down the growth of the pollen tube along the style and by the time it reaches the embryo sac, oocytes are highly likely to have lost their fertility [7]. According to Clarke & Robert [8], the most important factors that also affect the observed changeability in bee-pollinator activity include temperature and solar radiation. Still, the OP gave higher fruit set compared to HB, a fact that proves that the insect pollinators of the research area are very effective. However, no record of these pollinators (species diversity or abundance) is known, and it is a subject of further experimentation.

Other factors that have been reported to affect fruit set and should be investigated further are the nutritional state of trees [7], the low and high temperatures during the flowering period [5], [19], [34], [41], as well as the graft-rootstock combination [2]-[4], [11]. As regards the effects of the wind on the pollination of the ‘Ferrovia’ cultivar, it appears from the results of treatment IS that the wind is not a means of transporting pollen for cherry pollination, and this is also corroborated by James & Measham [24]. The greatest difference in ‘Ferrovia’ yields was observed in 2021, and this is likely due to the lower rates of fruit set and hence to the lower fruit load born by the HB treatment trees. Einhorn et al. [15] investigated the effects of thinning cherry fruit bearing organs on production, quality, and value of the finished product. The trees that had undergone thinning had a 40% to 54% lower yield compared to the control trees, but produced a higher percentage of large sized fruits.

‘Regina’ exhibited lower percentages of fruit set (HB: 37.50%; OP: 38.00%) in year 2021, both in comparison with those in 2020 (HB: 56.90%; OP: 59.00%) and with the mean fruit set of earlier observations on the same farm, estimated to be equal to 48% [7]. Experiments by Sagredo et al. [36] have showed that the period of effective pollination of the ‘Regina’ cultivar lasts approximately 5-6 days, significantly dependent on temperature. In our study, too, it appears that the low temperatures prevailing in April 2021 adversely affected fruit set, exactly as it happened with ‘Ferrovia’ trees. In treatment HB a higher rate of fruit drop was recorded in the first abscission wave, which resulted in fewer fruits remaining on the trees. The lower average production in 2021 in both treatments (IS & HB) is due to the smaller rate of fruit set taking place in this year. It can also be concluded that the wind does not contribute at all to the pollination of ‘Regina’ flowers. The lower fruit load born by the HB treatment trees resulted in a significantly greater average diameter in comparison to those in the OP treatment.

Results indicate that the self-fertile ‘Lapins’ formed fruits without the presence of insect-pollinators in treatment IS, albeit with a significantly lower fruit set compared to HB and OP. According to Klein et al. [26], sweet cherry pollination without insect visitation is only possible with passive self-pollination. Higher mean fruit set rates in open pollination (Open: 54.5% - Caged with bees: 48.6%) were recorded by Andersen & Choi [1]. The differences observed in the fruit set rate were attributed to the shading caused by the nets and the limited bee activity. In the present case, a possible reason that this self-fertile cultivar produced smaller fruit set rates in treatment HB could be that the bees demonstrated very little activity within the cage owing to its exceptionally small size, since the IS treatment concerned solely a single tree. The daily rainfall recorded in the study area between 23/03/2020 and 07/04/2020 (190 mm in total) appears to have negatively affected fruit set in ‘Lapins’, as compared to year 2021. Somerville [37] claims that during rainfall, bee flights are limited and bees fly only for very short distances. Low temperatures and high atmospheric humidity inhibit bee activity, suppress the dehiscence of anthers and slow down pollen release from open flowers [41]. In addition, Clarke & Robert [8] report that after rainfall, the germination of ‘Regina’ pollen was reduced from 78% to 28%, and the number of pollen grains transported to the stigma was also smaller.

Significantly reduced was the average production in IS treatment as compared to treatments HB and OP, a fact that is attributed to the lower fruit set percentage. By comparing the results for both years, it can be observed that both fruit set and yield were considerably lower in 2020, as compared to 2021. It became evident from the beginning of the experiment that the intense pruning of ‘Lapins’ had a negative impact on its flowering in 2020 and this resulted in reduced yields. According to von Bennewitz et al. [39], the highest yields are achieved with no pruning or with soft pruning treatments, while medium- and large-scale treatments cause substantial yield reductions per tree. Fruit diameter differences among treatments are, in all cases, due to the smaller fruit load born by the trees that yielded bigger sized fruit.

V. CONCLUSION

From the results of the present research project it can be concluded that the pollination of cherry flowers with insects is an ecosystem service, essential to both cross- and self-fertile cherry cultivars. Wind is not a means of transporting pollen to sweet cherry trees.

Honeybees are exceptionally effective managed pollinators and thus they constitute a valuable agricultural input that ensures high yields in commercial sweet cherry orchards. At the same time, the presence of other pollinators, mainly bees, is shown to be of great importance. Although in this study no records of other pollinators' diversity have been kept, the maintenance of a landscape suitable for nesting sites for solitary bees and bumble bees seems to support pollination services required for higher yields. Honeybees may be more numerous, but solitary bees may be more efficient. The latter still needs to be investigated, taking into account the particular varieties as well as the particular landscape composition and climatic conditions.

The applied experimental method, was fast, simple, of low labor cost, and yielded robust results that are easily comprehensible by the sweet cherry growers.

One of the disadvantages of the "isolation" method is that for its application the planting schedule of the cultivars under investigation should be carried out in a manner that facilitates their joint isolation in cages, so as to avoid using blooming branches of the pollinating cultivars, but whole trees. Furthermore, big-sized isolation cages must be used so that pollination conditions simulate those prevailing in open fields.

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