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Role of Oxygenation in Drip Irrigation on Plant Growth

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Introduction

Irrigation is the process of artificially supplying water to land for the purpose of cultivation. Normally, the land receives water from natural sources such as rain, but the amount of water received from rain is insufficient for plants to develop.

Drip Irrigation

Trickle irrigation or targeted irrigation are other names for drip irrigation. Drip irrigation is a kind of irrigation that reserves water and fertilizer by allowing water to slowly fall in drops on the surface of the soil or onto the root field using equipment including as valves, emitters, tubes, and pipes. Drip irrigation is carried out using small tubes that provide water straight to the plant's base.

Oxygenation

The process of 'oxygenation' is aeration of the irrigation stream. Irrigation with oxygen is a relatively recent technology. As a tool, oxygenation gives air to the crop root zone. By using a venturi, ambient air is mixed with irrigation water and delivered via a surface or subsurface drip irrigation system

Why plant roots need oxygenation

Plant diseases will be exacerbated by rising soil temperatures, salt, and soil compaction. Plant roots and soil microorganisms both need oxygen to live. Hypoxia in the root zone has a negative impact on crop yield and quality. It was discovered that increasing soil oxygen levels can boost crop output and quality in the root zone. A number of research in recent years have shown that hypoxic stress has a negative impact on the root zone, and that

ventilation technology can improve crop output and quality. Lack of oxygen in soils with insufficient aeration reduces plant growth and productivity for a variety of reasons, including: reduced root growth and root size; reduced root ability to absorb minerals and water; reduced photosynthesis and plant growth due to stomatal closure; loss of soil N due to microbe inactivity; adverse changes in soil chemistry; increased susceptibility to disease; and a shift in the balance and supply of plant growth.
In compacted, salty, and water-logged soil, as well as with high BOD effluent irrigation water, oxygen constraints can be substantial. As a result, oxygenation's potential applications expand beyond improving water use efficiency and yields with regular drip and subsurface drip irrigated crops to addressing additional circumstances that obstruct oxygen transport in the rhizosphere

Role of Oxygenation in plants

In plants, oxygen serves a critical role in oxygenation. If the plant root is exposed to anaerobic conditions or does not receive enough oxygen for an extended period of time, the root's ability to absorb water and nutrients will be compromised. It will also alter the plant's hormone levels and enzyme activity, obstruct photosynthesis, limit the function of vegetative organs, and ultimately result in a decrease in crop output and quality. As a result, the additional air boosts root respiration and microbial activity, improving growing conditions. Improving the amount of oxygen in the crop root zone has a big impact on crop output and quality. A sufficient supply of oxygen improves root absorption of mineral elements and soil water, allowing them to be utilised more efficiently. Drip irrigation provides oxygenation, which not only boosts crop output but also saves water and aids in water shortage situations

Techniques of Oxygenation in drip irrigation / airjection irrigation

• Air permeability is a composite indication of soil fertility that can reflect the texture, structure, compactness, and dry and wet conditions of the soil.
• First, air permeability has a substantial impact on soil oxygen content, and it is also influenced by soil texture and bulk density; second, irrigation may have an impact on soil permeability.
• Plant growth and yield are restricted by low oxygen levels in the soil.
• This approach is important in improving the soil environment in terms of water, fertilizer, gas, and heat in the crop root zone because it may effectively improve soil air permeability and oxygen content (Goorahooet al., 2002).
• When utilizing an air injector, the oxygen concentration in the crop root zone increases by 2.4 to 32.6 percent. The ability of the soil to breathe rises by 42 percent to 100 percent when it comes to oxygenation (Chen et al., 2011).
• Bhattaraiet al. (2004) proposed a new irrigation approach in which a venturi air injector was inserted in the first segment of the irrigation system and used to achieve aeration via subsurface drip irrigation.
• This method has proven to be effective, particularly in thick clay and saline soils (Bhattaraiet al., 2010 ;Pendergastet al., 2013).

Methods of Oxygenation / airjection in irrigation

Airjection irrigation is adding air to the process of irrigation or aeration following irrigation. Usually, we use air pump, super micro bubble generating system or venturi injector to deal with irrigation water. These methods are also named oxygenation, oxygation, subsurface oxygenation, aeration sub surface drip irrigation or aerated irrigation.The followings analyze the airjection irrigation for current conventional ways of root zone.

a. Method of ventilation after irrigation
b. Method of irrigation water and air simultaneously
c. Method of mixing gases irrigation

a. Method of ventilation after irrigation

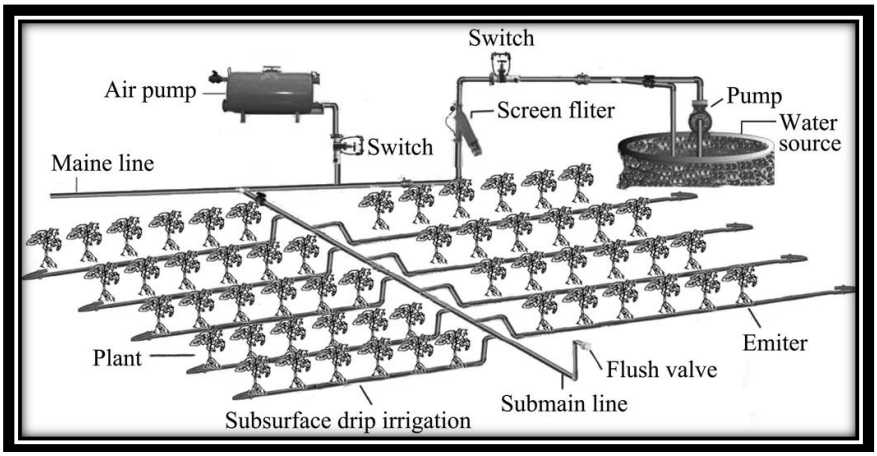

Fig. 2.Sketch map of ventilation after irrigation

buried drip irrigation belts and hose with holes attached to the water and air compressor above ground portion of belts in the soil surrounding the roots Inject pure oxygen or compressed air into the root zone of the soil using a compressor. The ventilation after irrigation method is the term given to this procedure. To begin with, the process of ventilation after watering is nearly identical to the original drip irrigation system, with the exception of the addition of an air pump. The benefit of this method is that it will have less negative effects on the original soil. Second, this method improves the dripper's anti-clogging performance, hence extending the drip irrigation belts' service life (Zhaiet al., 1999)

b. Method of irrigation water and air simultaneously

Prior to irrigation, the water is disposed of using a super micro bubble generating system, which enriches the water with bubbles with diameters of less than 3 m.

This is a form of irrigation that uses both water and air at the same time. The consequence of aerated irrigation is that it considerably improves the content of chlorophyll, soluble protein, stomatal conductance, and super oxide dismutase activity in leaves, while decreasing the level of malondialdehyde. Aerated irrigation effectively slows leaf senescence and extends the leaf functional period. As a result, it boosts photosynthesis efficiency and encourages grain filling (Zhu et al., 2010)

c. Method of mixing gases irrigation

Use a venturi injector at the entrance of the underground irrigation system to inject a specified amount of air, which is then carried to the soil in the crop root zone by water. Mixing gases irrigation is the name for this technique. Due to the decreased radius of the throat, Bernoulli's law states that when water flows through the Venturi at a certain pressure, the flow velocity will increase. Water pressure energy is converted to kinetic energy, and side wall pressure is reduced. A negative pressure will arise if the side wall pressure is lower than the atmospheric pressure, and air will be drawn into the pipes. Furthermore, air and water flow to the soil at the crop root zone.

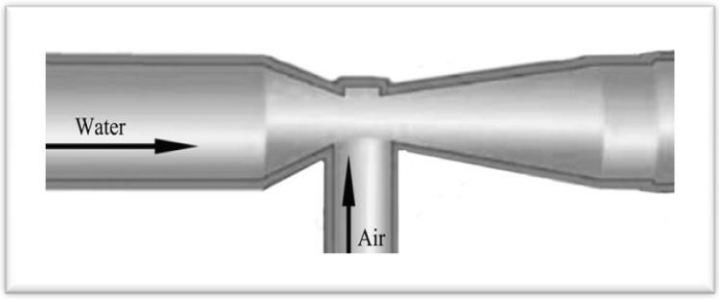

Fig.3. Venturi injector

A venturi is a device that introduces air into irrigated water streams. It has the favorable effect of reducing hypoxia. Subsurface irrigation with aerated water (water with 12 percent air) promotes above-ground growth and improves reproductive success

Advantages of Oxygenation in drip irrigation

The main benefits of oxygation can be stated as follows: i. Improved WUE, resulting in higher yield and profitability from water use
ii. Lessening of difficulties caused by saline soils or irrigation water
iii. Environmentally friendly as well as cost-effective.

Conclusions and Research prospects

Drip irrigation using oxygenation technology can dramatically boost crop yield and quality. Aeration boosts the oxygen environment of the rhizosphere, and sufficient oxygen ensures the normal activities of soil microorganisms and root activity. It also improves the ability of water, mineral absorption, canopy light interception rate, and photosynthetic efficiency. As a result, crop output and quality improve. A lot of aerated tests have been done recently for a variety of crops. This irrigation system has only been employed on a small scale due to a lack of associated studies and crop growth data in numerous parameters, as well as a lack of comparison between different technologies

Future thrust areas

On the topic of oxygenation in drip irrigation technology, domestic and international researchers did considerable research and made some progress. However, there were still a number of difficulties that needed to be investigated further. As a result, we will make the following recommendations: Hormonal regulation, antioxidant enzyme system, gene regulation, and cell signal transmission, among other topics, should be the emphasis of future research rather than plant apparent shape, production, and quality. Aerated drip irrigation should be studied for its ability to absorb water and fertilizer via crop roots, as well as the impact of changes in crop physiology. Studies might be undertaken on the potential dangers of aerated drip irrigation, such as if the excessive gas destroys the soil microbial population and is damaging to crop root growth. Researchers should conduct research on drip irrigation technology standardization and select appropriate technology and parameters to meet various needs.

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