Controlling docks (*Rumex obtusifolius* L.) using herbicides applied to seedling or established grassland

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Abstract

Docks are a widespread problem associated with intensively managed grassland. The experimental site was reseeded with perennial ryegrass in October 2009. A plot experiment (plots of 5m × 10m) was laid down in a randomised complete block design with nine treatments and eight replicates. Four treatments were each of four herbicides: (1) Linuron + 2,4-DB + MCPA; (2) MCPA + 2,4-DB; (3) CMPP; (4) Fluroxypyr + Triclopyr) applied at the seedling stage (SSH) in April 2010 and another four treatments (5) Amidosulfuron; (6) thifensulfuron; (7) Fluroxypyr + Triclopyr, and (8) Aminopyralid + Fluroxypyr) applied to established grassland (EGH) in April 2012. The ninth was an untreated control. Dock numbers and herbage production were measured over five years (2010-2014). SSH gave more (P<0.001) effective, enduring and eco-efficient control than EGH. EGH varied (P<0.001) in their effectiveness. In 2014 dock herbage dry matter (DM) production (Mg ha^{-1}) was 3.41 in the control compared with 1.38 for EGH and 0.55 for SSH. Across treatments in 2014 dock herbage suppressed grass herbage DM production (Mg ha^{-1}): grass = 11.17 – 1.047 × dock (R^2=0.73; P<0.001). Cost-effective long-term control was achieved by herbicide application during sward establishment.

Keywords: *Rumex obtusifolius*, docks, herbicides, grassland

Introduction

Broad-leaved dock (*Rumex obtusifolius* L.) hereafter described as 'dock' or 'docks' is a very common weed of intensively managed temperate grassland (Hopkins, 1986; Humphreys *et al.*, 1999). At low populations docks are of little consequence to grass production but at higher densities docks reduce the both the productivity of the sward and the intake of grazing animals (Derrick *et al.*, 1993; Hopkins and Johnson, 2003). In intensively managed temperate grassland, the control of docks is almost exclusively by selective herbicides. Control can often be poor and generally short-term with further applications required after a year or so (Hopkins and Johnson, 2003). The Sustainable Use of Pesticides Directive (SUD), Directive 2009/128/EC (Anonymous, 2009), places a legal framework on the general principles of reducing pesticides in agricultural production and the promotion of Integrated Pest Management (IPM). One of the principles of IPM is that herbicides should be targeted at weeds at their most susceptible developmental stage. Most of the published work on herbicide control was carried out on mature docks with very little conducted on seedling docks and the authors are not aware of any experiment comparing the effectiveness of seedling dock and mature dock herbicide treatments. The objectives of this study were to investigate the effectiveness of herbicides applied to seedling docks following grassland renovation or to mature docks in established grassland.

Materials and methods

The experimental site (52°35N, 7°31W and 20 m.a.s.l.) was reseeded with perennial ryegrass in October 2009. A plot experiment (plots 5×10 m) was laid down in a randomised complete block design with nine treatments and eight replicates. Four treatments were each of four herbicides applied at the seedling stage (SSH) in April 2010 and another four treatments applied to established grassland (EGH) in April 2012 (Table 1). The ninth was an untreated control. The herbicide treatments were selected based on approved

Table 1. Herbicide treatments in grassland over five years.

Seedling stage herbicides	
1.	3.5 l ha^{-1} Alistell (Linuron 30 g l^{-1} + 2, 4-DB 220 g l^{-1} + MCPA 30 g l^{-1}; United Phosphorus Ltd.)
2.	5.0 l ha^{-1} Legumex DB (MCPA 40 g l^{-1} + 2,4-DB 240 g l^{-1}; Hygeia Chemicals Ltd.) + 10 g ha^{-1} Triad (Tribenuron-methyl 50% w/w; Headland Agrochemicals Ltd.)
3.	2.5 l ha^{-1} Duplosan KV (Mecoprop-P 600 g l^{-1}; Nufarm UK Ltd.)
4.	1.5 l ha^{-1} Doxstar (Fluroxypyr 100 g l^{-1} + Triclopyr 100 g l^{-1}; Dow AgroSciences)
Established grassland herbicides	
5.	60 g ha^{-1} Eagle (Amidosulfuron 75% w/w; Bayer Crop Science Ltd.)
6.	22.5 g ha^{-1} Prospect SX (thifensulfuron-methyl 500 g kg^{-1}; Du Pont (UK) Ltd.)
7.	3.0 l ha^{-1} Doxstar (Fluroxypyr 100 g l^{-1} + Triclopyr 100 g l^{-1}; Dow AgroSciences)
8.	2.0 l ha^{-1} Forefront (Aminopyralid 30 g l^{-1} + Fluroxypyr 100 g l^{-1}; Dow AgroSciences)

product registration and all products were applied according to manufacturers' recommendations. In November 2009, dock seedling numbers were assessed in 0.25 m^2 quadrats at 10 m intervals along ten 100 m transects, placed at random positions across the experimental site. On average there were 8.1 seedling docks per m^2, standard deviation = 4.03. Plots were rotationally grazed by dairy cows each spring in February and March and then closed for silage. Silage was harvested in late May and in July. Subsequently, the plots were grazed rotationally by dairy cows for the remainder of the growing season; typically mid-November.

Dock population densities were assessed on two occasions (spring and autumn) each year over the course of five years (2010-2014). The total number of visible dock ramets was counted in each plot. A dock ramet was defined as having at least 4 leaves for the purposes of these assessments. Herbage was harvested for both silage cuts each year using a Haldrup plot harvester (J. Haldrup, Logstor, Denmark). Dry matter (DM) yield of harvested herbage was determined. Herbage from each plot was separated by hand into dock and other herbage before drying at 105 °C for 16 hours to determine the relative proportions of docks and other herbage on a dry-weight basis.

Dock numbers per plot in all nine treatments were subjected to a two-factor (herbicide treatment × sampling date) ANOVA with ramet numbers in April 2010 (prior to herbicide application) as a covariate. The main effects of each factor and interactions between factors were examined. Grass and dock herbage yields were each summed for each year over three years (2012, 2013 and 2014) and subjected to a two-factor (herbicide treatment × year) ANOVA. Relationships were examined using linear regression.

Results and discussion

In the untreated treatments dock numbers decreased initially with the lowest ramet densities recorded in autumn 2011 and during 2012 (Table 2). Subsequently, ramet numbers increased (P<0.001) substantially during 2013 and 2014. Following herbicide application SSH gave more (P<0.001) effective and enduring control than EGH (Table 2). The substantial increase in ramet numbers during 2013 and 2014 was evident across all treatments and was almost exclusively by clonal propagation. The rate of increase across all plots was proportional to the number of ramets present in each plot in spring 2013: dock numbers in autumn 2014 = 1.78 + 2.87 × dock numbers in spring 2013 (R^2=0.81; P<0.001). This substantial increase in ramet numbers, which commenced three and a half years after seedling establishment, has clear implications for the economic consequences of the herbicide treatments. Dock herbage yields increased (P<0.001) with dock numbers in 2013 and 2014 (R^2 = 0.51). Furthermore in 2014 dock herbage DM production (Mg ha^{-1}) was 3.41 in the untreated control compared with 1.38 for EGH and 0.55 for SSH.

Table 2. Dock ramet densities m^{-2} in grassland over five years.

Sampling dates	Dock ramets m^{-2}								
	Autumn 2010	Spring 2011	Autumn 2011	Spring 2012	Autumn 2012	Spring 2013	Autumn 2013	Spring 2014	Autumn 2014
Untreated	4.53	3.92	3.39	3.59	3.81	3.78	7.84	11.24	11.83
Seedling stage herbicides	**Post-application**								
1.	1.94	1.59	1.49	1.52	1.69	1.59	3.35	5.25	5.39
2.	1.53	1.30	1.30	1.28	1.49	1.33	2.20	3.08	3.58
3.	1.39	1.99	1.36	1.34	1.55	1.40	2.50	3.59	3.91
4.	0.90	0.37	0.43	0.43	0.43	0.46	0.62	0.85	1.03
Established grassland herbicides	**Pre-application**				**Post-application**				
5.	5.08	3.57	3.44	3.45	3.13	3.03	6.57	9.73	11.78
6.	4.47	3.98	3.31	3.38	2.36	2.27	5.31	8.86	9.82
7.	4.60	3.50	3.20	2.91	2.00	1.61	3.51	6.36	7.96
8.	5.38	5.18	3.79	3.84	1.15	0.69	2.86	5.46	5.84
	Herbicide			**Sampling date**			**Herbicide × sampling date**		
P-value	<0.001			<0.001			<0.001		
SEM[1]	0.201			0.438			0.604		

[1] SEM = standard error of the means.

Across treatments in 2014 dock herbage suppressed grass herbage DM production (Mg ha^{-1}): grass = 11.17 – 1.047 × dock (R^2=0.73; P<0.001). This relationship was not as strong in each of the earlier years. Impact of docks on grass herbage production increased as the dock became more prominent in swards during the course of the study.

SSH also gave more eco-efficient control than EGH. For example, treatment 4 involved 50% of the application rate of the same active ingredient as treatment 7, whereas the level of control of dock numbers achieved by treatment 4 in 2012, 2013 and 2014 was between 3.5 and 7.7 times better than treatment 7 (Table 2). The SSH targeted at the more vulnerable dock seedlings gave more cost-effective and eco-efficient control, in line with the SUD. It should be recommended to farmers to prioritise the application of post-emergence herbicides during grassland renovation even though the extent of dock problem might not become fully apparent until four years later.

Conclusions

Cost-effective, long-term and eco-efficient control of docks in intensively managed grassland was achieved by herbicide application during sward establishment.

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