

Drip fertigation for

Enhancing crop and water productivity

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Drip fertigation is an effective and convenient mean of applying water and fertilizer. In this method, water soluble fertilizers are applied as per crop needs in the vicinity of plant roots using drip line and drippers. This method is useful in water scarce situations, and for horticultural and cash crops requiring high dose of nutrients and water at frequent intervals. Up to 90 % of the applied nutrients are absorbed with fertigation while it is only about 40% with the conventional surface application of dry fertilizer. It reduces fertilizer dose by about 25 % for most soils (loamy sand, sandy clay, clay loam and silty clay loam) and thereby, fertigation has potential to partially help in overcoming the fertilizers crisis. Adverse effects of chemical fertilizers on environment can also be reduced. Results from All India Coordinated Research project on Irrigation Water Management showed that there was 26–45% increase in crop yield due to drip fertigation. Water productivity in crops due to fertigation ranged from 30.2 to 103.2 kg/ha.mm. Results further indicated that 25% of recommended N, P and K fertilizer can be applied as basal dose at planting using conventional solid fertilizers. For P, even up to full dose can be placed as basal in certain soils. Location specific fertigation schedules should be followed for higher water, nutrient and economic efficiency.

Keywords: Fertigation, Scheduling, Soil types, Vegetables, Yield

VEGETABLE and flower crops require high amount of water at frequent intervals. The adverse effects of climate change on these crops have resulted in reduced crop productivity. The shift in occurrence time and prolonged nature of dry spell due to rainfall aberration under climate change are compelling to opt for irrigated agriculture. On the other hand, the share of water for irrigation is likely to decrease from 85% to 74% due to increased demand from competing sectors such as domestic use, industries, power, etc. Increased water scarcity for agriculture and fisheries is forcing to opt for “more crops per drop”. Drip irrigation system is most efficient for fruit, vegetable and flower crops which are grown in rows with considerably wide spaces. In this water saving irrigation method, there is scope for saving nutrients by depositing them through drippers

in the root zone of plants either from above the soil (surface drip) or from below the surface (subsurface drip). The latter one is more efficient in water and nutrient use, but with additional cost on placing lateral and main pipes below the soil surface and some management problems.

Advantages with drip fertigation

- Drip fertigation in vegetable crops can reduce water use by 50–60 % and increase yield by 30–40 % compared with the conventional surface irrigation. The reduction in water use is still more in fruit crops planted at a wider spacing with lower cost of drip installation as compared to vegetable and flower crops.
- The regulated supply of water through drippers favours high irrigation and nutrient use efficiency due to negligible loss through deep percolation,

and reduced loss through evaporation. Water is the vehicle for nutrient movement and hence, nutrients are largely retained in root zone along with the applied water.

- Drip irrigation maintains a favourable soil water regime and restricts the fluctuation of soil water in a narrow range. It recharges the root zone and maintains the uniformity of moisture for a longer period. The drip irrigation system has an edge over surface irrigation since the soil moisture spreads horizontally as well as vertically and maintains soil moisture near field capacity near root zone due to frequent and light irrigations.
- The drip irrigation system applies controlled and precise amounts of water to the field, and hence, the negative impacts such as surface runoff, soil

erosion, deep percolation, and soil compaction are avoided.

- More fertilizers may be needed for surface irrigated fields than the drip irrigated fields because of minimal nutrient loss with the leached down water beyond the root zone. In conventional method, N and K fertilizer are applied in a few number of splits (usually in 2–3), providing less opportunity for plant uptake and resulting in more losses. In drip fertigation, nutrients are applied in 8–10 splits in seasonal field crops. The fertilizer dose is reduced by 25 % in drip fertigation as compared to surface irrigation. So, fertigation has potential to help in partially overcoming the fertilizer crisis.
- Distribution of applied nutrients within the wetted soil volume favours the nutrient uptake by roots. Up to 90 % of the applied nutrients are absorbed with fertigation while it is only up to 40% with the conventional surface application of dry fertilizer.
- Nutrient application in several splits can be matched with the crop demand and thereby over or underfeeding by crops is avoided.
- Adequate availability of water and nutrients in root zone leads to optimum root and shoot growth, higher crop yield and low incidence of diseases, insect pests and weeds.
- The timing, amount, concentration and ratios of the nutrients are easily controlled.
- By adopting fertigation, crops may be grown to their potential even on less fertile, shallow soils and inert media. So, the problem of less land availability per capita can be partly overcome.
- Groundwater pollution is less under drip fertigation due to less leaching of nutrients and other agrochemicals.

Disadvantages with drip fertigation

- Initial capital costs are associated with the equipment needed to dissolve and inject the fertiliser

into the irrigation water and overall drip fertigation system installation.

- Drip fertigation system generates a concentrated root system in a limited space within the wetted soil volume. About 70–80 % roots grow in surface soil. So, it is essential to ensure application of macro- and micro- nutrients at optimum dose in that root zone.
- Water soluble fertilizers are required for drip fertigation which are very costly.
- Generation of PVC and plastic wastes after 6–8 years of life period of main and lateral pipes, and drippers.
- Basic training is required for maintenance and operation of drip fertigation system including backwash of filtration system, regular cleaning of drippers etc.
- Good quality clean water is required to avoid clogging of the system.
- Chemical reactions between some types of fertilisers when mixed, potentially may cause significant equipment blockages.

Fertigation units

- Venturi system– A venturi of ¾ inch size discharges 750 to 1000 ml water per minute and attached with pressurized irrigation system.
- Fertilizer tank system- A fertilizer tank of 20–30 litre capacity is attached. The discharge rate is 3–3.5 litres per minute and is attached with pressurized or gravity fed irrigation system.
- Fertilizer injection pumps.
- Use of water storage tank.

Table 1. Distribution of nutrients in water soluble fertilizers

Grade	19:19:19	17:44:0	0:52:34	13:0:45	12:61:0	0:0:50
Total Nitrogen by wt (%)	19	17	0	13	12	0
Ammonical N(%)	4.5	17	-	-	12	-
Amide N (%)	10.5	0	0	0	0	0
Nitrate N (%)	4.0	0	0	13	0	0
Water Soluble P ₂ O ₅ (%)	19	44	52	0	61	0
Water Sol K ₂ O (%)	19	0	34	45	0	50

Characteristics of fertilizer suitable for fertigation

- High nutrient content and readily available to plants.
- Fully water soluble at field temperature conditions.
- Fast dissolution in irrigation water.
- No clogging of filters and emitters.
- Low content of insoluble materials (<0.02%).
- Compatible with other fertilizers.
- No drastic changes of water pH (3.5<pH<9.0).

Commonly available water soluble fertilizers

The commercially available water soluble fertilizers used for fertigation are Urea, 19:19:19, 18:18:18, 12:61:0, 17:44:0, 0:0:50, 13:0:45 etc. Some fertilizers contain NPK, NP, NK, PK or K only. Nitrogen fertilizers contain ammonical, amide and nitrate form in different proportions. Some crops do not prefer ammonical and amide form of N. Accordingly, fertilizers should be selected as per the crops to be grown. For crops not sensitive to the form of N, fertilizers should be selected as per the price per kg N.

Factors likely to affect fertigation schedule

Fertigation schedule is affected by soil (texture, available NPK status, organic carbon, pH, moisture at field capacity, available water capacity, and aggregate size distribution), crop (crop type and its physiological growth stages), drip system (discharge rate, variation and uniformity coefficient) and weather parameters (evapotranspiration rate, temperature). The efficient fertigation schedule requires attention to three factors, viz. a) Plant growth stage wise nutrient

requirement, b) Nutrient delivery -frequency and intervals to meet the crop needs and c) Regulated water supply to minimize leaching of soluble nutrients below the effective root zone. When making a pre plant application of any nutrient, it is important that the fertilizer be placed within the wetting zone of the drip system. A crop specific fertigation schedule can be developed using growing degree days and crop growth pattern. Nutrient can be injected at various frequencies (daily to bimonthly) depending upon system design, soil type and grower preference. Frequent injection is needed for sandy soil with poor water and nutrient holding capacity.



View of fertigation in Brinjal (Bathinda Center)

Suitable crops

The drip irrigation or fertigation system can be installed in number of field crops depending upon crop spacing, soil type, lateral spacing and climatic requirement mainly evapo-transpiration rate. The field crops suitable for drip fertigation are orchard crops (grapes, banana, pomegranate, orange, citrus, tamarind, fig, mango, lemon, custard apple, sapota, guava, pineapple, coconut, cashew nut, papaya, aonla, litchi etc.); vegetable crops (tomato, capsicum, cabbage, cauliflower, onion, brinjal, bitter gourd, bottle gourd, ridge gourd, cucumber etc.); cash crops (sugarcane, cotton, strawberry etc.); and flower crops (rose, carnation, gerbera, anthurium, orchids, jasmine, lily, mogra, tulip, dahilia, marigold etc.).

Fertigation scheduling

The calculated amount of water-soluble fertilizers is divided into 8–10 equal parts and each part is applied at 5–7 days intervals. Each fertigation event may be done either on continuous basis from start of irrigation to its finish or in three stage application, the latter being better. The stage application follows: (a) Irrigation starts without fertilizers to make the soil wet (b) Fertilizer injection begins after the soil is wet (c) Finally, injection is cut out before the irrigation cycle is completed since remainder of the

irrigation cycle allows the fertilizer to be flushed out of the system.

Effect of fertigation on yields

Fertigation experiments were conducted at different centres under All India Coordinated Research Project on Irrigation Water Management. At Bhatinda (Punjab) on loamy sand soil, the maximum tomato and brinjal yields were obtained with 75 % NK Fertigation with 75% P as basal (Table 2). In this treatment tomato yield, water productivity, fertiliser saving and B: C ratio were 46.3 t/ha, 90.8 kg/ha.mm, 25% and 2.4, respectively. There was 39% higher yield in comparison to 100% NPK conventional fertiliser application. Brinjal yield, water productivity,

fertiliser saving and B:C ratio were 52.2 t/ha, 103.2 kg/ha.mm, 25% and 3.9, respectively. In brinjal, there was 45% higher yield in comparison to 100% NPK conventional fertiliser application

At Palampur (Himachal Pradesh) in silty clay loam soil, treatment with 19 % NPK as basal and 56 % NPK through fertigation resulted in significantly higher broccoli yield. The broccoli yield, water productivity, fertiliser saving and B:C ratio were 15.4 t/ha, 30.2 kg/ha.mm, 25% and 2.0, respectively. There was 26% higher yield in comparison to 100% NPK conventional fertiliser application. In cabbage, the treatment with 25% NPK as basal and 75% NPK through fertigation resulted in significantly



View of fertigation in Broccoli (Palampur Center)

higher cabbage yield. The cabbage yield, water productivity, fertiliser saving and B:C ratio were 33.2 t/ha, 89.0 kg/ha.mm, Nil and 2.0, respectively. In cabbage, there was 30% higher yield in comparison to 100% NPK conventional fertiliser application.

At Navsari (Gujrat), the treatment with 100 % NPK through fertigation resulted in significantly higher cauliflower yield on clay soil. The cauliflower yield, water productivity, fertiliser saving and B:C ratio were 27.7 t/ha, 71.8 kg/ha.mm, Nil and 2.6, respectively. There was 40% higher yield in comparison to 100% NPK conventional fertiliser application.



View of fertigation in cauliflower (Navsari Center)

At Chalakudy (Kerala) on sandy clay loam soil, treatment with 19 % NPK as basal and 56 % NPK through fertigation had significantly higher chilli yield. The chilli yield, water productivity, fertiliser saving and B:C ratio were 23.2 t/ha, 34.7 kg/ha.mm, 25% and 2.6, respectively. There was 35% higher yield in comparison to conventional fertiliser application.

Table 2. Effect of fertigation on crop and water productivity and benefits

Crop	Location	Soil Type	Best treatment	Yield (t/ha)	Water productivity (kg/ha.mm)	Fertiliser saving (%)	B:C Ratio
Tomato	Bathinda	Loamy sand	75 % NK Fertigation + 75 % P basal	46.3	90.8	25	2.4
Brinjal	Bathinda	Loamy sand	75 % NK Fertigation + 75 % P basal	52.2	103.2	25	3.9
Broccoli	Palampur	Silty clay loam	19 % NPK basal + 56 % NPK Fertigation	15.4	30.2	25	2.0
Cabbage	Palampur	Silty clay loam	25 % NPK basal + 75 % NPK Fertigation	33.2	89.0	Nil	2.4
Cauliflower	Navsari	Clay	100 % NPK Fertigation	27.7	71.8	Nil	2.6
Chilli	Chalakudy	Sandy clay loam	19% NPK basal + 56% NPK fertigation	23.2	34.7	25	2.4

Source: AICRP on IWM experiments



View of fertigation in Chilli (Chalakudy Center)

SUMMARY

Fertigation is a very effective and convenient way of applying fertilizer and nutrients to wide spaced row crops at a time when

there is a scarcity of inputs and adverse effects of chemical fertilizers on environment is widely realized. Fertigation in general led to increase in crop yield by 26–45% as compared to conventional fertilizer application in solid form. The optimum fertigation schedule for loamy sand soil was 75% P as basal and 75% NK through fertigation. The optimum fertigation schedule for clay soil was 100 % NPK through fertigation and for sandy clay loam soil was 19% NPK as basal and 56% NPK through fertigation. So, location specific fertigation schedules should be followed to achieve higher water and nutrient use efficiency.

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