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Seasonal Variations in the Uptake and Status of the Secondary Nutrients in Leaf Terminals in Cashew in Coastal Districts of Andhra Pradesh, India

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A B S T R A C T

Investigations on the seasonal fluctuations in the uptake and status of the secondary nutrients (Ca, Mg and S) in both fruiting and non-fruiting terminals in cashew carried out during 2006 and 2007 in twelve plantations spread over the cashew growing districts of north coastal Andhra Pradesh revealed that the nutrient contents ranged from 0.216 to 1.532% (low to high), 0.132 to 0.226% (low to adequate) and 0.087 to 0.174% (low to high) with respect to Ca, Mg, and S, respectively. In both cases, the peak was observed during September to November, indicating depletion of the nutrients due to mobility to the developing fruits. Thereafter, there was a decline in leaf Ca content, possibly due to utilization by sinks of initiation and differentiation of flower buds. As regards Mg, the non-fruiting terminals in general recorded higher uptake during the same period and a declining trend was observed from May to July. There was increase in leaf S from July to January followed by a decline thereafter till March. Presumably, the greater nutrient concentration in both fruiting and non-fruiting terminals during the period of November to January coincided with the flower bud initiation and formative stage of the plant. Non-fruiting terminals showed higher nutrient contents in comparison to the fruiting terminals during all the months under study.

Introduction

Cashew (*Anacardium occidentale* L.) is an important revenue generating crop in north coastal Andhra Pradesh. However, there is much scope to increase its yield through nutrient management. Reports on nutrient uptake and management in cashew grown in the area is very meager, more so with respect to the secondary nutrients (Ca, Mg, and S). Plant Tissue analysis is an established effective tool for plant diagnosis, while leaf, a major metabolic centre, is an ideal choice for carrying out such plant tissue analysis studies for the uptake and requirement of nutrients, and work out a fertilizer schedule based on the results of such studies. The mineral composition of leaves varies due to several factors (Kumar *et al.*, 1985). An investigation was accordingly undertaken to study the

seasonal fluctuations in the uptake and status of the secondary nutrients during the growth phases in both fruiting terminals and non-fruiting terminals with the principal objective of designing an effective fertilizer programme for the plant cultivated in north coastal Andhra Pradesh.

Materials and Methods

Plantations located within twelve mandals (Tekkali, S. Bommalli, R. B. Puram, Rolugunta, Salur, Narsipatnam, Nidadavol, J. R.Gudem, Vetapalem, Chinnaganjam, Bapatla and Karlapalem) were selected. Five uniform 'look like' trees from around ten years old plantation from each mandal were selected at random, and leaf samples from fruiting and non-fruiting terminals of the selected trees were collected at bimonthly intervals from July 2006 to May 2007. The fifth leaf from the terminal bud was chosen and such leaves from all four sides of the trees were collected from fruiting and non-fruiting terminals as followed by Chapman (1964). Standard methods were followed for the determination of Ca, Mg (Jackson, 1973), and S (Cottenie *et al.*, 1979). The observations recorded in field and laboratory from different treatments were subjected to statistical analysis by adopting randomized block design as described by Panse and Sukhatme (1967).

Results and Discussion

The results on periodical analysis for (Table 1) revealed that the leaf Ca content ranged from 0.216% in fruiting terminal during May in plantations of Chinnaganjam mandal, Prakasam district to 1.532% in non- fruiting terminals during November in plantations of Rolugunta mandal, Visakhapatnam district. Ca content ranged from low to high in accordance to the leaf analysis standards followed by Robinson *et al.*, (1997) for diagnosing nutrient status in cashew (Table 4). Plants in some of the plantations were low in leaf Ca during different months under study suggesting in undertaking further studies on the aspect. Sanyal and Mitra (1991) reported that Ca content ranged from 0.38 to 0.48% in cashew grown in different areas of West Bengal. Likewise, Richards (1993) reported that Ca content ranged from 0.10 to 0.54%, while Jagadeshkumar (2005) reported 0.09 to 0.16 % in different varieties in Kerala. Further, much difference with regard to leaf Ca content in fruiting and non-fruiting terminals was observed during all the months of study; also, there were appreciable differences among the mandals with regard to the leaf nutrient (Fig. 1). Ca is practically immobile and therefore, its supply at a time when required for metabolic activity and normal growth is a must, failing which various physiological disorders like reduction in growth and root system, deformed multiple buds etc. are observed; the disorders as stated eventually result in reduced yield in terms of both quantity and quality.

As regards the mean leaf Ca content in fruiting and non- fruiting terminals, the peak was observed during the months of September and November, indicating depletion of nutrients due to consequent mobility of Ca to developing fruits (Fig. 2). It could be due to $CaCO_3$ present in the soils in high amounts and due to relatively immobile nature of Ca in plants resulting in accumulation in leaves. The results of this study are in conformity with those of Thakur *et al.*, (1981), and Bopaiah *et al.*, (1989). There was a decline in leaf Ca content after November, possibly because of leaf Ca having been utilized by sinks of flower bud initiation and differentiation.

Leaf Mg content ranged from 0.141% in fruiting terminals in plantations of Vetapalm mandal of Prakasam district during May to 0.234 % in non-fruiting terminals in plantations of Rolugunta mandals of

Visakhapatnam district during November (Table 2). Sanyal and Mitra (1991) reported that Mg content ranged from 0.15 to 0.22 % in cashew grown in different parts of West Bengal, while Richards (1993) reported the same to range from 0.16 to 0.34%. Jagadeshkumar (2005) reported that leaf Mg content in different varieties of cashew grown in plantations of Kasargod area in Kerala ranged from 81.3 ppm (Cv.H-2/16) to 172.2 ppm (Cv.VTL-53/2). Further, in the plantations in almost all the mandals, the mean leaf Mg content was found to be in 'low' category in accordance to the leaf nutrient guide of Robinson *et al.,* (1997). The nutrient guide as stated is presented in Table 4. Also, the leaf Mg content was found to decline from July to May in both fruiting and non-fruiting terminals, indicating that there is a need to provide Mg, since the nutrient is more critically involved in plant metabolic process during that period. The results further revealed that the leaf Mg in cashew grown in all the plantations were in 'low' category. Comparatively higher values were observed during September and November in both fruiting and non-fruiting terminals (Fig. 3). Similar results were also reported by Chadha *et al.,* (1984) who stated that the drain of nutrients might be due to its translocation to the developing fruits. Beena Bhaskar (1992) reported that the concentrations of Mg were higher during post-harvest phase than in the fruiting phase of the plant. Koo and Young (1977), Bopaiah and Srivastava (1984) Bopaiah *et al.,* (1989), and Kotur and Singh (1993) reported similar results in the case of the primary and secondary nutrients viz. N, P,K, Ca and Mg in other fruit trees, and proposed similar reasoning too.

The mean leaf Mg content declined from July to May (Fig. 4) in different mandals. However, during the same period, K content increased unlike the case with Mg, confirming that K and Mg are antagonistic to each other. These results also suggest that while applying potassic fertilizers, necessary steps are to be adopted in such manner that the increased supply of K in no way proves detrimental to the supply of Mg to the plants. Srivastava and Singh (2003) also reported similar antagonistic relationship between K and Mg in sweet orange.

The monthly mean leaf S content in fruiting and non-fruiting terminals in cashew plantations in all the mandals showed significant differences and ranged from 0.087% in fruiting terminals during May in Bapatla mandal of Guntur district to 0.174 % in non-fruiting terminals during January in Jagareddygudeum mandal of West Godavari district (Table 3). Sanyal and Mitra (1991) reported that leaf S content ranged from 0.125 to 0.141% in cashew grown in West Bengal. S is a constituent of S containing amino acids, and is thus involved in the synthesis of proteins and enzymes; S is also involved in nitrogen metabolism and its disulphide linkage is intimately associated with the structure of protoplasm; the function of S is thus of great metabolic significance.

In accordance to the leaf nutrient guide of Robinson *et al.,* (1997) (Table 4), the leaf S content in cashew was 'low' in plantations of all the mandals of all the districts. The deficiency of S may result in biochemical disorders resulting in reduction in plant growth with typical chlorotic symptoms. Under such circumstances, it is necessary to ensure immediate supply of S through either inorganic or organic sources.

The non-fruiting terminals contained more leaf S than the fruiting terminals (Fig. 5). The mean leaf S content was found to be increasing from July to January and thereafter, it decreased till March (Fig. 6). The decline as stated might be due to utilization of the nutrient for fruit development.

Table.1 Month wise mean leaf Ca content (%) of fruiting and non-fruiting terminals (FT and NFT) in cashew

Plantations	Jul-06		Sep-06		Nov-06		Jan-07		Mar-07		May-07		Mean	
	FT	NFT	FT	NFT	FT	NFT	FT	NFT	FT	NFT	FT	NFT	FT	NFT
Tekkali	0.512	0.584	1.194	1.374	1.285	1.395	0.377	0.391	0.356	0.365	0.235	0.367	0.660	0.746
S. Bommalli	0.542	0.598	1.224	1.405	1.352	1.425	0.409	0.423	0.383	0.394	0.266	0.393	0.696	0.773
Salur	0.476	0.508	1.192	1.384	1.408	1.431	0.418	0.443	0.353	0.365	0.247	0.371	0.682	0.750
R. B. Puram	0.478	0.537	1.223	1.402	1.438	1.423	0.412	0.431	0.387	0.398	0.279	0.402	0.703	0.766
Rolugunta	0.538	0.547	1.195	1.375	1.516	1.532	0.408	0.452	0.341	0.356	0.234	0.366	0.705	0.771
Narsipatnam	0.508	0.526	1.214	1.359	1.395	1.415	0.402	0.416	0.410	0.384	0.256	0.382	0.698	0.747
Nidadavol	0.475	0.505	1.215	1.385	1.372	1.394	0.416	0.428	0.393	0.406	0.267	0.394	0.690	0.752
J.R. Gudem	0.532	0.521	1.238	1.453	1.428	1.458	0.412	0.424	0.378	0.387	0.255	0.384	0.707	0.771
Vetapalem	0.511	0.517	1.156	1.345	1.350	1.403	0.331	0.345	0.365	0.375	0.246	0.378	0.660	0.727
Chinnaganjam	0.476	0.486	1.214	1.388	1.298	1.394	0.388	0.402	0.308	0.314	0.216	0.345	0.650	0.722
Bapatla	0.429	0.465	1.178	1.352	1.323	1.372	0.359	0.373	0.332	0.345	0.186	0.309	0.635	0.703
Karlapalem	0.426	0.443	1.194	1.374	1.321	1.367	0.377	0.391	0.354	0.364	0.218	0.354	0.648	0.716
Range	0.426 0.542	0.443 0.598	1.156 1.238	1.345 1.453	1.298 1.516	1.367 1.532	0.331 0.418	0.345 0.452	0.308 0.393	0.314 0.406	0.216 0.279	0.309 0.402		
Mean	0.492	0.520	1.203	1.383	1.374	1.417	0.392	0.410	0.363	0.371	0.242	0.370		
SEm+	0.08	0.08	0.07	0.07	0.04	0.04	0.01	0.01	0.02	0.01	0.01	0.01		
CD (0.05)	0.21	0.21	0.19	0.19	0.14	0.12	0.04	0.04	0.03	0.03	0.02	0.03		
CV (%)	8.81	8.46	12.72	11.24	7.99	7.07	8.28	7.23	7.86	6.98	7.47	7.20		

Table.2 Month wise mean leaf Mg content (%) of fruiting and non-fruiting terminals (FT and NFT) in cashew

Plantations	Jul-06		Sep-06		Nov-06		Jan-07		Mar-07		May-07		Mean	
	FT	NFT	FT	NFT	FT	NFT	FT	NFT	FT	NFT	FT	NFT	FT	NFT
Tekkali	0.181	0.192	0.187	0.218	0.197	0.218	0.185	0.215	0.182	0.186	0.181	0.193	0.186	0.204
S. Bommalli	0.184	0.195	0.158	0.189	0.186	0.207	0.153	0.187	0.178	0.190	0.152	0.164	0.169	0.189
Salur	0.209	0.211	0.179	0.210	0.206	0.227	0.177	0.218	0.181	0.187	0.175	0.187	0.188	0.207
R. B. Puram	0.204	0.215	0.181	0.212	0.204	0.226	0.180	0.210	0.184	0.192	0.173	0.184	0.189	0.208
Rolugunta	0.206	0.217	0.182	0.213	0.213	0.224	0.185	0.211	0.181	0.190	0.179	0.191	0.190	0.209
Narsipatnam	0.208	0.219	0.179	0.211	0.194	0.211	0.174	0.185	0.177	0.187	0.152	0.164	0.181	0.197
Nidadavol	0.215	0.226	0.189	0.220	0.198	0.209	0.182	0.200	0.172	0.180	0.161	0.173	0.186	0.201
J.R. Gudem	0.211	0.222	0.192	0.223	0.208	0.229	0.187	0.210	0.179	0.191	0.178	0.190	0.193	0.211
Vetapalem	0.175	0.186	0.152	0.183	0.196	0.217	0.150	0.181	0.181	0.185	0.141	0.152	0.166	0.184
Chinnaganjam	0.183	0.191	0.133	0.164	0.175	0.195	0.153	0.183	0.180	0.183	0.156	0.168	0.163	0.181
Bapatla	0.158	0.169	0.155	0.186	0.177	0.198	0.132	0.161	0.176	0.184	0.163	0.172	0.160	0.178
Karlapalem	0.162	0.173	0.137	0.168	0.173	0.194	0.135	0.165	0.175	0.179	0.151	0.163	0.156	0.174
Range	0.158	0.169	0.133	0.164	0.179	0.194	0.132	0.161	0.175	0.179	0.141	0.152		
	0.215	0.226	0.192	0.223	0.213	0.234	0.187	0.218	0.184	0.192	0.181	0.193		
Mean	0.191	0.201	0.169	0.200	0.194	0.214	0.166	0.194	0.179	0.186	0.164	0.175		
SEm+	0.05	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.04		
CD (0.05)	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.03	0.02	0.01	00.1		
CV (%)	6.05	5.98	6.08	5.97	6.03	6.02	6.07	6.07	7.95	6.08	5.78	5.84		

Table.3 Month wise mean leaf S content (%) of fruiting and non-fruiting terminals (FT and NFT) in cashew

Plantations	Jul-06		Sep-06		Nov-06		Jan-07		Mar-07		May-07		Mean	
	FT	NFT	FT	NFT	FT	NFT	FT	NFT	FT	NFT	FT	NFT	FT	NFT
Tekkali	0.139	0.151	0.123	0.140	0.121	0.126	0.142	0.170	0.092	0.110	0.111	0.121	0.121	0.138
S. Bommalli	0.126	0.145	0.124	0.142	0.123	0.129	0.144	0.172	0.095	0.112	0.110	0.130	0.120	0.139
Salur	0.124	0.143	0.120	0.138	0.112	0.122	0.130	0.150	0.094	0.098	0.106	0.112	0.114	0.127
R. B. Puram	0.122	0.124	0.094	0.108	0.104	0.100	0.132	0.138	0.095	0.094	0.098	0.105	0.108	0.112
Rolugunta	0.126	0.145	0.121	0.140	0.114	0.124	0.131	0.141	0.094	0.098	0.108	0.114	0.116	0.127
Narsipatnam	0.120	0.140	0.119	0.138	0.112	0.121	0.129	0.148	0.091	0.090	0.106	0.120	0.113	0.126
Nidadavol	0.132	0.154	0.113	0.143	0.126	0.132	0.136	0.171	0.110	0.111	0.102	0.124	0.120	0.139
J.R. Gudem	0.142	0.160	0.126	0.148	0.123	0.130	0.146	0.174	0.096	0.112	0.112	0.131	0.124	0.143
Vetapalem	0.120	0.122	0.092	0.106	0.102	0.098	0.128	0.132	0.094	0.089	0.094	0.106	0.105	0.109
Chinnaganjam	0.113	0.115	0.088	0.103	0.100	0.094	0.123	0.120	0.091	0.095	0.090	0.104	0.101	0.105
Bapatla	0.116	0.119	0.084	0.101	0.098	0.100	0.120	0.124	0.089	0.093	0.087	0.101	0.099	0.106
Karlapalem	0.115	0.117	0.090	0.105	0.102	0.098	0.125	0.130	0.092	0.098	0.092	0.106	0.103	0.109
Range	0.113	0.115	0.084	0.101	0.098	0.094	0.120	0.120	0.089	0.089	0.087	0.101		
	0.142	0.160	0.126	0.148	0.126	0.132	0.146	0.174	0.110	0.112	0.112	0.131		
Mean	0.125	0.136	0.108	0.126	0.111	0.115	0.132	0.148	0.094	0.100	0.101	0.115		
SEm+	0.08	0.08	0.0 7	0.07	0.04	0.04	0.01	0.01	0.02	0.01	0.01	0.01		
CD (0.05)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		
CV (%)	7.51	7.16	7.44	7.70	7.52	7.45	6.79	7.33	7.52	7.36	7.63	7.44		

Table.4 Leaf nutrient guide for cashew (Robinson *et al.*, 1997)

Nutrient	Deficient	Low	Adequate	High
N%	<1.38	1.39-2.39	2.40-2.58	**>2.58**
p%	<0.14	0.141-0.15	0.16-0.20	**>0.20**
K%	<0.26	0.27-1.09	1.10-1.20	**>1.20**
S%	<0.08	0.09-0.10	0.11-0.14	**>0.14**
Ca%	<0.11	0.10-0.23	0.24-0.75	**>0.75**
Mg%	<0.11	0.10-0.21	0.22-0.31	**>0.31**
Cu (mg kg^{-1})	<7	-	>7	-
Zn (mg kg^{-1})	<12	13-20	>20	-
Mn (mg kg^{-1})	<26	27-90	91-204	**>204**
Fe (mg kg^{-1})	<92	95-147	148-165	**>165**
B (mg kg^{-1})	**<39**	**40-55**	**56-67**	**>67**

Fig.1 Mean leaf Ca content of cashew in different mandals

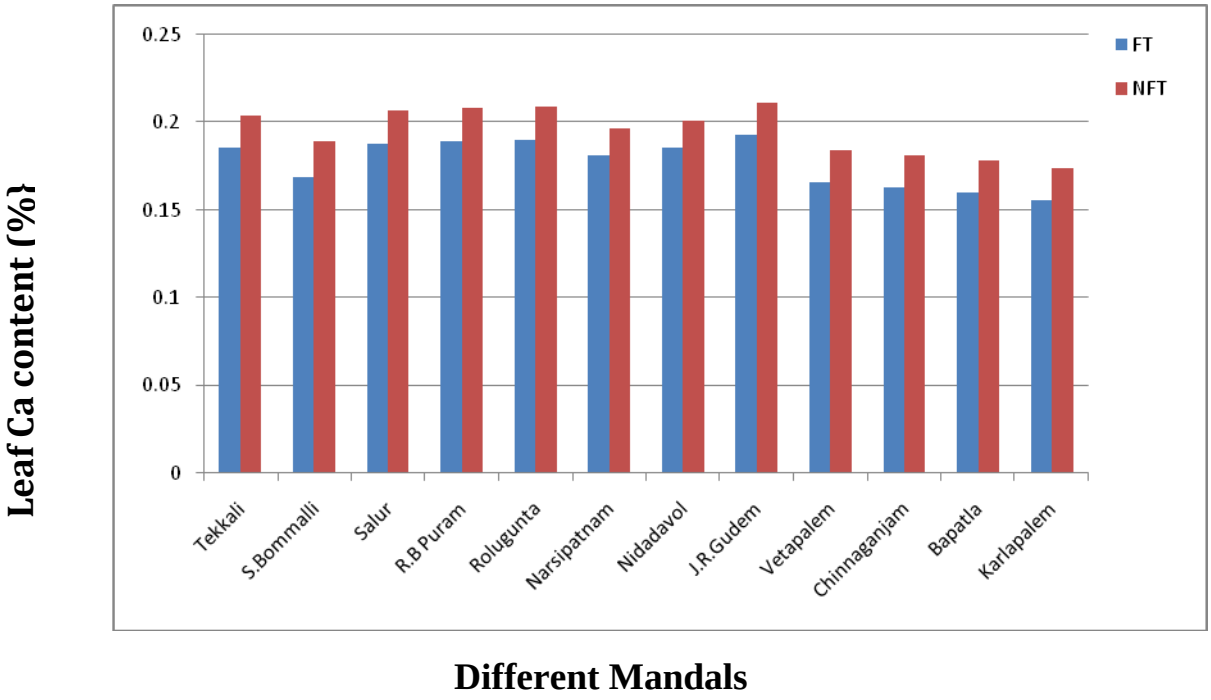


Fig.2 Mean leaf Ca content of cashew during different months

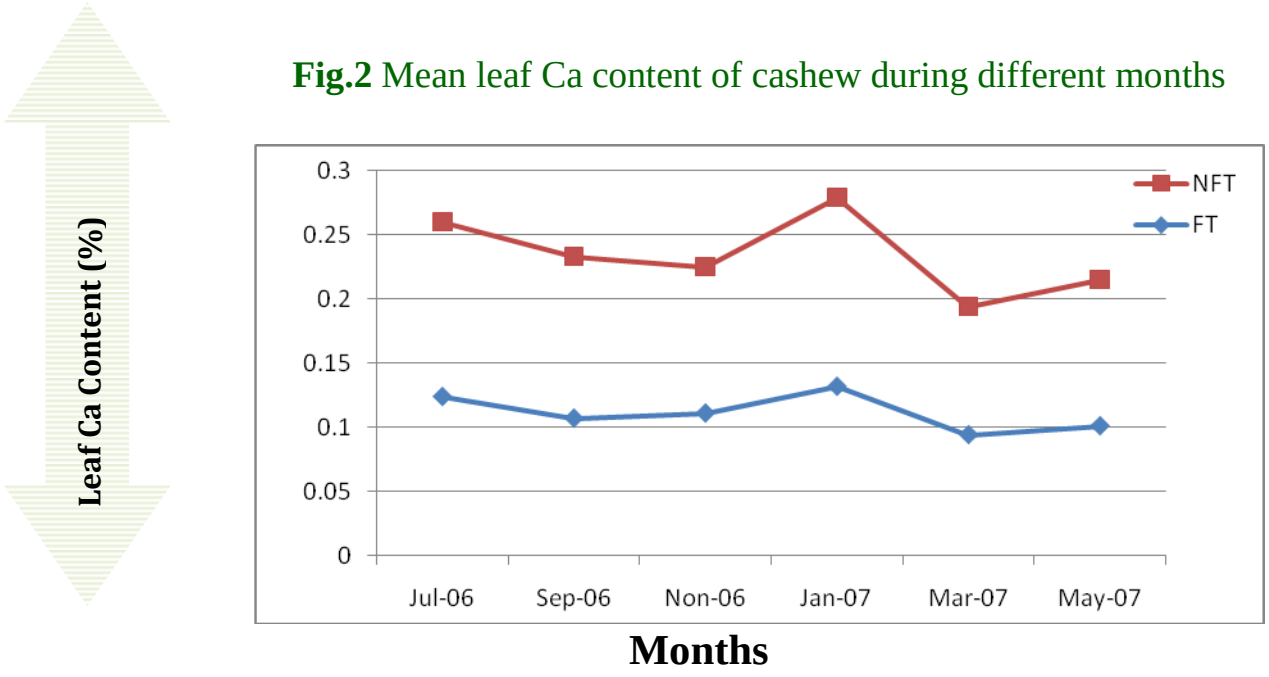


Fig.3 Mean leaf Mg content of cashew in different mandals

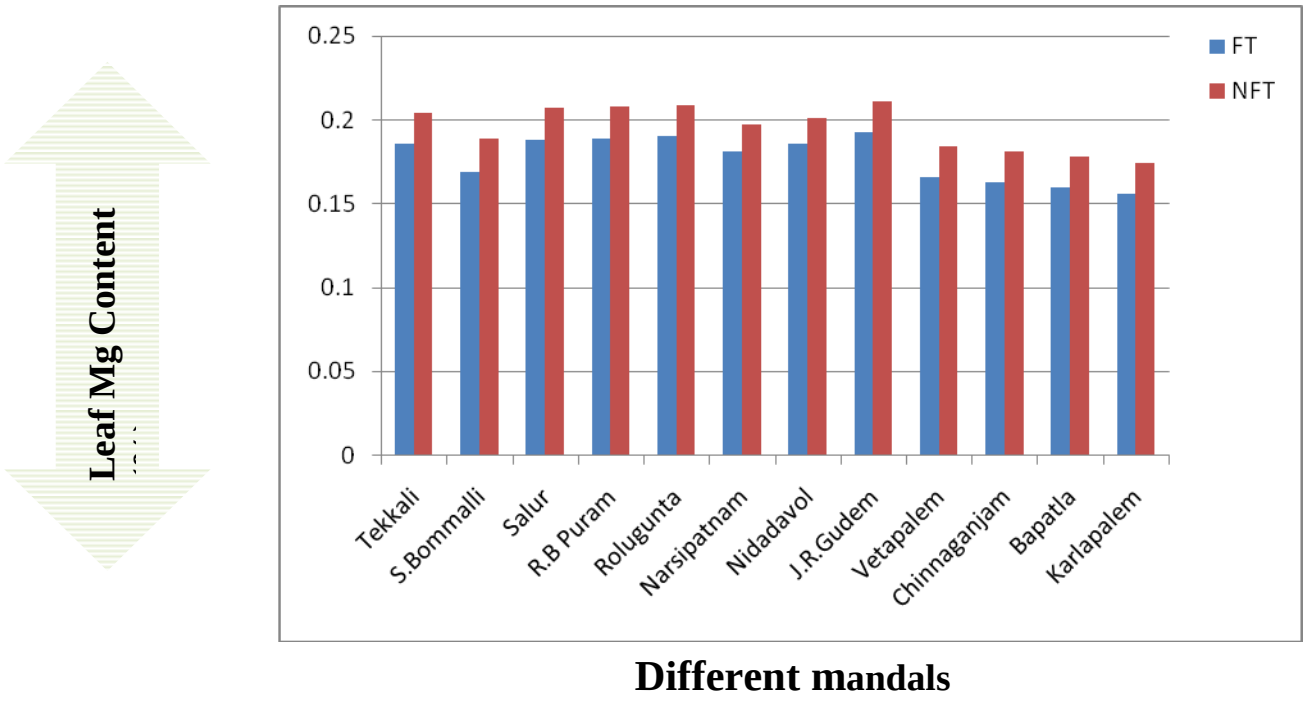


Fig.4 Mean leaf Mg content of cashew in different months

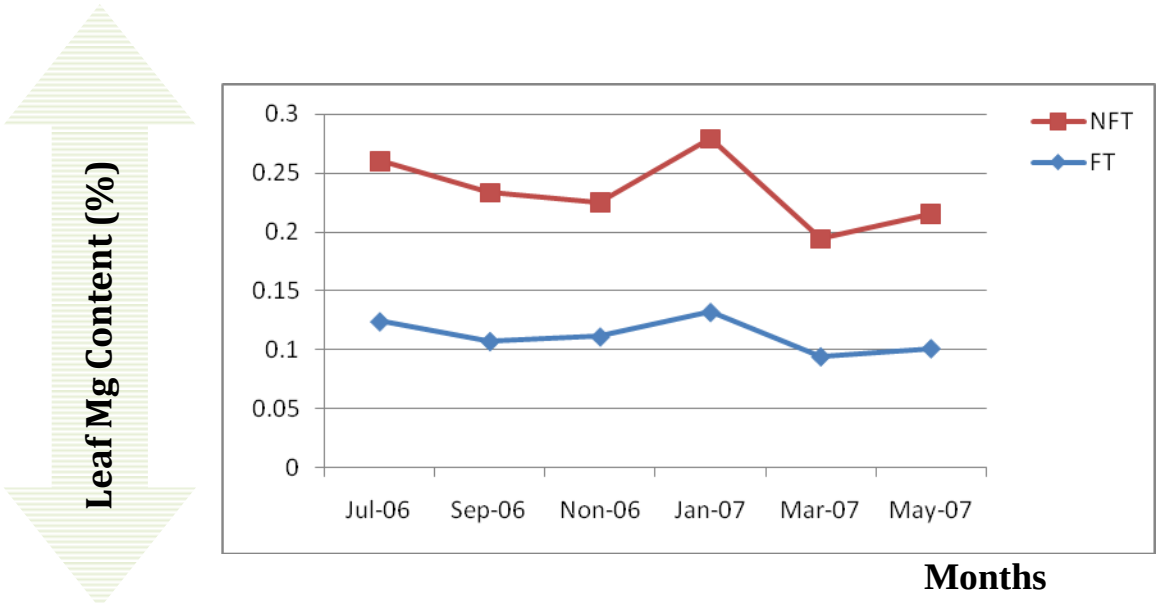


Fig.5 Mean leaf S content of cashew in different mandals

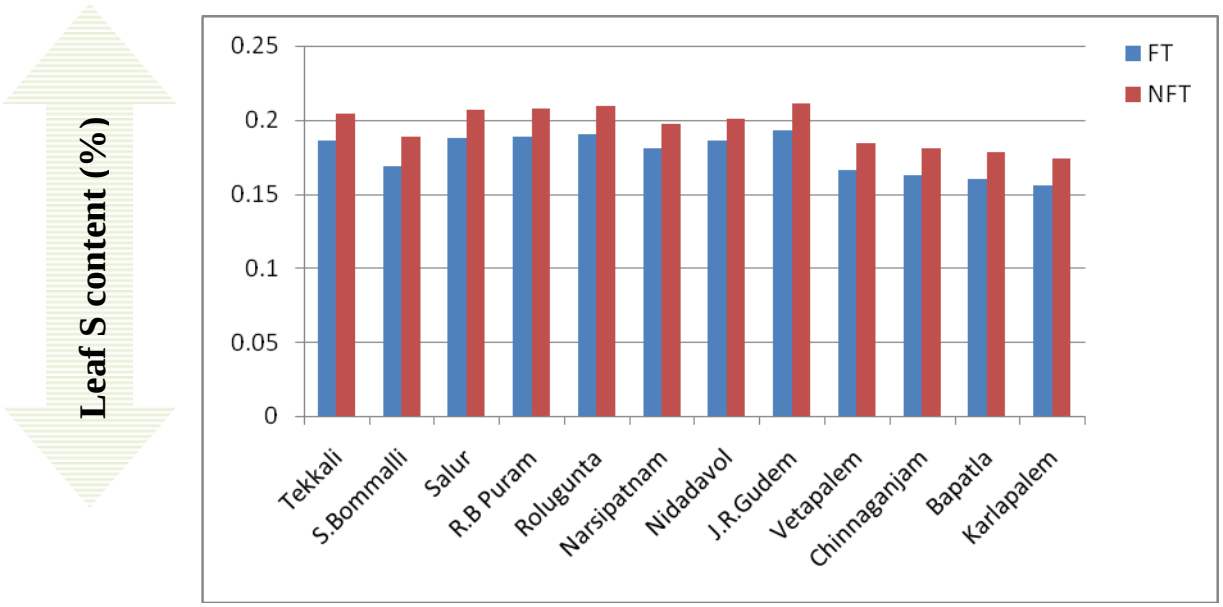
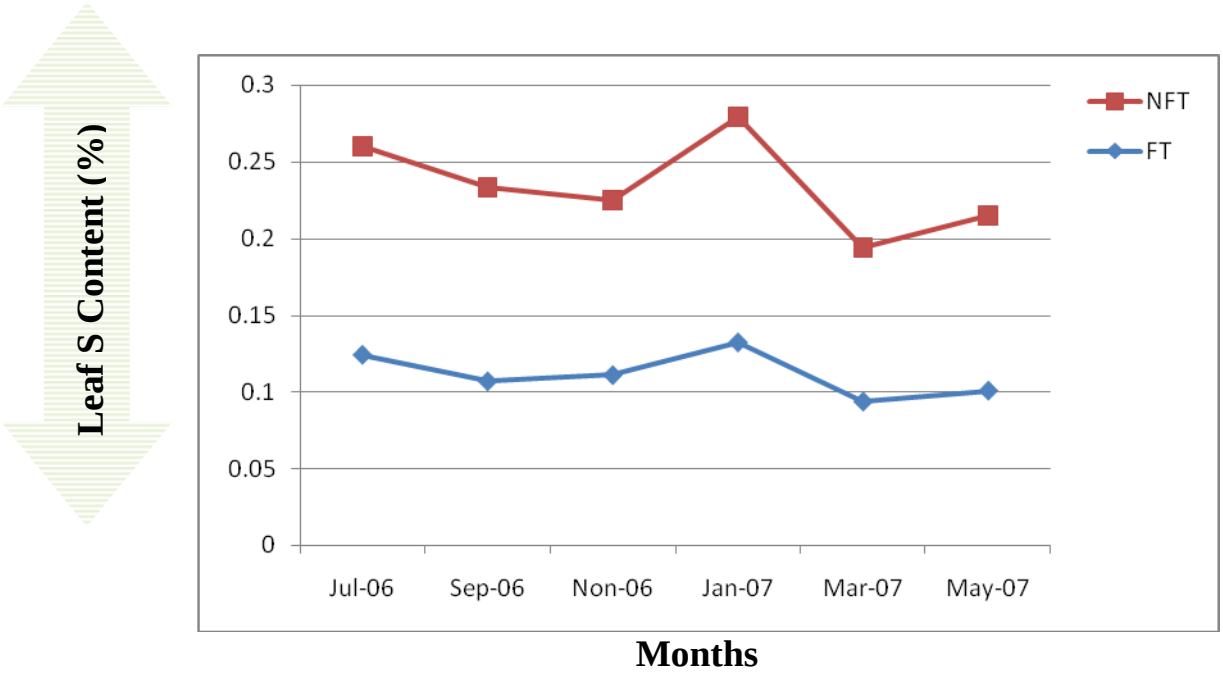


Fig.6 Mean leaf S content of cashew in different months



Beena Bhaskar (1992) reported that the concentration of S during the post-harvest phase was higher than that during the non-fruiting phase of the plant. Thakur *et al.*, (1981) and Kotur and Singh (1993) reported that the leaf S content in non-fruiting

terminals was higher than that in fruiting terminals. The greater nutrient concentration in both fruiting and non-fruiting terminals during November to January coincided with the flower bud initiation and formative stage of the plant.

The leaf Ca in all the twelve mandal cashewnut orchards in different months varied from 0.216 to 0.598 per cent and it ca content was found to be adequate in all the mandals of al coastal districts of Andhra Pradesh. J.R Gudem mandal orchards of West Godavari district recorded higher leaf Ca content followed by Rolugunta mandal orchards of Visakhapatnam district and Rambhadrapuram mandal orchards of Vizianagaram district. In all the months of study, in general it is observed that non-fruiting terminals recorded higher leaf Ca content than fruiting terminals. The leaf Ca content found to be low in March and May but maximum peak was found during the month of November and September.

The leaf Mg in all the twelve mandal cashewnut orchards in different months varied from 0.141 to 0.234 per cent. The leaf Mg content was found to be in a low range. J.R Gudem mandal orchards of West Godavari district recorded higher leaf Mg content followed by Rolugunta mandal orchards of Visakhapatnam district and Salur mandal orchards of Vizianagaram district. In general, the non-fruiting terminals recorded comparatively higher values in all the months but higher values in non-fruiting terminals from July to November and declined from November to May in both fruiting and non-fruiting terminals.

The leaf S content in all the twelve mandal cashewnut orchards in different months varied from 0.087 to 0.174 per cent. The leaf S content was found to be in low to adequate range. J.R Gudem mandal orchards recorded higher leaf S content followed by Nidadavol and Tekkali mandal orchards. In general, it is observed that non-fruiting terminals recorded higher S content than fruiting terminals. The leaf S content was fond to be increasing from November to January and thereafter exhibited declining trend up to March by upward trend up to May.

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