Hellenic Plant Protection Journal **17:** 59-69, 2024
DOI 10.2478/hppj-2024-0005

Pollination and fruit set of the Protected Designation of Origin apple cv. 'Delicious Pilafa Tripoleos' depends on insect pollinators

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Summary Insect dependency of apple crop for pollination vary in different cultivars. The cv. 'Delicious Pilafa Tripoleos', is a Protected Designation of Origin apple of Greece, which lacks information on self-compatibility and needs for insect pollination for commercial fruit production. Here, the effect of wind, free (wind and insects), honeybee, free with at least one visit from a bumblebee and hand pollination was examined on fruit set and fruit characteristics. Also, the effect of flowering patches as a practice to attract pollinators in the apple orchards, on fruit quality characteristics was studied. A pollinizer apple variety and insect pollinators are necessary for successful pollination of 'Delicious Pilafa Tripoleos' since hand pollination with pollen of the same cv., and wind pollination resulted in very low fruit set. Single flower visits by honeybees could give fruit set, however, free pollination with at least one visit of *B. terrestris* resulted in higher fruit set compared to the other pollination treatments. Free pollination resulted in more fruits with higher number of seeds than wind pollination (only one fruit obtained). Apples produced from flowers adjacent to the flowering mixture patches had significantly higher skin firmness and lower total soluble solids at harvest (both desirable traits for 'Delicious Pilafa Tripoleos'), compared to fruits from trees in naturally occurring groundcover.

Additional keywords: apple, bees, Delicious Pilafa Tripoleos, fruit characteristics, fruit set, pollination

Introduction

Apple (*Malus domestica* Borkh., Rosaceae) is one of the most economically important fruit crops globally (FAO, 2022). Apple crop is highly dependent on insects for its pollination as the majority of apple cultivars are self-incompatible and insect pollinators act as vectors for pollen movement among cultivars (Jahed and Hirst, 2017; Nunes-Silva *et al.,* 2020). Therefore, enhancing pollinator management in apple crop may result in large financial benefits (Garratt *et al.,* 2014). However, when discussing the economic benefits and management of pollinators in apple orchards, a basic concern is how pollinator dependency and potential yield deficiencies vary throughout different apple cultivars (Garratt *et al.*, 2016).

In a recent global study in 177 commercial apple orchards across 33 countries, honey bees were the dominant pollinator across all biogeographical zones, while other managed and wild bee species (644 bee species/ morphospecies collected) were recorded in lower numbers (Leclercq *et al.*, 2023). Apple growers utilize honey bees, *Bombus* spp., *Osmia* spp., and other bee species to ensure adequate levels of pollination and hence apple yields (Osterman *et al.,* 2021). Especially, bumblebees are considered excellent pollinators by farmers due to their ability to forage in low temperatures, common during apple's spring bloom (Brittain, 1935). In addition, conservation practices such as providing floral resources have been used to attract bees aiming to promote ecosystem stability and enhance food security in insect pollination dependent crops like apples (Park *et al.*, 2012; Campbell *et al.*, 2013).

Insect pollination is known to increase cross-pollination between cultivars and thus

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improve fruit set and yields of apples (Leonhardt *et al*., 2013), which are self-incompatible to some extent depending on the cultivar (McGregor, 1976). However, the influence of insect pollination on apple fruit quality characteristics is not clear yet (Samnegard *et al.*, 2019). For example, no significant differences were observed between wind-pollination, wind + bee-pollination and hand-pollination treatments in fruit firmness, soluble solids content, titratable acidity, dry matter and starch content, while fruit weight increased moving from the first to the third abovementioned treatment (Vizzotto *et al*., 2018). Moreover, insect pollination has been reported to improve apple fruit weight, length, diameter (Hünicken *et al*., 2020). Also, better fruit quality (greater fruit symmetry) was recorded in apples produced in trees close to *Osmia lignaria* Say nests (Sheffield, 2014).

When valuing ecosystem services such as pollination to agricultural production, it is always important to consider the apple variety (Garratt *et al*., 2014). The apple 'Delicious Pilafa Tripoleos', is a Protected Designation of Origin (PDO) cultivar which is produced in altitude higher than 600 m, mainly at the Tegea plateau, in the Prefecture of Arcadia Peloponnese, Greece (European Union 1997, Kizos and Vakoufaris, 2011). 'Delicious Pilafa Tripoleos' apples were recognized as PDO by the Greek Ministry of Agriculture in 1962 (225700/13362) (peliti.gr), but they were cultivated for the first time in Greece in 1920 as a sporophyte (Davidis, 1981). Their irregular shape, rough texture of their skin and short life of storage do not give the best first impression to the consumers, but they have excellent organoleptic characteristics for which are famous to apple connoisseurs (Mitropoulos and Lambrinos, 2005; Mitropoulos and Lambrinos, 2007; Thanopoulos *et al*., 2021). 'Delicious Pilafa Tripoleos' flowering period is very short, usually less than two weeks from mid to late April (Barda *et al*., 2023). Moreover, the weather in April is usually unstable in Tegea plateau, resulting in frost problems and limited fruit setting (Hatziiremia, 2021). Honey bees and wild bees, i.e., *Andrena*, *Anthohora*, *Bombus* (e.g., *B. terrestris*, *B. argilaceus*), *Xylocopa*, *Lasioglossum* (e.g., *L. marginatum*), Megachilidae have been recorded on flowers of 'Delicious Pilafa Tripoleos' (Barda *et al*., 2023). Therefore, the study of 'Delicious Pilafa Tripoleos' pollination aiming to enhance pollination services and possibly improve fruit marketable characteristics is of great interest for promoting and preserving this local cv. In addition, there is no previous relevant study for the cv. 'Delicious Pilafa Tripoleos', which makes this study novel.

The aim of this study is to evaluate the effect of a) free pollination with contribution of insects and wind pollination on 'Delicious Pilafa Tripoleos' fruit set and fruit quality characteristics; b) different pollinator taxa (honey bees and bumblebees) to fruit set, and c) groundcover management practices (patches of flowering plants established to attract pollinators *vs* naturally occurring groundcover in the apple orchard) to fruit quality characteristics.

Materials and Methods

To study the effect of different pollination treatments and groundcover on 'Delicious Pilafa Tripoleos' fruit set and fruit quality, three field experiments were conducted during the years 2020, 2021, 2022.

Effect of free pollination (insects and wind) vs wind pollination on fruit set and fruit characteristics of the cv. 'Delicious Pilafa Tripoleos'

The study took place in an IPM apple orchard (palmette, 0.45 ha) located in Tegea plateau, Arcadia, Peloponnese, Greece (37.4415, 22.40492) in year 2020. To minimize variability effects due to different tree vigor, site and other factors that could affect pollination and fruit setting, the treatments were set in pairs on branches of the same tree. In particular, two branches of the same length, approximately 1m, on the same apple tree were selected at pink bud stage, one was marked as "free pollinated" and the second was closed in an insect-proof net (1.20m x

0.50m, 16/10) which allows pollen entry, and marked as "wind pollinated" (Figure 1a). After the end of flowering, the net was not removed from the "wind pollinated" branches aiming to protect them. For the same reason a net was also placed on the "free pollinated" branches. A total of 8 paired replicates per treatment were set. During flowering no plant protection products were applied.

To evaluate the effect on fruit setting, the following measurements were conducted in the field a) the number of buds on each selected branch at the pink bud stage (BBCH 57) (Meier et al., 2009), b) the number of fruits two weeks after petal fall (BBCH 71), c) 'initial fruit set' as the proportion of fruits on BBCH 71 to flowers on BBCH 57, d) the number of fruits after natural fruit drop and fruit thinning by hand, e) fruits on harvest (BBCH 87), f) 'final fruit set' as the proportion of fruits on BBCH 87 to flowers on BBCH 57. Apple fruits produced by free pollination, wind pollination and randomly selected apples from free pollination without net after petal fall (as a control), were harvested to study the effect of pollination treatment on fruit quality characteristics. 'Initial fruit set' is considered the best indicator of pollination success, as measurements are taken before any fruit loss due to diseases, pests, or natural abscission by the tree (Klein *et al.*, 2012). The 'final fruit set', was also recorded in autumn as an important pollination success indicator for orchard managers (Campbell *et al.*, 2017b).

The fruit quality characteristics examined in the laboratory were: a) fruit weight (g), b) maximum fruit length (mm), c) minimum fruit length (mm), d) maximum fruit width (mm), e) minimum fruit width (mm), f) seeds/fruit, g) seeds' weight/fruit (g), d) total soluble solids - TSS (°Bx) (Figure 1e). Fruit width and length were measured using a digital caliper (Figure 1f) and TSS using a hand refractometer calibrated with distilled water.

Effect of pollination by different taxa of pollinators on the cv. 'Delicious Pilafa Tripoleos' fruit set

The study was carried out in an organic apple orchard (palmette, 0.25 ha) located in Tegea plateau, Arcadia, Peloponnese, Greece (37.43705, 22.46942) in year 2022. Two bumblebee hives (Bioinsecta Bombox Fruit) of the species *Bombus terrestris* L. (Apidae) were established in the orchard, as an adopted practice by the farmers, to ensure visits of *B. terrestris* on the apple flowers. Visits of *Apis mellifera* L. (Apidae) on apple flowers were already guarantied as beekeepers transfer their hives in Tegea plateau during apple flowering. The bumblebee hives were placed in the field on 13 April 2022 to acclimatize. The apple blossom started on 25 April 2022. Insect net cages (1.20m x 0.50m, 16/10) were placed in apple inflorescences (corymb) at the pink bud stage (BBCH 57), on 19 April 2022. Regarding plant protection applications, these included one application of a copper product before apple flowering, and one application of a *Beauveria bassiana* product after the end of flowering.

Apple inflorescences were caged (30 cm x 20cm, density type: 16/10) at the pink bud stage to be able to handle the following a, b and d treatments. The following treatments were implemented: a) wind pollination, using an insect-proof net (30 cm x 20cm, 16/10) which allows pollen but not insects entry, b) a single visit by *A. mellifera*. Inflorescences caged at the pink bud stage, were released on full bloom under supervision for observation of a single honey bee visit. The flower visited by a honey bee was caged again individually after destroying the rest of the flowers of the inflorescence, c) at least one visit by *B. terrestris*. Flowers that were free to pollination by wind and insects and received (recorded by observation) at least one visit by *B. terrestris*. Upon the bumblebee visit, one flower was kept in each cage (destruction of the flowers of the inflorescence not visited by the bumblebee), d) Hand pollination, was performed using a flower from a neighboring tree of the same variety (also a way to check whether self-incompatible or compatible), by tapering its anthers on the stigma of the examined flower, destruction of the rest of the rosette's flowers, then close the flower in an insect-proof cage (Figure 1b, 1c, 1d)

The measurements recorded were: a) duration of each pollinator visit to one flower (in seconds), to provide a measure of mean visitation period for each pollinator (Garantonakis *et al.,* 2016), b) fruit set, in each pollination treatment, two weeks after the end of anthesis.

Effect of patches of flowering plants on the apple fruit quality

To determine any possible differences of different groundcover management practices, the above mentioned IPM apple orchard in the 2020 experiment was used with the establishment and the plant species of the flowering mixture described in Barda *et al*. (2023). All fruits were free-pollinated and randomly harvested. In autumn 2021, 12 apple fruits were harvested from apple trees in rows which during spring had been surrounded by flowering mixture patches (main flowering by *Vicia sativa* L., *Vicia faba* L., *Eruca sativa* L. Cav. and *Coriandrum sativum* L.) and 12 fruits from trees in rows that had been surrounded by naturally occurring groundcover of the orchard (main flowering by *Ranunculus repens* L., *Veronica* persica Poir., *Veronica hederifolia* L., *Calepina irregularis* (Asso) Thell., *Cardaria draba* L.). The quality characteristics examined were the same as those examined in the year 2020 with the addition of three characteristics a) fruit skin firmness (kg), b) flesh firmness (kg), c) apple shape, measured as the difference between maximum and minimum fruit width. The skin firmness was measured using a penetrometer at two antidiametrical points, flesh firmness was measured using a penetrometer by cutting the apple in half and measured at two points of the flesh between the ovary and the skin of the fruit.

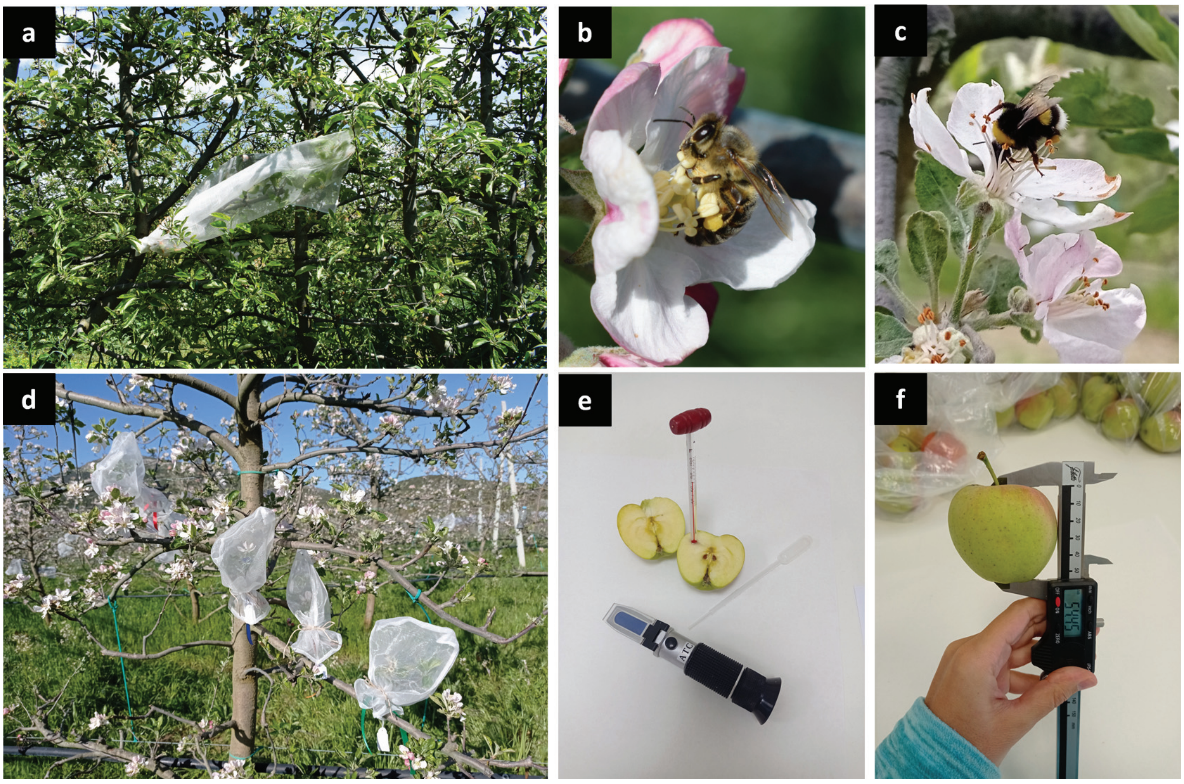

Figure 1. Investigation of the importance of different pollination treatments in fruit set and fruit characteristics of the "Delicious Pilafa Tripoleos" apple: a) branch with insect-proof net (wind pollination), experiment 2020, b) visit of *Apis mellifera* to an apple flower, c) visit of *Bombus terrestris* to an apple flower, d) different pollination treatments inside insect proof cages (*A. mellifera, B. terrestris*, wind pollination, hand pollination), experiment 2022, e) Measurement of total soluble solids by hand- refractometer, f) measurement of fruit length with a caliper.

Statistical analysis

T-test was applied to determine any statistically significant differences between: a) fruit quality measurements of fruits from free pollination, kept in the net after petal fall *vs* free pollination without the net after petal fall in 2020; b) free pollinated fruits adjacent to flowering patches *vs* the naturally occurring groundcover (control) in year 2021, when data followed the normal distribution (α=0.05); Kruskal-Wallis nonparametric test when data did not follow the normal distribution (α=0.05). Differences among pollination treatments on fruit set in the 2022 experiment were separated by Dunn's test, while visit duration differences between honey bees and bumblebees were determined by Kruskal-Wallis nonparametric test.

Results and Discussion

In year 2020, the bagged branches allowing only wind pollination, gave very low fruit set indicating that insect visits are necessary for apple flower pollination of the cv. 'Delicious Pilafa Tripoleos'. The positive effect of free pollination (wind and insects) is obvious even from the 'initial fruit set' and is clearly depicted on the 'final fruit set' (Table 1). Only one fruit from wind pollinated flowers was obtained on harvest. On the contrary, 36 fruits were obtained by free pollinated flowers indicating the importance of insect pollinators in fruit set. The importance of the insect mediated pollination has been underlined for diverse apple varieties (Garratt *et al.,* 2016; Pardo *et al.,* 2020; Burns, 2022) and is confirmed for 'Delicious Pilafa

Table 1. Fruit set of the cv. 'Delicious Pilafa Tripoleos' flowers after free pollination or wind pollination: number of flowers at pink bud stage (BBCH 57); number of fruits two weeks after petal fall (BBCH 71); 'initial fruit set' as proportion of fruits at BBCH 71 out of flowers at BBCH 57; fruits on harvest (BBCH 87); final fruit set as the proportion of harvested fruit out of flowers at BBCH 57, Tegea plateau, spring-autumn 2020.

Tree	Pollination treatment	Nr of flowers at BBCH 57	Nr of fruits at BBCH 71	Initial fruit set	Fruits after fruit thinning*	Fruits on harvest	Final fruit set
1	Wind	50	0	0.00	0	0	0.00
	Free	20	17	0.85	7	7	0.35
2	Wind	19	10	0.53	0	0	0.00
	Free	25	14	0.56	8	8	0.32
3	Wind	5	2	0.40	0	0	0.00
	Free	9	8	0.89	4	4	0.44
4	Wind	4	0	0.00	0	0	0.00
	Free	12	6	0.50	2	2	0.17
5	Wind	31	1	0.03	0	0	0.00
	Free	28	24	0.86	5	5	0.18
6	Wind	21	1	0.05	0	0	0.00
	Free	16	9	0.56	4	4	0.25
7	Wind	51	1	0.02	0	0	0.00
	Free	24	18	0.75	4	4	0.17
8	Wind	11	2	0.18	1	1	0.09
	Free	12	6	0.50	2	2	0.17

* Fruit thinning was applied as it is a common practice by apple producers and to have the same parameters that affect fruit quality between wind, free pollination and the control fruits (free pollinated fruits without net, randomly selected on harvest).

Tripoleos'.

In the experiment of 2022, the results of the wind pollination treatment confirmed the results of the 2020 experiment that insect pollinators are necessary for successful pollination of 'Delicious Pilafa Tripoleos' apples (Figure 2). Hand pollination gave only 3 fruits out of 17 hand pollinated flowers, highlighting the importance of a pollinizer apple variety on the pollination of the cv. 'Delicious Pilafa Tripoleos' (Figure 2).

Pollinator visit duration on a single apple flower differed significantly between honey bees and bumble bees ($p < 0.001$) with honey bees spending approximately twelve times longer time per flower than bumblebees. Specifically, the mean duration of a single honey bee visit on an apple flower was 48.1 ± 3.81 seconds and for bumblebees 4.09 ± 0.35 seconds. 'Free + *B. terrestris'* treatment resulted in significantly higher fruit set followed by honey bee and hand pollination, while wind pollination resulted in the lowest fruit set (Kruskal-Wallis, Dunn's test: p= 0.0047), (Figure 2). Pairwise multiple comparison Dunn's test did not show any differences (marginally, p= 0.055) between '*A. mellifera'* and 'Free + *B. terrestris' treatments* but Wilcoxon test showed that the latter resulted in significantly higher fruit set than single visits from honey bees (p= 0.0188). This demonstrates that a single

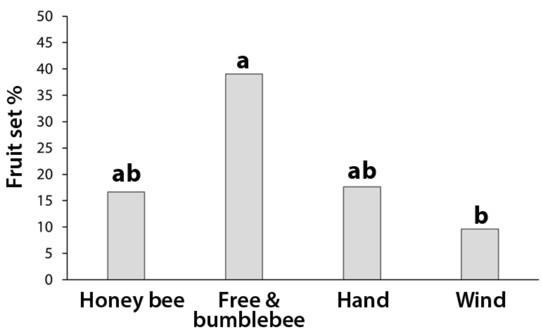

Figure 2. Percentage of fruit set two weeks after petal fall of flowers of the apple cv. 'Delicious Pilafa Tripoleos' after different pollination treatments: (a) a single visit of *A. mellifera,* (b) at least one visit of *Bombus terrestris*, (c) hand, (d) wind, Kruskal-Wallis: χ^2= 12.959, p= 0.0047, Tegea, plateau, Greece, spring 2022. Small letters indicate statistically significant differences between the pollination treatments.

flower visit from a honey bee (although longer than the one of a bumblebee) does not guarantee successful pollination, supporting the results of previous studies that fruit set requires repeated pollinator visits (Bernauer *et al.*, 2022). Moreover, longer visit duration does not always equal better pollination than shorter visit durations as pollination effectiveness depends on a variety of factors such as pollinator hair density, body length and flower handling (Roquer-Beni *et al.*, 2022). Other factors such as pollen carryover and pollinator movement are also important. For instance, bumblebees have been reported to outperform honey bees in terms of outcross pollen delivery per flower visited in apple (Hung *et al.*, 2023), as *Bombus* spp. frequently contact stigmas while foraging thus deposit more pollen to apple stigmas than honey bees (Thomson and Goodell, 2001). This aligns with the higher fruit set of the 'Free + *B. terrestris'* treatment in the present study from flowers which had received at least one visit of *B. terrestris,* although previous visits by other pollinators cannot be excluded. Nevertheless, both honey bees and bumblebees store moistened pollen in the corbicula of their hind legs, making pollen generally unavailable for pollination (Westerkamp, 1991; Michener, 2007), hence further research with more wild bee taxa which possess different structures and ways to carry pollen should be conducted.

Considering possible effect of pollination treatments on fruit quality characteristics, analyses on the 2020 harvested fruits from free (insects and wind), wind pollinated flowers and free (insects and wind) pollination without net until harvest, revealed some differences. Given the low number of apples harvested from the insect exclusion (wind pollination) treatment, we could not assess its effect on fruit quality. However, the wind pollinated fruit had one seed, whereas the free pollinated in cages and the control (free pollination – randomly selected fruits) had more than 3 seeds/fruit. Seed set is an indicator of apple fruit quality parameters, with greater seed numbers resulting in greater production of top commercial value fruits (Webber *et al*., 2020). Statistically significant differences were found between the fruits from free pollination and the control which was also free pollinated but without the effect of the net-cage after petal fall (Table 2). The latter (control) showed significantly higher fruit weight, minimum, maximum fruit length and minimum fruit width ($p= 0.0120$, $p= 0.0047$, $p= 0.0141$, $p= 0.0197$ respectively). These differences could possibly be attributed to the effect of the net used only in the free pollination treatment from BBCH 71 to BBCH 87, as published studies mention that net covering can affect production and fruit quality of apple and other fruits (Manja *et al*., 2019; Jordaan, 2023).

Regarding any possible effect of groundcover management on fruit quality characteristics, no effect was found on most of the fruit characteristics examined in year 2021. Floral plantings, which attract wild bees and enhance overall pollinator abundance in apple orchards (Campbell *et al.,* 2017a; Barda *et al.,* 2023) have been reported to have positively affected apple size (Ratto *et al.,* 2021) whereas no differences were found in the current study. Also, others reported that apple shape measured as the difference between maximum and minimum fruit width was significantly affected by pollination with insect-excluded treatment fruits being more misshapen (Campbell *et al.,* 2017b). Here, only fruits derived from free pollinated flowers were studied. The fruit shape did not differ between fruits produced from free pollination close to the flowering mixture and fruits from trees in the natural occurring groundcover ($p= 0.7175$) (Table 3). However, fruits produced from flowers adjacent to the flowering mixture had significantly higher skin firmness ($p= 0.0224$) while fruits from the control showed significantly higher total soluble solids when harvested ($p= 0.0004$). As the fruit matures, total soluble solids readings increase. However, both fruit samples were obtained the same day from the same field. In general, it is recommended to harvest apples with readings around 12% to 14% total soluble solids, but this varies by cultivar and target markets for the fruits (Farcuh, 2023). Lower total soluble solids at harvest may warrant longer storability period for 'Delicious Pilafa Tripoleos' apples. Generally, there is a positive trend of increasing consumer preference in apples with firmness (Harker *et al.,* 2008) which underlines the positive effect of the flowering mixture to the marketability of 'Delicious Pilafa Tripoleos' apples.

Conclusions

Overall, we can conclude that a pollinizer apple variety and insect pollinators are necessary for successful pollination and fruit set of 'Delicious Pilafa Tripoleos' apples. Wind pollination cannot result in fruit set. Single flower visits by honey bees can successfully pollinate flowers in a low percentage, which we assume could be increased with more visits. However, free pollination with at least one visit of *B. terrestris* (use of bumblebee hives is an increasingly applied farming practice) resulted in higher fruit set. Enhancement of pollinators using a groundcover management scheme of flowering patches in the apple orchard seems to have a further positive impact on pollination and fruit quality characteristics in 'Delicious Pilafa Tripoleos' since fruits produced from flowers neighboring the flowering mixture patches had significantly higher skin firmness (desirable by consumers) and significantly lower total soluble solids at harvest (may warrant longer storability period). Further research with diverse bee taxa is suggested to study the effect of different pollinators on fruit set and fruit quality.

Funding Information

This work was partially supported by the Hellenic Entomological Society, scholarships for PhD students 2021–2022.

We would like to thank the apple producers Antonios Mitropoulos, Dimitrios Mitropoulos and Nikolaos Karras for providing the apple

Table 2. Fruit quality characteristics (mean ± SE) of 'Delicious Pilafa Tripoleos' apples obtained from: a) wind pollination (1 fruit), b) free pollination with insect proof net from petal fall until harvest (37 fruits), c) free pollination without insect proof net (control, 32 fruits), Tegea, plateau, Greece, spring 2020.

Pollination treatment	Fruit weight (g)	Maximum fruit length (mm)	Minimum fruit length (mm)	Maximum fruit width (mm)	Minimum fruit width (mm)	seeds/fruit	Seeds' weight/ fruit (g)	Total soluble solids (°Bx)
Free pollination (n=37)	115.35 ± 5.29 **b**	60.97 ± 1.14 **b**	55.05 ± 0.96 **b**	64.86 ± 1.13	60.47 ± 0.94 **b**	3.58 ± 0.24	0.19 ± 0.01	15.45 ± 0.20
Control (n=32)	129.50 ± 3.48 **a**	64.56 ± 0.81 **a**	58.37 ± 0.64 **a**	67.40 ± 0.67	63.22 ± 0.62 **a**	4.28 ± 0.34	0.23 ± 0.02	15.95 ± 0.12
*Wind pollination (n=1)	117.07	64.39	52.88	62.76	62.01	1.00	0.01	14.73

Small letters indicate statistically significant differences between 'free pollination' and 'control' treatments (T-test, Wilcoxon test, $\alpha = 0.05$). Analysis was not possible for wind pollinated fruits since only one fruit was obtained; n = number of fruits.

Table 3. Means of fruit quality characteristics of 'Delicious Pilafa Tripoleos' apples obtained from free pollination on trees close to the flowering mixture (FM) and trees close to naturally occurring groundcover (control), Tegea plateau, Greece, year 2021.

Groundcover	Fruit weight (g)	Maximum fruit length (mm)	Minimum fruit length (mm)	Maximum fruit width (mm)	Minimum fruit width (mm)	seeds/fruit	Seeds' weight/ fruit(g)	Total soluble solids (°Bx)	Skin firmness (kg)	Flesh firmness (kg)	Fruit shape
Free pollination FM (n= 12)	175.74 ± 6.35	69.63 ± 1.30	62.28 ± 1.30	77.04 ± 1.14	71.48 ± 1.11	6.42 ± 0.66	0.34 ± 0.04	14.62 ± 0.19 **b**	2.67 ± 0.08 **a**	2.24 ± 0.11	5.55 ± 0.77
Free pollination Control (n=12)	188.46 ± 11.41	71.31 ± 1.67	64.33 ± 2.00	77.99 ± 1.80	72.82 ± 1.38	5.58 ± 0.79	0.31 ± 0.04	15.94 ± 0.25 **a**	2.43 ± 0.10 **b**	1.99 ± 0.13	5.18 ± 0.70

Small letters indicate statistically significant differences between the treatments (T-test, Wilcoxon test, $\alpha = 0.05$); n= number of fruits.

orchards and sharing their invaluable field experience, the Professor Emeritus Stavros Vemmos (Agricultural University of Athens) for his guidance regarding apple fruit characteristic measurements, the Researcher Kyriaki Varikou (ELGO-DEMETER) for her field advice regarding the bagging of the apple flowers, the Professor Ioannis Karapanos (Agricultural University of Athens) for providing the penetrometer and instructing the first author on the use of the equipment and the company Hellagro for donating the net used in the different pollination treatments.

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Received: 8 January 2024; Accepted: 15 January 2024

Η επικονίαση και καρπόδεση της Προστατευόμενης Ονομασίας Προέλευσης ποικιλίας μηλιάς «Ντελίσιους Πιλάφα Τριπόλεως» εξαρτάται από έντομα επικονιαστές

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Περίληψη Η ανάγκη επικονίασης από τα έντομα στην καλλιέργεια της μηλιάς διαφέρει ανάλογα με την ποικιλία. Η «Ντελίσιους Πιλαφά Τριπόλεως» είναι καλλιεργούμενη ποικιλία μηλιάς Προστατευόμενης Ονομασίας Προέλευσης για την οποία δεν υπάρχουν στοιχεία σχετικά με τον βαθμό αυτοασυμβίβαστου που παρουσιάζει και τις ανάγκες για επικονίαση από τα έντομα για εμπορική παραγωγή. Στην παρούσα εργασία εξετάστηκε η επίδραση της επικονίασης από τον άνεμο (άνθη σε κλωβούς), άνεμο και έντομα (άνθη χωρίς κλωβούς), από τη μελιττοφόρο μέλισσα, από ελεύθερη επικονίαση με τουλάχιστον μία επίσκεψη βομβίνου, και με το χέρι, στην καρπόδεση και στα χαρακτηριστικά του καρπού. Επίσης, μελετήθηκε η επίδραση ανθοφόρων φυτικών μειγμάτων με τη μορφή νησίδων εντός του μηλεώνα ως πρακτική για την προσέλκυση επικονιαστών, στα ποιοτικά χαρακτηριστικά των καρπών. Για την επιτυχή επικονίαση της μηλιάς cv. «Ντελίσιους Πιλαφά Τριπόλεως» είναι απαραίτητη η παρουσία επικονιάστριας ποικιλίας και εντόμων επικονιαστών, καθώς η επικονίαση με το χέρι με γύρη ανθέων από την ίδια ποικιλία, και η επικονίαση με τον άνεμο οδήγησαν σε χαμηλά ποσοστά καρπόδεσης. Μία επίσκεψη *A. mellifera* ανά άνθος μηλιάς οδήγησε σε καρπόδεση, ωστόσο, η ελεύθερη επικονίαση με τουλάχιστον μία επίσκεψη από *B. terrestris* είχε ως αποτέλεσμα υψηλότερο ποσοστό καρπόδεσης σε σύγκριση με τις άλλες μεταχειρίσεις επικονίασης. Η «ελεύθερη» επικονίαση οδήγησε σε περισσότερους καρπούς με μεγαλύτερο αριθμό σπερμάτων από ότι η επικονίαση με τον άνεμο (η οποία έδωσε μόνο έναν καρπό). Τα μήλα που προέρχονταν από άνθη που βρίσκονταν κοντά σε νησίδες ανθοφόρου μείγματος είχαν σημαντικά μεγαλύτερη συνεκτικότητα φλοιού και χαμηλότερα ολικά διαλυτά στερεά συστατικά κατά τη συγκομιδή (και τα δύο επιθυμητά χαρακτηριστικά για την cv. «Ντελίσιους Πιλαφά Τριπόλεως»), σε σύγκριση με καρπούς δένδρων που γειτνίαζαν με νησίδες αυτοφυούς χλωρίδας.

Hellenic Plant Protection Journal **17:** 59-69, 2024