The effect of co-blending water treatment residual with manure on the concentrations of soluble phosphorus in surface runoff

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Introduction Water treatment residual (WTR) is a waste product from the purification of potable water whereby chemical products (Aluminium [$Al_2(SO_4)_3$] or iron salts ($FeCl_3$)) are included for coagulation of suspended sediment and dissolved organic carbon. Such residues have high levels of unutilised amorphous Al or Fe and could be used as an amendment to lower manure water soluble P (WSP). The aim of this study was to 1) characterise WTR phosphorus absorption maxima (Pmax) (2) determine the WTR capacity to lower WSP in cattle manure in the laboratory and the optimum time required for co-blending WTR with manure and 3) determine if runoff phosphorus (P) is lowered when WTR is pre-mixed with manure and surface applied in the field.

Materials and methods WTR from Carron Hill water treatment works, Co. Armagh was dried and ball-milled to <150µm. Phosphorus sorption isotherms were generated by batch equilibrium to determine WTR Pmax. WTR (25 g WTR/L) was shaken with standard P solutions (ranging from 0 to 3.5 g P/L, as KH_2PO_4) at 150 rpm for six days at 20ºC. The isotherm data were fitted to the linearised Langmuir model (Olsen and Watanabe, 1957) and a Pmax value was determined. In the laboratory, WTR was added to dairy slurry (2.5g WSP/kg) at 36, 72 and 144 g/kg. Samples were incubated in triplicate at 10ºC and removed from the incubator at 10, 24, 48, 72 and 108 hours. Samples were homogenised, centrifuged and analysed for residual WSP by the colorimetric method of Murphy and Riley (1962). For the field runoff experiment, slurry was mixed with WTR at two rates (100 and 250 g/kg) and after four days was surface applied at 50 m^3/ha to 0.5 m^2 grassland plots. A control slurry received no WTR amendment. Simulated rainfall was applied for 30 minutes at 40 mm/hr, two days later. Total runoff was collected and analysed for total P (TP) and dissolved reactive P (DRP). Logarithmic transformations (log base 10) were performed on all P concentrations and runoff volumes and differences in flow-weighed mean P concentrations between slurry treatments were assessed by analysis of variance.

Results A Pmax of 82.6 g P/kg was calculated for the WTR. This was much higher compared to the Pmax reported for 18 WTRs in the US, 10.4 to 37.0 g/kg (Dayton and Basta, 2005). In the laboratory experiment it was only with the highest WTR rate that WSP was found to be substantially reduced (Fig. 1). At 108 hours, WSP was reduced from 2.15 to 0.61 g P/kg, approximately 70%. Applications of WTR were further increased in the field runoff experiment to maximise the potential of reducing runoff P concentrations. However, although runoff P concentrations in runoff from WTR co-blended manures were lower than the control manure no significant difference was found in either P concentrations or runoff volume. A possible reason for this may be the increased manure dry matter which prevented thorough mixing.

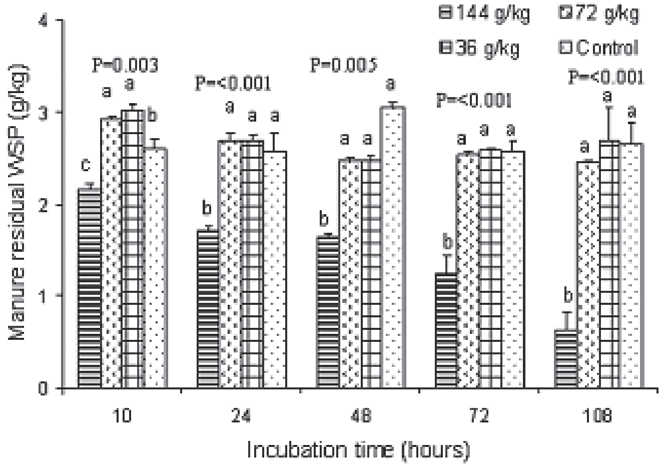

Figure 1 Rate of WSP sorption by WTR in dairy manure

Table 1 Effect of WTR on Flow weighted mean P concentrations and runoff volume

Manure treatment g WTR/kg manure	TP mg P/L	DRP mg P/L	Runoff mm
Control	3.7	3.0	0.3
100	2.7	2.4	0.4
250	2.0	1.9	0.9
P	NS	NS	NS

NS, not significant

Conclusions This is the first study to assess the effect of co-blending WTR with manure on P concentrations in runoff. To date only WTR applications in soil incorporation and as buffer strips have been investigated. Given that WTR may be a stronger sorbing material in Northern Ireland than in the US further work is required to optimise the rate of WTR rate in slurry as well as temperature and moisture conditions during incubation to realise the full potential of WTR co-blended manures as a best management practice.

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