IMPACT OF CALLIANDRA ON THE POROSITY OF AN ANDISOIL

The cultivated andisoils in the Reunion Highlands are exposed to a fierce climate, and situated on steeply sloping land. Farming practices, which encourage desiccation, are rendering these soils fragile. Their structure then aggregates in hydrophobic pseudo-sand which is easily moved by flotation (ROSELLO, 1984). Erosion by surface runoff then becomes considerable, as is shown, for example, by the Piton Hyacinthe market-garden zone, where one metre of soil has disappeared in about ten years (PERRET, 1993).

The recent boom in horticultural products in this region is causing farmers to adopt the practice of closing in their plots with hedgerows, particularly with the use of forage hedges of *Calliandra calothyrsus* (ROEDERER, 1991).

To get a better idea of the way these systems work in relation to surface runoff, it is helpful to assess the impact of the *Calliandra calothyrsus* hedge, and especially its rooting system, on certain physical and hydric andisoil parameters : porosity, poral distribution, and hydraulic conductivity.

MATERIALS AND METHODS

The study concerned a network of isohypse hedges situated at an altitude of 900 metres in the Trois Bassins Commune, and was assisted by two student courses (MARÉCHAUX, 1993 ; CATTET, 1994).

Preliminary observations on the rooting system of *Calliandra calothyrsus* were made under three hedges, respectively one, two and three years old, after developing profiles with a depth corresponding to the lower limit of horizon (B), and with the aid of an elementary 5×5 cm mesh grid. Roots with a diameter greater than 1 mm were counted for each mesh (MARÉCHAUX, 1993).

Use was then made of tension infiltrometry (GUILLUY & PERRET, 1991) to assess the porosity and conductivity of the soil close to a 4-year-old hedge. Measurements were made using 250 mm and 80 mm bases placed directly beneath the hedge (uphill and down) and at 1.50 m downhill from the hedge. Four negative water supply pressures were made : 0 mm (saturation), – 10 mm, – 30 mm and – 60 mm, with 5 repeats for each of them. Additional soil moisture humidity measurements (W %) were made based on a sampling taken in the infiltration bulb for each repeat. The bulk density (b.d.) was calculated on the basis of samplings taken close to the infiltrometry. Then the following were calculated :

- the volumic humidity ($Hv\ \% = b.d. \times W\ \%$),
- the water index ($I_W = W\ \% \times 2.7$),
- the void index ($I_v = Iw/Hv\ \% - 1$),
- the void saturation rate ($Sat\ \% = I_w/I_v \times 100$) and
- the poral spectrum

$$X\ \% = (I_{w1} - I_{w2}) \times 100 \times I_{ws}$$

where I_{w1} and I_{w2} are the water indices at suctions 1 and 2, with suction 1 > suction 2, and I_{ws} is the water index at saturation.

RESULTS

DESCRIPTION OF THE ROOTING SYSTEM AND SOIL RESTRUCTURING

□ **Under the 1-year-old hedge,** the rooting system of *Calliandra calothyrsus* divides at horizon A, with a thickness of 10 cm, and at the first 30 cm of horizon B. No soil structuring really seems to occur.

□ **Under the 2-year-old hedge,** on the other hand, there is a structural difference in horizon A, depending on the distance of the axis from the hedge. At 70 cm from the hedge, the structure of this horizon is homogeneous and powdery, and thus easily moveable by runoff water. At less than 50 cm, on the contrary, on the surface, there are lots of worm piles which lend this horizon a more aggregated structure.

Under the 2-year-old hedge, there is considerable soil colonization by the roots. At 30 cm from the axis of the hedge there are creeping, suberized roots, which extend to horizon

(B) to a depth of 70 cm, as well as thinner, whitish roots, which are the functional ramifications of the creeping roots. The same observations made under the 2-year-old hedge were repeated under the 3-year-old hedge.

ROLE OF THE HEDGE IN IMPROVING MACROPOROSITY

The results are shown in the table opposite.

Distribution of the average size of aggregates in horizon A of an andisoil, close to a *Calliandra calothyrsus* hedge (from PERRET *et al.,* 1994).

Position	Average diamater of aggregates (mm)
under the hedge	2.36
at 1 m from the hedge	1.60
in the middle of the plot	1.10

□ **Bulk density**. A significant difference (P = 0.007 at the threshold of 5 % for 43 ddl) emerges between bulk density densities recorded up- and downhill beneath the hedge, on the one hand (b.d. = 0,67), and those recorded at 1.50 m downhill from the hedge on the other (b.d. = 0.71).

□ **Voids index** (I_v). The index of voids is higher beneath the hedge (I_v = 3.05) than at 1.50 m downhill from it (I_v = 2.80).

□ **Macroporosity spectrum**. The increased suction gives rise to a drainage of ever fines pores and a reduction in the thickness of the hydration layers covering the solid particles. The JURIN-LAPLACE law gives the maximum diameter of water-filled pores at a given negative water supply pressure (PERRET & GUILLUY, 1991).

Using the above-mentioned formula, the X % value was calculated, expressing the percentage in volume of the pores concerned by water drainage between the two states of hydration. This has helped to draw up a spectrum of pores larger than 300 µm (Fig. 1). The X % values show a noticeable difference for the total macroporosity as a whole (pores with a diameter greater than 500 µm), which increases beneath the hedge by 31 % uphill and 18.8 % downhill. At 1.50 m downhill from the hedge, the macroporosity represents just 5.7 % of the total porosity. Under the hedge, the saturation conductivity varies little between up- and downhill. On the contrary, it is four times higher under the hedge (downhill side) than on bare ground at 1.50 m donwhill from it (Fig. 2).

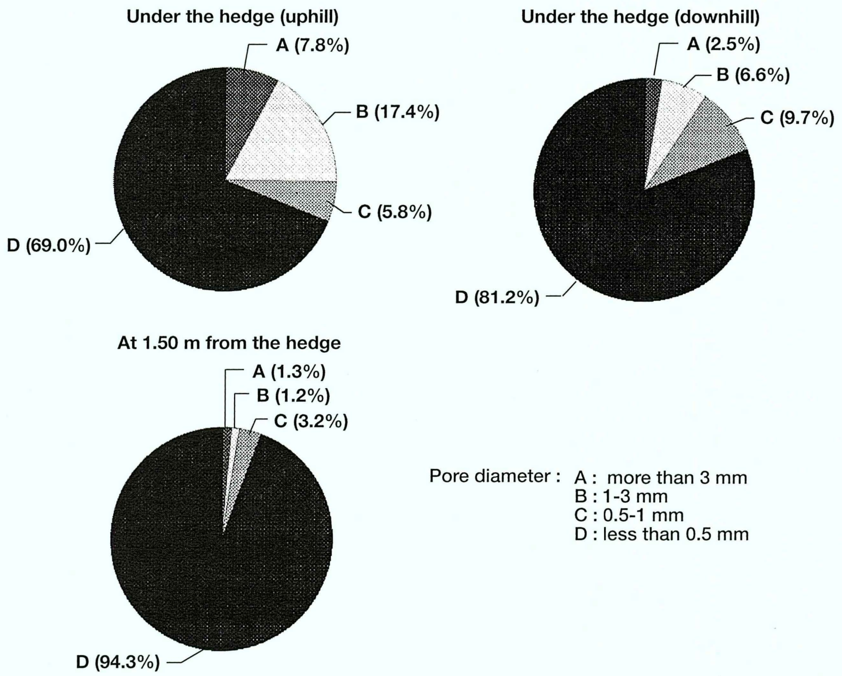

Figure 1. Distribution of the poral spectrum of horizon A of an andisoil close to a Calliandra calothyrsus *hedge.*

DISCUSSION AND CONCLUSION

The study clearly shows a restructuring of horizon A near the hedge, as was suggested in the study by PERRET *et al.* (1994, cf. table above). The improvement to the structure of this horizon, under the influence of the hedge (rooting system, reintroduction of organic matter) and the macrofauna in the soil associated with it, gives a better infiltration of rainwater and limits the surface runoff and conveyance of materials downhill.

The results also show a higher macroporosity uphill from the isohypse hedge. It would seem that this difference may be attributed to the fact that the residue from crops and *Calliandra* pruning accumulate in a more concentrated way uphill than down, bearing in mind, in particular, the terrace profile which is progressively formed. Biological activity appears to be higher as a result, and the macroporosity is probably increased.

Consequently, the isohypse hedge is a particularly effective system for reducing surface runoff, as part of the development of andisoils in the Reunion Highlands. □

For bibliography, see the French version.

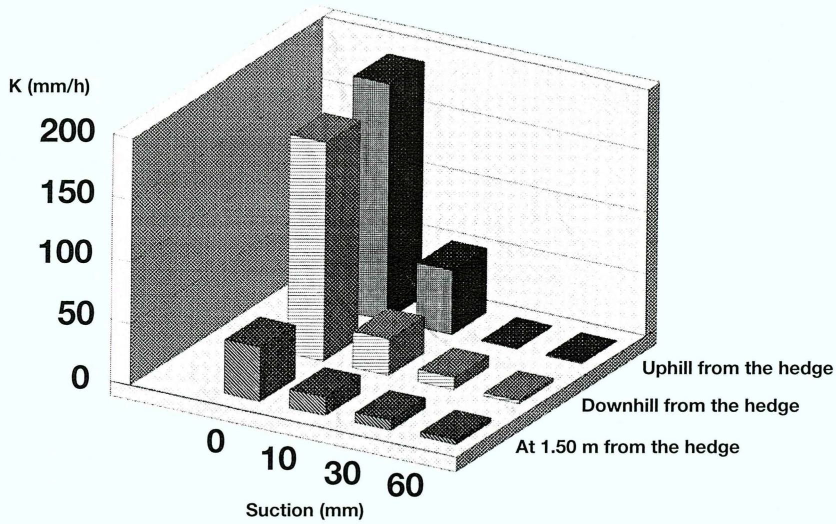

Figure 2. Conductivity of horizon A of an andisoil close to a Calliandra calothyrsus *hedge and under different controlled suctions.*

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