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Fertigation in High Tech Agriculture

A Success Story of A Lady Farmer

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Research results indicate that fertigation increases the use efficiency of both water and fertiliser nutrients. What happens at the farm level is more important than the experimental results. Many a times, there exists lack of precision at the farm level. This may do more harm than good. Fertigation is a costly technique. Therefore, it suits well in high tech agriculture. In this paper, various aspects of fertigation have been discussed and an example of its use at farm level has been cited. Measures to make it more effective at farmer's level have also been suggested.

Fertigation is the application of water soluble solid fertiliser or liquid fertiliser through drip irrigation system. The factors that governs the fertigation are soil types, crops, methods of irrigation used, water quality, types of fertilisers available, economic feasibility etc. Fertigation has become an attractive method of fertilisation in modern intensive agriculture systems. This has assumes added importance after the introduction of micro- irrigation system like drip in irrigated agriculture.

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 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 scare. Under this disadvantaged condition the use efficiency of these is also very low.

Micro-irrigation systems are the most modern systems of irrigation where the 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. With the advent of this new method of irrigation system, traditional method of fertilisation which is still in 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. Rather, fertiliser needed is to be applied frequently and periodically in small amount with the each irrigation to ensure adequate supply of water and nutrient in the root zone. Therefore, as a result of the shift from surface irrigation to drip method of irrigation, fertigation becomes the most common 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.

As any system has both advantages and disadvantages, so has the fertigation. The advantages and disadvantages of fertigation are mentioned below:

Advantages

1) In drip fertigation, fertiliser application is synchronized with plant need which varies from plant to plant In drip fertigation, the amount and form of nutrient supply is regulated as per the need of the critical stages of plant growth.

2) Saving in amount of fertiliser applied, due to better fertiliser use efficiency and reduction in leaching.

3) Optimisation of nutrient balance in soils by supplying the nutrients directly to the effective root zones as per the requirement.

4) Reduction in labour and energy cost by making use of water distribution systems for nutrient application.

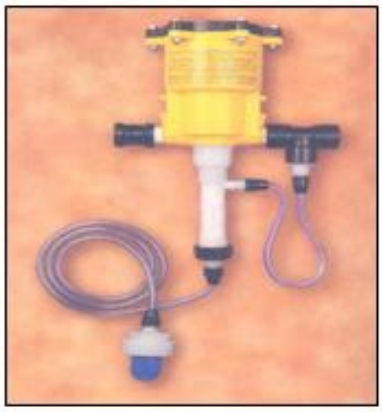
5) Better yield and quality of products obtained.

6) Timely application of small but precise amounts of fertilisers directly to the roots zone, this improves fertiliser use efficiency and reduces nutrient leaching below the root zone.

7) Ensures a uniform flow of water and nutrients.

i. Venturi

ii. Fertiliser tank



iii. Fertigation pump

8) Improves availability of nutrients and their uptake by crop.
9) Safer application method, as it eliminates the danger affecting roots due to higher dose.

10) Soil and water erosion are prevented.

Disadvantages

The main disadvantages are given below:

1) Both the components (drip and water soluble fertiliser) are very costly.

2) Maintenance of drip irrigation is difficult. There is possibility of theft and rat infestation.

3) Good quality water is very essential. Clogging of emitters may cause a serious problem.

4) It needs water soluble fertilisers, the availability of these types of fertilisers is limited.

5) Adjustment of fertilisers to suit the need is not easy.

6) Infestation of insects pest and diseases increases.

7) Area under micro irrigation is now increasing mainly because of subsidy in microirrigation, if subsidy is withdrawn, the area under micronutrient may also reduced. So also would be the fate of fertigation.

8) Due to fear of yield loss, because of 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 (Sugar cane) lower yield and lower profits.

Fertigation Equipments

Fertiliser can be injected into drip irrigation system by selecting appropriate equipment. Commonly used fertigation equipments are :

i) Venturi pumps

ii) Fertiliser tank

iii) Fertiliser injection pump

Venturi Injector

This is a very simple and low cost device. A partial vacuum is created in the system which allows 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 pass 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 results in uneven water and fertiliser distribution in the field. The suction rate of venturi is 30-120 litre per hour.

Fertiliser Tank

In this systems part of irrigation water is diverted from the main line to flow through a tank containing the fertiliser in a fluid or soluble solid form, before returning to the main line, the pressure in the tank and the main line is the same but a slight drip in pressure is created between the off take and return pipes for the tank by means of a pressure reducing valve. This causes water from main line to flow through the tank causing dilution and flow of the diluted fertiliser into the irrigation stream. With this system the concentration of the fertiliser entering the irrigation water charges continuously with the time, starting a high concentration. As a result uniformity of fertiliser distribution can be a problem. Fertiliser tanks are available in 90, 120, 160 liters capacity.

Fertigation Pump

These are piston or diaphragm pumps which are driven by the water pressure of the irrigation systems and such as 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, no serious head losses are incurred and operating cost is low. Another advantage is that if the flow of water stops, fertiliser injection also automatically stops. This is perfect equipment for accurate fertigation. Suction rates of pumps varies from 40 to 160 litre per hour.

Commercial Fertilisers Suitable for Fertigation

There are several commercial N , P and K fertilisers that can be used for fertigation. **(Table 1)**

Crop Suitable for Fertigation

Fertigation can be practised in large number of crops **(Table 3)**. Row crops are most suited for fertigation.

Area under microirrigation is about 4.14 m ha **(Table 4)**. But what percentage of 4.14 m ha is employed for fertilisation is not known.

Some Examples of Use of Drip Fertigation

Drip fertigation is found to be well suited for horticultural crops. In India, the adoption of this twin technology has resulted in enhancement of horticultural production. Water use efficiency and yield enhancement in vegetable production through drip irrigation are mentioned in **Table 5**.

Efficacy of Drip Fertigation

The benefit of drip irrigation mainly depends on the practice of fertigation because drip has a special feature, which is absent in other system of irrigations. In drip fertigation only 30-40% of the soil is moistened by the emitters . This is true in case of orchard crop. If the fertilisers and water are applied separately, the fertiliser use efficiency decreases because the fertiliser nutrients do not get dissolved in the dry zones where the soil is not wetted. As a result, the benefits is not fully expressed. This is why, 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 **(Table 6)**.

Use of drip fertigation is also very effective in high value row crop like sugarcane. Fertiliser use is quite high in sugarcane. In traditional method of fertiliser application large quantity of fertilisers are either banded near the crop row or broadcast in the inter-row space. Water is then allowed to flow through inter row space. Thus a major portion of fertiliser is washed away to the end of the field or to the side of the drain. The localization of the nutrient at the root zone is very poor. Therefore, the fertiliser use efficiency is also very low. 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. The traditional method of application is inefficient because a high dose of fertiliser is placed on the surface and furrow irrigated. In the fertigation the

Table 1 – Nutrient content of common fertilisers suited for fertigation

Nutrient	Compound	Nutrient content in solid fertiliser (N: P_2O_5: K_2O)	Nutrient content in saturated liquid fertilisers (25°C)
Nitrogen (N)	Urea	46-0-0	21-0-0
	Ammonium Nitrate	33-0-0	21-0-0
	Ammonium Sulphate	21-0-0	10-0-0
Phosphorus (P)	Phosphoric acid		0-51-0
	Mono Ammonium Phosphate	12-61-0	4-18-0
	Di Ammonium Phosphate	18-46-0	

Source : (6)

Table 2 – Cost comparison of water soluble fertiliser VS conventional fertiliser

Products	Cost Rs. / kg WSF 2006-07	WSF 2009-10	Conventional fertiliser 2006-09	Ratio 2006-07	Ratio 2008-09
19:19:19	51.00	71	7.35	7:1	9.66:1
13:40:13	55.00	98	10.52	5:1	9.32:1
13:00:45	35.00	73	4.85	7:1	15.05:1
MAP - 12:61:00	51.00	75	13.68	4:1	5.48:1
MKP - 00:52:34	74.00	112	13.13	5.5:1	8.53:1
SOP – 00:00:50	26.00	51	3.83	7:1	13.32:1

Source (8)

Table 3 – Crops suited for the drip fertigation

Orchard crops	:	Grapes, Banana, Pomegranate, Orange, Citrus, Tamarind, Mango, Fig, Lemon, Custard Apple, Sapota, Guava, Pineapple, Coconut, Cashew nut, Papaya, Aonla, Litchi, Watermelon, Muskmelon etc.
Vegetables	:	Tomato, Chilly, Capsicum, Cabbage, Cauliflower, Onion, Okra, Brinjal, Bitter gourd, Bottle gourd, Ridge gourd, Cucumber, Peas, Spinach, Pumpkin etc.
Cash Crops	:	Sugarcane, Cotton. Arecanut, Strawberry etc.
Flowers	:	Rose, Carnation, Gerbera, Anthurium, Orchids, Jasmine, Lily, Mogra, Tulip, Dahilia, Marigold etc.
Plantation	:	Tea, Rubber, Coffee, Coconut etc.
Spices	:	Turmeric, Cloves, Mint etc.
Oilseed	:	Sunflower, Oil palm, Groundnut etc
Forest crops	:	Teakwood, Bamboo etc.

Source (11)

Table 4 – Area under drip and sprinkler irrigation as on 31.03.09 (ha)

S. No.	State	Drip	Sprinkler	Total
1.	Rajasthan	18455	731984	750439
2.	Maharashtra	505158	229590	734748
3.	Haryana	7904	529572	537476
4.	AP	400449	218066	618515
5.	Karnataka	190242	279942	470184
6.	Gujarat	182114	143598	325712
7.	Tamil Nadu	134378	27308	161686
8.	West Bengal	181	150171	150352
9.	MP	26117	125249	151366
10.	Chattishgarh	4175	72697	76872
11.	Orissa	4731	23844	28575
12.	UP	10778	10631	21409
13.	Punjab	12949	10677	23626
14.	Kerala	14585	2842	17427
15.	Sikkim	88	11033	11121
16.	Nagaland	0	4358	4358
17.	Goa	762	376	1138
18.	HP	127	639	766
19.	Ar Pradesh	674	0	674
20.	Jharkhand	146	402	548
21.	Bihar	237	357	594
22.	Assam	116	129	245
23.	Mizoram	72	106	178
24.	Uttaranchal	38	6	44
25.	Manipur	30	0	30
26.	Others	16500	33000	49500
Total		**1531007**	**1531007**	**2606574**	**4137581**

Source : (11)

Table 5 – Water economy and yield enhancement in vegetable production through drip irrigation

Vegetable crop	Yield increase (%)	Water saving (%)
Tomato	50-60	40-60
Potato	20-30	40-50
Brinjal	20-30	40-60
Chilli	30-40	60-70
Cauliflower	60-80	30-40
Cabbage	30-40	50-60
Bottle gourd	30-40	40-50
French bean	55-65	30-40
Okra	25-40	20-30

Source (12)

Table 6 – Fertiliser use efficiency in fertigation (%)

Nutrient	Soil application	Drip+soil application	Drip + fertigation
N	30-50	65	95
P_2O_5	20	30	45
K_2O	60	60	80

Source (12)

nutrients are placed at very low concentrations through water move down into the lower soil layers where the absorptive roots exist.

Impact of Drip Fertigation in Sugarcane

Sugarcane is a very important commercial crop grown in the country. India has the second position in the sugarcane areas and production next to Brazil in the world. The use of fertiliser and irrigation water is also high. Various components of high tech farming are introduced from time to time in this crop to enhance the productivity. Fertigation is one such agro-technique which has proved to be a catalyst to boost the productivity of sugarcane **(Table 7)**.

Table 7 – Impact of drip fertigation in sugarcane

Particulars	Drip	Flood	Gains over	Flood
Yield(tonnes-t)	85	55	54.5 %	30
Water saving(mm)	1200	2200	45.5%	1000
Electricity consumption(Kwh)	900	2100	58.5%	1260
Water used per tonnes cane production(mm)		14.1	44	64.75% 25.9 mm
Cost per tonne(Rs)	379.4	541	29.9%	161.6
Electricity use per tonnes production (Kwh)	10.6	39.3	73 %	28.7

Source (8)

Water and plant nutrient are the key components to enhance sugarcane productivity. Water availability is a serious problem. There is a heavy demand for water for domestic, industrial and other purposes. Therefore, efficient use of water is very much needed. Fertiliser nutrients are also very valued inputs. India is not self sufficient in fertiliser production. About 40 percent of fertiliser consumed in the country is imported, resulting huge outgo of foreign exchange. Therefore, fertiliser use efficiency has to also to be improved. Interestingly drip fertigation is such an excellent agro-technique, adoption of which results in the use 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 use of new water soluble fertilisers which are most suited for fertigation are also being encouraged

Cost of installation of drip is high. Because of subsidies payment by government for the installation of drip, farmers are able to install the same. The cost of water soluble fertilisers is also very high. Hopefully government fertiliser policy would suitably address these issues.

SUCCESS STORY OF A LADY FARMER

Vegetable cultivation backed by proper marketing has been successfully used as a tool to alleviate poverty. Cultivation of non traditional vegetable like green capsicum is more profitable than

traditional vegetables. Coloured capsicum cultivation through high-tech agriculture provides still higher income. A success story of Coloured capsicum cultivation through high-tech agriculture using fertigation finds a place here.

The name of the farmer is Minatai Visnu Jagtap, she belongs to Village Pimpalgao Vasant, P. O. Pimpalgao Vasant, District Nasik, Maharashtra (India).

Background Information

Ms M V Jagtap constructed a poly house at a cost of Rs 2.7million on 0.4 ha area in 1994 to cultivate flower. It continued for more than 8 years. The venture turned out to be a profitable one after payment of the investment she made. To make more income she decided to go in for coloured capsicum cultivation in the same poly house.

Techniques Adopted

In the first week of June, 2008 hybrid coloured capsicum seeds were planted in nursery. Three feet wide beds were made up of soil, coco pit, and organic manure. Seedlings were planted in row a spacing of 18 inches and plant to plant spacing of 12 inches. The total plant population in 0.4 ha was 11000. A drip lateral was placed in between the two rows. Other practices followed were as follows:

1) After planting, daily irrigation through drip for 15-20 minutes.

2) Daily fertigation after 45 days of planting as mentioned in **Table 8.**

3) In addition, top dressings of fertiliser were also done as indicated in **Table 9.**

4) Disease –pest infestation was less.

5) Powdery mildew, downy mildew and sucking insect attack were suitably taken care of.

6) Harvesting started after two months of planting

7) Harvesting was done thrice in a week in the morning **(Table 10)**.

Economics

The monthly yields obtained are mentioned in **Table 10**. The average per kg price was Rs.40 with a range of Rs.20-Rs.120, total yield was 42 tonnes/acre (0.4 ha). The total income generated was Rs.1.68 million while the cost incurred was Rs.0.68 million resulting a net income of Rs.1 million/acre i.e. the per ha profits generated would be Rs.2.5 million per annum.

Table 8 – Weekly fertigation schedule

Day	Name of fertilser	Quantity
Monday	Calcium nitrate	6 kg
Tuesday	12:61:0	2kg
Wednesday	13:40:13	3kg
Thursday	13:0:45	4kg
Saturday	Zinc Sulphate+ hexolin	As per recommendation
Sunday	Nicolef +Magnesium sulphate	As per recommendation

Source (14)

Table 9 – Top dressing of plant nutrients (per acre)

Name of fertiliser/manure	Quantity (kg)	Time of application
DAP (18:46:0)	100	All these were mixed together and applied thrice at an interval of 2 months
SSP	50	
MOP	50	
Borecole	100	
Organic manure	150	

Source (14)

Table 10 – Yield and net profit generated per acre (0.4ha)

Month	Yield (tonne)
September,08	3
October,08	4
November,08	5
December,08	5
January,09	8
February,09	8
March,09	5
April,09	4
Total yield	42
Income(Rs)	16,80,000
Expenditure (Rs)	6,80,000
Net income(Rs)	10,00,000
Net income(Rs)/ha	25,00,000

Source (14)

CONCLUSION

Fertigation increases water and nutrient use efficiency. With the increase of coverage of area under drip irrigation, the area under fertigation is likely to increase. Of late, use of drip in rice which is the most important food crop of the country has been reported from AP. But drip has its own limitations. It can not be a substitute of traditional irrigation system in high rainfall area and in the area where traditional irrigation system has been well developed Fertigation has to be used as per the recommendations. It has been seen that in practice farmers also use traditional method of nutrient application in addition to fertigation due to fear of yield loss because of less application of fertilisers and water. It was found that in hot summer in Maharashtra a papaya farmers resorted to furrow irrigation to save his crop. This shows farmers need to be educated and motivated to use fertiliser and water efficiently through fertigation.

REFERENCES

1. Balasubranium, N S, Palaniappan, S.P and Chelliah, S. *Yojna*, May,(1999)
2. Biswas, B C and Kumar, Lalit, *FMN* 41(6) 3-14(2010).
3. Hagin, J and Lowengart, Anat, Fertigation for minimizing environmental pollution by fertilisers. *Fertilisers Research*,43:5-7.(1999)
4. Kumar, S Asrey, Ram and Singh, Ranbir, Ferrtigation : Need of Modern Agriculture, *Yojona*,July, 2000.
5. Krishna, B, Krishnappa, K S, Reddy, K S and Anjanappa, M *Mysore, J Agric Sci*, 33:33-38 (1999).
6. Magen, H *Fert. News* 40 (12) 97-100 (1995).
7. Micro-Irrigation: Way to judicious water use, *Agriculture Today*, March, 2009.
8. Nanda, RS, *Indian J. Fert.* 6(2) 13-16 (2010).
9. Neena, Chauhan and Chandel, J S *Indian J. Agric Sci.* 78(5) 389-393 (2008).
10. Russan, M J M Technical and Practical aspect of fertigation, Arab Fertilisers 52, Sept-Dec, 2008).
11. Rajput, T B S Role of water Management in Improving Agriculture Productivity. *Indian J Fertilisers* 6 (4), April (2010).
12. Soman, P Improving Water Use Efficiency to Enhance Crop Productivity,FAI Annual Seminar (2009).
13 Tambare, A D , Shinde, B N and Bhoite, S U *Indian J. Agron.* 44(1)176-178 (1999).
14. Tuhin Kumar, Annadata Bangla, Marc.