INTRODUCTION

Soil management, although intended to create favorable structural conditions for crop growth and development, without the prior assessment of potential benefits and limitations, can represent a factor influencing the degradation of soil structure and its structural quality are generally evaluated by some physical soil attributes such as bulk density, total porosity, and soil penetration resistance (PR).

The PR is a physical parameter supporting the identification of areas with different stages of compaction and thus can be used to define appropriate management for soil remediation. Besides, this parameter depends on intrinsic soil factors (texture, structure, and mineralogy) and soil and surface condition; thus, PR values with bulk density and decreases with it. Therefore, PR values can be used to evaluate and manage the soil compaction level in fields where soil management practices are carried out.

OBJECTIVE

To evaluate the spatial and temporal variability of PR in a field cultivated with sugarcane, under conventional tillage system.

MATERIAL AND METHODS

The research was carried out in the Canpina Sugarcane Experimental Station (EECAC), Pernambuco, Brazil (Fig. 1). A grid of 70 x 70 m with intervals of 10 m (Fig. 2) was selected and soil samples were collected in each grid point at 0 - 0.30 m and 0.30 - 0.60 m depth. The first sampling was done 6 months after subsoiling (Time 6) and before harrowing and planting, the second sampling after 12 months of subsoiling (Time 12, six months after harrowing and planting), whereas the third sampling after 18 months of subsoiling (Time 18), before harvesting (Fig. 3). At each sampling time, in situ PR measurements were carried out with the Solo Track equipment (Fig. 4) and the simultaneous soil values of water content were determined and associated with the PR data ($\theta_w$).

RESULTS AND DISCUSSION

The average PR values determined after Time 6 are above those recommended for the root system growth, being higher than the critical limit, i.e., PR$_0$ > 2 MPa; however, the values determined after Time 18 were the lowest during the one-year cultivation and were probably influenced by the sugarcane root system. Thus, PR values showed that the subsoiling did not promote a positive effect on the soil physical quality, with PR values in Time 18 the PR values reduced to 1.04 – 1.54 MPa and therefore below the critical value.

The classification used for the degree of spatial dependence (SD) was SD ≤ 25% strong dependence; 25% < SD < 75% moderate dependence; SD > 75%, weak dependence. Thus, $\theta_w$ showed spatial dependence ranging from strong (6.28 to 23.28 %) to moderate (27.10 to 54.07 %); while PR presented a strong dependence (5.65 to 25.00 %). The semivariograms model that best fit to PR and $\theta_w$ were spherical or exponential (and linear in case of the pure nugget effect). The pure nugget effect presented in the $\theta_w$ for Time 6, 0.30 - 0.60 m depth, can be explained by the sampling distance, since the variation of this attribute in the area occurs on a smaller scale than that adopted in this research (10 m, Fig. 2), therefore a finer sampling grid, with lower distance between the collection points should have been adopted at Time 6.

The evaluation of the CV, as a measure of spatial variability, showed that the values for $\theta_w$ and PR were of medium variability (12 ≤ CV ≤ 60), with lower values for $\theta_w$ (14.44 to 26.03%) compared to those associated with PR (26.25 to 46.87%).

The range results showed a different behavior for $\theta_w$ and PR. It is noted that, in general, the range of $\theta_w$ increases from Time 6 to 18, mainly on the surface where it changed from $\theta_w$ 49 m to 200 m. This result can be justified by the heavy rainfall event of about 1000 mm (Fig. 3), occurred in the area one month before sampling in Time 18, homogenizing the soil moisture with a greater effect on the surface (≤ 200 m).

On the other hand in Time 6, the range values for PR reflected the subsiding effects on the soil surface, with greater range (≥ 593 m) and consequently more similar compared to the deeper soil (0.30-0.60 m) where the range resulted of about 26 m. However, harrowing and planting, carried out two months before Time 12 (Fig. 3), changed the values of the surface range, reducing them to $\theta_w$ 17 m and increasing in the subsurface to 282 m. Thus, the growth of the root system sugarcane, Time 12, reduced the soil resistance to penetration, promoting lower values of the subsurface range in Time 18 (27 m).

CONCLUSIONS

- Spatio-temporal variability of soil penetration resistance is greater than that associated with soil water content.
- Soil water content had a moderate degree of spatial dependence, indicating the need to increase the number of sampling points.
- Subsoiling was not adequate to increase the soil physical quality, being the main result associated to the action of sugarcane root system.
- The range values associated with PR are inversely related to the growth of sugarcane root system.

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