Effects of agricultural practices on spatial dispersal patterns of four permanent grassland species

Bernard Amiaud, A. Merlin, A. Damour, Etienne Gaujour, Sylvain Plantureux

EFFECTS OF AGRICULTURAL PRACTICES ON SPATIAL DISPERSAL PATTERNS OF FOUR GRASSLAND SPECIES

AMIAUD B. [1], MERLIN A. [1], DAMOUR A. [1], GAUJOURD E. [1] and PLANTUREUX S. [1]

[1] *Nancy Université, UMR Agronomie Environnement INPL-(ENSAIA)-INRA, Vandoeuvre-lès-Nancy, FRANCE*

bernard.amiaud@ensaia.inpl-nancy.fr

The effects of agricultural practices on floristic composition of grasslands are well known but few studies investigated these effects on plant spatial patterns involved in the maintenance of plant diversity. In order to identify major processes controlling dispersal patterns of four grassland species, presenting several dispersion modalities (anemochorous, barochorous and zoochorous *sensu* Grime *et al.*, 1988), we have used spatial analysis (4TLQV and Wavelet) adapted to grids sampling. With these methods, when the quadrat variances are plotted against block size, the peaks of these graphs are interpreted as the scale of the mapped phenomena (Guo and Kelly, 2004). A generalization of mowing impact according to dispersal modalities was highlighted by our results. Indeed, an effect of mowing on spatial patterns from functional traits connected to dispersion was showed by spatial analysis. For example, dispersal distances of barochorous species such as *Ranunculus bulbosus* is enhanced by mowing and grazing. In contrast, zoochorous grass (*Festuca arundinacea*) which have the theoretical capacities to produce expansive lateral spread up to 1 meter was limited in his expansion by cutting and grazing. This study showed that disturbance can play an important role in dispersal and the spatial structure of grasslands species.

Introduction

The effects of agricultural practices on floristic composition of grasslands are well known with a recent interest in plant traits. Plant traits are any morphological, physiological or phenological feature measurable at the individual level, from the cell to the whole-plant level, without reference to the environment or any other level of organization (Violle et al., 2007). The identification of plant traits that explain responses of species to grazing or mowing intensity is one of the main tools in management of grazed systems (Weiher et al. 1999) but few studies investigate the management practice effects on plant spatial patterns involved in the maintenance of plant diversity. Spatial distributions in grasslands and meadows were mainly dependent on the vegetation propagation mode and the seed dispersal. Species with structures that favour wind and animal dispersal have better regional local invasion success. At smaller spatial scales, further research is required on the determining factors of dispersal and colonization patterns. Indeed, the natural dispersal capacities of plant can be modified by the effect of agricultural practices. Here, we explore agricultural practices effects on the plant spatial patterns of plant species showing different capacities of dispersion (anemochorous, barochorous and zoochorous *sensu* Grime *et al.*, 1988).

Materials and methods

We studied spatial patterns of two common grasses (*Festuca arundinacea*, *Lolium perenne*) and two forbs (*Ranunculus bulbosus*, *Taraxacum officinale*) choose for their dispersal characteristics and lateral expansion capacities *sensu* Grime *et al.* (1988) (Table 1). *F. arundinacea* wasmainly dispersed by animals and its theoretical lateral spreadwas up to 1 meter. *T. officinale* was dispersed by wind and its lateral spread do not exceed 0.10 meter. *T. pratense* and *R. bulbosus* were grassland species with unspecialized dispersion mode with a lateral spread limited, respectively, to 0.25 meter and 0.10 meter. We established experimental grids on six permanent grasslands into clay-loamy soil at the experimental installation INRA-SAD at Mirecourt, France (6°81' E, 53°6') in May 2007. Three grasslands were grazed by dairy cows with a stocking rate of 1.5 UGB/ha/an and three were mowed twice a year. One experimental grid (4 x 4 m) was randomly selected in each permanent grasslands and coverage of species was recorded in each 1,600 (10 x 10 cm) quadrats.

Table 1. Dispersal capacities and spatial pattern analysis for (*Festuca arundinacea*, Trifolium pratense, *Ranunculus bulbosus, Taraxacum officinale*) under grazed and mowed management.

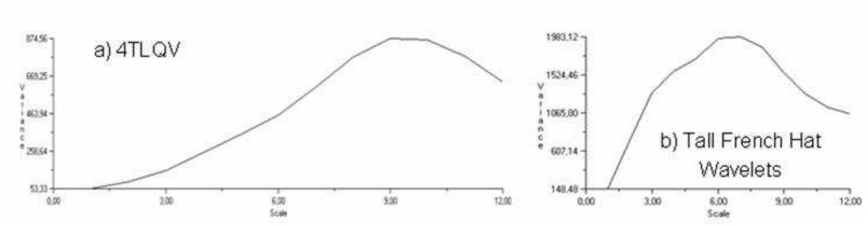
Species	Dispersal agent	Theoretical spatial patterns (m)	Lateral spread (m) sensu Grime et al. 1988	4 TLQV spatial	patterns (m)	Tall Hat spatial	French Wavelet patterns
				grazed	mowed	grazed	mowed
F. arundinacea	zoochorous	random	0.25 -1.00	0.30	0.30	-	-
T. pratense	unspecialized	aggregated	0.10 - 0.25	0.90	0.50	-	0.70
R. bulbosus	barochorous	aggregated	< 0.10	1.00	0.90	-	-
T. officinale	anemochorous	random	< 0.10	0.80	1.00	-	-

In order to identify major processes controlling dispersal patterns of four grassland species, presenting several dispersion modalities (anemochorous, barochorous and zoochorous *sensu* Grime *et al.*, 1988), we used two spatial analysis: 4TLQV and Tall French Hat Wavelet, adapted to grids sampling. With these methods, when the quadrat variances are plotted against block size, the peaks of these graphs are interpreted as the scale of the mapped phenomena i.e. the size of the patch and the zone of inflection of the curve was the size of the gaps (Guo and Kelly, 2004; Perry et al., 2006). All analysis were performed with Passage package (Rosenberg 2001).

Results and discussion

Impacts of mowing and grazing according to dispersal modalities were highlighted by our results (Table 1). Indeed, an effect of mowing and grazing on spatial patterns from functional traits connected to dispersion was showed by spatial analysis. However, the Tall French Hat Wavelett method does not give satisfying results.Dispersal distances of barochorous species *Ranunculus bulbosus* and unspecialized species *Trifolium pratense* were enhances by mowing and grazing. The size of the patch, highlighted by the spatial pattern analysis of *R. bulbosus*, increased and reached a maximum of 1 meter under grazed management (Table 1). In the case of *T. pratense*, the patch size was greater under grazing conditions than under mowing management (0.90 meter and 0.50 meter, respectively) (Figure 1). The grazing can locally reduce aboveground competition with others species in the community by increasing the availability of light. *T. pratense* responded by developing rhizomes in grazing conditions probably faster than in mowed grasslands. In contrast, the zoochorous grass *Festuca arundinacea* which has the theoretical capacities to produce expansive lateral spread up to 1 meter was limited in his expansion by cutting and grazing to patch size around 0.30 meter. The effect of grazing or cutting modified the random theoretical patterns expected by decreasing lateral expansion of *F. arundinacea* (Table 1). *Taraxacum officinale* had a theoretical random spatial patterns due to its mainly dispersal agent. Under management, the spatial pattern observed for *T. officinale* became aggregated and the patch size was higher than its lateral capacities (Table 1) so wind was not effective for the dispersion of seeds. The competitive pressure with surrounding tall grasses like *Lolium perenne* or *Alopecurus pratensis* (data not shown) probably limits the *T. officinale*'s dissemination capacities.

Figure 1. Spatial patterns for *T. pratense* in grazed grasslands (a: 4TLQV) and mowed grasslands (b: Tall French Hat Wavelets). The scale of window-width is plotted in units of quadrats (0.1 m).



Conclusions

The analysis of spatial patterns performed in this study did not give similar results and their use must be complementary. The size of the grid seems insufficient because the zone of inflection of the curve is not observed and this does not make possible to obtain the size of the gaps. However, this study showed that agricultural practices could play an important role in dispersal regime and in the spatial structure of grasslands species. Indeed, grazing and the mowing decrease or increase the size of the theoretical spatial patterns according to the dispersal characteristics of considered species.

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