

## Evaluating potential nitrogen tests for Irish grassland soils

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### Introduction

Current fertiliser nitrogen (N) recommendations used for Irish grassland are based on various factors such as production intensity, enterprise type, manure history and other management factors, but do not fully acknowledge the capacity of different soil types to supply mineralisable N ( $N_0$ ). A reliable, repeatable and economically viable soil-N test would provide the information that could differentiate soils, optimise grassland production, reduce fertiliser costs and negate some aspects of losses of N to the environment. Researchers have strived to enhance or develop new N tests with the aim of identifying the potential  $N_0$  from the soil for many years. Assessments of many previously developed quick chemical soil N tests have been conducted and comparisons made with reliable but time consuming biological methods (Selles *et al.*, 1999; Bushong *et al.*, 2007). The objective of this study is to evaluate the ability of a range of soil N tests to differentiate soils and quantify  $N_0$  supply for grass production in Ireland.

### Materials and Methods

During May and June 2010, soils were sampled to a depth of 10 cm from 37 sites across the island of Ireland. The composite samples collected from each site were sieved to 6.3 mm and a 0.25 kg sub-sample of fresh soil was retained and stored (<4°C). The remaining sample was dried to 40°C, sieved to 2 mm and stored for later analysis. Soil moisture content and background site information was gathered at sampling. The  $N_0$  potential of each soil was determined using the standard 7 d anaerobic incubation (AI-7) method using dried soil. The soils were also analysed using a selection of chemical soil N testing methods using fresh and dried soils as specified. These methods included: (1) Cold and (2) Hot (100°C waterbath for 4 h) 2M KCl extractable nitrate, nitrite and ammonium-N ( $NO_3^-$ ,  $NO_2^-$  &  $NH_4^+$ -N) methods (3) Mild acid-oxidation method yielding  $NH_4^+$ -N, (4) the recently developed Illinois soil N test (ISNT), measuring amino sugar &  $NH_4^+$ -N concentrations, and (5 & 6) Ultraviolet (UV) absorbance of 1M KCl filtered soil extract at 260 nm and 210 nm, respectively. Regression and stepwise regression analyses were performed on the data using the PROC REG statement in SAS in order to model soil N mineralization potential of these soils. The models included chemical soil test values and soil, site and management parameters and their interactions as sources of variation.

### Results and Discussion

A summary of mineral N concentrations in the 37 soils is shown in Table 1 for both cold and hot KCl methods.

Concentrations of  $NO_3^-$ -N ranged from 0.96 mg kg<sup>-1</sup> in the light sandy soils to 76.88 mg kg<sup>-1</sup> in heavier textured soils. Levels of  $NO_3^-$ -N measured by these two methods were relatively similar. The range in  $NH_4^+$ -N was narrow using the cold KCl method (0-11.3 mg kg<sup>-1</sup>) however the more rigorous hot KCl method showed a wider range (29.1-113.6 mg kg<sup>-1</sup>) between the soils as this method makes tightly bound exchangeable  $NH_4^+$ -N more available for extraction.

**Table 1.** Range and means of  $NH_4^-$  &  $NO_3^-$ -N levels obtained by 2M cold KCl and hot KCl extractable methods on 37 Irish soils.

N method	$NH_4^-$ -N	$NH_4^-$ -N	$NO_3^-$ -N	$NO_3^-$ -N
	Range (mg kg <sup>-1</sup> )	Mean (mg kg <sup>-1</sup> )	Range (mg kg <sup>-1</sup> )	Mean (mg kg <sup>-1</sup> )
Cold KCl	0-11.3	3.7	0.96-76.88	20.31
Hot KCl	29.1-113.6	54.3	2.4-92.9	30.1

Table 2 shows the simple regression analysis of the candidate chemical test values vs.  $NH_4^+$ -N mineralised using the AI-7 method. By itself the ISNT had the strongest relationship with AI-7 and was the strongest chemical method for predicting  $NH_4^+$ -N mineralisation. This is consistent with Bushong *et al.* (2008) who reported that the ISNT was an accurate predictor of N mineralisation in cultivated and pasture soils. The hot KCl and UV 210 nm test methods were more poorly related to the AI-7 method, while the UV 260 nm, acid oxidation and cold KCl test methods were not significantly related to the AI-7 method.

**Table 2.** Coefficient of determination ( $r^2$ ) for the regression analysis of AI-7 vs. the candidate tests.

Candidate tests vs. AI-7	$r^2$	Method used
AI-7 v's. ISNT	0.82	Khan 2001
AI-7 v's. Hot KCl	0.44	Schomberg 2009
AI-7 v's. UV 210 nm	0.39	Bushong 2007
AI-7 v's. UV 260 nm	0.35	Bushong 2007
AI-7 v's. Acid Oxidation	0.29	Bushong 2007
AI-7 v's. Cold KCl	0.00	Mulvaney, 1996

### Conclusions

The results from Irish soils show that large differences exist between soil types in their capacity to mineralise N. By itself the ISNT shows potential to predict  $N_0$  levels in Irish soils, however further analysis is needed to explore these relationships with the inclusion of other soil parameters (e.g. organic matter) and to validate these findings in the field.

### Acknowledgements

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### References

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