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## Principles and Practices of Fertigation

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#### Abstract

An approach for efficient utilisation of water and fertilisers is necessary for agriculture in the 21<sup>st</sup> century. As the use of conventional irrigation methods not only results in considerable loss of water but is also responsible for development of wide spread salinity, water logging and leaching of nutrients from the rhizosphere. Fertilisers supplied under traditional methods of irrigation are not effectively utilized by the crops. As an alternative, fertigation is gaining popularity all over the world. It was first started in the late 1960's in Israel with the development of drip irrigation and over 75% of the irrigated area is fertilized by fertigation.

#### Introduction

Once investment on drip irrigation is made it is very easy to achieve the full benefits through the next ultimate step called as fertigation. Fertigation is a coined term to irrigate and give fertilisers along with it. In other words, fertigation is addition of fertilisers to irrigation water and application via drip or similar micro irrigation system.

Fertigation provides Nitrogen, Phosphorus and Potassium as well as the essential trace elements directly to the active root zone, thus minimizing the loss of expensive nutrients, which ultimately helps in improving productivity and quality of farm produce. Nutrients are delivered to the restricted root zone (wetted soil) in a readily available form and frequent delivery of water and nutrients replenish the small volume of soil in the active root zone, nourishing the crop throughout the entire growing season.

One of the major factors to promote modern fertigation is the development of Micro Irrigation Systems (MIS), which includes drip, jets and micro sprinklers. Field experiments in Israel in the early 1960's showed that when only part of the field area is irrigated, as in MIS, the use of standard broadcast application of fertilisers is ineffective. The limited root zone and the reduced amount of mineralization in the restricted wetted zone are the main reasons for the reduced nutrient availability to the plant. Recognition of these facts led to the installation of fertigation facilities with almost all applications of MIS. Fertigation is by far the most common, and in some cases the only method of fertilizing the green houses, orchard, vegetables and drip irrigated field crops (Bar Yosef, 1999). The fertilizer use efficiency for various application methods are given in Table 1.

Table 1: Fertilizer use efficiency under various application methods

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

## Fertilizers for Fertigation

**W**ater in which fertilizers are to be dissolved should have pH levels between 5.8 and 7.8. The solubility of some common fertilisers used in drip irrigation are presented in Table 2.

Table 2: Fertilizers commonly administered in fertigation

| Name                     | Chemical name                                                  | N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O content | Solubility (g/l) at 20 °C |
|--------------------------|----------------------------------------------------------------|-----------------------------------------------------------|---------------------------|
| Ammonium nitrate         | NH <sub>4</sub> NO <sub>3</sub>                                | 34-0-0                                                    | 1830                      |
| Ammonium sulphate        | (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>                | 21-0-0                                                    | 760                       |
| Urea                     | CO(NH <sub>2</sub> ) <sub>2</sub>                              | 46-0-0                                                    | 1100                      |
| Monoammonium phosphate   | NH <sub>4</sub> H <sub>2</sub> PO <sub>4</sub>                 | 12-61-0                                                   | 282                       |
| Diammonium phosphate     | (NH <sub>4</sub> ) <sub>2</sub> HP <sub>2</sub> O <sub>5</sub> | 18-46-0                                                   | 575                       |
| Potassium chloride       | KCl                                                            | 0-0-60                                                    | 347                       |
| Potassium nitrate        | KNO <sub>3</sub>                                               | 13-0-44                                                   | 316                       |
| Potassium sulphate       | K <sub>2</sub> SO <sub>4</sub>                                 | 0-0-50                                                    | 110                       |
| Mono potassium phosphate | KH <sub>2</sub> PO <sub>4</sub>                                | 0-52-34                                                   | 230                       |
| Phosphoric acid          | H <sub>3</sub> PO <sub>4</sub>                                 | 0-52-0                                                    | 457                       |

## Special Water Soluble Fertilizers

**W**ater soluble specialty fertilisers specifically meant for fertigation are available at present and most of them are imported in India and marketed by Irrigation Systems and Fertilizer Dealers (Table 3).

Table 3: Special water soluble fertilisers suitable for fertigation

| Name      | N  | P <sub>2</sub> O <sub>5</sub> | K <sub>2</sub> O |
|-----------|----|-------------------------------|------------------|
| Poly feed | 19 | 19                            | 19               |
| Poly feed | 20 | 20                            | 20               |
| Poly feed | 11 | 42                            | 11               |
| Poly feed | 16 | 8                             | 24               |
| Poly feed | 15 | 15                            | 30               |
| MAP       | 12 | 61                            | 0                |
| Multi – K | 13 | 0                             | 46               |
| MKP       | 0  | 52                            | 34               |
| SOP       | 0  | 0                             | 50               |

## Useful Formulae in Scheduling Fertigation

1. Amount of fertilizer (W)

$$W \text{ (kg)} = \frac{Q_s \times V \times C}{1000 \times E \times q_i}$$

2. Concentration of fertilizer in the irrigation water (C)

$$C \text{ (PPM)} = \frac{1000 \times W \times E \times q_i}{Q_s \times V}$$

3. Required container capacity (V)

$$V \text{ (Litres)} = \frac{1000 \times W \times E \times q_i}{Q_s \times C}$$

4. Required injection rate (q<sub>i</sub>)

$$q_i \text{ (LPH)} = \frac{Q_s \times C \times V}{1000 \times W \times E}$$

Where,

W = Amount of fertilizer (kg);

Q<sub>s</sub> = Sectional flow of the irrigation system (m<sup>3</sup>/ hr);

q<sub>i</sub> = Injection rate (lit./hr);

C = Concentration of fertilizer in the irrigation water (ppm);

V = Container volume (litres);

E = Concentration of the nutrient in the fertilizer (Decimals).

## Certain Principles in Fertigation

| Do's                                                              | Dont's                                                                         |
|-------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Use completely soluble fertilisers                                | Avoid fertilisers with impurities and low solubility                           |
| Use MAP or Ortho Phosphoric acid for P                            | Avoid Super Phosphate for fertigation                                          |
| Prefer White Potash against Red Potash for K                      | Avoid Chloride fertilisers for grapes and quality fruits and tobacco           |
| Select fertilisers with high nutrient contents                    | Avoid fertilisers causing clogging, corrosion to fertigation devices and pipes |
| Ensure correct drip fertigation design and schedule               | Improper design leads to wastage of fertiliser and water                       |
| Use regulated emitters only                                       | Avoid tap and micro tubes                                                      |
| Fertigation at more frequent intervals with low application rates | Avoid high rates of fertiliser per application and long intervals              |

## Merits of Fertigation

- Fertigation ensures uniform and regular flow of both water and nutrients, resulting in increased growth, yield and quality of crops.
- Through fertigation the three major nutrients are supplied in one solution to the active root zone resulting greater absorption.
- Small quantities of fertilisers can be applied at close intervals.
- The system enables accurate and uniform distribution of nutrients in the root zone.
- Each irrigated plant receives the same proportion of nutrients.
- When combined with proper management, fertigation can reduce nutrient losses from leaching, volatilization and/or fixation.
- Large savings on labour and energy in nutrient application.
- Increases the availability and uptake of nutrients.

- Maximizes water and nutrient productivity.
- Micronutrients can be effectively applied by fertigation.

## Conclusion

Through fertigation, due to synergism and combination of water and nutrient leads to an efficient use of both by the plant. Based on the studies conducted in various commercial, horticultural and high value crops, it was found that adoption of this technology improves the yield and the quality of crops. It is also highly beneficial to the farming community in reducing the cost of production. Further it helps in sustaining the soil health for better productivity and reducing environmental hazards.

## Reference

Bar Yosef, B., 1999. Advances in fertigation. *Advances in Agronomy*, 65, 1–77.