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Judicious nutrient management for irrigated tomato in red loamy sand soil

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Abstract : Field experiments were conducted to optimize the fertilizer schedule for tomato under irrigated condition in red loamy sand soil. The encouraging response of tomato to N and K could be well visualized with significantly higher fruit yield. Application of 80 - 60 - 40 kg N, P_2O_5 and K_2O ha^{-1} was optimum in increasing the yield and uptake of tomato. The T.S.S was altered by P and K levels and not by the N levels. The acidity was found to be independent of nutrient levels. The soil available N varied markedly among the N levels while the P availability was influenced by P and K levels. The uptake of nutrients was markedly influenced by the N and K levels as compared to P fertilization.

Key words: Irrigated tomoto, Fertilizer, Yield, Uptake, Nutrients, Acidity

Introduction

Vegetable cultivation is gaining importance in the recent years due to more returns per unit input cost. In the north western zone of Tamil Nadu, among the different vegetable crops, tomato occupies a larger area both under irrigated and rainfed conditions. However, the productivity is far below the average owing to many soil constraints. The soils of tomato growing area is coarse textured associated with poor fertility status. Under the above conditions, the yield is mainly determined by fertilizer management rather than any other factor. Any attempt made to improve the fertility cum productivity of these soils would pave way for better prosperity of the tomato growers of the zone. This study is focused on the fertilizer management for tomato under irrigated condition in red soils of North Western Zone of Tamil Nadu.

Materials and Methods

Field experiments were carried out in June - July season during 1994 - 97 in a red loamy sand soil (Typic Ustorthent). The soil of the experimental field was having EC

Table 1. Effect of N, P and K on fruit yield (t ha^{-1}) of tomato

Level	P_0			P_{60}			P_{120}			Mean
	K_0	K_{40}	K_{80}	K_0	K_{40}	K_{80}	K_0	K_{40}	K_{80}	
N_0	26.9	29.4	30.2	32.0	37.2	27.8	19.5	31.6	13.4	27.6
N_{40}	37.8	34.3	28.7	36.1	28.9	18.9	39.7	34.9	34.9	32.8
N_{80}	31.7	37.5	39.7	30.8	29.9	38.7	49.0	34.0	49.5	38.0
N_{120}	29.6	35.9	28.9	30.8	32.8	36.0	37.3	31.8	33.4	32.9
Mean	25.2	28.9	25.7	25.7	27.2	26.3	25.0	25.0	26.2	-

N - Mean				P- Mean			K - Mean		
N_0	N_{40}	N_{80}	N_{120}	P_0	P_{60}	P_{120}	K_0	K_{40}	K_{80}
27.6	32.8	38.0	32.9	26.1	26.4	26.2	25.3	27.3	26.1

Source	N	P	K	N x P	N x K	P x K	N x P x K
CD (P=0.05)	1.5	NS	1.3	2.6	2.6	NS	NS

Table 2. Effect of N, P and K on T.S.S. (briggs) of tomato

Level	P_0			P_{60}			P_{120}			Mean
	K_0	K_{40}	K_{80}	K_0	K_{40}	K_{80}	K_0	K_{40}	K_{80}	
N_0	3.6	3.9	3.6	4.3	4.4	4.8	4.1	4.4	4.7	4.20
N_{40}	3.8	3.6	4.6	3.0	4.4	4.1	404	3.9	4.5	4.03
N_{80}	4.0	3.7	4.2	3.8	4.6	4.6	3.8	3.8	4.1	4.06
N_{120}	3.8	3.8	3.8	4.2	4.8	4.3	4.2	3.0	4.3	4.02
Mean	3.80	3.75	4.05	3.83	4.53	4.45	4.13	3.78	4.40	-

N - Mean				P- Mean			K - Mean		
N_0	N_{40}	N_{80}	N_{120}	P_0	P_{60}	P_{120}	K_0	K_{40}	K_{80}
4.20	4.03	4.06	4.02	3.87	4.27	4.10	3.92	4.02	4.30

Source	N	P	K	N x P	N x K	P x K	N x P x K
CD (P=0.05)	NS	0.16	01.8	NS	NS	NS	NS

Table 3. Effect of N, P and K on the acidity (%) of tomato

Level	P_0			P_{60}			P_{120}			Mean
	K_0	K_{40}	K_{80}	K_0	K_{40}	K_{80}	K_0	K_{40}	K_{80}	
N_0	0.60	0.44	0.40	0.56	0.44	0.46	0.50	0.46	0.48	0.48
N_{40}	0.54	0.50	0.43	0.50	0.41	0.46	0.54	0.51	0.48	0.48
N_{80}	0.50	0.46	0.40	0.47	0.42	0.43	0.46	0.42	0.52	0.45
N_{120}	0.40	0.48	0.52	0.44	0.48	0.44	0.46	0.50	0.42	0.46
Mean	0.51	0.47	0.44	0.49	0.44	0.45	0.49	0.47	0.48	-

N - Mean				P- Mean			K - Mean		
N_0	N_{40}	N_{80}	N_{120}	P_0	P_{60}	P_{120}	K_0	K_{40}	K_{80}
0.48	0.48	0.45	0.46	0.47	0.46	0.48	0.50	0.48	0.46

Source	N	P	K	N x P	N x K	P x K	N x P x K
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

0.18 dSm^{-1}, pH 7.8, available N 172 kg ha^{-1}, P 10.5 kg ha^{-1} and K 224 kg ha^{-1}. The treatments consisted of four levels of N (0, 40, 80 and 120 kg ha^{-1}), three levels of P_2O_5 (0, 60 and 120 kg ha^{-1}) and three levels of K_2O (0, 40 and 80 kg ha^{-1}). Thus, there were thirty six treatment combinations with three replications. The experiment was conducted in a factorial randomized block design under irrigated condition with tomato var. Paiyur-1 as test crop. Fruit yield was recorded. Representative fruit samples were drawn during fifth picking and the T.S.S. using hand refrectometer and acidity (by titrimetry) were assessed. The soil samples collected at harvest were processed and analysed for available N (Subbiah and Asija, 1956), P (Watenabe and Olsen, 1965) and K (Hanway and Heidal, 1952). The plant samples were analysed for the total N (Humphries, 1956), P and K (Jackson, 1973) contents and uptake was computed using the contents and yield. The data were subjected to statistical scrutiny following the procedures outlined by Snedecor and Cochran (1968)

Table 4. Effect of N, P and K on nutrient uptake (kg ha^{-1}) by tomato crop

Level	P_0			P_{60}			P_{120}			Mean
	K_0	K_{40}	K_{80}	K_0	K_{40}	K_{80}	K_0	K_{40}	K_{80}	
Nitrogen										
N_0	44.3	74.4	85.7	56.3	75.7	63.3	45.7	70.2	60.1	63.9
N_{40}	56.3	84.5	77.7	104.1	73.5	64.0	56.3	86.0	83.7	76.2
N_{80}	64.5	76.3	78.2	86.7	75.7	100.0	93.8	73.3	106.7	83.9
N_{120}	63.8	92.7	73.2	64.4	84.0	66.6	87.3	86.0	80.4	77.6
Mean	57.2	82.0	78.7	77.9	77.2	73.5	70.8	78.9	82.7	-
N - Mean				P- Mean			K - Mean			
N_0	N_{40}	N_{80}	N_{120}	P_0	P_{60}	P_{120}	K_0	K_{40}	K_{80}	
63.9	76.2	83.9	77.6	72.6	76.2	77.5	68.6	79.4	78.3	
Phosphorus										
N_0	26.3	33.9	37.2	30.3	44.1	35.4	35.0	36.5	32.1	34.5
N_{40}	37.4	38.1	31.1	44.4	48.5	36.8	39.3	42.9	46.1	40.5
N_{80}	30.9	44.4	49.5	30.5	35.9	48.2	50.0	40.0	66.2	44.0
N_{120}	30.2	44.1	47.6	31.4	38.9	47.6	38.1	36.8	46.1	40.1
Mean	31.2	40.1	41.3	34.1	41.8	42.0	40.6	39.1	47.6	
N - Mean				P- Mean			K - Mean			
N_0	N_{40}	N_{80}	N_{120}	P_0	P_{60}	P_{120}	K_0	K_{40}	K_{80}	
34.5	40.5	44.0	40.1	37.5	39.3	42.4	35.3	40.3	43.6	
Potassium										
N_0	17.7	38.8	49.8	28.2	45.0	49.0	30.0	34.8	26.5	35.5
N_{40}	29.2	41.5	41.0	27.8	38.2	29.2	35.0	49.9	69.1	40.1
N_{80}	34.9	57.8	52.4	23.8	52.6	72.4	75.5	41.1	70.8	53.5
N_{120}	26.1	71.1	55.3	37.3	25.3	55.4	37.0	35.0	44.1	42.9
Mean	27.0	52.3	49.6	29.3	40.3	51.5	44.4	40.0	52.6	-
N - Mean				P- Mean			K - Mean			
N_0	N_{40}	N_{80}	N_{120}	P_0	P_{60}	P_{120}	K_0	K_{40}	K_{80}	
35.5	40.1	53.5	42.9	43.0	40.4	45.7	33.6	44.3	51.2	

CD (P=0.05)

Source	N	P	K	NxP	NxK	PxK	NxPxK
N	6.9	NS	7.8	NS	NS	NS	NS
P	5.4	3.4	4.7	NS	NS	NS	NS
K	10.1	NS	9.2	NS	NS	NS	NS

Results and Discussion

Fruit yield

The encouraging response of tomato to N and K in course textured soil could be well visualized with significantly higher fruit yield. Comparing with K, the effect of N levels was more prominent (Table 1). Application of 80 kg N ha^{-1} registered the highest yield of 38.0 t ha^{-1} with an yield improvement of 37.7 per cent over N_0. Favourable influence of N in enhancing the fruit yield in the present study find support from Subbiah (1990). However, further increase in N dose to 120 kg ha^{-1} failed to increase the yield and its effect was almost equal to 40 kg N ha^{-1}. The K level at 40 kg ha^{-1} proved its significance over control but declined at 80 kg ha^{-1}. Albeit the marginal differences among the P levels,

Table 5. Effect of N, P and K on post harvest soil fertility (kg ha^{-1})

Level	P_0			P_{60}			P_{120}			Mean
	K_0	K_{40}	K_{80}	K_0	K_{40}	K_{80}	K_0	K_{40}	K_{80}	
Available Nitrogen										
N_0	162	165	160	172	161	170	156	159	166	163.4
N_{40}	168	170	165	180	170	180	168	172	180	172.6
N_{80}	180	186	165	186	190	170	174	172	172	177.21
N_{120}	178	192	190	186	186	188	186	184	195	187.2
Mean	172.0	178.3	170.0	181.0	176.8	177.0	171.0	171.8	178.3	-
	N - Mean				P- Mean			K - Mean		
N_0	N_{40}	N_{80}	N_{120}	P_0	P_{60}	P_{120}		K_0	K_{40}	K_{80}
163.4	172.6	177.2	187.2	173.4	178.3	173.3		174.7	175.6	175.1
Available Phoshphorus										
N_0	9.3	10.6	11.6	9.6	10.6	12.6	11.2	9.8	10.8	10.7
N_{40}	9.8	11.2	11.2	9.8	9.9	13.0	10.0	11.2	11.6	10.9
N_{80}	9.9	10.5	10.9	9.6	11.3	9.9	12.6	10.6	14.8	11.1
N_{120}	10.0	10.8	10.8	10.0	11.4	10.6	10.4	10.4	13.6	10.9
Mean	9.8	10.8	11.1	9.8	10.8	11.5	11.1	10.5	12.7	-
	N - Mean				P- Mean			K - Mean		
N_0	N_{40}	N_{80}	N_{120}	P_0	P_{60}	P_{120}		K_0	K_{40}	K_{80}
10.7	10.9	11.1	10.9	10.2	10.7	11.4		10.2	10.7	11.8
Available Potassium										
N_0	214	224	220	225	235	224	226	222	235	225.0
N_{40}	216	210	207	220	240	232	242	208	217	221.3
N_{80}	210	208	210	220	230	214	228	206	228	217.1
N_{120}	222	210	204	210	226	218	235	225	230	220.0
Mean	216.5	213.0	210.3	218.8	232.8	222.0	232.8	215.3	227.5	-
	N - Mean				P- Mean			K - Mean		
N_0	N_{40}	N_{80}	N_{120}	P_0	P_{60}	P_{120}		K_0	K_{40}	K_{80}
225.0	221.3	217.1	220.0	213.3	224.5	225.5		222.7	220.4	219.9

CD (P=0.05)

Source	N	P	K	NxP	NxK	PxK	NxPxK
N	5.2	NS	NS	NS	NS	NS	NS
P	NS	0.38	0.45	NS	NS	NS	NS
K	NS	NS	NS	NS	NS	NS	NS

P_2O_5 at 60 kg ha^{-1} becomes essential as a maintainer dose to avoid soil P depletion and also for balanced crop nutrition.

Fruit quality

The T.S.S. content of fruit was altered by P and K levels and not by the N. A value of 3.87 briggs at P_0 got increased to 4.27 (P_{60}) and declined to 4.10 briggs with subsequent increase in P level (Table 2). However, the T.S.S. progressively increased with increase in K levels with respective values of 3.92, 4.02 and 4.30 briggs at 0, 40 and 80 kg K_2O ha^{-1}. The acidity, an important quality determining factor was found to be independent of nutrient levels and the differences ensured by the treatments were of numerical but not significant (Table 3). Similar trend of ineffectiveness of N on quality of tomato under rainfed condition was earlier reported by Duraisamy *et al.* (1999).

Nutrients uptake

The N uptake was favourably increased by the application of N, P and K and the effect of N levels was more prominent than P and K (Table 4). Among the N levels, the N uptake ranged from 63.9 to 83.9 kg ha^{-1} and exhibited a curvilinear trend with progressive increase in uptake upto 80 kg ha^{-1} and declined there after. The P and K levels increased the N uptake but at a decreasing rate at higher levels. The present results corroborate with the findings of Balasubramaniam *et al.* (1998). The P uptake of 34.5 kg ha^{-1} at N_0 level got increased to 44.0 kg ha^{-1} at 80 kg ha^{-1} and declined at 120 kg N ha^{-1} (40.1 kg ha^{-1}). Among the P levels, the highest uptake of 42.4 kg ha^{-1} was recorded at 120 kg P_2O_5 ha^{-1}. The uptake of P was more favoured by K levels with a range of 35.3 to 43.6 kg ha^{-1}. This clearly indicates that the K application has aided in better absorption and translocation of P. The K uptake was prominently affected by N and K levels with higher values registered at N_{80} (53.5 ha^{-1}) and K_{80} (51.2 kg ha^{-1}) levels.

Soil available nutrients

The soil available N varied markedly among the N levels. With increasing N levels, the availability also progressively increased (Table 5). A value of 163.4 kg ha^{-1} in control got increased to the maximum of 187.2 kg ha^{-1} at 120 kg ha^{-1} level. However, the P and K levels though brought about changes in N availability, the differences were within narrow limits. The P availability differed as influenced by P and K levels with a range of 10.2 to 11.4 and 10.2 to 11.8 kg ha^{-1}, respectively. In both the cases, the P availability showed a linear increase with the levels. The magnitude of variation in P content of soil due to N levels was not to that extent of P and K. The various treatments though differed the soil available K, the values remained to be on par and this might be due to the high available K status of the experimental soil.

It may be concluded that application o 80-60-40 kg N, P_2O_5 and K_2O ha^{-1} is optimun in improving the yield and nutrient uptak by irrigated tomato and maintenance of soi fertility in the red loamy sand soil.

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