USE OF NEUTRON MOISTURE METER TO ESTIMATE WATER AND NUTRIENT UPTAKE OF RAINFED CROPS

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During the past decades, it has been clearly demonstrated that a soil moisture neutron probe is practically the only device offering the possibility to determine, at a given spot, the temporal change of moisture content with depth, including in the root zone, and to obtain easily spatial informations allowing studies at different scales of application. Furthermore, the technique is non destructive, and quite precise (depending upon the accuracy of the calibration curve of the moisture meter).

It has also become evident that fluxes of water and solutes should be determined to obtain information related to plant nutrient uptake in relation to plant growth and production. This presentation intends to discuss critically the various problems met in the field to determine root uptake estimations from soil moisture measurements, but also to show the advantages offered by this technique.

The most delicate point is to determine soil water flux. In the general situation, it is estimated by application of Darcy's law. It is therefore necessary to measure, besides the soil water content θ, the gradient of hydraulic head from tensiometers reading and the hydraulic conductivity-water content relationship $K(\theta)$. The estimation of K is the weakest point of the method. It is indeed shown that one should determine it by a fairly elaborated procedure on the measurement site itself, this precludes in most of the cases any spatial study. However, when this is done locally, and providing the fact that uncertainties remain small, it is possible to obtain nutrient convective flux by combining at a given depth the determination of soil water flux and the measurement of soil solution concentration, obtained with the use of a suction cup. The total plant uptake can then be estimated from difference between inputs, outputs, and changes of storage in the root zone. An example of application will be given where comparison between the lixiviation losses of water and various mineral components beyond the root zone were determined, during a complete crop cycle, for different fertilization treatments.

There exist however specific situations, quite representative to dry-tropic areas, where straitghforward estimation of fluxes of water and nuturient can be obtained in the root zone without knowledge of the soil hydraulic conductivity. It is the case when the soil remains dry enough at a given depth in the profile, when rainfall events are followed by periods of drought of 1 to 2 weeks and when plant water requirement is large. Fluxes of water at various depths can then be simply inferred from changes of soil water strage, and nutrient concentration given by analysis of soil water extraction. In this case it is quite easy to repeat spatially the measurements, with different sites equipped each one with an access tube and some suction cups implemented at various depths in the root zone. As illustration, results obtained in Senegal on comparative effect of fertilization of millet and peanut by Dr. L. CISSE from ISRA Bambey, will be presented.

We will also discussed other related problems, such as the method of calibration of the neutron probe, mostly near the soil surface, the determination of $K(0)$ by simplified field technique, and the associated uncertainties, the extraction of the soil solution...

Finally whatsoever its limits, we will show that one of the greatest advantage of this method is that it permits fully to account for the spatial and temporal variability of the soil and of the crop at 2 different levels: choice sampling scheme and modelization. For many years agronomic observations, mostly in terms of effects of fertility and cultural techniques, have been done with the assumption that data obtained from replications of treatment where independent, whatsoever the size of the blocks and of the plots. It is now clearly established that this is very questionnable and may induce systematic statistical bias in data analysis. It will be shown how the use of geostatiscal concepts applied to neutron probe measurements of soil water storage can lead to the estimate of the minimum size of blocks in order to make the results spatially uncorrelated. Concerning the 2nd point, examples will also be given on the possibility to obtain pertinent parameters, from neutron probe measurements, to be used in various models (including stochastic ones) in term of calibration and validation. Typical outputs of those models are: prediction of plant production and/or evapotranspiration depending upon the applied treatment.