An agro-environmental mowing regime favors the number of inflorescences and flower-visiting insects but not ground beetles of herbaceous boundaries of arable fields

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Abstract

Herbaceous boundaries adjacent to arable fields can deliver ecosystem services not sufficiently provided at the field scale, as well as disservices such as increased weed pressure. The levels of services and disservices depend on the management regime implemented in these boundaries. Our study was conducted in Western France, where herbaceous boundaries of many arable fields constitute the road verge, and various mowing regimes were tested for conservation purposes. Until now, most studies of the influence of mowing regimes focused on one taxonomic group and documented contrasting results depending on the environmental context. This study aimed to compare the influence of two mowing regimes on road verges by evaluating different taxonomic groups that could potentially deliver services or disservices to adjacent arable fields. The mowing regimes used were a standard and an agro-environmental regime, the latter being characterized by one late mowing, a high mowing height and biomass removal. We monitored, during two consecutive years, seven road verges and their adjacent arable fields. Each road verge was divided into two zones of equal length, characterized by a different mowing regime. Communities of plants, flower-visiting insects and ground beetles were sampled in herbaceous boundaries and/or arable fields in the period between the mass-flowering of oilseed rape and sunflower crops. In zones where the agro-environmental mowing regime had been implemented, the average number of inflorescences and flower-visiting insects within boundaries were higher than under the standard mowing regime. However, between the two mowing regimes, no differences in weed cover within arable fields and the average number of ground beetles within boundaries and arable fields were observed. To conclude, our study suggests that in our particular environmental context, an agro-environmental mowing regime could promote pollination in adjacent arable fields without increasing weed pressure within the field.

Keywords:

Road verge; Field boundary; Arable field; Winter wheat; Arable weeds; Flower-visiting insects; Ground beetles; Inflorescences; France

Introduction

The intensive agricultural production model based on an increasing use of external chemical inputs is currently questioned because of issues concerning environment and public health, as well as agronomic and socio-economic relevance (Bourguet & Guillemaud, 2016; van der Werf, 1996). In order to reduce the reliance on external inputs, several alternative directions have been proposed, considering efficiency-based and biodiversity-based agricultures (Duru et al., 2015). The biodiversity-based direction, considering environmentally-friendly agroecological practices for pest management, aims for a reduction of external inputs by promoting both a spatial and a temporal diversification of agroecosystems (Duru et al., 2015). In particular, it would be possible to reduce pest pressure by managing semi-natural habitats at the landscape scale in specific ways rather than just focusing on pest management at the field scale (Gurr et al., 2017; Holland et al., 2016).

These semi-natural habitats, and especially herbaceous boundaries, are indeed able to deliver ecosystem services that may be no longer sufficiently provided at the field scale, including crop pollination and pest control (Knapp et al., 2019; Persson & Smith, 2013; Stanley & Stout, 2014; Tschumi et al., 2015). Concerning pollination, boundaries can provide nesting sites as well as food for pollinators between periods of mass-flowering of different crops (Stanley & Stout, 2014), thus potentially avoiding a sharp decline of the number of pollinators due to limiting resources provided by arable fields after these flowering periods. Concerning pest control, boundaries can provide shelter for natural enemies, such as ground beetles, after crop harvest or during winter (Ganser et al., 2019; Labruyere et al., 2016), thus increasing the abundance of natural enemies and/or predation intensity in adjacent arable fields (Hof & Bright, 2010; Mansion-Vaquié et al., 2017). Nevertheless, these boundaries are also habitats for weed species able to colonize arable fields. Thus, boundaries may also supply disservices to adjacent arable fields, by an increase in weed pressure (Chaudron, Perronne, et al., 2016; Smith et al., 1999). However, the level of ecosystem services and disservices delivered by herbaceous boundaries to adjacent arable fields should depend on the management regime of these boundaries. Indeed, changes in vegetation structure and/or phenology can affect the habitat quality of boundaries for pollinators and natural enemies. As an example, the mowing regime can influence the number of flowering shoots (Jantunen et al., 2007; Noordijk et al., 2010), and consequently the number of visits by flower-visiting insects (Noordijk et al., 2009; Pywell et al., 2011), as well as the abundance of ground-dwelling arthropods (Albrecht et al., 2010; Buri et al., 2016; Noordijk et al., 2010). The timing of mowing can also influence the abundance of invertebrates in some environmental contexts (Humbert et al., 2012; van Klink et al., 2019) and change the quantity of propagules able to spread to adjacent arable fields and become problematic arable weeds (Chaudron, Chauvel, et al., 2016; Leng et al., 2011).

Our study was conducted in Western France, where herbaceous boundaries of many arable fields correspond to the road verge and are usually managed by mowing. Since 1986, in the French metropolitan territory, changes in mowing regimes have been tested, including an increased height of mowing, a decrease in mowing frequency, a delayed first date of mowing and/or a removal of biomass. These changes have been recommended to allow seed production by annual plants, to avoid the increase of soil nutrient levels and therefore the proliferation of nitrophilous species, to increase the taxonomic diversity of plants in boundaries, to avoid direct invertebrate mortality due to low mowing height, and to provide refuges and food resources for invertebrates such as flower-visiting insects (Association Hommes et Territoires, 2011; Association Nord-Nature Chico Mendès, 2009). Beyond the French context, these changes in mowing regime have also been recommended in other European countries such as Belgium and the Netherlands (Godefroid et al., 2005; Sykora et al., 2002).

We were interested in road verges adjacent to arable fields in Western France as a case study in order to investigate the impact of changes in mowing regime carried out in these road verges on different taxonomic groups that could potentially deliver ecosystem services or disservices to adjacent arable fields. Until now, most studies that examined the influence of mowing regime on road verges focused on one taxonomic group and a few diversity metrics, especially species richness of plants on the boundary, and recorded contrasting effects depending on the frequency and timing of mowing and whether biomass was removed or not (Jakobsson et al., 2018). Moreover, invertebrates (e.g. arthropods, Hemiptera) have been much less studied (Jakobsson et al., 2018), and the influence of a particular management practice usually appears to affect the level of diversity differently depending on the taxonomic group. For instance, the number of mowings per year can have a marginally positive impact on flower abundance, which appears significantly positively related to the number of visits by flower-visiting insects (Noordijk et al., 2009). These responses to mowing regimes furthermore appear highly context-dependent. For instance, compared to a less intensive regime, a higher diversity of ground beetles after two cuts with biomass removal was shown in the Netherlands (Noordijk et al., 2010), while a higher diversity in uncut areas compared to mown areas was found in Scotland (Haysom et al., 2004). These context-dependent responses have also been observed for road verge plant communities for which delaying the first date of mowing from early to late summer did not change plant species richness in Finland (Valtonen et al., 2006), but had a negative impact and could increase weed pressure in adjacent fields in France (Chaudron, Perronne, et al., 2016). In light of these considerations, assessing the relevance of changes in mowing regimes with the aim of maximizing ecosystem services while minimizing disservices delivered by boundaries to adjacent arable fields therefore requires to focus on a particular environmental context.

In our case study, two mowing regimes were compared: the standard mowing practice (one mowing in early summer, a short mowing height and without biomass removal), and an agro-environmental mowing practice (one late mowing between two and three months after the standard mowing date, a higher mowing height and biomass removal). Concerning herbicide treatments in arable fields adjacent to road verges, herbicides focusing on a broad spectrum of species were only applied before the sowing period; therefore, although weed pressure from road verges is underestimated, it gives us an idea of potential disservices delivered by boundaries to adjacent arable fields. In addition, although we did not directly measure ecosystem services, we adopted abundance-based metrics that are commonly used as proxies of these services (Noriega et al., 2018), and we assessed whether the implementation of the agro-environmental mowing regime changed (i) the weed cover in adjacent arable fields, (ii) the number of inflorescences and flower-visiting insects within boundaries and (iii) the number of ground beetles in boundaries and adjacent arable fields. In particular, we hypothesized that the agro-environmental mowing regime should increase (i) weed cover in the first meters from the boundary into the arable field, (ii) the number of inflorescences and flower-visiting insects within boundaries and (iii) the number of ground beetles within the boundary and in the first meters from the boundary into the arable field.

Materials and methods

Study area

The survey was carried out in an agricultural area dominated by cereal production located in Western France, Pays de la Loire region, Vendée department, France (46°29’N, 0°58’W). Seven arable fields under conventional farming (Appendix A) and their boundaries were monitored. The herbaceous boundary of each arable field was divided into two zones of equal length. In one part, the vegetation was mown in early summer at 5 cm above the ground level and the mown biomass was left on site (hereinafter standard mowing regime). This boundary zone and the adjacent arable field part constitute the standard site (Fig. 1). On the other part, the vegetation was mown in late summer at 25 cm above ground level and the biomass was removed (hereinafter agro-environmental mowing regime). This zone and the adjacent arable field part constitute the agro-environmental site (Fig. 1). The agro-environmental mowing regime has been operating for three consecutive years (2015, 2016 and 2017). In 2015, the mowing regimes were randomly allocated to the left and right halves of the field margin and then kept for the next two years (see Appendix B for details about standard and late mowing periods). Vegetation and flower-visiting insect surveys were performed in all field margins in both the years 2016 and 2017, while the sampling of ground beetles occurred in 3 winter wheat fields in 2016 and 3 winter wheat fields in 2017 (no field sampled twice during these consecutive years).

Data collection

Environmental data

The years 2016 and 2017 were characterized by distinct meteorological conditions (Appendix C), which influenced phenological stages of plants and thus associated insects. Therefore, to compare surveys between sampling periods, we expressed days in terms of accumulated growing degree-days (thereafter GDD) which were calculated following the method by McMaster and Wilhelm (1997) assuming a base temperature of 0 °C.

Vegetation surveys

In the boundary zone of each site, the vegetation was sampled along one transect (length: 25 m) positioned in the center of the relevant boundary section (14 transects in total, i.e. 7 boundaries × 2 mowing regimes). The two transects per boundary (i.e. one transect per mowing regime) were placed 40 m apart, each being positioned at 20 m from the center of the boundary section (Fig. 1A). All vascular plant species of all boundaries were recorded before mowing in the summers 2016 and 2017. The abundance of each species was estimated following the Braun-Blanquet species abundance-dominance codes (Braun-Blanquet, 1964) and then converted into relative percentage of cover.

In the arable field part of each site, three or four transects were positioned perpendicular to the boundary and at various distances into the field (Fig. 1A). These transects were placed 20 m apart from each other, while the distance between the first transect of the standard site and the first transect of the agro-environmental site was 40 m (Fig. 1A). On each transect, the cover of each arable weed species was estimated within four quadrats of 0.25 m^2. Following Gaba et al. (2017), arable weeds are defined as “the set of wild plants found in agro-ecosystems that are well adapted to disturbed environments and have been associated with crop production since the origin of agriculture”. Weed cover was always estimated after a similar weed management program conducted in the whole field, usually including soil tillage and/or pre- and post-emergence herbicide application depending on the crop (see Appendix A for weed management information in wheat). The quadrats were positioned at 1 m, 5 m, 15 m and 25 m from the boundary into the field. For each site, the average cover of each species per distance was computed.

Inflorescence and flower-visiting insect surveys

On each boundary zone, the number of inflorescences of dicotyledonous species was counted within three or four quadrats of 1 m^2 positioned 20 m apart from each other (Fig. 1B). The mean number of inflorescences of each species per boundary zone was computed. Flower-visiting insects on each boundary zone were studied in one plot of 100 m length × 1 m width positioned in the center of the zone. The two 100 m^2 plots per boundary (i.e. one plot per mowing regime) were placed 40 m apart, each being positioned at 20 m from the center of the boundary length (Fig. 1B).

Butterflies (Lepidoptera), honeybees and solitary bees (Hymenoptera), bumblebees (Hymenoptera), and hoverflies (Diptera) were recorded during 10 minutes every two weeks between June and July of both 2016 and 2017, resulting in 3 counts per year, 42 counts per mowing regime (3 counts × 7 boundary zones × 2 years). Flower-visiting insect counts were coincident with inflorescence surveys. Walks were carried out between 9.00 am and 17.00 pm when weather conditions were sunny and calm. In order to ensure that the sampling of inflorescences and flower-visiting insects is done each year at similar GDDs, we took into account the sowing date of the crop of the different fields.

Ground beetle sampling

Ground beetles were sampled in 3 winter wheat fields in 2016 and 3 winter wheat fields in 2017 (no field sampled twice). On each site, two transects were positioned perpendicular to the boundary and at various distances into the field (Fig. 1C). These transects were placed 20 m apart from each other, while the distance between the first transect of the standard site and the first transect of the agro-environmental site was 40 m. Along each transect, three sample points were positioned at different distances from the boundary: 0 m (within the boundary), 2.5 m and 25 m (Fig. 1C). Ground beetles (Coleoptera: Carabidae) were sampled with one pitfall trap partly filled with a soap mixture (5% soap, 95% water) and salt (500 mg.L^{-1}) to prevent the development of bacteria and fungi. Sampling occurred between May and June of each year, resulting in four (year 2017) or five (year 2016) sampling periods per year, each sampling period lasted one week. For each boundary zone and each year, the mean of ground beetles across the several sampling periods was computed to obtain a more complete measure of the ground beetle assemblage (see e.g. Noordijk et al., 2010).

Statistical analyses

Taxonomic composition of plant communities within boundaries

Variations in taxonomic composition of plant communities due to differences in mowing regime were investigated using a Principal Component Analysis (PCA) performed on Hellinger-transformed species data based on relative cover (Legendre & Gallagher, 2001), and the statistical significance was assessed using a permutation test (Appendix D). We also used a partial Redundancy Analysis (RDAp) based on the same data to estimate the unbiased amount of explained variance due to mowing regime (see Appendix D for details).

Weed cover in arable fields

We examined how the mowing regime affected the average weed cover at four different distances from the edge. To avoid a confounding effect related to the crop type sampled on weed composition and abundance, we used only sites located in winter wheat (i.e. three sites in 2016 and four in 2017, with no field sampled twice). These sites were subjected to soil tillage interventions and/or pre-emergence herbicide application before sampling. We implemented linear mixed models (LMMs) to assess the effect of mowing regime (a factor with two levels), year (a factor with two levels), distance (a quantitative variable) and all second-order interactions as fixed effects on weed cover, accounting for field identity as a random intercept effect. We chose to apply LMMs with Box-Cox transformation rather than binomial generalized linear mixed models (GLMMs) due to a strong asymmetry in the data distribution; requirements were met after the Box-Cox transformation (see Appendix E for details).

Number of inflorescences and flower-visiting insects

We examined how the mowing regime affected the average number of inflorescences of dicotyledonous species and the number of flower-visiting insects in all sites in 2016 and 2017. We focused on the counts made at around 360 GDD in 2016 and 320 GDD in 2017 after the standard mowing for both the average number of inflorescences and the number of flower-visiting insects to allow a comparison between years despite different meteorological conditions. This count was made between the flowering periods of the two mass-flowering crops in the area, i.e. oilseed rape and sunflower (see also Requier et al., 2015). We implemented quasi-Poisson generalized linear mixed models (thereafter GLMMs) to assess the effect of the mowing regime, the year and the interaction as fixed effects on the mean of inflorescences (or the number of flower-visiting insects), accounting for the field identity as a random intercept effect (see Appendix F1 for details). In addition, a Kendall rank correlation test was used to estimate the coefficient of correlation τ between the average number of inflorescences of dicotyledonous species and the number of flower-visiting insects, assuming a positive correlation between these two variables ($P < 0.05$).

Number of ground beetles in boundaries and arable fields

We examined how the mowing regime affected the average number of ground beetles, within the boundary and in the winter wheat field. We implemented quasi-Poisson GLMMs to assess the effect of mowing regime, year, distance and all second-order interactions as fixed effects on the average number of ground beetles trapped, accounting for field identity as a random intercept effect (see Appendix G1 for details).

For all LMMs and GLMMs tested, we checked for the homogeneity of variances, normality of the residuals, and applied a transformation when necessary. We applied sum to zero contrasts on fixed factors and Helmert contrasts on the random factor before fitting models, and a likelihood-ratio test based on the χ^2 distribution to evaluate the significance of the effect. The full model was compared with all models based on Akaike information criterion (AIC), and only the best model was presented, with both the lowest AIC and with all explanatory variables significant ($P < 0.05$). Statistical analyses were performed using R 3.5.1 (R Development Core Team, 2018) and its packages ‘vegan’ for PCA and RDAp (Oksanen et al., 2019), ‘forecast’ for Box-Cox transformation (Hyndman et al., 2019), ‘lme4’ for LMMs (Bates et al., 2015), ‘glmmTMB’ for quasi-Poisson GLMMs (Brooks et al., 2017) and ‘stats’ for Kendall rank correlation test.

Results

Taxonomic composition of plant communities within boundaries

The PCA of Hellinger-transformed species abundance data based on relative cover showed significant compositional differences between plant communities in boundaries depending on the mowing regime (Appendix D). However, the partial RDA highlighted that the influence of the mowing regime explained only a small part of the compositional differences after accounting for field identity (R^2_{adj} = 14.8%, Appendix D).

Weed cover in arable fields

A total of 21 arable weed species were recorded (Appendix E1). The average weed cover varied with the distance from the boundary, while the year and the mowing regime of the boundary appeared non-significant (χ^2 = 32.82, P < 0.001, Fig. 2, see Appendix E for details). The weed cover decreased from the first meter within the field to the field core (Fig. 2). The weed cover appeared usually low in arable fields but varied between fields, which could explain that the mowing regime had no influence although the agro-environmental practice presented a mean weed cover lower than the standard practice at all distances from the boundary (Fig. 2).

Number of inflorescence and flower-visiting insects

Taking into account all sampling periods, a total of 1521 flower-visiting insects were observed, including 612 bees, 520 hoverflies, 216 butterflies and 173 bumblebees. Considering counts made at around 360 GDD in 2016 and 320 GDD in 2017 after the standard mowing, we observed that the average number of inflorescences of dicotyledonous species varied with mowing regime (χ^2 = 32.14, P < 0.001), the year of the survey (χ^2 = 13.11, P < 0.001), and the 'mowing regime × year' interaction (χ^2 = 10.63, P < 0.01), with a stronger negative effect of the standard compared to the agro-environmental practice in 2017 than in 2016. In addition, mowing regime showed a higher explanatory power than the other variables (Fig. 3A, see Appendix F for details). The number of flower-visiting insects also varied with mowing regime (χ^2 = 27.79, P < 0.001) and year (χ^2 = 10.61, P < 0.01), with mowing regime showing a higher explanatory power than year (Fig. 3B, see Appendix F). In addition, the average number of inflorescences and the number of flower-visiting insects were positively correlated, although the correlation coefficient was low (τ = 0.23, P < 0.05).

Number of ground beetles in boundaries and arable fields

Taking into account all sampling periods, a total of 2270 ground beetles were trapped. Contrary to the number of inflorescences and flower-visiting insects, mowing regime did not influence the average number of ground beetles over the May-June sampling period, and year of the survey and distance into the arable field were also non-significant (see Appendix G2 for details). In addition, using data per sampling period rather than the average number of ground beetles over the May-June sampling period did not change the results (results not shown). However, within boundaries where the agro-environmental practice was used, the mean number of ground beetles was higher than within boundaries under the standard practice, although this difference was not significant (Appendix G).

Discussion

Our study showed that an environmentally-friendly (so-called "agro-environmental") mowing regime carried out on arable field boundaries differently affected communities depending on taxonomic group. In comparison with the standard mowing regime, the agro-environmental mowing regime increased the average number of inflorescences and flower-visiting insects within boundaries, but did not influence the average weed cover within arable fields and the average number of ground beetles within boundaries and arable fields.

Considering plant communities, the mowing regime only slightly changed the taxonomic composition of boundaries and did not influence weed cover within arable fields, which was probably due to the short duration of the survey, which covered only the first three years after the change of the mowing regime. Moreover, the arable fields studied were intensively managed for weed control, which could have limited the development of weed populations from boundaries. However, in accordance with previous studies (e.g. Cordeau et al., 2011; Marshall, 1989; Romero et al., 2008), we found that weed cover was significantly higher near the boundary, < 1 m from the edge of the field, with than at distances further away. This could be explained by a less intensive management of field boundaries, resulting in a denser seedbank than in the field core (José-María & Sans, 2011), and a higher proportion of seed dispersed from the herbaceous boundary (Chaudron, Chauvel, et al., 2016; De Cauwer et al., 2008; Petit et al., 2013).

Considering inflorescences and flower-visiting insects, the higher numbers observed in our study under the agro-environmental mowing regime appear in agreement with previous studies conducted on field boundaries (Potts et al., 2009; Valtonen et al., 2006; Woodcock et al., 2007), while other studies have highlighted different mowing regimes to promote floral resources and flower-visiting insects (Noordijk et al., 2009; Pywell et al., 2011). Moreover, in our study, the abundance of flower-visiting insects was positively correlated with the average number of inflorescences of dicotyledonous species, which is also in agreement with previous studies (Milberg et al., 2016; Noordijk et al., 2009). This positive effect of the agro-environmental mowing regime on the number of inflorescences and flower-visiting insects is likely due to the delay of the first mowing, allowing a longer flowering period for many species as well as seed production to provide the opportunity to produce seed for more species, therefore extending the availability of floral resources for flower-visiting insects, while an early mowing would cause a sudden decrease of resources which may potentially not be compensated later in the season (Jantunen et al., 2007). This important decrease in floral resources leads to a sharp decline in pollinator populations within agricultural landscapes (Persson & Smith, 2013). However, mowing twice a year or maintaining uncut refuges may also be recommended to increase floral resources and promote flower-visiting insects in other contexts (Buri et al., 2014; Noordijk et al., 2009). Moreover, biomass removal in agro-environmental mowing regimes could have also increased the cover and richness of dicotyledonous species at the expense of grasses (e.g. Pywell et al., 2011) due to the reduced competition and a higher light penetration to the ground (Tix & Charvat, 2005; Tognetti & Chaneton, 2015), which may benefit various groups of flower-visiting insects. However, the positive effect of the agro-environmental mowing regime may also be due to a temporal concentration effect (Kleijn et al., 2011). Indeed, although one mowing in late summer extends the availability of floral resources that attracts more flower-visiting insects, the advantage of the agro-environmental mowing regime may only be concentrated temporally, thus having a limited effect at the landscape scale (Johansen et al., 2019). However, this advantage allows greater availability of floral resources between the flowering periods of the oilseed rape and sunflower mass-flowering crops in our environmental context, which appears important to avoid the decline in pollinator populations between these two crops. Finally, in both the number of flower-visiting insects and the number of inflorescences, we found a significant effect of study year, which could be due to the smaller cumulative precipitation in 2017 compared to 2016, which may have constrained the regrowth of the vegetation after mowing. This inter-annual variability was observed in other studies (Potts et al., 2009; Pywell et al., 2011).

Considering ground beetles in boundaries and arable fields, we did not find any influence of the mowing regime on their number in accordance with previous studies

(Haysom et al., 2004; Lafage & Petillon, 2014), this being potentially explained by the weaker influence of mowing on Coleoptera than on other arthropods (Morris, 2000). Moreover, it is possible that some functional groups respond to the mowing period and/or to the removal of the biomass, while others do not, as shown by Lafage and Petillon (2014) as regard to the mowing period.

Conclusions

Changing the mowing regime is a way to enhance some ecosystem services and reduce disservices delivered by boundaries adjacent to arable fields (Chaudron et al., 2018; Chaudron, Perronne, et al., 2016; Noordijk et al., 2009) as well as urban road verges (O'Sullivan et al., 2017). Based on a case study in Western France, we highlighted that one late mowing, with high mowing height and biomass removal could promote flower-visiting insects without increasing weed pressure in adjacent arable fields. However, long-term surveys are needed to confirm these results, as well as the lack of influence of the mowing regime on the abundance of ground beetles both in boundaries and adjacent arable fields. Moreover, in a context of changes in management practices carried out on road verges, our results encourage multi-taxon studies, to provide more comprehensive information for decision-makers. The kind of agro-environmental mowing regime studied here should be tried out in other environmental contexts, especially to allow the generalization of the observed results. This will help maximizing services while minimizing disservices delivered by herbaceous boundaries in a context of declining pollinator populations (Potts et al., 2010) and increasing weed resistance to herbicides (Délye et al., 2013; Heap, 2014).

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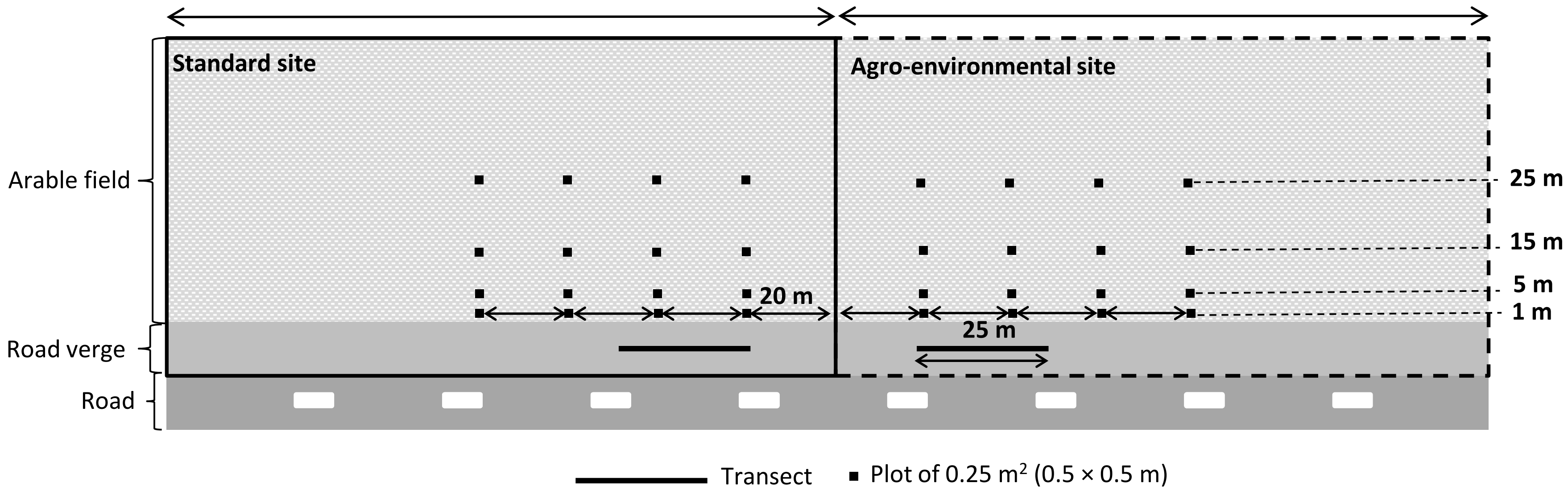
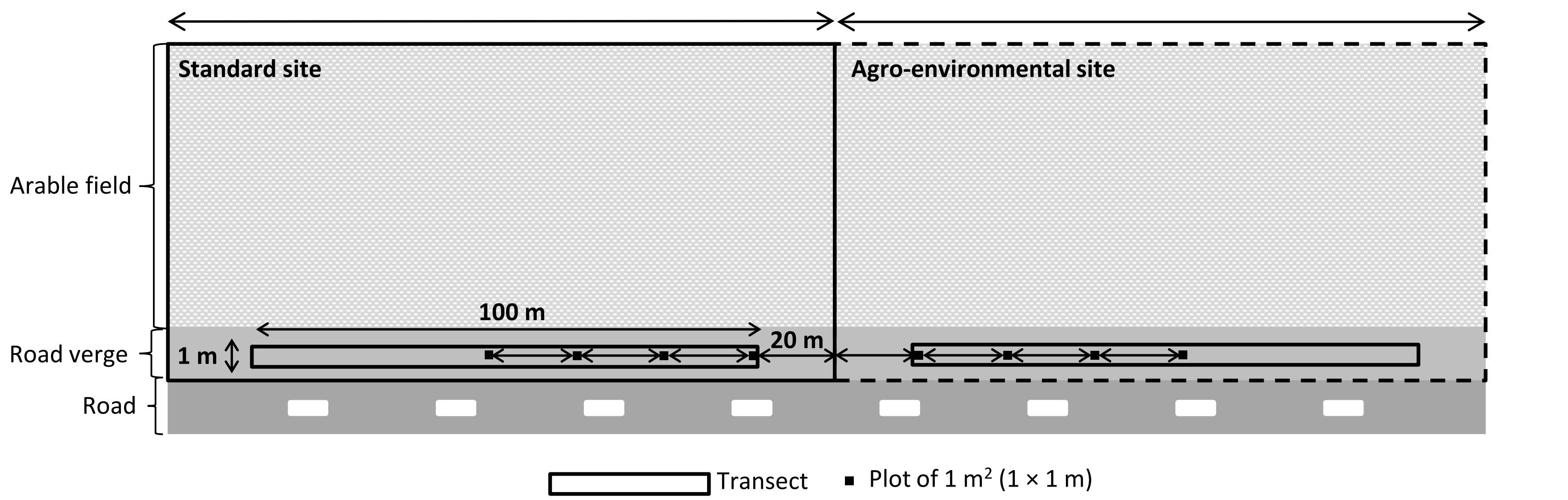
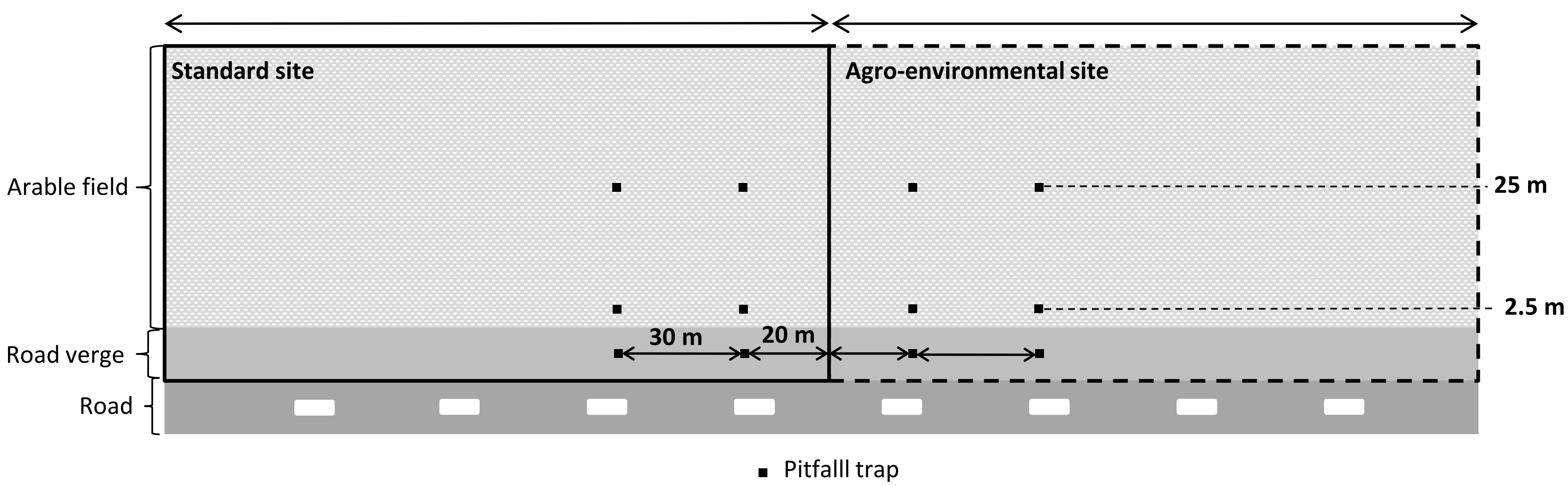
(A) Vegetation

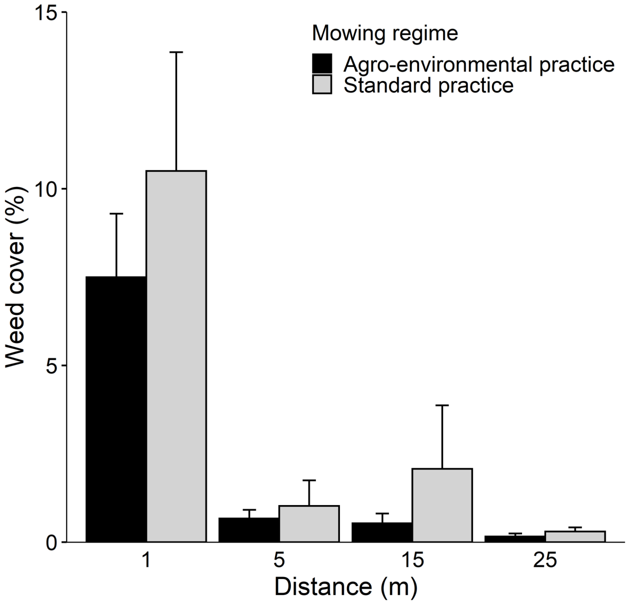


(B) Inflorescences and flower-visiting insects

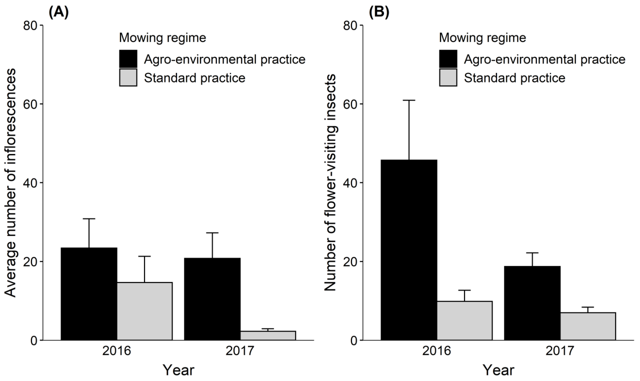


(C) Ground beetles





Mowing regime
Agro-environmental practice
Standard practice
Weed cover (%)
15
10
5
0
1
5
15
25
Distance (m)


(A)
Average number of inflorescences
0
20
40
60
80
Mowing regime
Agro-environmental practice
Standard practice
2016
2017
Year
(B)
Number of flower-visiting insects
0
20
40
60
80
Mowing regime
Agro-environmental practice
Standard practice
2016
2017
Year