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Balanced application of N, P and K fertilizers in tomato (*Lycopersicon esculentum* Mill.) for high yield in dry temperate conditions of Himachal Pradesh

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Abstract

Twenty four treatment combinations comprising of four N levels (75, 100, 125 & 150 kg ha^{-1}), two P_2O_5 levels (50 & 75 kg ha^{-1}) and three K_2O levels (25, 50 & 75 kg ha^{-1}) were evaluated for tomato fruit yield, nutrient uptake and economics for the two consecutive summers (2003 & 2004) at Highland Agricultural Research and Extension Centre, Kukumseri, CSK HPKV, Palampur. The fruit yield, mean uptake of N, P and K, net returns and B: C ratio increased significantly with the increasing N levels upto 125 kg N ha^{-1}. Application of 150 kg N ha^{-1} had no benefit over 125 kg N ha^{-1} in influencing yield, N and K uptake and net returns. Phosphorus application at 75 kg P_2O_5 ha^{-1} resulted in significantly higher fruit yield, N, P and K uptake, net returns and B: C ratio over 50 kg P_2O_5 ha^{-1}. Tomato crop responded positively to potassium application up to the highest level *i.e.* 75 kg K_2O ha^{-1}. However, mean uptake of N, P and K increased significantly only up to 50 kg K_2O ha^{-1}. Interaction between N, P and K was found significant. Among all the combinations, $N_{125}P_{50}K_{75}$ resulted in highest fruit yield, net return and B: C ratio but was statistically at par with $N_{150}P_{75}K_{25}$, $N_{150}P_{75}K_{50}$ and $N_{150}P_{75}K_{75}$.

Key words: Tomato, NPK, productivity, economics, dry temperate condition.

Introduction

In dry temperate region especially in Lahaul Valley, tomato crop is a new introduction. There is acute shortage of tomato in the local market as transportation cost from other parts of the state to the valley is very high. Therefore tomato grown in the valley fetches remunerative prices. However the information on increasing its production through improved practices is meager especially under dry temperate region. The region is characterized by high wind velocity, scarcity of rainfall, extreme variation in temperature, low relative humidity and high rate of evaporation coupled with low water holding capacity of the soil. There is a single cropping season and only a few crops viz., pea, potato, buckwheat, barley are raised. Tomato cultivation is a good option for diversification. Among the various components of production technology, fertilizers are the kingpin for improving productivity. The nutrient requirement for economic productivity of tomato in other parts of the state has been worked out (Sharma, 1995, Thakur and Bhardwaj, 2000).The fertilizer requirement is dependent upon variety/cultivar and environmental conditions, thus it is pertinent to have information on nutrient requirement for newly introduced tomato crop for its sustainable productivity in the Lahaul Valley. The present investigation was, therefore, undertaken to workout the balanced supply of nutrients for tomato crop under dry temperate conditions of Lahaul Valley.

Material and Methods

A field experiment was conducted for two consecutive summers (2003 and 2004) at the Highland Agricultural Research and Extension Centre of CSK HPKV, Palampur at Kukumseri. The station is situated at 32°46'15"N latitude and 76°41'23"E longitude at an elevation of 2734 m msl in the dry temperate zone of north-western Himalaya. The soil of the experimental field was sandy loam in texture, high in organic carbon status (1.1%), with a pH 6.5. The soil had available N 141.4 kg ha^{-1}, P 35.8 kg ha^{-1} and K 168.7 kg ha^{-1}. The tomato variety EC 129601 was transplanted on 2nd June, 2003 and 4th June, 2004 at 45 cm x 20 cm spacing using 35 days old seedlings. Twenty four treatment combinations comprising four N levels (75, 100, 125 & 150 kg ha^{-1}) as main plot factors, two P_2O_5 levels (50 & 75 kg ha^{-1}) as sub plot factors and three K_2O levels (25, 50 & 75 kg ha^{-1}) as sub-sub plot factors were arranged in split-

split plot design with three replications. N, P_2O_5 and K_2O were supplied through urea, single super phosphate and muriate of potash, respectively. The total amount of phosphorus and potassium was applied with half the dose of N at transplanting and the remaining N was applied in two equal splits; the first one month after transplanting and second at flowering. The crop was raised in accordance with the recommended package of practices. Yield was harvested from net plot. The economics of the treatments was worked out using the then market price.

Results and Discussion

Nitrogen

The fruit yield of tomato increased with increasing rate of nitrogen up to 125 kg ha^{-1} (Table 1). Hedau *et al.* (2001) have also recorded highest fruit yield of tomato with 125 kg N ha^{-1}. Nitrogen at 125 kg ha^{-1} increased tomato fruit yield by 50.8 and 27.6 per cent over 75 and 100 kg ha^{-1}, respectively. Nitrogen at highest rate (150 kg N ha^{-1}) had non significant effect on the fruit yield of tomato over 125 kg N ha^{-1}. N and K uptake by tomato crop was increased with increasing rates of N up to 125 kg ha^{-1}, whereas P uptake increased up to the highest level (150 kg ha^{-1}) tried. Owing to higher yields, net return and B:C ratio increased with increasing rates of N up to 125 kg ha^{-1} beyond which no significant benefit was realized. 125 kg N ha^{-1} gave 59.4 and 31.6 per cent higher net return over 75 and 100 kg N ha^{-1}, respectively.

Phosphorus

Phosphorus application at 75 kg P_2O_5 ha^{-1} resulted in 11.8 per cent higher fruit yield of tomato over its application at 50 kg ha^{-1}. Response of tomato to P application at rates as high as 100 kg ha^{-1} (Arya *et al.*, 1999) and 150 kg ha^{-1} (Singh and Kohli, 1999) has been reported. The higher P and K uptake by tomato crop owing to P application at 75 kg ha^{-1} over 50 kg P_2O_5 ha^{-1} may be due to significantly higher yield under former level. P application at 75 kg P_2O_5 ha^{-1} increased net returns and B: C ratio by 13.3 and 8.1 per cent, respectively over 50 kg P_2O_5 ha^{-1}.

Table 1. Effect of N, P and K on yield, nutrient uptake and economics

Treatments	Yield (t ha^{-1})			Mean uptake (kg ha^{-1})			Net returns (Rs.ha^{-1})	B:C ratio
	2003	2004	Mean	N	P	K		
N levels								
N_{75}	77.9	73.0	75.4	84.1	20.7	120.9	297392	3.71
N_{100}	89.4	88.7	89.1	105.5	30.0	182.7	360120	4.22
N_{125}	114.4	113.1	113.7	115.9	35.7	226.2	473942	5.00
N_{150}	116.6	115.3	115.9	115.9	41.2	224.9	483867	5.04
LSD (P=0.05)	7.5	7.3	3.1	8.1	1.4	6.1	14114	0.12
P levels								
P_{50}	93.8	92.3	93.0	110.8	29.4	165.6	378710	4.32
P_{75}	105.3	102.8	104.0	99.9	34.4	211.7	428951	4.67
LSD (P=0.05)	2.1	3.9	2.2	6.1	0.8	3.5	10131	0.09
K levels								
K_{25}	95.1	91.0	93.1	92.6	28.2	171.8	378670	4.31
K_{50}	99.6	99.0	99.3	110.0	34.8	209.9	407459	4.52
K_{75}	103.9	102.5	103.2	113.5	32.7	184.4	425363	4.64
LSD (P=0.05)	2.8	4.7	3.0	5.0	1.1	5.7	13793	0.12

Potassium

Likewise, tomato crop responded to potassium application up to the highest rate tried *i.e.* 75 kg K_2O ha^{-1}. Response of tomato to still higher doses of potassium has been documented (Thakur and Bhardwaj, 2000; Singh *et al.*, 2000). However, mean uptake of N, P and K increased significantly only up to 50 kg K_2O ha^{-1}. Application of 75 kg K_2O ha^{-1} resulted in highest net returns and benefit cost ratio. Increase in net return and benefit cost ratio owing to 75 kg K_2O ha^{-1} was 12.3 and 4.4 per cent and 7.7 and 2.7 per cent over 25 and 50 kg K_2O ha^{-1}, respectively.

NxPxK interaction

Interaction between N, P and K was significant for yield, nutrient uptake, net return and B: C ratio (Table 2). Among all the combinations, $N_{125}P_{50}K_{75}$ remaining at par with $N_{150}P_{75}K_{25}$,

$N_{150}P_{75}K_{50}$ and $N_{150}P_{75}K_{75}$ resulted in significantly higher year-wise and mean fruit yield, net return and B: C ratio. Thakur and Bhardwaj (2000) also obtained higher yield and net return with 150 kg N + 112.5 kg P_2O_5 + 82.50 kg K_2O ha^{-1}.

The present investigation conclusively inferred that an application of 125 kg N, 50 kg P_2O_5 and 75 kg K_2O ha^{-1} provided sustainable and economic productivity of tomato in Lahaul valley conditions of Himachal Pradesh.

Table 2. Effect of nutrient levels on yield, nutrient uptake and net financial return of tomato in dry temperate region

Nutrient levels	Yield (t ha^{-1})			Nutrient uptake (kg ha^{-1})			Net return (Rs.ha^{-1})	B:C ratio
	2003	2004	Mean	N	P	K		
$N_{75}P_{50}K_{25}$	72.0	51.7	61.8	65	17	99	234903	3.12
$N_{75}P_{50}K_{50}$	74.3	73.9	74.1	98	18	115	291652	3.69
$N_{75}P_{50}K_{75}$	76.3	75.6	75.9	118	22	102	299669	3.75
$N_{75}P_{75}K_{25}$	83.0	78.1	80.5	91	16	97	320904	3.92
$N_{75}P_{75}K_{50}$	77.0	77.0	77.0	69	26	164	304293	3.77
$N_{75}P_{75}K_{75}$	84.7	81.7	83.2	64	23	149	332930	4.00
$N_{100}P_{50}K_{25}$	76.8	75.6	76.2	116	21	148	301037	3.77
$N_{100}P_{50}K_{50}$	80.4	79.5	80.0	84	21	137	318335	3.91
$N_{100}P_{50}K_{75}$	86.4	90.8	88.6	116	34	180	358249	4.22
$N_{100}P_{75}K_{25}$	90.6	92.8	91.7	95	33	192	372100	4.31
$N_{100}P_{75}K_{50}$	97.3	95.8	96.6	110	34	194	394570	4.47
$N_{100}P_{75}K_{75}$	104.8	97.9	101.3	112	37	246	416431	4.62
$N_{125}P_{50}K_{25}$	99.6	99.1	99.4	87	34	201	407964	4.59
$N_{125}P_{50}K_{50}$	112.3	113.5	112.9	164	43	262	470363	5.00
$N_{125}P_{50}K_{75}$	127.6	129.1	128.4	142	34	200	541750	5.41
$N_{125}P_{75}K_{25}$	117.1	114.8	115.9	88	32	257	484183	5.07
$N_{125}P_{75}K_{50}$	119.9	117.2	118.5	128	45	272	495947	5.13
$N_{125}P_{75}K_{75}$	109.7	104.7	107.2	87	27	165	443445	4.79
$N_{150}P_{50}K_{25}$	98.1	97.9	98.0	89	33	148	401547	4.53
$N_{150}P_{50}K_{50}$	108.7	106.8	107.8	122	38	223	446472	4.83
$N_{150}P_{50}K_{75}$	113.2	113.7	113.5	130	37	174	472580	4.99
$N_{150}P_{75}K_{25}$	123.6	118.2	120.9	110	39	232	506719	5.19
$N_{150}P_{75}K_{50}$	126.9	128.4	127.7	105	53	312	538038	5.36
$N_{150}P_{75}K_{75}$	128.9	126.5	127.7	139	48	260	537846	5.35
LSD (P=0.05)	7.8	NS	8.4	14	3	16	39013	0.35

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