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Influence of fertigation levels on nutrient uptake and soil fertility in tomato (*Solanum lycopersicum* L.)

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Abstract
The poly house experiment was carried out at College of Horticulture, Hiriyur Karnataka during *2020*, to study the Influence of levels of fertigation on nutrient uptake and soil nutrient status of tomato The experiment was laid out in randomized block design with seven treatments and three replications. The soil of experimental site was clay loam in texture, alkaline in pH, medium in Organic matter and phosphorous. Low in available nitrogen and medium in available potassium. The effects of levels of fertigation and soil application on nutrients *viz*., N, P, K, Ca and Mg, content of tomato plant were found to be statistically significant. The nutrient content in tomato plant were measured at different growth stages like vegetative, flowering and fruiting stages. The soil application 100:100:100 kg NPK per acre (T_1) increased the nutrient content followed by the soil application of 40:40:40 kg NPK per acre along with 4 kg 19:19:19 per acre through fertigation. There was an increase in nutrient content at different growth stages. This is mainly due the fact that as the growth of plant increases the nutrient uptake is also increased. Uptake increased with the increasing fertilizer doses and this may be due to improved absorption and utilization of nutrients at higher rates of application. Among the different treatment received soil application of 100:100:100 kg NPK per acre (T_1) decreased OC of soil after harvest of crop. The treatment received the soil application of 100:100:100 kg NPK per acre (T_1) decreased N, P & K content of soil at flowering and harvest stage compared to other fertigation treatments. The soil application of 100:100:100 kg NPK per acre (T_1) decreased Ca, Mg & S content soil at harvest stage. This might be due to the more uptake and utilization of nutrients by for its growth and development, due to more uptake it was recorded less nutrient content compared to fertigation.

Keywords: Fertigation, polyhouse, drip irrigation, nutrient uptake, soil nutrient status

Introduction
Tomato (*Solanum lycopersicum* L.) has a prime position among the popular vegetables in India. In the recent past, the productivity of tomato has increased several folds, which could be attributed to the cultivation of high yielding and nutrient responsive genotypes and also by adoption of improved horticultural techniques. In recent years fertigation as effective method finding important places in the nutrient management in most of the horticultural crops, especially in vegetable crops like tomato, which are affected by many nutrient deficiencies. Various studies, made elsewhere, have thrown some light on the effect of fertigation on most widely cultivated vegetables, such as tomato. In the present study was carried out to study nfluence of Fertigation Levels on Nutrient Uptake and Soil Fertility in Tomato.

Materials and Methods
A field experiment on effect of levels of fertigation on growth and quality of tomato under polyhouse condition was conducted at college of horticulture, Hiriyur. The soils of the experimental site was clay loam in texture having pH - 8.31, organic carbon 0.71 per cent with medium in available nitrogen (128.25 kg ac^{-1}), medium in available phosphorus (21.35 kg ac^{-1}) and high in available potassium (197.30 kg ac^{-1}). The experiment was conducted with following treatment details.

Treatment details
- **T_1:** 100:100:100 kg NPK ac^{-1}(RDF under open condition)
- **T_2:** 20:20:20 kg NPK ac^{-1} + 3 kg 19:19:19ac^{-1}through fertigation (RDF under polyhouse condition)
- **T_3:** 20:20:20 kg NPK ac^{-1} + 2 kg 19:19:19 ac^{-1}through fertigation

- **T_4:** 20:20:20 kg NPK ac^{-1} + 4 kg 19:19:19 ac^{-1}through fertigation
- **T_5:** 40:40:40 kg NPK ac^{-1} + 2 kg 19:19:19 ac^{-1}through fertigation
- **T_6:** 40:40:40 kg NPK ac^{-1} + 3 kg 19:19:19 ac^{-1}through fertigation
- **T_7:** 40:40:40 kg NPK ac^{-1} + 4 kg 19:19:19 ac^{-1}through fertigation

Note

- 50:100:100 kg NPK ac^{-1}, 20:20:20 kg NPK ac^{-1}, 40:40:40 kg NPK ac^{-1} was applied to the soil as basal dose
- 19:19:19 is through fertigation after 30 days of transplanting at weekly interval

The experiment was laid out in a randomized block design, replicated thrice and Novo 81 a semi-determinate high yielding private hybrid seeds was used in the present study. Fifteen days old healthy seedlings were transplanted in the main field at a spacing of 50 cm X 45 cm. Fertilizers used for soil application were urea, di ammonium phosphate and muriate of potash and water soluble fertilizers 19:19:19. In fertigation the fertilizers were injected in weekly intervals through the drip line. TSS, lycopene content and Ascoric acid content were determined using standard procedures.

Table 1: Initial soil physical and chemical properties of experimental site

Physical properties	
Sand (%)	41.60
Silt (%)	26.12
Clay (%)	31.18
Textural class	Clay loam
Bulk density (g cm^{-3})	1.43
Chemical properties	
pH (1:2.5)	8.31
Electrical conductivity (dS m^{-1}) at 25^0 C (1:2)	1.43
Cation exchange capacity [cmol(p^+) kg^{-1}]	18.50
Organic carbon (g kg^{-1})	7.10
Available N (kg $acre^{-1}$)	128.25
Available P_2O_5(kg $acre^{-1}$)	21.35
Available K_2O (kg $acre^{-1}$)	197.30
Exchangeable Ca (meq $100g^{-1}$)	8.70
Exchangeable Mg (meq $100g^{-1}$)	4.76
Available S (mg kg^{-1})	8.20
DTPA extractable Micronutrients (mg kg^{-1})	
Iron	4.21
Copper	1.25
Zinc	1.71
Manganese	3.45

Results and Discussion

The effects of levels of fertigation and soil application on nutrients *viz.,* N, P, K, Ca and Mg, content of tomato plant were found to be statistically significant. The nutrient content in tomato plant were measured at different growth stages like vegetative, flowering and fruiting stages (Table 6 & 8). The soil application 100:100:100 kg NPK per acre (T_1) increased the nutrient content followed by the soil application of 40:40:40 kg NPK per acre along with 4 kg 19:19:19 per acre through fertigation. There was an increase in nutrient content at different growth stages. This is mainly due the fact that as the growth of plant increases the nutrient uptake is also increased. Uptake increased with the increasing fertilizer doses and this may be due to improved absorption and utilization of nutrients at higher rates of application.

Among the fertigation treatments T_7 (soil application of 40:40:40 kg NPK per acre along with 4 kg 19:19:19 per acre through fertigation) recorded high nutrient content, this might due to the better availability of nutrients in root zone as a result of frequent application of nutrients coupled with better root activity. Further, it was also due to the reduced loss of nutrients primarily because of leaching. These findings are also in line with those of Cannel *et al.* (1960) and Anand and Muthukrishnan (1974).

Effect of levels of fertigation on nutrient content and uptake by of tomato crop (plant + fruit) at harvest

The data on nutrient content of tomato plant (Table 8 and 9) as influenced by different levels of fertigation application, increase in the nutrient content of tomato plant as the increase in quantity of fertilizers among the fertigation treatments. However, at harvest the soil application of 100:100:100 kg NPK per acre recorded higher nutrient concentration than the fertigation treatments with very low level of ferilizers. It may due to high improve absorption of nutrients like N, P and K at higher doses. Mamonova (1978) [6], Belicheki *et al.* (1982) [4] and Subbiah and Perumal (1986) [11] have also reported increased uptake of N, P, and K with the increasing levels of applied fertilizer doses.

Among the fertigation treatments T_7 with soil application of 40:40:40 kg NPK per acre along with 4 kg 19:19:19 per acre through fertigation recorded high nutrient content and uptake by tomato (Figure 6). This might due to the better availability of nutrients in root zone as a result of frequent application of nutrients coupled with better root activity. Further, it was also due to the reduced loss of nutrients primarily because of leaching. These results are in conformity with earlier findings of Scholberg *et al.* (2000) [9], Singandhupe *et al.* (2003), Singandhupe *et al.* (2005), Badr and Abou El-Yazied (2007) [2], Shedeed *et al.* (2009) and Singh *et al.* (2011).

Effect of different levels of fertigation on nutrient content and uptake by tomato fruit

Nutrients play a major role in enhancing growth, yield and quality of a crop. Nutrient uptake had positively and significantly higher correlation with yield. Uptake of major (N, P and K) by tomato fruit was significantly influenced fertigation levels at harvest.

The nutrient content of tomato fruits measured at harvest stage was significantly influenced by fertigation levels (Table 10 & 11). Soil application 100 per cent RDF under drip irrigation increased nutrient content of tomato fruits significantly followed by the T_7 (soil application of 40:40:40 kg NPK $acre^{-1}$ + 4 kg 19:19:19 $acre^{-1}$ through fertigation). Nitrogen uptake in tomato fruit has been presented in table 8. An examination of data revealed that the maximum amount of uptake of N (19.96 kg $acre^{-1}$) by tomato fruits was recorded under treatment T_1 with 100:100:100 kg NPK per acre through soil application which was significantly higher than all the fertigation treatments with lower dose of fertilizers. The uptake of nitrogen by the fruit went on increasing with the successive increase in the levels of NPK. The effects are quite convincing since the uptake is a resultant of concentration and biological yield. Mamonova (1978) [6], Belicheki *et al.* (1982) [4] and Subbiah and Perumal (1986) [11] have also reported increased uptake of N with the increasing

levels of applied N fertilizer doses.

A perusal of data reveals that phosphorus uptake in tomato fruit (Table 8) reveals that the P removal of 4.34 kg per acre, was found to be the maximum under treatment T_1. Imposition of all the treatments exerted a significant influence on the P removal by tomato fruit over lower fertilizer dose (20:20:20 kg NPK acre^{-1} + 3 kg 19:19:19 acre^{-1} through fertigation). The lowest amount of P removal by tomato fruit was recorded under T_3 (1.64 kg acre^{-1}). Phosphorus uptake also went on increasing with increasing NPK levels, this may be due to improved absorption and utilization of P at higher rates of application. These findings are in line with those of Cannel *et al.* (1960) and Anand and Muthukrishnan (1974).

Potassium uptake tomato fruit has been presented in table 8 revealed that maximum removal of K by tomato fruit (45.42 kg acre^{-1}) was under treatment T_1 with 100:100:100 kg NPK per acre through soil application, whereas The minimum amount of K (16.58 kg acre^{-1}) was removed under treatment T_3 (20:20:20 kg NPK acre^{-1} + 2 kg 19:19:19 acre^{-1} through fertigation). Similar to N and P, K uptakes also increased with the increasing fertilizer doses and this may be due to improved absorption and utilization K at higher rates of application. These findings are in line with those of Cannel *et al.* (1960) and Anand and Muthukrishnan (1974).

Effect of different levels of fertigation on chemical properties of soil harvesting

Soil application of 100:100:100 kg NPK per acre (T_1) decreased OC of soil after harvest of crop. This might be due to the decomposition of organic matter leads to mineralization of nutrients. Most of the nutrients utilized by plant for its growth and development hence OC of soil decreased as compared to control. But it was less than initial this is because more uptake of nutrients by plant helps in reduction in OC.

The soil application of 100:100:100 kg NPK per acre (T_1) decreased (Table 5) CEC of soil followed by the soil application of 40:40:40 kg NPK per acre along with 4 kg 19:19:19 per acre through fertigation (T_7). It was less than initial CEC of soil. The reduction in CEC of soil which might be due to more uptake of nutrients by plants.

The treatment received the soil application of 100:100:100 kg NPK per acre (T_1) decreased N, P & K content (Table 5) of soil at harvest stage compared to other fertigation treatments. This might be due to the more uptake of nutrients and utilization by plant for its growth and development. However N, P and K status found less than initial value. The available nitrogen in soil increased with increase in NPK levels. Higher available nutrient status may be due to higher application rates (Tisdale *et al*., 1995; Dimri and Lal, 1988) [12, 5].

The soil application of 100:100:100 kg NPK per acre (T_1) decreased Ca, Mg & S content (Table 6) of soil at harvest stage. This might be due to the more uptake and utilization of nutrients by for its growth and development, due to more uptake it was recorded less nutrient content compared to fertigation treatments with lower doses.

Conclusion

- The results showed that the soil application of 100:100:100 kg NPK per acre increased the growth, yield and quality along with uptake and content by tomato fruit and plant of tomato under poly house condition.
- Among the different fertigation treatments the effect increases with increase in fertigation levels. However, the maximum effect was observed due to soil application of 40:40:40 kg NPK per acre + 4 kg 19:19:19 per acre at weekly interval.
- The highest benefit was observed due to the soil application of 100:100:100 kg NPK per acre.

Table 2: Nutrient content in Tomato fruit at harvest stages

Treatments	Nutrient content									
	Primary nutrients (%)			Secondary Nutrients (%)			Total micro nutrients (mg kg^{-1})			
	N	P	K	Ca	Mg	S	Fe	Zn	Cu	Mn
T_1	1.73	0.58	3.43	1.33	0.70	0.35	212.93	31.90	34.05	172.42
T_2	1.43	0.39	2.36	1.13	0.52	0.26	209.63	28.78	31.57	166.85
T_3	1.34	0.32	2.09	1.12	0.49	0.27	208.23	28.27	30.43	165.91
T_4	1.46	0.41	2.52	1.15	0.50	0.28	210.83	29.08	32.11	169.40
T_5	1.50	0.44	2.82	1.16	0.52	0.27	211.50	29.41	32.54	170.85
T_6	1.53	0.47	2.87	1.18	0.54	0.30	211.57	30.39	32.72	171.44
T_7	1.65	0.54	3.05	1.21	0.55	0.30	212.78	30.90	33.09	171.85
S.Em±	0.04	0.01	0.12	0.04	0.02	0.01	2.58	0.96	1.05	2.70
CD @ 5%	0.13	0.03	0.37	0.12	0.05	NS	NS	NS	NS	NS

Table 3: Nutrient uptake by Tomato at harvest stages

Treatments	Nutrient uptake (kg acre^{-1})					
	N	P	K	Ca	Mg	S
T_1	79.70	24.48	163.26	52.52	28.46	14.50
T_2	45.92	11.71	80.62	33.20	14.96	8.16
T_3	41.84	9.64	74.28	31.36	13.47	7.74
T_4	48.69	12.76	89.80	35.83	15.03	8.84
T_5	53.02	14.43	100.40	38.73	16.65	9.69
T_6	59.64	16.85	116.15	41.71	18.92	11.31
T_7	66.04	19.57	126.64	44.46	19.99	11.52
S.Em±	1.92	0.44	4.30	1.26	0.70	0.44
CD @ 5%	5.93	1.38	13.27	3.88	2.16	1.38

Table 4: Effect of different levels of fertigation on chemical properties of soil at flowering stage

Treatments	pH	EC (dSm-^{1})	OC (g kg^{-1})	CEC [cmol(p^{+}) kg^{-1}]	Available N (kg acre^{-1})	Available P (kg acre^{-1})	Available K (kg acre^{-1})
T_1	8.31	1.51	6.25	16.35	174.36	48.08	194.27
T_2	8.20	1.58	6.91	16.97	93.48	22.47	134.53
T_3	8.21	1.50	7.10	17.21	101.70	22.12	134.10
T_4	8.26	1.53	6.41	16.47	95.31	22.00	136.79
T_5	8.32	1.55	6.36	16.44	94.40	21.74	139.17
T_6	8.23	1.62	6.18	16.42	93.94	23.03	143.51
T_7	8.33	1.67	6.41	16.29	92.76	24.24	144.78
S.Em±	0.06	0.08	0.10	0.11	3.17	0.92	3.44
CD @ 5%	NS	NS	0.32	0.34	9.79	2.85	10.61

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