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Deficit Irrigation: A Boon to Horticulture

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INTRODUCTION

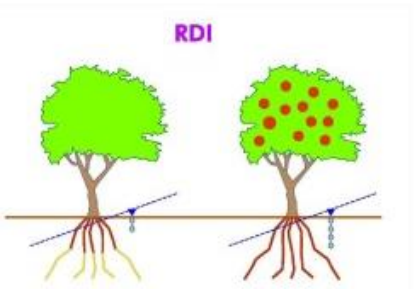
Water is becoming scanty resource worldwide due to its increased consumption, mismanagement and pollution. The predicted increase of dry days per year for many areas of the globe will further worsen the problem. The major consumer of water is irrigated agriculture which accounts for about two thirds of the total fresh water diverted to human uses. In the global debate about water scarcity, agriculture is commonly associated with the image of inefficiency. This is due to poor irrigation water use efficiency. The increasing demand of water resources and limited availability makes water an increasingly valuable commodity. Water scarcity (in quantity and quality) and the increasing competition for water resources between agriculture and other sectors are forcing growers to consider the adoption of water saving strategies more seriously especially in areas of intensive horticulture production and limited water resources. As a result, improving crop water-use efficiency has been a matter of concern to researchers in recent years.

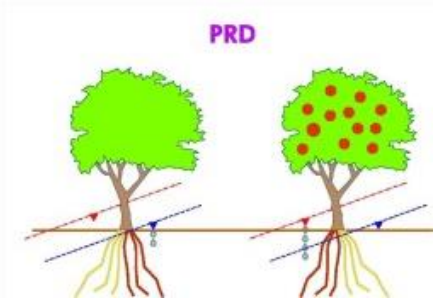
What is deficit irrigation: When irrigation is applied during drought-sensitive growth stages of a crop and irrigation is limited or even unnecessary outside these periods, it may be termed as deficit irrigation. It allows the crops to sustain some degree of water deficit and sometimes, some yield reduction with a significant reduction of irrigation water. The classic deficit irrigation strategy implies that water is supplied at levels below full evapo-transpiration throughout the season. When irrigation is applied at rates below the ET, the crop extracts water from the soil reservoir to compensate for the deficit. If the stored soil water that was extracted is replenished by seasonal rainfall, the deficit irrigation practice is sustainable and has the advantage of reducing irrigation water use. Deficit irrigation strategies have the potential to optimize water productivity in horticulture, improve nitrate use efficiency and minimize leaching of nutrients.

Nevertheless, the effects of deficit irrigation on yield or harvest quality are crop-specific. Knowledge of how different crops cope with mild water deficits is the basis for a successful application of deficit irrigation into practice. Based on the physiological knowledge of crops response to water stress, the two main deficit irrigation strategies are regulated deficit irrigation and partial root-zone drying.

1. Regulated deficit irrigation: The main principle is that plant sensitivity to water stress is not constant during the growth season and that intermittent water deficit during specific periods may benefit water-use efficiency, increase water savings and even improve harvest quality. Plant water status is maintained within certain limits of deficit during certain phases of the crop cycle, normally when fruit growth is least sensitive to water reductions.

2. Partial root drying: It involves exposure of roots to alternate drying and wetting cycles, which can be operated in drip or furrow-irrigated crops. This will decrease water loss and vegetative growth and increase water-use efficiency. The partial root drying strategy may also increase root growth at deeper layers of the soil as for grapevine or in overall root system, as for tomato. It can influence carbohydrates partitioning between the different plant organs and affect the quantity and quality of the harvest.





Important points for deficit irrigation:

- Before implementing a deficit irrigation programme, it is necessary to know crop yield responses to water stress, either during defined growth stages or throughout the whole season.
- High-yielding varieties are more sensitive to water stress than low-yielding varieties.
- Crops or crop varieties that are most suitable for deficit irrigation are those with a short growing season and are tolerant of drought.
- In order to ensure successful deficit irrigation, it is necessary to consider the water retention capacity of the soil. In sandy soils, plants may undergo water stress quickly under deficit irrigation, whereas plants in deep soils of fine texture may remain unaffected by low soil water content. Therefore, success with deficit irrigation is more probable in finely textured soils.
- Under deficit irrigation practices, agronomic practices may require modification, e.g. decrease plant population, apply less fertilizer, adopt flexible planting dates, and select shorter-season varieties.

Benefits:

- Deficit irrigation strategies can be successfully applied to several important horticultural crops, in particular to those that are typically resistant to water stress in order to improve water-use efficiency and save water. Major horticultural production areas are located in hot and dry climates where high light, high temperatures often co-occur with low soil water content. Thus, deficit irrigation strategies may help to save more water and optimize or stabilize yields and quality in these areas and they have been investigated for several horticultural crops, namely grapevines, orchard fruit trees and

vegetables. In many horticultural crops, regulated deficit irrigation has been shown to improve farmers' net income.

- The deficit irrigation strategies offer great opportunities for saving water without compromising production. Under regulated deficit irrigation strategy, water is saved from 43% to 65% with a small reduction in yield, but with higher quality of produce. In general, the fruit and vegetable yield reduced in deficit irrigation system by size and weight reduction of produce, but quality parameters contents in fruit increased by water restrictions. The adoption of deficit irrigation improves fruit composition of orange, peach, and grape by improving key functional quality parameters. Similarly, vegetable crops such as melons, cucumber, tomato, brinjal, and spinach have shown poor-quality water use efficiency without much loss of yield, but with added produce quality.
- Combination of deficit irrigation strategies with other practices like mulching, or protected cultivation may also help to improve water-use efficiency and minimize losses in yield or quality in vegetable crops. Grafting on specific rootstocks more adapted to water stress conditions may be another tool to improve crop growth response under artificially imposed mild water stress.

Disadvantages:

- The major disadvantage of the regulated deficit irrigation is that it is required to maintain a plant's water status within narrow limits, which is difficult to achieve in practice.
- A practical inconvenience of partial root drying is that it obliges to use double the amount of tubes than regulated deficit irrigation, thus, increasing the installation costs.
- Greater risk of increased soil salinity due to reduced leaching, and its impact on the sustainability of the irrigation.

Both water use and consumption are reduced by deficit irrigation but yields may be negatively affected.