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Standardization of foliar sampling technique in Kinnow mandarin (*Citrus nobillis X Citrus deliciosa*)

A.S. Rehalia, Him Prasad Bhattaria and Sanjeev Sharma*
Department of Pomology, Dr. Y.S. Parmar University of Horticulture and Forestry, NAUNI – SOLAN (H.P.) INDIA

ABSTRACT
The present investigatorns were under taken with an objective to standardize foliar sampling techniques in kinnow mandarin (*Citrus nobillis x Citrus deliciosa*) at Regional Research Station, Dhaulakuan. Leaf N content increased to attain maximum value on August 20 and decreased, thereafter, with the advancement of sampling season. Leaf P Content decreased upto October 20, irrespective of position of leaves on shoot and increased significantly on November 20 in both fruiting and non-fruiting shoots. A decreasing trend of leaf K content was observed with the advancement of leaf age. However, the trend was reverse for leaf Ca and Mg contents. A nutrient stability period was observed in case of middle leaves between July 20 to October 20 in both fruiting and non-fruiting shoots. Therefore, the middle leaves either from fruiting or non-fruiting shoot should be sampled from July 20 to October 20 when the leaves were 4-7 months old for analysis of macronutrients.

Key words : Standardization, Foliar sampling, Known mandarin.

INTRODUCTION

Kinnow, an interpecific mandarin hybrid of King sweet orange and willow – leaf mandarin (*Citrus nobillis x Citrus deliciosa*), has established as a promising cultivar owing to its profuse bearing, excellent fruit quality and higher profits in low hills and valley areas of Himachal Pradesh. As a result of precocity and profuse, bearing a poor supply of required nutrients led to early decline (Singhy, 1978). In addition, improper nutritional management in Kinnow orchards has been observed as a major caused of early decline (Chahill *et al.* 1988). Moreover, consideration of economy energy and environment make it imperative that fertilizers should be used efficiently to ensure high crop yield and sustain the available soil nutrient status at maintenance level. Recent advances in mineral nutrition have shown that foliar analysis is the most reliable method to determine the nutritional status of fruit trees. The leaf analysis to be diagnostic value must be based to standard sampling method (Bould, 1963). The accuracy of foliar analysis, however, depends upon the specificity of sampling with respect to leaf age (Embleton *et al.* 1973), position of leaf on shoot (Harting *et al,* 1972) as well as agroclimatic region where the crop is grown (Leece and Gilmore, 1974). The foliar sampling techniques followed for kinnow in Himachal Pradesh are based on the information developed elsewhere and no such information seems available under agroclimatic conditions of Himachal Pradesh. Therefore, it was thought necessary to standardize foliar sampling techniques in kinnow mandarin.

MATERIALS AND METHODS

The present studies were carried out at Regional Research Station, Dhaulakuan during 2002-2003. Twenty healthy trees of kinnow mandarin budded on *Citrus jambhiri* of uniform age and vigour were selected for these studies. To standardize the leaf sampling techniques, both the fruiting and non fruiting shoots from spring cycle flush were tagged during May. The experiment waslaid down under Randomized Block Design (RBD). To avoid any possible variation, 50 healthy and undamaged leaves were collected from three positions viz., terminal, middle and basal at monthly interval. The leaves were thoroughly washed and dried as suggested by Chapman (1964). Nitrogen was determined by using microkjedhal distillation method described by AOAC (1970). Phosphorus was determined by using Vanadomolybdo-phosphoric acid yellow method described by Jackson (1967). Potassium was estimated by using flame photometer (Piper, 1950). Calcium and magnesium were determined by using "Z-6100 polarized Zeemen" atomic absorption spectrophotometer. The result of all the elements were expressed as percentage on dry matter basis.

RESULTS AND DISCUSSION

Mean N content of kinnow leaf in fruiting and non-fruiting shoots increased significantly irrespective of position of leaf on shoot from June 20 to August 20. There was a significant decreasing trend of leaf N afterward August 20 which continued upto November 20 (Table 1). Mean N content with respect to position of leaf onboth types of shoots was recorded maximum on terminal leaves followed by middle and basal leaves. In case of middle leaves, a statistically stable period was noticed from July 20 to October 20 in both types of shoots, whereas in case of basal leaves it was from August 20 to September 20. The present finding are in conformity with the investigation of Gururani and Singh, 1983 and Chahill *et al.,* 1988 and Shrivastava *et al,* 1994 in Nagpur mandarin.

Mean leaf P content decreased gradually with the advancement of season from June 20 October 20 in both fruiting and non-fruiting shoots, irrespective of their position of shoot. Significient increase in leaf P was recorded in both types of shoot on November 20 (Table 2). Mean P content with respect to position of leaf on shoots followed a decreasing trend from terminal to basal position. The nutrient stability period was observed between July 20 to October 20 and August 20 to September 20 in case of middle and basal leaves respectively Similar results were obtained by Chahill etal., 1988 in kinnow and Singh et al 1990 in acid lime.

Mean K content decreased gradually with the advancement of sampling season in both types of shoot (Table 3) due to high mobility of the element and utilization by growing fruits (Smith and Reuther, 1950). The result are in conformity with the findings of Randhawa and Kar, 1967 in Mandarin and Gururani and Singh, 1983 in kinnow mandarin. Mean leaf K content with respect to position of leavers on both types of shoots declined, basipetally. There was continuous decrease in leaf K in terminal leaves throughout the sampling dates. However, very less variation in leaf K was recorded in middle and basal leaves between July 20 to October 20 and August 20 to October 20 respectively in fruiting and non-fruiting shoots. Unlike N, P and K contents, mean Ca concentration remained low at initial stage and increased continuously with the advancement of sampling season irrespective of position of leaves of fruiting and non-fruiting shoots (Table 4). In case of terminal leaves the trend of increment continued throughout the sampling dates, but non-significant variation in leaf Ca was recorded between July 20 to October 20 and August 20 to September 20 in middle and basal leaves respectively in both types on shoots. The present findings also agree with the findings of Nadar, 1967, Randhawa and Kar, 1967 and Gururani and Singh, 1983.

Mean Mg content of leaf increased gradually with the advancement of sampling season in fruiting as well as non-fruiting shoots. Mean Mg content as influenced by positions of leaf on both types shoots followed a basipetal trend. A nutrient stability period was observed in case of middle leaves sampled from fruiting as well as non-fruiting shoot from July 20 to October 20. The above findings

*Author for correspondence

Table 1 : Seasonal trends in leaf N content as influenced by position of leaves on shoot and time of sampling (% dry weight basis).

Treatment	Type of shoot							
	Fruiting				Non-fruiting			
	Leaves immediately after fruit (terminal)	Middle leaves	Basal leaves	Mean	Terminal leaves	Middle leaves	Basal leaves	Mean
Jan-20	2.37	2.31	2.22	2.30	2.42	2.32	2.25	2.33
July-20	2.55	2.44	2.35	2.45	2.58	2.48	2.39	2.48
August-20	2.69	2.51	2.49	2.56	2.72	2.53	2.54	2.60
September-20	2.54	2.48	2.46	2.49	2.56	2.50	2.52	2.53
October-20	2.41	2.40	1.91	2.24	2.42	2.44	1.96	2.27
November-20	2.25	2.16	1.73	2.05	2.28	2.19	1.78	2.08
Mean	2.47	2.38	2.19		2.50	2.41	2.24	

$CD_{0.05}$		
Sampling date (Mean)	0.10	0.11
Position of leaf on shoot (Mean)	0.07	0.08
Position of leaf on shoot x sampling date	0.12	0.13

Table 2 : Seasonal trends in leaf P content as influenced by position of leaves on shoot and time of sampling (% dry weight basis).

Treatment	Type of shoot							
	Fruiting				Non-fruiting			
	Leaves immediately after fruit (terminal)	Middle leaves	Basal leaves	Mean	Terminal leaves	Middle leaves	Basal leaves	Mean
Jan-20	0.194	0.157	0.135	0.162	0.204	0.169	0.150	0.174
July-20	0.178	0.142	0.118	0.146	0.186	0.148	0.133	0.156
August-20	0.162	0.139	0.102	0.134	0.168	0.147	0.116	0.144
September-20	0.148	0.138	0.101	0.129	0.151	0.146	0.114	0.137
October-20	0.132	0.130	0.083	0.115	00.134	0.132	0.097	0.121
November-20	0.158	0.153	0.102	0.138	0.165	0.164	0.115	0.148
Mean	0.162	0.143	0.107		0.168	0.151	0.121	

$CD_{0.05}$		
Sampling date (Mean)	0.011	0.013
Position of leaf on shoot (Mean)	0.007	0.009
Position of leaf on shoot x sampling date	0.013	0.016

Table 3 : Seasonal trends in leaf K content as influenced by position of leaves on shoot and time of sampling (% dry weight basis).

Treatment	Type of shoot							
	Fruiting				Non-fruiting			
	Leaves immediately after fruit (terminal)	Middle leaves	Basal leaves	Mean	Terminal leaves	Middle leaves	Basal leaves	Mean
Jan-20	1.71	1.43	1.31	1.48	1.77	1.46	1.33	1.52
July-20	1.53	1.19	1.15	1.29	1.62	1.23	1.17	1.34
August-20	1.36	1.15	0.89	1.13	1.45	1.19	0.91	1.18
September-20	1.22	1.12	0.88	1.07	1.28	1.17	0.90	1.12
October-20	1.08	1.07	0.86	1.00	1.13	1.10	0.89	1.04
November-20	0.89	0.85	0.71	0.82	0.91	0.88	0.73	0.84
Mean	1.30	1.13	0.97		1.37	1.17	0.99	

$CD_{0.05}$		
Sampling date (Mean)	0.10	0.12
Position of leaf on shoot (Mean)	0.07	0.09
Position of leaf on shoot x sampling date	0.13	0.14

Table 4 : Seasonal trends in leaf Ca content as influenced by position of leaves on shoot and time of sampling (% dry weight basis).

Treatment	Type of shoot							
	Fruiting				Non-fruiting			
	Leaves immediately after fruit (terminal)	Middle leaves	Basal leaves	Mean	Terminal leaves	Middle leaves	Basal leaves	Mean
Jan-20	3.87	4.35	4.48	4.23	3.71	4.11	4.24	4.02
July-20	4.04	4.52	4.65	4.40	3.85	4.28	4.38	4.17
August-20	4.22	4.56	4.83	4.54	4.02	4.31	4.53	4.29
September-20	4.38	4.57	4.84	4.60	4.18	4.33	4.55	4.35
October-20	4.55	4.65	4.98	4.73	4.35	4.37	4.70	4.47
November-20	4.71	4.85	5.15	4.90	4.51	4.57	4.85	4.64
Mean	4.29	4.58	4.82		4.10	4.32	4.54	

$CD_{0.05}$	Fruiting	Non-fruiting
Sampling date (Mean)	0.12	0.10
Position of leaf on shoot (Mean)	0.09	0.08
Position of leaf on shoot x sampling date	0.15	0.13

Table 5 : Seasonal trends in leaf Mg content as influenced by position of leaves on shoot and time of sampling (% dry weight basis).

Treatment	Type of shoot							
	Fruiting				Non-fruiting			
	Leaves immediately after fruit (terminal)	Middle leaves	Basal leaves	Mean	Terminal leaves	Middle leaves	Basal leaves	Mean
Jan-20	0.441	0.479	0.502	0.474	0.364	0.403	0.418	0.395
July-20	0.460	0.502	0.520	0.494	0.380	0.423	0.434	0.412
August-20	0.478	0.505	0.539	0.507	0.397	0.425	0.457	0.426
September-20	0.497	0.507	0.559	0.521	0.414	0.427	0.473	0.438
October-20	0.515	0.518	0.577	0.537	0.430	0.435	0.490	0.452
November-20	0.535	0.537	0.596	0.556	0.450	0.453	0.510	0.471
Mean	0.488	0.508	0.548		0.406	0.427	0.464	

$CD_{0.05}$	Fruiting	Non-fruiting
Sampling date (Mean)	0.014	0.012
Position of leaf on shoot (Mean)	0.010	0.009
Position of leaf on shoot x sampling date	0.017	0.015

are in the line with those of Soni and Randhawa (1980) and Gururani and Singh (1983), who also reported an increase in leaf Mg content with the advancement of growing season.

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