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Nutritional status of tomato leaves in North Western Himalayas

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ABSTRACT

Status of major and micro nutrients in representative leaves of tomato (Solanum lycopersicum) of Saproon valley of Solan district in north western Himalayas were studied. The nitrogen, phosphorus and potassium content in tomato leaves samples varied from 3.45 to 5.77, 0.28 to 0.89 and 2.10 to 4.40 per cent, respectively. The average concentrations of Ca, Mg and S in leaves were recorded as 2.23, 1.17 and 0.46 per cent, respectively, showing adequacy of nutrient content in the leaf samples. Leaf Fe, Mn, Cu and Zn content ranged between 271.7 and 847.8, 21.0 and 476.7, 20.1 and 105.4 and 20.8 and 189.4 mg kg^{-1}, respectively. A negative and significant correlation existed between available K content and leaf Ca and Mg. Available P had significant and negative correlation with Ca, Mg and Zn. Available Zn had significant and positive relationship with Mn content in leaves.

Key words: Major nutrients, micro nutrients, tomato, leaves, Solan

INTRODUCTION

After attaining food security, country is now striving hard to achieve health security, endangered by malnutrition. In this context, production of so-called protective food "Vegetables" need to be stepped up, as there is an alarming gap between the availability (135 g/day/capita) and minimum requirement (285 g/day/capita). Himachal Pradesh, an important hill state in Western Himalayas, is endowed with varied agro-climatic conditions especially, agro-climatic 'niches'. In the state, the area under vegetable cultivation has been on a rise from 38700 ha (1991-92) to 79500 ha (2012-13). However, production has increased at a slow pace from 476.0 thousand metric tons (1991-92) to 1521.1 thousand metric tons (2012-13), despite use of high yielding hybrids and improved agro- technologies. The average vegetable productivity of the state is 19.1 metric tons ha^{-1} and the yield growth rate is 1.0 per cent only. The total area under vegetable crops in Solan district is about 8454 ha which is approximately 13 per cent of the total area in Himachal Pradesh, whereas the production is around 19.16 per cent. The Saproon valley of district Solan in North Western Himalayas which is famous for the production of vegetable crops, has a total area of about 753 hectares out of which 177 hectares area is under cultivation. The off-season vegetable crops such as tomatoes, peas, capsicum and cauliflower are produced in this valley at a time when they are not available in plains, therefore fetch higher premium in the market. The tomato crop has achieved the mark of major crop of this area. Tomato is an important cash crop of Solan area due to its off-season fruiting duringthe rainy season, middle of June to October, providing Himachal Pradesh a unique opportunity of marketing the crop at higher price at Delhi, Ludhiana, Jullundur, Amritasar and Chandigarh. Approximately 18,500 tonnes of tomatoes are exported from Solan area during this season.

Although one or more essential nutrients are commonly applied to vegetable crops in Himachal Pradesh particularly in Solan district, the amount of nutrients removed in harvested crops are generally much higher than the quantity added and hence resulting in exhaustive mining of nutrients from the soil, thus increasing the nutrient related stresses and yield losses. The problem has been further aggravated due to introduction of heavy nutrient feeders and high yielding hybrid varieties. As the demand of nutrients for higher yields increases the plant's need for nutrients, nutrient deficiencies are likely to become more acute. In the present era of intensive agriculture, in view of sustainable crop production, it is being strongly felt that deficiency and sufficiency of nutrients in the crop must be assessed for different crops and locations. This valuable knowledge on the crop nutritional status is essential to formulate the strategies for

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amelioration of such deficiencies, timely and more precisely along with a better fertilizer input practice.

MATERIALS AND METHODS

The study area Saproon Valley is located between $30^0 55'$ North latitude and $77^0 9'$ East longitude with an altitude ranging from 1390 to 1500 meters above mean sea level. It represents sub-humid to sub-temperate climate with an average rainfall of 1300 mm and. The soils have been derived from red and grey gypsiferrous and calcareous shales, are medium deep and mostly sandy loam to sandy clay loam in texture. Tomato leaf samples adjacent to inflorescence three in numbers from each twenty one villages i.e. sixty three samples were collected at mid bloom stage (Jones *et al.*, 1991 and Bhargav and Raghupati, 1993). The leaf samples of tomato were oven dried at 60^0C, grinded and digested in a diacid mixture of HNO_3: $HClO_4$ (4:1) for estimation of macro and micro nutrients. Phosphorus, potassium, calcium and magnesium were determined by adopting standard procedures (Jackson, 1973). Nitrogen in leaves was analyzed by the micro-kjeldhal's method. Sulphur was determined by turbidimetric method (Chesnin and Yien (1950). Iron, manganese, copper and zinc in acid digest were determined on atomic absorption spectrophotometer. The data was subjected to statistical analysis by adopting simple correlations to find out the extent of relationship between the soil nutrient characteristics and leaf nutrient status.

RESULTS AND DISCUSSION

The amounts of N, P and K content in the tomato leaves (Table 1) varied from 3.45 to 5.77, 0.28 to 0.89 and 2.10 to 4.40 per cent, respectively with majority of samples sufficient in N, P and K which may be attributed to the foliar spray of urea and other fertilizers by the farmers to the tomato crop. The observations are in agreement with those made by Campbell (2000).

Table 1: Leaf macronutrient status (per cent)

Name of the village	N	P	K	Ca	Mg	S
Saproon	4.82-5.71	0.51-0.54	3.40-3.91	1.69-2.70	0.32-0.53	0.23-0.70
Kailar	3.98-4.85	0.39-0.48	4.09-4.32	1.55-1.94	0.25-0.45	0.27-0.38
Bajrol Khurd	4.12-4.87	0.28-0.42	3.28-3.82	0.85-1.64	0.21-0.43	0.53-0.87
Lavi Khurd	4.25-4.85	0.46-0.71	3.16-3.86	0.85-1.19	0.29-0.32	0.31-0.45
Lavi Kalan	4.99-5.14	0.46-0.52	3.03-3.09	1.47-1.75	0.22-0.31	0.47-0.56
Bajrol Kalan	4.54-5.02	0.53-0.59	3.50-3.88	1.20-1.61	0.15-0.27	0.35-0.43
Sandrol	4.99-5.46	0.40-0.44	2.92-2.95	1.21-1.75	0.28-0.41	0.27-0.32
Sheel I	4.57-5.1	0.48-0.83	3.24-4.03	1.80-2.41	0.29-0.35	0.46-0.60
Sheel II	3.98-4.56	0.55-0.59	3.30-4.05	2.00-2.69	0.36-0.48	0.41-0.48
Bairtee I	4.67-5.71	0.42-0.63	2.44-3.72	2.17-3.40	0.40-0.52	0.40-0.67
Bairtee II	3.61-4.38	0.47-0.56	2.36-2.99	2.80-4.45	1.04-1.06	0.40-0.55
Kothi Deora I	4.66-5.23	0.38-0.46	2.84-2.90	1.72-2.75	1.02-1.05	0.24-0.48
Kothi Deora II	3.45-4.55	0.48-0.51	2.28-3.30	1.88-2.74	1.03-1.06	0.29-0.45
Top Ki Ber	4.89-5.48	0.51-0.59	3.06-3.32	1.55-3.20	1.04-1.06	0.50-0.52
Ghatti	4.79-5.67	0.45-0.74	2.55-3.07	1.76-2.44	1.02-1.03	0.37-0.71
Bhannat	4.87-5.77	0.48-0.74	2.10-2.87	1.78-1.99	1.03-1.04	0.27-0.44
Loharon	4.78-5.42	0.33-0.49	3.67-4.07	1.54-1.92	1.10-1.11	0.32-0.74
Jagaat Khana	4.81-5.32	0.51-0.68	3.36-3.85	2.08-2.89	1.08-1.10	0.39-0.43
Chakli	3.99-5.02	0.49-0.59	3.84-4.00	1.62-1.89	1.09-1.10	0.49-0.55
Deothi	5.10-5.39	0.46-0.65	3.03-4.40	1.88-2.09	1.06-1.11	0.36-0.64
Kiartoo	4.65-5.11	0.46-0.82	3.08-3.26	1.20-2.76	1.08-1.10	0.40-0.49

The average concentration of Ca, Mg and S in leaf samples (Table 1) ranged from 0.85 to 4.45, 0.15 to 1.11 and 0.23 to 0.87 per cent, respectively with 76 per cent samples intermediate in range for Ca and 100 per cent samples high in both Mg and S content (Table 3). All the plant samples for S fall in high range, however, soil analysis data shows that the soils are deficient in available sulphur. This, therefore, indicates that there is a need either to check the suitability of 0.15 % $CaCl_2$ reagent or the critical limit of it for assessing the soil fertility status of the area.

Table 2: Leaf micronutrient status (mg kg^{-1})

Name of the Village	Iron	Manganese	Copper	Zinc
Saproon	493.6-568.4	21.0-229.8	81.10-105.40	54.2-82.6
Kailar	328.8-563.4	22.8-118.0	26.40-48.20	20.8-31.8
Bajrol Khurd	336.6-847.8	175.8-280.9	28.90-34.20	42.6-58.1
Lavi Khurd	374.3-618.2	82.6-229.6	20.10-32.60	41.2-48.8
Lavi Kalan	281.7-316.6	129.8-397.4	23.90-29.50	56.1-89.8
Bajrol Kalan	311.6-369.0	25.4-270.6	22.60-32.00	62.1-173.7
Sandrol	321.1-406.4	40.3-143.8	40.10-52.20	66.3-189.4
Sheel I	284.2-331.6	92.2-120.1	25.10-29.50	47.8-122.5
Sheel II	376.1-421.4	155.0-257.6	22.00-32.60	44.8-52.6
Bairtee I	364.0-389.0	77.3-84.5	20.70-98.60	54.6-116.5
Bairtee II	319.1-389.0	97.2-254.8	23.90-30.80	45.6-65.3
Kothi Deora I	326.6-384.0	61.8-476.7	77.20-94.10	38.3-82.8
Kothi Deora II	321.6-364.0	67.4-137.3	26.40-61.50	28.6-91.5
Top Ki Ber	336.6-346.6	53.4-165.4	23.20-28.90	32.4-94.6
Ghatti	336.6-369.0	69.2-189.5	23.90-35.20	26.1-82.8
Bhannat	311.6-349.1	103.7-111.2	23.90-40.20	39.3-137.5
Loharon	339.1-389.0	61.1-72.2	68.10-76.30	65.6-75.5
Jagaat Khana	311.6-401.5	110.3-297.7	38.80-55.30	44.6-74.3
Chakli	437.6-473.8	21.0-98.3	31.20-32.60	74.2-142.5
Deothi	329.1-351.6	22.8-118.0	23.20-33.90	35.9-104.5
Kiartoo	271.7-311.6	77.1-92.4	27.60-33.30	51.8-112.5

Leaf Fe, Mn, Cu and Zn content (Table 2) ranged between 271.70 and 847.80, 21.00 and 476.70, 20.10 and 105.40 and 20.80 and 189.40 mg kg^{-1}, respectively with majority of samples sufficient in leaf micronutrient status which is in confirmation with the sufficiency of these nutrients in the soils of the valley, spray of blue copper by the farmers of the area and consciousness of the farmers to supply micronutrients particularly Zn through foliar sprays also indicating that DTPA extractant is quite suitable for the soils of the area.

Table 3: Per cent plant samples falling in various categories of nutrient levels

Nutrient element	Per cent samples		
	Deficient	Intermediate	High
Nitrogen	-	-	100
Phosphorus	-	-	100
Potassium	-	60	40
Calcium	15	76	9
Magnesium	-	-	100
Sulphur	-	-	100
Iron	-	-	100
Manganese	-	14	86
Copper	-	-	100
Zinc	-	-	100

The correlation values between soil characteristics and leaf nutrient content are presented in Table 4. The pH of the soils had a negative and significant correlation with leaf Fe (r=-0.65**) with Mn (r=-0.51**) and Cu content (r=-0.55**) which can be attributed to the lower solubility and unavailability of these nutrients at neutral to higher pH. The available P content of the soils registered significant and negative relationship with leaf Ca (r=-0.49*), which is due to the fixation of phosphorus as calcium phosphate which reduces the availability of both the nutrients, by making them insoluble. Available K content in the soils also had a negative and significant correlation with leaf Ca (r=-0.52**) and Mg content (r=-0.57**). This gets its support from the fact that there is an antagonistic relationship between available K and exchangeable Ca and Mg, as these nutrients compete for same absorption sites on plant roots. The exchangeable Mg had a significantly negative correlation with leaf Fe (r=-0.66**) in soils. This may be due to the fact that with high exchangeable Mg, soils will be at higher pH at which Fe becomes insoluble unavailable for plant uptake. Available SO_4^--S of surface soils and leaf Fe content had significant and positive relationship (r=0.50*). This may be attributed to mineralization of S reduces which the pH, thus making Fe soluble and available for plant uptake.

Table 4: Simple correlation coefficient (r) between soil characteristics and leaf nutrient status

Soil / Leaf	N	P	K	Ca	Mg	S	Fe	Mn	Cu	Zn
pH	-0.01	0.43	-0.21	0.16	0.26	-0.30	-0.65**	-0.51*	-0.55**	0.28
EC	-0.09	-0.23	-0.29	0.06	-0.31	0.11	0.19	0.40	-0.05	0.05
OC	0.11	0.09	0.05	-0.13	-0.38	-0.02	-0.04	0.01	-0.27	0.07
N	0.09	0.19	0.19	-0.11	-0.36	-0.020	-0.08	-0.07	-0.31	0.10
P	0.08	0.23	0.07	-0.49*	-0.61**	-0.23	-0.02	-0.03	-0.14	0.46*
K	0.06	-0.05	0.43	-0.52*	-0.57**	-0.01	0.09	-0.08	-0.22	0.39
Ca	-0.04	-0.07	-0.21	0.05	-0.42	0.03	0.14	-0.08	-0.33	0.06
Mg	0.10	0.29	-0.50*	0.29	0.40	-0.31	-0.66**	-0.14	-0.12	0.22
S	0.16	-0.21	0.22	-0.34	-0.27	0.49*	0.50*	0.20	0.08	0.07
Fe	0.14	-0.20	0.40	-0.33	-0.47*	0.25	0.49*	0.41	0.36	-0.19
Mn	0.19	-0.366	-0.08	-0.44*	-0.48*	-0.18	-0.02	0.06	-0.01	0.51*
Cu	0.09	-0.381	-0.22	0.12	-0.34	0.11	0.13	0.15	0.21	-0.03
Zn	0.24	-0.068	0.15	0.11	-0.18	0.37	0.05	0.16	0.19	0.04

***.Significant at the 0.01 level*
**. Significant at the 0.05 level*

The results of the present study revealed that nitrogen, phosphorus and potassium content in tomato leaves ranged from 3.45 to 5.77, 0.28 to 0.89 and 2.10 to 4.40 per cent, respectively. The average concentrations of Ca, Mg and S in leaves were recorded as 2.23, 1.17 and 0.46 per cent, respectively, showing adequacy of nutrient content in the leaf samples. The majority of leaves were sufficient in micronutrient status. The status of nutrients in leaves was affected by the status of these nutrients in soil and soil properties.

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