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Nutritional Status and Sufficiency Ranges of Nutrients Based on DRIS Method of Onion Plants (*Allium cepa L.*) Grown in Sandy Soil

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Abstract: The Diagnosis and Recommendation Integrated System (DRIS) method was employed to monitor the nutrients status of onion plants (*Allium cepa* L.) grown in sandy soil at winter season in the Nubaria, Behira Governorate. DRIS norms were established for various nutrient ratios obtained from high yield group of onion plants. Seventy two samples of bulb were analyzed for N, P, K, Fe, Mn, Zn and Cu content and bulb yield were recorded of onion farms fromNubaria, Behira Governorate. The forms of expression for different nutrients and their norms were selected, based on the highest variance ratio between low and high yielding group. The results showed that the average yield in the high-yielding group was 16.14ton ha^{-1}, while the average yield in the low-yielding group was 11.18ton ha^{-1}. Theselected DRIS norms of onion plants grown in sandy soil wereP/N: 0.154, K/N: 0.348, N/Fe: 83.45, Mn/N: 0.0015, Zn/N: 0.0017, Cu/N: 0.006, P/K: 0.441, P/Fe: 12.74, P/Mn: 106.5, Zn/P: 0.011, Cu/P: 0.004, Fe/K: 0.035, Mn/K: 0.004, Zn/K: 0.005, Cu/K: 0.002,Fe/Mn: 8.382, Fe/Zn: 7.202, Fe/Cu: 20.34, Zn/Mn: 1.164, Cu/Mn:0.413, Cu/Zn: 0.355. The sufficient ranges for N, P and K were 1.987 - 2.769 %, 0.282 - 0.448 % and 0.704 - 0.944 %, respectively. As well as, the sufficient ranges for Fe, Zn, Mn and Cu were 258.3 - 312.7, 29.72 - 38.64, 34.96 - 44.46 and 11.79 - 16.51 ppm, respectively. Determine the optimum values in bulb are an important indicator of the high quality of the bulbs, becausethe relationship between of those nutrientsand all these vehicleswhich are expressive on bulbquality.

Keywords: DRIS method; Nutrients status; Sufficiency ranges; Onion plants.

1. Introduction

Onion plant (*Allium cepa* L.) is a species of the Alinaceae family that has a great economic importance and the second most important vegetable crop in the world. Cultivated area of onions annually in Egypt of about 150,000feddan, Egyptian production of onion crop with 7% of world production [1]. Onion plant is cultivated for ultimate uses as green and bulbs. Additionally, it has medicinal properties in the treatment and prevention a number of serious diseases [2, 3] that attributed with onion biochemical constituents.

The diagnosis of the nutritional status of a crop can be done through the interpretation of the results of leaf analysis, using different methods such as Critical level (CL), Sufficiency Range (SR), Diagnosis and Recommendation Integrated System (DRIS) and Compositional Nutrient Diagnosis (CND).

Diagnosis and Recommendation Integrated System (DRIS) was created by Beaufils [4], and it is depends on comparison of indices calculated in accordance with the reciprocal relationship between twonutrients. Afeature of this method is decreasing dilution or concentration effects because it is based on a relationship of equilibrium between nutrients [5].The first step to execution DRIS or any other diagnostic method is the establishment of standard values or norms [6]. To set up the DRIS norms, it is necessary to use a representative value of nutrient concentrations and total yield toobtain accurate estimates of means and variances ofcertain nutrient ratios that distinguish betweenhigh- and low-yielding populations.

The aim of this paper study nutritional state and establishment of sufficiency ranges of onion(*Allium cepa* L.) plants grown in sandy soilby using DRIS method.

2. Materials and Methods

A total of 36 onion fields were sampled during the 2015 season fromNubaria region west of Nile Delta of Egypt.Somephysical and chemical properties of the cultivated soilwere evaluated in samples (0-15 cm) taken during the period of onion harvest according to standard procedures reported by Cotteine [7] to be then presented in (Tables, 1 and 2)

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Table-1. Some physical properties of soils during the period of onion harvest.

Depth (cm)	Sand %		Silt %	Clay%	Texture. Class
	Coarse	fine			
0 - 15	79.90	15.18	0.66	4.26	Sand

Table-2. Some chemical properties of soils during the period of onion harvest.

Depth cm	$CaCO_3$ %	pH *	ECe mmohs m^{-1}	Anions meq/1				Cationsmeq/1			
				Cl^-	$CO_3^=$	HCO_3	$SO_4^=$	Na^+	K^+	Ca^{++}	Mg^{++}
0-15	1.70	8.1	1.2	0.96	nd	1.10	9.60	1.54	0.52	6.12	4.60

nd= not determined * (1:2.5) suspension

Onion yield data and seventy two leaf samples were collected in commercial onion fields. Onion yield data were collected from sampled fields. Yield and nutrients concentration built a databank, which was divided into high- (≥12 ton ha^{-1}) and low- yield (yield ≥12 ton ha^{-1}) groups. Leaf samples were dried at 65C° for 48 hrs, ground and wet digested using H_2SO_4: H_2O_2 method described by Cotteine [7]. The digests samples were then subjected to measurement of N using Micro-Kjeldahle method; P was assayed using molybdenum blue method and determined by spectrophotometer [8], K was determined by Flame Photometer, while Fe, Zn, Mn and Cu were determined using atomic absorption spectrophotometer.

Nutrient concentration data DRIS norms and coefficients of variation (CVs) of the bulb yield and bulb tissue were derived according to the procedure of [9]. Mean values or norms for each nutrient expression together with their associated CVs and population ofand variances were then calculated for the two sub-populations. The mean values in the high-yielding subpopulation of twenty one expressions involving seven nutrients (N, P, K, Fe, Zn, Mn and Cu) were ultimately chosen as the diagnostic norms for onion plants. The sufficiency range for leaf tissues of onion crop was determined by the DRIS technique. The range of 'sufficiency' are the values derived from the mean ± 4/3 SD and mean ± 8/3 SD (standard deviation), respectively [10]. The value of nutrients< (mean-8/3 SD) are considered deficient, whereas their low range included all values between> (mean-8/3 SD) and < (mean - 4/3 SD). Values between> (mean - 4/3 SD) and < (mean + 4/3 SD) are taken as sufficient, whereas the range between >(mean + 4/3 SD and <(mean + 8/3 SD) are expressed as high. The nutrient concentrations > mean + 8/3 SD are expressed as excessive or toxic.

3. Results and Discussion

Onion crops in 50 fields were ranked in the high-yielding group (yield ≥12 ton ha^{-1}), while 22 fields yielded <12 ton ha^{-1}. The average yield in the high-yielding group was 16.14ton ha^{-1}, while the average yield in the low-yielding group was 11.18ton ha^{-1} (Table, 3).

Data in (Table, 3) indicated to comparison between the values of yield and N, P, K, Fe, Mn, Zn and Cu under high and low group. Naturally, the values of yield and nutrients under high group are higher than under lower group. Logically, there is a strong correlation between a high content of nutrients within the different plant parts and high values of the crop. These results were in agreement with several researchers such as Bailey, *et al.* [11], [12], [13].

Table-3. Mean, coefficient of variation (CV), variance and variance ratio between the low- and high yielding groups (S^2_L/S^2_H) of both yield and nutrient contents in the bulbs dry matter of onion at high- and low- yielding groups.

Variable	Group	Mean	CV (%)	Variance	S_L/S_H
Yield (ton ha^{-1})	High Low	16.14 11.18	20.07 15.80	13.24 4.339	0.328
N (g kg^{-1})	High Low	2.378 2.082	3.616 5.908	0.086 0.123	1.430
P (g kg^{-1})	High Low	0.365 0.341	1.096 0.587	0.004 0.002	0.500
K (g kg^{-1})	High Low	0.842 0.742	0.971 1.078	0.008 0.008	1.000
Fe (mg kg^{-1})	High Low	285.5 272.7	145.6 93.40	415.8 254.7	0.613
Mn(mg kg^{-1})	High Low	34.18 30.71	32.71 29.19	11.18 8.964	0.802
Zn (mg kg^{-1})	High Low	39.71 36.94	31.91 15.12	12.67 5.585	0.623
Cu (mg kg^{-1})	High Low	14.15 12.91	22.16 11.55	3.136 1.491	0.475

The mean, coefficient of variation, variance of all nutrient ratios of the high- (S^2_H) and low-yielding group (S^2_L) and the variance ratio between the low- and high- yielding group(S^2_L/S^2_H) ratio are shown in (Table, 4).The selection of a nutrient ratio as DRIS norms (i.e.: N/P or P/N) is indicated by the S^2_L/S^2_H ratio [14].The selected DRIS norms of onion plants grown in sandy soil were P/N: 0.154, K/N: 0.348, N/Fe: 83.45, Mn/N: 0.0015, Zn/N: 0.0017, Cu/N: 0.006, P/K: 0.441, P/Fe: 12.74, P/Mn: 106.5, Zn/P: 0.011, Cu/P: 0.004, Fe/K: 0.035, Mn/K: 0.004, Zn/K: 0.005, Cu/K: 0.002,Fe/Mn: 8.382, Fe/Zn: 7.202, Fe/Cu: 20.34, Zn/Mn: 1.164, Cu/Mn:0.413, Cu/Zn: 0.355.Caldwell, *et al.* [15] showed that DRIS norms of onion plants grown in sandy soil were taken from five factorial fertilizer trials conducted in the field from 1988 to 1990, DRIS norms were P/N, K/N, Mn/N, Zn/N, Cu/N, Mn/P, Zn/P, Cu/P, Mn/K, Zn/K, Cu/K, Zn/Mn, Cu/Mn and Cu/Zn.

Table-4. Mean, coefficient of variation (CV) and variance (S2) of nutrient ratios of the low- and high-yielding groups, the variance ratio (S^2_L / S^2_H) and the selected ratios for onion DRIS norms.

Ratios	High yielding group			Low yielding group			S^2_L/S^2_H	Selected ratios
	Mean	CV(%)	Variance (S^2_H)	Mean	CV(%)	Variance (S^2_L)		
N/P	6.604	12.43	0.674	6.113	10.27	0.394	0.585	
P/N	0.154	12.99	0.0001	0.165	10.30	$29*10^{-5}$	0.723	√
N/K	2.891	8.72	0.064	2.813	13.72	0.149	2.346	
K/N	0.348	8.91	0.001	0.362	14.09	0.0026	2.707	√
N/Fe	83.45	12.43	107.537	76.47	16.76	164.3	1.528	√
Fe/N	0.012	16.67	$4*10^{-6}$	0.013	15.38	$4*10^{-6}$	1.00	
N/Mn	698.7	12.74	7924.6	681.5	17.53	14280.2	1.802	
Mn/N	0.0015	13.33	0.0001	0.001	30.00	$9*10^{-8}$	2.250	√
N/Zn	601.1	12.87	5984.6	565.1	16.91	9129.8	1.526	
Zn/N	0.0017	11.76	$4*10^{-8}$	0.002	15.00	$9*10^{-8}$	2.250	√
N/Cu	1693.2	12.64	45796.0	1623.4	18.55	90661.2	1.980	
Cu/N	0.006	1.17	$5*10^{-9}$	0.001	10.00	$1*10^{-8}$	2.041	√
P/K	0.441	8.16	0.001	0.46	8.91	0.0017	1.297	√
K/P	2.283	8.19	0.035	2.19	9.00	0.039	1.110	
P/Fe	12.74	12.32	2.46	12.5	12.56	2.465	1.000	√
Fe/P	0.08	15	$14*10^{-4}$	0.081	13.58	$12*10^{-4}$	0.840	
P/Mn	106.5	11.64	153.8	111.1	11.18	154.3	1.003	√
Mn/P	0.01	10	$10*10^{-7}$	0.009	11.11	$1*10^{-6}$	1.000	
P/Zn	91.65	11.95	119.9	92.28	11.55	113.6	0.948	
Zn/P	0.011	9.09	$10*10^{-7}$	0.011	9.09	$1*10^{-6}$	1.000	√
P/Cu	257.7	10.23	694.850	264.4	11.58	937.6	1.349	
Cu/P	0.004	10	$16*10^{-8}$	0.004	12.50	$2.5*10^{-7}$	1.563	√
K/Fe	28.82	6.711	3.740	27.18	9.06	6.061	1.621	
Fe/K	0.035	8.571	$9*10^{-6}$	0.037	10.81	$16*10^{-6}$	1.778	√
K/Mn	241.35	7.396	318.6	241.9	8.93	466.6	1.464	
Mn/K	0.004	7.5	$9*10^{-8}$	0.004	10.00	$1.6*10^{-7}$	1.778	√
K/Zn	207.4	6.051	157.5	200.7	7.99	257.0	1.631	
Zn/K	0.005	6	$9*10^{-8}$	0.005	8.00	$1.6*10^{-7}$	1.778	√
K/Cu	584.7	6.691	1530.4	575.6	9.59	3047.0	1.991	
Cu/K	0.002	5	$10*10^{-9}$	0.002	10.00	$4*10^{-8}$	4.000	√
Fe/Mn	8.382	4.939	0.171	8.911	4.41	0.154	0.901	√
Mn/Fe	0.12	5	$36*10^{-6}$	0.112	4.46	$25*10^{-6}$	0.694	
Fe/Zn	7.202	2.791	0.040	7.392	2.49	0.0339	0.838	√
Zn/Fe	0.139	2.878	$16*10^{-6}$	0.135	2.22	$9*10^{-6}$	0.563	
Fe/Cu	20.34	7.645	2.418	21.2	4.93	1.0920	0.452	√
Cu/Fe	0.049	6.122	$9*10^{-6}$	0.047	4.26	$4*10^{-6}$	0.444	
Mn/Zn	0.861	5.459	0.0022	0.83	2.53	$4.4*10^{-4}$	0.200	
Zn/Mn	1.164	5.069	0.0035	1.205	2.49	0.0009	0.259	√
Mn/Cu	2.427	5.356	0.017	2.379	2.48	0.0035	0.206	
Cu/Mn	0.413	5.085	$44*10^{-5}$	0.42	2.62	$1.2*10^{-4}$	0.274	√
Zn/Cu	2.824	6.480	0.033	2.867	3.63	0.0108	0.323	
Cu/Zn	0.355	6.197	$48*10^{-5}$	0.349	3.72	0.0002	0.349	√

Some of the selected nutrients ratios showed a lower coefficient of variation (CV) than the other possible nutrient ratio for the same pair of nutrients (i.e.: $CV_{N/Fe}$ = 12.43% < $CV_{Fe/N}$ = 16.67%), this resultwas in agreement with [16].

The DRIS method can be employed to calculate deficient, low, sufficient, high and exceed rangesfor nutrients, following the procedure developed by Bhargava [10] and Abd El-Rheem, *et al.* [17]**.** The Sufficiency ranges of N, P, K, Fe, Zn, Mn and Cu derived from a nutrient indexing survey of onion crop grown in sandy soil are shown in (Table, 5).

Table-5. Sufficiency ranges of nutrients derived DRIS method of onionbulbs grown in sandy soil.

Nutrients	Deficient	Low	Sufficient	High	Exceed
N (%)	< 1.597	1.597-1.987	1.987 - 2.769	2.769 - 3.159	> 3.159
P (%)	< 0.200	0.200- 0.282	0.282 - 0.448	0.448 - 0.530	> 0.530
K (%)	< 0.584	0.584 - 0.704	0.704 - 0.944	0.944 - 1.064	> 1.064
Fe (ppm)	< 231.1	0.231 - 258.3	258.3 - 312.7	312.7 - 339.9	> 339.9
Mn (ppm)	< 25.26	25.26 - 29.72	29.72 - 38.64	38.64 - 43.10	> 43.10
Zn (ppm)	< 30.21	30.21 - 34.96	34.96 - 44.46	44.46 - 49.20	> 49.20
Cu (ppm)	< 9.427	9.427 - 11.79	11.79 - 16.51	16.51 - 18.87	> 18.87

It was found that the sufficient ranges for N, P and K were 1.987 - 2.769 %, 0.282 - 0.448 % and 0.704 - 0.944 %, respectively. Likewise, the sufficient ranges for Fe, Zn,Mn and Cu were 258.3 - 312.7, 29.72 - 38.64, 34.96 - 44.46 and 11.79 - 16.51 ppm, respectively. Caldwell, *et al.* [15] indicated that sufficiency ranges for N, P, K 3.00 - 3.8 %, 0.27 - 0.40 % and 2.00 - 3.40 %, respectively of onion leaves grown in sandy Ultisols.

Determine the optimum values in bulb are an important indicator of the high quality of the bulbs, because the relationship between of those nutrients and all these vehicles which are expressive on quality. Bulb quality was including bulb content of carbohydrates, protein and fat, water and total of soluble solids. The nutrients which significantly contribute in increasing the bulb carbohydrate levels respectively are Mg> C>Ca = P> S>N, because important role of these nutrients in photosynthesis process, chlorophyll molecules and formation and translocation of carbohydrate in onion plants [18]. Alam, *et al.* [19] showed that increasing N, K and S content led to increase the protein of onion bulb, because N serves as a component of protein, K involves in protein synthesis and S is a component of some of amino acids.

As well as, the optimum or sufficient ranges of nutrients were important indicator of a perfect management fertilization program, which led to increasing quantity and quality of yield especially under newly reclaimed soils. Optimum fertilizers application for onion and cultivation of suitable cultivars under reclaimed soils are necessary for obtaining high quality of bulbs. The essential nutrients particularly N, P and K are necessary for plants growth, bulb yield and quality [20, 21].

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