POINT OF VIEW

The search for maximum water use efficiency, an objective not to be disconnected from an integrated vision of the production system

Drip irrigation, and more subsurface drip irrigation, are particularly popular techniques for irrigating crops in regions where water resources are a major constraint. However, as François Gontard of BRL Exploitation shows, installing this equipment does not guarantee maximum water use efficiency, only highly specialised irrigators are able to fully exploit its potential.

Drip irrigation, a very efficient and widespread technique

Saving water remains a priority in a context of increasing climate demand and pressure on resources. Part of these savings rely on the selection of irrigation technique and equipment. This aspect was addressed in an Irstea[1] study, which produced a set of guidelines on potential water savings by changing irrigation equipment. This work shows that drip irrigation and more subsurface drip irrigation are the techniques with the greatest potential for water savings.

In the coastal territories of the Occitanie region drip irrigation in market gardening, viticulture and arboriculture is rapidely spreading (Photo 1). This development can be explained both by the technical suitability of this equipment to the crops concerned and by its performance in terms of water use efficiency.

Some counter-examples to the efficiency of the drip system

However, common field situations faced in the agricultural context illustrate the limitations of drip irrigation water use efficiency.

The drip irrigation water supply may reduce the development of the root system, especially in orchards with high water needs or not. Such inadapted scheduling results in roots that do not occupy large volume of soil and hence are not able to make full use of the rainfall. In practice, irrigation resumes quickly after the rains or is not even suspended which leads to additional consumption compared to a better rooted orchard. For the same reason, these orchards are less resilient in case of accidental interruption of irrigation.

1. Évaluation des économies d'eau à la parcelle réalisables par la modernisation des systèmes d'irrigation (Evaluation of plot water savings achievable through modernisation of irrigation systems), Irstea, 2017, https://www.inrae.fr/sites/default/files/pdf/DP Irstea Economies deau en irrigation.pdf

However, drip irrigation is to be associated to fertigation to ensure a higher efficiency of fertilisers application. In fact, the localized water supply does not always ensure a good dissolution of the mineral fertilizers applied to the soil. Spring fertilisation is often carried out when irrigation is not necessary because of sufficient rainfall at this time of year. In other words, the water supplied is used only to transport the fertiliser without any benefit to the crop.

In the case of subsurface drip irrigation it is necessary to control root intrusion inside the drippers. This type of problem has been encountered, for example, on peach trees grown using a deficit irrigation method (Photo ❷). One of the recommendations to avoid this problem is to use very regular and quite plentiful supplies to maintain an anoxic zone around the drippers which repels the roots. This approach request not reducing irrigation once the harvest is over and maintaining post-season supplies beyond what is done with sprinkler equipment.

These three issues, which may become cumulative, mean that in practice drip irrigation is not the most water efficient technique in a number of situations..

No easy matter to achieve maximum in drip irrigation!

The studies carried out in the course of research and at testing stations have made it possible to quantify the potential water savings that can be achieved through drip irrigation. It is important to note that this level of performance is only achievable with a high level of technical expertise from the irrigators. It involves accurately determining the crops water needs and controlling inputs using various decision-support tools (Figure ❶).

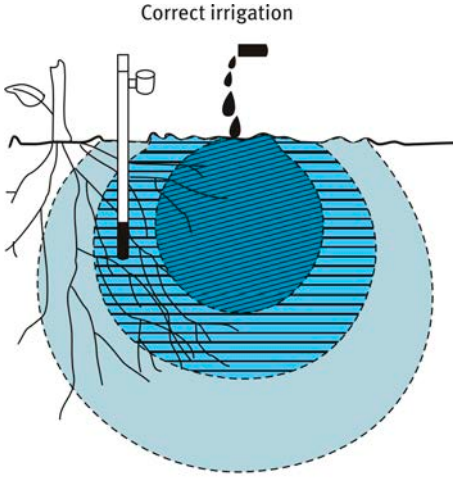
The precise management of irrigation is difficult to achieve with conventional "soil" sensors (tensiometers, capacitive probes) as the positioning of these sensors in relation to the drippers will influence on the water management. Using additional more advanced tools (dendrometers, basic potential measurements, sap flow, etc.) is not accessible to all farms for technical or economic reasons. In this context the most popular approach will maintain a certain level of irrigation comfort to avoid risk of under-irrigation induced crop accident.

Moreover, drip irrigation is susceptible to clogging depending on water quality. To maintain the performance of the equipment regular maintenance is essential (flushing of the pipes, injection of acid and bleach). A regular check of the water applied is also necessary (monitoring the volume and flow rate of irrigation applications, checking the uniformity of the drippers discharge). Failure in equipment maintenance will result in application heterogeneity that farmers will face with an overall increase in irrigation to satisfy the under-irrigated areas.
Finally the technical nature of precise drip irrigation does not always work well with the day-to-day on farms constraints. This results in a number of situations in which drip irrigation is no more efficient than with sprinkler techniques.

❶ Subsurface drip irrigation in a vineyard.

❷ Root intrusion in a dripper in a peach orchard.

❶ Positioning of humidity sensors
(source: Guide pratique Irrigation, Cemagref, 2003).



Water efficiency at the expense of collateral benefits

Drip irrigation is characterised by a localised supply of water, as opposed to full coverage sprinkler systems. This is the basis for the excellent water application efficiency but becomes a limiting factor when it comes to other services provided by irrigation.

In organic agriculture where it is almost impossible to find soluble or liquid drip-applied fertilisers, the problem arises of the mineralisation of organic products in the absence of rainfall. Only full coverage irrigation systems allow them to be properly moistened and decomposed by micro-organisms in dry climate.

There are a number of reasons to encourage the presence of grass cover on perennial crops, as opposed to complete eradication of weeds[2]:

- fight against soil erosion;
- establishment and maintenance of service crops (e.g. planting of annual leguminous crops contributing to the nitrogen supply of the main crop);
- combating soil compaction. This is a key issue, for example, for certain varieties of apple trees that are harvested late in periods that may be rainy;
- creation of biodiversity (Photo ❸);
- mitigation of extreme temperatures in the fields. Drip-irrigated apple trees suffered from extreme temperatures at the end of June 2019 with burns on the lower fruit and leaves. The issue seems to have been less in orchards irrigated by micro-jet with grass cover. Burns phenomena were reportedly mitigated by both a dissipation of energy during transpiration by the grass cover and a lower reflection of energy from the soil.

Aming at these objectives implies the use of micro-jet or sprinkler type equipment less efficient than drip irrigation but more preservative. In addition, inputs must be increased to meet the needs of the service crop cover.

Conclusion

In systems where the water resource is the major constraint seeking for maximum water use efficiency is strategic and drip irrigation offers the best performance from this point of view. However installing this equipment is not a guarantee of water use efficiency and only highly skilled irrigators will be able to fully exploit its potential.

Moreover under less constrained environment it becomes possible to address objectives that are complementary to the fulfilment of the crop's water requirements, such as:

- development of the root system to maximize the exploration of the soil for water and nutrients uptake;
- stimulation of soil biological activity for mineralisation of organic matter and soil amendements;
- development of associated crops (service crops);
- struggle against soil erosion;
- selection of irrigation equipment easier to maintain and manage than drip irrigation.

It will then be necessary to use micro-jet or sprinkler irrigation equipment, theoretically less efficient than drip irrigation but allowing other services to be fullfiled. Water application will then be slightly increased to meet the needs of the service plant cover. ■

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2. Full weed control is often recommended in drip irrigation to limit competition for water between the crop and the grassed area.

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3 *Composite hedge.*