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Evaluating the hybrid soil moisture deficit model as a tool for indicating suitability for machinery traffic

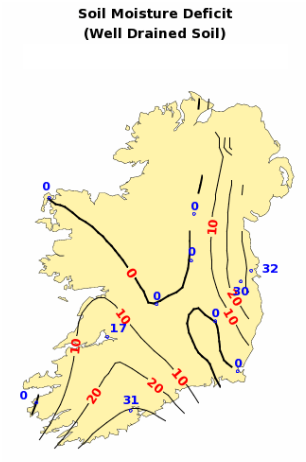

Image courtesy of Met Eireann (www.met.ie)

Key external stakeholders:

Advisors, farmers, agricultural contractors, policy makers.

Practical implications for stakeholders:

This research showed that the hybrid soil moisture deficit model, which is currently calculated and made available on a daily basis from Met Eireann, is a useful indicator of the suitability of soil conditions to receive machinery traffic for slurry application.

Main results:

Traffic by slurry application machinery had greater long term negative impact on soil bulk density and grass growth when the soil moisture deficit (SMD) was < 10 mm.

Opportunity / Benefit:

This study has shown the SMD model is a useful tool that could be applied in decision support to assist in determining whether traffic of soils on a given day will result in long-term negative impacts on the soil.

Collaborating Institutions:

UCD
Met Eireann
University of Ulster

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Teagasc project team: Mr. Stan Lalor (PI)
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External collaborators: Prof. Nick Holden, UCD

1. Project background:

Compaction is regarded as one of the main causes of degradation of agricultural soils. The vulnerability of a soil to compaction depends on the soil moisture content. Slurry application is one of the machinery operations in grassland that involves high axle loads and ground pressure, and can result in soil compaction if conducted under wet conditions. Soil compaction following slurry application is of particular concern given the potential for reduced grass growth, nutrient uptake and overland flow from compacted soils, resulting in reduced utilisation of slurry nutrients. Slurry application in early spring has been shown to be particularly advantageous for increasing the nitrogen fertiliser value. However, opportunities for slurry application in spring have also been shown to be restricted by soil conditions that are suitable for damage-free traffic. Therefore, a decision support tool to help identify days where soil conditions are suitable for machinery traffic may assist in optimising slurry spreading opportunities on farms.

2. Questions addressed by the project:

The aim of this study was to investigate the use of the hybrid soil moisture deficit (SMD) model as a proxy for volumetric soil water content to determine the suitability of grassland soils to support vehicle traffic with slurry spreading equipment.

3. The experimental studies:

Three experimental sites at Teagasc Johnstown Castle (Wexford) were selected, to represent well, moderate and poorly drained soils. Each site comprised 32 plots (4m x 5m) divided into 4 replicated blocks. Treatments were assigned randomly within each block. The hybrid SMD model was used to make daily predictions of SMD, based on the soil drainage class and weather data recorded at Johnstown Castle. Trafficking treatments were targeted at SMD = 0, 5, 10 and 20mm. Measurements in each plot were made of soil bulk density (n=8) and rut profiles (n=4). Measurements were taken prior to and after trafficking with a single axle slurry spreading tanker equipped with a splashplate (total weight c.18 tonnes) both in and between the wheel tracks. At 30 and 60 days subsequent to trafficking, these measurements were repeated, and herbage yield measurements were made within the wheel rut and the non-trafficked area. Statistical analyses were conducted using GenStat (14th Ed) and included ANOVA and repeated measurement of ANOVA, using the LSD to compare the means with a 5% probability level. Factors tested under these analyses included soil bulk density, rut cross-sectional area and herbage dry matter yield.

4. Main results:

The soil bulk density within the wheel rut increased significantly ($P<0.05$) by 8% to 22% compared with pre-traffic values depending on the SMD at the time of trafficking. The changes in soil bulk density recorded in the non-trafficked area were not significant ($P>0.05$). This suggests that the compaction incurred during slurry spreading is largely confined to within the wheel ruts. Soil bulk density in the wheel rut decreased significantly over time ($P<0.05$) by 8% to 17% depending on SMD. Where field traffic was conducted at SMD greater than 10mm, soil bulk density in the wheel rut decreased to near pre-traffic levels at 60 days post-trafficking (Figure 1).

Rut dimensions were significantly ($P<0.05$) influenced by the SMD; relatively larger ruts were formed at SMD 0 and 5mm compared with SMD 10mm or greater. The area of the rut profiles decreased over time ($P<0.05$), however, regardless of the SMD, the soil surface was not restored to its pre-traffic condition. Grass dry matter yield (DMY) was significantly reduced in the wheeled compared to the non-wheeled area ($P<0.05$). Trafficking at SMD 10mm or higher did not have a significant effect ($P>0.05$) on DMY as recorded 60 days subsequent to trafficking (Figure 2).

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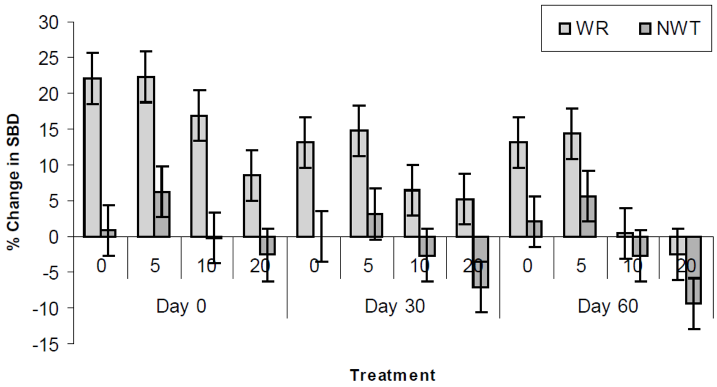
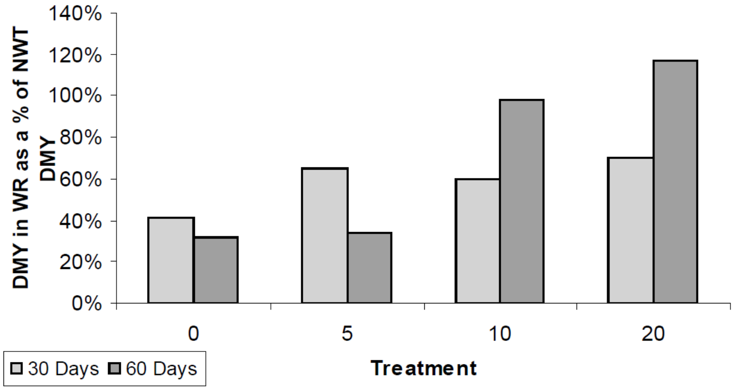


Figure 1. Changes in soil bulk density in wheel tracks (WR) compared to non-wheel track (NWT) areas subsequent to trafficking at 0, 5, 10 and 20mm SMD.

Figure 2. DMY in the wheel track (WR) relative to the non-wheel track (NWT) area in the 30 and 60 day period after traffic.



5. Opportunity/Benefit:

The results of this study suggested that a guideline value of SMD of 10mm will be suitable to indicate the limit for trafficability with standard slurry spreading equipment. This guideline value could be used to minimise the risk of long-term soil compaction and to maximise the opportunities for safe slurry spreading.

6. Dissemination:

The results of this study have been presented at Scientific Conferences and have been submitted for peer review publication.

Main publications:

Example:

Vero, S.E., Antille, D.L., Lalor, S.T.J. and Holden, N.M. (2012) ‘Soil moisture deficit as a predictor of grass field trafficability.’ *Agmeteorology 2012 – Science and Practice.*

Vero, S.E., Antille, D.L., Lalor, S.T.J. and Holden, N.M. (2012) ‘The effect of soil moisture deficit on the susceptibility of soil to compaction as a result of vehicle traffic.’ *ASABE Annual International Meeting 2012*.

Vero, S.E., Antille, D.L., Lalor, S.T.J. and Holden, N.M. (2012) ‘The potential of soil moisture deficit as a predictor of soil compaction following machinery traffic.’ *Sino-European Symposium on Environment and Health 2012.*

Vero, S.E., Antille, D.L., Lalor, S.T.J. and Holden, N.M. (2013) ‘Determining threshold values for grass field trafficability using the hybrid soil moisture deficit model. *Agricultural Research Forum 2013*.

7. Compiled by: Stan Lalor, Sara Vero

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