Mechanical aeration and liquid dairy manure: application impacts on grassland runoff water quality and yield

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Introduction Wet weather on heavy soils reduces oxygen availability in the root zone and reduces forage yields. Mechanical aeration can improve forage yield in these soil conditions. Research has shown that under certain conditions, mechanical aeration can increase yield by improving drainage and aeration (Davies *et al*., 1989); aeration can also increase depression, storage and infiltration thus reducing surface runoff and improving nutrient distribution in the root zone. Aeration on sloping, fertilised grassland can provide environmental (Douglas *et al*., 1995) and agronomic benefits. The objectives of this study were to evaluate the runoff water quality and agronomic impacts of mechanical aeration and liquid dairy manure (LDM) applied to hillside grasslands.

Materials and methods A mechanical Aerator (Model: AerWay®) was evaluated on pasture consisting of cocksfoot with 10-20% lucerne, which had not received LDM for 6 years. The soil is a well-drained silt loam. The experiment was RCB with four treatments and three replicates. Each treatment block (2.5mx 2.5m) received 67 mm of simulated rainfall (SR) to generate runoff. Each block was surrounded on three sides with metal borders and on the fourth (down-slope) side with a runoff collector. Treatments included: 1) control, no aeration and no liquid dairy manure (CTL), 2) aeration only (AER), 3) manure only (MAN), 4) aeration and manure (AER+MAN). Runoff water quality analysis included: nitrate, ammoniacal-N, Total N (TKN), Dissolved Reactive Phosphorus (DRP), total P, Total Suspended Solids (TSS), runoff depths and rainfall leaving plots.

Results Water quality impacts included 1) Runoff Depth; Aeration during spring did not improve infiltration of water. 2) Nutrients; Nutrient concentrations in the simulated runoff events were higher with LDM and were unaffected by aeration. Aeration reduced losses of three or more nutrient species (N and P) in two of six SR events only in manured plots. Concentrations and loadings indicated that aeration of manured plots was more effective in reducing DRP losses than other species (Table 1). Total mean loadings of individual nutrient species in SR were reduced by ≥26% by AER+MAN vs MAN. 3) Suspended Solids; TSS concentrations were significantly higher with aeration but not with LDM application. Loadings of TSS from AER were >30% higher than the other three treatments. Forage yield impacts 1) In two of three harvests, MAN increased forage yield significantly vs CTL and AER while AER+MAN reduced yield vs MAN in one harvest. 2) Compared with MAN, total forage yields with CTL, AER, and AER+MAN were 78%, 67%, and 81%, respectively.

Table 1 Pollutant loadings in the first simulated runoff event

Treatment	Mean (SD)[a] nutrient loading (g/ha)					Mean (SD)[a] TSS loading (kg/ha)
	NO_3^--N	Ammoniacal-N	TKN	DRP	Total P	
CTL, control	27 (17)	4c[b] (4)	269 (101)	23(9)	32b (10)	2.9 (1.1)
AER, aeration	19 (3)	1c (2)	254 (92)	45 (55)	27b (4)	1.8 (0.6)
MAN, manure	40 (18)	112a (18)	531 (24)	210 (20)	186a (21)	2.4 (2.0)
AER+MAN Aeration+Manure	40 (17)	72b (14)	644 (347)	151 (160)	181a (102)	4.8 (2.4)
LSD[d]	(NS)	17	(NS)	(NS)	79	(NS)

[a]Mean and standard deviation based on three replicates;[b]Treatment means, followed by the same letter are not significantly different at α=0.05;,[c]ANOVA; [d]Fisher's least significant difference (p=.05)

Conclusions Aeration partially improved runoff water quality from manured grassland but adversely affected crop yield and nutrient uptake. Further studies should be performed on pastures with livestock traffic. Also, there is need for aerators that minimise surface soil disturbance to reduce TSS losses.

References

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