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ECONOMICS OF TOMATO FERTIGATION FOR MAJOR NUTRIENTS

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ABSTRACT : The fertigation plays very important role in successful cultivation of horticultural crops and enhance yield & minimize environmental pollution. The fertilizer use efficiency of N, P & K increased under fertigation in comparison to conventional fertilizer application with surface irrigation. The economics of tomato fertigation for major nutrients (N, P & K) for recommended dose of fertilizer N: P: K: : 111:67:133 kg/ha is calculated for various treatments *i.e.,* T_1 (conventional fertilizer application), T_2 (N through fertigation and P & K through conventional fertilizer application), T_3 (N & P through fertigation and K through conventional fertilizer application), T_4 (N & K through fertigation and P through conventional fertilizer application) and T_5 (N, P, & K through fertigation). The fertilizer cost for various treatment conditions varies between around Rs. 8418 to 42, 703 for different fertilizer sources conventional and water soluble considered in this study.

Keywords : *Tomato, fertigation, nutrient, fertilizer use efficiency, cost.*

The practice of supplying fertilizers via the irrigation water to crops is called fertigation (Bar-Yosef, 1). The fertigation plays very important role in successful cultivation of horticultural crops and provides an excellent opportunity to maximize yield and minimize environmental pollution (Hagin *et al.,* 4) by increasing fertilizer use efficiency, minimizing fertilizer application and increasing return on the fertilizer invested. In fertigation, timing, amounts and concentration of fertilizers applied are easily controlled. It is done with the aid of special fertilizer apparatus (injectors) installed at the head control unit of the system, before the filter. The most commonly applied fertilizer is nitrogen, however, application of phosphorous, potassium and other micro-nutrients are common for different horticultural crops.

The fertigation is essential because irrigation & fertilizers are the most important management factors through which farmers control plant development and yield (Hasan *et. al.,* 6). Though there are many factors which affect the performance of fertigation but the cost of fertilizer and its availability plays important role in making fertigation successful (Hartz and Hochmuth, 5).

There are varied choices of water soluble fertilizer for supplying the N, P & K. A large range of fertilizers, both solid and liquid, are suitable for fertigation depending on the physicochemical properties of the fertilizer solution. The solid fertilizer sources are typically a less expensive compared to liquid formulations for large scale field operations (Kafkafi and Tarchitzky, 10).

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The fertigation scheduling mainly depends on three factors, crop & site specific nutrient requirements, timely nutrient delivery to meet crop needs and controlling irrigation to minimize leaching of soluble nutrients below the effective root zone. The total N, P & K requirements vary considerably by area, soil type and crop (Hochmuth and Hanlon, 9); Hartz and Hochmuth, 5). Once the total N, P & K requirements have been estimated and preplant application (if any) made, the balance of fertilizer can be delivered through the drip system in multiple applications over growing season. From crop nutrient uptake characteristics one can apportion fertigation to meet nutrient requirements by crop growth stage. To calculate fertilizer application on the basis of daily or weekly need, one must account for the relative rate of crop development, which is dependent on temperature; however, total crop nutrient requirements are relatively independent of environmental conditions.

Drip irrigation is an effective way to supply water to tomato (Hochmuth, 8) and fertigation improves fertilizer use efficiency, affecting tomato yields (Dangler and Locascio, 2). Hebbar *et al.,* 7) observed higher tomato yield through fertigation than banded and furrow irrigation or banded and drip irrigated.

The tomato yield is 50% lower when 100% preplant application of N and K is applied in comparison to fertigation (Locascio and Myers, 11). On a coarse-textured soil preplant application of all the P

and of 40% of the N and K, with 60% of the N and K fertigated with drip irrigation tomato yields were greater than when all nutrients were applied preplant (Locascio and Smajstrla, 12).

Sheedeed *et al.* (15) reported that fertigation with 100% NPK water-soluble fertilizers increased tomato fruit yield significantly (58.76 t/ha) over furrow irrigated control, drip irrigation with 50% fertigation (48.18 t/ha) and 75% NPK fertigation (54.16 t/ha). The normal fertilizers used in the experiment were urea, single super phosphate and potassium sulphate, whereas, ammonium nitrates, phosphoric acid (85%) and potassium sulphate were water soluble fertilizers in fertigation treatments.

Though a lot of study has been conducted for fertilizer application of N, P & K for tomato under conventional fertilizer application with surface irrigation, conventional fertilizer application with drip irrigation and fertigation of N, P & K. Once the total N, P & K requirement of tomato is determined based on area and soil type, the total requirement for tomato is also affected by way fertilizer is given to plant i.e. preplant/fertigation because fertilizer use efficiency of N, P & K varies with the condition during cultivation. Once the final requirement N, P & K is calculated, its fertigation can be done by providing N, P & K alone and other nutrient through preplant application, fertigation of N, P & K through various combination and remaining fertilizer through preplant application and fertigation of all the three major nutrients (N, P & K). But the cost involved in each case will be different based on application method of fertilizer (preplant/fertigation) and source of N, P & K chosen for fertilizer application. Keeping all the above facts involved in fertigation, the study was undertaken to evaluate the cost economics of tomato cultivation using varied fertilizer sources and application methods of N, P & K.

MATERIALS AND METHODS

The recommended dose of fertilizer taken for economics analysis of tomato is N: P: K:: 111:67:133 kg/ha and dose is considered without considering the effect of fertilizer use efficiency. The economics of tomato fertigation for major nutrients (N, P & K) is calculated based on conventional fertilizer application (preplant) & important possible combination of fertigation. The treatment conditions considered are T_1 (conventional fertilizer application), T_2 (N through fertigation and P & K through conventional fertilizer application), T_3 (N & P through fertigation and K through conventional fertilizer application), T_4 (N & K through fertigation and P through conventional fertilizer application) and T_5 (N, P, & K through fertigation). The fertilizer source (conventional and water soluble) used for economics analysis with its name, chemical formula, N: P: K content % and market price (₹ /kg) is given in Table 1 and Table 2 respectively.

Table 1: List of fertilizer (non water soluble), the per cent elemental composition and price per unit.

Fertilizers	Formula	N:P:K content %	Price (₹/kg)
Urea	$(NH_2)_2CO$	46-0-0	7.00
DAP (Di Ammonium Phosphate)	$(NH_4)_2HPO_4$	18-46-0	28.00
MOP (Muriate of Potash, Red)	KCl	0-0-60	19.00
MAP (Mono Ammonium Phosphate)	$(NH_4)H_2PO_4$	11-44-0	18.20
SSP (Single Super Phosphate)	$Ca\ (H_2PO_4)_2$	0-16-0	7.44

Table 2 : List of fertilizer (water soluble), the per cent elemental composition and price per unit.

Fertilizers	Formula	N:P:K content %	Price (₹/kg)
Urea	$(NH_2)_2CO$	46-0-0	7.00
Urea Phosphate	$CO(NH_2)_2H_3PO_4$	17-44-0	75.00
Potassium Nitrate	KNO_3	13-0-45	130.00
MOP (Muriate of Potash, White)	KCl	0-0-60	80.00
18:18:18		18-18-18	78.00
MAP (Mono Ammonium Phosphate)	$(NH_4)H_2PO_4$	12-61-0	90.80
SOP (Sulphate of Potash)	K_2SO_4	0-0-50	75.00

RESULTS AND DISCUSSION

The economics of tomato fertigation for major nutrients (N, P & K) is calculated using conventional fertilizer application & important possible combination of fertigation is discussed below.

Conventional fertilizer application

The conventionally the fertilizer is given to plants through broadcasting, band application and side/top dressing. But the problems with these methods are that the fertilizer use efficiency of conventional fertilizers application with surface irrigation is 30-50% for N, 20% for P and 50% for K (Wichmann, 16). This leads to lower return on money spent on per unit of fertilizer, along with increased soil salinity. The three main potential avenues of N losses are leaching of N (nitrate and urea) outside the root zone, accumulation of N salts on the dry soil surface due to soil solution evaporation; and losses of nitrate by denitrification. The total cost of fertilizer per hectare for conventional fertilizer application for recommended dose of 111:67:133 kg/ha with fertilizer source of urea, DAP, MOP, MAP and SSP is given in Table 3. The quantity of fertilizer required is calculated on NPK content % for each fertilizer on mass basis and multiplied with cost of fertilizer (₹/kg) as given in Table 1 to calculate the total cost in each condition for various fertilizer combination used. The cost of fertilizer varies between around ₹ 8418 to 9590 for 1 hectare of tomato, this shows that there is not substantial difference in cost of fertilizer application when different fertilizer sources are used. The Ministry of Agriculture and Farmers welfare, Government of India spent huge money each year for fertilizer subsidies especially on nitrogenous fertilizer (mainly Urea). But the fertilizer use efficiency of N under conventional fertilizer application with surface irrigation is very low (30-50%), thus apart from loss of big exchequer each year it also pollute water resources. So there is urgent need to focus on the methods which can increase the fertilizer use efficiency.

Table 3: Total cost of fertilizer per hectare for conventional fertilizer application.

Fertilizer source	Quantity (kg)	Total Cost (₹)
Urea, DAP & MOP	184.3, 146, 221.7	9590.40
Urea, MAP & MOP	204.8, 152.3, 221.7	8417.76
Urea, SSP & MOP	241.3, 419, 221.7	9018.76

N through fertigation and P & K through conventional fertilizer application

The fertilizer use efficiency of conventional fertilizers application with drip irrigation is 65% for N, 30% for P & 60% for K and fertilizer use efficiency enhanced to 95%, 45% & 80% respectively for N, P & K under drip irrigation with fertigation (Wichmann, 16). Under the condition N is applied through fertigation and P & K through conventional fertilizer application & irrigation are done through drip system, the fertilizer use efficiency of N increased from 30-50% to 95%. Even though P & K is given through conventional fertilizer application, the fertilizer use efficiency of P & K increased from 20% to 30% and 50% to 60% respectively. Because the fertilizer use efficiency of NPK increased under this condition in comparison to NPK under conventional fertilizer application, so the fertilizer requirement will be less than the recommended dose of N: P: K:: 111:67:133 kg/ha.

The total cost of fertilizer per hectare for N through fertigation and P & K through conventional fertilizer application for recommended dose of 111:67:133 kg/ha with fertilizer source of urea, DAP, MOP, MAP and SSP is given in Table 4. The cost of fertilizer varies between around ₹ 8418 to 9590 for 1 hectare of tomato is same as given for NPK through conventional fertilizer application as given in Table 3.

Table 4 : Total cost of fertilizer per hectare for N through fertigation and P & K through conventional fertilizer application.

Fertilizer source	Quantity (kg)	Total Cost (₹)
Urea, DAP & MOP	184.3, 146, 221.7	9590.40
Urea, MAP & MOP	204.8, 152.3, 221.7	8417.76
Urea, SSP & MOP	241.3, 419, 221.7	9018.76

N & P through fertigation and K through conventional fertilizer application

Although, N is major nutrient applied through fertigation, the P can be applied successfully through fertigation systems with certain precautions (Mikkelsen, 13; Rolston *et al.,* 14). The important precautions required in its fertigation are, it should be injected as phosphoric acid alone and acidification of the irrigation water might be needed to minimize P precipitation during fertigation. Although there are problems and considerations while injecting P, there are several potential benefits also *i.e.,* P is immobile in the soil, so only one or two applications would be required and plant recovery of nutrients can be

increased when they are applied through the drip system (Mikkelsen, 13; Rolston *et al.,* 14)).

The total cost of fertilizer per hectare for N & P through fertigation and K through conventional fertilizer for recommended dose of 111:67:133 kg/ha with conventional fertilize urea & MOP and water soluble fertilizer MAP & urea phosphate is given in Table 5. The quantity of fertilizer required is calculated on NPK content % for each fertilizer on mass basis and multiplied with cost of fertilizer (₹/kg) to calculate the total cost for various fertilizer combination used. The cost of fertilizer varies between around ₹ 15, 670 to 16, 931 for 1 hectare of tomato, this shows that there is not substantial difference in cost of fertilizer application when different sources of fertilizers are used.

Table 5 : Total cost of fertilizer per hectare for N & P through fertigation and K through conventional fertilizer.

Fertilizer source	Quantity (kg)	Total Cost (₹)
Urea, MAP (12:61:0) & MOP	212.6, 109.8, 221.7	15670.34
Urea, Urea Phosphate & MOP	185.2, 152.3, 221.7	16931.20

N & K through fertigation and P through conventional fertilizer application

All soluble nutrients (N, P & K) can be applied effectively by fertigation with drip irrigation but N and K are the major nutrients applied because they move readily with the irrigation water. Preplant application of P is common for several reasons because soluble P sources (e.g. phosphoric acid) are more expensive than granular forms and its precipitation during fertigation (Rolston *et al.,* 14). The movement of drip applied P away from the point of injection is governed mainly by soil texture and pH, so only small portions of the root zone (near the emitter) would be exposed to the P, not all of the root system (Drew and Saker, 3). So the required P is most efficiently applied preplant in the root zone.

The total cost of fertilizer per hectare for N & K through fertigation and P through conventional fertilizer application for recommended dose of 111:67:133 kg/ha with conventional fertilizer (urea, DAP & SSP) and water soluble fertilizer (KNO_3 sulphate of potash & MOP) is given in Table 6. The quantity of fertilizer required is calculated on NPK content % for each fertilizer on mass basis and multiplied with cost of fertilizer (₹ /kg) to calculate the total cost for various fertilizer combination used. The cost of fertilizer varies between around ₹ 22, 542 to 42, 703 for 1 hectare of tomato, this shows that there is substantial difference in cost of fertilizer application when different sources of fertilizers are used. The highest cost is coming for Urea, KNO_3 & SSP combination because the cost of KNO_3 (₹/kg) is around 135.

Table 6 : Total cost of fertilizer per hectare for N & K through fertigation and P through conventional fertilizer application.

Fertilizer source	Quantity (kg)	Total Cost (₹)
Urea, KNO_3 & SSP	158, 296, 419	42, 703.36
Urea, SSP & Sulphate of Potash (0:0:50)	241.3, 419, 266	24, 756.46
Urea, SSP & MOP (white)	241.3, 419, 221.7	22, 542.46
Urea, DAP & MOP (white)	184.3, 146, 221.7	23,114.10

N, P & K through fertigation

The total cost of fertilizer per hectare for N, P & K through fertigation for recommended dose of 111:67:133 kg/ha with water soluble fertilizer (urea, MOP, MAP, sulphate of potash, urea phosphate & 18:18:18) is given in Table 7. The quantity of fertilizer required is calculated on NPK content % for each fertilizer on mass basis and multiplied with cost of fertilizer (₹/kg) as given in Table 2 to calculate the total cost for various fertilizer sources used for NPK fertigation. The cost of fertilizer varies between around ₹ 29, 194 to 39, 196 for 1 hectare of tomato; this shows that there is substantial difference in cost of fertilizer application when different sources of fertilizers are used.

Table 7 : Total cost of fertilizer per hectare for N, P & K through fertigation.

Fertilizer source	Quantity (kg)	Total Cost (₹)
18:18:18, Urea & MOP	95.7, 372, 110	38, 485.90
18:18:18, Urea & Sulphate of Potash	95.7, 372, 132.08	39, 195.66
Urea, MAP & MOP	212.6, 109.8, 221.7	29,194.04
Urea, Urea phosphate & MOP	185.2, 152.3, 221.7	30,454.90

CONCLUSION

The economics of tomato fertigation for major nutrients (N, P & K) for recommended dose of fertilizer N: P: K:: 111:67:133 kg/ha is calculated for various

treatments. The cost of fertilizer varies between around ₹ 8418 to 9590 for 1 hectare of tomato under conventional fertilizer application and N through fertigation and P & K through conventional fertilizer application. It varies between around ₹ 15, 670 to 16, 931, ₹ 22, 542 to 42, 703 & ₹ 29, 194 to 39, 196 respectively for N & P through fertigation & K through conventional fertilizer application, N & K through fertigation & P through conventional fertilizer application and N, P, & K through fertigation based fertilizer sources taken. The overall cost economics of fertigation depends on application of fertilizer (preplant/ fertigation) and source of N, P & K chosen for fertilizer application.

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REFERENCES

1. Bar-Yosef B. (1992). Fertilization under drip irrigation. In : *Fluid Fertilizer, Science and Technology.* Ed. by D.A. Palgrave. Marcel Dekker, New York. pp. 285-329.
2. Dangler J. M., and Locascio S. (1990). Yield of trickle-irrigated tomatoes as affected by time of N and K application. *J. Amer. Soc. Hortic. Sci.,* **115** : 585-589.
3. Drew M. C. and Saker L. R. (1978). Nutrient supply and the growth of the seminal root system in barley. III. Compensatory increase in growth of lateral roots, and in rates of phosphate uptake, in response to a localized supply of phosphate. *J. Experi. Bot.,* **29** : 435-451.
4. Hagin J., Sneh M. and Lowengart-Aycicegi A. (2002). Fertigation – Fertilization through irrigation. IPI Research Topics No. 23. Ed. by A.E. Johnston. International Potash Institute, Basel, Switzerland.
5 Hartz T. K. and Hochmuth G. J. (1996). Fertility management of drip irrigated vegetables. *Hort Tech.,* **6** : 168-172.
6. Hasan M., Singh M. C., Singh A. K., Kaore S. V., Tarunendu N. S. and Tomar B. S. (2010). *Fertigation scheduling for horticultural crops.* Director, IARI, New Delhi and Marketing Director, IFFCO, New Delhi.
7. Hebbar S. S., Ramachandrappa B. K., Nanjappa H. V. and Prabhakar M. (2004). Studies on NPK drip fertigation in field grown tomato (*Lycopersicon esculentum* Mill.). *European J. Agron.,* **21** : 117-127.
8. Hochmuth G. J. (1994). Plant petiole sap-testing guide for vegetable crops. *Florida Cooperative Extension Service Circular* 1144.
9. Hochmuth G. J. and Hanlon E. A. (1995). Commercial vegetables crop nutrient requirements. *Florida Cooperative Extension Service Circular* SP-170.
10. Kafkafi U. and Tarchitzky J. (2011). *Fertigation; A tool for efficient fertilizer and water management.* IFA, Paris, France and IPI, Horgen, Switzerland
11. Locascio S. J. and Myers J. M. (1974). Tomato response to plug-mix mulch and irrigation method. *Proc. of the Florida State Horticulture Society,* **87** : 126-130.
12. Locascio S. J. and Smjstrla A. G. (1989). Drip irrigated tomato as affected by water quality and N and K application timing. *Proc. of the Florida State Horticulture Society,***102** : 307-309.
13. Mikkelsen R. I. (1989). Phosphorus fertilization through drip irrigation. *J. Production Agri.,* **2** : 279-286.
14. Ralston D. E., Rauschkolb R. S., Phene C. J., Miller R. J. Urier K., Carson R.M. and Henderson D. W. (1981). Applying nutrients and other chemicals to trickle-irrigated crops. *University of California, Division of Agricultural Sciences, Bulletin* 1893.
15. Sheedeed S. I., Zaghlout S. M., Yadeen A. A. (2009). Effect of method and rate of fertilizer application under drip irrigation on yield and nutrient uptake by tomato. *Ozean J. Aappl. Sci.,* **2** (2) : 139-147.
16. Wichmann W. (1992). IFA world fertilizer use manual. *Intern. Fertilizer Association* (IFA), Paris, France.

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