2013 EGF ICELAND

The Role of Grasslands in a Green Future

Threats and Perspectives in Less Favoured Areas

Edited by

Á. Helgadóttir
A. Hopkins

EGF

VOLUME 18
GRASSLAND SCIENCE IN EUROPE

Lucerne (*Medicago sativa*) or grass-clover as cut-and-carry fertilizers in organic agriculture

Burgt G.J.H.M. van der [1], Eekeren N. van[1], Scholberg J.[2] and Koopmans C.[1]
[1] *Louis Bolk Institute LBI, Hoofdstraat 24, 3972 LA Driebergen, Netherlands*
[2] *Wageningen University, Droevendaalsesteeg 1, 6708 PB Wageningen, Netherlands*
Corresponding author: g.vanderburgt@louisbolk.nl

Abstract

On-farm nitrogen fixation is a driving force in organic agriculture. The efficiency with which this nitrogen is used can be increased by using lucerne (*Medicago sativa*) or grass-clover directly as sources of fertilizer on arable land: cut-and-carry fertilizers. In two arable crops, the use of lucerne and grass-clover as fertilizers was compared with the use of poultry manure and slurry. The nitrogen-use efficiency at crop level was comparable or better for the cut-and-carry fertilizers as compared to the animal manures. The relative P and K content of these fertilizers came closer to the crop demand than that of the poultry manure. Crop yields were comparable or better when using lucerne or grass-clover as fertilizer. It is concluded that cut-and-carry fertilizers are a serious alternative for manure as part of an overall farm soil fertility strategy.

Keywords: organic farming, cut-and-carry fertilizers, lucerne, grass-clover

Introduction

The objective of this study was to address the issue of developing intensive cropping systems that facilitate more effective use of on-farm N-fixation (Antichi *et al*., 2008). This was achieved by developing cropping systems based on grass-clover or lucerne used as fertilizer Burgt *et al*., 2013). Nutrients accumulated by these crops can be used as soil amendment rather than being sold off-farm as forage. This is desirable because the revenues from these crops are rather limited, whereas the on-farm nutrient-use efficiency can be improved.

Materials and methods

The experiments were located on an organic farm in the centre of the Netherlands on a well-drained clay soil with 2.6% of organic matter. During 2009 the use of fresh cut grass-clover, fresh cut lucerne and lucerne silage were compared with the application of chicken manure as a nutrient source for spinach. All materials were applied in four replicates of 3×15 m per plot five weeks before the sowing of spinach. After application, the fertilizers were mixed with the soil till 8 cm depth. The aim was for 200 kg N ha^{-1} to be applied. The realized N application rates are presented in Table 1.

Table 1. Nitrogen applied in 2009.

Treatment	Applied days until sowing	Fertilizer applied t ha^{-1} fresh	N-content kg t^{-1} fresh	N applied kg ha^{-1}
Control		0	0	0
Lucerne fresh late	10 days	27.0	6.1	165
Lucerne silage	36 days	18.2	11.0	200
Poultry manure	36 days	8.2	24.6	202
Grass-clover fresh	36 days	23.3	11.4	266
Lucerne fresh	36 days	24.4	11.1	271

In 2010 the experiment was repeated in a potato crop, using slightly adapted treatments. The treatments, again in four replicates with plots of 3×15 m, were: control, fresh-cut lucerne, lucerne silage, lucerne silage early application, poultry manure and a mixture of cattle slurry with vinasse. Lucerne early application was realized when the potatoes were planted; the other applications took place three weeks later when the ridges were formed. The aim was 125 kg N ha^{-1} to be applied. This was realized for all treatments, except for the mixture of cattle slurry and vinasse, which received 93 kg ha^{-1}.

Results

Fresh yield of spinach in 2009 was the highest with the use of fresh-cut grass-clover and fresh-cut lucerne, applied 5 weeks before sowing (Figure 1). Compared with chicken manure, use of lucerne and grass-clover applied 5 weeks before sowing increased N-production efficiency by 32-44% (Table 2). However, delaying application to 10 days before sowing did not result in an appreciable improvement of N-production efficiency. Mineral removal rates amounted to 67-126 kg N, 13-17 kg P and 122-233 kg K ha^{-1}. The P and K content of the forage crops closely matched actual crop demands of spinach resulting in only relatively slightly positive nutrient balances (Table 2). The P surplus of the poultry manure was very high.

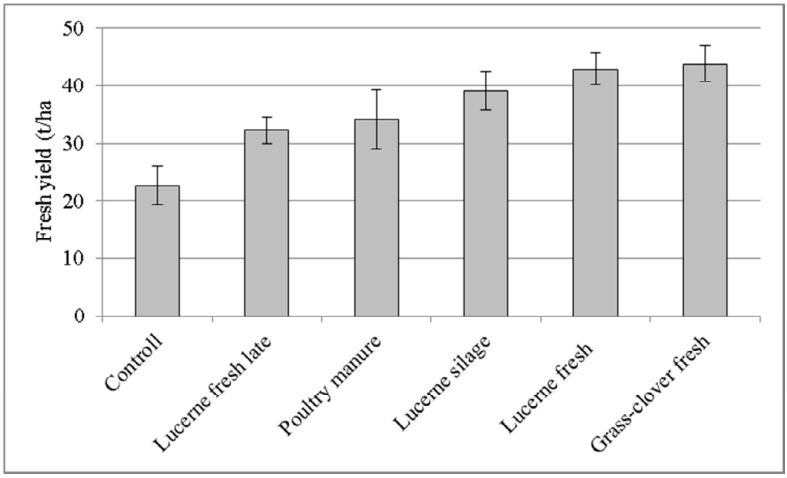

Figure 1. Fresh yield and standard deviation of spinach in 2009 in different fertilizer treatments.

Table 2. Mineral balance of phosphorous and potassium and ANR for spinach in 2009.

	P (kg ha^{-1})*		K (kg ha^{-1})		ANR(%)* §	
Control	-7	E	-31	C	-	
Lucerne fresh late	36	B	70	A	21	ab
Lucerne silage	21	C	36	Bc	23	a
Poultry manure	141	A	61	Ab	15	b
Grass-clover fresh	20	C	89	A	22	ab
Lucerne fresh	14	D	59	B	22	ab

* Significant for $P<0.05$ after ANOVA

§ Apparent Nitrogen Recovery: N-yield treatment[i] minus N-yield control, divided by N applied in treatment[i]

When the ridges were formed in the 2010 potato experiment, soil mineral N in the lucerne silage early-application plots was, on average, 38 kg ha^{-1} higher than on the other plots. The marketable yield of the potatoes was in all treatments higher than in the control. The lucerne silage early-application treatments had the highest yields, but differences were not statistically significant. Nitrogen removal rates varied from 64 to 92 kg ha^{-1}.
The P content of forage crops closely matched actual crop demands of potatoes resulting in only relatively slightly positive nutrient balances (Table 3). For K, all treatments except the slurry/vinasse showed negative balances. The apparent nitrogen recovery (ANR) was lower for the poultry manure.

Table 3. Mineral balance of phosphorous and potassium and ANR for potato in 2010.

	P (kg ha^{-1}) §	K (kg ha^{-1}) §	ANR(%) *
Control	−16	−139	
Lucerne fresh	11	-83	20 b
Lucerne silage early	2	−68	22 b
Lucerne silage	3	−58	20 b
Poultry manure	132	−28	11 a
Slurry/vinasse	−10	26	18 b

§ P and K based on measured input and default P and K content
*Significant for $P<0.05$ after ANOVA

Discussion

The nitrogen provided by lucerne and grass-clover gave a comparable or better ANR then nitrogen provided by poultry manure or slurry/vinasse. At crop level the P balance was much better using lucerne or grass-clover in both crops. Use of chicken manure resulted in a hyper-accumulation of phosphorus of 132-141 kg P ha^{-1}. The K balances were more ambivalent. This shows that cut-and-carry fertilizers such as lucerne and grass-clover have a high potential as providers of nitrogen fertilizer, while at the same time substantially reducing the risk of unbalanced P applications.
The overall effect on the mineral balance of introducing cut-and-carry fertilizers and reducing manure purchase in a farming system will strongly depend on the starting situation and the choices made by the farmer. An economic evaluation study indicated that the cut-and-carry fertilizers are of interest with prices above 12 € per ton of cattle slurry (€3.50 kg N^{-1}).

Conclusions

It is concluded that a cut-and-carry fertilizer system facilitates an effective use of perennial leguminous forage crops for sustaining inherent soil fertility. Based on studies with crops of spinach and potato it appears that use of fresh cut or silage materials from such leguminous crops will result in comparable yields, while also reducing the dependence of arable farms on external animal manures by closing nutrient cycles more effectively.

References

Antichi D., Mazzoncini M., Barberi P., Bigongiali F. and Carpi G. (2008) Leguminous cover crops: an important tool for improving resource use efficiency in organic arable cropping systems. Poster at: *Cultivating the Future Based on Science*, 2nd Conference of ISOFAR, Modena, Italy, 18-20 June, 2008.
Burgt G.J.H.M. van der, Werkman D. and Bus M. (2013) PlantyOrganic: Design and results 2012, Louis Bolk Institute, The Netherlands, 37 p.