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Nutritional Diagnosis of Anna Apple Trees in Some Egyptian Soils

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Abstract: A field study was carried out to evaluate the nutrient status of apple orchards in forty one commercial farms in Gharbia, as alluvial soils and Menofiya, as newly reclaimed soils, governorates, Egypt. The use of leaf and soil analysis is an important tool for monitoring plant nutritional status. Results revealed that the nutrients shortage of these soils mostly cases related to their alkalinity, clay content, low organic matter. Iron may be a limiting factor of apple growth at both locations. It is of interest to note also that the correlation of soil properties and its nutrient concentration, with leaf nutrients content indicated the occurrence of imbalanced nutrition. The obtained results will be used as a basis for subsequent experimental fertilizer treatments. This will lead to determine the most suitable fertilization policy for improving crop yield of apple and quality to maintain soil fertility and to reduce environmental pollution.

Key words: Apple trees, alluvial soils, newly reclaimed soils, nutrient concentrations

Introduction

Anna is a newly established apple cultivated in Egypt. In order to obtain maximum productivity from a given cultivated area, it is necessary to evaluate the nutritional requirements for apple grown in it as well as to determine the availability of nutrients in the soil in order to apply a balanced fertilizing program.

The concentrations of mineral nutrients in the soil solution, i.e., the available nutrient concentration varies widely, depending on many factors such as soil pH, soil organic matter content and fertilizer application (Marschner, 1986).

In high pH soils, it is known that micro nutrients as well as some macro-nutrients may be limiting (Miller *et al.*, 1998).

Application of N and P fertilizers, without K or micro nutrients can be a reason for imbalanced nutrition of trees (Saurate, 1987 and Fawzi, 1992). The major limiting elements differ from crop to crop and from one location to an other for the same crop (El-Fouly, 1984).

The purpose of the following investigation was therefore to evaluate the nutritional status of apple trees under two different conditions to increase yield and improve fruit quality.

Materials and Methods

A survey study was carried out in 2001 season on Anna apple grown in orchards located at Tanta, as alluvial soils, Gharbia governorate (30 orchards) and Sadat City, as a newly reclaimed soil, Menofiya governorate (11 orchards), Egypt.

Trees were 8-12 years old. A representative soil samples from the surface layer of every orchard (0-40 cm) were taken before fertilizers application. All the orchards received available amount of fertilizers depending on farmer practices for each farm (Table 1).

Table 1: Farmer's practices in Gharbia and Menofiya governorates, Egypt

Item	Gharbia G.	Menofiya G.
Organic manure (m^3)	12.0	8
N (kg/fed.)	250.0	200
P_2O_5 (kg/fed.)	52.5	45
K_2O (kg/fed.)	0.0	24
Micro nutrients (kg/fed.)	-	-

Samples of leaves were taken in middle growth season at random from each orchard to determine nutrient concentration according to Chapman and Pratt (1978).

The values are evaluated according to Ankerman and Larg (1974). Correlations between soil characters and leaf nutrient concentration were computed using COSTAT statistical program.

Results and Discussion

Soil characterization and nutritional status: Data in Table 1 show that apple trees were fertilized with low amounts of farmyard manure, higher amounts of N and P than recommended, once and without either K or micro nutrients fertilizers were added.

The soil reaction was highly alkaline, in the same time the organic matter content of almost all samples were low (below 2%) (Table 2). In this respect, Sillanpää (1982) reported that low organic matter content associated with high pH cause the reduction in most micro nutrients availability.

Analytical data of soil samples in Table 2 indicated that soils of most samples contained $CaCO_3$ levels lower than 4% which considered low and thus has no effect on nutrient availability.

The tested soils varied with respect to their texture from sandy clay loam in Gharbia to loamy sand in Menofiya. The importance of such variation resides in the well known relationship between soil texture and soil reserve of the various nutrients (El-Damaty *et al.*, 1973). Decrease in amount of available nutrients in Gharbia G., most probably due to high clay content which inhibit the root growth. Similar result was previously obtained by Torbert and

Table 2: Soil physico-chemical characteristics of apple trees in Gharbia and Menofiya governorates.

Characters	Gharbia governorate			Menofiya governorate		
	Mean		S.D	Mean		S.D
pH (1:2.5 H_2O)	8.17	H	± (0.20)	8.21	H	± (0.36)
$CaCO_3$ %	1.89	L	± (1.56)	3.69	M	± (2.55)
O.M%	1.73	L	± (0.49)	0.42	L	± (0.21)
Clay %	44.13	H	± (6.41)	7.73	L	± (4.77)
Texture	Sandy clay loam			Loamy sand		
mg/100g						
N	59.38	M	± (16.93)	18.83	L	± (8.80)
P	4.45	VH	± (1.70)	1.285	M	± (0.99)
K	34.14	VH	± (15.85)	13.71	L	± (8.21)
mg/kg soil						
Fe	9.68	L	± (6.01)	1.97	L	± (1.29)
Mn	8.18	L	± (5.35)	1.78	L	± (1.37)
Zn	2.49	M	± (1.79)	0.71	L	± (0.68)
Cu	4.60	VM	± (1.90)	0.77	L	± (0.82)

L : Low M : Medium H : High VH : Very High

Table 3: Nutrients concentration of apple leaves in Gharbia and Menofiya governorates

Characters	Gharbia governorate			Menofiya governorate		
	Mean		S.D	Mean		S.D
%						
N	2.73	H	± (0.62)	3.15	H	± (0.96)
P	0.12	L	± (0.02)	0.18	M	± (0.07)
K	0.49	L	± (0.25)	0.36	L	± (0.21)
mg/kg						
Fe	201.77	H	± (74.92)	177.8	H	± (71.22)
Mn	55.98	L	± (15.26)	60.2	L	± (15.53)
Zn	20.78	L	± (7.38)	15.02	L	± (2.64)
Cu	10.59	M	± (4.46)	6.85	L	± (2.05)

L : Low M : Medium H : High VH : Very High

Table 4: Correlation coefficient between soil characteristics (0-40cm depth) and leaf nutrient concentrations, in the surveyed apple orchards of Gharbia governorate

Soil characters	Leaf nutrient concentration (%)						
	N_1	P_1	K_1	Fe_1	Mn_1	Zn_1	Cu_1
Clay %	0.331 NS	-0.219 NS	0.089 NS	-0.144 NS	-0.235 NS	0.174 NS	-0.057 NS
O.M %	0.194 NS	-0.378 *	-0.157 NS	-0.127 NS	-0.176 NS	-0.247 NS	-0.286 NS
$CaCO_3$ %	-0.081 NS	-0.319 NS	0.134 NS	-0.045 NS	-0.360 *	-0.022 NS	-0.167 NS
pH (1:2.5)	-0.053 NS	0.023 NS	0.344 NS	0.167 NS	-0.123 NS	0.062 NS	-0.045 NS
N (mg/100g)	0.197 NS	-0.408 *	-0.150 NS	-0.154 NS	-0.186 NS	-0.284 NS	0.246 NS
P (mg/100g)	0.050 NS	0.317 NS	-0.225 NS	0.063 NS	0.307 NS	-0.098 NS	0.307 NS
K (mg/100g)	-0.315 NS	8.168 **	-0.342 NS	-0.015 NS	-0.067 NS	-0.259 NS	-0.020 NS
Fe (ppm)	0.170 NS	-0.344 NS	-0.198 NS	-0.186 NS	-0.399 *	0.122 NS	0.180 NS
Mn (ppm)	0.319 NS	-0.329 NS	0.108 NS	-0.099 NS	-0.167 NS	0.031 NS	-0.138 NS
Zn (ppm)	0.197 NS	-0.180 NS	-0.404 *	-0.291 NS	-0.129 NS	0.035 NS	0.090 NS
Cu (ppm)	0.255 NS	-0.238 NS	-0.026 NS	-0.244 NS	-0.285 NS	0.048 NS	-0.198 NS

NS: Non significant *, **, Significant at 0.05 and 0.01 probability levels, respectively. r 0.05 = 0.361 r 0.01 = 0.463

Table 5: Correlation coefficient between soil characteristics (0-40cm depth) and leaf nutrient concentrations, in the surveyed apple orchards of Sadat City in Menofiya governorate.

Soil characters	Leaf nutrient concentration (%)						
	N_1	P_1	K_1	Fe_1	Mn_1	Zn_1	Cu_1
Clay %	-0.312 NS	-0.225 NS	-0.431 NS	5.973 NS	-0.072 NS	0.147 NS	0.158 NS
O.M %	0.245 NS	0.388 NS	-0.013 NS	0.257 NS	0.258 NS	0.446 NS	-0.011 NS
$CaCO_3$ %	0.141 NS	-0.059 NS	-0.347 NS	0.172 NS	-0.234 NS	0.085 NS	-0.237 NS
pH (1:2.5)	-0.070 NS	-0.548 NS	-0.087 NS	0.640 NS	0.064 NS	0.288 NS	-0.047 NS
N (mg/100g)	-0.261 NS	0.721 *	0.089 NS	-0.069 NS	0.187 NS	0.288 NS	-0.056 NS
P (mg/100g)	-0.126 NS	0.183 NS	0.720 NS	0.287 NS	-0.027 NS	0.598 NS	-0.203 NS
K (mg/100g)	-0.377 NS	0.353 NS	0.181 NS	-0.470 NS	2.698 **	0.069 NS	0.152 NS
Fe (ppm)	0.148 NS	0.301 NS	0.217 NS	-0.603 /*	-0.387 NS	-0.183 NS	-0.155 NS
Mn (ppm)	-0.329 NS	0.180 NS	0.132 NS	-0.370 NS	-0.180 NS	0.189 NS	-0.019 NS
Zn (ppm)	0.144 NS	0.336 NS	0.411 NS	-0.333 NS	0.081 NS	0.408 NS	0.089 NS
Cu (ppm)	-0.413 NS	0.453 NS	0.614 *	0.114 NS	-0.395 NS	0.239 NS	-0.290 NS

NS : Non significant *, **, Significant at the 0.05, 0.01 probability levels, respectively. r 0.05 = 0.602r 0.01 = 0.735

Wood (1992). On the other hand, shortage of nutrient availability of Sadat City soil, Menofiya G. may be attributed to high sand percentage (loamy sand texture) and its poverty in available nutrients. Similar results were reported by Abdel-Salam *et al.* (1974). It is also possible to observe that nitrogen in both locations ranged between medium in the former to low in the latter location. High clay content of the former location probably led to more potassium and phosphorus fixation by clay minerals and thus, reduction in their availability. The same results reported by (Mengel and Kirkby, 1982).

It seemed that high values of available macro and micronutrient concentrations in Gharbia soils when compared with Menofiya soils might be a result of higher organic matter in soil of the former than in the latter one. El-Fouly (1984) mentioned that the plants remove considerable amounts of macro and micronutrient yearly from the soil and not sufficient supplied with nutritional needs for giving maximum yield. This imbalanced fertilizer regime maximizes the negative effects of high pH and low organic matter (Serry, 1980).

Nutritional status in leaves: Data of total macro and micro nutrients content in leaves of Anna apple are presented in Table 3. It is observed that nitrogen content of leaves in most of samples taken from two locations was reflected the high N-dose applied. Leaves of the two locations showed a variation in their phosphorus content. Low values were shown for leaves of Gharbia G. as would be expected for high clay content, while the medium values were given for those of Menofiya G. These results are in harmony with those of Mengel and Kirkby (1982). On the other hand, Gahoonia *et al.* (1992), reported that application of phosphorus fertilizers to alkaline soil dose not always improve the phosphorus concentration in the leaves as the availability of this element in this soil is low.

Leaves from apple trees grown in both alluvial and newly reclaimed soils showed K-deficient concentrations (Table 3). This may be attributed to high application of N-fertilizer. Therefore, efficiency of plants in utilizing high concentration of K in soil is low. Numerous reports have shown that $NH^+{}_4$ nutrition reduce the uptake of K^+ (Barker *et al.*, 1967 and Kirkby, 1968). On the other hand Wadleigh and Richards (1951) concluded that decreasing soil moisture causes an increase in N-concentration in plant tissue and a decrease in K concentration.

The analysis of both soil and leaf samples for nitrogen, phosphorus and potassium and subsequent results of correlation between soil and plant contents of each element is intended to be used, later on, to suggest certain recommendations for fertilization with these elements.

Consequent to higher organic matter content in the first location, Fe-concentration was higher than in the second location, although the organic matter content was generally low.

The data further showed that leaves of apple were found deficient in Mn and Zn content at both locations (Table 3). This depression may be attributed to high Fe concentration and its interaction with each. This finding is in agreement with the findings of Wallace *et al.* (1986) and Baza *et al.* (1988). Biddulph (1953) suggested that the metal may be precipitated by P within the conducting tissue of the plant shoots and therefore would not be available to meet the plant's nutritional requirements. Such low content may be attributed also to the increase in N supply, regardless of N sources, decreased the Zn content of tops (Ozanne, 1955). This may also be due to the retention of Zn in roots as a result of the formation of immobile Zn-protein complexes.

Concerning copper, it was found that the leaves of the former location contained more Cu concentration compared to the later. This result was related to Cu-concentration in the soils of both locations. The above-described results of micro nutrients status point to the necessity of giving more attention to micronutrient requirements of apple trees.

Table 4 presents the correlation coefficients between soil characteristics and leaf nutrient concentrations in Gharbia governorate. It is worth to mention here that highly significant and positive correlation coefficients were obtained between soil-K and leaf-P. In addition, a significant and negative correlation coefficients were found between Leaf-P and both O.M and soil-N, also between leaf-Mn and $CaCO_3$ and Fe of soil content. The same was true between soil-Zn and leaf-K.

A highly significant positive correlation was observed between soil-K and leaf-Mn (Table 5). Soil pH of Menofiya governorate significantly correlated negatively and positively with Leaf-K and Fe, respectively, also significant positive correlation between soil-Cu and Leaf-K as well as soil-N and Leaf-P were found. On the other hand, a significant negative correlation was obtained between soil-Fe and leaf-Fe. Highly significant negative correlation was observed between pH and leaf-K reflecting the imbalanced nutrition and demand of trees to these elements.

Disorders in the balance between elements in the nutrient medium result in deficiencies and decrease in plant growth development. Thus, correction of plant nutrition disorders may be accomplished by foliar application with necessary nutrients (Miller *et al.*, 1995). In this respect, Ishag *et al.* (1989) and Mobarak and Abdalla, (1992) reported that correction of micro nutrients deficiency through foliar supply can improve the root growth.

The above mentioned results indicate the occurrence of imbalance nutrition not only in newly reclaimed soils (Sadat City) but also in alluvial soils (Tanta) leads to the conclusion that the disorder in the availability status of apple nutrients is a reflection of soil conditions especially pH, organic matter and clay contents such disorders limits the orchard productivity. In addition, iron may be a limiting factor of apple growth at both locations.

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