Information Sheet

6.12 Vertical mulching

Vertical mulching is the incorporation of an ameliorant through a vertical slot (see Figure 1) into the soil below the soil surface (typically up to 400 mm depth). While a wide range of products can be applied using this method (sand, ashes, slags and organic amendments), it is most often organic amendments that are used to alleviate subsurface soil constraints thus improving root growth and water and nutrient availability.

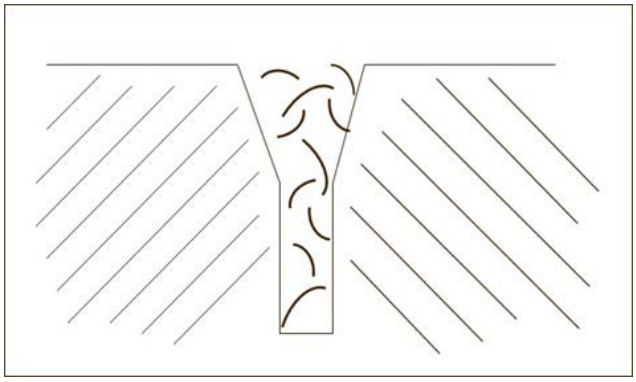

Figure 1: An illustration of a vertical slot in the soil filled with a soil improving ameliorant (most often organic in nature).

Value of vertical mulching

Poor or degraded soils results in shallow root systems which limit the soil water and nutrient storage as well as supply capacity resulting in frequent plant stress. This can lead to yield decline and increase the replant frequency. Vertical mulching may provide a more rapid solution to affected soils through more immediate alleviation of constraining conditions. Poor or degraded soils that are often suitable for vertical mulching are characterised by:

- Shallow topsoil layers overlying crop limiting subsoils (E horizons, plinthite) or constraints (acidity, compaction).
- A surface crust causing low water infiltration rates.
- Compacted layers or plough pan at between 15 and 25 cm depth.
- Low organic matter status.
- A high water table in the wet season.

Several trials have shown the benefit of the technique to improve both short and long-term cane yield. For instance, a long-term (12 years) vertical mulching trial conducted in the Mtunzini region on a shallow Westleigh soil had the following treatments:

- Control – conventional flat cultivation.
- Vertical mulching with topsoil.
- Vertical mulching with river sand at 100 t/ha.
- Vertical mulching with filtercake at 100 t/ha.

These treatments were applied once only before planting and never again, yet significant yield responses to the filtercake treatment were obtained for 9 crops with an average improvement of 1.3 tons sucrose per hectare per crop or 10 tons cane per hectare per crop. Other improvements included increased infiltration rate (three-fold), lower bulk density, increased rooting depth and improved nitrogen (N) and phosphorus (P) use. In soil with severe subsoil constraints, it is expected that the benefits could be higher.

Soil type suitability

Soils that will benefit from this type of tillage practice are generally found on mid to higher slope positions. They are shallow and are from the grey group of soils derived from Dwyka Tillite, Table Mountain Sandstone (ordinary) and Middle Ecca sediments. Soil forms suitable for vertical mulching are Longlands, Westleigh, Glenrosa, Mispah, Milkwood, Swartland, Valsrivier, Sterkspruit, Cartref, Estcourt and Kroonstad. Vertical mulching trials conducted in

eSwatini on soils with a vertic topsoil (Arcadia) responded well with a filtercake treatment, indicating that this soil may also benefit from this practice (see example of soil types in Figure 2).

The general physical properties of these soils are high susceptibility to crusting and compaction, with low water infiltration rates, high vulnerability to soil erosion, low water and nutrient retention capacity and low organic matter content. At least 40% of the soils under sugarcane fall within this classification.

▲ Figure 2: Examples of soil types that will benefit from vertical mulching (from left to right: Kroonstad, Westleigh and Longlands).

Application technique

This involves the incorporation of an ameliorant into a vertical slot in the soil. The intent is to concentrate the ameliorant in the slot over a depth of at least 400 mm to improve the rooting depth and water infiltration rate and to reduce the bulk density of the soil.

The ameliorant may be band placed on the row (see Figure 3) before incorporation using the vertical mulcher, in which case the tine of the implement will be pulled through the banded material. Alternatively, a hopper can be fitted onto the toolbar of the vertical mulcher and the ameliorant fed through a 200 mm diameter downpipe directly behind the tine and into the open slot.

Vertical mulching should be done at crop establishment, either following minimum tillage or conventional plough-out operation. There is insufficient evidence to recommend it as a ratoon practice. However, where considered for ratoon, care should be taken as interrow vertical mulching can damage the roots and might cause movement of the stool which might lead to yield losses.

The distribution of the ameliorant in the vertical slot is not uniform. The highest concentration is in the surface region and it decreases with depth. The advantage of this distribution pattern is that most of the ameliorant is present in the surface zone to combat crusting and natural re-compaction. Continuous aeration of the soil is greatly improved and water infiltration rates are about 3 times faster. Rainfall use efficiency is improved and runoff reduced and the risk of soil erosion minimised.

▲ Figure 3: Band placement of an ameliorant.

The implement

The implement used for vertical mulching is a ripper tine with vertical 'wings' attached (see Figure 4). The implement is pulled through the soil to a depth just covering the top part of the wings (about 400 mm) to allow the material on the soil surface to flow over the top part of the wings and to fall into the slot kept open by the wings. The design and dimensions for the implement shown should be as follows:

- The opening of the top part between the wings (looking at the implement from the back) should be 200 mm and 100 -150 mm at the bottom. This will ensure that all material on the soil surface will 'flow' into the slot.

- The length of the wings extending away from the tractor should be 400 mm long to ensure that the slot is kept open long enough to allow the material to fall to the bottom of the slot before it is closed.
- The depth of the wings will depend on the depth of the soil. The aim is to increase rooting depth and the implement should be able to create a slot to a depth of at least 500 mm. However, reaching this depth is not always possible in very shallow soils, and 400 mm is therefore a good average depth to allow when attaching the wings to the tine. This means that the depth from the top of the wings to the tip of the shoe on the tine must be 400 mm, and 300 mm for the depth of only the wing. This will result in an effective slot depth of about 350 mm (50 mm depth is lost because of the wave in front of the tine).

▲ Figure 4: Modification of the ripper tine to incorporate the ameliorant into a vertical slot.

Common problems encountered

A practical problem is how to get the ameliorant onto the field in a commercial situation. The following are options for band placing the ameliorant on the strip that is to be vertical mulched:

- Use manual labour with fertiliser bags.
- Moving slowly, offload directly from the trailer via a trough onto the strip to be cultivated.
- Fit a hopper onto the toolbar of the vertical mulcher, with a 200 mm diameter guide pipe to feed the ameliorant directly into the open slot behind the tine. It may be necessary to manually force the ameliorant through the downpipe. Alternatively, the hopper could be fitted with a vertical worm for this purpose.

Additional problems include:

- Small tractors and 2x4's cannot keep direction accurately, and often pull the vertical mulcher where there is no ameliorant. The tractor to be used should be at least a 50 kW 4x4.
- The ameliorant must be dry and free of clods when applied. If it is not, then a minimum till rotavator should be used to mix the ameliorant with the topsoil before it is vertically mulched into the soil. Composted filtercake (six months and older) is preferred.

Ameliorants

The type of ameliorant to be used depends on soil type and the problems associated with it. For example, a sandy soil will require an ameliorant that will improve water retention and structure, and in a clay soil the ameliorant should improve water infiltration and drainage.

Long-term trials conducted on a Longlands soil form at Mtunzini and an Arcadia soil form in eSwatini showed that the best responses came from the treatments where filtercake or mila was used. Other ameliorants evaluated in these trials were topsoil and river sand. Other organic materials that could be used include chicken manure, sawdust, bark chips, chopped sugarcane residue, bagasse, and wood pith. It is, however, always better to use well composted material. This should be chemically analysed to determine the C/N ratio, the maximum quantity to be used, and the additional nutrients to be added. If the C/N ratio is above 25, additional N will be required as per FAS recommendations. Ideally, the C/N ratio or organic materials to be used should be below 20.

Other ameliorants that might be considered are river sand, fly ash, gypsum and lime. These ameliorants should be used only in special circumstances, for example, where soils have a high clay content, high pH or an unacceptably high extractable aluminium index.

Cost

It is difficult to give guidelines on the economics of vertical mulching, as many factors affect the cost. However, evidence from trials indicate that yield responses (vertical mulching with filtercake) were on average 22% per crop over the first 9 years, in terms of sucrose and stalk yield. Yield response is also very dependent on the annual weather conditions and yield response over the 9 year period varied between 4 and 56%, with the highest responses obtained for the driest seasons.

Rian van Antwerpen (Senior Soil Scientist)

July 2022