agronomy

Article

Enhancing the Rural Landscape Character: The Low Frequency of Inter-Row Wildflower Meadow Harvest Positively Affects Biodiversity While Maintaining Grape Quantitative and Qualitative Traits in a 'Sultanina' Vineyard in Greece

Angeliki T. Paraskevopoulou [1,*], Euaggelos Pappous [1], Katerina Biniari [2], Konstantinos F. Bertsouklis [1], Ioannis Daskalakis [2] and Dionysios Perdikis [3]

[1] Laboratory of Floriculture and Landscape Architecture, Department of Crop Science, School of Plant Sciences, Agricultural University of Athens, Iera Odos 75, 118 55 Athens, Greece; geoefodiavbn@yahoo.com (E.P.); kber@aua.gr (K.F.B.)
[2] Laboratory of Viticulture, Department of Crop Science, School of Plant Sciences, Agricultural University of Athens, Iera Odos 75, 118 55 Athens, Greece; kbiniari@aua.gr (K.B.); john-daskalakis@aua.gr (I.D.)
[3] Laboratory of Agricultural Zoology and Entomology, Department of Crop Science, School of Plant Sciences, Agricultural University of Athens, Iera Odos 75, 118 55 Athens, Greece; dperdikis@aua.gr
* Correspondence: aparas@aua.gr; Tel.: +30-210-529-4551

Citation: Paraskevopoulou, A.T.; Pappous, E.; Biniari, K.; Bertsouklis, K.F.; Daskalakis, I.; Perdikis, D. Enhancing the Rural Landscape Character: The Low Frequency of Inter-Row Wildflower Meadow Harvest Positively Affects Biodiversity While Maintaining Grape Quantitative and Qualitative Traits in a 'Sultanina' Vineyard in Greece. *Agronomy* **2022**, *12*, 550. https://doi.org/10.3390/agronomy12030550

Academic Editors: Anastasios Darras, Stefanos Hatzilazarou and Stefanos G Kostas

Received: 28 January 2022
Accepted: 21 February 2022
Published: 23 February 2022

Abstract: The development of inter-row wildflower meadows in vineyards could restore and preserve biodiversity as well as enhance the local rural landscape character. Herein, the prospect of inter-row development of a wildflower meadow from spontaneous vegetation growing within a table grape 'Sultanina' vineyard was studied for two years through the effect of different intensities of harvest on the meadow composition, arthropod presence, and grape vine produce. Three harvest treatments (constant, periodic, and none) were examined. The growth (height and area of groundcover) and number of plants per species that composed the inter-row wildflower meadow as well as the insects found within it and on the grape vine plants were recorded. At maturity, the main quantitative (yield/vine) and qualitative characteristics (soluble solids, pH, and total titratable acidity) of the grapes were evaluated. Results showed that both the quantitative and qualitative characteristics of the grape vines did not differ between treatments. The inter-row vineyard meadow composition that constituted of 21 herbaceous species did not differ between the periodic- and no-harvest treatments. Insect pests hosted within the meadow did not pose a threat to 'Sultanina' grapes, although thrips within the inter-row meadow showed a preference for *Convolvulus arvensis*. The overall results suggest the application of either a periodic- or no-harvest on the spontaneous vegetation of a Mediterranean 'Sultanina' vineyard over two years and constitutes the development of inter-row wildflower meadows from spontaneous vegetations as an appealing and promising sustainable vineyard floor management practice for permanent use that needs to be further researched.

Keywords: landscape character; harvest; local flora; biodiversity; grape vines; qualitative and quantitative characters

1. Introduction

Since 1962, the EU's Common Agricultural Policy focused on increasing production and supporting the mechanization and intensification of agriculture, overlooking the socio-environmental and topographic characteristics of the landscapes, which gradually resulted in the loss of biodiversity [1,2]. In contrast to traditional agricultural practices and organic farming that supports biodiversity, the application of intensive agriculture has led to the homogenization of the landscape and the loss of diversity [3]. Furthermore, pollution from intensive agriculture constitutes one of the main threats to biodiversity [4]. In 1992, Agenda

21 recognized the need in promoting sustainable agriculture, while the Florence Declaration on Landscape [5] urged "intergovernmental agencies and secretariats responsible for United Nations programs and international conventions together with non-governmental organizations concerned to: strengthen the global awareness on the need to safeguard and improve landscapes as an integral element of sustainable development processes . . . ".

Biodiversity is a key factor in the maintenance of ecosystem functions such as corridors to connect isolated habitats and ecosystem services such as erosion prevention, recycling of nutrients, pollination, pest control, and conservation [1,6,7]. The conservation of biodiversity is dependent on the values humans associate with them such as ecological, economic, cultural, and aesthetic, among others [8]. The 2030 Agenda for Sustainable Development Goals includes "to implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, . . . " [9]. Among the 17 UN Sustainable Development Goals, the second Sustainable Development Goal states to "End hunger, achieve food security and improved nutrition and promote sustainable agriculture" [10]. The EU also supports sustainable agriculture, emphasizing that in addition to environmental issues, it fosters economic viability and social acceptability [11]. In 2021, the Council and the European Parliament adopted the new Common Agricultural Policy with nine specific objectives, one of which is to "contribute to the protection of biodiversity, enhance ecosystem services and preserve habitats and landscapes".

Viticulture in Greece dates back to shortly before 6000 BC and is amongst the oldest in the world [12] with 171,235 holdings and a surface area of 1,089,000,000 m^2 [13]. The intensification of agriculture during the 1960s and 70s resulted in the replacement of old cultivars with new cultivars produced from the Greek breeding institutes or imported from abroad [4], and consequently to the genetic erosion of many Greek plant genetic resources including grapevines and to the abandonment of traditional agricultural practices. Under the threat of climate change and the fact that high-quality wines are generally associated with optimum climatic conditions, the preservation of traditional vine cultivars well-adapted to environmental stresses is crucial for future generations [14]. Features of cultural, historical, and aesthetic value are associated with vineyards [15]. The presence of vineyards is aesthetically pleasing and often represents a feature of the rural landscape, and a source of inspiration for travelers, painters, and writers [16–19]. On the other hand, within Greece, natural growing wildflower meadows are particularly attractive due to the country's high diversity of plant species [20]. The flora of Greece is amongst the most biodiverse in Europe and the Mediterranean and of high endemism, with 5752 species and 1893 subspecies of vascular plants of which 1278 are endemic species that constitute 22.2% of all species present and 452 endemic subspecies [4].

In the 1990s, the high nature values farming concept was developed [21] to describe areas where " . . . agriculture is a major (usually the dominant) land use and where that agriculture supports, or is associated with, either a high species and habitat diversity or the presence of species of European conservation concern, or both." [22]. Overall, semi-natural vegetation in agricultural land can be categorized into large surface areas such as semi-natural grasslands, and agro-forestry areas and smaller surface areas of unfarmed features such as field margins, buffer strips, and hedgerows [1]. Wildflower meadows found growing naturally in rural landscape are a by-product of traditional agricultural practices [23]. Spontaneous herbaceous meadow communities develop from abiotic stress such as grazing, fire, drought, etc., impacting on vegetation that inhibits the growth and succession of shrub and trees species. Wildflower meadows are composed of several often flower-rich, herbaceous plant species [23,24]. The aesthetic appreciation of species-rich vegetation may attract tourism and support the region's economy [8]. Europe's Landscape Convention [25] states that "landscape contributes to the formation of local cultures and that it is a basic component of the European natural and cultural heritage" and that "landscape is an important part of the quality of life for people". Therefore, human appreciation of wildflower meadows in rural landscape is threatened by their decline, led by the rapid changes in agricultural practices and the consequently generic loss of biodiversity in rural areas [24]. Wildflower meadows, particularly those composed of several flowering herbaceous species, are aesthetically pleasing and constitute a sustainable form of planting [23,26–28]; they preserve biodiversity, provide habitats for wildlife, require reduced maintenance resources compared to other forms of cultivations, and can contribute to enhancing the local natural landscape character. In the Mediterranean area, there are limited studies on wildflower meadows [29].

In viticulture, the quantity and quality of grapevine yield is largely influenced by vineyard floor management. Water, soil nutrient and weed management, enhanced biodiversity for pest management, and habitat creation for beneficial insects constitute key objectives of vineyard floor management [30]. Common vineyard practices for vineyard floor management are cultivation, herbicide application, and the use of cover crops and mulches [30,31]. Traditionally, weed growth is controlled through inter-row cultivation, or tillage. In dry climates, grapevine roots are unaffected by shallow cultivation as they usually avoid growing in the top 100 mm of the soil [32]. Cultivation disrupts soil structure and organisms as well as increases the costs of cultivation. Furthermore, bare soils with no protective plant cover, particularly in steep-sloped vineyards combined with the Mediterranean high rainfall intensity, increase runoff and erosion risks [33–35]. A promising method of vineyard floor management but is the least understood is the manipulation of weed populations within vineyards [36]. Within vineyards, wildflower meadows that do not require significant management could potentially be developed between rows through appropriate manipulation of inter-row weed population (wildflower meadow strips). The development of such meadows in vineyards could support high nature value farming systems, restore and preserve biodiversity as well as enhance the local rural landscape character, consequently economically benefiting local farmers [35]. It could also potentially support the commercial development of seed mixes for wildflower meadows suitable for vineyards or other applications in the landscape architecture industry for their aesthetic appeal. Sown wildflower meadows are increasingly recommended as an agri-environmental intervention measure despite the lack of evidence for the successful establishment of seed mixes, maintenance of flower species over time, and the beneficial effect to arthropods [6,37]. The composition of natural or semi-natural ecosystems such as spontaneous wildflower meadows depend on land management practice and spontaneous biological and environmental processes [38].

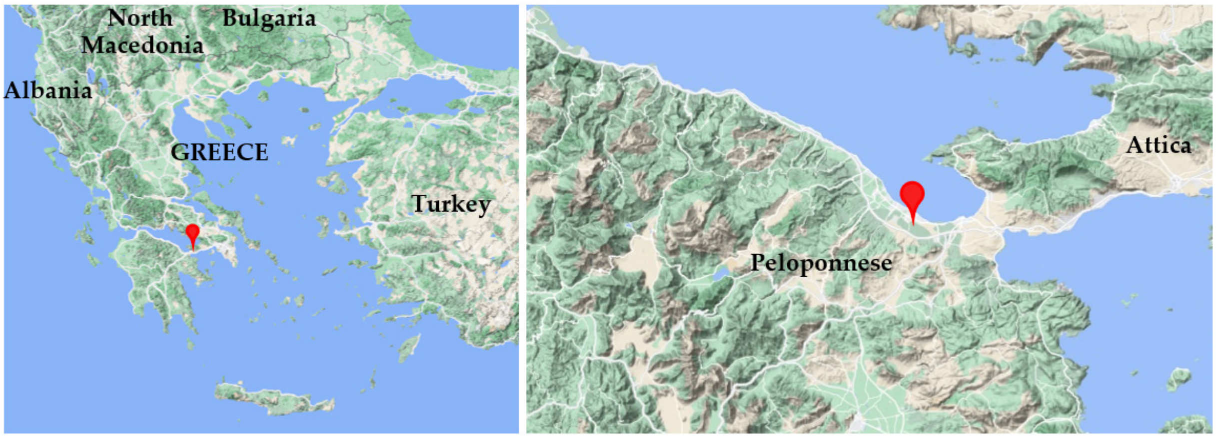
The presence of spontaneous vegetation within a vineyard influences pest densities depending on site-specific environmental conditions and the grape cultivar [39]. Despite the benefits to the farmers by conserving the vegetation cover in their crops [40], farmers are concerned with the development of potential “disservices” by the natural vegetation such as the potential increase of insect pest infestations or the impact on the yield of their crops (i.e., through competition for water or nutrients). For these reasons, farmers are generally reluctant to maintain the wildflower floor in their crops. This becomes more evident in the case of intensive farming systems such as the table grape crops. However, although in wine producing vineyards the role of natural vegetation has been explored with positive results [41,42], our knowledge on the potential compatibility of vegetation conservation with the cultivation of table grapes is still in its infancy. In fact, a search in Scopus (15 January 2022) returned only 18 articles with searching terms: “table grapes” and “biodiversity”. Therefore, research to clarify whether the conservation of natural vegetation poses a threat to pest management and the crop yield of table grapes is urgently needed.

The objective of this study was to evaluate the prospect of inter-row development of a wildflower meadow from the spontaneous vegetation (i.e., local flora addressed by lay public as “weeds”) growing within a vineyard cultivated with the variety ‘Sultanina’ without negatively affecting grape yield and grape quality. The effect of different intensities of harvest (i.e., frequency of cuts of the above-ground biomass of the inter-row vineyard meadow) on the meadow composition, arthropod presence, and quantity and quality of the grapes is presented. Considering the above, the three hypotheses are that harvest intensity will have an effect on: (i) the growth of individual species that compose the wildflower meadow, (ii) the arthropod abundance found on the above-ground biomass of wildflower meadow plant species and the adjacent grapevine canopy (leaves, shoots, inflorescences, and grapes), and (iii) the quantitative characteristics of the grapes and the qualitative characteristics of the grapes during three stages of grape development (pea-sized berry, veraison, and technological maturity).

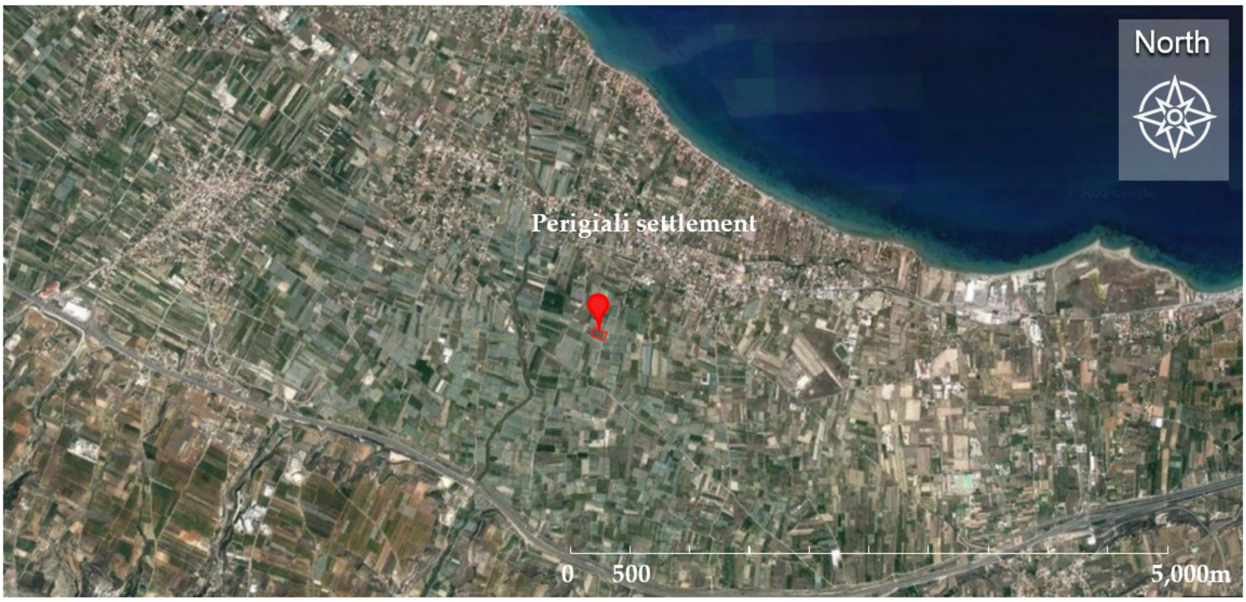
2. Materials and Methods

2.1. Experimental Site and Growth Conditions

Within a popular viticulture region of Greece located south of the settlement of Perigiali, Korinthia with a population of 1616 [43], a vineyard was used to study the effect of different intensities of harvest on the meadow composition, arthropod presence, and the main quantitative and qualitative characteristics of the grapes (Figure 1). The vineyard studied hosts 850 plants of the table grape cultivar 'Sultanina' grown on the rootstock B41 that are established over a 5000 m^2 surface area. The area surrounding the studied vineyard within a 5 km radius is composed of relatively small sized properties ranging between 4000–7000 m^2 surface area, mainly established with table grape vineyards and occasional olive, peach, and apricot orchards. The vine grape cultivar 'Sultanina' is a popular table grape that has been cultivated in Greece since its introduction in the 12th century [14].



Google, Mapa Data ©2022 Google, Mapa GISrael Greece (source of map **left**), Google, Mapa Data ©2022 Greece (source of map **right**)



Google, Imagery ©2022 CNES/Airbus. Landsat/Copernicus, Maxar Technologies, Map data ©2022 Greece (source of aerial photograph)

Figure 1. Site location of the studied 'Sultanina' vineyard at Perigiali, Korinthia, Greece, indicated with the red colored pin.

The study was undertaken over two years during the productive growth period of the vine plants between 5 March–20 August 2016 as well as 5 March–20 August 2017. Analysis of the meteorological data (Table 1) obtained during the aforementioned experimental time period overall indicated that during March–May in both years, more than usual warm and dry conditions prevailed in Perigiali [44–47]. More specific, the paired sample t-test showed that both the mean maximum monthly temperatures during March–May 2016 and 2017 were significantly greater than normal (climatic data 1988–2010) at $p < 0.05$ (t = 7.784, df = 2, p-value= 0.016; t = 50.408, df = 2, p-value= 0.000, respectively). During the summer months of June–August in both years, both the mean monthly temperature in 2016 and mean monthly maximum temperature in 2017 were significantly greater than normal at $p < 0.05$ (t = −5.000, df = 2, p-value= 0.038; t = 4.466, df = 2, p-value= 0.047, respectively); reaching as high as 40.5 °C in July 2017 (Table 1). Concerning precipitation during March–May, rainfall seemed generally less than normal in both years while during June–August, rainfall seemed less than normal in 2016 and greater than normal in 2017, reaching 85.8 mm in July 2017 [44–47]; however, these differences were not significant at $p < 0.05$ (t = −1.554, df = 2, p-value= 0.260; t = −3.120, df = 2, p-value= 0.089 and t = −3.712, df = 2, p-value= 0.066; t = 1.074, df = 2, p-value= 0.395, respectively).

Table 1. Prevailing meteorological conditions in Perigiali, Korinthia, Greece throughout the experimental time period (March–August 2016 and March–August 2017). Meteorological and climatic data obtained from the nearest meteorological station (lat. 38°00′, long. 22°42′ alt 15 m; lat. 37°58′, long. 22°45′, alt 19 m, respectively).

Month	[1] T_{mean} (°C)	[1] T_{max} (°C)	[1] T_{min} (°C)	[2] RH_{mean} (%)	[2] RH_{max} (%)	[2] RH_{min} (%)	[3] P (mm)	[4] AWS (km/h)	[5] DWD
Year 2016 [44]									
March	12.8	21.9	5.8		86.9	57.5	56.6	8.4	NW
April	17.8	28.8	9.1		77.1	44.7	0.2	8.1	NW
May	19.5	33.3	9.8		77.0	43.9	5.6	9.4	NW
June	25.5	38.3	15.4		73.5	38.5	0.4	7.8	NNE
July	28.1	36.8	19.8		66.3	36.2	0.0	7.1	E
August	27.8	37.2	18.9		66.4	37.6	0.4	7.0	NNE
Year 2017 [45]									
March	13.6	24.5	5.8		80.0	49.2	40.4	7.4	SW
April	16.3	27.9	8.1		76.4	40.3	4.8	7.6	NNE
May	20.4	33.2	13.0		76.8	41.0	15.8	8.4	NW
June	24.8	42.6	16.3		78.7	41.5	15.4	6.4	NNE
July	28.1	40.5	17.8		68.0	34.9	85.8	7.4	NNE
August	28.2	38.6	18.7		63.3	33.6	7.4	6.9	E
Climatic data 1988–2010 [46,47]									
March	11.8	16.5	6.5	70.9			53.7	6.8	E
April	15.7	20.3	9.0	65.9			26.7	7.1	E
May	21.1	25.7	12.9	59.7			22.3	6.8	E
June	26.1	30.7	16.8	54.0			6.4	6.9	E
July	28.7	33.2	19.5	53.3			5.0	6.9	E
August	28.1	32.9	19.8	56.7			11.9	6.2	E

[1] T_{mean}, T_{max}, and T_{min}: monthly mean, monthly mean maximum, and monthly mean minimum air temperature, respectively; [2] RH_{mean}, RH_{max}, RH_{min}: monthly mean, monthly mean maximum, and mean minimum relative humidity, respectively; [3] P: monthly precipitation; [4] AWS: monthly average wind speed; [5] DWD: monthly dominant direction of wind.

2.2. Experimental Design and Treatments

Prior to the start of the experiment, the vineyard was tilled. Within the vineyard, a total of 12 plots sized 2 m × 18 m were marked with pegs that constituted the surface area between rows on either side of 10 grapevine plants (Figure 2). Within each of the 12 plots, two subplots sized 1 m × 1 m were also marked with pegs from which measurements for the meadow composition were taken. Each of the 12 plots was allocated to a single treatment. Four plots (replicates) of each treatment were determined. Three harvest intensities (H1, H2, H3) applied to the natural growing meadow ("weed populations") in the inter-rows of the table variety 'Sultanina' vineyard constituted the treatments. Treatments were allocated in the 12 experimental plots completely at random.

Εικόνες ©2016 Google, Δεδομένα χάρτη ©2016 Google
(translation: Images ©2016 Google, Map data ©2016 Google)

Figure 2. The table variety 'Sultanina' vineyard at Perigiali, Korinthia, Greece showing the experimental layout constituting 12 plots (marked with different colors; each color indicating a different treatment). The treatments constituted three different harvest intensities (H1, H2, H3) applied to the natural growing meadow ("weeds") in the inter-rows of the vineyard. Each harvest intensity (treatment) was applied in four plots (source of aerial photograph: Εικόνες ©2016 Google, Δεδομένα χάρτη ©2016 Google; translation: Images ©2016 Google, Map data ©2016 Google).

More specifically, three different intensities of harvest applied to the spontaneous vegetation (i.e., the natural meadow growing between the rows of the vineyard) were studied: none, periodic, and constant (control). In the no-harvest treatment, the local flora grew naturally without receiving any harvest treatment. The periodic-treatment received a limited number of harvests per year (i.e., three cuts made using a strimmer) that involved cutting the above-ground biomass of the plant species comprising the naturally growing local flora meadow at a 10 cm height. The harvest-time was undertaken on 5 March, 5 June, and 17 July, as determined by the life-cycle of the meadow plant species that coincided with the end of seed dispersal of the main plant species composing the meadow. Each year, the first harvest time (5 March) marked the start of the experiment. The "control" treatment constituted the normal standard or most usual practice undertaken by the farmers in the region and involved the constant (weekly) harvest of the above-ground biomass of the spontaneous vegetation (common referred to as "weeds") in the inter-rows of the vineyards. Spontaneous vegetation growing directly beneath the vines in the intra-rows were cut regularly using a strimmer throughout the vineyard. During the productive growth period of the vines, all grape vine plants, irrespective of the treatment, received the same cultivation practices (i.e., pruning, July flood irrigation once) and were sprayed twice with the insecticide deltamethin 2.5 (Phantom 2.5 EC: ELLAGRET S.A., Greece) on 8 May and 26 June 2016 and 2017. Each year, the end of the experiment was marked when grapes reached technological maturity [48] (20 August).

2.3. Measurements

2.3.1. Meadow Composition

Within each experimental subplot, the composition of the local flora meadow was measured at fortnight intervals in both 2016 and 2017 from 20 March to 20 August. To facilitate the process of taking measurements, a wooden frame dimensioned 1 m × 1 m and divided with taunt strings nailed on the frame into 100 squares (dimensioned 10 cm × 10 cm) was positioned above each marked subplot. The measurements taken within the area of the wooden frame were the number of plants per species, the height of three randomly selected plants per species, and the surface area of the groundcover of the plants per species expressed as percentage (%) of the corresponding subplot.

2.3.2. Arthropod Abundance

Furthermore, within each plot, the arthropods found on the above-ground biomass of the natural growing herbaceous plant species as well as adjacent to the corresponding plots' grapevine canopy (leaves, shoots, inflorescences and grapes) were separately sampled and their number recorded at weekly intervals from 5 March to 26 June 2016. Three plants of each "weed" species (composing the natural growing meadow) per subplot and 10 of each of the stems, inflorescences, and/or grape clusters of grapevines per plot were examined per sampling date. Thrips were recorded by shaking the foliage, inflorescences, or grape clusters onto an A4 sized white paper sheet.

2.3.3. Quantitative and Qualitative Characteristics of Grapes

The qualitative characteristics (total soluble solids, pH, and titratable acidity) of the grapes were calculated during three stages of grape berry development (pea-sized berry, veraison, technological maturity). Three grape clusters were randomly collected from each plot. The grape juice obtained from each cluster collected was used to determine, at room temperature, the total soluble solids with a digital refractometer, the pH, and the titratable acidity as indicated by a color change (clear to pink) using 0.1 N NaOH solution and 1% phenolphthalein (alcoholic solution).

Furthermore, in August, at grape technological maturity, the main quantitative characteristics (cluster length, width and weight) of the grapes were calculated. Grape length was measured from the tip of the top berry to the end of the bottom berry using a ruler. Grape width was also measured at the widest point of the cluster using a ruler. Finally, the grape cluster was weighed using a scale accurate to two decimal places.

2.4. Statistical Analysis

The experimental plot followed a complete randomized design with one factor that constituted the different intensities of harvest (none, periodic-, and constant-harvest) applied on the naturally growing meadow between the vine rows of the vineyard. A one-way analysis of variance (ANOVA) was applied to test the significance of the experimental data collected from 5 March until 20 August in 2016 and 2017 using SPSS Statistical Software

v. 17.0 (SPSS Inc., Chicago, IL, USA). Differences in means were defined using the Tukey HSD test at a significance level of $p < 0.05$.

3. Results

3.1. Meadow Composition

Over the two years of study, within the vineyard, the meadow composition between the rows included twenty-one naturally growing herbaceous plant species. More specifically, seventeen broadleaved species (*Anagalis arvensis*, *Chichorium intybus, Convolvulus arvensis*, *Ecballium elaterium*, *Equisetum arvensis*, *Euphorbia helioscopia*, *Foeniculum vulgare, Galinsoga parviflora*, *Galium aparine*, *Malva sylvestris*, *Oxalis pes-caprae*, *Parietaria judaica*, *Plantago lagopus*, *Polygonum aviculare, Sinapis alba*, *Sonchus arvensis*, *Thlaspi arvense*) and four grass species (*Agrostis stolonifera*, *Avena sterilis*, *Lolium* spp., *Sorghum halepense*) were identified (Figure 3). Furthermore, *Rubus* sp., a creeping shrub often found in rural areas of Greece, was also identified between the rows of the vineyard. All species with the exception of one broadleaved species in 2016 (*Polygonum aviculare*) and six broadleaved species (*Anagalis arvensis*, *Chichorium intybus, Equisetum arvensis, Euphorbia helioscopia, Galinsoga parviflora, Galium aparine*) in 2017 were present in the meadow during both years of the study.

Most of the plant species identified including *Rubus* sp. did not show significant differences in the number of plants, the percentage of groundcover of the plants, and the height of the plants between the "none" and "periodic" harvest treatments ($p < 0.05$). In most cases, the number of plants, the percentage of groundcover of the plants, and the height of the plants in both the no- and periodic-harvest treatments were significantly greater than in the control (constant-harvest treatment). More specifically, significant differences between the no- and periodic-harvest treatments were found for three grasses (*Avena sterilis*, *Lolium* spp., *Sorghum halepense*), and one broadleaf (*Convolvulus arvensis*) species (Figure 4). The number of *Avena sterilis* in 2016 and *Lolium* spp. in 2016 and 2017 plants decreased significantly after the March harvest in the periodic-harvest treatment compared to the no-harvest treatment ($p < 0.05$) (Figure 4). In addition, the number of all grass species significantly reduced or did not grow after the July cut in the periodic-harvest treatments whereas in the no-harvest treatments, with the exception of *Avena sterilis* in 2016, they continued to grow until the end of the summer. Additionally, the number of *Convolvulus arvensis* plants decreased after both the June and July harvest in the periodic-harvest treatment compared to the no-harvest treatment ($p < 0.05$).

The percentage of groundcover of the grasses *Avena sterilis* in 2017, *Lolium* spp., and *Sorghum halepense* in 2016 and 2017 and the broadleaved *Convolvulus arvensis* in 2016 and 2017 decreased significantly ($p < 0.05$) after the July harvest in the periodic-harvest treatment and was similar to the constant-harvest treatment (Figure 5). The percentage of groundcover of *Convolvulus arvensis* also decreased significantly ($p < 0.05$) after the June harvest in the periodic-harvest treatment and was similar to the constant-harvest treatment. These results agree with the results shown for the number of *Convolvulus arvensis* plants. In springtime (April–May) 2016, although the number of *Convolvulus arvensis* plants did not differ ($p < 0.05$) between the no- and periodic-treatments, the percentage of groundcover was less in the no-harvest treatment compared to the periodic-treatment ($p < 0.05$) and not significantly different ($p < 0.05$) from that of the control (constant-harvest treatment).

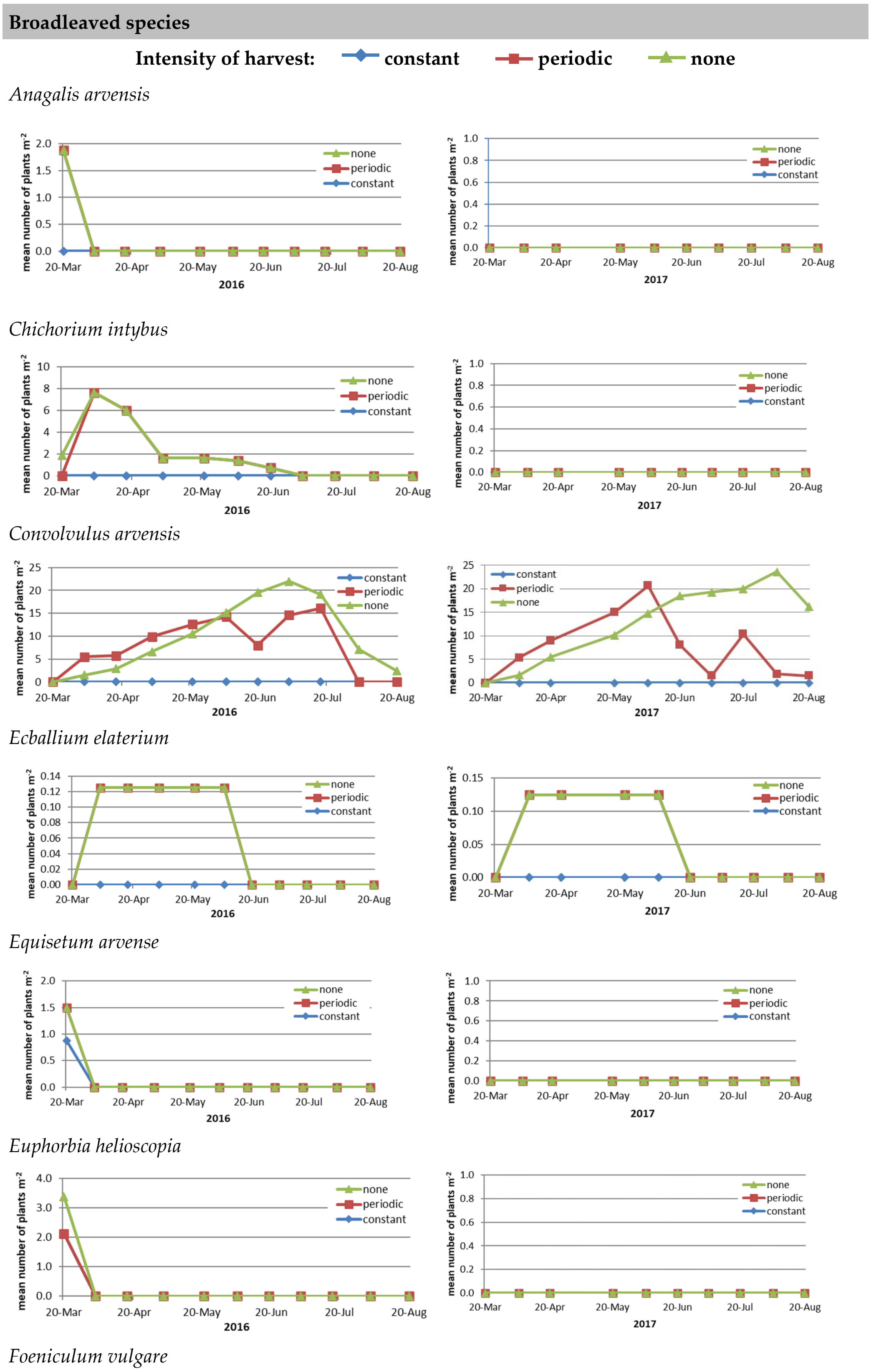
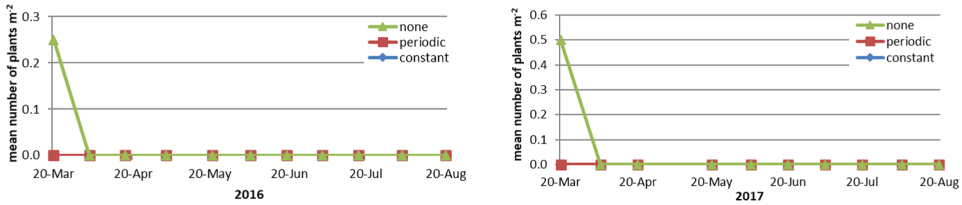
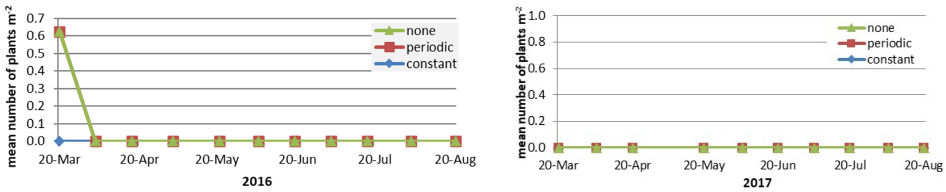


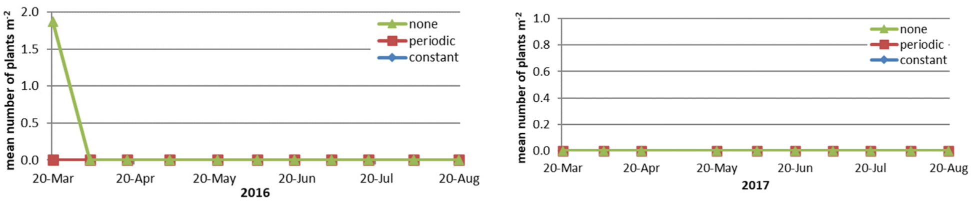
Figure 3. *Cont.*



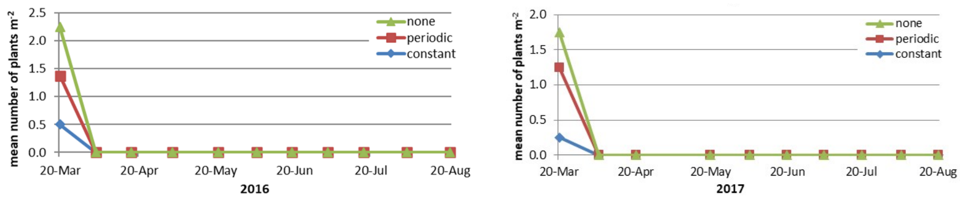
Galinsoga parviflora



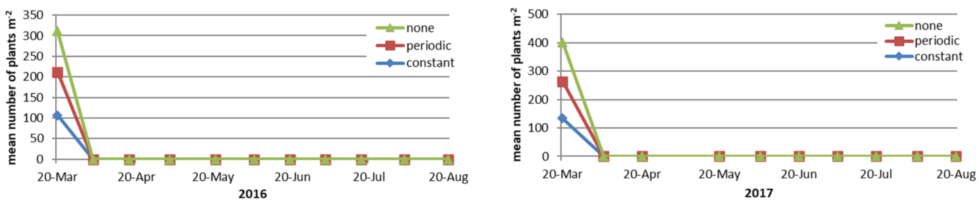
Galium aparine



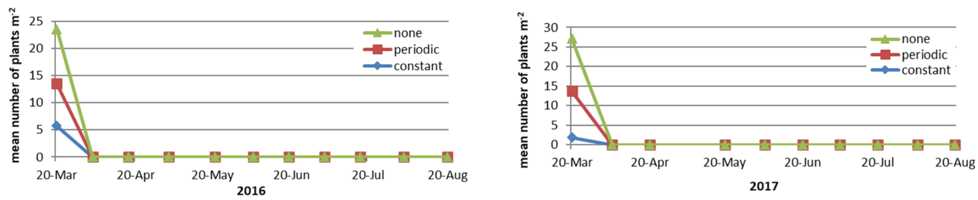
Malva sylvestris



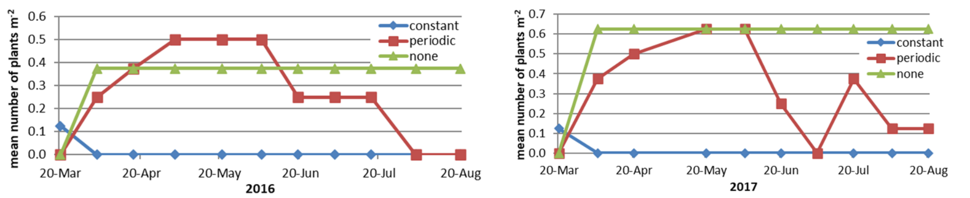
Oxalis caprae



Parietaria judaica



Plantago lagopus



Polygonum aviculare

Figure 3. *Cont.*

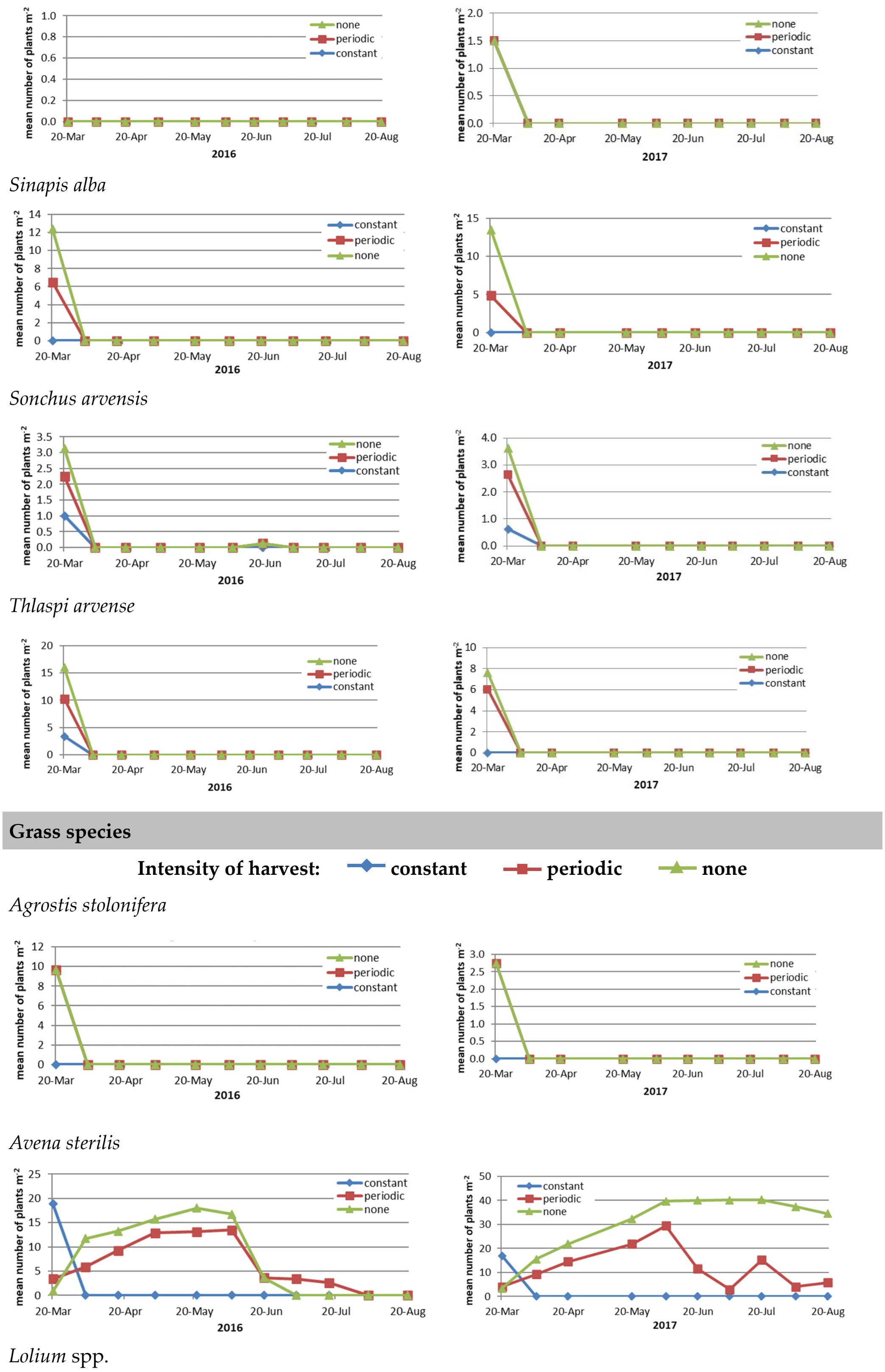
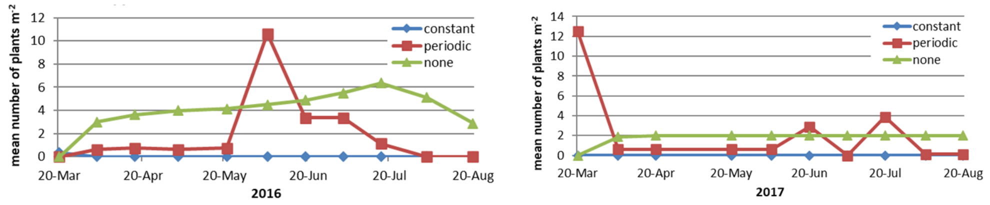
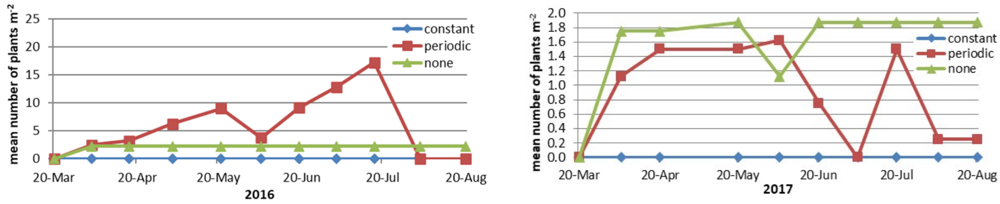


Figure 3. *Cont.*



Sorghum halepense



Shrub species

Intensity of harvest: **constant** **periodic** **none**

Rubus sp.

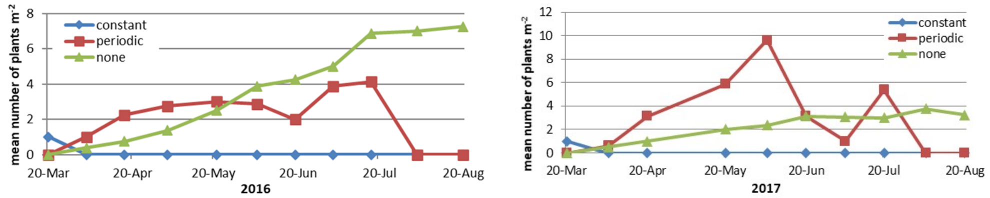


Figure 3. Plant species identified within the meadow naturally growing between the rows of the vineyard (expressed as mean number of plants per m^2) under different harvest treatments (constant, periodic, or none) during 20 March–20 August in 2016 and 2017.

The height of *Sorghum halepense* after the June harvest in both years was greater ($p < 0.05$) in the no-harvest compared to both the periodic-harvest and control (constant-harvest) treatments (Figure 6). In springtime (April–May) in both years, the height of *Avena sterilis* was significantly greater in the no-harvest treatment, followed in descending order by the periodic-harvest and control treatments (Figure 6). In the following month (June) of 2016, the height of *Avena sterilis* did not differ significantly between the no- and periodic-harvest treatments whereas from June onward, there were no differences shown between the treatments $p < 0.05$). On the other hand, in mid-June 2017 and thereafter, the height of *Avena sterilis* was significantly greater in the no-harvest treatment than the other two harvest treatments ($p < 0.05$). In springtime (April–May) as well as during July 2016, the height of *Lolium* spp. in both the no- and periodic-harvest treatments was greater compared to that in the control, and only in May was the height of *Lolium* spp. in the no-harvest treatment greater than in the periodic-harvest treatment ($p < 0.05$) (Figure 6). During March–June 2017, the height of *Lolium* spp. in the no-harvest treatment was greater than the control (constant-harvest treatment), while from June onward, the height of *Lolium* spp. in the no-harvest treatment was greater than both the periodic-harvest treatment and the control ($p < 0.05$). During the summer of 2016, the height of *Convolvulus arvensis* in the no-harvest treatment was greater than in the other treatments whereas in 2017 (except for the start of June), the height of *Convolvulus arvensis* in the no-harvest treatment did not differ from the height of both the periodic- and constant-harvest treatments ($p < 0.05$) (Figure 6).

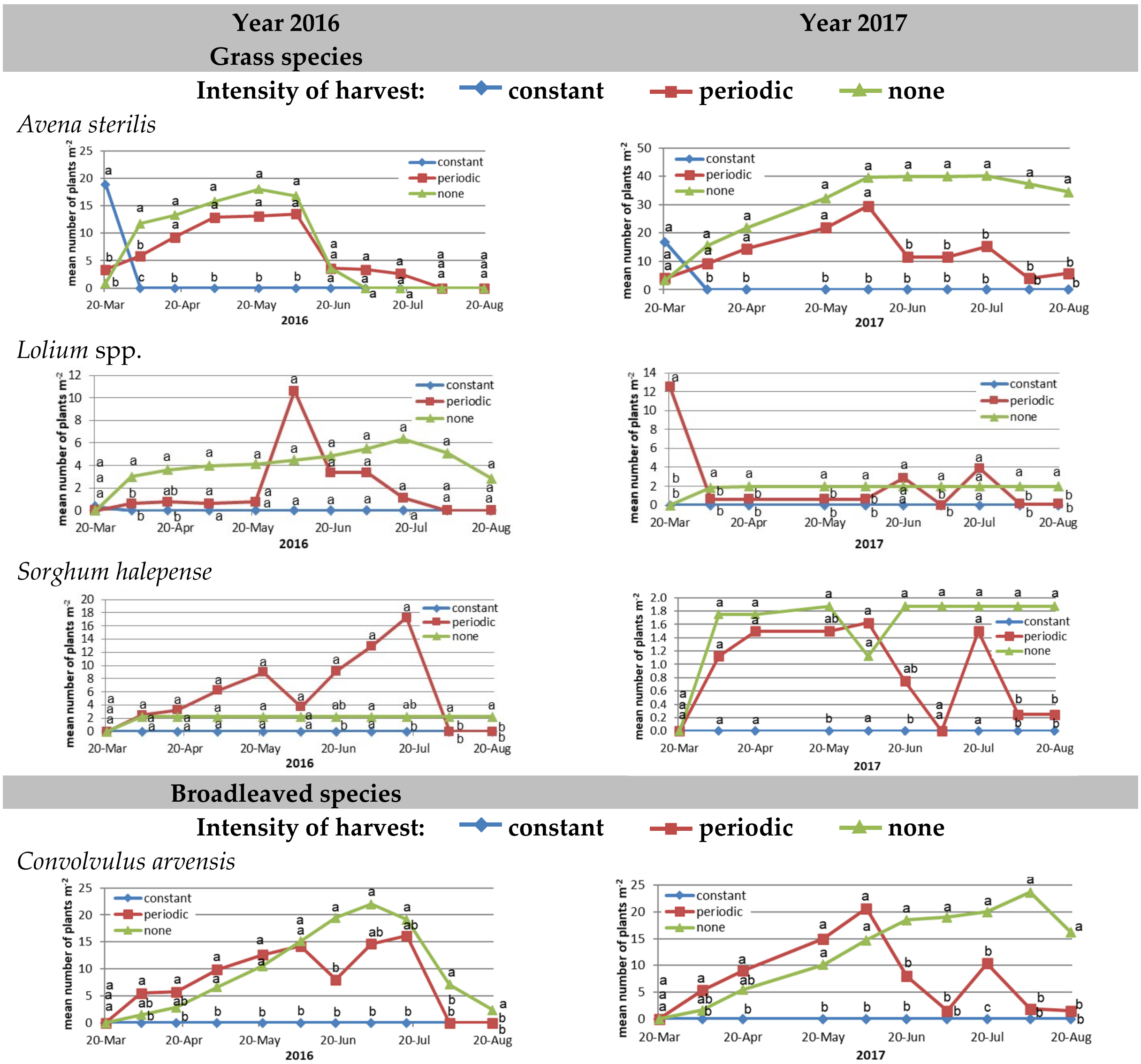


Figure 4. Mean number of plants per m^2 for individual species naturally growing between the rows within the vineyard under different harvest treatments (constant, periodic, or none) during 20 March–20 August in 2016 [49] and 2017. Means in columns not followed by the same letter are significant (Tukey HSD, at $p < 0.05$, $n = 8$).

3.2. Arthropod Abundance

Results showed the presence of negligible populations of insect pests on the vines in the plots of all treatments. However, noticeable sized populations of grapevine pests were present within the meadow growing between the vine rows under the no-harvest and the periodic-harvest treatment. The pests recorded were thrips (Thysanoptera: Thripidae) and leafhoppers (Hemiptera: Cicadellidae). Thrips were present within the meadow throughout the duration of the study mainly on *Convolvulus arvensis*. Overall, in the no-harvest treatment, thrips were present in all samplings. Their numbers were highest in the first two samplings when three individuals were recorded per plant species. In the periodic-harvest practiced plots, thrips were present for a shorter period, from 26 March to 28 May 2016. The number of thrips was significantly higher in the no-harvest than the periodic-harvest treatment ($F = 20.58$, $df = 1.96$, $p < 0.001$). Significant differences were recorded between the two treatments in the first two samplings when the largest population of thrips was recorded in the no-harvested meadow (Figure 7). While thrips were not found within the meadow after the harvest on June 4 in the periodic-harvest treatment, they continued to be present in the no-harvest treatment. Moreover, within the periodic-harvest treatment, the number of thrips decreased after the May pesticide application while in the no-harvest treatment, the number of thrips remained relatively steady.

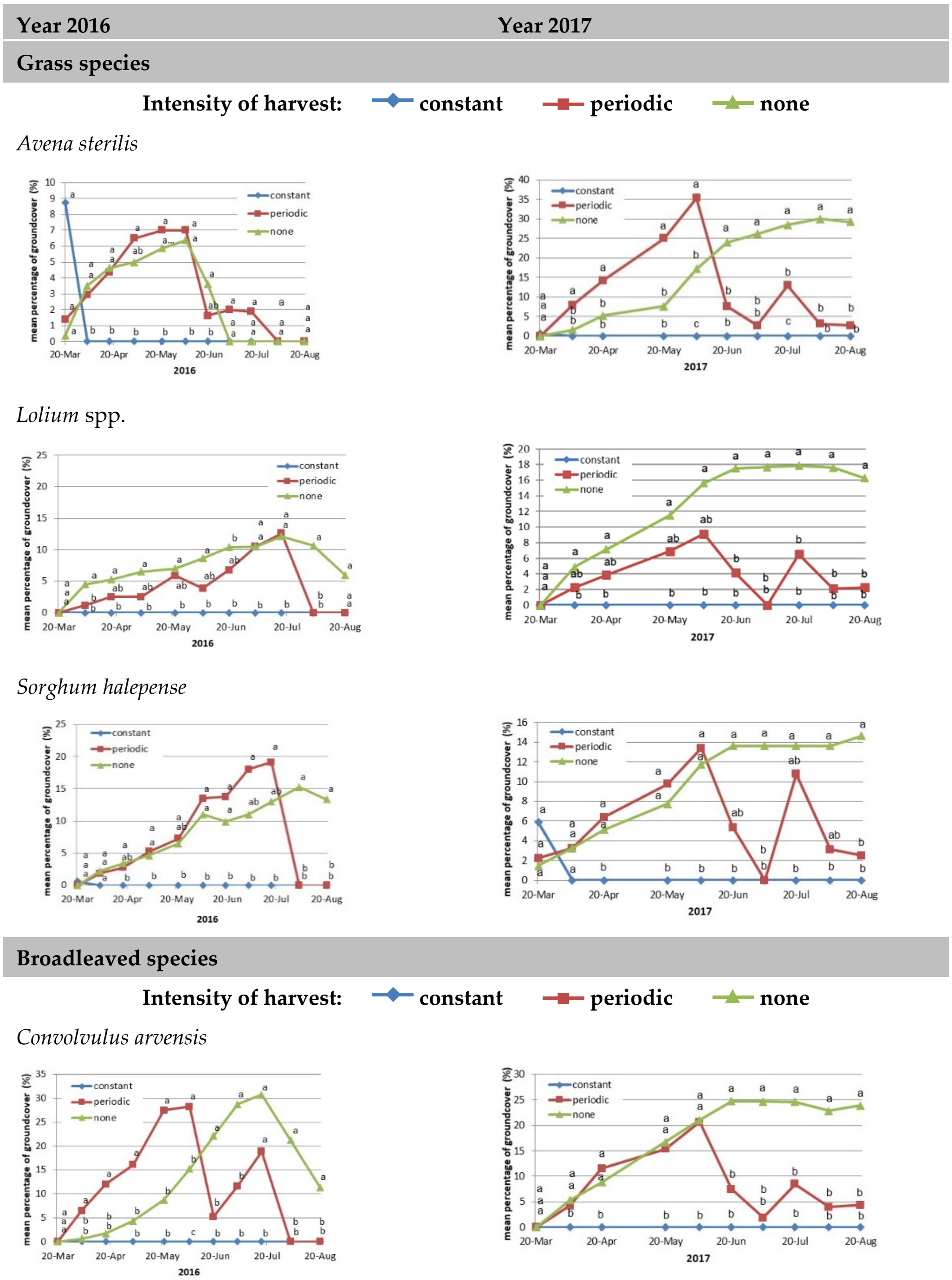


Figure 5. The mean percentage of groundcover for individual species naturally growing between the rows within the vineyard under different harvest treatments (constant, periodic, or none) during 20 March–20 August in 2016 and 2017. Means in columns not followed by the same letter are significant (Tukey HSD, at $p < 0.05$, $n = 8$).

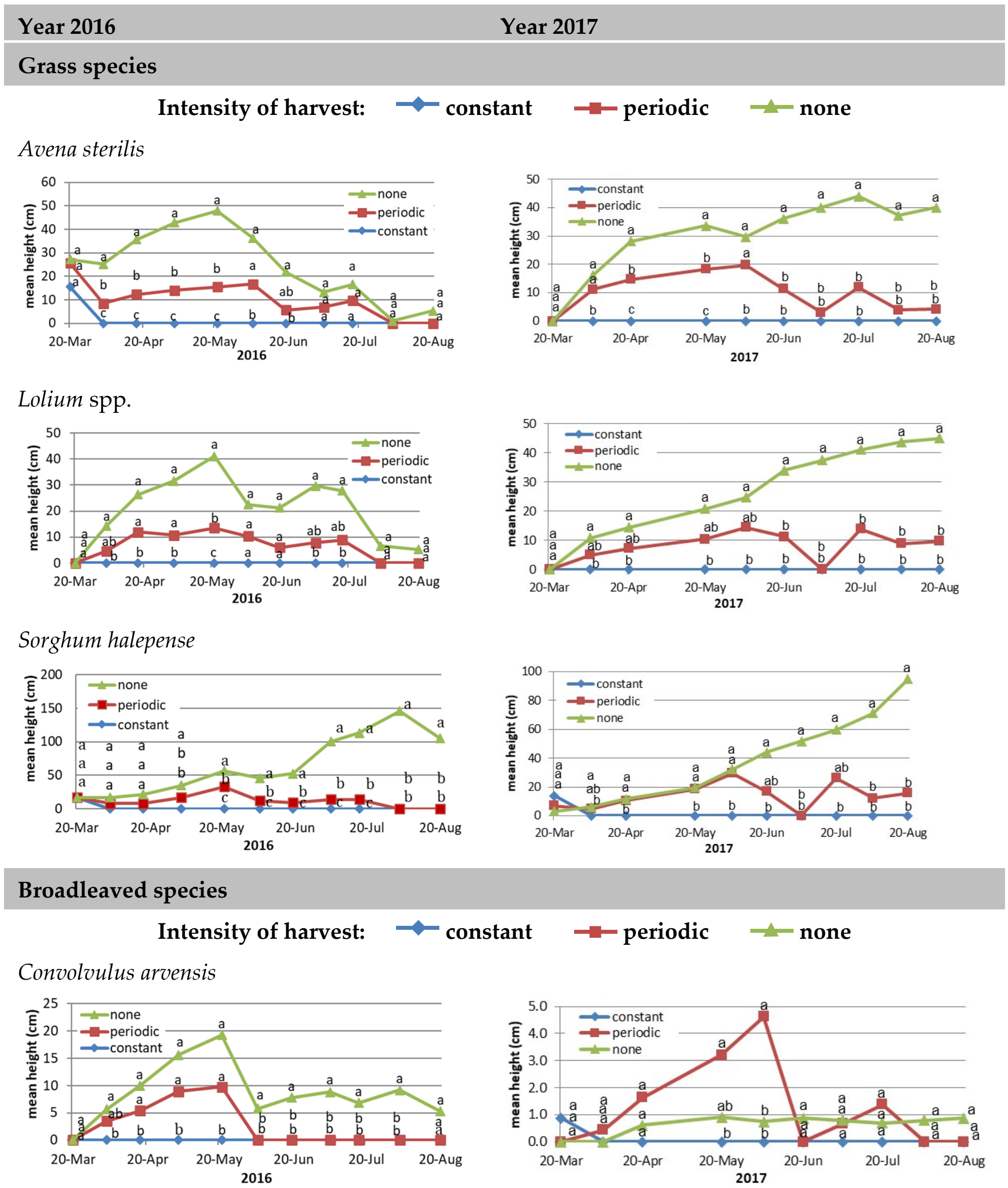


Figure 6. The mean plant height (cm) for individual species naturally growing between the rows within the vineyard under different harvest treatments (constant, periodic, or none) during 20 March–20 August in 2016 and 2017. Means in columns not followed by the same letter are significant (Tukey HSD, at $p = 0.05$, $n = 8$).

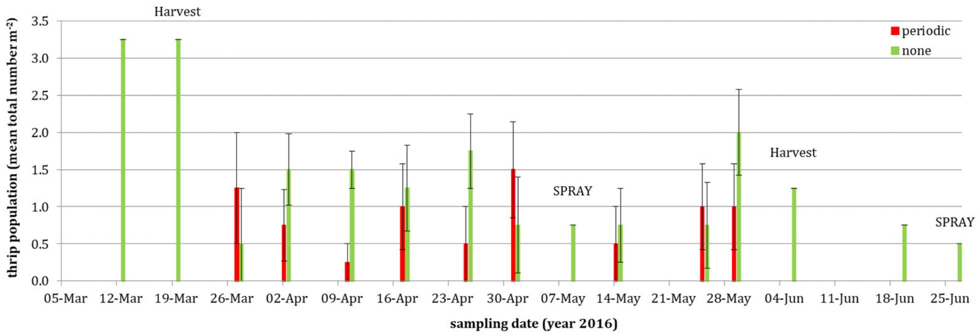


Figure 7. Population (expressed as mean total number per m^2) of thrips found in the plots of the meadow within the vineyard under the no- and periodic-harvest treatments from 12 March to 26 June in 2016.

Results also showed the presence of Cicadellidae (leafhoppers) within the meadow growing between the vine rows from mid-April to the end of June; mainly recorded on *Rubus* spp. Generally, the number of leafhoppers recorded was not significantly different between the two treatments (F = 1.08, df = 1.96, p-value = 0.30) (Figure 8). The most popular technique for managing leafhopper populations is the application of pesticides. The application of pesticide in May decreased the number of leafhoppers in both the periodic-and no-harvest treatments and after a second application in June, the leafhoppers did not appear again.

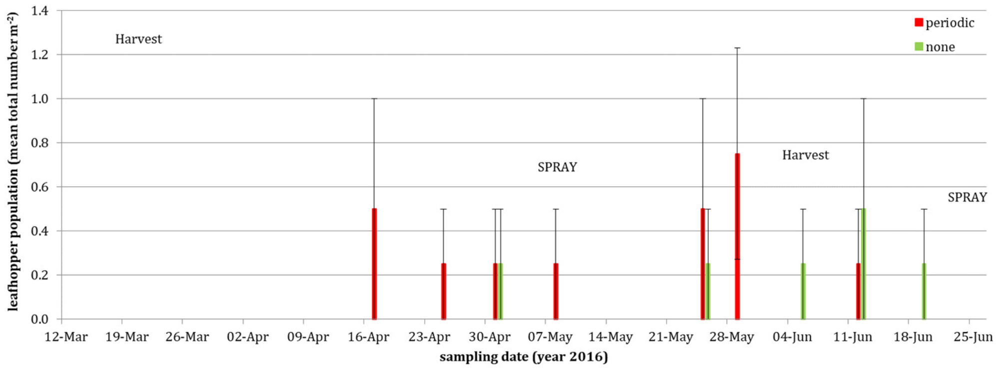


Figure 8. Population (expressed as mean total number per m^2) of leafhoppers found in the plots of the meadow within the vineyard, under the no- and periodic-harvest treatments from 12 March to 26 June in 2016.

3.3. Quantitative and Qualitative Characteristics of Grapes

In both years, the mean length, width, and weight of the grape clusters did not differ significantly ($p < 0.05$) among the different intensities of harvests (Figure 9). In the second year, the 'none' treatment (without cutting) had the highest weight of grapes, in absolute value, without a statistically significant difference from the other two treatments. Concerning the qualitative characteristics of the grapes, both the total soluble solids (TSS) and pH of the must showed a significant gradual increase at $p < 0.05$ over the three stages of grape berry development (pea-sized berry, veraison, technological maturity) (Figure 10). On the other hand, the total titratable acidity of the must showed a significant gradual decrease ($p < 0.05$) between the grape pea-sized berry and each of the other two grape berry development stages (veraison and technological maturity). At each stage of the grape development, the total soluble solids of must, pH, or total titratable acidity derived from vines that received the constant harvest treatment (control) did not differ significantly ($p < 0.05$) from the corresponding total soluble solids of must, pH, or total titratable acidity derived from vines that received either of the other two harvest treatments (periodic and none).

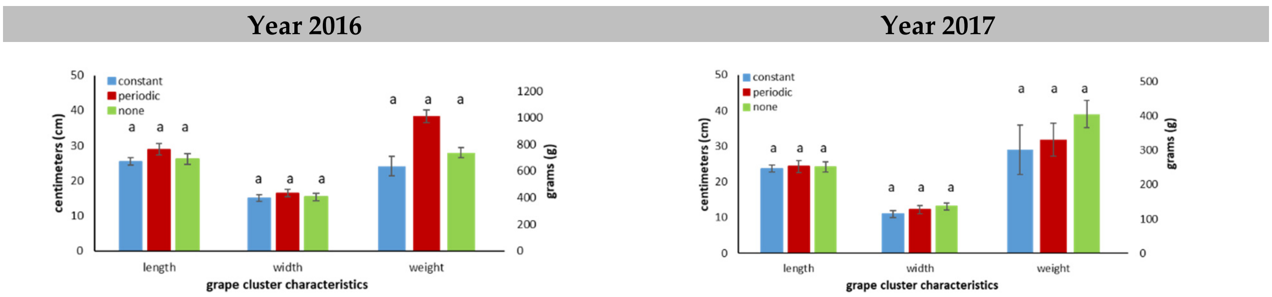


Figure 9. The effect of different wildflower meadow harvest treatments (constant, periodic, or none) on the quantitative characteristics of the grape clusters (mean length, width, and weight) in 2016 and 2017. Within each measurement, statistical differences are denoted by different letters (Tukey HSD, at $p < 0.05$, $n = 12$).

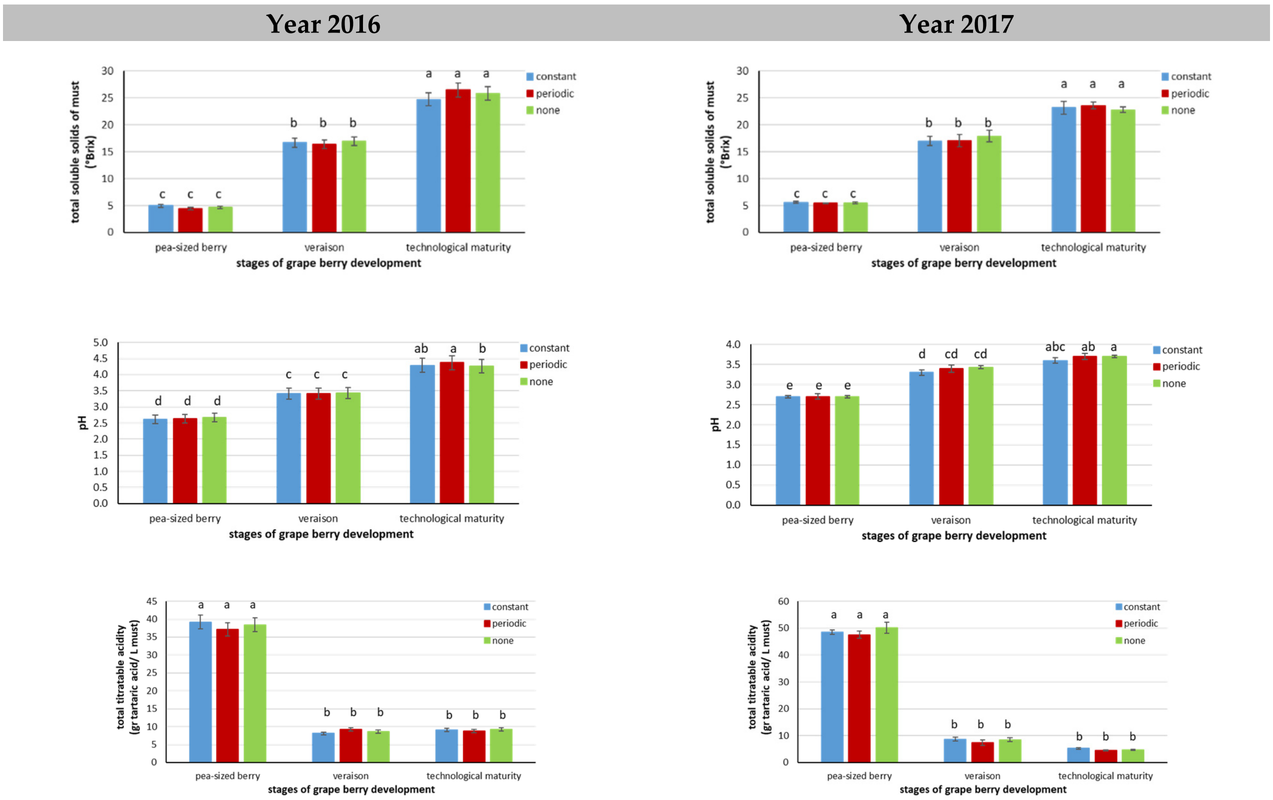


Figure 10. The effect of different wildflower meadow harvest treatments (constant, periodic, or none) on the qualitative characteristics of the grapes (total soluble solids of must, pH, and titratable acidity) during three stages of grape development (pea-sized berry, veraison, and technological maturity) in 2016 [49] and 2017. Within each measurement, statistical differences are denoted by different letters (Tukey HSD, at $p < 0.05$, $n = 12$).

4. Discussion

4.1. Meadow Composition

Interannual climate variability influences wildflower meadow composition [50,51]. In both years, most of the species that composed the wildflower meadow within the vineyard developed in spring until mid-April and were mainly broadleaved species. March–April temperatures in 2017 were higher than in 2016, which possibly facilitated earlier plant development of species including the annual species *Anagalis arvensis*, *Equisetum arvensis*, *Euphorbia helioscopia*, *Galinsoga parviflora*, *Galium aparine* not found in March 2017; it is also possible, as these species showed small populations in March 2016 (<2 plants per m^2) that they were unable to grow due to competition with other vigorous plant species that may have developed earlier as a result of the warmer than usual climatic temperatures of the area. Furthermore, the higher temperatures in March 2017 also seem to have contributed to the introduction of an additional annual species (i.e., *Polygonum aviculare* with <2 plants per m^2). Similarly, Stampfli [52], in a six-year study of a traditionally mown meadow, showed variation among the meadow species due to direct or indirect responses of interacting species, depending on the climatic conditions per year.

In both years, between mid-April and 20 August, fewer species developed compared to the corresponding springtime (from 20 March to mid-April) due to the "harsher" summer conditions for plant growth. Water availability affects plant diversity and has been found to increase in wetter years [53]; however, differences in precipitation were not significant. Therefore, without considering the effect of June–July precipitation, it is uncertain to establish what other parameters likely caused the population increase and longer presence within the meadow of *Avena sterilis* compared to 2016 where the population of *Avena sterilis* gradually decreased after mid-June 2016. Similarly, in 2017, following the June–July precipitation, the presence of the species *Convolvulus arvensis* was elongated compared to 2016. Overall, studies investigating community composition triggered by climate change are limited [50]. Further study is necessary to understand the changes in the meadow composition of the vineyard in relation to weather from year to year.

The studied vineyard is located within a popular table grape viticulture region of Greece where spontaneous vegetations is regularly cut as weeds inhibiting the beneficial effects of biodiversity. Species richness and biomass yield of natural vegetation in temperate climates can increase by applying intermediate cutting frequencies (once or twice annually) [54]. Additionally, low frequency cutting allows the existing plant community to increase in height, enhance pollination services, and aesthetics [55]. In North American tallgrass prairie, it has been found that species richness can be supported, and the abundance of dominant species was reduced by cutting [56]. The removal of above-ground biomass approximately 5 cm above-ground through cutting reduces interspecies differences, prevents the exclusion of small species by competition, and allows for species differing in shoot size to coexist [57]. The hypothesis that the intensity of harvest will have an effect on the growth of individual species that compose the wildflower meadow was proven for most grass species and rejected for nearly all herbaceous broadleaf species. The results of this study showed that in both years, the harvest treatments had an overall negative effect on the growth of nearly all grass species (*Avena sterilis, Lolium* spp., *Sorghum halepense*) whereas the growth of all but one herbaceous broadleaf species was not affected. Although March harvest had a positive effect on the growth (percentage of groundcover) of *Convolvulus arvensis*, both June and July harvests had a negative effect. The first possible cutting date needs to be considered carefully in cases where meadow conservation is the primary goal of management [58], as is the case of the current study to enhance the local natural landscape character. It seems that spring cutting may contribute to the increase of biodiversity in herbaceous broadleaf species such as *Convolvulus arvensis*. On the other hand, the higher growth rates that grasses generally have make them compete against herbaceous broadleaf species [24]. The July harvest seemed to suppress the growth of grass species in both years of the current study. It has been found that delaying harvest time from spring to summer in European meadowlands can have a positive effect on plant species richness [58]. Furthermore, the dry conditions and high summer temperatures in 2016 led to the discoloration of grape clusters in the constant-harvest treatment caused by sunburn, reducing the commercial value of the grapes, whereas grape clusters in both the periodic- and no-harvest treatments were unaffected as the foliage from the adjacent meadow offered grape cluster protection from direct sunlight (data not shown).

Mixes of herbaceous plant species, particularly flowering plant species, are used in vineyards to increase biodiversity [34]. The understanding of the dynamic of these mixes is limited [34]. There is a need for further understanding of the dynamic of herbaceous plant mixes with regard to their composition, evolution over time, and growth [34]. The use of local herbaceous species is desirable due to their adaption to the local climate and soil conditions [59]. Additionally, the use of the wildflower meadow contributes to reducing soil loss [34]. The cost to seed herbaceous plant mixes is less preferred to developing a wildflower meadow from the spontaneous vegetation of the vineyard [34]. However, herbaceous seed mixes can be used in cases of extremely degraded soils with poor fertility and seed bank [34]. Further research of managing the vineyard is necessary to study the dynamic of the wildflower meadow (i.e., the effect of different harvest times on the growth of the herbaceous broadleaf species and meadow biodiversity (composition) as well as their potential protection on table grape clusters from direct sunlight).

4.2. Arthropod Abundance

Thrips and leafhoppers constitute important pests for vines whose distribution and abundance in vineyards are affected by the presence of wild flowering plants. A study of an organic vineyard in northern California, USA showed a beneficial effect since both leafhopper and thrip numbers on the vines gradually increased as the distance of the vine rows from the meadow increased due to the high abundance of predators on the meadow [60]. The same study showed an even distribution of both leafhopper and thrip populations in the part of the vineyard without a meadow strip.

Wildflower left areas are a flexible tool to enhance biodiversity as they are easy to establish or remove [6]. In this regard, apart from solely taking benefit of the naturally grown meadow in the vineyards, a step forward in our approaches would be to develop appropriate management strategies of the meadow to increase benefits for the crop. In fact, arthropod abundance and diversity are directly influenced by the plant composition of the meadow [61]. In sequence, its plant species composition and richness are determined by the most appropriate harvest time [58]. Generally, biodiversity can be supported by determining the first-harvest date and a low annual cutting frequency [58]. The hypothesized effect of harvest intensity on arthropod abundance found on the above-ground biomass of the wildflower meadow plant species varied for different pests; it was proven for thrips and rejected for leafhoppers. Our study showed that the application of a single harvest time is unlikely to be suitable for all invertebrate species, whereas the application of different harvest regimes such as the case of the periodic-harvest in the current study can increase invertebrate diversity. Similarly, as already above-mentioned for meadow biodiversity, the first possible cutting date needs to be considered carefully. Therefore, harvest time regimes of the meadow may become a key-tool in managing arthropod biodiversity in vineyards and should be further assessed.

In the current study, among the several plants recorded in the inter-row meadow, only *Convolvulus arvensis* was recorded to host an important population of thrips that suggests a preference for this particular species. An earlier study reported that on this plant, thrips overwinter and establish their populations in early spring in the borders of onion fields [62]. Its role on the population levels of thrips in vineyards has not been studied, however, our results emphasize that this plant may play a key role in the early establishment and increase in thrip populations early in the season. Therefore, future studies should investigate its role in more detail.

The hypothesized effect of harvest intensity on arthropod abundance found on the adjacent to the harvested meadow grapevine canopy was rejected since the presence of insect pests on the vines was negligible in both the none and periodic-harvest treatments. The conservation of the local flora that grew naturally in the studied vineyard does not seem to pose a threat as a potential source of insect pests for 'Sultanina' grapes. Farmers can benefit from the services provisioned by the conservation of vegetation on their farms without facing increased pest infestations. These results suggest that the conservation of many herbaceous flowering species can perhaps be a compatible farm practice under integrated pest management (IPM) strategies. Furthermore, this can be a practice included in vine production based on ecologically-based pest management (EBPM) schemes [63]. This delivers important information for farmers of this crop, which is intensive, and traditionally, wildflowers are considered as weeds and thus, they are destroyed. Future studies should elaborate on this, further exploring the associations between plant species and insect pests in table grape crops in more areas and under more farming practices.

4.3. Quantitative and Qualitative Characteristics of Grapes

The hypothesis that the intensity of harvest will have an effect on both the quantitative characteristics of the grapes and the qualitative characteristics of the grapes at each of the three stages of grape development (pea-sized berry, veraison, and technological maturity) was rejected. Vineyard floor management studies in Mediterranean areas studying the effect of inter-row spontaneous vegetation on grape yield and quality is sparce and usually constitutes the typical management practice (i.e., the control) to study the effects of various cover crops in vineyards [64,65]. The use of inter-row spontaneous vegetation tilled in fall (October) and before bud break in spring (April) represents typical management in drip-irrigated vineyards in Australia [65]. Additionally, the use of spontaneous vegetation mowed and then tilled in California, USA represents typical management in drip-irrigated vineyards [64]. In the current study, bare soil constituted the typical management practice (i.e., the control) to study the effects of the periodic- and non-harvest treatments in the vineyard to enhance the local landscape character through the development of a wildflower meadow from the spontaneous vegetation; irrespective of treatments, the vineyard was irrigated only once at the start of July after the berry set. It seems somehow, that the non-harvest treatment in the current study was similar to the typical management practices applied in Australia and the USA.

The predormancy period is critical for grape yield [66]. Prior to dormancy and during the growth season, carbohydrate reserves are formed by the uptake and accumulated nutrients by the vine that are used, in spring, by the grapevine to develop its new canopy [67]. Moreover, inflorescence primordia initiation and differentiation within latent buds occur in the pre-dormancy period and during the anthesis or flowering period [68,69]. In both years (2016 and 2017), the meadow treatments (i.e., the periodic- and no-harvest) showed no effect on both the quantitative and qualitative characteristics of grapes ($p < 0.05$). Additionally, the no-harvest treatment was the least expensive harvest treatment followed by the periodic-harvest treatment due to the reduced cutting costs in comparison to the constant harvest treatment.

A three-year study of a drip irrigated wine grape cultivar 'Carignano' vineyard in northwestern Sardinia, Italy [39] showed that natural covering spontaneous vegetation dominated by annual grasses (*Bromus hordeaceus* L., *Avena sterilis* L., and *Vulpia myuros* L.) reduced grape cluster weight in the third year compared to the traditional management practice (soil tillage); total soluble solids of must were not significantly affected during the different stages of grape development as well as titratable acidity during technological maturity (although technological maturity was influenced in the first sampling dates, i.e., was greater in the first year after 60 days anthesis, less in the second year 60–74 days after anthesis as well as in the third year 60 days after anthesis).

Generally, the effects induced by cover crops on the soil properties of a vineyard are limited to the area where the cover crop is established and concentrated in the top 0–20 cm of the soil [34]. Therefore, their effect on the nutrient and carbon content in the vineyard, although significant, is limited and associated with the growth area of the cover crop (i.e., the inter-row area) [34]. Recommendations on the most suitable vineyard floor management system cannot be generalized as vineyard yield and quality are site-specific and dependent on the combination of various factors such as cultivar, location, climate, etc. [39]. The results of the first two years of study are promising, however, further research is necessary to determine the long-term effect of both periodic- and non-harvest treatments.

5. Conclusions

This is the first study to examine for two consecutive years the effect of different intensities of harvest on the inter-row development of a wildflower meadow derived from spontaneous vegetation, commonly referred to as 'weeds' within a table grape 'Sultanina' vineyard with regard to meadow composition, arthropod presence, and quantity and quality of the grapes. The contemporary effects of the intensification of viticulture and threatened biodiversity altogether call for the application of agricultural practices that safeguard biodiversity and improve landscapes as an integral element of sustainable development processes. The use of spontaneous vegetation as a wildflower meadow in the 'Sultanina' vineyard under the periodic- and no- harvest treatment supported biodiversity (totaling twenty-one herbaceous species), did not pose a threat as a potential source of insect pests for 'Sultanina' grapes, and sustained a stable grape production (both yield and quality) for two years. The species *Convolvulus arvensis* hosted an important population of thrips, suggesting a preference for the particular species. Both the periodic- and no-harvest treatments were proposed for developing a wildflower meadow in a 'Sultanina' vineyard over two years. The overall results, combined with the additional benefits associated with wildflower meadows make the development of inter-row wildflower meadows from spontaneous vegetation as an appealing and promising sustainable vineyard floor management practice for long-term (permanent) use.

Continuation of the study is necessary to examine the long-term effect of the studied treatments on the vineyard's meadow composition, arthropod abundance, and produce (yield and quality). Furthermore, as generalizations in viticulture are difficult, it is necessary to apply the study in vineyards cultivated with different cultivars of both wine and table grapes in different locations to develop a more in depth understanding of the effect of the different intensities of harvest on the growth of the naturally growing herbaceous species, the developed meadow biodiversity (composition), and the arthropod abundance in relation to grape vine produce. A better understanding of the meadow dynamics can enhance the local landscape character to economically benefit the local farmers and be used to produce local seed mixes in cases of extremely degraded soils with poor fertility and seed bank.

Author Contributions: Conceptualization, A.T.P.; Methodology, A.T.P., K.B. and D.P.; Formal analysis, E.P., A.T.P., K.B., D.P., K.F.B. and I.D.; Investigation, E.P. and A.T.P.; Resources, E.P., A.T.P., K.B. and D.P.; Data curation, E.P., A.T.P., K.B. and D.P.; Writing—original draft preparation, A.T.P.; Writing—review and editing, A.T.P., K.B., D.P. and K.F.B.; Supervision, A.T.P., K.B. and D.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. García-Feced, C.; Weissteiner, C.J.; Baraldi, A.; Paracchini, M.L.; Maes, J.; Zulian, G.; Kempen, M.; Elbersen, B.S.; Pérez-Soba, M. Semi-natural vegetation in agricultural land: European map and links to ecosystem service supply. *Agron. Sustain. Dev.* **2015**, *35*, 273–283. [CrossRef]
2. Kefalas, G.; Kalogirou, S.; Poirazidis, K.; Lorilla, R.S. Landscape transition in Mediterranean islands: The case of Ionian islands, Greece 1985–2015. *Landsc. Urban Plan.* **2019**, *191*, 103641. [CrossRef]
3. Bretzel, F.; Vannucchi, F.; Romano, D.; Malorgio, F.; Benvenuti, S.; Pezzarossa, B. Wildflowers: From conserving biodiversity to urban greening—A review. *Urban For. Urban Green.* **2016**, *20*, 428–436. [CrossRef]
4. Ministry of Environment, Energy & Climate Change. *National Biodiversity Strategy and Action Plan*; Hellenic Republic, Ministry of Environment, Energy & Climate Change: Athens, Greece, 2014; p. 128.
5. UNESCO. *Florence Declaration on Landscape. Final Declaration of the UNESCO International Meeting on "The International Protection of Landscapes"*; UNESCO: Florence, Italy, 2012.
6. Haaland, C.; Naisbit, R.; Bersier, L.-F. Sown wildflower strips for insect conservation: A review. *Insect Conserv. Divers.* **2010**, *4*, 60–80. [CrossRef]
7. Greenwell, M.P.; Brereton, T.; Day, J.C.; Roy, D.B.; Oliver, T.H. Predicting resilience of ecosystem functioning from co-varying species' responses to environmental change. *Ecol. Evol.* **2019**, *9*, 11775–11790. [CrossRef]
8. Lindemann-Matthies, P.; Junge, X.; Matthies, D. The influence of plant diversity on people's perception and aesthetic appreciation of grassland vegetation. *Biol. Conserv.* **2010**, *143*, 195–202. [CrossRef]
9. UN. *Transforming Our World: The 2030 Agenda for Sustainable Development*; A/RES/70/1; UN General Assembly: New York, NY, USA, 2015.
10. UN. *The Sustainable Development Report, 2021*; United Nations Publications: New York, NY, USA, 2021.
11. European Commission. *Sustainable Agriculture for the Future We Want*; European Union: Luxembourg, 2012; p. 8.
12. Dessyllas, M. Organic viticulture in Greece. In Proceedings of the 6th International Congress on Organic Viticulture, Basel, Switzerland, 25–26 August 2000; pp. 58–61.
13. ELSTAT. *2009 & 2010 Statistical Yearbook of Greece*; Hellenic Statistical Authority: Piraeus, Greece, 2011; p. 613.
14. Banilas, G.; Korkas, E.; Kaldis, P.; Hatzopoulos, P. Olive and Grapevine Biodiversity in Greece and Cyprus—A Review. In *Climate Change, Intercropping, Pest Control and Beneficial Microorganisms*; Lichtfouse, E., Ed.; Springer: Dordrecht, Germany, 2009; pp. 401–428. [CrossRef]
15. Verešová, M.; Supuka, J. Changes of landscape structure and cultural values of vineyard landscape. *Acta Univ. Agric. Silvic. Mendel. Brun.* **2013**, *61*, 1459–1470. [CrossRef]
16. Weinberg, A.M. The Exile in Search of Refuge: Lines written among the Euganean Hills. In *Shelley's Italian Experience. Studies in Romanticism*; Weinberg, A.M., Ed.; Palgrave Macmillan: London, UK, 1991; pp. 21–43. [CrossRef]
17. Bruwer, J.D.W.; Lesschaeve, I. Wine Tourists' Destination Region Brand Image Perception and Antecedents: Conceptualization of a Winescape Framework. *J. Travel Tour. Mark.* **2012**, *29*, 611–628. [CrossRef]

18. McNicol, B.J.; Glorioso, R.S. Second home leisure landscapes and retirement in the Canadian Rocky Mountain community of Canmore, Alberta. *Ann. Leis. Res.* **2014**, *17*, 27–49. [CrossRef]
19. Bennett, J. *The Artist' Garden, the Secret Spaces That Inspired Great Art*; White Lion Publushing: London, UK, 2019; p. 19.
20. Sfikas, G. *The Botanical Paradises of Greece*; Toubis Editions: Athens, Greece, 2001; p. 256.
21. Paracchini, M.L.; Petersen, J.-E.; Hoogeveen, Y.; Bamps, C.; Burfield, I.; van Swaay, C. *High Nature Value Farmland in Europe—An Estimate of the Distribution Patterns on the Basis of Land Cover and Biodiversity Data*; EUR—Scientific and Technical Research Series; Office for Official Publications of the European Communities: Luxembourg, 2008; p. 87.
22. Andersen, E.; Baldock, D.; Bennet, H.; Beaufoy, G.; Bignal, E.; Brower, F.; Elbersen, B.; Eiden, G.; Godeschalk, F.; Jones, G.; et al. *Developing a High Nature Value Farming Area Indicator*; Internal Report for the European Environment Agency; IEEP: Bruxelles, Belgium, 2007.
23. Hitchmough, J.D. Semi-Natural Grasslands and Meadows. In *Environmental Horticulture, Science and Management of Green Landscapes*; Cameron, R.W.F., Hitchmough, J.D., Eds.; CABI: Wallingford, UK, 2016; pp. 175–191.
24. Hitchmough, J. Naturalistic herbaceous vegetation for urban landscapes. In *The Dynamic Landscape*; Dunnett, N., Hitchmough, J., Eds.; Spon Press: London, UK, 2004; pp. 130–183.
25. Council of Europe. *European Landscape Convention. European Treaty Series—No. 176*; Council of Europe: Florence, Italy, 2000; p. 7.
26. Bretzel, F.; Pezzarossa, B. Sustainable Management of Urban Landscapes with Wildflowers. *Acta Hortic.* **2010**, *881*, 213–219. [CrossRef]
27. Bullock, J.M.; McCracken, M.E.; Bowes, M.J.; Chapman, R.E.; Graves, A.R.; Hinsley, S.A.; Hutchins, M.G.; Nowakowski, M.; Nicholls, D.J.; Oakley, S.; et al. Does agri-environmental management enhance biodiversity and multiple ecosystem services? A farm-scale experiment. *Agric. Ecosyst. Environ.* **2021**, *320*, 107582. [CrossRef]
28. Hitchmough, J. The plant community: A model for horticultural thought and practice in the 21st century? *Acta Hortic.* **2017**, *1189*, 113–118. [CrossRef]
29. Bretzel, F.; Pezzarossa, B.; Carrai, C.; Malorgio, F. Wildflower plantings to reduce the management costs of urban gardens and roadsides. *Acta Hortic.* **2009**, *813*, 263–270. [CrossRef]
30. Guerra, B.; Steenwerth, K. Influence of Floor Management Technique on Grapevine Growth, Disease Pressure, and Juice and Wine Composition: A Review. *Am. J. Enol. Vitic.* **2012**, *63*, 149–164. [CrossRef]
31. Baumgartner, K.; Steenwerth, K.L.; Veilleux, L. Cover-Crop Systems Affect Weed Communities in a California Vineyard. *Weed Sci.* **2008**, *56*, 596–605. [CrossRef]
32. Madge, D. *Organic Farming: Vineyard Weed Management*; Department of Primary Industries: Melbourne, VC, Australia, 2007; p. 10.
33. Beslic, Z.; Pantelić, M.; Dabic, D.; Todic, S.; Natić, M.; Tesic, Z. Effect of vineyard floor management on water regime, growth response, yield and fruit quality in Cabernet Sauvignon. *Sci. Hortic.* **2015**, *197*, 650–656. [CrossRef]
34. Gómez, J.A. Sustainability using cover crops in Mediterranean tree crops, olives and vines—Challenges and current knowledge. *Hung. Geogr. Bull.* **2017**, *66*, 13–28. [CrossRef]
35. Novara, A.; Cerda, A.; Barone, E.; Gristina, L. Cover crop management and water conservation in vineyard and olive orchards. *Soil Tillage Res.* **2021**, *208*, 104896. [CrossRef]
36. Bekkers, T. Weed Control Options for Commercial Organic Vineyards. *Wine Vitic. J.* **2011**, *26*, 62–64.
37. Carvell, C.; Mitschunas, N.; McDonald, R.; Hulmes, S.; Hulmes, L.; O'Connor, R.S.; Garratt, M.P.; Potts, S.G.; Fountain, M.T.; Sadykova, D.; et al. Establishment and management of wildflower areas for insect pollinators in commercial orchards. *Basic Appl. Ecol.* **2021**, *58*, 2–14. [CrossRef]
38. Koniak, G.; Noy-Meir, I.; Perevolotsky, A. Modelling dynamics of ecosystem services basket in Mediterranean landscapes: A tool for rational management. *Landsc. Ecol.* **2011**, *26*, 109–124. [CrossRef]
39. Muscas, E.; Cocco, A.; Mercenaro, L.; Cabras, M.; Lentini, A.; Porqueddu, C.; Nieddu, G. Effects of vineyard floor cover crops on grapevine vigor, yield, and fruit quality, and the development of the vine mealybug under a Mediterranean climate. *Agric. Ecosyst. Environ.* **2017**, *237*, 203–212. [CrossRef]
40. Power, A.G. Ecosystem services and agriculture: Tradeoffs and synergies. *Philos. Trans. R. Soc. B Biol. Sci.* **2010**, *365*, 2959–2971. [CrossRef] [PubMed]
41. Sáenz-Romo, M.G.; Veas-Bernal, A.; Martínez-García, H.; Campos-Herrera, R.; Ibáñez-Pascual, S.; Martínez-Villar, E.; Pérez-Moreno, I.; Marco-Mancebón, V.S. Ground cover management in a Mediterranean vineyard: Impact on insect abundance and diversity. *Agric. Ecosyst. Environ.* **2019**, *283*, 106571. [CrossRef]
42. Fiera, C.; Ulrich, W.; Popescu, D.M.; Bunea, C.-I.; Manu, M.; Nae, I.; Stan, M.; Markó, B.; Urák, I.; Giurginca, A.; et al. Effects of vineyard inter-row management on the diversity and abundance of plants and surface-dwelling invertebrates in Central Romania. *J. Insect Conserv.* **2020**, *24*, 175–185. [CrossRef]
43. ELSTAT. *Απογραφή Πληθυσμού—Κατοικιών 2011. Μόνιμος Πληθυσμός (Census 2011)*; Hellenic Statistical Authority: Piraeus, Greece, 2011.
44. IERSD-NOA. *Monthly Bulletin*; Institute of Environmental Research and Sustainable Development of the National Observatory of Athens: Penteli, Greece, 2016. Available online: https://meteo.gr/Monthly_Bulletins.cfm (accessed on 5 January 2022).
45. IERSD-NOA. *Monthly Bulletin*; Institute of Environmental Research and Sustainable Development of the National Observatory of Athens: Penteli, Greece, 2017. Available online: https://meteo.gr/Monthly_Bulletins.cfm (accessed on 5 January 2022).

46. HNMS. *Climatic Bulletin*; Hellenic National Meteorological Service: Helliniko, Greece, 2016. Available online: http://www.emy.gr/emy/en/climatology/climatology (accessed on 5 January 2022).
47. HNMS. *Climatic Bulletin*; Hellenic National Meteorological Service: Helliniko, Greece, 2017. Available online: http://www.emy.gr/emy/en/climatology/climatology (accessed on 5 January 2022).
48. Meléndez, E.; Ortiz, M.; Sarabia, L.; Íñiguez, M.; Puras, P. Modelling phenolic and technological maturities of grapes by means of the multivariate relation between organoleptic and physicochemical properties. *Anal. Chim. Acta* **2013**, *761*, 53–61. [CrossRef]
49. Paraskevopoulou, A.; Pappous, E.; Bertsouklis, K.; Biniari, K.; Daskalakis, I.; Perdikis, D. The potential use of a wildflower meadow in a vineyard to enhance the local rural landscape character. *Acta Hortic.* **2020**, *1278*, 29–38. [CrossRef]
50. Liu, H.; Mi, Z.; Lin, L.; Wang, Y.; Zhang, Z.; Zhang, F.; Wang, H.; Liu, L.; Zhu, B.; Cao, G.; et al. Shifting plant species composition in response to climate change stabilizes grassland primary production. *Proc. Natl. Acad. Sci. USA* **2018**, *115*, 4051–4056. [CrossRef]
51. Albano, C.M.; McClure, M.L.; Gross, S.E.; Kitlasten, W.; Soulard, C.E.; Morton, C.; Huntington, J. Spatial patterns of meadow sensitivities to interannual climate variability in the Sierra Nevada. *Ecohydrology* **2019**, *12*, 2128. [CrossRef]
52. Stampfli, A. Species composition and standing crop variation in an unfertilized meadow and its relationship to climatic variability during six years. *Folia Geobot.* **1995**, *30*, 117–130. [CrossRef]
53. Wheeler, M.M.; Collins, S.L.; Grimm, N.B.; Cook, E.M.; Clark, C.; Sponseller, R.A.; Hall, S.J. Water and nitrogen shape winter annual plant diversity and community composition in near-urban Sonoran Desert preserves. *Ecol. Monogr.* **2021**, *91*, 1450. [CrossRef]
54. Bernhardt-Römermann, M.; Römermann, C.; Sperlich, S.; Schmidt, W. Explaining grassland biomass—The contribution of climate, species and functional diversity depends on fertilization and mowing frequency. *J. Appl. Ecol.* **2011**, *48*, 1088–1097. [CrossRef]
55. Przybysz, A.; Popek, R.; Stankiewicz-Kosyl, M.; Zhu, C.; Małecka-Przybysz, M.; Maulidyawati, T.; Mikowska, K.; Deluga, D.; Griżuk, K.; Sokalski-Wieczorek, J.; et al. Where trees cannot grow—Particulate matter accumulation by urban meadows. *Sci. Total Environ.* **2021**, *785*, 147310. [CrossRef] [PubMed]
56. Collins, S.L.; Knapp, A.K.; Briggs, J.M.; Blair, J.M.; Steinauer, E.M. Modulation of Diversity by Grazing and Mowing in Native Tallgrass Prairie. *Science* **1998**, *280*, 745–747. [CrossRef]
57. Klimešová, J.; Janeček, Š.; Bartušková, A.; Lanta, V.; Doležal, J. How is Regeneration of Plants after Mowing Affected by Shoot Size in Two Species-Rich Meadows with Different Water Supply? *Folia Geobot.* **2010**, *45*, 225–238. [CrossRef]
58. Humbert, J.-Y.; Pellet, J.; Buri, P.; Arlettaz, R. Does delaying the first mowing date benefit biodiversity in meadowland? *Environ. Évid.* **2012**, *1*, 9. [CrossRef]
59. Sweet, R.M.; Schreiner, R.P. Alleyway Cover Crops Have Little Influence on Pinot noir Grapevines (*Vitis vinifera* L.) in Two Western Oregon Vineyards. *Am. J. Enol. Vitic.* **2010**, *61*, 240–252.
60. Nicholls, C.I.; Parrella, M.; Altieri, M.A. The effects of a vegetational corridor on the abundance and dispersal of insect biodiversity within a northern California organic vineyard. *Landsc. Ecol.* **2001**, *16*, 133–146. [CrossRef]
61. Franin, K.; Barić, B.; Kuštera, G. The role of ecological infrastructure on beneficial arthropods in vineyards. *Span. J. Agric. Res.* **2016**, *14*, 303. [CrossRef]
62. Schwartz, H.F.; Gent, D.H.; Fichtner, S.M.; Otto, K.; Boateng, C.O.; Szostek, S.; Cranshaw, W.S.; Mahaffey, L.A. *Thrips tabaci* (Thysanoptera: Thripidae) and Iris yellow spot virus Associated with Onion Transplants, Onion Volunteers, and Weeds in Colorado. *Southwest. Èntomol.* **2014**, *39*, 691–704. [CrossRef]
63. Wilson, H.; Daane, K.M. Review of Ecologically-Based Pest Management in California Vineyards. *Insects* **2017**, *8*, 108. [CrossRef] [PubMed]
64. Lee, J.; Steenwerth, K.L. Rootstock and vineyard floor management influence on 'Cabernet Sauvignon' grape yeast assimilable nitrogen (YAN). *Food Chem.* **2011**, *127*, 926–933. [CrossRef] [PubMed]
65. Steenwerth, K.L.; McElrone, A.J.; Hanifin, R.C.; Storm, C.; Collatz, W.; Manuck, C.; Calderón-Orellana, A. Cover Crops and Tillage in a Mature Merlot Vineyard Show Few Effects on Grapevines. *Am. J. Enol. Vitic.* **2013**, *64*, 515–521. [CrossRef]
66. Dias, F.A.N.; Torregrosa, L.; Luchaire, N.; Houel, C.; Pellegrino, A. The microvine, a model to study the effect of temperature on grapevine latent bud development and fruitfulness. *OENO One* **2019**, *53*, 393–407. [CrossRef]
67. Stavrakakis, M.N. *Αμπελουργία (Viticulture)*; Tropi Publications: Athens, Greece, 2013; p. 744.
68. Lebon, G.; Wojnarowiez, G.; Holzapfel, B.; Fontaine, F.; Vaillant-Gaveau, N.; Clément, C. Sugars and flowering in the grapevine (*Vitis vinifera* L.). *J. Exp. Bot.* **2008**, *59*, 2565–2578. [CrossRef] [PubMed]
69. Keller, M. *The Science of Grapevines: Anatomy and Physiology*; Elsevier Inc. Academic Press: London, UK, 2010; p. 377.