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RESEARCH PAPER

LEAF NUTRIENT STATUS OF OIL PALM PLANTATIONS IN ANDHRA PRADESH

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ABSTRACT

A survey was conducted in Nellore, Krishna, East and West Godavari districts of Andhra Pradesh to ascertain the leaf nutrient status in 1086 mature oil palm plantations. Leaf nitrogen, phosphorus, potassium and magnesium contents were analyzed by standard methods. Leaf number 17 was selected for the sampling. Majority of the plantations had optimum leaf nitrogen content except in Krishna, where 87.5 % of the plantations were deficient in Nitrogen. The leaf Phosphorus content was deficient in all the plantations surveyed. About 54.6 % plantations in West Godavari possessed optimum leaf P content. Regarding Potassium content, 50% of the plantations in West Godavari and Krishna possessed optimum levels. Majority of the plantations in East Godavari and Nellore recorded deficient leaf K levels. Surprisingly, about 42.7% of the plantations of West Godavari had excess leaf Potassium contents. Leaf Magnesium levels were optimum in majority of the plantations in West Godavari and Krishna districts but it was excess in East Godavari and Nellore plantations. The deviation in the results of leaf nutrient content from the general trend may be attributed to the variation in management practices and soil nutrient status.

Keywords: Oil Palm, leaf nutrient status, Andhra Pradesh

INTRODUCTION

The Technology Mission on Oilseeds and Pulses (T.M.O. & P) has taken up a massive oil palm development programme to cover an area of 80,000 ha in the states of Andhra Pradesh, Karnataka, Tamil Nadu and other states like Gujarat, Orissa, Assam and Tripura under irrigated conditions. Among these states, Andhra Pradesh leads in terms of area and production. The districts of Krishna, East and West Godavari in Andhra Pradesh represent the bulk of the oil palm cultivated area. In Oil Palm cultivation, fertilizer is a costly input, which accounts for greater part of production costs. A large amount of nutrients are removed by the fruit bunches harvested from the mature palms. Nearly 75 kg of N, 11 kg of P and 93 kg of K are present in 25 tonnes of fruit bunches (Ng and Thamboo, 1967). Economic yields of oil palm are achieved when the supply of nutrients from the soil, palm residues and fertilizers are properly integrated in required quantities by the farmers. Leaf analysis is an analytical tool for detecting the nutrient requirements in oil palm and other perennial crops, which are slow growing and can provide easily defined standard leaf material for analysis due to leaf phyllotaxis. Nutrient deficiency symptoms are also an important means for determining the nutritional problems in oil palm since the crop presents easily identifiable N, K and Mg deficiency symptoms (Fairhurst, 1997). However, by the time symptoms are evident, nutrient deficiency might have already affected growth and yield. Also the nutrient supply may be insufficient even before the appearance of leaf symptoms. This paper mainly deals with the leaf nutrient status of low and high yielding mature oil palm plantations in Nellore, Krishna, East and West Godavari districts of Andhra Pradesh.

MATERIALS AND METHODS

A total of 1086 composite leaf samples were collected from the farmers fields in Krishna (112), East Godavari (380), West Godavari (515) and Nellore (79) districts of Andhra Pradesh during the months of April and May 2000. The age of plantations ranged from 5 to 10 years. Plantations with a yield of less than 15 tonnes/ha/year were considered as low yielding and above 15 tonnes/ha/year as high yielding. Leaf number 17 was selected for sampling. The leaflets from the central portion of the leaf were used in the analysis. The middle portions of the leaflets were separated, cleaned and midribs were removed. The strips of laminae were chopped into smaller pieces and oven dried at 75^{0}C for 6h. The samples were later ground and used for the estimation of nutrients. Nitrogen was

estimated by micro-kjeldhal method (Bremmer, 1965) using kjel plus unit (Distil-M, Pelican Instruments). Phosphorus was estimated by vanado-molybdate acid yellow color method (Jackson, 1973) using U-V Spectrophotometer (Hitachi U-2001). Potassium was determined by using Flame Photometer (Elico-CL22D). Magnesium was estimated by using Atomic Absorption Spectrophotometer (GBC 932 AA).

RESULTS

The results of the leaf analysis data of the 1086 samples have revealed that the majority of the plantations had optimum leaf nitrogen content except Krishna, where 87.5 % of the plantations were deficient in Nitrogen (Table.1). The leaf Phosphorus content was deficient in all the plantations surveyed. About 54.6 % plantations in West Godavari possessed optimum leaf P content. Regarding Potassium content, 50% of the plantations in West Godavari and Krishna possessed optimum levels. Majority of the plantations in East Godavari and Nellore recorded deficient leaf K levels. Surprisingly, there were about 42.7% of the plantations of West Godavari, which had excess leaf Potassium contents. Leaf Magnesium levels were optimum in majority of the plantations in West Godavari and Krishna districts but it was excessive in East Godavari and Nellore plantations.

Ten-year-old plantations

The nitrogen content in the low yielding gardens of West Godavari ranged from 2.10 to 2.70 % and that of high yielding from 1.30 to 2.90 % (Tab.2 ; Fig.1). In Krishna, the values ranged between 1.08-2.28 % and 1.30-2.28 % in the low and high yielding gardens respectively. The leaf

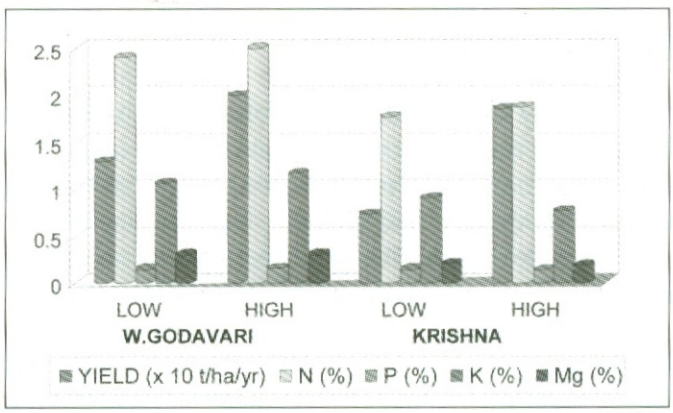

Fig.1: Ten - year - old plantations

Table 1: Status of leaf nutrient levels of plantations in Nellore, Krishna, East and West Godavari districts expressed in percentage

District	N	Nitrogen			Phosphorus			Potassium			Magnesium		
		D	O	E	D	O	E	D	O	E	D	O	E
Krishna	112	87.5	12.5	0	77.7	21.4	0.9	34.8	53.61	11.6	47.3	50.9	1.8
W.Godavari	515	30.7	53.4	15.9	36.9	54.6	8.5	2.35	54.95	42.7	10.5	57.7	31.8
E.Godavari	380	35.2	58.3	6.5	81.8	16.1	2.1	60.7	29.5	9.8	2.6	19.3	78.1
Nellore	79	32.9	65.8	1.3	55.7	32.9	11.4	73.4	26.6	0	0	16.5	83.5

N = Number of plantations analyzed, D = Deficient, O = Optimum, E = Excess

Table 2: Leaf nutrient status of ten - year - old high and low yielding mature oil palm plantations in Krishna, East and West Godavari Districts of Andhra Pradesh

District	Status	Mean Yield (t/ha/yr)	S.D	Mean N (%)	S.D	Mean P (%)	S.D	Mean K (%)	S.D	Mean Mg (%)	S.D
W.G	Low	13.00	2.20	2.40	0.20	0.14	0.01	1.06	0.20	0.30	0.10
Krishna	Low	7.37	5.94	1.77	0.50	0.14	0.02	0.91	0.23	0.20	0.06
E.G	Low	10.00	2.46	2.50	0.10	0.13	0.03	0.70	0.20	0.60	0.20
W.G	High	20.00	3.60	2.50	0.30	0.15	0.02	1.17	0.25	0.30	0.10
Krishna	High	18.60	2.69	1.88	0.36	0.13	0.01	0.76	0.16	0.18	0.04
E.G	High	20.80	1.34	2.44	0.13	0.13	0.03	0.77	0.35	0.64	0.30

nitrogen content ranged between 2.46-2.65 % in the low yielding gardens and 2.28-2.54 % in the high yielding gardens of East Godavari. The leaf phosphorus content in the low and high yielding gardens of West Godavari ranged between 0.12-0.16 % and 0.11-0.18 % respectively. In Krishna, it was 0.13-0.17 % in the low yielding gardens and 0.11-0.16 % in the high yielding gardens. In East Godavari, the low and high yielding gardens possessed 0.09 - 0.16 % and 0.10 - 0.25 % respectively. The potassium content was between 0.90-1.33 % and 0.72-1.84 % respectively in the low and high yielding gardens of West Godavari. In Krishna, the values were 0.60-1.30 % and 0.50-1.10 % in the low and high yielding gardens. The low and high yielding gardens of East Godavari possessed 0.50 - 1.30 % and 0.43-1.75 % K contents respectively. The magnesium content in the low yielding gardens of West Godavari, Krishna and East Godavari ranged between 0.24-0.42, 0.13-0.29 and 0.30-0.92 % respectively. Similarly it was 0.10-0.71 %, 0.11-0.27 % and 0.30-1.37 % respectively in the high yielding gardens of the above places.

The FFB yield in the low yielding gardens of West Godavari, Krishna and East Godavari ranged between 10-15, 1.0-14.8 and 8-12 t/ha/yr respectively. It was 16-34, 15.5-23.3 and 20-23 t/ha/yr in the high yielding gardens. The highest yield was recorded in West Godavari, followed by Krishna and East Godavari districts.

Seven-year-old plantations

Nitrogen content in the low yielding gardens of West Godavari ranged between 0.69-3.50 % and it was 0.90-3.00 % in the high yielding gardens (Tab.3 ; Fig.2). In Krishna and East Godavari, the values of low yielding gardens ranged between 1.08-2.16 % and 2.16-2.58 % respectively. It was between 2.08-2.39 and 2.30-2.66 % in the high yielding gardens in the above places. Phosphorus content in the low and high yielding gardens of West Godavari ranged between 0.12-0.20 % and 0.04-0.34 %. The low yielding gardens of Krishna and East Godavari had the same phosphorus range of 0.1-0.14 %, but the values ranged between 0.12-0.15 and 0.10-0.15 % in the high yielding gardens. The potassium content in the low yielding gardens of West Godavari, Krishna and East Godavari ranged between 0.79-1.68, 0.50-1.10 and 0.15-0.90 % respectively. Similarly it was 0.64-1.75, 0.8 - 1.3 and 0.40-1.05 % in the high yielding gardens. The low yielding gardens of West Godavari, Krishna and East Godavari had the magnesium content between 0.13-0.77, 0.14-0.24 and 0.23-0.77 %. The values ranged between 0.10-0.68, 0.19-0.26 and 0.42-0.72 % respectively in the high yielding gardens.

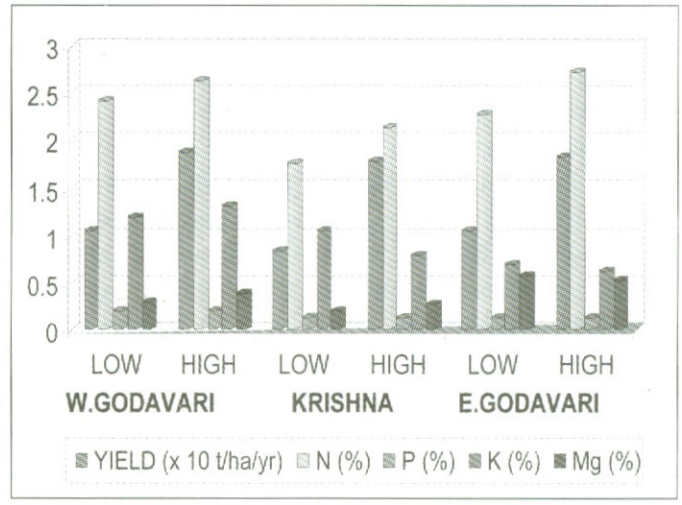

Fig.2 Seven - year - old plantations

In West Godavari, the yield ranged between 6.0-15.0 and 16.0-26.0 t/ha/yr in the low and high yielding gardens. Similarly, Krishna and East Godavari recorded yields ranging from 4.1-14.0 and 6.0-15.0 t/ha/yr in the low yielding gardens and 16.0-22.1 and 16.0-20.0 t/ha/yr in the high yielding gardens.

Table 3 : Leaf nutrient status of seven - year - old high and low yielding mature oil palm plantations in Krishna, East and West Godavari Districts of Andhra Pradesh

District	Status	Mean Yield (t/ha/yr)	S.D	Mean N (%)	S.D	Mean P (%)	S.D	Mean K (%)	S.D	Mean Mg (%)	S.D
W.G	Low	12.50	2.42	2.43	0.48	0.15	0.02	1.16	0.23	0.36	0.14
Krishna	Low	11.50	4.14	1.73	0.40	0.12	0.02	0.74	0.23	0.19	0.04
E.G	Low	9.42	2.38	2.39	0.14	0.12	0.01	0.63	0.18	0.51	0.14
W.G	High	19.40	2.82	2.42	0.38	0.15	0.03	1.15	0.23	0.34	0.13
Krishna	High	20.00	3.49	2.24	0.40	0.14	0.02	0.80	0	0.22	0.04
E.G	High	19.20	1.40	2.46	0.19	0.12	0.02	0.71	0.20	0.56	0.12

Six-year-old plantations

The nitrogen content in West Godavari ranged from 1.40-2.90 and 1.6-3.50 % in the low and high yielding gardens respectively (Tab.4 ; Fig.3). In Krishna and East Godavari, the contents ranged between 0.71-2.60 and 2.09-3.33 % in low yielding gardens and 0.99-2.37 and 2.03-2.80 % in the high yielding gardens. The phosphorus content in the low yielding gardens of West Godavari, Krishna and East Godavari ranged between 0.11-0.22, 0.12-0.16 and 0.10-0.20 % and it was 0.12-0.19, 0.12-0.14 and 0.10 - 0.20 % in the high yielding gardens. The potassium content ranged between 0.75-2.13, 0.50-1.20 and 0.35-1.90 % in the low yielding gardens of West Godavari, Krishna and East Godavari respectively. In the high yielding gardens, it was 0.74-1.72 % in West Godavari, 0.5 - 1.0 % in Krishna and 0.35 - 1.45 % in East Godavari. Magnesium content in the low yielding gardens of West Godavari ranged between 0.14-0.67 % and 0.16-0.65 % in the high yielding gardens. In Krishna and East Godavari, the contents ranged between 0.17-0.33 and 0.21-1.59 % in the low yielding gardens and 0.13-0.26 and 0.34-1.35 % in the high yielding gardens.

The yield in the low yielding gardens of West Godavari and Krishna ranged from 4.0-15.0 t/ha/yr and it was 5-15 t/ha/yr in East Godavari. In the high yielding gardens of West Godavari, Krishna, and East Godavari, it was 16.0-25.0, 15.4-23.4, 16.0-28.0 t/ha/yr respectively.

Five-year-old plantations

In the low yielding gardens of West Godavari, Krishna, and East Godavari nitrogen content ranged between 0.90-3.0, 1.01-2.31, 2.06-2.5 % respectively, whereas in the high yielding gardens the values are between 2.50-2.80, 1.83-2.60, 2.36-2.95 % respectively (Table 5 ; Fig.4). The phosphorus content in the low yielding gardens of West Godavari ranged between 0.12-0.34 % and in the high yielding gardens the content was between 0.16-0.18 % . In Krishna and East Godavari the values are between 0.13-0.17 and 0.10-0.19 % in the low yielding gardens and 0.12-0.16 and 0.11-0.14 % in the high yielding gardens respectively. In West Godavari, Krishna and East Godavari the potassium content in the low yielding gardens was between 0.59-1.88, 0.70-1.70 and 0.35-1.20 % respectively. In the high yielding gardens, the contents were 0.96-1.43, 0.50-1.0 and 0.43-0.85 %. The low yielding gardens of West Godavari, Krishna and East Godavari had the magnesium content between 0.17-0.63,0.12-0.34 and 0.09 - 0.99 %. The values ranged between 0.21-0.69, 0.15-0.51 and 0.42-0.75 % respectively in the high yielding gardens.

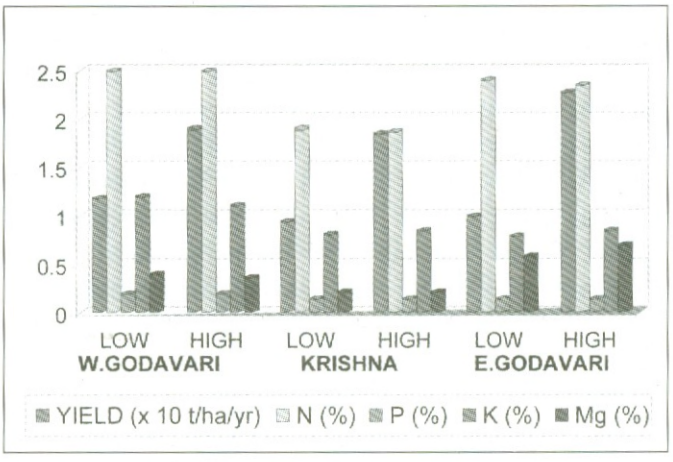

Fig.3: Six - year - old plantations

In West Godavari, the yield ranged between 3.0-15.0 and 17.0-21.0 t/ha/yr in the low and high yielding gardens respectively. Krishna and East Godavari recorded yields ranging from 4.0-14.6 and 2.0-15.0 t/ha/yr in the low yielding gardens and 15.0-24.9 and 17.0-20.0 t/ha/yr in the high yielding gardens.

Table 4: Leaf nutrient status of six - year - old high and low yielding mature oil palm plantations in Krishna, East and West Godavari Districts of Andhra Pradesh

District	Status	Mean Yield (t/ha/yr)	S.D	Mean N (%)	S.D	Mean P (%)	S.D	Mean K (%)	S.D	Mean Mg (%)	S.D
W.G	Low	11.70	2.74	2.50	0.25	0.15	0.02	1.21	0.25	0.39	0.13
Krishna	Low	9.5	3.07	1.89	0.52	0.13	0.01	0.80	0.16	0.21	0.04
E.G	Low	9.96	3.68	2.42	0.23	0.13	0.02	0.79	0.27	0.59	0.20
W.G	High	18.80	2.12	2.49	0.35	0.15	0.01	1.13	0.20	0.36	0.13
Krishna	High	18.4	3.09	1.87	0.39	0.13	0.01	0.84	0.16	0.21	0.04
E.G	High	22.70	4.46	2.35	0.17	0.13	0.04	0.85	0.32	0.69	0.32

Table 5: Leaf nutrient status of five - year - old high and low yielding mature oil palm plantations in Krishna, East and West Godavari Districts of Andhra Pradesh

District	Status	Mean Yield (t/ha/yr)	S.D	Mean N (%)	S.D	Mean P (%)	S.D	Mean K (%)	S.D	Mean Mg (%)	S.D
W.G	Low	10.60	3.00	2.41	0.39	0.16	0.03	1.16	0.23	0.35	0.12
Krishna	Low	8.30	4.85	1.75	0.43	0.14	0.01	1.04	0.35	0.21	0.06
E.G	Low	10.37	3.55	2.28	0.16	0.13	0.02	0.69	0.20	0.57	0.20
W.G	High	18.70	2.08	2.63	0.15	0.17	0.01	1.27	0.27	0.42	0.25
Krishna	High	17.80	3.28	2.13	0.22	0.14	0.01	0.80	0.14	0.28	0.10
E.G	High	18.20	1.47	2.72	0.31	0.12	0.01	0.63	0.16	0.53	0.12

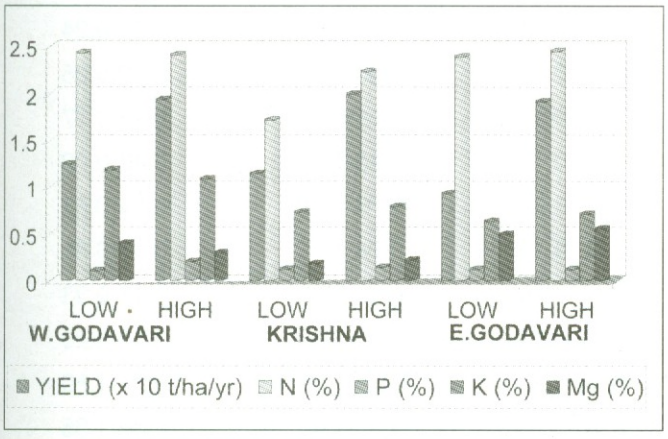

Fig.4: Five - year - old plantations

DISCUSSION

In the ten-year-old plantations, the lowest mean yield recorded was 7.37 t/ha/yr and highest was 20.80 t/ha/yr (Table 6). Higher mean nitrogen contents were recorded in the high yielding gardens than those of low yielding gardens except in East Godavari. With regard to P and Mg contents, there was no specific influence on the yield. Mean K levels were also more in the high yielding gardens compared to the low yielders. In seven-year-old plantations, 9.42 t/ha/yr was the lowest mean yield recorded and 20 t/ha/yr was the highest yield obtained. In general, mean nitrogen, potassium and magnesium contents were higher in the high yielders than those of low yielders except for West Godavari. Mean P was same in both the high and low yielders. The lowest and the highest mean yield recorded in six-year-old plantations were 9.5 and 22.7 t/ha/yr. The mean N was slightly low in high yielders than in low yielders. P content remained the same in both the low and high yielders. Mean K content was found to be high in the high yielders except in West Godavari. Mean Mg content did not show any trend with yield.

In the five-year-old gardens, 8.30 t/ha/yr was the lowest and 18.70 was the highest mean yield obtained. Higher N values were recorded in high yielders and low values in the low yielders. P content did not show any trend with yield. K content was slightly lower in high yielders except in West Godavari. Mg content was higher in high yielders than in low yielders except East Godavari. In general it was observed that high yields were obtained in gardens having high leaf N content. Piggot (1968) also observed that yield and leaf N content may increase with increased N application but response may be greater when K fertilizer is also applied. Though no particular trend between leaf P and yield was observed may be because of the synergism between N and P uptake, leaf P concentration must be assessed in relation to leaf N concentration (Ollagnier and Ochs, 1981). This is due to the constant ratio between N and P in protein compounds found in plant tissue. Leaf K was found to influence the yield, as higher K values were recorded in high yielding gardens than in low yielding gardens, which is in conformity with Ochs (1965). He has also observed that yield was often directly related to leaf K concentration, when leaf P is greater than the critical concentration of 0.15%.

The differences in the leaf nutrient levels between high and low yielding plantations were not significant. In most of the cases, the ranges of the nutrient levels of the high and low yielding plantations overlapped each other. Poor yields in plantations with low leaf nutrient levels may be attributed to poor nutrition, but plantations which have high leaf nutrient levels and poor yields may indicate poor management of some other critical input like water, etc. A similar phenomenon can be seen in the data reported by Udaya Kumar (1996), wherein large differences in yield were observed between high and low yielding plantations with small or no differences in leaf nutrient levels. Low nutrient

Table 6: Range of mean Leaf nutrient status of low and high yielding oil palm plantations in Krishna, East and West Godavari Districts of Andhra Pradesh

Age (Yrs)	District	Status	N (%)	P (%)	K (%)	Mg (%)
10	W.G	Low	2.10-2.70	0.12-0.16	0.90-1.33	0.24-0.42
	W.G	High	1.30-2.90	0.11-0.18	0.72-1.84	0.10-0.71
	Krishna	Low	1.08-2.28	0.13-0.17	0.60-1.30	0.13-0.29
	Krishna	High	1.30-2.28	0.11-0.16	0.50-1.10	0.11-0.27
	E.G	Low	2.46-2.65	0.09-0.16	0.53-1.30	0.30-0.92
	E.G	High	2.28-2.54	0.10-0.25	0.43-1.75	0.30-1.37
7	W.G	Low	0.69-3.50	0.12-0.20	0.79-1.68	0.13-0.77
	W.G	High	0.90-3.00	0.04-0.34	0.64-1.73	0.10-0.68
	Krishna	Low	1.08-2.16	0.10-0.14	0.50-1.10	0.14-0.24
	Krishna	High	2.08-2.39	0.12-0.15	0.80-1.30	0.19-0.26
	E.G	Low	2.16-2.58	0.10-0.14	0.15-0.90	0.23-0.77
	E.G	High	2.30-2.66	0.10-0.15	0.40-1.05	0.42-0.72
6	W.G	Low	1.40-2.90	0.11-0.22	0.75-2.13	0.14-0.67
	W.G	High	1.60-3.50	0.12-0.19	0.74-1.72	0.16-0.65
	Krishna	Low	0.71-2.60	0.12-0.16	0.50-1.20	0.17-0.33
	Krishna	High	0.99-2.37	0.12-0.14	0.50-1.00	0.13-0.26
	E.G	Low	2.09-3.33	0.10-0.20	0.35-1.90	0.21-1.59
	E.G	High	2.03-2.80	0.10-0.28	0.35-1.45	0.34-1.35
5	W.G	Low	0.90-3.00	0.12-0.34	0.59-1.88	0.17-0.63
	W.G	High	2.50-2.80	0.16-0.18	0.96-1.43	0.21-0.69
	Krishna	Low	1.01-2.31	0.13-0.17	0.70-1.70	0.12-0.34
	Krishna	High	1.83-2.60	0.12-0.16	0.5-1.0	0.15-0.51
	E.G	Low	2.06-2.50	0.10-0.19	0.35-1.20	0.09-0.99
	E.G	High	2.36-2.95	0.11-0.14	0.43-0.85	0.42-0.75

Optimum levels of leaf nutrients (N = 2.40-2.80 %, P= 0.15-0.18 %, K=0.90-1.20 %, Mg = 0.25-0.40%), as per Von Uexkull and Fairhurst (1991)

levels in high yielding plantations may indicate large mobilization of leaf nutrients into fresh fruit bunches as the samples were taken before the application of fertilizers, which necessitate the immediate replenishment of nutrients through fertilizer application. However, there is need for taking large number of samples from various locations during different seasons and analyse for leaf nutrient and interpret with yield and develop methodology for giving fertilizer recommondations.

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