Preliminary DRIS ratio norms for diagnosis of nutrient imbalance in Coorg mandarin

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ABSTRACT

The nutrient management strategies for rational fertilizer application were developed for Coorg mandarin through crop specific and reliable nutrient standards/norms using Diagnosis and Recommendation Integrated System (DRIS) technique. DRIS provided comprehensive leaf nutrient standards for diagnosis of nutrient imbalance for Coorg mandarin. DRIS is a dual ratio concept where the nutrient concentration ratios were considered rather than absolute nutrient concentrations in isolation. The diagnostic norms were essentially developed through a survey conducted in Kodagu region in Karnataka. The data bank of nutrient concentration vs. yield was divided into two sub-groups as low and high yielding based on the yield potential in individual orchards. The individual nutrient concentrations were expressed in as many forms as possible (e.g. N/P, N X P). The variance ratios and coefficient of variation were calculated for all forms of expressions. The nutrient expressions with high variance ratio and low coefficient of variation were chosen as diagnostic norms. Twenty eight nutrient expressions were derived for identification of nutrient imbalance in Coorg mandarin. Among the nutrient expressions selected as diagnostic norms for Coorg mandarin, some expressions such as N/P (6.427), N/K (1.703) and P/Zn (0.0134) were found to have greater physiological rationale in seedling plants. The ratio of N/P (7.17), N/K (1.395) and Zn/P (77.80) and Ca /Mg (5.92) were found important in budded plants. The nutrient imbalance in plants was diagnosed through DRIS indices. DRIS identified zinc and magnesium as the most yield-limiting nutrients.

Key words: Coorg mandarin, DRIS ratio norms, nutrition.

INTRODUCTION

Coorg mandarin is grown extensively in Kodagu district of Karnataka. The performance of the crop however, in the region has steadily declined since early 1980's due to several reasons including that of poor nutrition. Undoubtedly plant nutrition management is one of the most important factors that govern yield potential in Coorg mandarin. Balanced application of nutrients through constant monitoring of leaf nutrient concentration is essential to increase the yield levels of many of the orchards that are showing the symptoms of decline in the recent years. The diagnostic norms are usually developed based on the localized survey of orchards and therefore such norms are region specific. Both the plant analysis information and diagnostic norms are required for evolving nutrient management strategy in Coorg mandarin production. The objective of the investigation was to develop DRIS diagnostic norms for different nutrients based on regional survey for the purpose of identifying yield-limiting nutrients.

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MATERIALS AND METHODS

The data required for establishing leaf nutrient concentration vs. yield data bank was mainly derived based on the survey carried out in various orchards of Coorg mandarin involving collection of leaf samples in orchards with varying yield potential. Total of 233 leaf samples were collected units out which 74 samples were from budded plant and 159 from seedling plants. Both high and medium yielding orchards were included for data bank. The details of the information generated were published earlier (Raghupathi *et al*., 4). The growers in the region adopted no exclusive fertilization package for Coorg mandarin cultivation, as the crop was grown mainly as a mixed crop with coffee. The leaf samples from 4 to 5-month-old non-fruiting terminals at three-fourth leaf expansion stage were collected randomly from the different orchards in the month of December - January. About one hundred leaves were sampled from around 5 to 10 trees per sample. The soils were acidic in reaction and were dominantly Alfisols belonging to great group Typic Paleustalfs. The samples were washed in sequence with liquid detergent, dilute HCl and with double-distilled water. The leaf samples were dried, wet digested and analyzed for N by Kjeldahl's method. Another part of the sample was digested with HNO_3: $HClO_4$ (9:4 v/v). Phosphorus was estimated by vanado-molybdate method and K was estimated by flame photometer (Bhargava and Raghupathi, 2). Atomic absorption spectrophotometer (Perkin Elmer AA Analyst 200) was used for determining Ca, Mg, Fe, Mn and Zn in the acid digest.

Diagnosis and Recommended Integrated System (DRIS) represents a holistic approach to the mineral nutrition of the crops and it is an integrated set of norms representing calibration of plant nutrient composition, soil composition, environmental parameters and farming practices as a function of yield of a particular crop. The premise that the concentration of nutrients changes with the age of the crop or as the concentration of other nutrients increases or decreases, whereas their ratio or product remain fairly constant over a period of time is the under principle of DRIS. Nutrient ratio pairs, rather absolute nutrient concentration is used as reference criteria, since they tend to be relatively stable with the age of the crop. The first step in implementing DRIS is the establishment of standard value or norms. This is done by survey approach in which the yield vs. nutrient concentration data are collected from cropping enterprises and or field experiments from large number of locations, in order to build up the data bank representative of the variation of the growth factors through out the cropping industry.

The DRIS developed by Beaufils (1) was used for interpretation of results and for developing norms for leaf nutrient concentration. The whole population was divided into two groups based on yield performance, as high and low yielding as stated earlier. The high yielding population was made use for norm deriving based on which the yield limiting nutrients in the low yielding plants were identified. Each parameter was expressed in as many forms as possible, *e.g.*, N/P, P/N etc. Mean of each sub-population was calculated for various forms of expressions. The variance ratio between yields of sub-population for all forms of expressions was calculated together with the coefficient of variation. All forms of expressions were taken for developing formulae for calculating the indices. Among different forms of expressions the one showing higher variance ratio (variance of low yielding ÷ variance of high yielding population) was selected as diagnostic norm.

DRIS provides a means of ordering nutrient ratios or products into a meaningful expression called DRIS index. Essentially a nutrient index is mean of deviations of the ratios containing a given nutrient from their respective optimum or norm value. All indices were balanced around zero. Therefore, nutrient indices sum to zero (Walworth and Sumner, 7). The higher negative an index, the more lacking in the nutrient it represented relative to other nutrients used in the diagnosis. Alternatively, a large positive index indicated that the corresponding nutrients were present relatively excessive quantity.

RESULTS AND DISCUSSION

The mean ratio values of high yielding population of the 28 nutrient expressions chosen as diagnostic norms are presented in Tables 1 and 2 for seedlings and budded plants, respectively. Among the nutrient ratios selected to form diagnostic parameters, some expressions like K N/P (6.427), N/K (1.703) and P/Zn (0.0134) were found to have greater physiological rationale in seedling plants. The ratio of N/P (7.17), N/K (1.395) and Zn/P (77.80) and Ca /Mg (5.92/N (1.32) and P/K (0.057) had shown clear physiological rationale in budded plants. The expressions with relatively large CVs were less critical for crop performance. Nonetheless, when the nutrient in question is a major yield-building component, needs to be kept in state of relative balance for maximum efficiency of dry matter production. Ideally it was observed that for particular nutrient ratio to be chosen as a norm should have high variance ratio and small coefficient of variation between high and low yielding groups for higher diagnostic precision

Among different forms of expression P/N ratio norm was 7.17 indicating relatively higher demand for N and lower P in budded plant. The other important expression was N/K/ ratio, which were 1.703 for seedlings and 1.935 for budded plants indicated lower demand for K among budded plants. The other physiologically important expression for banana is P/Zn ratio was 0.0134 and reciprocal of the same express for budded plant was 77.80. The Ca/Mg ratio was 5.828 and 5.92 indicating that the Ca requirement was five times higher compared to that of Mg. Similarly, the norms developed for other nutrients help in identification of critical ratios for normal growth and development. As indicated above when a particular nutrient ratio is not balance compared to the established norms, it becomes difficult to determine which nutrient element is deficient in the ratio. Therefore, it is essential to develop indices for diagnosis of yield limiting nutrients.

The DRIS indices are usually developed for every individual low yielding orchard for diagnosis of yield limiting nutrients and the diagnosis defer for every orchard depending on the soil fertility status and management practice followed. The DRIS indices developed for selected low yielding orchards are presented in Tables 3 and 4. Although no single element was responsible for low yield, Zn was the most common yield-limiting nutrient. The example of indices shown also indicates that although when the nutrient concentration of an element in question was more or less same in seedling and budded plants, the diagnosis was different depending on the relative

Table 1. DRIS ratio norms of nutrient concentration for Coorg mandarin seedling plants.

Ratio	Value	CV %	Ratio	Value	CV %
N/P	6.427	66.54	Mg/K	0.311	86.50
N/K	1.703	50.73	K/Fe	0.0133	69.75
N/Ca	1.417	80.63	K/Mn	0.0407	82.44
N/Mg	6.449	49.52	K/Zn	0.0390	82.33
N/Fe	0.0211	77.80	Ca/Mg	5.828	48.21
N/Mn	0.0563	79.25	Ca/Fe	0.0189	70.42
N/Zn	0.0557	87.11	Ca/Mn	0.055	83.73
P/K	0.399	135.36	Ca/Zn	0.0564	90.26
P/Ca	0.361	153.98	Mg/Fe	0.0032	70.14
P/Mg	1.287	63.43	Mg/Mn	0.0113	97.37
P/Fe	0.00395	84.86	Mg/Zn	0.010	81.51
P/Mn	0.0153	141.63	Mn/Fe	0.570	86.59
P/Zn	0.0134	98.82	Zn/Fe	0.560	93.66
Ca/K	1.587	82.85	Zn/Mn	1.092	54.10

Table 2. DRIS ratio norms of nutrient concentration for Coorg mandarin budded plants.

Ratio	Value	CV %	Ratio	Value	CV %
N/P	7.17	39.25	Mg/K	0.151	30.07
N/K	1.395	32.36	Fe/K	53.81	59.28
Ca/N	0.645	34.59	K/Mn	0.0419	44.75
N/Mg	9.42	20.96	Zn/K	14.74	36.76
Fe/N	38.04	48.02	Ca/Mg	5.92	31.14
N/Mn	0.055	43.54	Ca/Fe	0.0189	34.67
N/Zn	10.781	27.12	Ca/Mn	0.0363	53.01
P/K	0.231	58.02	Ca/Zn	0.0641	45.45
Ca/P	4.754	57.78	Fe/Mg	346.91	42.74
Mg/P	0.795	44.90	Mg/Mn	0.00602	42.39
Fe/P	276.66	64.00	Zn/Mg	100.09	29.95
P/Mn	0.0085	54.64	Fe/Mn	2.02	51.08
Zn/P	77.80	48.95	Fe/Zn	3.585	40.97
Ca/K	0.910	46.23	Zn/Mn	0.572	37.87

concentration of other nutrients. Also, the concentration of the some of the nutrients in leaf was in optimum range when compared with the established norms through conventional technique (Srivastava and Shyam Singh, 5), while DRIS diagnosed the same nutrient concentration as yield limiting factor indicating that the absolute nutrient concentration is not important in diagnosis of nutrient imbalance, rather it is their relative with reference to other nutrients. Interactions among different nutrient have been highlighted in different crops earlier (Fageria, 3).

DRIS showed higher diagnostic sensitivity compared to conventional critical values or optimum ranges. The order in which different nutrients were limiting the yield varied from orchard to orchard. Independent values can be substituted for low yielding orchards for identification of nutrient imbalance by DRIS indices. The sum of the indices irrespective of sign indicated the overall imbalance of nutrients refered to as nutrient imbalance index (NII). The greater is the sum, higher is the imbalance. In the present investigation NII showed the significant

Table 3. Concentration and preliminary DRIS indices for seedling plants.

Nutrient	N	P	K	Ca	Mg	Fe	Mn	Zn	Sum*
			%				ppm		
Concentration	2.25	0.60	0.75	0.67	0.18	42.4	23.5	21.4	
Indices	125	140	-16	-103	-58	-80	7	-15	544
Concentration	1.88	0.50	0.60	1.45	0.23	42.3	25.9	21.3	
Indices	49	89	-67	33	-11	-85	13	-23	370
Concentration	2.89	0.68	0.60	1	0.24	47.2	27	21.4	
Indices	158	136	-99	-47	-26	-89	8	-43	606
Concentration	2.10	0.39	0.70	1.27	0.43	96.4	27.5	22	
Indices	30	1	-76	-40	93	56	-10	-55	361

Table 4. Concentration and preliminary DRIS indices for budded plant samples.

Nutrient	N	P	K	Ca	Mg	Fe	Mn	Zn	Sum*
			%				ppm		
Concentration	2.69	0.64	1.50	1.83	0.28	211.4	30.4	23.1	
Indices	-13	156	-90	-23	-32	285	-179	-105	883
Concentration	2.52	0.46	1.55	1.91	0.28	222.8	28.2	24.7	
Indices	-29	52	-68	1	-19	323	-200	-61	753
Concentration	2.27	0.74	1.30	2.15	0.27	119.9	38.7	24	
Indices	-74	227	-125	69	-25	53	-64	-61	698
Concentration	2.55	0.74	1.80	1.65	0.25	180.7	28	25.5	
Indices	-34	224	-18	-50	-79	219	-209	-54	887

*Sum of indices irrespective of sign

negative correlation with yield among the low yielding orchards (data not shown). Srivastava and Shyam Singh (6) reported significant lowering of in NII due to correction of yield limiting nutrients in Nagpur mandarin.

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