Mole and gravel mole drainage

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Mole drains are unlined channels installed in high clay content soils; gravel mole drains are used in less cohesive soils to prevent channel collapse. Gravel moles are, in effect, mole drains packed with gravel. Mole and gravel mole drains are installed as shallow drainage systems in Ireland, but many questions remain about their use. Farmers and contractors constantly ask questions such as:

- How does the performance of ordinary mole and gravel mole drains compare?
- Do installation conditions affect performance of mole and gravel mole drains?

These are important questions as gravel mole drains are much more expensive than ordinary mole drains. A project conducted recently at the Teagasc research farm in Solohead provided answers.

Where should mole drainage be used?

Where soils are poorly permeable, the drain spacings provided by conventional drainage systems are not adequate to provide satisfactory drainage. It is necessary to resort to drainage methods which disturb and crack the soil, improving its water carrying capacity. These methods include mole drainage and gravel mole drainage.

The suitability of a soil for mole drainage is open to debate. While there are some soils where mole channels have a long life (typically they have more than 45% clay and less than 20% sand), there are others (fine sandy and gritty soils) where gravel mole drainage is called for. There is a range of soils between these limits where uncertainty exists. The soil cracking, which is required for effective mole drainage performance, depends on the soil water content during installation. Dry soil conditions during installation encourage a high rate of soil cracking but, due to weather, farmers are often forced to install mole channels in less than ideal conditions. The consequences of this are poorly understood.

Assessment of techniques

The recent study looked at the relative performance of such techniques on one of these "borderline" soils where it is not clear which technique is most appropriate. The study was undertaken on the Teagasc Solohead research farm, which is dominated by poorly permeable clay-loam textured soils (sand 36%, silt 36% and clay 28%); not ideal for stable mole channel formation. While gravel mole drainage, designed for such situations could be used, the high cost (€1,500/ha to €2,800/ha vs. €125/ha to €300/ha for mole drainage) make it unattractive.

Four drainage treatments were established: (A) un-drained, (B) mole drainage installed in January 2011 (in non-ideal installation conditions), (C) mole drainage installed in July 2011 (ideal installation conditions) and (D) gravel mole drainage installed in July 2011. The installation of treatment B resulted in extensive surface and sward damage on the wet soil. This was due to the timing of the operation and the high soil water content. However, the mole channels themselves were formed in good conditions. Surface disruption was minimal during the installation of treatments C and D, as a result of drier soil conditions.

Drain system performance

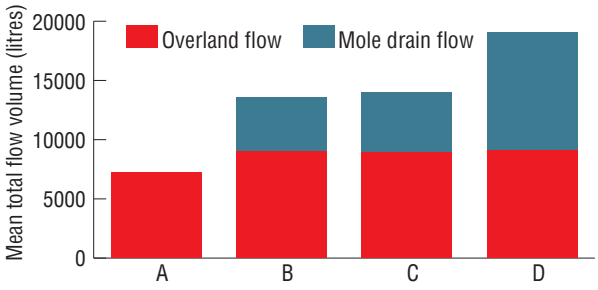
Both mole and gravel mole drainage were effective in the removal of excess water. The mean total amount drained via overland flow and subsurface drain flow during rainfall events in treatments A, B, C and D was 7,700, 14,140, 14,700 and 19,740 litres, respectively, from identically sized (1,500 m^2) plots. Gravel mole drainage was generally more effective than mole drainage in removing excess water, with consistently higher peak flow rates and greater total flows.

The performance of the mole drainage systems (B and C) was similar throughout and, therefore, were not affected by installation conditions. There was a clear behavioural change

Soil type is a key factor in deciding what type of drainage to use.

Figure 1

Mean total overland and mole drain flow during rainfall events from treatments; A (un-drained), B (mole drains installed in January 2011: non-ideal installation conditions), C (mole drains installed in July 2011: ideal installation conditions) and D (gravel mole drains installed in July 2011) from identically sized (1500 m²) plots.



in flow response during the study with a decrease in drain flow from all treatments over time. The watertable was consistently closer to the soil surface in the un-drained plots relative to the drainage treatments. Mean water-table depth was 0.52m in treatment A relative to 0.71m, 0.72m and 0.78m in treatments B, C and D, respectively.

Practical application

Despite the deterioration in effectiveness over time, mole drain flow was maintained, albeit at a lower level, for approximately two years and the drainage provided was adequate to control watertable depth below that of the un-drained plots.

Mole drainage is a temporary measure, which must be repeated in order to maintain effectiveness. Given its low cost, mole drainage could be repeated every two years on this soil type. The cost of gravel mole drainage does not allow for frequent repetition of the operation.

Given the disparity between installation costs, it is likely that regularly rejuvenated (two years) mole drains, while less effective than gravel mole drains, could provide adequate drainage on such a soil at a much lower long term cost.

The capacity and life-span of mole and gravel mole channels is substantially improved by the installation of a piped drain network, excavated at right angles to, and deeper, than the mole drains acting as an outfall. This shortens the mole channels and substantially increases drainage capacity, lessening both the chances of failure and the impact of isolated failures on the whole system.

Future research studies will need to look at the optimum mole/gravel mole channel length in a range of soil types for such combined systems, having mole or gravel mole drainage as a supplementary measure to a field drain network. This would have significant cost implications, however, as such field drains cost approximately €5-7/m.

The impact of repeated installation on soil compaction would also need to be evaluated, particularly where installed in wet conditions.

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