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## ESTIMATION AND SEASONAL VARIATIONS OF MACRO AND MICRO NUTRIENTS IN TEA OF HIMACHAL PRADESH

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Samples of green shoots of Kangra local, Chinery hybrid type of tea (*Camellia sinensis* (L.) O. Kuntze) were analysed for macro and micro nutrients for a period of two years. The potassium level was found to be high, but calcium and magnesium contents were lower. The concentrations of various micro nutrients, except copper and manganese, were found to be in the optimum range. The nutrient content of the tea leaves showed a relationship to weather conditions.

### INTRODUCTION

As a result of the large scale dispersal of the tea plant as well as the free hybridization between geographical races seed tea populations are highly heterogeneous. Clones, climate and soil conditions of the region of its cultivation are primarily responsible for the chemical composition of tea shoots and hence the quality of tea. Variations of chemical constituents in fresh tea leaf due to climate have been widely reported (Sanderson, 1964; Sanderson and Kanapathipillai, 1964; Wickremasinghe *et al.*, 1966).

The importance of soil and plant nutrients for growing a disease free healthy tea bush with higher yields and quality liquor is well understood. Significant effects on yield of green leaf (Treshchov, 1971), defoliation, stunting growth, chlorosis and discolouration in tea due to nutrient deficiencies have been reported by various workers (Chenery and Shoenmaekers, 1959; Tolhurst, 1962; Pethiyagoda and Krishnapillai, 1970; 1971; Barpujari and Dey, 1982). On the other hand nutrition and conditions of the tea plant determine not only its health and vigour but, is an important guiding factor for the yield of green leaf (Barua and Dutta, 1972). The changing weather during different seasons has also been held responsible for fluctuations in nutrients in tea plants (Hasselo, 1965).

Although work on N, P and K fertilizer applications and their effects on yield have been reported (Mehta, Marwah and Sharma, 1974; Marwah, Mehta and Sharma, 1977; Sharma, 1987) no systematic work on the nutrient status of tea in Himachal Pradesh is

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available in the literature. Measures to rectify deficiencies, if any, are also handicapped for lack of availability of basic data. Surprisingly there is hardly any practice to compensate nutrients other than N, P and K in tea gardens. It could be one of the contributory factors for the regional average yield of about 443 KMT/H to be much below the national average of about 1515 KMT/H (Anon. 1986). The present work was, therefore undertaken to evaluate the Kangra local tea for macro and micro nutrient status with a view to provide some information for formulating fertilizer levels for future nutritional studies.

## **MATERIALS AND METHODS**

Leaf samples (two and a bud) of Kangra local jat were collected from the Tea Experiment Station, Himachal Pradesh Krishi Vishvavidyalaya, Palampur (elevation : 1290 m amsl, latitude : 32° 6' N, longitude : 76°3'E). The climate is sub-temperate humid with slightly hot and humid summer season and cold winter with an annual rainfall ranging from 226-280 cm. The tea bushes were 24 years old and sampling was done at about fifteen day intervals from April to October for two plucking seasons of 1987 and 1988. In 1988 no samples could be collected in mid - April due to extreme cold and unprecedented hail storm as well as again in the latter half of October due to the dry season. Recommended cultural practices were uniformly adopted during the period of the present investigations.

The samples were washed thoroughly with distilled water, dried at  $60 \pm 5^{\circ}\text{C}$  for 48h (Chapman and Pratt, 1961 a) and finally crushed by hand. The nutrients were estimated in a 100 ml solution prepared after digesting one g leaf sample in diacid. Total phosphorus was determined by vanadomolybdate method (Jackson, 1967) while potassium was estimated flame spectro-photometrically (Chapman and Pratt, 1961 b). The other elements were determined in an atomic absorption spectrophotometer, Varian tectron-175. All analytical observations were done in triplicate, simultaneously, to reduce any experimental error to a minimum. The data were analysed statistically in a Randomised Block Design.

## **RESULTS AND DISCUSSION**

The results of analyses in terms of mean values for the macro and micro nutrients are represented in Tables 1 and 2, respectively.

It is evident from Table 1 that, in general, the trends of variation in macro nutrient concentration are almost similar for both the years. However, calcium and magnesium showed more fluctuations between the corresponding periods compared to the fluctuations in potassium and phosphorus. Phosphorus did not show much variation with changing weather conditions. The level of potassium in the leaf increased during the wet season.

From Table 2 it is seen that, except for zinc content in the mid-month flush, the relative trend of variations of micro nutrients during 1987 and 1988 were almost identical. However, the fluctuations in their levels over the corresponding dates were quite marked. Zinc, copper and manganese showed greater fluctuations than iron and sodium. The levels of micro nutrients in green tea shoots were either constant or showed a decline at the beginning of the plucking season; however, significant variations were observed with the advancement of the plucking season as a result of changing weather conditions. The trend of seasonal variation for manganese was opposite to that of iron.

TABLE 1 – Macro nutrient contents in green tea shoots of Kangra local during 1987-88 (% dry weight basis)

Date of plucking	Phosphorus		Potassium		Calcium		Magnesium	
	'87	'88	'87	'88	'87	'88	'87	'88
13/4	0.41	—	2.77	—	0.29	—	0.12	—
28/4	0.40	0.44	3.03	2.87	0.37	0.37	0.15	0.14
13/5	0.40	0.37	2.93	3.05	0.40	0.40	0.14	0.17
27/5	0.41	0.34	2.92	2.89	0.26	0.28	0.15	0.18
10/6	0.41	0.31	3.03	3.07	0.35	0.36	0.17	0.17
28/6	0.40	0.36	3.08	3.21	0.53	0.31	0.18	0.14
11/7	0.38	0.44	3.20	3.17	0.47	0.47	0.18	0.13
28/7	0.38	0.38	3.34	3.41	0.38	0.39	0.17	0.13
9/8	0.39	0.37	3.33	3.34	0.37	0.33	0.18	0.15
27/8	0.42	0.37	3.33	3.33	0.24	0.40	0.16	0.15
12/9	0.37	0.33	3.38	3.36	0.34	0.24	0.17	0.15
30/9	0.36	0.30	3.29	3.22	0.53	0.52	0.21	0.18
17/10	0.38	0.32	3.27	3.19	0.53	0.54	0.20	0.20
28/10	0.33	—	3.18	—	0.52	—	0.20	—
CD at 0.05%	NS	0.04	0.14	0.14	0.07	0.05	0.01	0.02

TABLE 2 – Micro nutrient contents ( $\mu\text{g g}^{-1}$ ) in green tea shoots of Kangra local during 1987-88 (dry weight basis)

Date of plucking	Copper		Manganese		Zinc		Iron		Sodium	
	'87	'88	'87	'88	'87	'88	'87	'88	'87	'88
13/4	12.66	—	623.00	—	38.66	—	330.00	—	123.00	—
28/4	11.66	13.33	862.00	877.00	37.66	34.00	443.00	179.00	150.00	95.33
13/5	9.00	14.66	824.33	1015.66	30.66	36.66	286.66	159.00	109.33	116.00
27/5	11.00	12.33	868.00	876.66	33.33	27.66	258.00	177.00	133.00	140.00
10/6	10.33	13.33	868.66	1071.33	33.66	28.33	250.66	182.33	123.00	116.00
28/6	16.00	16.66	1145.66	635.66	32.66	22.66	163.33	170.33	152.33	137.66
11/7	10.66	16.00	856.66	477.00	33.33	28.66	120.66	159.00	129.66	115.33
28/7	11.66	13.00	678.66	482.66	36.00	24.33	339.00	176.00	156.66	129.33
9/8	12.00	16.00	839.00	710.00	39.00	22.66	287.33	175.00	109.00	88.66
27/8	11.66	12.66	640.00	623.66	39.33	26.33	149.66	105.66	95.33	95.33
12/9	11.33	13.33	708.33	673.00	37.00	26.00	195.66	110.33	109.33	116.00
30/9	15.33	15.33	1057.00	743.00	32.00	19.00	126.33	92.66	123.00	109.00
17/10	14.66	13.33	893.33	998.00	33.00	29.33	230.66	121.66	150.33	142.00
28/10	15.00	—	995.33	—	36.66	—	109.33	—	164.00	—
CD at 0.05%	1.32	1.97	70.75	97.72	3.94	3.59	130.64	42.43	24.52	35.40

## **Phosphorus**

The phosphorus content in the green tea shoots ranged between 0.30 to 0.44 per cent. The variations were not significant during 1987, but significant differences were recorded in 1988. Overall the total phosphorus content was within the optimum range. However, it was higher at the beginning and minimum at the end of the plucking season. Such a trend could be due to phosphate fertilizer application in the month of February - March which increased the amount in the foliage to luxury consumption. Seasons did not seem to affect phosphorus uptake by the tea bush.

## **Potassium**

The potassium content in Kangra local tea leaf varied between 2.77 and 3.41 per cent. This level was high compared to the levels reported in various other teas (Portsmouth, 1953). The lowest potassium level of 2.77 and 2.87 per cent was recorded in April 1987 and 1988, respectively. Its concentration in the green leaf increased gradually with the onset of the monsoon and reached a maximum level after which it declined gradually reaching intermediate values towards the end of the plucking season. These findings are contrary to that observed by Wood *et al.* (1964), who reported a decreasing trend of potassium in green shoots with the onset of the monsoon. The differences observed in the present studies were significant. Since potash manuring increases potassium content in the soils, it is reasonable to believe that during the monsoon water would have facilitated potassium ion uptake by the tea bush.

## **Calcium**

Calcium ranged from 0.24 to 0.54 per cent thus showing deficiency levels (Anon, 1954). The differences were significant with a maximum calcium content of 0.53 and 0.54 per cent towards the end of the sampling period. The level of calcium concentration was erratic throughout the sampling period. The lower values of calcium in the leaf of Kangra local may be attributed to the non-calcareous soils of this region (Duggal, 1966). Depletion of calcium from the soil may be partly due to leaching of this nutrient associated with high rainfall in this region and partly due to soil erosion. Moreover, factors enhancing potassium uptake may depress calcium absorption (Boynton and Oberly, 1966).

## **Magnesium**

Like calcium the magnesium content in the green leaf of Kangra local was low (0.12 and 0.14 per cent) in the beginning and increased significantly (0.20-0.21 per cent) at the end of the plucking season. Similar seasonal variations of magnesium in plum leaf of Himachal Pradesh have been reported by Badyal and Kar (1985). Lekhova (1977) attributed such trends to the environmental factors associated with the plant. A magnesium level below 0.20 per cent has been associated with its deficiency in green tea leaf (Chenery and Schoenmaekers, 1959). Although most of the values recorded in the present studies (Table 1) were below this limit, no foliar magnesium deficiency symptoms, i.e., chlorotic interveinous areas with main veins remaining green (Pethiyagoda and Krishnapillai, 1970), could be observed in the tea bushes growing in this region.

## Copper

The level of copper estimated in the Kangra local tea leaves was found to vary between 9 and 16.66  $\mu\text{g g}^{-1}$ . It varied significantly throughout the plucking season. At the beginning of the plucking season the copper content was significantly low. With the onset of the monsoon its level suddenly increased for a very short period. Variations during the rainy season were comparatively less predominant; a significant increase was again recorded towards the end of the plucking season. Different copper concentrations in teas of various regions have been reported (Child, 1955; Ramaswamy, 1960). A comparison of these with the present values indicated that copper content in Kangra local tea is low.

## Manganese

The manganese content varied between 477 and 1145.66  $\mu\text{g g}^{-1}$  in the Kangra local tea leaves (Table 2). The highest concentration was recorded in the dry season, i.e. 28.6.87 and 13.5.88, 10.6.88 and 17.10.88. The manganese content was significantly low during the wet season. A depressing effect of manganese concentration in tea leaves with rainfall and low temperature have been reported by Hasselo (1965). A significant increase in the manganese content in the post-monsoon flush towards the end of the plucking season lent further support to these observations. High manganese content, 1900 ppm in ordinary flush of Kenya tea (Eden, 1976) and 9000 ppm in mature Malawi tea leaves (Chenery, 1955) indicated that the manganese level in Kangra local tea leaves may be low. This could be due to the non-availability of exchangeable manganese in soils of this region as the major portion of manganese in soils of Himachal Pradesh has been reported to exist in the form of stable metal-organic complexes (Takkar and Bhumbra, 1968).

## Zinc

Zinc content in Kangra local tea leaves varied between 19 and 39.33  $\mu\text{g g}^{-1}$ . The minimum concentration of zinc in tea leaf below which growth is likely to be affected was found to be 17 ppm (Barpujari and Dey, 1982). Hence, it can be concluded that zinc level in Kangra local tea leaves is not deficient.

## Iron

The iron content of the Kangra local tea leaves was found to be very high and showed interesting variations throughout the plucking season. While its concentration was as high as 443  $\mu\text{g g}^{-1}$  in the flush obtained on 28.4.87, maximum level of 182.33  $\mu\text{g g}^{-1}$  was recorded on 10.6.88. This is probably due to variation in soil temperature, moisture and rainfall which affect the availability of iron influencing redox potential, hydration and dehydration of iron compounds. In both the years significantly high concentrations of iron were noticed throughout the plucking season. Seasons did not seem to affect iron concentration in the tea leaves of Kangra local. It is interesting to note that the fluctuating trend exhibited by iron content was opposite to that of manganese. Similar correlations between iron and manganese content in tea leaves has been reported by Hasselo (1965) who attributed it to temperature and rainfall. The present results are in conformity with the earlier observations made by Eden (1976) who holds manganese responsible for variable and remarkably low iron content in tea leaves.

## Sodium

The highest values of 164 and 142  $\mu\text{g g}^{-1}$ , for sodium concentration in the tea leaves were recorded in the flush plucked on 28.10.87 and 17.10.88, respectively. Sodium content decreased significantly in the middle of the rainy season, i.e. August during both the years; after which it showed significant increase towards the end of the plucking season. Low levels of sodium in the rainy season could be due to heavy rainfall causing depletion of sodium.

The present investigations indicate that the levels of calcium, magnesium, copper and manganese in the tea leaves of Kangra local are lower than desired for the tea crop. Although no visual symptoms of deficiency were noticed in the foliage, the deficiency levels of the various nutrients should be adequately met with in the tea growing regions of Himachal Pradesh if yields are to be increased.

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