Delta J. Sci. 16 (3) 1992

APPLICATION OF STEP-WISE MULTIPLE REGRESSION IN PLANT NUTRIENT STUDIES

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Received:24-8-1992

ABSTRACT

Step-wise multiple regression was used to evaluate the interrelationship between different edaphic factors and nutrient concentration levels in Citrus reticulata, Citrus aurantium, Psidium guajava and Olea europaea grown in different agroecosystems in Egypt.

The results revealed that, different edaphic factors impacted differently on the nutrients levels in each of the studied species. The same edaphic factor may affect the same or different element in each species. However, in each species, some specific elements were obviously affected by specific edaphic factors.

INTRODUCTION

Performance of fruit trees is a product of several characters. Each in turn is affected by the habitat factors. The association of these with each other can provide useful information about how the habitat influences tree growth, yield, accumulation of nutrient elements, and other metabolites. The association between tree response and the environment depends on environmental diversity. Thus monitoring of biological processes as nutrient uptake,

translocation and allocation usually cover different areas and different seasons and years (Kwanchai and Arturo 1984).

Horticultural and agricultural research is most concerned with the performances of the whole plant and communities of plants, and the subsequent production of harvestable materials (Rose and Charles-Edwards 1981). In line with this concern, the aim of this paper is to review progress in the application of a stepwise regression model with the purposes of prediction. The assumption that several of the X-variables, and perhaps most of them, may contribute little or nothing to the accuracy of the prediction, raises the question of which and how many variables to select and retain in prediction.

MATERIALS AND METHODS

Sampling

The selected sites for sampling of Citrus reticulata, Citrus aurantium and Psidium guajava represented a wide range of environmental conditions. Two were located in El-Behera, two in the New Valley, and one in Kafr El-Sheikh governorate. Five representative trees of each orchard were selected for plant materials. The trees were about the same size and age (15 years). Twelve orchards were selected in Siwa Oasis for the study of Olea europaea.Five representa-tive trees were sampled in each orchard for plant material. The trees were about the same size and age (about 40 years). Sampling was undertaken during winter and summer season of 1991. In each season 68 replica were taken from each of soil and leaves.

Eight composite samples of leaves of the four species were taken from each orchard.After washing and drying at 65^{0}C, the samples were ground and digested for determination of macro- and micronutrient elements using atomic absorption spectrophotometer. At each orchard, four soil samples were taken from beneath each tree from the active roots depth (30-60 cm). Soil samples were sieved and air dried. Soil texture, hygroscopic moisture, organic matter, water holding capacity and $CaCO_3$ were measured in air dry soil, while soil pH and EC were tested in 1:5 soil water extract. The procedures of analysis are outlined by Allen *et al* (1974). Air temperature was measured at sampling times.

Data analysis

Stepwise multiple regression was performed to identify the soil variables that exert the greatest effect on the nutrient concentration levels in leaves of the selected plant species. One way ANOVA was applied to selected variables. The methods are described in Kwanchai and Arturo (1984).

RESULTS AND DISCUSSION

It is known that variation in environmental factors, such as temperature and soil physical and chemical properties can affect the mineral nutrient content of leaves considerably. These factors influence both the availability and uptake of nutrients by the roots and the shoot growth rate (Marschner 1986). The effect of irradiation and temperature on the nutrient content of leaves in different plant species can be significant (Bates 1971). Rain and dust are other

environmental factors to be considered in the analysis. Dust on leaf surface, especially on mature leaves, has to be removed carefully in order to prevent contamination with micronutrients such as iron (Jones 1972).

A stepwise multiple regression analysis is considered appropriate to predict the important edaphic factors that influence the nutrient concentration levels in leaves. The X variables (assumed independent) introduced include: air temperature, and soil texture, total organic matter (O.M), water holding capacity (W.H.C.), hygroscopic moisture (H.M), pH, electric conductivity (EC) and $CaCO_3$. The regressed variables were the concentration of nutrient elements (N, P, K, Ca, Mg, Cu, Fe, Mn and Zn) in leaves of the four species (Citrus reticulata, Citrus aurantium, Psidium guajava and Olea europaea).

Table (1) represented the range of variations in the edaphic factors and the concentrations (mg/g D.Wt) of different elements in leaves of the different fruit trees, respectively. On the other hand , figure (1) represents the variables selected by the analysis that have a prime influence upon the concentration levels of each element, and the F-value for each of the selected variables. It is remarkable that the F-value for most of the selected variables was significant in all species.

In C. reticulata and C. aurantium, soil pH and $CaCO_3$ concentration of the soil were the most effective factors in accounting for variation in the concentration levels of more than 50% of the total elements respectively. Mg was the only

element that showed no relationship to any one of the X variables.

In Psidium guajava, Fe was highly correlated with soil texture and electric conductivity. Moreover, K and Mg showed correlation with texture and $CaCO_3$, and P and Ca with pH and EC.

In Olea europaea , the concentration of N and Cu was highly correlated with soil texture and air temperature, that of P and Zn with hygroscopic moisture and pH, that of Fe and Mn with total organic matter and electric conductivity. pH was one of the most important factor vis-a-vis the concentration levels of Ca and Mg, and $CaCO_3$ was the most important with regard to K and Fe.

Soil chemical factors as pH, salinity and nutrient availability, and some soil physical factors as texture and structure, determine the performance and distribution of crop plants and natural vegetation (Marschner 1986). The rate of uptake of different nutrient elements and their accumulation in plant organs is pH dependent (Mengel and Kirkby 1987). For example, pH regulates the ratio of HPO_4^- / HPO_{4-} in the soil solution which has a bearing on phosphate uptake. The uptake rate for cations seems to be highest in the more neutral pH range (Arnon et al. 1942). On the other hand, at high pH (>7) of calcareous soil as that in the present study, K-uptake was depressed by high $CaCO_3$ % in most citrus soils in Cyprus (Jacobson, et al. 1960). The same was confirmed by El-Darier (1992) in citrus agroecosystems in Egypt. To go through with this, in grape vine, Marschner and Schropp (1977) and Mengel

and Malissiovas (1981) found that the accumulation of bicarbonate in soils leads to increased P availabilities which if taken up in excess by the plant induces Fe-deficiency. Nawar (1991 & 1992) and El-Darier and Sadek (1993) reported that, Fe-deficiency was ascribed mainly to the high P/Fe ratio resulted from high pH in the soil.

In the present study it is also notable that the same edaphic factors may influence the same or different elements. For example, soil texture and pH affect Fe and Mg in C. reticulata and O europaea, and N in C. aurantium and P. guajava. The same is true for the effect of pH alone on P & Ca levels in C. reticulata, on P C. aurantium and on Cu in P. guajava. Cu in C. reticulata and P and Ca in P. guajava were affected by pH and electric conductivity in soil solution. Similarly, by the application of step-wise multiple regression on apple agroecosystems at Nobaria, Egypt, El-Darier and Sadek (1993) concluded that, N content in apple leaves was strongly influenced by soil N and soil texture. K and Fe was significantly influenced by $CaCO_3$% sodium adsorption ratio (SAR) and potassium adsorption ratio (PAR) and by P% , $CaCO_3$ % and potassium adsorption ratio (PAR) respectively.

It is worth mentioning that Mg and Zn in the two Citrus species and Zn in P. guajava were not correlated with any of the X variables. One may conclude, at least in the context of linear correlations, that not all the elements are affected by edaphic factors, but still there are other factors as dust, and irradiation which may have a significant influence on the

concentration levels of nutrients in plant tissues.

ACKNOWLEDGMENT

Thanks are due to Professor M.Ayyad, Botany Department, Faculty of Science, Alexandria University, for revision of the manuscript.

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Table 1. Range of variations in the edaphic factors and air temperature for the fruit tree species in the present stu' (no. of records=136).

Soil properties		Species C. reticulata& C. aurantium	P. guajava	O. europaea
Soil texture	sand	97.70-39.40	97.60-36.60	90.40-89.00
	Silt	41.70- 0.40	27.46- 1.10	8.60- 7.20
	clay	32.75- 1.[illegible]	36.00- 1.30	1.50- 1.00
H. M.%		6.09- 0.05	4.07- 0.08	4.23- 0.09
W. H. C.%		57.62-12.70	62.40-22.70	52.70-14.90
O. M.%		10.72- 0.54	6.78- 0.66	7.25- 6.00
EC (mmhos/cm)		0.43- 0.15	1.26- 0.15	2.15- 0.46
$CaCO_3$		28.00-12.00	28.40- 5.40	26.00-23.00
pH		8.45- 7.63	8.22- 7.91	8.00- 7.80
Air temperature		38.00- 9.00	36.00-10.00	40.00- 5.00

Table 2. Range of variations in the concentration (mg/g D. wt) of different elements in leaves of fruit tree species in the present study (no of record=136).

Elements	Species			
	C. reticulata	C. aurantium	P. guajava	O. europaea
N	29.960–18.200	25.200–16.800	19.900– 7.000	28.800–15.800
P	3.250– 0.650	0.870– 0.500	1.370– 0.400	0.410– 0.750
K	8.300– 3.810	8.000– 2.600	16.000– 4.000	1.700– 8.150
Na	8.300– 1.000	3.000– 1.050	4.800– 1.100	3.700– 2.100
Ca	35.000 18.000	40.000– 9.000	20.000–16.000	38.000–14.000
Mg	22.800– 8.400	12.000– 6.000	11.400– 5.400	0.300– 2.280
Cu	0.021– 0.011	0.017– 0.001	0.022– 0.018	0.079– 0.001
Fe	0.340– 0.135	0.280– 0.120	0.950– 0.120	0.577– 0.129
Mn	0.020– 0.006	0.025– 0.007	0.083– 0.014	0.107– 0.016
Zn	–	–	–	0.200– 0.055

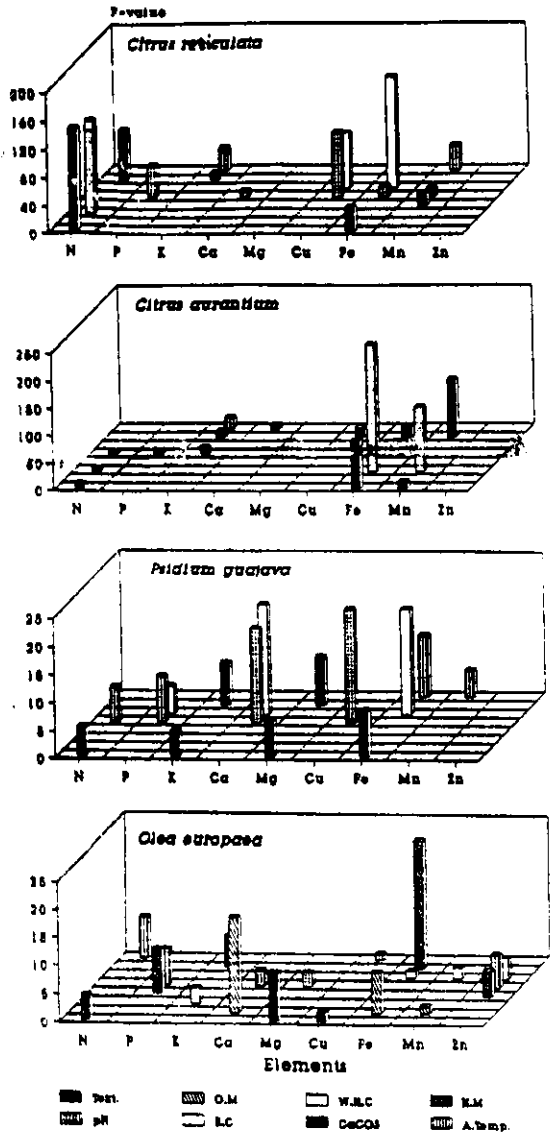

Figure (1). The variables selected by the model and their coresponded F-value for the four fruit tree species.

Delta J. Sci. 16 (3) 1992

إستخدام طريقة الإنحدار المرحلى المتعدد لدراسة العناصر الغذائية فى النبات

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لقد إستخدم فى هذه الدراسه طريقة الإنحدار المرحلى المتعدد لمعرفة العلاقة بين العوامل التربية المختلفة ومستويات تركيز العناصر فى أشجار اليوسفى البلدى والنارنج والجوافة البلدى والزيتون والتى تنمو فى نظم بيئية زراعية بمصر ٠

وقد أوضحت النتائج أن عوامل التربة المختلفة قد تؤثر بصور مختلفة على مستويات تركيز العناصر فى كل من الأنواع المدروسة ٠ وقد وجد أيضا أن نفس العامل قد يؤثر على نفس العنصر أو عناصر مختلفه فى كل من هذه الأنواع ؛ إلا أنه قد وجد أن بعض العناصر المعينه فى كل نوع من هذه الأنواع قد تتأثر بعوامل تربيه محدده ٠