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Fertigation Approach to Increase Fertilizer Use Efficiency

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Abstract
The relevance of fertigation in enhancing productivity efficiency and reducing water and nutrient usage while almost eliminating pollution is underlined. Fertigation is widely utilized as a cost-effective and effective technique of distributing soluble fertilizers to crops in innovative farming systems, efficiency, adequacy, uniformity are significant fertigation performance evaluation criteria. The term "fertigation uniformity" refers to a composite measure that includes indicators for irrigation and fertilizer application uniformity. Since its introduction in horticultural cropping systems, the usage of fertigation in combination with micro-irrigation has grown. This combination provides a technical solution in which nutrients and water may be delivered to the crop with pinpoint accuracy, resulting in excellent nutrient utilization efficiency. However, in fertigation cropping systems, accurate calculation of crop nutrient and water needs is critical for precise plant nutrition and high nutrient use efficiency. As a result of this technology, irrigation water can be saved by up to 50% as compared to surface irrigation, while crop yields and quality are also improved. Some soil parameters, such as infiltration rate, soil texture and water quality, surface as well as well water, must be addressed in system design and management to get the most out of drip irrigation.

Fertigation
Fertigation is a fertilizer application method in which the fertilizer is dissolved in irrigation water by a drip irrigation system. The fertilizer solution is spread evenly in irrigation in this system. Because the availability of nutrients is high, the efficiency is higher. Liquid fertilizers and water soluble fertilizers are employed in this manner. The efficiency of fertilizer use is raised from 80 to 90% when this strategy is used.

Fertigation is a relatively new cultural approach in which nutrients are mixed with irrigation water and applied through a drip irrigation system to increase fertilizer efficiency while also enhancing crop yields. Using an appropriate injection equipment, nutrient and water soluble fertilizer solutions are injected into irrigation water. Fertigation delivers necessary elements directly to the active roots zone, reducing costly nutrient losses while also boosting productivity and quality parameters of the produced product and lowering the danger of contamination. This article aims to provide insight into the various facets of fertigation technology.

- To promote uniform mixing of water and fertilizers, the fertilizer used must be free of deposits or residues and must not induce irrigation system corrosion.
- Constant operating pressure is required to facilitate uniform mixing of water and fertilizers.
- The most appropriate fertilizer and injection mechanism must be chosen.
- Fertilizer injection should not commence until all water lines are filled and emitters are operational.

Need of Fertigation

Fertigation is not an option when using pressurized irrigation systems; it is a need. Because only around 30% of the soil is wetted by drip irrigation without fertilisation, fertilizer efficiency suffers because nutrients aren't dissolved in the dry zones where the soil isn't wetted. As a result, the advantages of irrigation and fertilizer will not be discussed. As a result, fertigation is the best way for applying nutrients to micro-irrigated crops. The nutrient distribution pattern is also influenced by the type of irrigation and fertilizer used. Leaching loss of nutrients, particularly nitrogen, can occur in surface irrigation systems where fertilizers are applied via broadcasting method due to uneven distribution of both water and nutrients. The nutrient distribution will be localised in the drip irrigation method where nutrients are applied with soil application due to the limited availability of water near the root zone. In comparison to both of the above, when fertigation is done using drip irrigation, the plant root receives a uniform distribution of water and nutrients at the same time and in the same area, resulting in increased nutrient availability and uptake.

Methods of Fertigation

When using fertigation, the fertilizer solutions are prepared in advance in stock tanks and solution is then injected into the irrigation water. The type of fertigation chosen depends on the crop grown, the soil type and the farm management system.

There are mainly two types of fertigation.

1. Quantitative fertigation: It is the introduction of plant nutrients to the irrigation system in specified concentrations. For example, 20 ltr for block A and 40 ltr for block B. This is a popular procedure in soil. Using a fertilizer tank, the fertilizer is applied in a pulse after a specific water sheet without fertilizer. The inexpensive cost and low maintenance requirements of this technology are also advantages. There are certain restrictions, such as the system being influenced by changes in water pressure and the fertilizer concentration varying throughout application.

2. Proportional fertigation: Nutrients applied in a consistent and proportional ratio to the water discharge rate, resulting in a stable concentration of fertilizer in the irrigation water. One liter of fertilizer solution is put together with 1000 gallons of irrigation water, for example. In this instance, the Fertilizers are injected directly into the soil using fertilizer pumps. This technique is effective.

Mostly utilized in sandy soils and soils with little media. The precision of this procedure is an advantage. The quantity and injection time can be controlled, and the downsides include a high cost maintenance and a challenging operation

Basic Requirements for Fertigation

The incorporation of fertilizers into the irrigation system demands the following basic requirements:

A. Fertilizer Injection Equipment: It's just as vital to pick the right injection equipment as it is to pick the right nutrient. The pressure of the fertilizer solution injected must be larger than the internal pressure. A filter should be installed to prevent solids from clogging the

dripper allowing fertilizer solution particles to reach the dripper A back-flow preventer valve is a device that prevents water from flowing backward.

The fertigation unit's most significant component is the fertigation unit itself. Injectors are divided into three categories under:

1. Pressure differential (by-pass tank): This system works on the principle of a pressure differential created by valve and pressure regulation. The pressure difference forces the water to enter through a by-pass pipe into a pressure tank which contains the fertilizer and to go out again, carrying a varying amount of dissolved fertilizer. The application of nutrients is quantitative and inaccurate, therefore is adapted for perennial crops like citrus and fruit trees.

2. Vacuum injection (Venturi): This is based on the principle of venturi tube. A pressure difference is needed between the inlet and the outlet of the injector which cause a reduced pressure (vacuum) that sucks the fertilizer solution into the line.

3. Pump injection: Pumps are used to inject fertilizer solution into the line from a supply tank. Electric motors or hydraulic motors supply injection energy.

Advantages of Drip Fertigation

1. Plants are able to absorb more nutrients.
2. Less fertilizer, chemicals, and water are required.
3. Reduced nutrient leaching into the water supply.
4. Water consumption is reduced due to the plant's increased root mass' ability to catch and hold water.
5. Make the most of the available water.
6. The production and quality of the items obtained have improved.
7. Minimal labour costs and low operational costs.
8. Improves infiltration in low-input soils.
9. The ability to quickly adjust to advanced automatic control.
10. Improves seed germination by a factor of ten.

Fertilizers used in fertigation-:

Nutrient	Fertilizer use efficiency (%)	
	Soil application	Fertigation
Nitrogen	30-50	95
Phosphorous	20	45
Potassium	50	80

Nitrogen fertilizers

Plants absorb and use most of the nitrogen as nitrate or ammonium ions.

The main types of nitrogen are:

- nitrate - ammonium nitrate
- ammonium - sulfate of ammonia
- amide - urea

Phosphorous fertilizers

Phosphorus supply is usually provided by:

- phosphoric acid
- MAP (mono-ammonium phosphate)
- DAP (di-ammonium phosphate)

Potassium fertilizers

Irrigators can choose from:

- potassium nitrate
- potassium sulfate
- potassium chloride

Rules for Fertigation

The following are some guidelines to follow in order to get the most out of fertigation:

1. The fertilizer type and amount used must be soluble enough to dissolve in the fertilizer tank.
2. Before fertigation can commence, a pressured drip irrigation system must be installed.
3. Fertilizers should be injected before the filters to ensure that any undissolved particles are removed before the fertilizer reaches the drip tape.
4. To prevent consistent running when no water flows in the line, all fertigation devices should be attached to the pump switch control or a flow control switch in the main line.

Advantages of Fertigation

- High nutrient availability due to maintenance of soil moisture near root zone under drip irrigation.
- Minimum loss of nutrients through leaching to around 10 per cent as compared to 40-55 per cent in the traditional system, which further help in reducing environmental pollution.
- Unlike in traditional system, there is no damage to crop while top dressing of fertilizers.
- Fertilizers can be applied as frequently as possible in the needed amounts according to plant requirements.
- About 25-50% reduction in the quantity of fertilizer that resulted in higher fertilizer use efficiency.
- As small amounts are provided at regular intervals rather than giving in one or two big doses only, uptake and utilization of nutrients is very high with fertigation.
- Uniform application of nutrients can be done over the field.
- Considerable saving of labour and energy in the application of fertilizers.

Limitations of Fertigation

- Uneven nutrient distribution when the irrigation system is faulty.
- Chemical reactions of fertilizer with Ca and Mg may leads to chemical clogging.
- Phosphatic fertilizers and some micro nutrients may precipitate in micro-irrigation systems.
- Corrosion resistant fertigation equipment's are needed.
- Potential chemical backflow in to water supply source.
- The major factors limiting its large scale adoption are high initial cost and lack of information on various aspects such as crop water requirement, scheduling of irrigation and fertigation.

Precautions to be taken during fertigation

- Every emitting point must deliver the same amount of water, so fertigation can be done uniformly.

Conclusion

Fertigation is a cost-effective method of giving plant nutrients to field crops. Fertigation offers a number of advantages to users, including increased crop output and quality, resource efficiency, environmental safety, operational flexibility, effective weed management, and successful crop cultivation on undulating topography. It is considered environmentally benign since it prevents the leaking of nutrients, particularly N-NO3. For different situations, several fertigation methods might be applied. Fertigation equipment comes in a variety of varieties, which can be chosen based on the crop type and irrigation system. Fertilizers that dissolve in water or are liquid fertilizers are best for fertigation. Different fertiligation plans can be devised depending on the phenological state of the plant in tiny quantities and at the best moment. The nutrients are directed to the root zone, allowing the fertilizers to operate faster and be more effectively digested. Simultaneous and homoheneous distribution Before combining two or more fertilizers, consult the compatibility chart. The initial cost of setting up the fertigation system is higher, but it is more cost effective in the long run when compared to traditional fertilisation methods because it lowers the cost of cultivation by reducing fertilizer requirements and increases farm income through increased productivity.

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