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Effects of late mowing on plant species richness and seed rain in road verges and adjacent arable fields

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ABSTRACT

Delaying the first date of mowing of road verges is frequently practised as a way of preserving or enhancing biodiversity. Although the effects of this management practice on plant species richness remains controversial, it has been demonstrated that it allows more species to set seed. While an integrated management of the weed flora is currently promoted in arable fields adjacent to road verges, delaying the mowing of these field boundaries can be questioned, especially because seed dispersal from road verges to arable fields through field margins can be increased. In this context, the study aimed to assess the potential influence of delaying the first date of mowing of berms on (1) the species richness of berm standing vegetation (BSV), (2) the number of seeds and (3) the composition of seed rains in road verges and adjacent arable fields. To this end, we surveyed the standing vegetation and seed rain in four areas, i.e. in the berm, embankment, crop edge and field margin from a total of 252 sampling points. First, we analysed the effect of the mowing period (i.e. early or late summer) on species richness of both BSV and berm seed rain. Then, at each sample point in the four areas, we studied the variation in (i) seed abundance (i.e. number of seeds), (ii) contribution of BSV to each seed rain (i.e. Sorensen's similarity and Bray-Curtis' dissimilarity indices between the BSV and each sample point) and (iii) seed abundance of the most frequent species recorded in BSV.

Our findings showed that delaying the first mowing to late summer for four years had no impact on the species richness of BSV, while it increased species number and abundance of seeds in the berm seed rain. We also demonstrated that BSV of the late mown berms contributed more to the berm seed rain, than that of early mown berms. Moreover, our results suggest that compared to early mowing, only *Dactylis glomerata* dispersed more seeds from the late mown berms to field margins. Regarding the most frequent weed species observed in the BSV, for example *Elytrigia repens*, *Arrhenatherum elatius* and *Convolvulus arvensis*, the number of seeds trapped in field margins was low except for *A. elatius*. Finally, under our conditions, late mowing remained inefficient in promoting plant species richness on berms, but did not represent a particular factor of weed risk in field margins.

1. Introduction

Over the past century, the extension of road infrastructures and the increase in the area dedicated to arable fields have led to a loss of semi-natural habitats in agricultural landscapes (Coffin, 2007; Stoate et al., 2009). Nevertheless, road verges which are herbaceous boundaries between the road and the arable field represent remnant habitat patches favourable for many plant species (Huijser and Clevenger, 2006). In recent years, management practices on road verges have been defined in order to conserve and promote biodiversity in agricultural landscapes (e.g. Way, 1977; Parr and Way, 1988; Persson, 1995; Valtonen et al., 2006; Jantunen et al., 2007; Auestad et al., 2011). However, beyond the potential role of road verges in preserving plant biodiversity, several arable weed species occur frequently in these field boundaries (Hovd and Skogen, 2005). Weeds generally refer to plant species growing where it is not wanted and interfering with cultivated plants (Zimdahl, 2013). From an agricultural viewpoint, these plant species are particularly undesirable as they can compete with crop plants for nutrients, water and light, thus potentially affecting crop yield and quality of seed crops, and

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increasing cost management for weed-control (Zimdahl, 2013). Since some weeds occurring in field boundaries are able to colonise and reproduce within the cropped area (Marshall, 1989; Cordeau et al., 2012), management programs of road verges defined for conservation purposes may also be questioned as to their potential influence on weed dispersal in adjacent arable fields, particularly in the context of the current management strategy for arable fields aimed at reducing herbicide use (Blackshaw et al., 2006; Chikowo et al., 2009).

Management programs of road verge vegetation in some French regions currently involve delaying until late summer the first mowing of the berm, i.e. the area of the road verge located between the safety zone and the ditch (Fig. 1a, in this definition the safety zone represents the area along the roadway which is intensively managed to maintain visibility). A number of studies have demonstrated that impacts on plant diversity can be contrasting depending on the mowing period. Indeed, based on a meta-analysis of mowing practices on meadows, Humbert et al. (2012) highlighted that species richness could be enhanced when the first mowing was delayed from spring to summer while unchanged or reduced when delayed from summer to autumn or from early summer to late summer. In two studies conducted in Finland (Valtonen et al., 2006) and the United Kingdom (Parr and Way, 1988), no change in plant species richness was observed when road verge cutting was delayed by around one month in summer.

Delaying mowing also allows several plant species to complete their life cycle (Jantunen et al., 2007), in particular, it has been demonstrated that it can increase the number of species setting seed (Leng et al., 2011). In addition, several studies have shown that for some species the number of seeds increases according to the mowing date (Smith and Jones, 1991; Smith et al., 1996b; Lennartsson and Oostermeijer, 2001). Delaying mowing may thus increase seed abundance in the berm seed rain but could also promote weed dispersal in adjacent arable fields.

Seed dispersal – i.e. the movement of seeds away from their parent plants – is a complex process which occurs over time and space due to the persistence of seeds in the soil seed bank and potential spreading of seeds over long distances (Nathan and Muller-Landau, 2000). Humans also contribute to this process, for example, seed dispersal along roads over long distances can occur due to seeds being transported by vehicles (Von der Lippe and Kowarik, 2007). Seed dispersal in space is an important factor for weed population dynamics both within and between arable fields, potentially facilitating weed spread at various spatial scales (i.e. from the field to the landscape scale, Petit et al., 2013).

De Cauwer et al. (2008) reported that seed dispersal from a herbaceous boundary into a cultivated field decreased with increasing distance into the field. Based on the few studies which have investigated weed seed dispersal from boundary to arable field, only a few seeds seem able to spread to more than three or four meters into the field margin (Rew et al., 1996; De Cauwer et al., 2008). However, other studies have demonstrated that mowing practices can increase opportunities for seed dispersal of some species (Coulson et al., 2001; Leng et al., 2011), especially for therophyte species which reproduce and disperse only by seed (Milakovic et al., 2014) and are favoured by disturbances (Pedley and Dolman, 2014). While road verge management is established to preserve plant diversity, it may potentially conflict with an

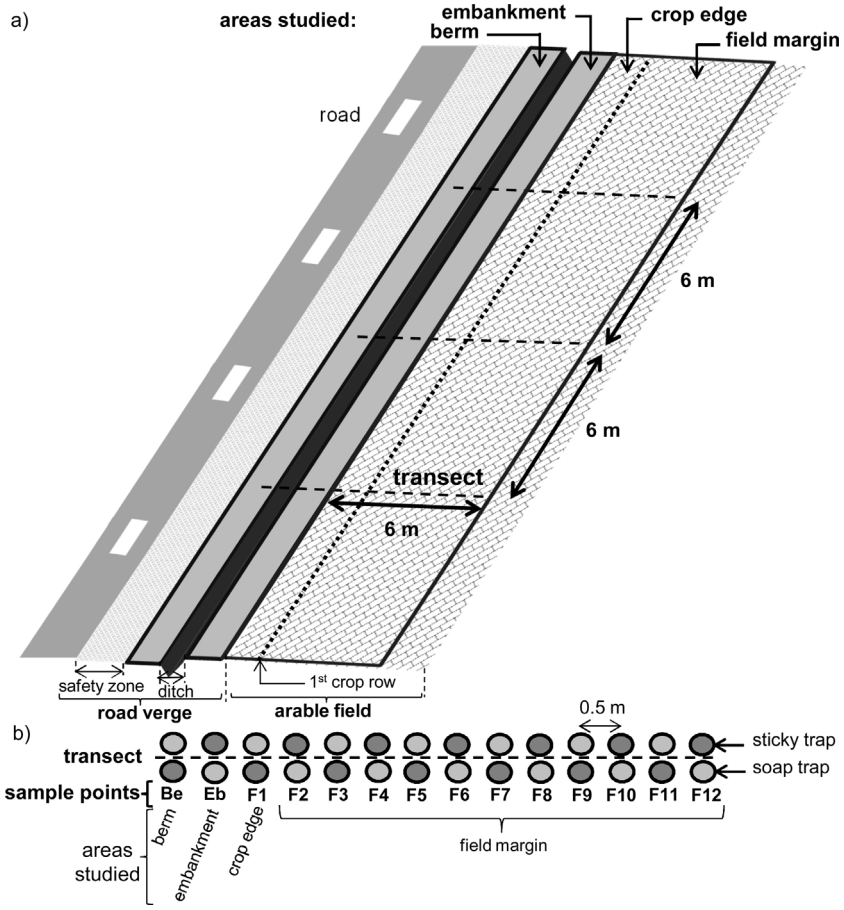

Fig. 1. Areas studied and sampling design used, (a) position of the three transects from the berm, to the field margin b) focus on one transect with sample points in the four areas, from left to right: berm (Be), embankment (Eb), crop edge (F1) and field margin (F2–F12).