Assessment of nutritional status in date palm (*Phoenix dactylifera*) orchards of cv. piarom through deviation from optimum percentage (DOP) method

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ABSTRACT

Many studies have been carried out in order to determine an accurate and proper method for assessment of nutritional status in plants. Current methods include both soil and plant tissues analysis. Plant analysis is a useful technique for evaluating the nutritional status of plants and can be used accompanied with soil test results in balanced fertilization programs, evaluating the use efficiency of nutrients by the plant. "Deviation from Optimum Percentage" (DOP) is a new and simplemethod compared to the oldermethod named "Diagnosis and Recommendation Integrated System" (DRIS) used forthe interpretation of foliar analysis. Meanwhile, calculation ofindividual nutrient index is much easier with DOP. This study was accomplished to estimatethe DOP of date palm cv. Piarom throughout 2012 growing season across private orchards in Hormozgan province, Iran. Foliar samples were collected in October from 39 date orchards. Average yield and concentration of N, P, K, Ca, Mg, Fe, Cu, Zn, Mn, B, Cl and Na in leaves were determined.The DOP index was calculated for each measured element using the following equation: $DOP = [(C \times 100)/C_R] - 100$, where C is an element concentration in the foliar dry matter, and C_R is the optimal concentration for the same conditions.Results showed that there was an imbalanced nutritional status in the orchards. The calculated average DOP indices in low-yield date palm orchard of cv. Piarom determined the required nutrients orderas: P > B > Zn > Ca > Fe > Mg > Mn > N > Cl > Na > Cu > K. Therefore, we strongly recommend the application of P and micronutrients fertilizers in date (cv. Piarom) orchards of Haji Abad area in Hormozgan provice.

Keywords: Leaf, Nutrient Balance, Nutrient Concentration, Optimal Concentration, Fertilizers.

INTRODUCTION

Date palm is a major agricultural crop in the Near East and North Africa, and it has historically beenconnected with sustaining human life in many of the hot and barren parts of the old world and has becomean integral part of the culture and tradition of the people of these regions (El-Juhany, 2010). Date palm is one of the most important trees in calcareous soils in southern region of Iran."Piarom" date palm has a high quality and a good market in the world (Saleh, 2009).Although plant mineral nutrition and optimization of mineral supply has been the subject of numerous studies for decades since the 19th century, today there is still controversy about the methods for diagnostics and fertilizer management designed to obtain optimal plant productivity and sustainability in agriculture (Osvalde, 2011).The search for an effective method to determine plant nutritional status has been the target of many of thestudies in the area of plant nutrition. Current methods include both soil and tissues analysis (MourãoFilho, 2004).Plant analysis technique is beneficial for evaluating the nutritional status of plants. This method can be used accompanied with soil test results in balanced fertilization programs to evaluate the use efficiency of nutrients in the plant. In addition to considering the timing samples, a standard technique of sampling and analysis, the plant analysis method efficiency is depended on the interpretation of the data of the analysis (Montanes *et al.,* 1993).Different ways of interpreting theresultsofplant analysis arecriticalconcentration, sufficiency level, and DRIS (Tisdale *et al.,* 1990; MourãoFilho, 2004; Osvalde, 2011). Criticalconcentrationisa range ofnutrientconcentrations thatin the lowerborder,plant yield starts to be declined, compared toplants with highernutrient concentrations.In other words, 90 to 95% of maximum yield could be observedin this concentration level.InDRISmethod,an index is calculatedusing the ratio ofnutrientsfor eachelement, which can be found as quantity relativebalanceof nutrientsandnutrient requirements. Unlike as deficiency approachand the criticalconcentration, diagnosis at any stage of plant growths is possible in DRISmethod.However, theabsence ofreliablereferencenorm for many of plant is a practical problem for using this method.Furthermore, DRIS uses nutrient ratios instead of absolute and/or individual nutrient concentrations for interpretation of tissue analysis (MourãoFilho, 2004). In contrast, a simple method was developed, named as Deviation from the Optimum Percentage (DOP).This method is an improvement of the critical levelmethod. It evaluates individual nutrient concentration in relation to the optimum value (Osvalde, 2011). In this method, an index (value) is calculated for eachnutrient. This value can be positive, negative or zero, indicating high, deficiency or suitable concentration of nutrient in the plant, respectively. Some researchers employed DOP method to evaluate the nutritional status of plants (Goudarzi, 2005 in vineyards; Monge at al., 1995 in peach; Samadi and Majidi, 2011 in grape).

The objective of thisstudy was toevaluate nutrientstatus ofdate palmcv. "Piarom" in Hormozgan province using DOP and determine the nutritionalstatus of the plant and the arrangement of the elements as a function of the degree of deficiency.

MATERIALS AND METHODS

The experiment was conducted at private orchards of Haji Abad area, Homozgan province of Iran on date palm cultivar 'Piarom' in 2012 growing seasons.Leaf samples were collected in October 2012 from 39 orchards (5 trees in each orchard were sampled, and then were combined). Samples were washed with tap water,HCl, distilled water and dried in an oven at 70° C for 48 hrs. Dried samples were ground in a stainless steel mill with 0.5 mm sieve,and then digested.Concentrations of N (using Micro- kjeldahl method), P and B (via colorimetry), K and Na (through flame-photometery),Ca, Mg, Fe, Cu, Zn and Mn (using atomic absorption spectrometery)were determined in leaves. Averageyieldwas also determined. In the next step, the orchards were divided into two groups, one group with high yield and the other one showing low yield. Boundaryseparatingthetwo communitieswas50kg pertree. The averageconcentration ofnutrientelementsin samplesfromorchardswithahigh yield (more than50kg pertree) was selected as standardizedandoptimizednutrient concentration. In order to determine thedeviationfromthe optimum percentage (DOP)for eachelementin orchards with low yield (less than50kg pertree), DOP index was calculated. This index evaluates the nutrient concentration in relation to the optimum value by the expression: DOP= $[(C\times100/C_R)-100]$, where C is the element concentration in the leaf dry matter sample and C_R is the optimal concentration for the same conditions (Mello Prado and Caione, 2012).

RESULTS AND DISCUSSION

Table 1shows Mean, Coefficient of Variation and Standard Deviation of nutrient concentrations in leaves belonging to the treeswith high yield. The nutrient concentration in these trees was used as standard nutrient concentration for calculatingthe indices of deviationfromthe optimum percentage (Montanesetal, 1993).

Table 2 shows indices of DOP and required nutrient order for date palm (cv. Piarom) orchards with low yield. The indicesare positive, 0 and negative. Zero value for a nutrient indicates the balanced (optimum) status for that nutrient inthe orchard. Positive and negative value shows excess and deficiency of a nutrient concentration in leavesof trees in an orchard, respectively.

The average of DOP indices in date (cv. "Piarom") orchards with low yield were calculated and required nutrients order was determined as follows:

P> B > Zn > Ca > Fe > Mg > Mn > N > Cl > Na > Cu > K

Results showed that there is an imbalanced nutritional status in the orchards. The required nutrients order indicates that P deficiency is higher than other nutrients. It may be due to the calcareous soils in this area, causingphosphorus to be fixed as apatite compounds. B and Zn deficiencies were placed in next orders. This seems reasonable, because application of micronutrients is not common in date (cv. piarom) orchards. According to the results, almost 90% of the low-yielding orchards were faced with micronutrients deficiency. Other researchers also reported that use of nitrogen and phosphorous (Saleh, 2009) and Fe (Saleh, 2008) fertilizers resulted in increasing date (cv. "Piarom") yield and improved quality of date fruit. Therefore, we strongly recommend the applicationof P and micronutrient fertilizers in date (cv. "Piarom") orchards of Haji Abad area in Hormozgan provice.

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Tables

Table 1: Mean, Coefficient of Variation and Standard Deviation of nutrient concentrations in tree leaves with high yield

Elements	Mean	Coefficient of Variation	Standard Deviation
N (%)	1.167	9.22	0.11
P (%)	0.116	131.38	0.15
K (%)	0.896	37.25	0.33
Ca (%)	0.580	30.19	0.18
Mg (%)	0.299	15.72	0.05
Na (%)	0.017	34.90	0.01
Cl (%)	0.890	15.90	o.14
Zn (mg kg $^{-1}$)	10.211	58.73	6.00
Mn (mg kg $^{-1}$)	61.655	51.67	31.86
Fe (mg kg $^{-1}$)	196.401	18.46	36.25
Cu (mg kg $^{-1}$)	4.972	31.95	1.59
B (mg kg $^{-1}$)	125.459	42.45	53.25

Table 2: Indices of deviation from the optimum percentage for the orchards with low yield

Orchard No.	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
1	-4.60	-25.28	47.37	-22.41	-6.37	3.61	-31.10	-33.21	-15.53	76.07
2	-0.82	-37.30	84.21	-39.66	-13.06	-40.12	-15.71	-48.59	-5.08	-21.01
3	14.78	-29.57	22.81	-10.34	3.66	-22.30	-8.98	-48.68	-5.08	-2.36
4	11.35	-23.56	19.46	-32.76	-3.03	-18.84	27.60	-43.49	37.16	113.77
5	9.20	-28.71	-44.18	12.07	0.32	49.03	-34.49	23.29	5.38	30.88
6	-0.57	-5.52	80.86	-36.21	-33.12	-33.17	-37.85	-7.46	26.70	-63.57
7	9.80	-5.52	-12.92	10.34	-3.03	14.15	-34.44	-7.46	-5.08	14.94
8	-5.88	-30.43	63.00	-3.45	-6.37	-6.52	16.55	23.29	47.62	-67.39
9	0.72	-48.47	32.85	-12.07	-6.37	-33.17	26.87	-29.00	-47.31	-56.80
10	9.80	-12.39	-29.67	27.59	10.35	11.61	0.38	18.10	26.50	-3.00
11	7.32	-39.88	64.11	-34.48	-13.06	-36.12	37.94	2.83	5.58	-74.75
12	2.60	-29.57	25.04	-27.59	-6.37	-2.97	29.43	-53.78	-26.19	22.43
13	-5.20	-36.44	50.72	-43.10	-23.09	-29.70	-19.96	-53.78	5.58	-51.51
14	-20.54	-28.71	-20.73	13.79	-9.71	27.65	0.38	28.39	47.62	-69.95
15	-8.37	-34.72	-60.93	12.07	17.04	3.18	10.70	-69.15	16.04	-44.13
16	15.46	-15.83	-14.04	24.14	3.66	10.54	-33.65	-17.84	-5.08	-82.65
17	10.75	58.90	182.46	-13.79	-16.40	-24.89	-2.08	-17.74	5.58	0.59
18	4.49	-26.13	66.35	-12.07	-9.71	-0.66	-23.45	13.01	121.42	-72.26
Mean	**2.79**	**-22.17**	**30.93**	**-10.44**	**-6.37**	**-7.15**	**-5.10**	**-17.85**	**13.10**	**-19.48**

Continue from Table 2

Orchard No.	Cl	Na	Requirement order	Yield (kg/tree)
1	14.61	74.00	Zn > Mn > P > Ca > Cu > Mg > N > Fe > Cl > K > Na > B	44
2	20.22	-16.00	Fe > Zn > Ca > P > B > Na > Mn > Mg > Cu > N > Cl > K	34
3	13.48	32.00	Zn > P > Fe > Ca > Mn > Cu > B> Mg > Cl > N > K > Na	22.6
4	3.37	26.00	Zn > Ca > P > Fe > Mg > Cl > N > K > Na > Mn > Cu > B	27
5	-25.84	2.00	K > Mn > P > Cl > Mg > Na > Cu > N > Ca > Zn > B > Fe	34
6	-19.10	2.00	B > Ca > Mn > Fe > Mg > Cl > Zn > P > N > Na > Cu > K	33
7	-12.36	-22.00	Mn > Na > K > Cl > Zn > P > Cu > Mg > N > Ca > Fe > B	36
8	20.22	44.00	B > P > Fe > Mg > N > Ca > Mn > Cl > Zn > Na > Cu > K	26
9	23.60	-4.00	B > P > Cu > Fe > Zn > Ca > Mg > Na > N > Cl > Mn > K	46
10	-12.36	2.00	K > P > Cl > B > Mn > Na > N > Mg > Fe > Zn > Cu > Ca	31.4
11	16.85	-16.00	B > P > Fe > Ca > Na > Mg > Zn > Cu > N > Cl > Mn > K	43
12	24.72	2.00	Zn > P > Ca > Cu > Mg > Fe > Na > N > B > Cl > K > Mn	31
13	14.61	2.00	Zn > B > Ca > P > Fe > Mg > Mn > N > Na > Cu > Cl > K	18.6
14	-14.61	26.00	B > P > K >N > Cl > Mg > Mn > Ca > Na > Fe > Zn > Cu	14
15	-22.47	-28.00	Zn > K > B > P > Na > Cl > N > Fe > Mn > Ca > Cu > Mg	34
16	-11.24	32.00	B > Mn > Zn > P > K > Cl > Cu > Mg > Fe > N > Ca > Na	26
17	4.49	-16.00	Fe > Zn > Mg > Na > Ca > Mn > B > Cl > Cu > N > P > K	29
18	24.72	62.00	B > P > Mn > Ca > Mg > Fe > N > Zn > Cl > Na > K > Cu	34
Mean	3.50	11.3	P > B > Zn > Ca > Fe > Mg > Mn > N > Cl > Na > Cu > K	