IMPACT OF GRASSLAND MANAGEMENT ON PESTS AND DISEASES OF WHITE CLOVER

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Introduction

Managed grassland systems rely on a number of sources for their nitrogen, including (i) industrially produced nitrogen fertilizer, (ii) biologically fixed nitrogen (N-fixation) via the symbiotic relationships of Rhizobia with leguminous plants, and (iii) nitrogen contained in animal manures and urine. One of the major aims of managing sustainable grassland systems is to minimise the use of industrially produced fertiliser, due the large amount of energy required for its production and the environmental and human health impacts arising from leaching into watercourses and aquifers (Frankow-Lindberg and Frame, 1996; Peeters, 2009) often because of improper application in timing and amount. Therefore, the introduction of legumes and the management of the composition of grassland sward to maximize atmospheric N-fixation is one of the pillars in these production systems worldwide (Peeters, 2009). White clover (*Trifolium repens* L.) is the dominant forage legume species in north-west Europe (Gierus et al., 2012) and is an integral part of many grassland systems in mixtures with perennial ryegrass (*Lolium perenne* L.). White clover is valued not only for its N-fixation ability, but also for its nutritive value (Gierus et al., 2012) for livestock, especially sheep (Harvey et al., 2000). However, the establishment and maintenance of clover to ensure an adequate balance in the sward for optimum feeding quality, is often difficult. Several pests and diseases are known to attack white clover in the UK and are one of the main reasons for its failure to thrive. In this study we identified pest damage to white clover plants in fields that had been resown with grass/ white clover mixtures in two consecutive years.

Methods

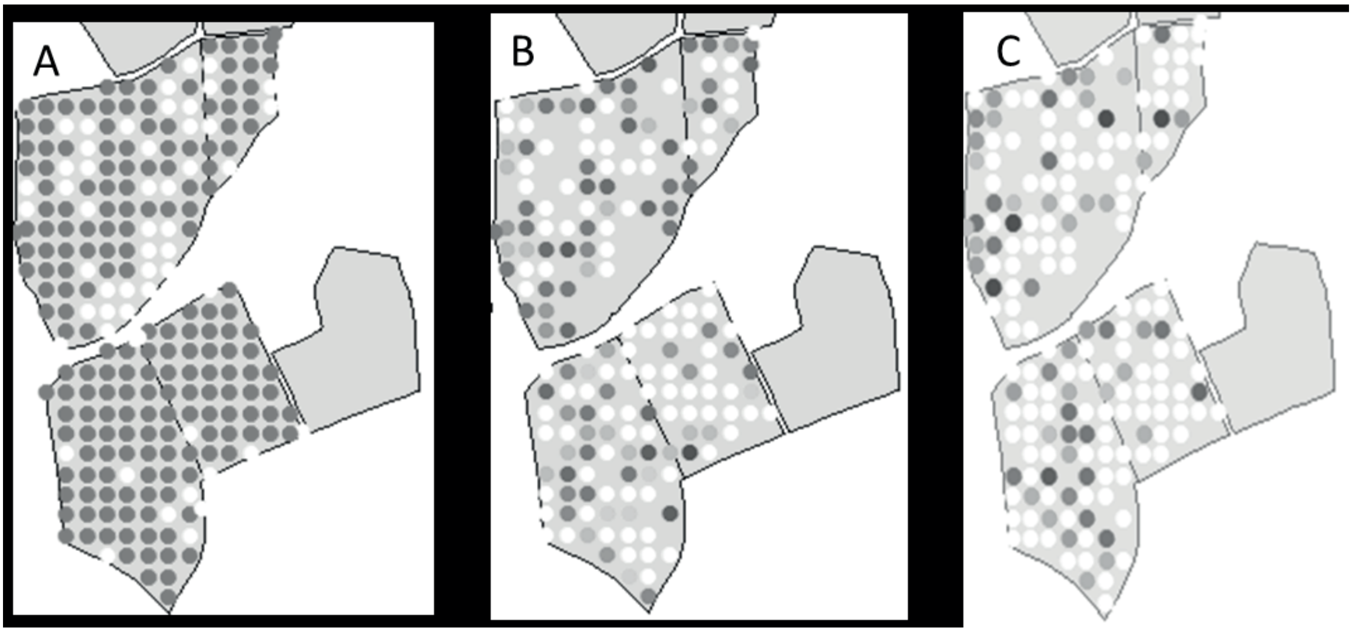
Two fields on the Rothamsted Research North Wyke Farm Platform (southwest England) were selected for study. One (Middle Wyke Moor) was reseeded with a *Lolum perenne* cv. AberMagic / *Trifolium repens* cv. AberHerald mixture in late summer 2013 and one (Dairy South) was reseeded with a similar mixture in 2014. Soil cores (8 cm diameter × 6 cm deep) were taken on a 25 m grid pattern across both fields in spring 2015. From the cores the stolon length (m m^{-2}) and the number of growing points (m^{-2}) of the clover were determined at each point. Generally, the identity of the damaging organisms can be identified easily by examining the shape and size of leaf holes made by pests and the lesions resulting from fungal diseases. We assessed the percentage damage due to *Sitona* spp. and *Apion* spp. weevils along with that caused by slugs on the first, i.e. youngest, fully unfolded leaf from each growing point (Clements and Murray, 1991). In addition, we estimated the percent incidence of large (*Pseudopeziza* spp.) and small (*Leptosphaerulina* spp.) spot diseases (Lewis and Thomas, 1991).

Results and Discussion

In total 276 cores were taken and leaves from over 17,000 growing points assessed. As would be expected, the field sown in 2013 had a significantly greater clover content than the field sown in 2014. The total damage i.e. percentage leaf area removed or colonised by the various organisms, varied significantly between fields (Table 1). The average loss of photosynthetic area across all fields was relatively low ranging from 3.4 to 5.1% (2013 vs 2014 sowing respectively), with *Sitona* spp. being the most injurious pest. Although the levels of *Sitona* infestation were low the sampling time probably underestimates the size of the pest problem as the main adult *Sitona* emergence from the soil is usually in late July/August. The assessment of the youngest leaf, which is easy to define and which has been exposed to pest and disease attack for the shortest period also led to an underestimation of the damage as older leaves do tend to exhibit greater tissue removal. The reasoning behind sampling as we did here was that we were sampling actively growing regions of the plant so we could assess the immediate damage. Older leaves rapidly start to senesce and we have no indication of how long they have been exposed. The results nevertheless indicate a resident population of pests. However, the main impact of *Sitona* in clover crops is that of the larvae feeding on the N-fixing root nodules. The adult lays eggs on the soil surface where they hatch. The first instar larvae then burrow down and feed on the nodules. Each larva can destroy up to 10 nodules (Gerard, 2001) and as the larvae develop they feed on progressively larger roots. Slugs were clearly present in both fields since they damaged leaves and in all probability there would have been grazing which was not recorded.

Figure 1 shows the spatial distribution of clover and damage at each of the sampling points. What is noticeable is that there was a fairly even establishment of clover across both fields, however the pattern of the distribution of the damage was not the same in both fields. For both *Sitona* and *Pseudopeziza* the damage levels in the newer 2014 sowing tended to be greatest around the edges of the field, whereas in the older 2013 sowing there tended to be a more even spread. This indicates that these pest organisms may be utilising the field margins as refugia allowing recolonization of the pasture.

Figure 1.
Spatial distribution of A. stolon length, B. *Sitona* spp. leaf damage and C. *Pseudopeziza* leaf spot disease in two ryegrass/white clover fields. The upper sown in 2014 and the lower in 2013. (The darker the colour the greater the stolon length, or pest and disease incidence.) (Arbitrary units)



Pest and disease damage, although relatively low, nevertheless represents continual attrition of plant resources putting pressure on the clover plants. Further work is necessary to identify mitigation strategies.

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Table 1.
Clover characteristics and pest and disease incidence on newly opened leaves of white clover (± s.e.).

	No. growing points (m^{-2})	Stolon length ($m\ m^{-2}$)	Sitona (%)	Slugs (%)	Apion (%)	*Pseudopeziza* (%)	*Leptosphaerulina* (%)
Middle Wyke Moor (sown 2013)	12977 ± 998.7	72.4 ± 5.42	1.59 ± 0.415	0.46 ± 0.109	0.25 ± 0.072	0.91 ± 0.192	0.23 ± 0.103
Dairy South (sown 2014)	4406 ± 609.6	26.5 ± 3.31	2.57 ± 0.407	0.88 ± 0.196	0.24 ± 0.058	1.09 ± 0.233	0.26 ± 0.092

References

Clements, R. O. and Murray, P. J. (1991). Incidence and severity of pest damage to white clover. *Aspects Appl. Biol.* 27, 369–372.

Frankow-Lindberg, B. E., and Frame, J. (1996). "Developments and challenges in sustainable grassland production," in *Proceedings of the 16th General Meeting of the European Grassland Federation*, eds G. Parente, J. Frame, and S. Orsi (Grado (Gorizia), Italy: ERSA, Ente Regionale per la Promozione e lo Sviluppo dell'Agricolture Via Montesanto, Italy), 337–345.

Gerard, P. J. (2001). Dependence of *Sitona lepidus* (Coleoptera: Curculionidae) larvae on abundance of white clover Rhizobium nodules. *Bull. Entomol. Res.* 91(02), 149–152.

Gierus, M., Kleen, J., Loges, R., and Taube, F. (2012). Forage legume species determine the nutritional quality of binary mixtures with perennial ryegrass in the first production year. *Anim. Feed Sci. Technol*. 172(3), 150–161.

Harvey, A., Parsons, A. J., Rook, A. J., Penning, P. D., and Orr, R. J. (2000). Dietary preference of sheep for perennial ryegrass and white clover at contrasting sward surface heights. *Grass Forage Sci.* 55(3), 242–252.

Lewis, G. C. and Thomas, B. J. (1991). Incidence and severity of pest and disease damage to white clover foliage at 16 sites in England and Wales. *Ann. Appl. Biol.* 118(1), 1–8.

Peeters, A. (2009). Importance, evolution, environmental impact and future challenges of grasslands and grassland-based systems in Europe. *Grassland Sci.* 55(3), 113–125.