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Diagnosis and recommendation integrated system norms in custard apple

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Abstract

A leaf sampling survey was carried out at 15 villages in states of Gujarat and Rajasthan during 2018-2020 and collected 338 samples in custard apple to develop diagnosis and recommendation integrated system (DRIS) norms. The leaf samples were collected in July month and the leaves present in the middle portion of the recently matured twig were analyzed for the nutrients, and classified based on standard deviation (SD) as deficient (< mean-8/3 SD), low (mean-8/3 SD to mean-4/3 SD), optimum (mean-4/3 SD to mean +4/3 SD), high (mean +4/3 SD to mean +8/3 SD)) and very high (> mean + 8/3 SD). The optimum concentration of nitrogen in the index leaf ranged from 1.96% to 3.06%, whereas phosphorus, potassium, calcium, magnesium, sulphur, iron, manganese, zinc and copper ranged from 0.13 to 0.17%, 0.59 to 0.99 %, 1.48 to 2.26%, 0.69 to 1.64%, 0.29 to 0.45%, 126 to 328 ppm, 243 to 323 ppm, 38 to 56 ppm, and 21 to 36 ppm, respectively. This information may be used for developing DRIS and CND norms and to predict nutrient needs based on DRIS indices in nutrient management of custard apple trees.

Key words: Custard apple, DRIS norms, CND, leaf sampling survey, nutrient management

Introduction

Custard apple (*Annona squamosa* L.) popularly known as sitaphal over India as well as sugar apple in rest of the world because of high sugar content (25-28% TSS), belongs to family Annonaceae. It is a perennial, small, semi-deciduous tree, which can well survive in both tropical and sub-tropical ecological condition, and seen mostly naturally growing in forest areas (Yadav *et al.,* 2017). The leaves of custard apple are not eaten by grazing animals due to *annonin* content which is toxic and it can also be used as botanical pesticide (Monadal *et al.,* 2018). Custard apple is delicious in taste having nutraceutical properties like vitamin K (58 mcg) and ascorbic acid 36.3 mg (44% DV) (Singh *et al.,* 2019), and minerals like potassium 247 mg, manganese 0.42 mg (20% DV) and magnesium (84 mg) per 100 g fresh pulp (Sugar apple:2020). The pulp of custard apple can be preserved and utilized in ice cream industry. In India, custard apple production is 347 thousand tons in 41 thousand hectares area with an average productivity 8.46 t/ha, and contributes 0.35 % in total fruit production (99,069 thousand tons in 6,664 thousand ha area with an average productivity 14.86 tons/ha) (Anonymous, 2020). In order to meet demand of growing population, custard apple may be a key fruit crops in removing malnutrition over the world, its production can be increased by proper nutrient management techniques. In fruit crops because of deep root system, nutrient diagnosis is generally done by leaf nutrient diagnosis in which DRIS is one of the important diagnostic tool to judge the nutrient needs of the fruit trees. Many scientists already developed DRIS norms for different fruit crops (Bhargava and Chadha, 1993) but so far for custard apple this technique was not developed therefore, an effort was made to develop DRIS norms by conducting leaf sampling survey in Gujarat and Rajasthan states.

Materials and Methods

A leaf sampling survey in custard apple was carried out in states of Gujarat and Rajasthan during the period 2018-2020 and 338 samples were collected in July month to develop DRIS norms and their details are presented in Table 1. Middle leaves of recently developed twigs are used for analysis. Leaf samples were properly washed with 0.1 N HCl, tap water, distilled water and double distilled water and dried at 68°C temperature, then finely powdered and used for analysis. The plant nutrients like nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, manganese, zinc and copper were estimated by using methods as described by Bhargava and Raghupathi (1993). The nutrient concentrations of entire population were divided into two sub populations *i.e.* low-yielding and high-yielding with a cut off value 21.2 kg fruits/tree. Nutrient concentrations derived from high yielding population were statistically analyzed and classified into deficient, low, optimum, high and toxic based on standard deviation (SD). The nutrient concentrations in the range with mean $\pm$ 4/3 SD are optimum, <(mean - 8/3 SD) are deficient, (mean - 8/3 SD) to (mean -4/3 SD) are low, (mean + 4/3 SD) to (mean + 8/3 SD) are high and > (mean + 8/3 SD) are toxic. DRIS norms were calculated following the methods suggested by Beaufiles (1973), which were clearly explained by Walworth & Sumner (1987) and Bhargava (1996).

The DRIS index for each nutrient was calculated as follows

Nutrient Index (A nutrient index is a mean of functions of all ratios containing a given nutrient)

$$N\ Index = \frac{[f(N/P) + f(N/K) + f(N/Ca) + f(N/Mg) + f(N/S) + f(N/Fe) + f(N/Mn) + f(N/Cu) + f(N/Zn) + f(N/Y)]}{Z}$$

Where,

When $N/P \geq n/p$,

$$f(N/P) = \{(N/P/n/p)\ 1\}1000/CV$$

When $N/P < n/p$,

$$f(N/P) = \{(1-(n/p/N/P)\}1000/CV$$

Where

1) N/P is the value of the ratio of two elements in the tissue of the plant being diagnosed.
2) n/p is the optimum value or norm for that ratio.
3) CV is the coefficient of variation associated with the norm.
4) Z is the number of functions comprising the nutrient index.

Results and Discussion

The total population was divided into two sub populations based on a cut off value of 21.2 kg yield per tree. One is high yielding population with trees yielding above 21.2 kg yield per tree and other one as low yielding population with trees yielding less than 21.2 kg per tree. In high yielding population with 183 trees the average concentration of nitrogen (2.51% and CV% 16.54), phosphorus (0.15% and CV% 12.21), potassium (0.79% and CV% 18.93), calcium (1.81% and CV% 15.8), magnesium (1.16% and CV% 30.49), sulphur (0.37% and CV% 16.10), iron (227 ppm and CV% 33.33), manganese (283 ppm CV% 10.54), zinc (47 ppm and CV% 14.09) and copper (29 ppm and CV% 19.84) were estimated. Based on variation the nutrients were classified and presented in Table 2. These nutrient concentrations and variation were used in developing DRIS index for diagnosing the leaf samples (Table 5). A proper concentration and ratio of nutrients are required for getting optimum yields and that

Table1. Geographical location of leaf samples collected in Gujarat and Rajasthan

S. No	Village	District	State	Geographical Location	Altitude (Feet)
1	Baina (33)	Dahod	Gujarath	22^0 39' 06.18" N, 73^0 57' 12.24" E	650
2	Bakrol (33)	Pancha Mahals	Gujarath	22^0 29' 30.29" N, 73^0 42' 39.21" E	567
3	Bhabhar (6)	Chota Udaipur	Gujarath	22^0 28' 36.31" N, 73^0 44' 40.76" E	679
4	Chittorgarh Fort (50)	Chittorgarh	Rajasthan	24^0 53' 12.70" N-74^0 38' 41.04" E	1659
5	Hathni Mata (16)	Pancha Mahals	Gujarath	22^0 39' 06.18" N, 73^0 57' 12.24" E	740
6	Jaisighpur (12)	Chittorgarh	Rajasthan	25^0 05' 40.28" N-74^0 34' 21.26 E	1414
7	Jesingpur (22)	Mahisagar	Gujarath	23^0 20' 17.66" N-73^0 28' 26.54" E	595
8	KVK,Chittorgarh(24)	Chittorgarh	Rajasthan	24^0 50' 51.18" N-74^0 34' 57.99 E	1388
9	Labadadhara(18)	Pancha Mahals	Gujarath	22^0 31' 26.28" N, 73^0 41' 51.83" E	608
10	Nathpura (9)	Pancha Mahals	Gujarath	22^0 28' 19.74" N, 73^0 41' 49.99" E	666
11	Poyali (19)	Pancha Mahals	Gujarath	22^0 27' 46.26" N, 73^0 43' 16.88" E	798
12	Rugnathpur(22)	Mahisagar	Gujarath	23^0 20' 36.5" N-73^0 26' 08.43" E	437
13	Sarasava (14)	Pancha Mahals	Gujarath	22^0 28' 23.86" N, 73^0 42' 42.30" E	705
14	Vejalpura(34)	Pancha Mahals	Gujarath	22^0 41' 23.98" N, 73^0 33' 47.86" E	368
15	Zinzari (26)	Pancha Mahals	Gujarath	22^0 31' 36.71" N, 73^0 40' 09.19" E	606

Table 2. Nutrients norms of custard apple for macro and micronutrients

Nutrient	Deficient	Low	Optimum	High	Toxic
Nitrogen	<1.40	1.40-1.96	1.96-3.06	3.06-3.62	>3.62
Phosphorus	<0.10	0.10-0.13	0.13-0.17	0.17-0.20	>0.20
Potassium	<0.39	0.39-0.59	0.59-0.99	0.99-1.19	>1.19
Calcium	<1.08	1.08-1.48	1.48-2.26	2.26-2.66	>2.66
Magnesium	<0.22	0.22-0.69	0.69-1.64	1.64-2.11	>2.11
Sulphur	<0.21	0.21-0.29	0.29-0.45	0.45-0.53	>0.53
Iron	<25	25-126	126-327	327-429	>429
Manganese	<204	204-243	243-323	323-363	>363
Zinc	<29	29-38	38-56	56-65	>65
Copper	<14	14-21	21-36	36-44	>44

information is given in the Table 3 & 4 for comparison, which were collected from different DRIS norms from different workers in various fruit crops which were mentioned by Bhargava and Raghupati (1993) and those optimum nutrients concentrations are compared with the optimum nutrients concentrations of present work of custard apple.

For higher yield, not only optimum nutrient concentration but also nutrient balance is required. Every plant maintains a definite and specific ratio of nutrient composition of its own nature and it is unique character of its species for optimum growth and yield. Table 5 reveals that as the summation of nutrient indices become zero or near to zero, the yield will be maximized, to interpret DRIS indices with elemental composition of leaves, custard apple trees along with average yield (kg/tree) are given in Table 5. These DRIS Indices indicate the order of deficiency or sufficiency of each element over the other elements. The element having more negative value is more deficient than the other having less negative value for example in tree No. 2 (Table 5) the order of requirement of nutrients for getting higher yield response is Ca> K> Mn> Zn> Cu> N> Fe> P> Mg. This indicates that the Ca is most important and required element and Mg is least required element to improve the yields of that tree. To get profitable response, Ca should be immediately applied as compared to other elements. The total of DRIS indices of various elements should be balanced (total of indices should be zero or nearer to zero) to get higher yield. Table 5 clearly indicates that tree with more balance in DRIS indices (with lower total number) gave higher yield when compared to those orchards having less balance in DRIS indices.

Table 3. Average nutrient concentration from DRIS norms of different fruit crops

Crop	N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	Reference
Mango	1.25	0.165	0.65	3.5	0.35	0.4	150	150	110	11	Bhargava and Raghupathi (1993)
Citrus	2.45	0.2	1.5	2.75	0.35	0.825	80	110	35	53	Bhargava and Raghupathi (1993)
Papaya	1.75	0.31	4.4	2	0.95	0.3	63	85	27	7	Bhargava and Raghupathi (1993)
Sapota	1.815	0.11	0.565	1.525	0.7	0.6	83	28	12	5	Appa Rao *et al*., (2006)
Aonla	2.085	0.135	0.675	0.98	0.555	0.135	125	33	11	16	Appa Rao *et al*., (2006)
Ber	1.895	0.23	1.535	0.335	0.131	0.2	90	39	17	14	Bhargava and Raghupathi (1993)
Banana	2.75	0.29	3.15	1.05	1.05	0.325	200	1100	32	18	Bhargava and Raghupathi (1993)
Custard apple	2.51	0.15	0.79	1.87	1.17	0.37	227	283	47	29	Present paper

Table 4. Nutrient ratios calculated for average values DRIS norms of different crops

Crop	N/P	N/K	N/Ca	N/Mg	N/S	N/Fe	N/Mn	N/Zn	N/Cu	Reference
Mango	7.58	1.92	0.36	3.57	3.13	83.33	83.33	113.64	1136.36	Bhargava and Raghupathi (1993)
Citrus	12.25	1.63	0.89	7.00	2.97	306.25	222.73	700.00	462.26	Bhargava and Raghupathi (1993)
Papaya	5.65	0.4	0.88	1.84	5.83	277.78	205.88	648.15	2500.00	Bhargava and Raghupathi (1993)
Sapota	16.50	3.21	1.19	2.59	3.03	218.67	648.21	1512.50	3630.00	Appa Rao *et al*., (2006)
Aonla	15.44	3.09	2.13	3.76	15.44	166.80	631.82	1895.45	1303.13	Appa Rao *et al*., (2006)
Ber	8.24	1.23	5.66	14.47	9.48	210.56	485.90	1114.71	1353.57	Bhargava and Raghupathi (1993)
Banana	9.48	0.87	2.62	2.62	8.46	137.50	25.00	859.38	1527.78	Bhargava and Raghupathi (1993)
Custard apple	16.73	3.18	1.34	2.15	6.78	110.57	88.69	534.04	865.52	Present paper

Table 5. Nutrient composition and calculated DRIS indices for custard apple trees

S. No.	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	Balance	Yield (kg /tree/year)
1 (tree)	1.9	0.14	0.33	0.66	0.19	0.07	135.00	30.1	11.6	7.8	-----	------
Index	2.67	11.38	4.26	5.53	0.77	-8.06	5.84	2.84	22.77	19.00	58.48	20.50
2 (tree)	2.91	0.16	0.33	0.52	0.32	0.12	121.5	25.7	5.35	7.4	-----	------
Index	4.67	11.28	10.4	12.44	20.5	10.46	7.7	-8.19	-7.4	-1.56	14.66	25.75

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