Overseeding clovers and forbs in permanent grassland on peaty soils

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Abstract

There is a growing interest for multi-species swards because of their benefits of nitrogen fixation and increased biodiversity. A challenge for these multi-species grasslands is persistency of clovers and forbs, especially in nutrient-rich peat soils. Attempts to overseed multi-species swards have yielded mixed results, prompting an investigation into two overseeding machines and pre-seeding management strategies to introduce clovers and forbs into permanent grasslands. Given organic matter losses on peaty soils, reseeding is not preferred, necessitating methods with minimal soil disturbance for forb introduction. An experiment initiated in August 2019 on a permanent grass sward on peaty soil, utilized a tine harrow in short grass (<3 cm) and longer grass (10 cm), along with a strip-till cultivator in short grass, compared to complete resowing. Two years of measurements (2020 and 2021) revealed the strip-till cultivator had the highest clover and forb content (39%) of the overseeding methods, followed by the tine harrow in short grass (19%) and long grass (6%) whereas reseeding control resulted in 48% clovers and forbs. All four treatments resulted in similar total dry matter yields. In conclusion, strip-till showed the highest clover and forb content of the overseeding methods, while reseeding showed even higher contents.

Keywords: multi-species swards, clover, persistence, legumes

Introduction

Multi-species swards have gained increasing attention in European grasslands due to their associated benefits, including nitrogen fixation, drought resistance, and increased biodiversity. However, the limited persistence of these species poses challenges in permanent productive grasslands (Baker *et al.*, 2023). Reseeding grasslands encompasses disturbance of soil which results in loss of soil organic matter (Iepema *et al.*, 2022), and is particularly undesirable on peat soils where soil subsidence and climate impacts are major concerns. Introducing clovers and forbs in existing pastures through overseeding has yielded mixed results, particularly in the context of competition with existing grasses (Skinner and Dell, 2010). This study aims to evaluate the efficacy of two overseeding machines and pre-seeding management practices for the introduction of clovers and forbs into permanent grassland in comparison with reseeding.

Materials and methods

The experiment was established in August 2019 on a permanent grassland sward on a peaty soil in Stolwijk, the Netherlands. Soil pH_{KCl} was 5.6, organic matter content was 51.9% and soil texture was 24% sand, 4% clay and 17% silt. The experiment was subjected to four treatments: (A) long mowing (10 cm) followed by overseeding with a tine harrow and pressing with a Cambridge roller; (B) short mowing (<3 cm) followed by overseeding as in (A); (C) mowing to <3 cm followed by overseeding using a strip-till cultivator that seeded into 8 cm wide strips at 30 cm intervals; and (D) reseeding using a pneumatic reseeding machine after the sward was destroyed using a rotary tiller followed by a power harrow. Plot size was 6m by 10m with five replicate blocks. No fertilizer was applied in the months preceding the over/reseeding. In 2020 all treatments received 60 kg nitrogen in the form of dairy cattle slurry. All sown mixtures consisted of 0.7 kg of *Cichorium intybus*, 1.3 kg of *Plantago lanceolata*, 3.0 kg of *Trifolium pratense*, 2.0 kg of *Trifolium repens*, 1.0 kg of *Carum carvi*, 0.6 kg of *Lotus corniculatus*, 0.3 kg of *Achillea millefolium*, and 0.3 kg of *Scorzoneroides autumnalis* per ha. Additionally, the reseeding treatment included 30 kg *Lolium perenne* per hectare to compensate for the destroyed grassland sward.

Dry matter yield (DMY) was determined for four cuts in 2020, and the first cut of 2021 using a Haldrup plot harvester. The proportion of grass, red clover, white clover, chicory and plantain in the sward on DM basis was determined for each harvest by sorting grab-samples. Statistical analysis (ANOVA and Tukey HSD, $P<0.05$) was carried out in Rstudio.

Results and discussion

The DMY was on average 12 502 kg DM ha^{-1} in 2020 and 6154 kg DM ha^{-1} in 2021 (first cut only), and there was no significant effect of treatment in either year (Table 1). The proportion of white clover did not show any significant effect of treatment in 2020 (Table 1). The proportions of the other species were lowest for treatment A and B. The proportion of red clover was highest in the reseeded treatment while the proportion of chicory and plantain were similar for treatment C and D. The total proportion of sown clovers and forbs was significantly ($P<0.05$) lower for the two-tine harrow overseeding treatments (A and B) compared to the strip-till overseeding and reseeding treatments (C and D) in 2020 (Figure 1). Additionally, in 2021, the total proportion of clovers and forbs of the reseeding treatment was significantly higher than treatment C. Similarly, the yield of sown clovers and forbs increased in the order A = B < C < D in both years (Figure 1).

Overall, strip-till appears to be the overseeding method that achieves the highest proportion and yield of sown clovers and forbs while having no negative consequence on total yield compared to other treatments. It shows the importance of setting back the existing grass population for the successful establishment of clovers and forbs. However, it does not achieve the same yield in sown clovers and forbs compared to complete reseeding.

Strip-till offers an opportunity for overseeding multi-species clovers and forbs into permanent grasslands, without the negative consequences of complete reseeding. This is especially important for peaty soils. It should be noted that the selected soil had a relative high pH for a peaty soil (5.6), the establishment of clovers and forbs might be less successful on peat soils with a lower (more typical) pH.

Conclusion

We conclude that overseeding using a strip-till method is an effective way of introducing clovers and forbs into existing grass swards because it creates a more suitable environment for establishment of the newly germinated seeds. However, complete reseeding showed to have the highest proportion of clovers and forbs.

Table 1. Effect of (A) overseeding after tine harrowing in long grass, (B) overseeding after tine harrowing in short grass, (C) strip-till overseeding and (D) reseeding on total DM yield in 2020 (total of four cuts), 2021 (first cut only), the proportion (DM-basis) of white clover, red clover, chicory and plantain over the whole yield of 2020.

Treatment	Yield (kg DM ha^{-1})		White clover	Red clover 2020	Chicory (2020)	Plantain 2020
	2020	2021	2020 (%)	(%)		(%)
A	12 150 (899)	6107 (531)	1.5 (1.2)	0.5^{a} (0.9)	1.4^{a} (2.0)	0.1^{a} (0.2)
B	12 257 (937)	6329 (907)	5.0 (2.3)	3.2^{a} (1.4)	1.1^{a} (0.9)	2.4^{a} (2.1)
C	12 202 (521)	5770 (655)	4.3 (2.3)	9.1^{b} (3.0)	7.3^{b} (2.5)	14.3^{b} (5.3)
D	13 423 (951)	6173 (141)	3.6 (2.6)	15.0^{c} (3.6)	10.2^{b} (4.1)	15.9^{b} (1.5)
Average	12 502	6154	3.7	6.8	4.5	7.5
P	ns	ns	ns	***	***	***

Superscript letters indicate significant differences between treatments at $P<0.05$ ($N=5$). Values in parentheses are standard errors.

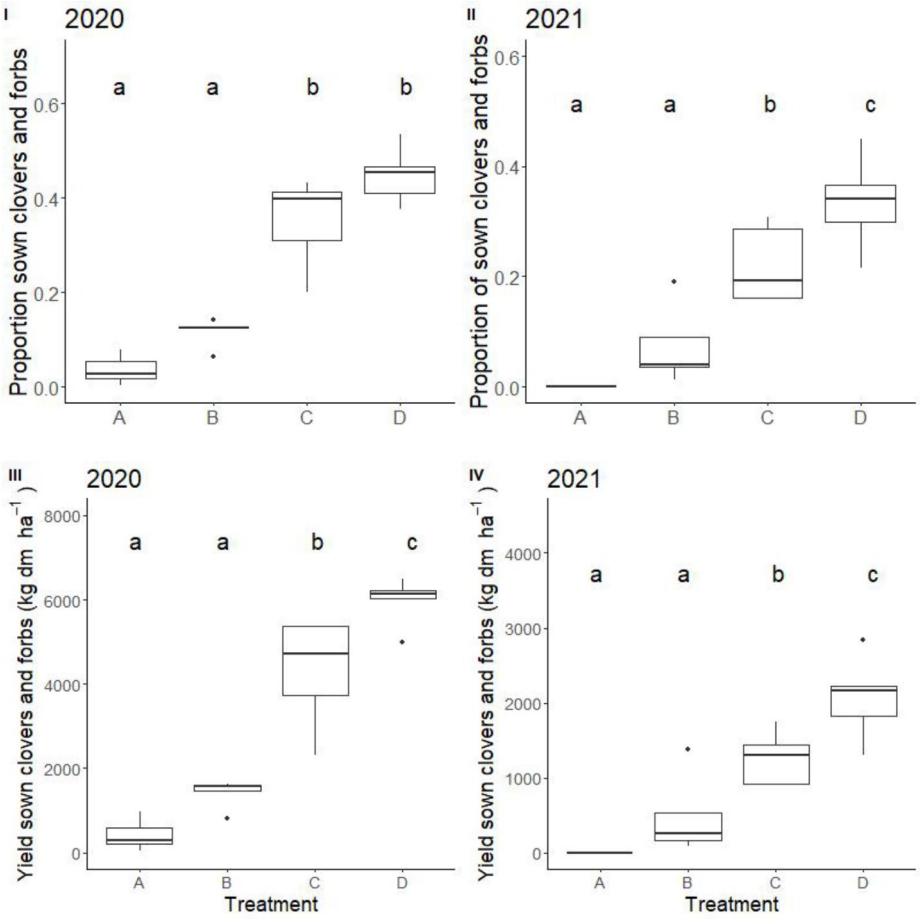

Figure 1. Effect of (A) tine harrow in long grass, (B) tine harrow in short grass, (C) strip-till overseeding and (D) reseeding on fraction of sown clovers and forbs in 2020 (I, $P<0.001$), 2021 (II, $P<0.001$), total yield of sown clovers and forbs in 2020 (III, $P<0.001$), 2021 (IV, $P<0.001$). Lower case letters show significant ($P<0.05$) difference between treatments ($N=5$).

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Why grasslands?

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