

Precision fertigation:

The key component for maximizing productivity

Tejas Mangesh Lingavale, H T Jadhav* and D P Pawar

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra 415 712

Fertigation plays a very crucial role in enhancing plant productivity. Presently, fertigation is done by various devices available in the market. They are having certain limitations and lower fertilizer use efficiency due to the non-uniform mixing of water-soluble fertilizers, uneven injection rate, non-uniform distribution of fertilizer throughout the entire field, etc. Considering the costs and drawbacks of the available fertigation systems, it was felt necessary to develop a cost-effective, user-friendly and efficient fertigation system that would be made easily from materials available in the market. Accordingly, a three-stage fertigation system was developed that can decide appropriate fertilizers quantity, mix them well and distribute them evenly throughout the field with significant uniformity. This article's goal is to give readers a concise overview of the three-stage fertigation system along with its benefits over the existing fertigation systems, the procedure to give fertigation by the developed system, general guidelines to be followed while giving fertigation using the developed system and potential for automation in the future to bring the more accuracy in the fertigation.

Keywords: Precision fertigation, Stock solution, Three-stage fertigation system, Uniform fertigation

In order to increase productivity, plant nutrition is crucial. Utilizing fertilizers at an optimum rate is necessary for higher crop yields. With the introduction of high yielding varieties after the green revolution, fertilizer use increased rapidly. However, at the moment, the use of more fertilizers is not resulting into higher productivity and fertilizer-use efficiency is steadily declining. In order to increase yield and enhance input-use efficiency, it is necessary to investigate new approaches and sources for plant nutrition. The application of plant nutrients via irrigation is known as fertigation. Chemical fertilizers dissolved in irrigation water are used in this technique, and the plant roots receive water and nutrients at the same time and place, conserving both expensive inputs: water and fertilizers. The time, quantity, concentration and ratio of the nutrients are all

easily controlled with a fertigation system. Crop yields and quality are higher as a result of this improved management than they would be with traditional methods of fertilizer application. Fertigation is a modern agro-technique that offers a fantastic chance to maximize productivity and reduce environmental damage. Any irrigation system is suitable for fertigation, but applying fertilizers with a traditional irrigation system can result in an unbalanced distribution of nutrients across the crop area. For fertigation, pressurized irrigation systems including drip, sprinkler and micro-sprinklers are ideal.

Need and essentiality of fertigation

The unequal expansion of fertilizer leads to insufficient or unbalanced fertilizer application, which frequently results in increased fertilizer use and import of fertilizers. The link between

fertilizer use and potential yield is further weakened by the loss in crop response to applied fertilizer as a result of uneven fertilizer application. In order to maximize the usage efficiency of both water and fertilizer, there is must necessity for the balanced application of fertilizer in the water-soluble form in the active root zone according to the stage-by-stage requirements of the crop.

Fertigation techniques available in the market and their limitations

Number of fertigation techniques are available in the market, ranging from very low cost to fully automated systems, to inject water soluble fertilizers into the irrigation system. But considering their costs, working principles, accessibility to the market, complexity, difficulties in operation, etc., farmers are reluctant to buy them. By using such devices over the years, farmers have

good knowledge about the existing devices, their flaws, demerits, problems incurred during their operation, etc. Some of the widely used fertigation techniques are as follows:

Venturi Injector: According to Bernoulli's law, when water flows through the Venturi at a certain pressure, the flow velocity will increase, due to the smaller radius of throat. Water pressure energy converts into kinetic energy and it reduces on side wall of the pipe. If the side wall pressure is lower than the atmospheric pressure, a negative pressure will be formed, and then fertilizer water will be sucked into the pipe. The cost of one Venturi injector assembly is about ₹2000. Besides its cost and other specifications, it has certain limitations regarding the suction of fertilizers. It requires a sufficient pressure difference (at least 20–25%) to suck the fertilizer into the pipe.

Fertilizer tank: It is a tank connected parallel to the irrigation pipe, able to support the irrigation pressure. It has a lid on top which allows compatible fertilizers to be placed inside and be closed hermetically later. It provided with inlet and outlet port. A valve is installed in the irrigation pipe between the inlet and the outlet to generate a pressure difference between 0.2 and 0.5 kg/cm². This provokes a diversion of flow through the tank which sweeps fertilizer water to the irrigation pipe. The cost of the fertilizer tank of capacity 60 litres is around ₹7500. Also, it has limitations regarding the uniform mixing of fertilizers.

Dosing pumps: It works on the principle of water pressure. Setting



Venturi injector
Source: www.growinsane.com



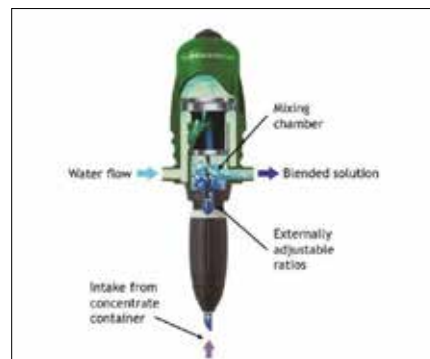
Fertigation tank
Source: Jain irrigation

up on the water network of the irrigation system the metering pump uses water pressure as the only driving force. When activated, it sucks in the concentrated product, doses it to the desired percentage, and then mixes it with the driving water. The solution is then sent downstream. The dose of fertilizer injected is always proportional to the volume of water flowing through the metering pump, regardless of variations in system pressure. The cost of the injection pumps is too high as compared to other fertigation devices and they also do not mix fertilizer solutions as precisely and effectively as other devices.

Problems occurred during fertigation process

The centre at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra has two polyhouses: GI polyhouse of area 644 m². and Bamboo polyhouse of area 740 m² Capsicum was cultivated inside the GI polyhouse and fertigation was given by the following t fertigation methods and the problems raised are stated below:

Firstly, three stock solutions were prepared, viz. A, B, and C with the help of our own developed nutrient management calculator. Solution A, contains calcium-containing fertilizers, solution B, contains phosphate and sulfates containing fertilizers and solution C, consists of micronutrients. Care was taken that calcium-containing fertilizers shouldn't mix with the phosphates and sulfate-containing fertilizers to avoid the formation of precipitates that would clog the entire system.



Dosing Pump
Source: www.dosatron.com

The following method was used after experiencing all the drawbacks of the readily available fertigation devices to give the fertigation:

Direct dosing of the fertilizers to the irrigation pipelines with the help of the Gattu water pump: As stated above, firstly three stock solutions were prepared. At the time of fertigation, the necessary amount of fertilizer solutions was drawn from the respective tanks into the plastic bucket to inject into the irrigation line. By forcing the concentrated fertilizer solutions with the help of 0.5 hp single phase Gattu pump water, soluble fertilizers were mixed into the (online) irrigation pipeline and fertilizers were allowed to flow

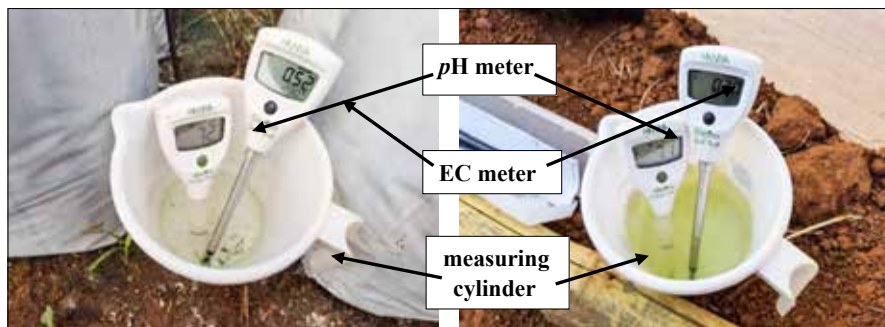


Fertigation with the Gattu pump of 0.5 hp
Source: AICRP-PEASEM, Dapoli

through the irrigation pipes to the individual crop entities.

The following problems occurred during the use of this method:

- Fertilizers were not uniformly mixed inside the irrigation water; as electrical conductivity



Variation between electrical conductivities found at the starting dripper and farthest dripper
Source: AICRP-PEASEM, Dapoli

found at the first plant of the first row was not equal to that at the last plant of the last row resulting in uneven growth of the plants.

- Problems occurred during the injection of concentrated fertilizers with the irrigation water, as the pressure of the irrigation water i.e., (Monoblock pump of 1.5 hp) was sufficiently more than that of 0.5 hp Gattu pump. So, there was the need to either reduce the pressure of the parent pump or shut off the parent pump during the injection of fertilizers and then it had to shut on after the injection had been completed. It was labour-dependent, time-consuming and complex work.

The best solution for precision fertigation

Taking all the limitations and flaws of the existing fertigation systems into account, we have developed and installed three stages user-friendly and cost-effective irrigation cum fertigation system on the research farm of the Centre. The working principle of the system is to give direct and well uniformly mixed fertilizers with the irrigation water itself in a more frequent manner.

A developed fertigation system for the GI polyhouse and Bamboo polyhouse of the Centre mainly consists of water tanks of a capacity of 1500 litres, pressure gauges, screen filters, irrigation pumps, three small containers for the storage of stock solutions and other fitting accessories. The fertigation system (three stages) includes:

- Deciding the fertilizer quantities using the specially developed

- nutrient management calculator,
- Preparation of three stock solutions and,
- Mixing of fertilizer stock solutions with the water in the supply tank as per daily requirements of the crop.

The procedure for giving fertigation

- Calculate the fertilizer requirement of the crop by using a nutrient management calculator which has been developed by the Centre.
- Prepare the stock solutions according to the requirements of the crop in three different small-size plastic containers.
- Fill the large-size supply tank with water which is enough for one day of irrigation considering the crop stage and the season.
- Add stock solutions considering the water quantity into the supply tank and mix them with the help of a stirrer.
- Start the irrigation motor (here, a 1.5 hp Monoblock pump is used).
- An irrigation motor will supply the fertilizer solution from the supply tank and through



Tanks A, B and C for storing the stock solutions
Source: AICRP-PEASEM, Dapoli

the irrigation pipelines to the individual crop entities.

- Fertilizers will distribute equally to each plant of each row.

Advantages of developed cost-effective three stage fertigation system over the existing fertigation systems

- Uniform mixing of water-soluble fertilizers is possible well before the fertigation.
- All plants get an equal concentration of fertilizers; so that uniform growth is found throughout the crop field.
- No need to give separate fertilizers.
- Elimination of errors in making a pressure differential, negative suction, dosing, injecting, etc. which causes uneven distribution of fertilizers throughout the field.
- The system is totally cost-effective as there is no use of any expensive item.
- The system is user-friendly; so that less skilled person can also operate it.
- Considering the accessibility to the material, maintenance and efficiency; it is one of the best solution to give irrigation cum fertigation.
- Saving of irrigation water and fertilizers.

General guidelines while giving fertigation using three stage fertigation system

- Stock solutions should be prepared in three different tanks; so that calcium and phosphates or sulfates containing fertilizers should not mix.
- Fertigation should be scheduled in a frequent manner per day



Developed three stage fertigation system
Source: AICRP-PEASEM, Dapoli

(You can give 1 or 2-days gap for the fertigation according to need).

- Before fertigation, stir the fertilizer solution with a stirrer in a fertigation tank for uniform mixing of fertilizers.
- Pressure of the system should not be much more or much less; it should be optimum. It should be sufficiently 1 kg/cm² at the farthest dripper.
- The outlet of the water tank should be at least 1" upstream of the pump suction inlet.
- Apply stock solution A and B on alternate days to avoid precipitate formation at the root zone of the crop and apply micronutrients i.e., tank C with any one of them i.e., either A or B in adequate quantity.

- Check the EC and pH of the leachate in between to get uniformity, accuracy and actual usage by the crop.
- Flush the irrigation pipelines regularly to remove the traces stuck inside them of previously applied fertilizers.

SUMMARY

The key to gaining maximum productivity is precision fertigation. Numerous fertigation tools are offered on the marketplace. There was a need to investigate and design a user-friendly, cost-effective and efficient fertigation system from the perspectives of their usage, accessibility to the material, costs, efficiency, problems that occurred during their operation, maintenance, complexity, etc. for

the protective cultivation of crops in developing countries. Considering the farmers' problems regarding fertigation in protective cultivation our Centre is trying to overcome them by performing different research activities. Over the existing fertigation systems, the developed three-stage fertigation system by our Centre has a number of advantages. With the appropriate fertigation system, we can increase crop productivity. Crops will grow with superior root systems. The growth and development of the plants are aided by uniform fertigation. Proper nutrition applied to crops increases the yield of crops.

*Corresponding author's e-mail:
htjadhav@gmail.com

HANDBOOK OF INTEGRATED PEST MANAGEMENT

To reverse the loss of environmental resources and also to reduce biodiversity loss, the Government of India has Integrated Pest Management (IPM) as part of the National Agricultural Policy. Integrated Pest Management emphasizes the growth of a health crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms. IPM is not new – mechanical, cultural and biological tactics were used by farmers for hundreds of years before chemical pesticides became available. Besides, there are IPM techniques that have been developed more recently and are effective in suppressing pests without adversely affecting the environment.



The task of spreading the message of IPM across is tough due to poor awareness about the subject among people in line-departments as also among the farmers. The information on integrated pest management as a whole is scattered. This *Handbook* comprehensively deals with all the aspects of integrated pest management in field crops, horticultural crops under traditional, protected systems. Information on basic strategies and tactics of different methods of management including mass production of biocontrol agents, IPM policy and pesticide registration is provided in comprehensive form.

The *Handbook of Integrated Pest Management* comprises 82 chapters which are well written in lucid language with crispy sentences by the renowned scientists. The role of IPM is elucidated with different pests like *Trichogramma*, *Bacillus thuringiensis*, *Nomuraea rileyi* etc. and agricultural crops like rice, wheat, maize, sorghum, pearl millet, pulses, soybean, rapeseed mustard, groundnut, minor-oilseed crops, sugarcane, cotton, jute and mesta, potato, vegetable crops, fruits, grapes, citrus, banana, pomegranate, coconut etc. This *Handbook* will provide information of available useful technologies to educate on how to reduce or judiciously use chemical pesticides, safeguard ourselves from chronic poisoning, save the National environment while also reducing input costs and raise farmers' income. This compilation will be useful to teachers, students, trainers, line-department personnel and policy makers.

TECHNICAL SPECIFICATIONS

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Directorate of Knowledge Management in Agriculture
Indian Council of Agricultural Research
Krishi Anusandhan Bhavan-I, Pusa, New Delhi 110 012
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