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# Field Margin Grass Strips: Opportunity or Threat for the Weed Management in Arable Landscapes?

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## Abstract

Sown grass strips could be an opportunity (refuge) or a threat (source of crop infestation) for weed management in arable landscapes. Firstly, our field surveys recorded 187 weed species, among which 90% were arable species, mostly perennial and wind dispersing species, here mostly represented by the *Asteraceae* family. Even if sown grass strips harboured a high richness of unsown species (26 weed species/grass strip), the richness did not vary according to the time since establishment. Weed community composition drastically changed over time, with a quick shift (within the 2 first years) from annual to perennial species, and from common agricultural weeds to non-arable species.

Secondly, flora surveys performed with continuous transects from the field margin to the field centre showed clear plant spatial patterns. The sown grass strips acted as an ecotone with a sharp vegetation transition. Weeds occurring within the centre of the sown grass strips radically differed from species occurring within the first 0.5m of the cultivated area (only 15% of similarity between communities occuring in both habitats). Moreover, classical field margins influenced the weed composition up to 4.5m in the field whereas sown grass strips influenced the weed composition only up to 2m. We concluded that sown grass strips could be an opportunity to maintain plant diversity at the landscape scale and to decrease weed dispersion from the field margin to the field core in the short term. However, we discussed the long term impacts, especially to maintaining high level of annual species and segetal species in these perennial semi-natural habitats.

**Keywords:** Field margin; Ecotone; Buffer zone; Segetal weed; Trait; Agroecology

## Introduction

During the few last decades, radical changes have occurred in the European landscape mosaic [1]. Firstly, changes were observed in the structure of the agricultural landscape mosaic, with a drastic decrease in the number and the length of field margins, hedges in particular. Secondly, land use significantly evolved since the 90's, with a decrease in perennial arable surfaces (e.g. meadows). This simplification of cropping system complexity coupled with the intensification of certain agricultural practices (i.e. herbicides) has led to a considerable decrease in floristic diversity in the arable landscape [2]. In fact, many nation-wide surveys throughout Europe have shown a decrease in floristic diversity in particular in the field core areas. For instance, in France, the comparison between a national-wide survey performed in 1970 and 2000 showed that richness and abundance of weed species decreased by 42 and 67%, respectively, in field cores [2]. However, the crop edges and the field margins still remain refuges for a number of species. Since 2003, sown grass strips were set up by farmers along the pre-existing field margin [3].

French farmers set up these grass strip buffer zones between the cultivated area and the watercourses to limit pesticide drifts. Since pesticide application is prohibited on these strips, they are managed by mowing. Even if these strips were established for environmental purposes, they represent an opportunity for maintaining biodiversity in the landscape. On the one hand, it could be an opportunity for plants to have a refuge in the landscape and thus maintain or possibly even increase floristic diversity at the landscape scale. On the other hand, farmers are reluctant to create sources of weed seed dispersal along their field edges [4]. The study examined the impact of the establishment of sown grass strips on weed species, in time (over years) and space (at the surrounding landscape scale). We aimed to identify the dominant response trait of weeds occurring in the sown grass strips, to predict weed composition dynamics over time and potential weed dispersion to adjacent crops.

## Materials and Methods

### Temporal patterns of weed communities

Method 1 - Vegetation surveys were performed on 66 sown grass strips of various ages (from 1 year-old to 6 years-old) on two sites in France during the same period and with the methodology previously described by Cordeau [5]. Surveys were carried out in 10 quadrats (each 0.36m$^2$) within the sown grass

strip. The cover percent of each species was recorded with the Braun-Blanquet cover scale [6]. The biological characteristics of species and their potential frequencies in fields were described according to [7]. All species not mentioned in the French flora of cultivated field were considered as non-arable species.

### Spatial patterns of weed communities

Method 2 - From March to April 2009, the effect of the establishment of sown grass strips was assessed on 10 fields near Dijon (France) with 5 transects located at each opposite end of the same field [3,8]. These two pairs of 5 transects were laid out perpendicularly from the field margin to the centre of the cultivated areas. Each transect was composed of more than 63 quadrats (0.25m$^2$ each) continuously arranged across the different landscape elements. Overall, vegetation was surveyed in a total of 6800 quadrats. Weed species presence and density (number of individuals/m$^2$) were recorded in each quadrat. The similarity (Jaccard index) of weed composition was computed for each pair of quadrats along transects and then submitted to cluster analysis.

## Results and Discussion

### Temporal patterns of weed communities

During the two years, a total of 187 species were recorded in the 77 sown grass strips, among which 90% could potentially be found in agricultural fields and 48.9% were considered as frequent species in agricultural fields [7]. Overall, 42.2% of the species were therophytes, 46.6% were hemicryptophytes and a few were geophytes. Within the 20 most frequent species we recorded numerous perennial species (e.g. *Cirsium arvense*, *Convolvulus arvensis*) and wind-dispersing species mainly represented by Asteraceae species (e.g. *Taraxacum officinale*, many *Picris* sp.). A woody species, *Rubus* sp. was observed very frequently (66.2% of the sown grass strips). Even though weed species richness was high (26 weed species on average per strip), the sown species dominated the un-sown species in 81.8% of the sown grass strips surveyed. The total vegetation cover never reached 100%. This suggests that open area exist in the sown grass cover and that light can reach the ground and stimulate germination [9].

Weed species richness was not affected by the age (i.e. time since establishment) of the sown grass strips (one-way ANOVA, P=0.40). One-year-old strips harboured a high number of species which is not surprising since sown grass strips were established on the edge of the fields where weed diversity is frequently higher than in the field core [2]. However, weed composition changed over time with a quick shift (2 years after establishment) from annuals to perennials. Moreover, frequent agricultural weeds decreased over time and were gradually replaced by non-arable plants. Furthermore, plant diversity was greatest in sown grass strips of intermediate age (3-5 years old).Community assembly theory suggests that evaluating functional traits rather than species can provide important insights and lead to a more mechanistic understanding of plant community dynamics [10]. We found that geophyte, competitive and monocotyledon species were more frequent and abundant in grass margin strips than were therophyte, ruderal and dicotyledon species [11].

### Spatial patterns of weed communities

A total of 101 different weed species were recorded. When the field margin was directly adjacent to the crop, similarity between the field margin quadrats, the crop edge quadrats and the quadrats of the 4.5 first metres of the field was 0.5. With the presence of a sown grass strip located between the field margin and the cultivated area, the similarity between field margin and sown grass strip quadrats decreased to 0.41, and down to 0.25 between the last quadrat of the sown grass strip and the crop edge, and down to 0.15 between the crop edge and the first quadrat of the field margin.

Four patterns were identified:

a. Perennial, competitive species occurred predominantly in field margins and colonised the sown grass strips but did not spread into the fields.

b. Species whose occurrence increased in the fields were mainly competitive and competitive-ruderal perennials.

c. Arable species were mostly present in the tilled area. The sown grass strips did not modify the distribution pattern of arable species in the fields.

d. Species occurring in the field margins and in the fields, but not in the sown grass strips, acted as a filter for exchanges between the field margins and the fields.

## Conclusion

Our study aimed to understand if the establishment of sown grass strips in arable landscapes could be an opportunity for maintaining plant diversity or a threat for weed management. We showed that sown grass strips represent an interesting habitat harbouring rich and diverse plant communities. Sown grass strips acted as a refuge first for arable species emerging from the seed bank, and secondly for species dispersing from the field margin to the sown grass strips. Moreover, we showed that the sown grass strips acted as buffer zones for weed species, limiting the crop infestation. In the short term (up to 6 years after establishment), the sown grass strips seem to be an opportunity in arable landscape to maintain plant diversity and limit crop infestation by weeds.

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## Conflict of Interest

The funding sponsors had no role in the design of the study, in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

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