Journal

J. Biol. Chem. Environ. Sci., 2011, Vol. 6 (1):131-151
www.acepsag.org

PRELIMINARY DRIS NORMS AND DRIS INDICES FOR MAIZE GROWN IN NUBARIA REGION, EGYPT.

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ABSTRACT

A regional survey was conducted in Nubaria region, concerning maize (Zea mays L.) in order to develop diagnostic norms and evaluate yield- limiting nutrients in case of low-yielding maize.The leaf nutrient status was interpreted using Diagnosis and Recommendation Integrated System (DRIS) of Beaufils (1973). Leaf samples were taken at the silking stage and analyzed for N, P, K, Ca, Ng, Fe, Mn, and Zn. Nutrient indices were calculated using published standards and locally-developed indices (Nubaria region). Preliminary DRIS norms for maize leaves are developed from 287 sets of data on elemental (NPKCaMgFeMnZn) leaf composition and corresponding yields. This is done by dividing the population of observations into two subpopulations on basis of yield. The norms are calculated from those forms of expressing the leaf parameters which significantly discriminate between the two subpopulations.

The degree of nutrient imbalance in plant is expressed in terms of DRIS index which measures the extent to which a particular nutrient deviates from the established norm. The norms are developed in such a way that the influence of age of tissue sampled on the diagnostic index is minimized. The DRIS norms enable one to diagnose whether N,P, K,Ca,Mg,Fe,Mn or Zn is the nutrient most limiting to maize production in a particular case to be diagnosed. However the DRIS studies can be made irrespective of variety and age at which the plant leaf is sampled.

The DRIS system in predicting nutrient imbalances even when the nutrient concentration in the plant is in or above the critical or suficiency level range, is illustrated.

Key words: plant, foliar and tissue analyses, mineral nutrition, physiological diagnosis, leaf composition, DRIS.

INTRODUCTION

Maize (Zea mays L.) requires substantial amount of nutrients for maximum yield and quality. Reliable nutrient norms for obtaining adequate nutrient balance is, therefore, required for rationalization of nutrient applications. Nutrient status in plants is diagnosed using nutrient concentration or dual ratios in selected tissues (Walworth and Sumner,1987). The use of dual ratios in the program of diagnosis and recommendation integrated system"DRIS"(Beaufils 1973) instead of nutrient concentration could reduce the effect of nutrient interation, dilution or accumulation in plant tissues. The DRIS developed norms from data banks of observations representative of a particular cropping system, consisting of a minimum of tissue nutrient contents and associated yields.The norms which are used as reference standards against which samples to be diagnosed and compared, are calculated as the means of the various forms of expressing the nutrients (N%,P%,K%,N/P,N/K,P/K,… etc.) for a high yield population of plants. DRIS norms are derived from a population of observations of leaf compositions and corresponding yields representing the variability encountered by the crop in the field. This population is subdivided on the basis of yield and visual appearance of the crop in the field into two subpopulations, one of which is a subpopulation of high-yielding, good-looking plants. The means are derived by selecting the forms expressing leaf composition (for example, N/P and N/K) and discriminate between the high-and low-yielding subpopulations in terms of a significant variance ratio, where the mean values for the selected forms are the basis of the norms.

This approach utilizes indices that measure the degree of nutrient balance within the plant and rank the nutrients in their limiting order of requirement by the plant (Beaufils, 1973; Beaufils and Sumner, 1977; Sumner, 1977, 1978 and 1979 and Raghupathi and Bhargava, 1998).

The objectives of this study are to develop DRIS indices for maize grown in newly reclaimed soils of low fertility and hence more than two or three nutrients were found to be yield- limiting . Comparing the locally derived norms with the existed nonlocal norms and identifying the order of the most nutrient (or nutrients) among the tested nutrients (N,P,K,Ca,Mg,Fe,Mn and Zn) and the order in which other elements would likely become limiting are next goals of the study .

MATERIALS AND METHODS

A regional survey was conducted in 287 locations of maize crop involving collection of leaf and soil samples, informations on yield, and other management practices. The samples were collected at the silking stage from plants distributed in five inspections of Nubaria region, i.e., Tiba, West Nubaria, North Tahrir, Sugar beet and El-Hammam.Inspection locations of the study area are as illustrated in Fig.1. The sites from which the samples were collected are shown in Fig. 2.

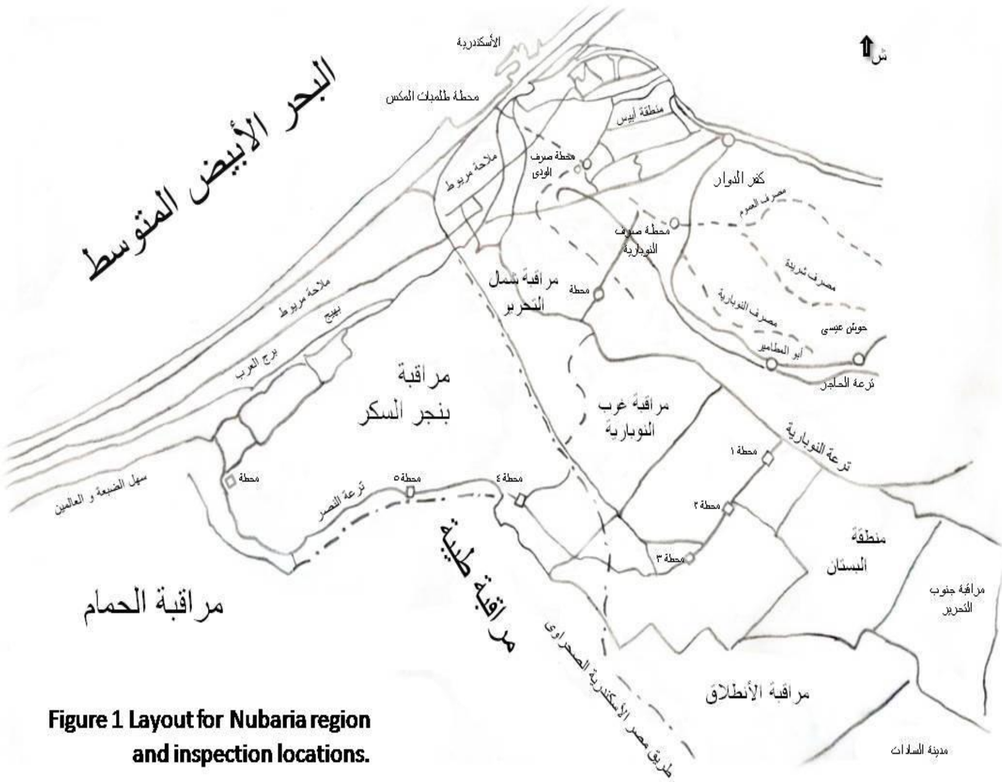

Figure 1 Layout for Nubaria region and inspection locations.

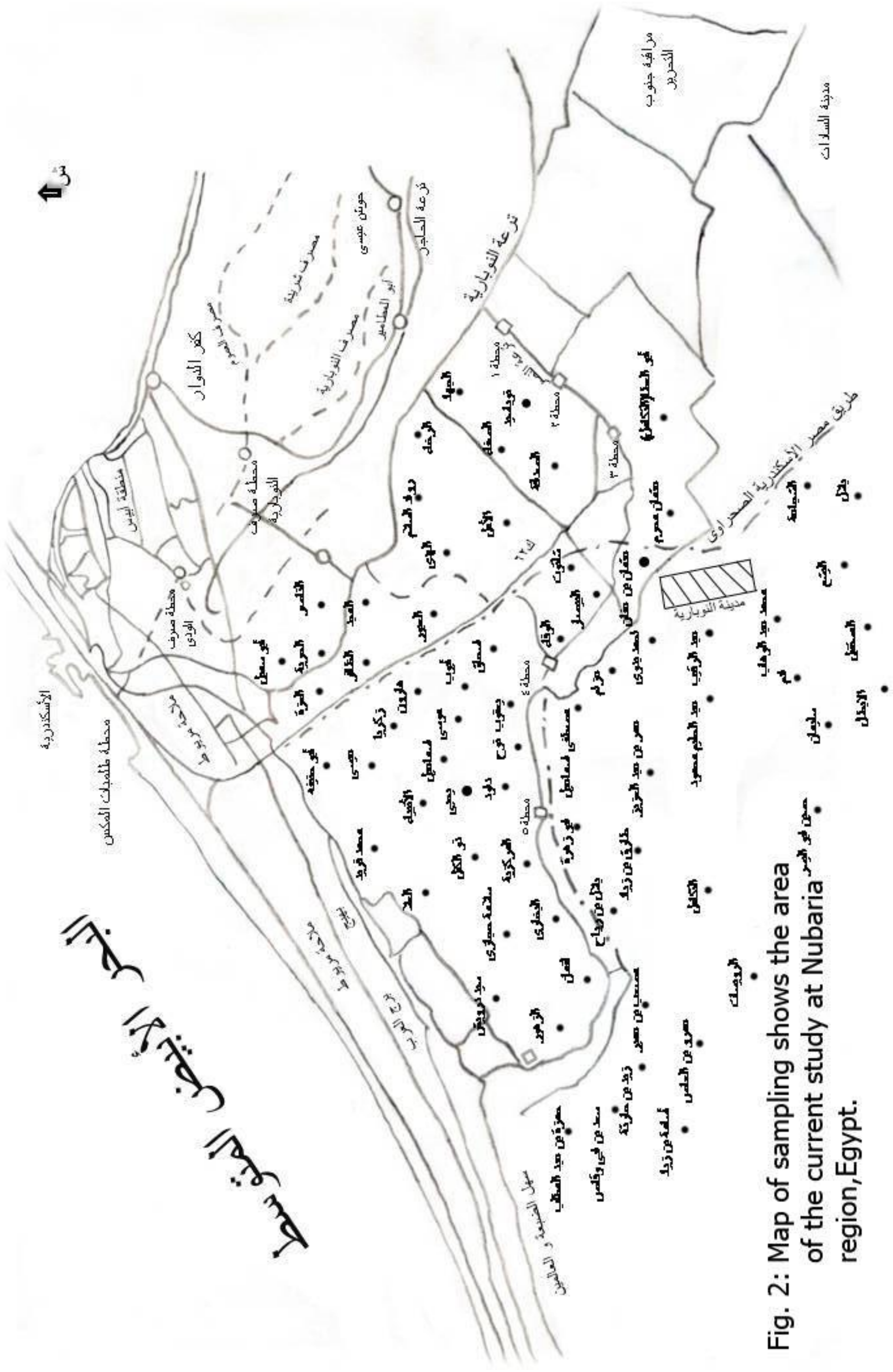

Fig. 2: Map of sampling shows the area of the current study at Nubaria region,Egypt.

At silking stage, from each selected field the leaf opposite and below ear was removed for nutrient analysis. The foliar samples were decontaminated, dried at 70 °C, ground and wet digested using H_2SO_4 and $HClO_4$ Total nitrogen was determined by the micro Kjeldahl method (Bremner and Mulvancy, 1982). Phosphorus in digests was colourmetrically measured according to the procedure of John (1970). Potassium was determined by flame photometer as described by Jackson (1967). Atomic absorption was used for estimation of Ca, Mg, Fe, Mn and Zn (Bhargava and Raghupathi, 1993).

Corresponding maize plants were harvested at maturity stage from each field and the grain yield was recorded. All collected samples(287) were divided into high yielding populationplants $\geq$ 3.24 Mg grains / feddan. DRIS norms were calculated for the high yielding population because the high yield usually results from balanced nutrients in plant.Physical snd chemical properties in soil are presented in Tables 1, 2 and 3.

Table 1: Soil physical properties of Nubaria soils of inspection.

Inspection	Depth cm	Bulk density Mg/m³	Partical size distribution			Texture class
			Sand %	Silt%	Caly %	
North Tahrir	0-30	1.32	49.43	1.102	29.47	Sandy clay loam
	30-60	1.36	46.45	25.37	28.18	Sandy clay loam
West Nubaria	0-30	1.26	88.40	4.10	7.50	Sand
	30-60	1.13	91.50	3.50	5.00	Sand
Sugar beet	0-30	1.45	51.00	26.00	23.00	Sandy clay loam
	30-60	1.61	46.00	24.00	30.00	Sandy clay loam
El-Hammam	0-30	1.55	53.10	21.60	25.30	Sandy clay loam
	30-60	1.59	57.00	16.00	27.00	Sandy clay loam
Tiba	0-30	1.29	48.00	24.00	28.00	Sandy clay loam
	30-60	1.33	50.30	23.50	26.20	Sandy clay loam

Table 2: Soil chemical properties of Nubaria soils of inspection.

Inspection	Depth cm	$CaCO_3$ %	pH	EC*	Soluble ions (mmolc/l)							
					Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}
North Tahrir	0- 30	18.80	8.10	1.75	7.14	1.68	7.83	0.36	0.00	1.87	7.84	7.30
	30-60	15.47	7.90	1.81	9.18	2.58	3.78	1.77	0.00	4.97	1.96	10.38
West Nubaria	0-30	13.22	8.00	1.50	7.14	1.19	6.75	0.35	0.00	2.91	5.88	6.64
	30-60	8.10	7.60	2.80	12.24	4.42	11.00	0.45	0.00	5.10	7.84	15.17
Sugar beet	0-30	33.20	8.60	4.00	15.30	5.96	16.87	3.00	0.00	6.19	9.80	25.14
	30-60	32.10	8.20	4.05	24.48	4.92	12.53	1.77	0.00	5.68	7.84	30.18
El-Hammam	0-30	29.23	8.40	3.25	11.73	5.91	14.40	0.46	0.00	4.25	11.76	16.49
	30-60	26.00	8.20	2.20	7.14	3.64	10.96	0.35	0.00	1.53	6.86	13.70
Tiba	0-30	37.20	8.70	2.60	12.18	5.03	10.96	0.50	0.00	9.40	5.88	13.39
	30-60	34.00	8.30	2.15	8.16	3.11	10.60	0.43	0.00	7.40	5.88	9.02

* EC in dS/m of the saturation extract.

Table 3: Soil contents of organic matter, total nitrogen and available phosphorus, potassium, iron, manganese and zinc in Nubaria inspections.

Inspection	Depth cm	$CaCO_3$ %	pH	EC*	Soluble ions (mmolc/l)							
					Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}
North Tahrir	0- 30	18.80	8.10	1.75	7.14	1.68	7.83	0.36	0.00	1.87	7.84	7.30
	30-60	15.47	7.90	1.81	9.18	2.58	3.78	1.77	0.00	4.97	1.96	10.38
West Nubaria	0-30	13.22	8.00	1.50	7.14	1.19	6.75	0.35	0.00	2.91	5.88	6.64
	30-60	8.10	7.60	2.80	12.24	4.42	11.00	0.45	0.00	5.10	7.84	15.17
Sugar beet	0-30	33.20	8.60	4.00	15.30	5.96	16.87	3.00	0.00	6.19	9.80	25.14
	30-60	32.10	8.20	4.05	24.48	4.92	12.53	1.77	0.00	5.68	7.84	30.18
El-Hammam	0-30	29.23	8.40	3.25	11.73	5.91	14.40	0.46	0.00	4.25	11.76	16.49
	30-60	26.00	8.20	2.20	7.14	3.64	10.96	0.35	0.00	1.53	6.86	13.70
Tiba	0-30	37.20	8.70	2.60	12.18	5.03	10.96	0.50	0.00	9.40	5.88	13.39
	30-60	34.00	8.30	2.15	8.16	3.11	10.60	0.43	0.00	7.40	5.88	9.02

* EC in dS/m of the saturation extract.

Calculating the DRIS indices:

The DRIS (diagnosis and recommendation integrated system) reference norms of Beaufils (1973) were established using the criterion of significant variance ratio between desirable (high yielding) and undesirable (low yielding) subpopulations .

Maize grain yield of 3.24 Mg/ fed. was taken as a value to separate the data base of 287 observations into low and high yielding subpopulations. The high yielding subpopulations of 116 observations comprised 40.42% of the total observations while, the low yielding subpopulations of 171 observations comprised 59.58% of the total observations.

Each of the eight tested nutrients (N, P, K, ca, Mg, Fe, Mn and Zn) was expressed as a numerator and again as a denominator of ratios with each of the other seven nutrients. The means and variances were calculated in the two subpopulations (high yielding and low yielding) for each nutrient. The DRIS reference parameters were selected as those nutrient ratios which gave the highest and significant values for the variance ratios between the two subpopulations (variance of low yielding populations / variance of high yielding populations). The DRIS norms for N/P, N/K and P/K show the highest and significant variance ratios between the two subpopulations.The N/P or N/K or P/K must be computed only for the high yielding subpopulations and then divided by the number of observations of each expression. Thus the norm of n/p = $\frac{\sum N/P}{z}$ and the norm of n/k = $\frac{\sum N/K}{z}$ and the norm of p/k = $\frac{\sum P/K}{z}$

Where:

N: Refers to nitrogen concentration percent N(%) in leaf under diagnosis.

P: Refers to phosphorus concentration percent P(%) in leaf under diagnosis.

K: Refers to potassium concentration percent K(%) in leaf under diagnosis.

z: Number of high yielding observations.

n/p: is DRIS norm for nitrogen / phosphorus.

n/k: is DRIS norm for nitrogen / potassium.

p/k: is DRIS norm for phosphorus/ potassium.

DRIS indices used in the current investigation are quantitative evaluations of the relative degree of imbalance among the nutrients under study that can be calculated from the following equations:

$$\text{N index} = +\left[\frac{f(N/P)+f(N/K)}{2}\right]$$

$$\text{P index} = -\left[\frac{f(N/P)-f(P/K)}{2}\right]$$

$$\text{K index} = -\left[\frac{f(P/K)+f(N/K)}{2}\right]$$

Where:

$$f(N/P)=\left[\frac{N/P}{n/p}-1\right]\frac{1000}{C.V}$$ when the actual value of N/P > n/p.

Or $$f(N/P)=\left[1-\frac{n/p}{N/P}\right]\frac{1000}{C.V}$$ when the actual value of N/P < n/p,

n/p is the mean (norm) value for N/P, and C.V is coefficient of variation for high-yielding populations.

The other terms of *f*(N/K) and *f*(P/K) are derived in a similar way using the means, n/k for N/K and p/k for P/K, respectively in place of n/p.

The DRIS indices have positive and negative values which always sum to zero as they measure the relative balance among N, P and K or other nutrients that might be included.

The order of plant nutrient requirements is affected by the value of the index where, the most negative index reflect the most required nutrient (Sumner, 1977a, 1977b, 1981; Letzsch and Sumner, 1984; El-Wali *et al.,* 1985; Walworth *et al.,* 1988; Goh and Malakout, 1992; Khiari *et al.*, 2001; Abdel Warth, 2002 and Abd El-Hady, 2004).

Physiological diagnosis chart for N, P and K:

The N/P, N/K and K/P forms of expression are interrelated in a three coordinate DRIS chart (Fig. 2). The point of origin in the center of the chart represents the mean of each expression N/P, N/K and K/P for the populations of high yielding plants. In other words, this is the composition desired in order to increase the chances of obtaining a high yield. However, this desired composition should not be considered as a single inflexible point but rather as a range encompassed by the inner of the two concentric circles as shown in Fig. (2). The diameter of the small circle is set at 4/3 SD (standard deviation) from the origin, which takes account of the variability in the population. A plant composition falling within this circle would be considered as relatively balanced is denoted by a horizontal arrow (→). As one moves away from the central zone along any axis, the degree of imbalance between the two elements increases. This zone of imbalance is divided into two sub-zones, the first is a zone of slight to moderate imbalance. This is depended an arrow at 45° degrees to the horizontal (⇖⇗) (⇙⇘) and is encompassed by the outer of the concentric circle which has a diameter of 8/3 SD. Beyond this circle is a zone of marked imbalance denoted by vertical arrows (↑) (↓) being either too high ot too low. The reason why the two circles are set at diameters of 4/3 SD and 8/3 SD is dealt with fully by Beaufils (1971-1973).

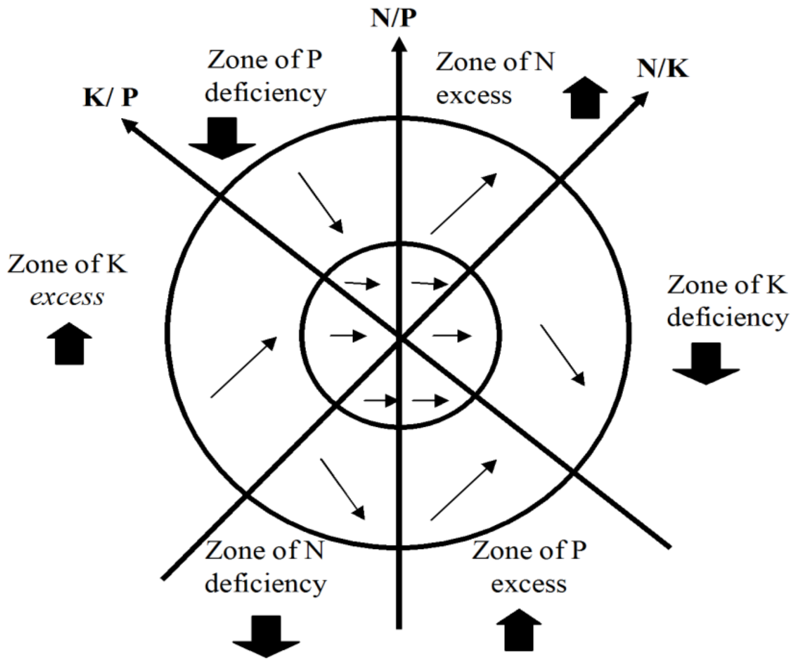

Fig. 2: Physiological Diagnosis chart for direct determination of N, P and K status.

RESULTS AND DISCUSSION

Calculation of DRIS norms

Table 4 Mean values of standard deviation (SD), coefficient of variation (CV), variance (δ^2), variance ratio of low-yielding/ high-yielding populations (V_{low}/V_{high}) of maize for different nutrient ratios for maize grown in Nubaria.

Nutrient ratio	High-yielding ♦				Low-yielding♦♦				
	Mean	SD	CV%	δ^2	Mean	SD	CV%	δ^2	V_{low}/V_{high}
N/P	8.93	1.85	20.69	3.42	9.11	2.81	30.90	7.91	2.32**
N/K	1.38	0.19	13.78	0.036	1.43	0.25	17.66	0.06	1.75**
Ca/N	0.31	0.078	25.17	0.006	0.42	0.135	31.92	0.018	2.97**
Mg/N	0.17	0.047	27.45	0.002	0.23	0.0799	34.92	0.006	2.84**
Fe/100N	0.36	0.117	32.46	0.014	0.48	0.182	37.93	0.033	2.41**
Mn/100N	0.23	0.048	20.78	0.002	0.32	0.0957	29.81	0.0092	3.92**
Zn/100N	0.18	0.0385	21.96	0.0015	0.22	0.0713	32.13	0.0051	3.43**
P/K	0.16	0.0375	23.28	0.0014	0.17	0.056	23.65	0.0031	2.20**
Ca/P	2.76	0.825	29.85	0.680	3.83	1.712	44.71	2.930	4.31**
Mg/P	1.54	0.510	33.18	0.260	2.09	1.090	52.14	1.187	4.56**
Fe/100P	3.25	1.316	40.45	1.732	4.29	1.914	44.61	3.664	2.12**
Mn/100P	2.07	0.584	28.20	0.341	2.91	1.210	41.65	1.463	4.29**
Zn/100P	1.56	0.457	29.33	0.209	1.99	0.831	41.70	0.691	3.30**
Ca/K	0.43	0.125	29.07	0.0157	0.60	0.207	34.53	0.0429	2.73**
Mg/K	0.24	0.072	30.24	0.0052	0.33	0.130	39.82	0.0168	3.23**
Fe/100K	0.50	0.186	37.04	0.0347	0.68	0.278	40.65	0.077	2.23**
Mn/100K	0.32	0.0756	23.53	0.0057	0.46	0.156	34.21	0.0244	4.28**
Zn/100K	0.24	0.0621	25.60	0.0039	0.32	0.114	36.18	0.013	3.38**
Ca/Mg	1.89	0.551	29.11	0.3035	1.95	0.648	33.29	0.419	1.38*
100Ca/Fe	0.98	0.450	46.05	0.2024	1.02	0.5175	50.55	0.2768	1.32*
100Ca/Mn	1.39	0.4418	31.72	0.1952	1.42	0.5616	39.65	0.3154	1.62**
100Ca/Zn	1.86	0.6204	33.42	0.3849	2.07	0.8206	39.72	0.6734	1.75**
100Mg/Fe	0.54	0.2584	47.59	0.06677	0.56	0.2985	53.78	0.0891	1.33*
100Mg/Mn	0.77	0.2527	32.88	0.0639	0.77	0.3271	42.47	0.107	1.68**
100Mg/Zn	1.03	0.3667	35.53	0.1345	1.13	0.5315	46.97	0.2825	2.10**
Mn/Fe	0.73	0.3176	43.56	0.10088	0.79	0.4253	53.65	0.1809	1.79**
Zn/Fe	0.54	0.2194	40.64	0.0481	0.55	0.3018	55.36	0.0911	1.89**
Mn/Zn	1.39	0.4229	30.41	0.1788	1.53	0.5038	32.90	0.2538	1.42*

♦ 116 observations represent high-yielding sub-population.
♦♦ 171 observations represent low-yielding sub-population.
*:significant at $P \geq 0.05$
**: significant at $P \geq 0.01$

Table 4 shows mean values, coefficients of variation (CV), standard deviations (SD) and variance (δ^2) ratio of low-yielding/ high-yielding **(V_{low}/V_{high})** for maize grown in Nubaria region.

Different expressions of nutrient ratios, i.e., n/p, n/k, …, and Zn/Mn for low and high-yielding populations, were calculated .

Binary nutrient ratio combinations of all eight nutrients were calculated, and summary statistics evaluated for each of the resulting 56 nutrient ratio expressions were done.

For both sets of populations (low-and high-yielding populations), S.D., CV% and δ^2 (variance) were calculated. Also, the variance ratio of low- and high-yielding populations was calculated for the above-mentioned experissions and its significancy was tested.

The variance ratio of most calculated experissions were significant at a probability level of 0.01.

These results are similar to those reported by (El-wali et al, 1985).

The significancy of variance ratios i.e., n/p,n/k,…,&Mn/Zn may be considered as a good evidence on the validity of the assumption used in separation low- and high-population which was set at 3.24 Mg/fed.

Low-yielding population showed high values of standard deviation and coefficient of variation as compared with high-yielding population. This could be attributed to the heterogenity in plant samples representing the low-yielding population. However, in case of the high-yielding population, the samples seemed to be more homogenized.

Calculation of DRIS indices for N, P, K, Ca, Mg, Fe, Mn and Zn in corn plants grown in Nubaria region, Egypt:

Table 5 shows DRIS indices as well as the order of limitation calculated from the published international norms reported by Elwali et al. (1985). With applying local DRIS norms to the data of the selected samples of plants grown in Tiba inspection, the obtained values of DRIS norms were almost similar to those shown by El Wali et. al.,(1985) particularly for N rather than P and K . As for micronutrients, iron occupied the third position as it was the third limiting nutrient.

Table 5. Leaf composition of nutrients, DRIS indices and diagnosis of the order calculated from international norms (Ewali et.al., 1985) for selected plant samples of low-yielding populations grown in Tiba inspection.

Sample Code No.	Leaves composition (%)								DRIS indices								Order
	N	P	K	Ca	Mg	Fe	Mn	Zn	N	P	K	Ca	Mg	Fe	Mn	Zn	
8	20.4	2.30	13.2	17.5	5.0	5.8	10.1	4.1	-18.64	-14.94	-24.31	45.95	2.74	-16.59	13.52	-5.72	K>N>Fe>P>Zn>Mg>Mn>Ca
9	21.1	1.70	21.0	15.0	5.0	7.0	8.0	5.0	-16.71	-34.82	7.47	31.86	2.89	9.0	14.07	4.25	P>N>Fe>Mg>Zn>K>Mn>Ca
14	24.8	1.50	15.1	12.5	10.0	8.8	8.1	4.0	-4.91	-48.07	-16.41	20.05	43.97	-1.49	15.03	-8.17	P>K>Zn>N>Fe>Mn>Ca>Mg
16	22.7	2.00	18.3	17.5	7.5	14.4	9.9	4.7	-23.14	-35.09	-12.14	32.4	15.31	11.73	18.48	-7.38	P>N>K>Zn>Fe>Mg>Zn>Ca
18	26.6	3.40	15.8	15.0	5.0	14.0	8.0	7.8	-12.14	-3.50	-24.25	18.34	-6.02	8.00	3.20	16.36	K>N>P>Mg>Mn>Fe>Zn>Ca
28	20.5	3.40	12.2	17.5	7.5	7.0	8.9	4.5	-24.31	3.45	-37.00	38.06	19.93	-12.58	17.35	-4.91	K>N>Fe>Zn>P>Mn>Mg>Ca
30	22.9	1.50	14.6	10.0	5.0	7.0	9.8	5.7	-5.11	-39.56	-12.92	11.82	6.28	-6.59	31.47	14.61	P>K>Fe>N>Mg>Ca>Zn>Mn
35	21.5	2.20	18.8	15.0	5.0	15.0	8.5	4.8	-21.14	-22.20	-5.48	25.41	-1.57	15.46	12.31	-2.80	P>N>K>Zn>Mg>Mn>Fe>Ca
193	19.0	1.70	17.3	12.5	5.0	8.8	5.4	5.0	-15.62	-26.59	1.15	25.12	7.07	2.31	-1.67	8.64	P>N>Mn>K>Fe>Mg>Zn>Ca
194	22.2	2.10	19.5	11.3	7.5	13.1	7.4	4.0	-15.62	-22.36	-0.88	10.89	19.77	11.29	6.55	-9.64	P>N>Zn>K>Mn>Ca>Fe>Mg
195	20.0	1.70	12.2	7.5	3.8	13.1	8.6	6.5	-12.49	-27.13	-23.09	-1.12	-5.13	18.35	25.89	24.72	P>K>N>Mg>Ca>Fe>Zn>Mn
204	26.4	1.70	17.8	10.0	5.0	5.9	10.0	8.2	-2.45	-38.34	-6.70	6.73	1.62	-18.25	26.15	31.25	P>Fe>K>N>Mg>Ca>Mn>Zn
207	21.3	2.10	21.5	6.3	3.8	7.0	7.1	6.5	-10.31	-14.12	12.40	-9.60	-4.95	-5.94	10.95	21.57	P>N>Ca>Fe>Mg>Mn>K>Zn

Comparison between local and international norms:

The two sets of norms (international and local) reveal a complete corespondence between n/p, n/k, p/k norms (Table 6). In this context the effect of regionality and or size of samples disappeared.

Table 6. Values of DRIS norm and coefficient of variation (CV) for local and international (Elwali et al., 1985) studies on maize.

Ratio	International (Elwali et al., 1985)		Local	
	Norm	CV	Norm	CV
N/P	9.035	23.64	8.93	20.69
N/K	1.463	29.12	1.38	13.78
P/K	0.169	31.95	0.16	23.28
Ca/N	0.160	35.63	0.31	25.17
Mg/N	0.071	40.85	0.17	27.45
Fe/100N	0.394	24.62	0.36	32.46
Mn/100N	0.151	57.62	0.23	20.78
Ca/P	1.447	42.29	2.76	29.85
Mg/P	0.639	51.64	1.54	33.18
Fe/100P	3.588	32.80	3.25	40.45
Mn/100P	1.416	75.01	2.07	28.20
Zn/100P	0.883	47.57	1.56	29.33
Ca/K	0.237	50.63	0.43	29.07
Mg/K	0.104	60.58	0.24	30.24
Fe/100K	0.568	35.39	0.50	37.04
Mn/100K	0.218	64.22	0.32	23.53
Zn/100K	0.140	48.57	0.24	25.60
100Ca/Fe	0.410	46.10	0.98	46.05
100Ca/Zn	1.919	56.64	1.64	33.42
100Mg/Fe	0.190	51.58	0.54	47.59
100Mg/Zn	0.830	60.72	1.03	35.53
Mn/Fe	0.405	61.48	0.73	43.56
Mn/Zn	1.716	68.47	1.39	30.41

Values of other norm expressions showed a wide diversity between the local and the international. The local ones were generally significantly higher than the international. Such deviation may be attributed to the effect of the region from which samples were collected and the availability of Ca, Mg, P, Fe, Mn and Zn under warm conditions of the semi arid region (Egypt). Also, this situation could suggest that regionality may affect to some extent the values of DRIS norms depending on soil properties at least with maize plants. However, the results are in a good agreement with those of Walworth *et al.* (1986). DRIS norms of the current study could be used on a large scale and may present rather valid norm not only for Nubaria, but also for the whole country.

Direct reading of N, P, K, Ca, and Mg indices for maize on physiological diagnosis (PD) chart :

Table 7 shows the direct reading of nutrient requirements by maize plant in terms of comparable functions of field as a reflection of the interation within the plant was first established by Beaufils (1957) for rubber trees. This reading was achieved by the means of tri-linear coordinate chart identical to the one reproduced in Figure 2. Readings by means of arrows, are explained in detail in previous work of (Beaufils and Sumner, 1976). The direct reading of N P K Ca Mg indices for corn on the PD (physiological diagnosis) chart was performed for selected observations (61) of the low-yielding population in each inspection and represented by the following example:

Tiba inspection: Sample code number is 193 (percentages of N, P, K, Ca and Mg in dried plant material were 19.00, 1.70, 17.30, 12.50 and 5.00, respectively).Ratio N/P = 11.18, N/K = 1.10, P/K=0.10, Ca/K=0.72, Ca/Mg=2.50, Mg/K=0.289 and Ca/P=7.35.

Reading from P N K chart gives: N↗↓ P↘↓ K↑↑ and the order of limitation is: P > N > K , reading from P K Ca chart gives: P↓↓ K↑↓ Ca↑↑ and the order of limitation is:P > K > Ca and reading from K Ca Mg chart gives : K↓→ Ca↑↗ Mg↘→ and the order of limitation is: K > Mg > Ca ; linkage between the three charts gives the qualitative order of requirement for these nutrients as: P > N > K > Mg > Ca

There is a complete correspondence between the order of limitations indicated by DRIS indices and PD chart.

Table 7. Basis for physiological diagnosis, established norms for interpretation of the nutrient balance in maize leaves (proposed reference data).

Symbol	Interpretation class	Nutrient ratio X/Y						
		N/P	N/K	P/K	Mg/K	Ca/K	Ca/Mg	Ca/P
↓↓	Severe deficiency	< 3.23	< 58	< 0.05	< 0.07	< 0.13	< 0.57	< 0.83
↓	Deficiency	3.23-6.45	0.58-1.12	0.05-0.10	0.07-0.13	0.13-0.25	0.57-1.14	0.83-1.65
↘	Tendency deficiency	6.46-7.69	1.13-1.24	0.11-0.12	0.14-0.18	0.26-0.34	1.15-1.50	1.66-2.20
→	Balanced (normal)	7.70-10.16	1.25-1.51	0.13-0.19	0.19-0.29	0.35-0.51	1.51-2.27	2.21-3.31
↗	Tendency excess	10.17-11.40	1.52-1.63	0.20-0.21	0.30-0.34	0.52-0.60	2.28-2.63	3.32-3.86
↑	Excess	11.41-22.80	1.64-3.26	0.22-0.40	0.35-0.68	0.61-1.20	2.64-5.26	3.87-7.72
↑↑	Severe excess	> 22.80	> 3.26	> 0.40	> 0.68	> 120	> 5.26	> 7.72
Mean of normal plants(norm)		8.93	1.38	0.16	0.24	0.43	1.89	2.76

The chart gives a semi-quantitative order of plant requirement for these nutrients as: N > P > K > Mg > Ca. The same order was obtained when calculated from the equations of DRIS indices (Table, 5). The obtained results are in a good agreement with those of Abdel-Wareth (2002) and Abdel-Hady (2004), in which there was a correspondence between the DRIS indices and the PD chart. A direct application of the proposed standard PD chart for maize to some of the low-yielding populations to test the balance of N, P, K, Ca and Mg in plants, showed a relative deficiency of N followed by P. These results are similar to the findings obtained with using the DRIS indices.

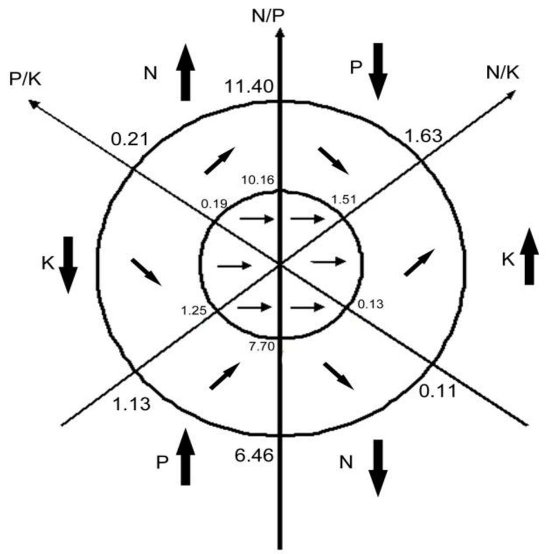

Fig. 3-a. DRIS chart for obtaining the qualitative order of requirement for N,Pand K in corn. Means of significant expressions (value at origin in chart) are:N/P = 8.93, N/K=1.38, P/K=0.16.

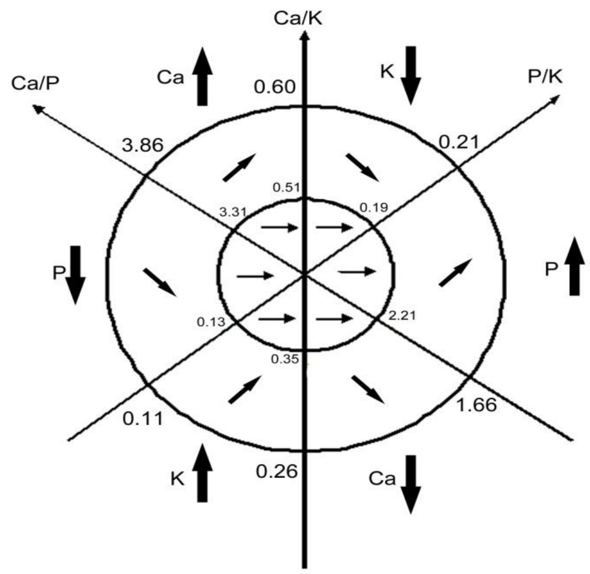

Fig. 3-b. Physiological Diagnosis chart for direct determination of the P, K and Ca status.

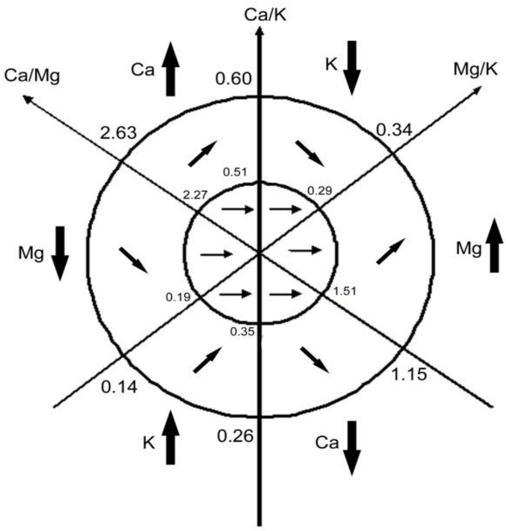

Fig. 3-c. DRIS chart for obtaining the qualitative order of requirement for K,Ca and Mg in corn. Means of significant expressions (value at origin in chart) are:Ca/K = 0.43 Ca/Mg=1.89,Mg/K=0.24.

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المعايير و الدلائل التمهيدية لنظام التشخيص و التوصية المتكاملة(DRIS) لمحصول الذرة الشامية النامية في منطقة النوبارية – مصر.

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اجري هذا البحث بغرض تطوير قاعدة بيانات يحسب منها معايير ودلائل نظام التشخيص والتوصية المتكاملة للذرة الشامية النامية في منطقة النوبارية_ مصر. مقارنة المعايير المحسوبة محليا مع تلك الغير محلية وكذلك تحديد المغذي اللازم للنمو من بين العناصر الثمانية المختبرة وترتيب أولويات الاحتياج الغذائي منها لنبات الذرة الشامية.

ولتحقيق هذه الأهداف :

- تم جمع 287 عينة نباتية في طور الحريرة من حقول الذرة الشامية النامية في قرى مراقبات منطقة النوبارية الخمسة وهي : شمال التحرير وغرب النوبارية والحمام وطيبة وبنجر السكر . وجمعت العينات في موسم صيفي2006 .
- أخذت العينات الطازجة وجففت علي درجة حرارة 70ºم لمدة 72 ساعة ثم طحنت لتمر من خلال منخل 0.5 مم وأخذت وزنة 0.5 جم من كل عينة وتم هضمها بخليط من حمض الكبريتيك والبيركلوويك وخففت إلى 50 ملل ثم قدرت عناصر النيتروجين والفوسفور والبوتاسيوم والكالسيوم والمغنسيوم والحديد والمنجنيز والزنك.
- تم تسجيل محصول كل حقل عند النضج ، وقسمت ال287 عينة الى مجموعات عالية الأنتاج ≤3.24 طن حبوب / فدان وحسبت معايير ال DRIS للمجموعات ذات الأنتاجية العالية التي عادة تنتج من أتزان للمغذيات في النبات .
- وحسبت معايير الـ DRIS مع الأخذ في الأعتبار نسبة التباين المعنوية لاختبار النسبة بين المجموعات عالية الانتاج والأخرى قليلة الإنتاج .
- شكلت المجموعات عالية الانتاج (116 عينة) 40.42% بينما المجموعة منخفضة الانتاج(171عينة) 59.58% .
- ولقد مثلت نسب العناصر الخمسة (N/P N/K, P/K, Ca/P, Ca/K, Ca/Mg, Mg/K) علي رسم ثلاثى المحاور وحسبت أيضا معايير الـ DRIS المعدلة .

ويمكن تلخيص النتائج كما يلى :

- أجريت دراسة حصرية لأصناف الذرة الشامية النامية بمنطقة النوبارية موسم صيفي 2006 .
- وتم التعبير عن درجة عدم اتزان المغذيات في النبات علي صورة دلائل الـ DRIS التي تشير إلي أى مدى تشتت مغذى معين عن المعايير المقدرة .
- وتم عمل توافقية لنسب المغذي الثنائية لكل المغذيات الثمانية وتمت حساباتها الأحصائية لكل من المجموعات عالية ومنخفضة الأنتاج ونسب النباين المحسوبة للنسب المذكورة للمغذيات الى بعضها(32 نسبه) كانت معنوية عند أحتمالية 0.01 .
- أظهرت المجموعات المنخفضة الإنتاج قيم عالية للانحراف القياسى ومعامل الاختلاف مقارنة بالمجموعات عالية الإنتاج.
- يمكن استخدام المعايير المحسوبة من هذه الدراسة مع ثقة عالية وذلك لأنها نتجت من قاعدة بيانات كبيرة (116عينة) وقيم المعايير المحسوبة من هذه الدراسة أغلبها كانت مرتفعة مقارنة

بتلك المحسوبة بواسطة El-Wali et. Al. (1985) وهذة الاختلافات ربما يعزى ذلك الى التأثير الأقليمي وخواص التربة التي جمعت منها العينات ومدى تيسر كل من الكالسيوم والمغنسيوم والفوسفور والحديد والمنجنيز والزنك في حال المناخ الدافىء والأقليم شبه الجاف (مصر).

أوضحت النتائج :

- وجد أن الفوسفور كان أكثر المغذيات تحديدا للنمو حيث أنه جاء في الرتبة الأولى للتحديد في عشر حالات من الثلاثة عشر (77%) وجاء مرة واحدة في الرتبة الثالثة (8%) .وأحتل النيتروجين المرتبة الثانية للتحديد وسبق البوتاسيوم في 9 حالات (69%). والثالث من بين العناصر المحددة في 4 حالات تمثل 31% من اجمالي العينات كان الحديد.
- أختبر61 عينة من مجموعة العينات الأقل انتاجا باستخدام المعايير المحلية فكان النيتروجين أكثر المغذيات تحديدا للنمو اذ جاء في الرتبة الأولى تحديدا للمحصول والحاجة إليه بواسطة المجموعات عالية الانتاج في تزايد .
- كذلك أظهرت الدراسة الطلب المتزايد علي الفوسفور حيث أنه جاء في المركز الثانى من حيث التأثير. كذلك يجب إضافة كل من الفوسفور والنيتروجين من خلال برامج تسميد جيدة.
- أجريت قراءة مباشرة لمعايير الـ N, P, K , Ca , Mg للذرة الشامية علي كارت التشخيص الفسيولوجى PD Chart لمجموعة عينات مختارة من المجموعات قليلة الانتاج في كل مراقبة وتم تمثيل ذلك بالمثال التالى :

الرقم الكودى للعينة 193 مراقبة طيبة أظهرت قراءتها علي كارت التشخيص

N↗↓ P↘↓ K↑↑

P↓↓ K↑↓ Ca↑↑

K↓→ Ca↑↗ Mg↘→ **وبالارتباط بين الثلاثة كروت**

وترتيب أولويات الاحتياج الغذائي هو P>N>K>Mg>Ca ونفس الترتيب تم الحصول عليه عندما حسب الترتيب من معادلات لدلائل الـ DRIS .

- أظهرت النتائج أن التطبيق المباشر للتشخيص بواسطة الكارت الفسيولوجى لمجموعة من العينات ذات المحصول المنخفض وذلك لاختيار اتزان النيتروجين والفوسفور والبوتاسيوم والكالسيوم والمغنسيوم في نباتات الذرة الشامية نقص نسبي في النيتروجين اعقبه نقص في الفوسفور وهذه النتائج مطابقة لنتائج دلائل الـ DRIS .
- جدير بالذكر ملاحظة أن الـ 70% من التطابق بين المعايير المحلية والعالمية يعكس إمكانية استخدام المعايير المحلية لتقييم الاتزان الغذائى لمحصول الذرة الشامية النامية من أجل زيادة فرص إنتاج محصول عالى.
- استخدمت معايير الـ DRIS المعدلة لتحديد ترتيب المغذيات المحددة للنمو والرتب المتحصل عليها من المعايير المعدلة هى نفسها المتحصل عليها من المعايير العادية .
- ان الحصول علي معايير المغذيات لمحصول الذرة الشامية يعتبر هدفا اساسيا للحصول على محصول عالى يعكس اتزان المغذيات في النبات ولتشخيص احتياجاتها من خلال حساب دلائل الـ DRIS أو التطبيق المباشر باستخدام كارت التشخيص الفسيولوجى PD chart بالنسبة لمغذيات مجاميع المحصول المنخفض . ويجب توجيه البحث إلي تكوين قاعدة بيانات التي من خلالها يمكن حساب معايير الـ DRIS للمحاصيل الاقتصادية لضمان أنتاج محصول عالى.