



RESEARCH ARTICLE

FERTIGATION: A NOVEL AND EFFICIENT MEANS FOR FERTILIZER APPLICATION

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ABSTRACT

In order to get optimum result from micro-irrigation, fertilizers in liquid form have to be applied to the crop along with the irrigation water directly to the region where most of the plants roots develop. This process is called fertigation, which is done with the aid of special fertilizer application devices (injectors) installed at the head control unit of the system, before the filter. Use of fertigation system to apply fertiliser reduces the need of mechanical operations and sometimes eliminates them altogether. Fertigation when combined with an efficient irrigation system, both nutrients and water can be manipulated and managed to obtain the maximum possible yield of marketable production from a given quantity of these inputs. Fertigation is typically used to address fertiliser deficiency which inhibits plant growth, labour and operational efficiencies. Fertigation is an absolute necessity in drip irrigation, to obtain maximum benefit cost ratio.

INTRODUCTION

Fertigation is the application of water soluble solid or liquid fertilisers through drip irrigation system. The factors that governs the fertigation are soil type, crop, method of irrigation used, water quality, types of fertilisers available, economic feasibility etc. Fertigation has become a striking method of fertilisation in modern intensive agriculture systems. Water and nutrient are the main factors of production in irrigated agriculture and are the major inputs in contributing higher productivity. In intensive agriculture, both fertiliser and irrigation management have contributed immensely in increasing the yield and quality of crops (Balasubranium *et al.*, 1999). The method of fertiliser and irrigation application affects the efficiency of these inputs in arid and semi arid regions. Improvement of the use efficiency of these valued inputs is of utmost importance because these are costly and scarce (Chauhan and Chandel, 2008). Micro-irrigation is the most modern systems of irrigation where the water use efficiency is very high and it is very popular in arid and semi-

arid conditions of the world. Of late, it is also becoming popular in the arid and semi-arid region of India particularly where canal irrigation systems are not developed (Hagin and Lowengart, 1999). With the advent of this new method of irrigation system, traditional method of fertilisation which is still practised by the farmers is being slowly replaced by fertigation. In drip irrigation, the wetted soil volume and thus the active root zone is reduced under drippers and this small volume does not allow the addition of all plant nutrients needed by the plants (Krishna *et al.*, 1999). Rather, fertiliser needed is to be applied frequently and periodically in small amount with irrigation to ensure adequate supply of water and nutrient in the root zone (Biswas and Kumar, 2010). Therefore, as a result of the shift from surface irrigation to drip method of irrigation, fertigation becomes the most efficient fertilisation in the irrigated agriculture. The use of soluble and compatible fertilisers, good quality irrigation water and application of actual crop and water need are the prerequisite of the successful fertigation system (Magen, 1995). As any system, fertigation also has got its own advantages and disadvantages.

Major advantages of fertigation

- 1) In drip fertigation, fertiliser can be applied directly to the effective root zone of plant growth. Fertiliser

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application is synchronized and optimised with plant need and the amount and form of nutrient supply is regulated as per the need of the critical growth stages of plant.

- 2) Nutrients can be applied any time during the growing season based on crop need, thus saving in amount of fertiliser applied, due to better fertiliser use efficiency and reduction in leaching due to unseasonal weather.
- 3) Reduction in labour and energy cost by making use of water distribution systems for nutrient application.
- 4) Well-designed injection systems are available and are simple to use and suit automation, ensures better yield and quality of products obtained.
- 5) Timely application of small but precise amounts of fertilisers directly to the roots zone, which improves fertiliser use efficiency and reduces nutrient leaching below the root zone.
- 6) Ensures a uniform flow of water and nutrients causing minimal crop damage.
- 7) Smaller amounts of fertiliser can be applied quickly to address any deficiency issues and highly mobile nutrients such as nitrogen can be carefully managed to ensure rapid crop uptake.
- 8) Safer application method, as it eliminates the danger affecting roots due to higher dose.
- 9) Soil erosion is prevented.

Disadvantages

- 1) Both components (water and water soluble fertiliser) are comparatively costly and its optimal management is little difficult.
- 2) Good quality water is very essential for avoiding clogging inside the emitters.
- 3) Due to fear of yield loss, owing to relatively lower dose of fertilisers in fertigation, farmers have the tendency to add additional fertilisers and irrigation water by traditional methods too. This may result in crop lodging lower yield and lower profits.
- 4) It is heavily reliant of overall irrigation infrastructure design.

Application of fertilizer

The fertilizer in liquid form is fed into irrigation system at low rates repeatedly, on a continuous basis. The rate of injection should be in such a way that the amount of required fertilizer solution is supplied at a constant rate during the irrigation cycle. Other parameters such as solubility, acidity, compatibility and cost of fertilizers are being considered in fertigation (Nanda, 2010).

Solubility

All the fertilisers are not suitable for fertigation as some are insoluble due to their chemical properties. The fertilizer stock solution should always be dissolved completely in a separate container and must not form scums or sediments which might cause emitter clogging problems (Russan, 2008). The solution should always be agitated, well stirred and any sludge deposited in the bottom of the tank should be periodically

removed. Hot water helps dissolve dry fertilizers and their degree of solubility varies according to the type and chemical nature.

Acidity

The acidity produced by different fertilizers is greatly affected by the kind of irrigation water and the type of soil. The soil pH should be checked at the beginning of the fertigation operations. Furthermore, a complete ionic analysis of the water is necessary.

Quantity

A simple method for calculating the amount of fertilizer required for fertigation is to divide the annual application by the number of applications. The nutritional requirement of each crop is different and varied to different growth stages. The total quantity of fertilizers applied is also related to the length of the growing season and the irrigation requirements.

Fertigation Equipments

Fertiliser can be injected into drip irrigation system by selecting appropriate equipment. These are operated by the system's water pressure. Commonly used fertigation equipments are:

- i) Venturi assembly
- ii) Fertiliser tank
- iii) Fertiliser injection pump

Venturi assembly

This is a simple and low cost device based on the principle of Bernoulli's theorem. A pressure difference is needed between the inlet and the outlet of the injector and a partial vacuum is needed to be created in the system for the suction of the fertilisers into the irrigation system through venturi action. The vacuum is created by diverting a percentage of water flow from the main and passes it through a constriction which increases the velocity of flow thus creating a drop in pressure. When the pressure drops the fertilisers solution is sucked into the venturi through a suction pipe from the tank and from there enters into irrigation stream. Although simple and with greater uniformity of dosing the fertilisers tank the venturi cause a high pressure loss in the system which may result in uneven water and fertiliser distribution in the field. The suction rate of venturi is 30-120 lph. They are relatively cheap compared to other injectors.

Fertilizer injection pump

This is a piston or diaphragm pump which is driven by the water pressure of the irrigation systems and the injection rate is proportional to the flow of water in the system. A high degree of control over the fertiliser injection rate is possible, and no head losses are incurred. Another advantage is that if the flow of water stops, fertiliser injection also automatically stops and it can be adjusted by small regulators. This is perfect equipment for accurate fertigation and also for automation.

They are more expensive than the venturi type injectors. Suction rates of pumps vary from 40 to 160 lph.

Fertilizer tank

This is a cylindrical, epoxy coated, pressurized metal tank, resistant to the system's pressure and connected as a by pass to the supply pipe of the head control. It operates by differential pressure created by a partially closed valve, placed on the pipeline between the inlet and the outlet of the tank. Part of the flow is diverted to the tank entering at the bottom and it mixes with the fertilizer solution and the diluted solution is ejected into the system. The dilution ratio and the rate of injection are not constant. The concentration of fertilizer is high at the beginning and very low at the end of the operation. However, this apparatus is still in service on a very small scale because of its simplicity.

Efficacy of drip fertigation

The benefit of drip irrigation mainly depends on the practice of fertigation. In drip fertigation only 30-40% of the soil is wetted by the emitters. If the fertilisers and water are applied separately, the fertiliser use efficiency decreases because the fertiliser does not get dissolved in the dry zones where the soil is not wetted, as a result the benefit is not fully expressed. Hence, traditional fertilisation is not appropriated, not convenient and efficient as the drip fertigation. Drip fertigation is therefore, the best means of fertilisation to the root zone of the crops. Use of fertigation is very effective in high value crop (Rajput, 2010). In addition, fertiliser application is limited to 2-3 splits applications during the life cycle of the crop limiting its availability to certain periods which reduces the fertiliser absorption and use. Fertilisers need to be placed at a certain depth in the soils to be effective. In the fertigation the nutrients are applied at very low concentrations through water, which move down into the lower soil layers where the absorptive roots exist (Tambare *et al.*, 1999).

Impact of drip fertigation

Various components of high-tech farming are introduced from time to time to enhance the productivity. Fertigation is one such agro-technique which has proved to be a catalyst to boost the productivity of many crops. Drip fertigation is found to be well suited for all horticultural crops. In India, the adoption of this dual technology has resulted in enhancement of horticultural production, water use efficiency and yield enhancement in vegetable production through drip irrigation (Soman, 2009).

Conclusion

Due to the heavy demand of water for domestic, agricultural, industrial and other purposes, the efficient use of water is very

much needed. Fertiliser nutrients are also very valuable inputs, as far as the fertilizer production is concerned. India is not self-sufficient in fertiliser production and about 40 per cent of fertiliser consumed in the country is imported, resulting huge outgo of foreign exchange. Therefore, fertiliser use efficiency has to be improved. Drip fertigation is such an excellent and hi-tech agro-technique, its adoption might results in increased efficiency of the both the key inputs. As the horticultural crop production is getting momentum in India where drip fertigation use is more convenient and economically attractive, the potential of increase in the drip fertigation is bright. The uses of new water soluble fertilisers which are most suited for fertigation are also being encouraged. Fertigation increases water and nutrient use efficiency and with the increase of coverage of area under drip irrigation, the area under fertigation is also likely to increase. Of late, use of drip in rice which is the most important food crop of the country has been reported from many parts of the country. It has been seen that farmers also use traditional method of nutrient application in addition to fertigation due to fear of yield loss because of lesser application of fertilisers and water. The farmers need to be educated and motivated to use fertiliser and water efficiently through drip irrigation and fertigation.

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