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5. SUMMARY

The objectives of the current investigation were to: (i) develop database for DRIS norms and indices of maizet grown in Egypt, (ii) compare the locally derived norms with the existing international norms **(Elwali *et al.* 1985)**, (iii) identify the order of the most limiting nutrient (or nutrients) among the tested N, P, and K nutrients and the order in which other elements would likely become limiting and (iiii) suggest the possible best combination between N, P and K

To achieve these objectives 300 plant samples were collected were collected at the silking stage from maize field distributed in seven counties of Kalubia Governorate**,** i.e., Toukh, Shebien El-Kanater, Kaluob, El-Kanater El-Khairia, El-Khanka, Benha and Kafer Shoukr. The samples were collected in season 2006. The collected fresh maize samples were weighed and small portions were taken and oven-dried at 70°C for 72 h, weighed and ground to pass a 0.5 mm – screen. Portions of 0.5 g each were digested using a mixture of sulfuric and perchloric acids, diluted and their contents of N, P ,K , Ca, Mg,Fe, Zn,and Mn were determined .

The 300 observations were divided into high yielding populations $\geq$ 3.7 ton (grains) / fed. DRIS norms were calculated for the high yield populations because the high yield usually results from balanced nutrients in plant.

The DRIS reference norms were established using the criterion of significant variance at ratio test between desirable

(high yielding) and undesirable (low yielding) subpopulations. The high yielding subpopulations comprised 58% of the total number of observations (174 observations) while, the low yielding subpopulations comprised 42% of the total number of observations (126 observations). The N/P, N/K and K/P forms of expression are interrelated in a three coordinate DRIS chart

The obtained results could be summarized as follows maize varieties:

A survey study was performed on maize varieties which were cultivated in Kalubia 2006 season and its results indicate that almost 82645fed were sown with maize in 2006 season. The bigest area was shown in Benha county (18202 fed) followed by Toukh (17243 fed), while the smallest area was found in El-Khanka county. Of 4868 fed,.

In case of Shibin El-Kanater county, 45 samples were collected, 75% of these samples were among the high-yielding population (Grain yield ≥ 3.7 Mg/fed) and low-yielding samples comprised 25%.

In case of Toukh, 60 samples were collected to represent 17243 fed. the high-yielding population samples comprised 60%, while the low-yielding ones constituted 40%.

In case of Banha, the high-yielding population showed the lowest proportion and comprised 46%, while the low-yielding population showed the highest proportion 54% of the tested samples. Kaluob was one of the most productive counties as the total wheat cultivated area was 12207fed, which were

represented by 45 samples. The high-yielding populations were 71% and the low-yielding populations were 29%.

The degree of nutrient imbalance in the plant was expressed in forms of a DRIS index, which measures the extent to which a particular nutrient deviated from the established norms.

Different expressions of nutrient ratios were calculated, i.e., n/p, n/k, p/n, p/k, k/n, np, nk and kp for low- and high-yielding populations.

The variance ratio of all calculated expressions was significant at probability level of 0.01. The variance ratios of the expression derived from dividing nutrient by the other are significant.

Low-yielding population showed high values of standard deviation, coefficient of variation as compared with high-yielding population.

DRIS norms for the high-yielding populations (174observations) were as follows10.89, 2.18, 2.87, 0.20, 0.27, 1.37,0.26,2.84,0.57,0.76,4.79,0.14,1.51,0.30,0.54,0.40,2.53,0.07, 0.78, 0.15,0.22,0.30, 3.25,0.65,1.17, 2.17, 0.85and 5.48 ,for n/p,n/k,n/Fe,p/k,p/Fe,k/Fe,Ca/n,C/p,Ca/k,Ca/Fe,Ca/Zn,Mg/n,Mg/p,Mg/k,Mg/Ca,Mg/Fe,Mg/Zn,Zn/n,Zn/p,Zn/k,Zn/Fe,Mn/n,Mn/p, Mn/k,Mn/Ca, Mn/ Mg, Mn/Fe and Mn/Zn respectively. Corresponding DRIS norms reported by **Elwali et al. (1985)** for maize plants derived from 10000 observations of high-yielding populations were 9.035, 1.463, 0.169, 0.160, 1.446, 0.237, 0.410, 1.919, 0.071, 0.639, 0.104, 0.465, 0.190, 0.830, 0.883, 0.140,

0.151,1.416, 0.218, 1.048,2.485, 0.405, and 1.716 for n/p, n/k, p/k, Ca/n, Ca/p, Ca/k, Ca/Fe, Ca/Zn, Mg/n,Mg/p, Mg/k, Mg/Ca, Mg/Fe, Mg/Zn, , Zn/p, Zn/k, Mn/n, Mn/p, Mn/k, Mn/Ca, Mn/Mg, MnFe, and Mn/Zn respectively.

The calculated norms in the current study can be used with reasonable confidence because the data base from which they were derived are taken from large number (174) of samples.

The DRIS norms calculated in the current study are different from those developed by **Elwali et al. (1985),** mainly in K and P levels. This situation suggests that some rationality may exist for DRIS norms dependent on soil properties at least with wheat plants**.**

Selected observations representing each county have been tested by the norms and the most limiting nutrient as well as the order of nutrient limitation was diagnosed.

In Toukh County, the obtained results showed that N was the most limiting nutrient as it came in the first order of limitation in 6 cases out of 11. It means that N was the first liming nutrient in 55% of the tested samples. In five cases only out of 11, N was considered as the second limiting nutrient 45%.

Phosphorus has occupied the second order of limitation and preceded P in 6 cases out of 11 cases 55%. However, k was the third limiting nutrient among the tested ones in eleven cases out of the tested 11, it comprises 100% of limitation. It is worthy to note that P came in the second order while .Potassium came in the third order, this may be due to the more attention paid by farmers to k fertilization then they did regarding P Selected

number 74 of low-yielding population was tested using the local norm and it suggested that Phosphorus was the most limiting nutrient and its requirements for the high-yielding populations are increasing. Also, there is a high demand of N by these populations as it came in the first and second order of limitation. Both phosphorus and nitrogen should be adequately covered through a sound fertilization program.

The two sets of norms (international and local) illustrate a variance between norms In this context the effect of rationality and or the size of samples are considered. Values of other norm expressions showed a wide diversity between the local expressions obtained in the current study and the international given by **Elwali et al(1985).** The local expressions were generally significantly higher than the international ones. Such deviation maybe attributed to the effect of the region from which samples were collected and the availability of nutrients under the warm conditions of the semi arid region (Egypt). Also, this could suggest that rationality 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 Kalubia Governorate, but also for the whole country.

The direct reading of NPK indices for wheat on the PD chart was performed for selected observations of the low-yielding population in each county and were represented by three examples as follows :

(1)Tukh county:

Sample code number is 3 (percentages of N, P and K in dried plant material were 2.33, 0.27 and 2.10%, respectively)

N/P ratio= 8.63, N/K = 1.11 and P/K = 0.13.

Reading from the NPK chart gives: N↓↓P↑↓ K↑↑

N > P > K

The chart gives a semi-quantitative order of plant requirement for these nutrients as N > P > K. The same order is obtained when calculated from the equations of DRIS indices Table 3. The obtained results are in a good agreement with those of Abdel-Warth (2002), in which there was a concordance between the DRIS indices and the PD chart.

(2) Al- Kanatir El- Khiria County:

Sample code number is 18 (percentages of N, P and K in dried plant material were 2.68, 0.20 and 1.87, respectively).

N/P ratio = 13.40; N/K = 1.43 and P/K = 0.11.

Reading from the PD chart gives: **N↑↓P↓↓ K↑↑**

P > N > K

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

(3) Shibin El-Kanater County:

Sample code number is 72 (N, P and K percentages in dried plant material were 3.20, 0.08 and 1.70, respectively)

N/P ratio = 40, N/K = 1.88, P/K = 0.05

Reading from PD chart gives the following order of limitation:

N↑↑ P↓↓↓ ↓K↑↑

P >K > N

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

This order is identical to that resulted from using DRIS indices. The order of limitation calculated from the PD chart enables the imbalance phenomenon to be observed. This indicates the general validity of the chart and reference data.

A direct application of the proposed standard physiological diagnosis chart (PD chart) for maize to some of the low-yielding populations to test the balance of N, P and K in wheat plants, showed a relative deficiency of N followed by phosphorus.

These results were similar to the findings obtained with using the DRIS indices.

It could be concluded that establishing DRIS norms for maize is a vital step towards production of high yields. DRIS norms could be used to test the nutritional balance of nutrients in plant and diagnose nutrient requirements through calculating DRIS indices or direct application of proposed standard physiological diagnosis (PD) chart to the low–yielding populations. Research should be directed towards establishment of a database from which DRIS norms for each of the most economic crops could be driven to ensure high-yield production.

The best combinations of the tested nutrients:

Field of 4^4 factorial experiments for N, P and K was executed and maize plants were used as an indicator plant. Combinations of four rates for the tested nutrients were applied to maize plants. Samples of whole plant at silking stage were collected and their contents of N, P and K were determined.

The best combinations which produced the highest yield of maize were 1-1-0,1-1-1,1-1-2,1-1-3,1-2-1,1-2-2,1-2-3,1-3-0,1-3-2,1-3-3,2-1-1,2-1-3,2-3-3,3-0-2 and 3-0-3. The treatment of 1-2-1 contained nitrogen and K at the recommended rates and P at 75% of the recommended rates produced the highest yield (4783 kg fed^{-1}), this result indicates that available P content in soil is enough to ensure a balanced P concentration in maize plants. The obtained results of DRIS show that K was the most limiting nutrient for maize followed by while P was the third limiting one. The result of direct reading of the data on PD chart almost similar to those obtained with calculating DRIS indicies.