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Review

Flower Strips and Their Ecological Multifunctionality in Agricultural Fields

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Abstract: Flower strips can be an important component of integrated pest management and contribute to reducing pressure on agroecosystems, which is why they are increasingly implemented as part of agri-environmental programs. They can be used as a multifunctional agronomic tool because they can prevent the decline of species diversity in the agroecosystem and increase functional biodiversity, which is a prerequisite for the provision of ecosystem services, such as pollination and natural pest control. Research highlights the great potential and multifunctionality of flower strips. This paper provides a synthesis of the most important information and research findings regarding flower strips and may be a useful tool in relation to the European Green Deal, which aims to move the EU towards a green transformation. Where intensive chemical treatments in agriculture have contributed to the degradation of the agricultural landscape, flower strips can support its ecological intensification.

Keywords: beneficial macro-organisms; biodiversity; organic cultivation; insect pest control; pollinators; ecological intensification; insect preferences for visiting of plants

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1. Introduction

Agriculture, as an industry that provides people with the food they need to survive, is one of the most essential areas of human activity. Due to the growing population, food production is increasing year after year, as are the areas of crops that should produce higher yields. This is leading to an intensification of activities in agricultural areas and may contribute to the degradation of natural landscape elements (e.g., tree canopies, small bodies of water or peatlands). Currently, pathogen and weed control still rely mainly on chemical methods, often involving environmentally hazardous chemicals that alter soil and water properties and are toxic to non-target organisms [1,2]. The aim of this paper is to provide a synthesis of the most important information and research findings regarding flower strips and their multifunctionality in agriculture fields.

Synthetic pesticides and mineral fertilisers have been criticised for their potentially negative impact on human health and the environment (e.g., serious problems concerning eutrophication of inland and coastal waters) and their effects reducing biodiversity [3–5]; however, they are still the most frequently used method to increase yield. On the other hand, awareness of increased environment pollution has led to a systematic growth in the interest in green agriculture and increased demand for organic products. This is related to increased production with organic agriculture, which is not only becoming more and more popular among conscious consumers but also acquiring more and more support from EU legal regulation.

Organic production is eco-friendly, and it is defined as a general system of managing farms and food production that combines the practices most advantageous for the agricultural habitat and is based on high biodiversity, protection of natural resources and application of strict standards of animal well-being. Plant production is largely based on natural substances and processes in soil [6]. The basis of organic crop production is plant nutrition, with nutrients mainly obtained through the soil ecosystem, and the primary method of plant protection is prevention in a broad sense [7]. Protection activities in the ecological system should be the focus throughout the vegetation season, from preparing seed grain to harvesting, and they should not only be based on protection programmes offered by agrochemical companies. All kinds of agrotechnical treatment (e.g., selection of cultivars, crop rotation, natural fertilisation) are aimed at creating advantageous, sanitary soil conditions and increasing plant resistance to disease and pests. It is admissible to only apply compounds of natural origin, with active substances aimed at eliminating or controlling particular pests. Considering resistance to fungicides and the EU legislation [8], which aims at limiting the application of pesticides, we need alternative methods of control that allow for the shaping of the infrastructure of agricultural field environment.

Farmland constitutes 43.4% of the area of Poland [9]. This is land with strong agrotechnical pressure that is practically excluded from activities aimed at permanently differentiating landscape structure [2]. Manipulating plant diversity in agricultural areas can be used as a natural method of shaping the agricultural landscape and increasing the effectiveness of biological control methods for pests while promoting their natural enemies. The use of appropriately adapted flower strips as a method of biological control has become more popular in recent years and is now an important tool in pest control [10], as well as part of the conservation strategy of the biological method. Due to the positive results of past research, farmers are increasingly encouraged to use flower strips to prevent the reduction of species diversity in the agroecosystem. This is not easy to implement, but the farmer should consider the potential advantages of this approach [11–14]. The natural pressure of the environment promotes a balance between different groups of organisms; unfortunately, the intensification of agriculture can lead to a rapid decline in biodiversity and weaken this pressure [15,16].

Wildflower strips, a semi-natural manmade habitat comprising mixtures of native herbaceous species, can be sown on arable field margins to provide multiple ecological, agricultural and conservation benefits. The main aim of creating flower strips is to enrich the fauna of farmland with the species that are beneficial in terms of the agricultural economy: animals that limit the population density of pests (e.g., parasitic insects, including parasitoids, predatory insects and spiders and birds) and pollinators (insects that feed on pollen or nectar), including those with economic significance [2]. For this reason, flower strips should be included in agri-environmental programs to enhance sustainable plant production and the biodiversity of pollinators on farmland [17] or natural aphid enemies [12,18], for example. Flower strips are thus increasingly frequently promoted in environmental programmes, and financial support is being implemented as an additional business incentive. We need biodiversity both for environmental and climate reasons, as it creates conditions for healthy societies and maintains the functioning of agriculture. The biodiversity of agrocenoses is, however, disappearing at an alarming rate: according to scientists, as many as 200 species die out daily. The results published by Hallmann et al. [19] showed a drastic fall in the average biomass of insects floating in air plankton of 76% (up to 82% in the middle of summer) in only 27 years in protected natural areas in Germany. Sanchez Bayo and Wyckhuys [4] predicted that, during the next few decades, 40% of the world's insect population will become extinct. Based on the gathered data, they indicated intensive farming and application of chemical pesticides as the main reasons for this situation. Moreover, long-term research in the USA showed a fall in the number of butterflies by 2% a year, which, during 21 years of systematic observations, led to an estimate of a cumulative decrease in butterfly abundance of 31% [20]. The EU strategy for biodiversity is thus a key element of the European Green Deal. It should help to recover biodiversity in Europe by 2030, and its activities include restoring degraded ecosystems by limiting the use of pesticides [21,22], implementing environmental eco-schemes and supporting green, carbon and generally sustainable farming.

1.1. Natural Enemies of Insect Pests

Due to a rich feed base (blooming plants) and the relatively constant habitats created (due to limited agrotechnical activities), flower strips positively influence the development, multiplication and wintering (if they are perennial) of the natural enemies of crops pests [2]. The presence of structurally complex plants, rich in species, with long blooming periods creates advantageous conditions for beneficial fauna and, consequently, enables the improvement of natural pest control both in annual and perennial crops [18]. Flower strips may constitute a preventive measure to control pests; e.g., in corn, potatoes, cabbage, cereals crops, field beans and even in orchards, as they can be applied together with other preventive or direct plant protection measures [11,12,23–25].

The most important parasitoids in the biological control of crop plant pests are Hymenoptera of the Ichneumonidae and Braconidae families, Chalcidoids of the Eulophidae and Pteromalidae families, Diptera of the Tachinidae family and some species of the Proctotrupidae, Scelionidae, Ceraphronidae and Bethylidae. Many of them attack insect larvae, others their pupae or eggs [2]. Flower strips are also an important refuge for one of the most abundant groups of beetles that inhabit farmland: Carabidae of the order Coleoptera, which regulate the population density of other invertebrates, as well as the insects that are pests of cultivated plants [2]. Unfortunately, due to the disappearance of refuges in fields, carabids are facing extinction [2,26]. Kujawa et al. [22] reported that as many as 46 carabid species were observed in flower strips. The most abundant species was *Harpalus rufipes* (hemizoophage, feeding on both plants and animals), which constituted 45.8% of the particular beetle numbers, and the most abundant of the 47 ground spider species was *Pardosa agrestis* (24% of all individuals).

Tschumi et al. [12] found that properly created flower strips improve biological control of aphids in nearby potato fields by controlling the gradation of pests and, thus, limiting the application of pesticides. The authors tested the effectiveness of one-year-old flower strips (composed of 11 plant species that provide abundant floral resources) for the promotion of key natural aphid enemies (e.g., hoverflies and ladybirds). Their abundance in the flower strips increased greatly, while aphid numbers in neighbouring potato fields dropped by 75%. A similar correlation was found in a winter wheat. The number of imagines of pests' natural enemies in flower strips increased considerably in comparison with control plots. A significant reduction in Oulema spp. leaf beetles, which are pests mainly of cereals crops, was observed (for eggs, by 44%; larvae, by 66%) and, consequently, the damage caused decreased too (by 40%). Additionally, the average yield of grain increased by 10% [11,12]. In another experiment conducted by Hatt et al. [27] located near a winter wheat field, ladybugs, as the most important aphid killers, were the most numerous predators, and their abundance was related to the type of flower mixture (which was not found in the case of net-winged insects and hoverflies).

Studies by Herrera et al. [24] on cabbage and adjacent flower strips also showed less pest infestation compared to control plants, although no significant differences in predator abundance were found. Chrysopidae insects used the flower strips not only as feeding sites but also for reproduction and hiding. The abundance of natural enemies increased significantly with the proportion of flowering plants in the flower strips. A similar relationship was found by Seree et al. [25] in beans. Increasing the proportion of flowering plants with available nectar increased the abundance of Syrphidae and aphid mummies (an effect of parasitic fly activity). In a study by Mei et al. [28], flower availability in control and border strips was also positively correlated with the abundance of natural enemies (Carabidae, Staphylinidae and spiders were most abundant).

Ditner et al. [29] found that the species richness of spiders and beetles and their abundance were much higher in flower strips located at the edges of fields than in the cabbage field. It has been suggested that spiders tend to remain in diversified patches and that extending the diversification throughout the whole crop (as in interspersed diversification) offers the best prospects for improving pest control [30]. The abundance of flowers in flower strips may attract potential prey, which increases the foraging efficiency of spiders.

Some prey may also accidentally become entangled in the webs [2]. In addition, studies have proven that Chrysopidae feed on selected plant species. In flower strips, they fed mainly on *Phacelia tanacetifolia* Benth pollen, while *Chrysopa carnea* (Steph.) showed a preference for *P. tanacetifolia* pollen and *Coriandrum sativum* L. over *Borago officinalis* L. and *Fagopyrum esculentum* Moench [28]. Flower strips can also contribute to the density of other animals that prey on the pests, such as birds and small mammals [2].

1.2. Pollinators

A total of 35% of global plant production depends on pollination performed mainly by insects. However, agricultural transformation has led to a fall in the abundance of bees and other pollinators due to the degradation of their habitats through the introduction of monocultures or the application of insecticides. Qualitative and quantitative falls in the pollinators' populations on farmland have been reported for dozens of years. Diversification of farming by sowing flower strips on fields may reduce this disadvantageous effect or at least help to strengthen the populations of the surviving species [31,32].

Strips of blooming plants offer food and shelter to many pollinators. Due to the fact that they are composed of many species of nectar plants that bloom in various months, they constitute an important substitute habitat for bees. Consequently, the diversity of these insects may increase greatly, including the species of economic importance (e.g., Bombus, Megachilidae), and effective protection of some endangered species may also be increased, such as solitary bees and many species of bumblebees [2]. In research by Azpiazu et al. [33], flower strips bloomed for over 3 months (13–14 weeks), enabling many species of bees, hoverflies and beetles to visit them and use the resources of nectar and pollen during two seasons of the year (spring and summer). In order to intensify activities beneficial for pollinators, Schmidt et al. [34] developed the Pollinator Feeding Index (PFI), which was calculated for sowed and spontaneously occurring plant species considering the production of pollen and nectar, as well as the period of blooming (the number of months of blooming [35]) and, finally, the plant cover. Grass species were not included, as their pollen seems to be used only in exceptional cases. According to the PFI, calculations, the availability of resources for pollinators was much higher in flower strips than in the control group. Pollen and nectar were mainly provided by sowed plants (*Leucanthemum vulgare*, *Daucus carota*, *Achillea millefolium*, *Centaurea jacea* and *Trifolium pratense*). From June to October, the plants from flower strips provided over twice as much nectar and pollen as spontaneously appearing plants, while from November to May, the opposite was the case, and spontaneously appearing plants provided most of the pollen and nectar; however, it was mainly of low values (the highest PFIs were obtained with *Capsella bursa-pastoris*, *Taraxacum* sect. *Ruderalia* and *Veronica persica*). In the research by Hatt et al. [27], spontaneously appearing species were dominated by *Cirsium arvense*, *Sinapis alba* and *Rumex obtusifolius;* however, the cover of all the other spontaneous species never exceeded the average of 3% of the studied plot. From our own observations (unpublished data from western Poland, 2022), we could infer that, among spontaneous species, the following were dominant depending on the period: *Viola tricolor* L., *Capsela bursa-pastoris* (L.) Medik., *Matricaria chamomilla* L., *Geranium pusillum* L. and *Conyza canadensis* L. (Figure 1).

For some anthophile species (i.e., those which feed on pollen or nectar), flower strips are an additional source of food, but, for typical pollinators (e.g., Apidae), they provide their basic diet. Butterflies visit flower strips mainly for the nectar but also for host plants that provide food for caterpillars, which makes them a substitute habitat decisive for survival in an agricultural landscape [2]. In research by Haaland and Gyllin [36], 86% of all the recorded butterflies and 83% of all the recorded bumblebees were reported from strips of sowed flowers, although they were mainly very common species. Rare species are usually stenotopic and more demanding in terms of habitat. In the above-mentioned research, the number of butterflies was, on average, 20 times as large in sowed flower strips as in the greenways typical of the region. Bumblebees were virtually absent from the typical greenways sown with grasses. In research by Kujawa et al. [22], 14 butterfly species of five families were observed in flower strips, and the most abundant species was *Vanessa cardui* L. (54%). As shown by our one-year observations (unpublished data from western Poland, 2022), the most frequently occurring butterfly in a flower strip was *Aglais io* L., which mostly favoured the inflorescence of *Trifolium pratense* (L.). Rollin et al. [37] found that rape and sunflower were much more often used by European honey bees than by bumblebees and wild bees, while wild bees preferred semi-natural habitats (they visited the crops that bloomed in mass much less often than honey bees). The authors indicated that bees with a long tongue (such as the families of Megachilidae and Apidae) can visit flowers both with deep and short corolla, while the bees with short tongues (such as the families Halictidae and Andrenidae) can gather pollen only from the short-corolla flowers; e.g., those of the Asteraceae family.

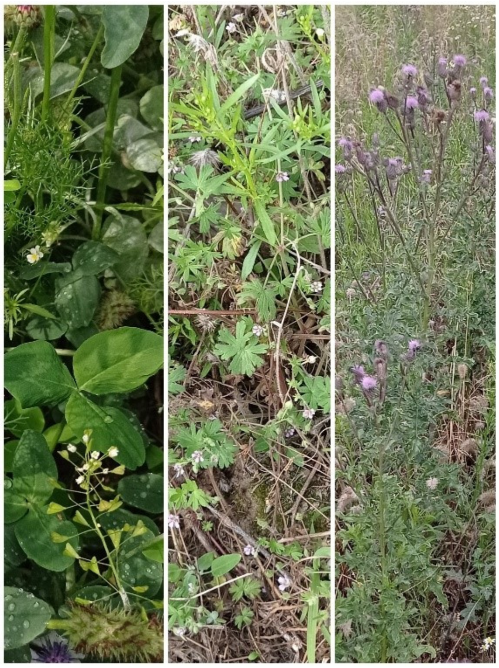

Figure 1. Weeds appearing spontaneously in flower strips. Left to right: heartsease (*Viola tricolor* L.) and shepherd's purse (*Capella bursa-pastoris* (L.) Medik.), small-flowered crane's-bill (*Geranium pusillum* L.), creeping thistle (*Cirsium arvense* (L.) Scop.) and horseweed (*Conyza canadensis* L.) (authors' observations, 2022).

The effectiveness of pollination is also affected by the distance of a flower strip from the main crop. According to research by Azpiazu et al. [33], the index of melon flower visits by pollinators decreased with the increase in the distance from a flower strip, while no significant differences in the yield were observed (fruit yield in tons per ha or in the quality parameters of melon fruits). Albrecht et al. [38] also observed a strong correlation between distance and pollination services. Pollination services decreased with the increase of the distance from flowers, and the pollination was more effective next to the strips with more diverse blooming plants. The effect of distance from the flower strip has also been observed in the changing abundance of zoophages, and a study by Kujawa et al. [20] suggests that distances between wildflower strips should not exceed 60 m due to the decreasing number of predators.

When considering the effectiveness of flower strips on farmland in relation to biocontrol, methods should take into consideration the features of the surrounding landscape. Creating them on a local level is more effective in simple landscapes with a high share of arable land, while preserving general diversity is important in complex landscapes [39]. The abundance of pollinators is affected both by the parameters of crops and the landscape; however, particular pollinator groups react differently to them. The height of crops, for example, is important, as is their cover, the blooming of weeds and the presence of hedges or shrubs. In the research by Brandt et al. [40], solitary bees were more frequent in the areas with blooming herbaceous plants than near forests, bumblebees preferred low trees and honey bees avoided high crops and preferred open arable land. In the research by Haaland and Gyllin [36], tree and bush plantings tended to improve overall diversity. While conducting research in North America, Europe and New Zealand, Albrecht et al. [38] defined the impact of flower strips and hedges on the control of pests. The presence of flower strips helped to control pests on adjacent fields by 16% on average (which was not reported for hedges), while the effect on pollination of cultivations and yield was varied. According to Aviron et al. [41], a changing diversity of butterflies can be seen in ecological compensation areas depending on the local area (land slope and orientation) and the semi-natural components of the surrounding landscape. This is why environmental variability must be considered on many scales to locate and interpret the actual usefulness of agri-environmental programs, and, e.g., two different groups of pollinators in a given area should be considered separately. Moreover, if activities differentiating the habitat structure are to become a common tool to increase habitat natural resistance, it is vital to understand long-term effects of semi-natural habitats on natural enemies of crop pests [18].

2. Composition of Flower Strips

2.1. Species Composition

Detailed guidelines as to seed mixtures, sowing time and proper flower strip management must be carefully adjusted to habitat conditions (soil, weeds and neighboring habitats) and specific aims. Pfiffner and Wyss [18] indicate that flower strips should be established on sites free of problem weeds (such as *Rumex obtusifolius* L., *Agropyron repens* L., *Cirsium arvense* L. and *Convolvulus arvensis* L.) that provide proper soil conditions (water availability). After careful soil preparation, flower strips are usually sown in spring in mineral soils and in autumn in organic soils to avoid weeds that sprout in spring (e.g., *Galinsoga* sp., *Setaria* sp.). In Polish conditions, however, the soil requirements for the plants sown in flower strips are not of much importance, as farmland is usually located on soils formed in oak-hornbeam forest habitats, appropriate for the development of a large number of plant species that are significant in terms of flower strips [2].

The composition of seed mixture for flower strips should particularly take into consideration the requirements of desired insect species; provide food for insects that feed on nectar and pollen (e.g., hoverflies and green lacewings) and whose larvae are predators; and include seeds of long-blooming plants to ensure continuity of blooming and food for herbivorous insects, thanks to which they will feed within the strip and not on cultivated plants. For instance, the plants of the Poaceae family may become a feeding place for crop pests. The selected plants should be particularly advantageous for the species that control pest populations and the plants whose pollen or nectar is often eaten by pests should be excluded. At the same time, it is important to differentiate the blooming times of particular species in the flower strip as much as possible [2,13] (Figure 2).

The species of plants for flower strips should offer vast resources, both of a flower and non-flower character (e.g., shelter as well as living and breeding places), and be favourable for natural enemies of cultivated plants pests. Flower strips rich in species may be attractive for beneficial fauna and bring higher tangible benefits than strips poor in species or composed of one species. The application of flower mixtures differentiates the resources, which leads to a higher diversity of pollinators and natural enemies due to insects' selective feeding. In research by Pontin et al. [42], clear differences in the attractiveness of flower species for bumblebees, honey bees and, to a lesser extent, hoverflies were observed. Bumblebees and honey bees almost exclusively visited phacelia, even when other flower species were available, while hoverflies visited all available plant species without clear preference, which confirms that it is possible to adjust the species composition of flower strips to maximise biological control and pollination. It is worth noting that bumblebees are active even in early spring, when air and ground temperatures are still low, so their presence is essential for the multiplication of the plants that bloom in that season [2]. In research by Haaland and Gyllin [36], two-thirds of all flower visits by butterflies were observed to *Knautia arvensis* L. (44%) and *Centaurea* spp. (*C. jacea* L. and *C. scabiosa* L. 20%). *Cirsium arvense* L., *Senecio* spp. and *Trifolium* spp. were other commonly visited plants. For bumblebees, visits to *Centaurea* spp. were totally dominant (72%), while 14% of all visits were recorded to *K. arvensis*, 5% to *Trifolium* ssp. and 4% to *C. arvense* L. Along with the accumulation of knowledge on particular insects' preferences for plant speciesm it will be easier to predict which flower species are appropriate for particular schemes of protection and pest control and minimize the risk of accidentally supporting harmful agrophages.

(**A**) (**B**)

Figure 2. Differentiation of blooming plants and insects in a flower strip in the National Park of Greater Poland: (**A**) blooming plants of the flower strip from the beginning of May to the end of June, every two weeks. (**B**) Diversity of insects in the flower strips; species from the top: *Chrisis ignita* L.—parasitic wasp, *Protaoetia cuprea metallica* Herbst, *Rhagonycha fulva* Scopoli—predatory beetles, *Bombus lucorum* L.—pollinator (authors' observations, 2022).

Pollinators are most attracted to the species with the highest numbers of flowers. The species best for flowers strips in Spain turned out to be *Coriandrum sativum* L., *Diplotaxis virgata* L., *B. officinalis* L. and *Calendula officinalis* L. They had the largest flower cover and were the highest in the mixture (50 to 100 cm), which probably made it easier for pollinators to find them (they also have open or partly hidden nectar). We observed (2022) that bumblebees very frequently visited the high (up to 100 cm) *Echium vulgare* L., which had a large number of flowers in inflorescence. Baden-Bohm et al. [43] found that the composition of the flower mixture and, consequently, flower structure affects the subsequent occurrence of honey bees. Flower strips of good quality, rich in pollen and nectar and spread evenly, attract more bees, unlike flower strips of poor quality, which are less satisfying for bees. In research by Tschumi et al. [12,13], flower strips greatly encouraged the diversity of hoverflies. The flower mixture was composed of native flowers of Switzerland and herbs grown in the region: *Anethum graveolens* L. (Apiaceae), *Anthemis arvensis* L. (Asteraceae), *Anthriscus cerefolium* Hoffm. (Apiaceae), *Bellis perennis* L. (Asteraceae), *Calendula arvensis* L. (Asteraceae), *Camelina sativa* (L.) Crantz (Brassicaceae), *Centaurea cyanus* L., (Asteraceae), *Coriandrum sa-tivum* L. (Apiaceae), *Fagopyrum esculentum* Moench (Polygonaceae), *Papaver rhoeas* L. (Papaveraceae) and *Sinapis arvensis* L. (Brassicaceae). Research by Amy et al. [32] did not show significant differences in terms of abundance and diversity of pollinators in single-species and multi-species strips. Only hoverflies were more numerous in the multi-species mixture.

Pontin et al. [40] note a situation in which a flower strip is more attractive for target insects than the cultivation itself; then, ecosystem services—i.e., biological pest control and pollination—can be at risk in the cultivation. This is why the blooming seasons of flower strips (affected by the selection of species and the cultivation itself) must be considered in order to ensure only minimal overlap in time. Describing melon cultivation as an example, Azpiazu et al. [33] confirm that a flower strip may act as a competitor if it blooms at the same time as the main cultivation; this is why *Calendula officinalis* L. should be avoided in melon cultivations. Flower strips may also compete with native plants. In research by Montero-Castaño et al. [44], strips of *Hedysarum coronarium* L. decreased the abundance of pollinators in the adjacent shrubberies by monopolising honey bee visits and attracting wild bees. Considering the above, further research is necessary to prepare guidelines on the flower mixtures that are definitely more advantageous for pollinators than neighbouring plants and semi-natural habitats.

2.2. Types of Flower Strips

2.2.1. Annual Flower Strips

Annual flower strips may be easily created from year to year in various places; they do not require particular care. They may also constitute a first step in introducing perennial flower strips in areas where they have not been used before. They quickly become local shelter for arthropods, including pest enemies that can help control the pests in neighbouring cultivations [22]. Research by Tschumi et al. [11] showed high effectiveness for annual flower strips that lower the abundance of pests below economic threshold, thus offering a real alternative for insecticides or providing a chance to limit insecticides in conventional winter wheat production. Annual flower strips positively influence the number of hoverfly larvae. Adult Syrphidae probably travel longer distances to lay eggs in a flower strip to avoid competition with other individuals using locally available flowers. Moreover, Syrphidae probably need less energy due to the better availability of nectar, thanks to which they can fly further [39,45]. Klatt et al. [46] recorded a rise in bumblebee colonies and their activity near annual flower strips; however, the effects decreased as the distance from the strips grew. The results of research by Kujawa et al. [22] confirm that, within only three months of their creation, annual flower strips became a habitat, with the species richness of carabids, spiders, butterflies and other pollinators, as well as predatory insects living on plants, being significantly higher than in the neighbouring rye field. Similar results were obtained by Boetzl et al. [47]. The neighbouring of annual flower strips increased the share of predatory insects and, at the same time, decreased the share of pests in an adjacent oilseed rape field.

On the one hand, annual flower strips may start blooming too late to ensure resources during the activity period of, e.g., solitary bees and wasps, but, on the other, they can be advantageous for ground predators (e.g., spiders, beetles), probably by providing more diversified shelter and a favourable microclimate directly after sowing [45,48,49]. Annual flower strips liquidated at the end of cultivation or after harvest are, however, poor wintering habitats for arthropods, as they can become ecological traps (e.g., the insects wintering in the ground will not survive ploughing) [50]. Raderschall et al. [49] estimated additional placement of beehives in fields with annual flower strips and broad bean cultivation. There was no adverse effect on the bumblebees visiting the broad beans, which suggests that competition was not strong enough to drive bumblebees from cultivations, while, in research by Bommarco et al. [51], adding beehives decreased the abundance of bumblebee males, thus eliminating the positive effect of flower strips. In this context, it should be borne in mind that the honey bee is neither wild nor an endangered species.

2.2.2. Perennial Flower Strips

A flower strip may cause positive population reactions in pollinators, such as decreased abundance and fecundity, which may lead to increased pollination. Perennial herbaceous plants and the connected fauna help common species remain common and ecologically important components of cultivations, and the insects that live on perennial plants are more diverse and specialised. They can also provide neighbouring fields with natural enemies and pollinators [23,52]. Species richness and the total abundance of insects are on average lower in wild flower strips in their first year than in older strips. Species richness of insects reflects the age and wild flower cover in the strips. The proportions of oligo- and monophagous species with only one generation a year and the species that winter in the form of eggs increase with strip succession, both in terms of species numbers and individual numbers [53].

Buhk et al. [17], in their research, estimated the general species richness of bees and butterflies; the abundance of bees clearly rose in the areas with perennial flower strips (after more than 2 years, a three- to fivefold increase in species richness was found). Perennial flower strips ensure diverse, rich plant cover and the related food resources for pollinators. Furthermore, it is worth noting that a high variety of spontaneously appearing plant species, which may colonise any gaps in a flower strip and provide pollen and nectar during the months of their scarcity, were observed [34]. Albrecht et al. [38] found that pollination increased by 27% in 2 year flower strips in comparison to the youngest ones, which may be explained by a higher number of breeding places and the possibility of wintering in older plantings. Perennial flower strips are a valuable wintering habitat for many arthropod taxa. In research by Ganser et al. [50], the age of perennial flower strips positively affected the wintering of spiders and the number of wintering pollinating flies and rove beetles did not change significantly with the age of the strip. Moreover, the number of beetles tended to decrease in the four-year-old flower strip in comparison with younger plantings. Research by Albrecht et al. [38] did not confirm increased pest control in the cultivations next to flower strips in subsequent years of the flower strip.

In order to achieve a maximum insect diversity, wild flower strips should be characterised by a high diversity of species and structure [53]. Wix et al. [54] recorded more butterflies and individuals in total in flower strips than in control plots, with the number of plant species as the key factor.

Flower strips must include plants that bloom even for several years, which requires careful planning and management, as the ability of plants to bloom decreases with time [34,54]. With environmental awareness continuously rising, the assumption in creating flower strips is to do so in the fields where plant protection chemicals are not used. Depending on the quality of the perennial flower strips (plant diversity, dominant species), they may need some treatment. Mowing or slight care treatments (every two or three years) may turn out to be necessary to minimise problems with weeds [18]. However, it must be borne in mind that rare mowing is beneficial for pollinators, particularly butterflies, which need constant access to nectar [36].

2.3. Width of Flower Strips

Apart from an appropriate species mixture, the width of the strip to seed the plants is also important. Tschumi et al. [13] showed that a 3 metre strip adjacent to a potato field was a place where the abundance of net-winged insects, hoverflies and ladybirds increased significantly, thus making it possible to limit the number of aphids. Although the research on flower strips covers strips of various widths (mainly 3 to 8 m) [27,29], one advantage of minimum 6 metre flower strips is undoubtedly the fact that they can act as a buffer zone protecting green cultivations from pollution by plant protection chemicals coming from neighbouring non-green cultivations. Moreover, if flower strips (e.g., perennial ones) include high plants, they may also become a mechanical barrier stopping pathogenic fungal spores carried by winds. It is worth noting that the plants in the strip are also often food for birds, which are a natural farmers' ally in biological protection [14] (Figure 3). A strip that is too narrow may then expose them to predators more easily, while a wider one can provide shelter and even a safe nesting place.

Figure 3. A 6 m flower strip with high plants surrounded by sweet corn cultivation, luring beneficial insects (mid-July 2022, authors' observations in the National Park of Greater Poland).

2.4. Weeds on Flower Strips

Some farmers fear that flower strips may become a reservoir of weeds that can then spread into the surrounding fields. Although there is such a risk, properly created and tended strips will not create problems [14]. Moreover, some weeds can be maintained on arable land, pathways, the lines of fences and non-cultivated areas at an acceptable level of density. Accompanying plants, the so-called weeds, strengthen landscape diversity, mainly playing a functional role in agricultural ecosystems and their biodiversity; they constitute a basis for the agricultural food web, providing food to many organisms [31,40,55,56]. For example, their presence increases regulatory services, as they ensure the survival of the Apidae [37,55]. The interactions between a weed and the pollinating insect are regulated by flower features, such as its colour, shape and smell, but also depend on the quality of available pollen and nectar. Rollin et al. [56] suggest three groups of pollinators as potential bioindicators for biological evaluation of balance within a farming land management strategy in a moderate climate: the species Geometridae and Bombyliidae visiting Caryophyllaceae and Papilionidae feeding on Apiaceae and Syrphidae, which visit Asteraceae. Molthan [57] also indicated preferences of insect groups visiting particular plant families. Syrphidae were indicated to prefer the plants of the Apiaceae (*Pastinaca satica* L., *Daucus carota* L.) and Asteraceae (*Matricaria chamomilla* L., *M. maritima* L., *Sonchus arvensis* L.).

3. Conclusions

The intensive use of chemicals in agriculture, related to the intensification of agricultural production and yields, has also led to the degradation of the agricultural landscape, which is reflected in the reduction of the area of natural habitats and their pollution, genetic eutrophication and weakening of ecosystem services [14]. Introducing flower strips to the landscape, due to their rich food base and creation of habitats, has a positive effect on the development, reproduction and wintering of beneficial organisms, and this in turn contributes to reducing the density of pests of crops. Ecological focus areas, including belts, are an important environmental refuge. They are clearly a challenge for farmers, as they require additional work and costs and require care and knowledge about the selection of mixtures and techniques for laying the belt. The literature contains many proposed species compositions for flowering plants, taking into account the selection of plants that produce significant amounts of nectar and pollen (e.g., *Fagopyrum esculentum*, *Hypericum perforatum*, species from the Apiaceae family), plants that vary in terms of their lifespan (annual, biennial, perennial species) and species with different flowering periods and flowering lengths [2,29]. It is also possible to plan one's own flower mix, depending on the preferences of the insects visiting it. An example is given in Table 1, but there are many references that can help to compose such a mix.

Table 1. Sample list of plants that can be used in flower strips and preferences of insect families in visiting plant species [28,57].

Family—Plants	Species—Plants	Family—Insects
Apiacae	*Daucus carota* L.	Syrphidae
	Pastinaca satica L.	
Asteraceae	*Calendula officinalis* L.	Syrphidae
	Centaurea cyanus L.	
	Chrysanthemum leucanthemum L.	
	Coreopsis tinctoria Nutt.	
	Cosmos bipinatus Cav.	
	Achillea millefolium L.	
	Matricaria chammomilla L.	
	Sonchus arvensis L.	
	Matricaria maritima L.	
	Echinacea purpurea (L.) Moench.	
Fabaceae	*Lotus corniculatus* L.	Apidae
	Lupinus angustifolius L.	
	Melilotus albus L.	
	Melilotus officinalis (L.) Pall.	
	Trifolium incarnatum L.	
	Trifolium pratense L.	
	Trifolium resupinatum L.	
	Trifolium repens L.	
Boraginaceae	*Borago officinalis* L.	Apidae
	Echium vulgare L.	
	Phacelia tanacetifolia Benth.	
Apiaceae	*Carum carvi* L.	Papilionidae
	Daucus carota L.	
Papaveraceae	*Papaver rhoeas* L.	Apidae
Lamiaceae	*Melissa officinalis* L.	Apidae
Malvaceae	*Malva sylvestris* L.	Apidae
Geraniaceae	*Geranium pratense* L.	Apidae
Polygonaceae	*Fagopyrum esculentum* Moench.	Apidae
Caryophyllaceae	*Gypsophila elegans* Bieb.	Geometridae, Bombyliidae
Linaceae	*Linum untatisimum* L.	Apidae

If commercial mixtures are used, it is worth checking the germination capacity of the seeds used beforehand. Strips of plants can also be a kind of buffer zone that can separate fields from other areas where chemical pest control methods are still used. This is extremely important when organic fields are adjacent to conventional fields, where there may be a risk of spray drift. The strips may not immediately provide the expected ecosystem services, but the benefits of their presence definitely outweigh the problems. Within the flower strips, chemical protection products cannot be used and plants in the flower strips should rather be mowed and not allowed to grow in natural succession.

Flower strips can support the environmental aspect of farming; however, a comprehensive estimate of their usefulness and risks is necessary. Batáry and Tscharntke [58] additionally point out the necessity of taking into consideration various scales and taxonomic groups while estimating agri-environment scheme activities to understand their environmental and economic effects and to develop their effectiveness further.

The need for further research on the impact of flower strips on individual crops in specific regions is very justified, as it is necessary to adapt the location of the flower strips to individual crops in a region, taking into account its climatic and environmental conditions. It is also important to establish principles of maintenance for the flower strips and the validity of mowing and to prove that the sowing of a mixture of herbaceous and flowering plants does not cause the threat of uncontrolled weed growth in the fields [59]. By systematizing the knowledge on flower strips and taking into account the results of research, it is hoped that the number of enthusiasts of this agricultural procedure will grow. To achieve this, it is necessary to popularize knowledge about flower strips.

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