GRASSLAND YIELD RESPONSE TO KNIFE/TINE SLURRY INJECTION EQUIPMENT – BENEFIT OR CROP DAMAGE?

Rodhe L.[1], Halling M.A.[2]
[1]JTI – Swedish Institute of Agricultural and Environmental Engineering, Box 7033, SE 750 07 Uppsala, Sweden, +46 10 5166951, lena.rodhe@jti.se
[2]Department of Crop Production Ecology, Swedish University of Agricultural Sciences, Box 7043, SE 750 07 Uppsala, Sweden, +46 18 671429, magnus.halling@vpe.slu.se

1 INTRODUCTION

Slurry injection into grassland has certain advantages over slurry spreading as it decreases ammonia losses and odour and improves forage hygiene. However, in spite of the reduction in ammonia emissions with slurry injection compared with surface spreading, many studies report little or no effect on yield from the injection technique compared with surface spreading. The most common explanation given for this is that damage to the grass sward caused by injector tools balances out the larger amount of ammonium nitrogen left after slurry injection. Shallow injection without slurry application (depth 0.05 m, tine spacing 0.25 m) has been shown to significantly reduce grass yields compared with no injection (Rodhe *et al*., 2006). On the other hand, knife attachments similar to injector tines are used on lawns to stimulate grass growth. The design of the injector device influences how well the slurry is incorporated. In order to minimise ammonia emissions, the slots in the soil into which the injectors place the slurry should be covered (Rodhe *et al*., 2004). However, some shallow injectors leave open V-shaped slots in the soil after injecting the slurry.

The overall objective of this study was to evaluate the sward damage caused by different kinds of knife/injector tine equipment used in spring or summer in three different grassland swards, with and without added mineral nitrogen.

2 MATERIALS AND METHODS

2.1 Experimental site and design of experiments

The experiments had three replicates and were conducted on a field located south-east of Uppsala (59°50´N, 17°42´E). In field experiments with a split-split-plot design, four different types of knife/injector tine (sub-sub-treatment) were combined with three different grassland swards (sub-treatment; monocultures of red clover (*Trifolium pratense* L.) cultivar Vivi; perennial ryegrass (*Lolium perenne* L.) cv. SW Birger; and red fescue (*Festuca rubra* L.) cv. Rubin), with or without added nitrogen (main treatment). In the treatment with added nitrogen, the two grass swards received 100, 80 and 60 kg N ha^{-1} at the three cuts. For red clover, the corresponding levels were 50, 30 and 20 kg N ha^{-1}. Control plots with no knife/injector tine treatments were also included. Two experiments were carried out, with treatments applied in spring or after the first cut in mid-June, respectively. The plots (15.5 m^2) were harvested three times per year during 2008 and 2009 using a Haldrup plot harvester with 1.5 m working width. The herbage removed was weighed and sub-sampled for dry matter (DM) determination.

The Mixed procedure in the statistics programme SAS Version 9 (Littell *et al.*, 2006) was used for statistical analysis. The model for the three factors nitrogen (N), grassland sward (GS) and application technique (AT) was:

$$Y = AT\ N\ GS\ AT{*}N\ AT{*}GS\ N{*}GS\ AT{*}N{*}GS$$

and the random term was:

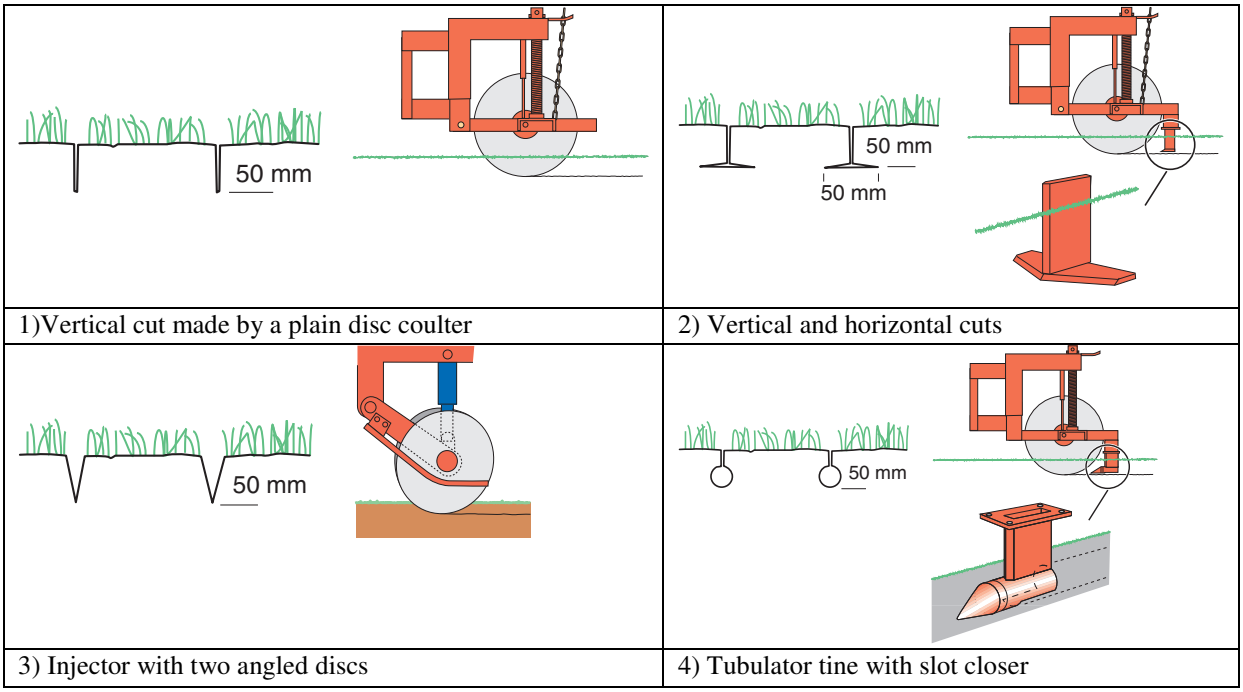
$$Block\ N{*}Block\ GS{*}Block\ AT{*}GS{*}Block\ N{*}GS{*}Block.$$

2.2 Soil and crop conditions

One composite soil sample consisting of 10 sub-samples randomly collected from the experimental site was analysed for texture and organic matter content. The soil at the site was classified as a loam, with 17.5% clay, 46.5% silt, 30.3% sand and an organic matter content of 5.7%.

2.3 Knife and injector tine equipment

The four knife/injector tine types used were: 1) Vertical cut made by a plain disc coulter; 2) vertical and horizontal cuts made by a plain disc coulter followed by a tine with a horizontal knife (0.06 m wide); 3) injector with two angled discs (open slot) (Rodhe *et al*., 2004); and 4) tubulator tine with slot closer (Rodhe *et al*., 2006), Figure 1. The knifes/injector tines were positioned at 0.25 m spacing over a total working width of 2 m and were operated at 0.05 m working depth.



1)Vertical cut made by a plain disc coulter | 2) Vertical and horizontal cuts

3) Injector with two angled discs | 4) Tubulator tine with slot closer

FIGURE 1 **Knife and injector tine equipment used in the experiment.**

3 RESULTS AND DISCUSSION

3.1 Yield

Statistical analyses revealed significant differences between the application techniques (Table 1). However, the type of application technique had no significant interaction with sward or nitrogen fertilisation level, which meant that all treatments (or levels) of these two factors had the same effect with all application techniques. The statistical analyses also revealed a significant interaction between species and N level (results not shown). The yield decreases caused by knife/tine injectors were larger when treatments were applied in spring (April) compared with summer (mid-June), especially during the first year, when all techniques gave significantly lower yields compared with the control. In the second year, this was also the case for all techniques except the injector with two angled discs (treatment 3), while for the total yields of the two years all treatments gave a significantly lower yield than the control in the spring experiment. In the summer experiment, there was no significant difference in total yield between the control and the vertical cutter (treatment 1) or between the control and the injector with two angled discs (3), but the yields for the vertical and horizontal knives (2) and for the tubulator tines (4) were both significantly lower than in the control. The yield was significantly lower in most cases in the cut directly following treatment for most of the techniques during both years, e.g. spring treatment gave a significantly lower first cut yield and summer treatment gave a significantly lower second cut yield. For both years, summer treatment gave a higher total yield than spring treatment.

During the first year, yields decreased by between 1 and 8% for the treatments with knives/injector tines compared with no knives/injector tines, while in the second year the decrease was 3-9%. The least harmful knife/injector equipment in spring and summer was the injector with two angled discs (3), while in the summer experiment the vertical cut coulter (1) also caused the smallest yield decreases. Overall, the results show that crop damage caused by the injection knives/tines may counteract any yield increase from nitrogen saved through injecting slurry into grassland.

TABLE 1 **Mean yields (kg DM ha^{-1}) in the control and in treatments with different knife/injector tine equipment (means for the three grassland species and with or without added nitrogen) in 2008, 2009 and sum of 2008 and 2009**

	2008		2009		Sum 2008-09	
Knife/tine equipment	**Spring**	**Summer**	**Spring**	**Summer**	**Spring**	**Summer**
1. Control	11 498	11 478	10 252	10 398	21 723	21 916
2. Vertical cutter	10 604	11 361	9 530	10 022	20 191	21 383
3. Vertical and horizontal cutter	10 600	10 745	9 377	9 941	19 977	20 687
4. Injector with two angled discs	10 837	11 226	9 911	10 126	20 748	21 414
5. Tubulator tine	10 634	10 669	9 546	9 982	20 258	20 651
Mean	10 835	11 096	9 723	10 094	20 579	21 210
P	0.0043	0.0006	0.0018	0.0737	0.0002	0.0022
LSD	494	403	431	339	692	653

LSD = least significant difference at $P<0.05$

4 CONCLUSIONS

All knife or injector tine equipment tested in grassland in spring resulted in significantly lower total yields compared with the control (no treatment). When such equipment was used in summer, the damage was not significant for all types of techniques, e.g. yields after treatment with a vertical cut coulter or an angled disc injector were not significantly lower than in the control.

Application technique had no significant interaction with sward, which meant that all treatments (or levels) of this factor had the same effect with all application techniques. However, the type of application technique had a significant interaction with nitrogen in one of the two years.

REFERENCES

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