NPK FERTILIZER ON YIELD OF TEA (CAMELLIA SINENSIS L O KUNTZ) IN NORTH-EAST INDIA.

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ABSTRACT

An experiment was conducted to study the effect of various dosage of fertilizer on yield of mature tea and to determine the nutrient concentrations in tea soils and leaves under different dosage. The standard clone TV-1 was taken into consideration in three different agro-climatic zones of Assam. Total eight treatments were imposed in the trial along with normal fertilizer dose. Although T6 (50% excess of normal dose ie. 195 kg Nitrogen, 60 kg phosphate and 195 kg Potassium per hectare per year) give maximum yield, it is evident from plant nutrient analysis values that the above & higher dose of nutrient application tends to create micronutrient imbalance. Therefore it has been inferred that T5 (25 % excess of normal dose ie. 162.5 kg Nitrogen, 50 kg Phosphate and 162.5 kg Potash per Ha per year) has emerged as best treatment without adversely affecting the nutrient status of the soil. It was observed that soil N, P and K are positively correlated with leaf N, P and K respectively and also the yield of green leaf.

Key Words: Assam, Fertilizer dose, Major Nutrient, Minor Nutrient, Soil and leaf Nutrient status, Tea (Camellia sinensis).

INTRODUCTION

Tea (*Camellia sinensis* L. (O.) Kuntz) is a woody perennial plant whose nutrient uptake is influenced to a great extent by the environmental factors and management practices. The plant tea is very unique in the sense that its tender shoots with a bud and two leaves are periodically harvested. Moreover, in NorthEast, apart from 30-32 rounds of plucking, the tea bushes undergo regular annual pruning of various magnitudes. These practices result in removal of large amount of nutrients from the soil every year. Judicious application of fertilizers, thus, helps in maintaining a sustained and increased production of tea over a longer period.

Plucking and pruning assume the most vital operations in tea plantation. Pruning is essential to maintain the bush at an operable height and also to stimulate the vigour. Tubbs (1937) felt that pruning is, at best, a necessary evil, and should be judiciously substituted by milder forms for a severe one, whenever possible, while Tanton (1979) opined that pruning reduction in size of stems is not likely to be advantageous. Barua (1981) advocated a reduction in the frame and wood to minimise the respiratory losses and to enhance the harvest index.

Removal of young, growing shoots comprising the apical bud, the internodes and the two or three leaves immediately below it, which constitute the crop in tea, is called plucking. Tender shoots with growing tips (sinks) and young foliage, which would in normal course have contributed to food reserves (source) are perpetually harvested at short, regular intervals,

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stimulating a rapid succession of new crop of shoots. The important objective of an efficient system of plucking should be to harvest the maximum possible crop, leaving a minimum period of rest to the buds, while simultaneously ensuring the health of the bush by retaining adequate maintenance foliage on the bush to meet the carbohydrate requirements of buds in active phase (Sharma, 1983).

Tea is well known as fertilizer dependent crop and its response to N, P and K has been well-documented (Sen, 1967; Dey, 1971; Rahman, 1977). With the introduction of high yielding clones and improved agronomic practices, the importance of increasing the dosage of these nutrients in order to sustain a high productivity has been acutely felt. There are reports of variable responses to fertilizer application from different tea growing regions of the world (Jain, 1988).

The present investigation therefore, was taken up with the following objectives:

- To find out the effect of various graded doses of NPK on yield.
- To find out the effect of various graded doses of NPK on soil and leaf nutrient status.
- To establish the relationship between the yield, soil nutrient levels and leaf nutrient content under different agro-climatic conditions.

MATERIALS AND METHODS

The investigation was carried out as multilocational trial under three different agro-climatic tea zones of Assam in three estates of Tata Tea Limited during January1996 to December 1999. The three experimental sites were Teok T.E., Nahortoli T.E. and Diffloo T.E.

Samples of soil and leaf were collected from the respective experimental sites at various points of time over a span of one pruning cycle of three years duration, which were analysed in the laboratory for detection of levels of various nutrient elements (Shimadzu 6401F AAS, CE Instruments NC 2500 Elemental Analyser). Sample analyses were undertaken at the University College of Agriculture, Kolkata and the Research and Development Center, Tata Tea Limted. A single standard clone TV-1 was chosen for the above programme.

The experiment consisted of the following treatments, all laid out in a Completely Randomised Block Design. Each of the treatments was replicated thrice, consisting of 100 bushes each.

1. **T1:** Normal Fertilizer dose (NPK @ 130, 40, 130 kg/ha respectively)
2. **T2:** 25% deficient of normal fertilizer dose (NPK @ 97.5, 30, 97.5 kg/ha respectively)
3. **T3:** 50% deficient of normal fertilizer dose (NPK @ 65, 20, 65 kg/ha respectively)
4. **T4:** 75% deficient of normal fertilizer dose (NPK @ 32.5, 10, 32.5 kg/ha respectively)
5. **T5:** 25% excess of normal fertilizer dose (NPK @ 162.5, 50, 162.5 kg/ha respectively)
6. **T6:** 50% excess of normal fertilizer dose (NPK @ 195, 60, 195 kg/ha respectively)
7. **T7:** 75% excess of normal fertilizer dose (NPK @ 227.5, 70, 227.5 kg/ha respectively)
8. **T8:** Special Schedule (NPK @ 200, 80, 200 kg/ha respectively. Based on cyclic yield Tea plant response to a maximum of 200 kg N)

The fertilizer was applied in 3 splits each year in the ratio of 40:30:30 at appropriate soil moisture by broadcasting them in respective plots. Nitrogen

was applied in the form of urea, P_2O_5 as single superphosphate and K_2O as muriate of potash. The above experiment was laid out in plantations under three different agro-climatic conditions. Soil and two and a bud leaf samples were collected at various points of time throughout the pruning cycle. The levels of N, P, K, Ca, Mg, S, Mn and Zn were estimated. The pretreatment cyclic yield of the experimental sections of Teok, Diffloo & Nahortoli TEs were 2520, 2392 & 1972 kg/Ha respectively. The crop records were also maintained. Efforts were thus made to establish a relationship between the soil nutrient content, leaf nutrient level and the green leaf yield with the various fertilizer doses applied, and to arrive at some conclusion regarding the optimum level of NPK requirement for an economic yield and to study internutrient relationship.

Soil and plant samples were analysed following standard procedures with sufficient control and were repeated whenever necessary. Soil samples were drawn from a depth of 0-30 cm as top-soil and also from 30-60 cm as sub-soil, generally a month after the 1st dose of fertilizer application (April) and continued at regular intervals till December. The first two leaves and a bud were collected as plant samples. Soil (available) and twig contents were determined using standard methods of analysis (Bray and Kurtz, 1945; Chapman & Pratt, 1961; Black, 1965; Jackson, 1973; Lindsay & Norvel, 1978; Barua and Ghosh, 1993).

All analyses were done in triplicate and simultaneously to reduce experimental errors to a minimum.

RESULTS & DISCUSSION

I. Leaf Yield:

NPK fertilizer application brought about significant increase in green leaf yield at all tea plantations where the trials were carried out. At Teok, the treatment T6 (50% excess of normal fertilizer dose) recorded the highest cyclic yield of 2922 kg/Ha. (Table 1).

Table 1. Effect of graded doses of NPK fertilizer on yield of mature tea, at Teok T.E

Treatment No.	Treatments	Cyclic Yield (Kg/Ha)
T1	Normal Fertilizer (130:40:130)	2537
T2	25% Less (97.5:30:97.5)	2230
T3	50% Less (65:20:65)	1845
T4	75% Less (32.5:10:32.5)	1768
T5	25% Excess (162.5:50:162.5)	2614
T6	50% Excess (195:60:195)	2922
T7	75% Excess (227.5:70:227.5)	2653
T8	Special Schedule (200:80:200)	2653

At Diffloo, T5 (25% excess) recorded the highest cyclic yield of 2547 kg/Ha followed by T6 (50% excess). The difference between T5 and T6 was small and statistically insignificant (Table 2). At Nahortoli also, the highest yield of green leaf was recorded in T6 at 2104 kg/Ha (Table 3).

Table 2. Effect of graded doses of NPK fertilizer on yield of mature tea, at Diffloo T.E.

Treatment No.	Treatments	Cyclic Yield (Kg/Ha)
T1	Normal Fertilizer (130:40:130)	2434
T2	25% Less (97.5:30:97.5)	2344
T3	50% Less (65:20:65)	2299
T4	75% Less (32.5:10:32.5)	2028
T5	25% Excess (162.5:50:162.5)	2547
T6	50% Excess (195:60:195)	2524
T7	75% Excess (227.5:70:227.5)	2434
T8	Special Schedule (200:80:200)	2434

From cyclic yield point of view, T6 appeared to be the best treatment for Teok and Nahortoli while for Diffloo, T5 proved to be the best .

Table 3. Effect of graded doses of NPK fertilizer on yield of mature tea, at Nahortoli T.E.

Treatment No.	Treatments	Cyclic Yield (Kg/Ha)
T1	Normal Fertilizer (130:40:130)	1985
T2	25% Less (97.5:30:97.5)	1839
T3	50% Less (65:20:65)	1751
T4	75% Less (32.5:10:32.5)	1664
T5	25% Excess (162.5:50:162.5)	1955
T6	50% Excess (195:60:195)	2104
T7	75% Excess (227.5:70:227.5)	2043
T8	Special Schedule (200:80:200)	2014

II. Soil & Leaf Analysis:

Major Nutrients: Data is presented in Tables 4,5,6 The study of changes in soil nutrient status revealed that in almost all the sampling occasions and sites, the soil N level in both top and sub-soil layers tended to increase with increasing application of NPK. The available P content of the soil also follows a near similar trend up to T6, but showed a declining trend when the fertilizer application exceeded 50% of normal fertilizer dose. The same trend has been observed for K. Leaf analysis also reveals the similar trend (Table 4, 5 & 6).

Table 4. Major nutrient status of the soil & leaf under different graded doses of NPK fertilizers at Teok TE

Treatments	N		P_2O_5		K_2O	
	Soil (%)	Leaf (%)	Soil (ppm)	Leaf (%)	Soil (ppm)	Leaf (%)
Normal Dose	0.108	3.87	6.56	0.362	111.48	2.146
25% Less	0.102	3.69	5.46	0.344	101.36	2.038
50% Less	0.089	3.61	4.55	0.333	89.93	1.876
75% Less	0.080	3.43	3.55	0.316	74.55	1.741
25% Excess	0.110	3.99	7.87	0.365	118.45	2.134
50% Excess	0.119	4.23	9.6	0.384	130.98	2.275
75% Excess	0.128	4.25	8.18	0.361	118.81	2.151
Special Schedule	0.200	4.43	9.45	0.364	116.90	2.111
LSD 5%	**0.019**	**0.427**	**0.75**	-	**34.92**	-
LSD 1%	**0.027**	**0.584**	**1.08**	-	-	-

Table 5. Major nutrient status of the soil & leaf under different graded doses of NPK fertilizers at Diffloo TE.

Treatments	N		P_2O_5		K_2O	
	Soil (%)	Leaf (%)	Soil (ppm)	Leaf (%)	Soil (ppm)	Leaf (%)
Normal Dose	0.104	4.33	12.31	1.997	117.64	0.336
25% Less	0.097	4.12	10.12	1.948	102.22	0.319
50% Less	0.087	3.86	8.61	1.868	90.09	0.307
75% Less	0.072	3.64	6.07	1.738	72.48	0.283
25% Excess	0.110	4.38	13.77	2.037	130.65	0.337
50% Excess	0.121	4.56	16.69	2.137	132.86	0.361
75% Excess	0.129	4.64	17.06	2.008	126.23	0.336
Special Schedule	0.144	4.74	21.74	2.010	138.07	0.346
LSD 5%	**0.001**	**0.775**	**7.75**	-	**35.41**	**0.0011**
LSD 1%	-	**1.061**	**10.62**	-	**48.48**	**0.0015**

Table 6. Major nutrient status of the soil & leaf under different graded doses of NPK fertilizers at Nahortoli TE

Treatments	N		P_2O_5		K_2O	
	Soil (%)	Leaf (%)	Soil (ppm)	Leaf (%)	Soil (ppm)	Leaf (%)
Normal Dose	0.108	4.26	13.38	1.967	131.91	0.507
25% Less	0.170	4.05	9.90	1.885	123.22	0.363
50% Less	0.135	3.94	7.66	1.843	103.28	0.352
75% Less	0.103	3.70	6.17	1.689	86.06	0.327
25% Excess	0.155	4.29	14.79	2.024	151.33	0.399
50% Excess	0.167	4.47	18.88	2.073	165.75	0.431
75% Excess	0.125	4.52	15.94	2.004	152.40	0.403
Special Schedule	0.188	4.63	23.05	2.015	169.98	0.422
LSD 5%	**0.162**	**0.318**	**5.69**	**0.032**	**22.34**	-
LSD 1%	**0.223**	**1.378**	**7.79**	**0.340**	**30.60**	-

Minor Nutrients: Data is presented in Tables 7,8,9 show that in general, soil S tends to decline with increasing application of NPK at all locations. Though no specific and clear cut trend was noticed in the fluctuations of available (Diethylene Triamine Penta Acetic Acid – DTPA extractable) soil Ca, in general, the treatments supplying higher doses of NPK recorded lower soil values as compared to the treatments supplying lower NPK dose. The available (DTPA extractable) soil Mg also tended to decline with heavy doses of NPK application. The available (DTPA extractable) soil Mn was found to follow a reverse trend to increase with increasing

dose of NPK fertilizer application. The available soil Zinc, on the other hand, showed no systematic trend or fluctuation in response to fertilizer application. The chemical analysis of 'two leaf and a bud' showed a more or less similar trend of changes in micronutrient contents (Table 7, 8, 9).

Table 7. Minor nutrient status of the soil & leaf under different graded doses of NPK fertilizers at Teok TE.

Treatments	S (ppm)		Ca (ppm)		Mg (ppm)		Mn (ppm)		Zn (ppm)	
	Soil	Leaf	Soil	Leaf	Soil	Leaf	Soil	Leaf	Soil	Leaf
Normal Dose	15.00	0.238	390.28	0.269	66.94	1310	35.68	438.8	3.81	21.40
25% Less	15.84	0.264	360.88	0.303	69.76	1312	38.50	403.4	3.75	25.98
50% Less	15.00	0.225	369.76	0.330	87.11	1424	23.57	386.1	3.44	28.60
75% Less	14.65	0.224	484.64	0.273	80.11	1312	21.18	391.7	3.40	30.95
25% Excess	15.70	0.228	373.57	0.302	59.70	1361	35.05	451.1	3.55	27.76
50% Excess	14.23	0.208	356.58	0.289	53.07	1319	49.00	452.1	3.81	25.95
75% Excess	14.29	0.208	393.07	0.260	46.11	1235	58.98	524.4	3.50	22.45
Special Schedule	13.25	0.201	312.07	0.263	57.11	1288	51.37	522.8	3.20	24.46
LSD 5%	**1.07**	-	**102.99**	-	**14.70**	-	**19.88**	-	**0.50**	-
LSD 1%	**1.54**	-	-	-	**20.15**	-	**27.23**	-	**0.73**	-

Table 8. Minor nutrient status of the soil & leaf under different graded doses of NPK fertilizers at Diffloo TE

Treatments	S (ppm)		Ca (ppm)		Mg (ppm)		Mn (ppm)		Zn (ppm)	
	Soil	Leaf	Soil	Leaf	Soil	Leaf	Soil	Leaf	Soil	Leaf
Normal Dose	17.76	0.230	367.24	0.352	52.12	1209	36.67	250.4	3.10	49.23
25% Less	17.30	0.226	363.69	0.111	50.10	1229	31.72	255.7	3.27	40.20
50% Less	18.57	0.282	364.30	0.080	57.54	1218	35.86	260.4	3.32	37.45
75% Less	18.40	0.228	353.33	0.127	60.10	1190	27.09	277.8	3.13	43.59
25% Excess	18.53	0.219	360.56	0.091	47.75	1180	35.68	257.5	3.44	50.52
50% Excess	15.76	0.213	366.76	0.085	52.20	1098	29.69	268.7	3.29	41.50
75% Excess	16.84	0.212	376.01	0.125	52.80	1159	29.83	263.7	2.51	49.72
Special Schedule	15.10	0.204	340.61	0.130	47.05	1166	28.01	243.9	2.57	37.60
LSD 5%	**1.62**	-	**76.45**	-	**20.28**	-	**8.42**	-	**0.13**	-
LSD 1%	**2.32**	-	**109.84**	-	**29.14**	-	**12.09**	-	**0.19**	-

Table 9. Minor nutrient status of the soil & leaf under different graded doses of NPK fertilizers at Nahortoli TE

Treatments	S (ppm)		Ca (ppm)		Mg (ppm)		Mn (ppm)		Zn (ppm)	
	Soil	Leaf	Soil	Leaf	Soil	Leaf	Soil	Leaf	Soil	Leaf
Normal Dose	20.16	0.254	337.23	0.375	82.38	1216	84.15	728.9	4.31	35.83
25% Less	19.08	0.257	407.37	0.415	78.20	1167	59.86	635.2	3.33	33.02
50% Less	17.60	0.266	323.70	0.421	82.37	1268	75.18	467.2	3.83	37.42
75% Less	18.64	0.262	395.00	0.472	92.17	1265	77.61	365.6	2.50	39.66
25% Excess	18.90	0.252	374.83	0.389	85.70	1144	88.32	632.2	3.95	31.38
50% Excess	18.47	0.237	403.35	0.439	70.49	1190	94.48	711.3	4.26	37.97
75% Excess	17.33	0.229	306.58	0.385	73.24	1212	90.39	602.2	3.42	31.76
Special Schedule	19.76	0.220	346.79	0.130	74.07	1210	83.92	726.9	3.37	34.76
LSD 5%	**0.80**	-	**17.78**	-	**8.51**	-	**7.17**	-	-	-
LSD 1%	-	-	**25.56**	-	**12.22**	-	**10.30**	-	-	-

Leaf N content increased steadily with increasing NPK application showing the peak values with 75% excess of NIPD fertilizer dose, indicating possible luxury consumption. Leaf P and K, however, showed declining trend beyond 50% excess of normal fertilizer dose. Although T6 (50% excess of normal dose i.e. 195 N: 60P: 195K) appeared to give maximum yield, higher dose of NPK application result in micronutrient deficiency as evident from leaf nutrient status. Thus, the treatment T5 i.e. 162.5 N : 50P : 162.5K emerged as a better treatment, giving good yield of crop without adversely affecting the nutrient status of the soil (Figures 1,2,3).The correlation studies have established that both soil & leaf N, P, K is positively correlated with each other and also with the yield of green leaf. (P=0.05).

Fig. 1. Regression line between soil N & leaf N

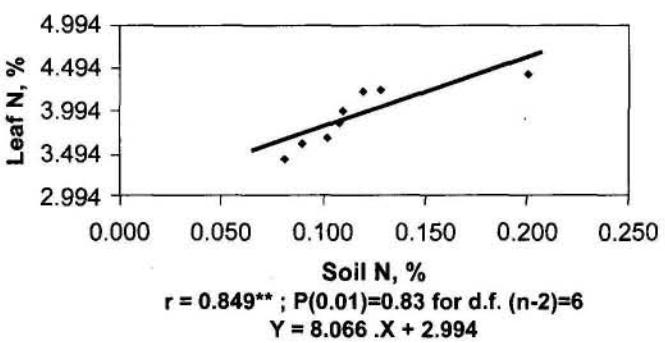


Fig. 2. Regression line between soil P & leaf P

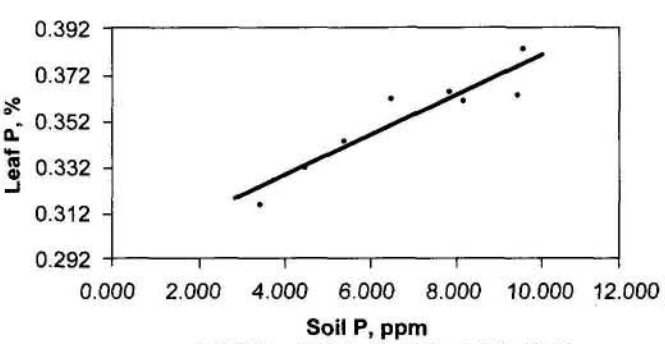
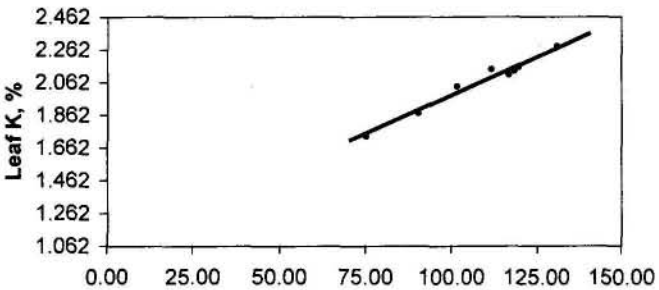


Fig.3. Regression line between soil K & leaf K



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Impact of Science on the Economy of Tea Industry

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