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in

Zdruli P. (ed.), Steduto P. (ed.), Kapur S. (ed.).
7. International meeting on Soils with Mediterranean Type of Climate (selected papers)

Bari : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 50

2002
pages 227-233

YIELD OF MAIZE IN RELATION TO SOIL FERTILITY PARAMETERS AT VEGORITIS AREA IN NORTHERN GREECE

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Introduction

Maize (*Zea mays*) is cultivated at a great extent in Vegoritis area (northern Greece) that half a century ago was covered by the waters of Vegoritis lake. At present, the high yielding maize cultivars absorbs large quantities of nutrient elements from the soil (Liang et al., 1996). Thus, it is important to establish the right amount and type of fertiliser to be applied in order to succeed to create the right balance of nutrients into the soil (Murillo et al., 1997; Randall et al., 1997).

However, better utilisation of soil nutrients for high grain yield of maize is attained under the influence of certain physicochemical soil characteristics such as pH, electrical conductivity as well as $CaCO_3$ and organic matter content (Bornman et al., 1998; Hergert et al., 1996; Katerji et al., 1996; Ramamurthy and Shivashankar, 1996). The present paper deals with the relationships between the main physicochemical soil characteristics and maize yields.

Materials and Methods

Forty-eight maize fields (cv. pioneer) were randomly selected for the conduction of the present study during the year 2000. Planting density was about 70,000 plants/hectare and standard cultivation practices were applied in regard to irrigation, insect, disease and weed control.

Soil samples were taken for each field from 0-30 cm and 30-60 cm depths and analysed for pH, free $CaCO_3$ content (%), electrical conductivity (mmhos/cm), organic matter content (%), as well P, K, Ca, Mg, B, Mn, Zn, Fe and Cu mineral content (ppm) (Table 1). The physicochemical soil characteristics were determined according to the following: pH, electrical conductivity (mmhos/cm), $CaCO_3$ content (%) and B content by Jackson (1958), P content by Olsen (1954), organic matter content (%) by Walkey Black method (Jackson, 1958), exchangeable potassium extracted with NH_4OAc by Arnold (1970) and the microelements Mn, Zn, Fe and Cu extracted with DTPA by Lindsay and Norvell (1978).

Only nitrogen fertilisers in the form of ammonium sulfate at a rate of 100 kg/ha as base application and ammonium nitrate at a rate of 170 kg/ha as a top dressing application were applied. The nutrients P, K, Ca, Mg, B, Mn, Zn, Fe and Cu were applied occasionally when soil nutrients were inadequate.

Yield (t/ha) was recorded by weighing the crop yield at harvest late in October. Multiple regression and stepwise variable selection analysis was performed for yield prediction

based on soil parameters. The predicted versus the observed yields were also compared (Velemis et al., 1998). Additionally, the range of soil parameters in maize fields as well as their effect on yield was defined. The statgraphics 3.0 package was used for the statistical analysis of the recorded data.

Results and Discussion

Table 1 presents the range of certain characteristics of the studied soils. The observed maize yields ranged from 7 to 15.5 t/ha, with a standard deviation (sd) of 2.54 t/ha and a mean yield 11.98 t/ha.

Table 1. Range of soil parameters in maize fields at the area of Vegoritis.

Parameters	Values	
	Lower	Higher
pH (1:1 in H_2O)	7.41	8.50
$CaCO_3$ (%)	0.88	40.48
E.C. (mmhos/cm)	0.37	3.52
Organic matter (%)	0.85	2.02
P (mg/Kg soil)	7.35	73.48
K (mg/Kg soil)	80.00	430.00
Ca exch. (mg/Kg soil)	105.60	1066.00
Mg exch. (mg/Kg soil)	7.68	190.80
B (mg/Kg soil)	0.12	1.19
Mn (mg/Kg soil)	1.40	9.12
Zn (mg/Kg soil)	0.12	3.26
Fe (mg/Kg soil)	1.60	46.10
Cu (mg/Kg soil)	0.12	5.56

Multiple regression analysis showed that maize yield was highly correlated with the studied soil parameters [r^2 (adj.)=0.990] (Fig. 1). However, by applying a stepwise variable selection program, pH, P, K, Cu and Mg were found to be the most important variables for yield prediction [r^2 (adj.)=0.990] (Table 2). Provided that our research target was to study the effect of each soil parameter on maize yield, all of them included in the model (Figs 2-4).

Table 2. Significance of soil parameters in relation to maize yields resulted by a stepwise variable selection program.

Significant parameters	F-value	Non significant parameters	F-value
pH	1049.15	$CaCO_3$	1.16
Mg	18.22	E.C.	1.75
P	9.04	Organic matter	1.10
K	8.63	B	0.70
Cu	4.27	Mn	0.62
		Zn	2.65
		Fe	0.95
		Ca	0.02

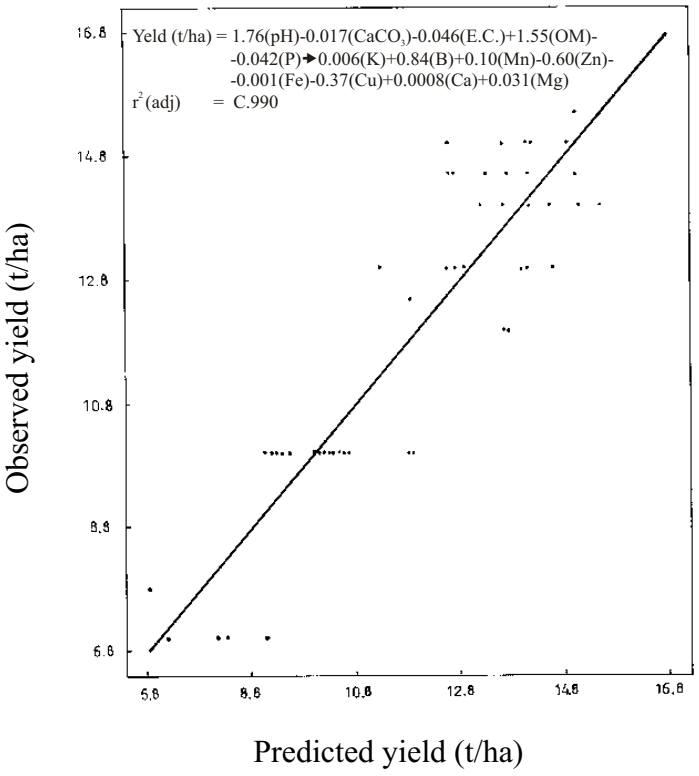

Figure1. Observed and predicted maize yields related to certain physical and chemical soil parameters (sd=2.54 t/ha)

The effect of physicochemical soil properties included in the model show that the higher are the values of pH and organic matter content the higher is the yield while opposite results were obtained with the respective values of $CaCO_3$ content and electrical conductivity (Fig. 2). Nevertheless, the positive or negative effects of these soil parameters, were not statistically significant, because the yield response was altered by less than the standard deviation of the mean maize yield (sd=2.54 t/ha).

In addition, increased soil content in K, Ca, B and Mn had a positive effect, while in P, Mg, Zn, Fe and Cu a negative one (Figs 3 and 4). Furthermore, the effects of the above-mentioned nutrients, except Mg, were not considered significant because of their low influence on yield. However, Mg soil values higher than 180 ppm decreased maize yield significantly. It seems that the low K/Mg ratio in soil increases K-Mg competition resulting in yield reduction.

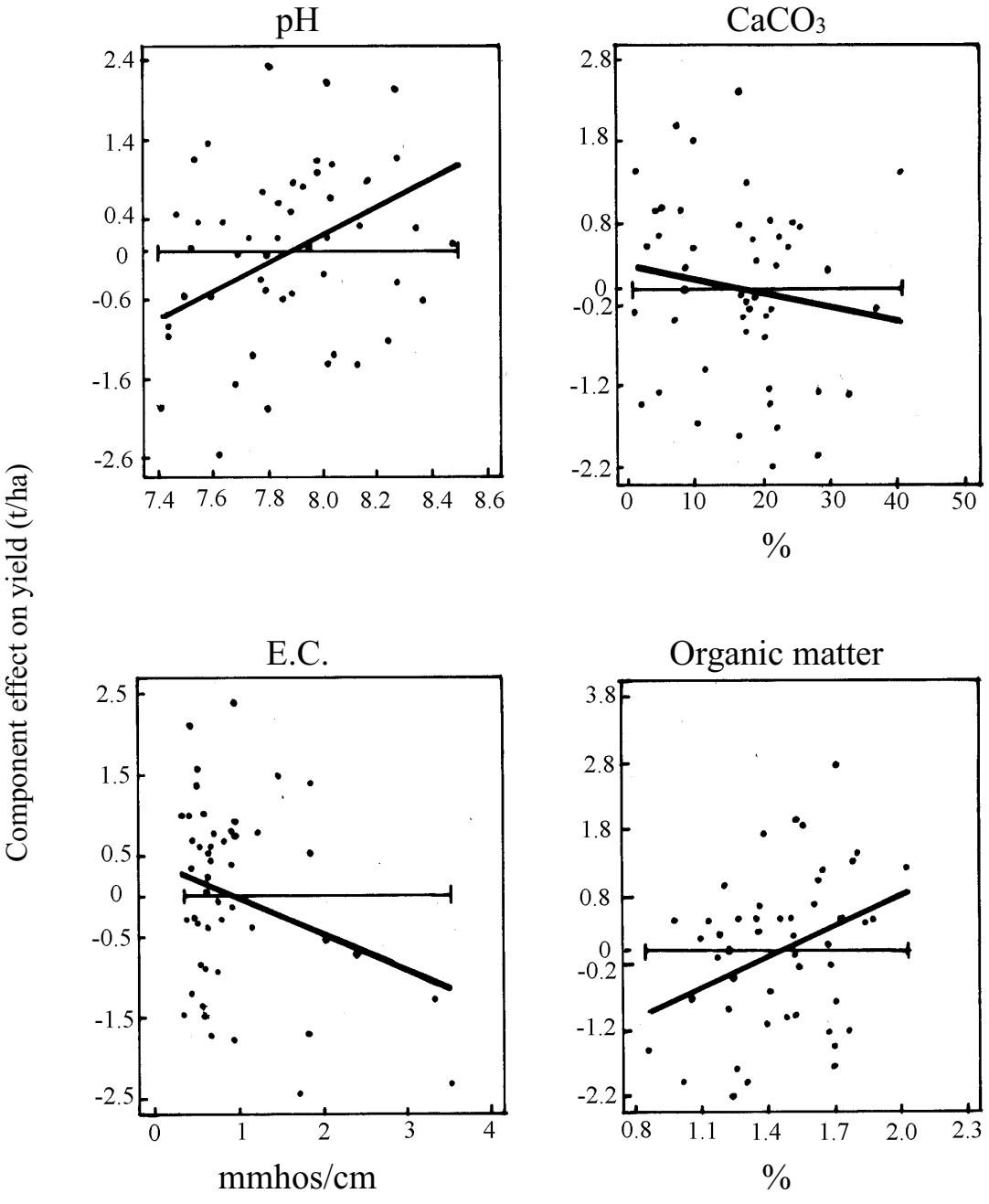

Figure 2. Component effect of soil pH, $CaCO_3$ content, electrical conductivity and organic matter content on maize yields (sd=2.54 t/ha).

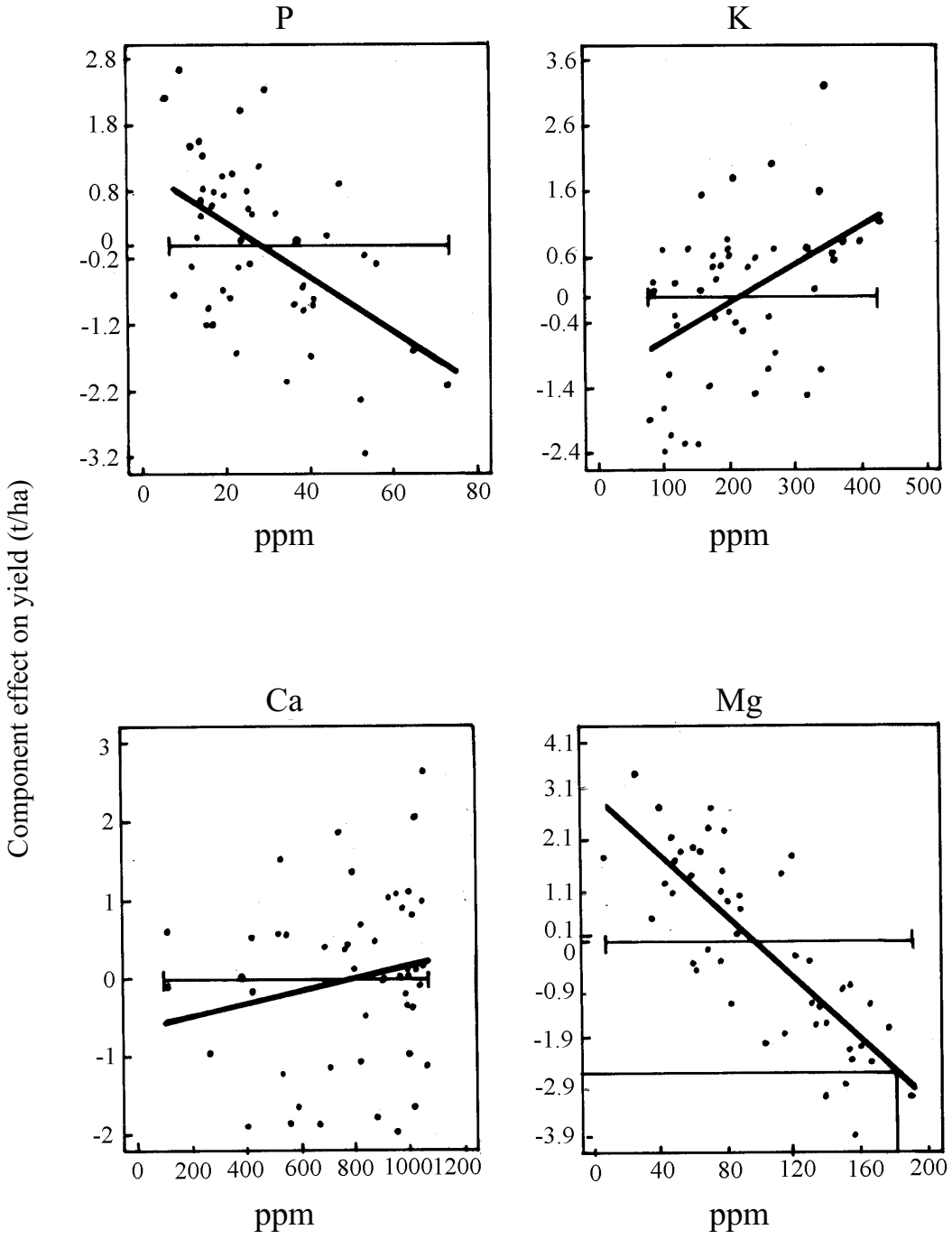

Figure 3. Component effect of soil P, K, Ca and Mg content on maize yields (sd=2.54 t/ha).

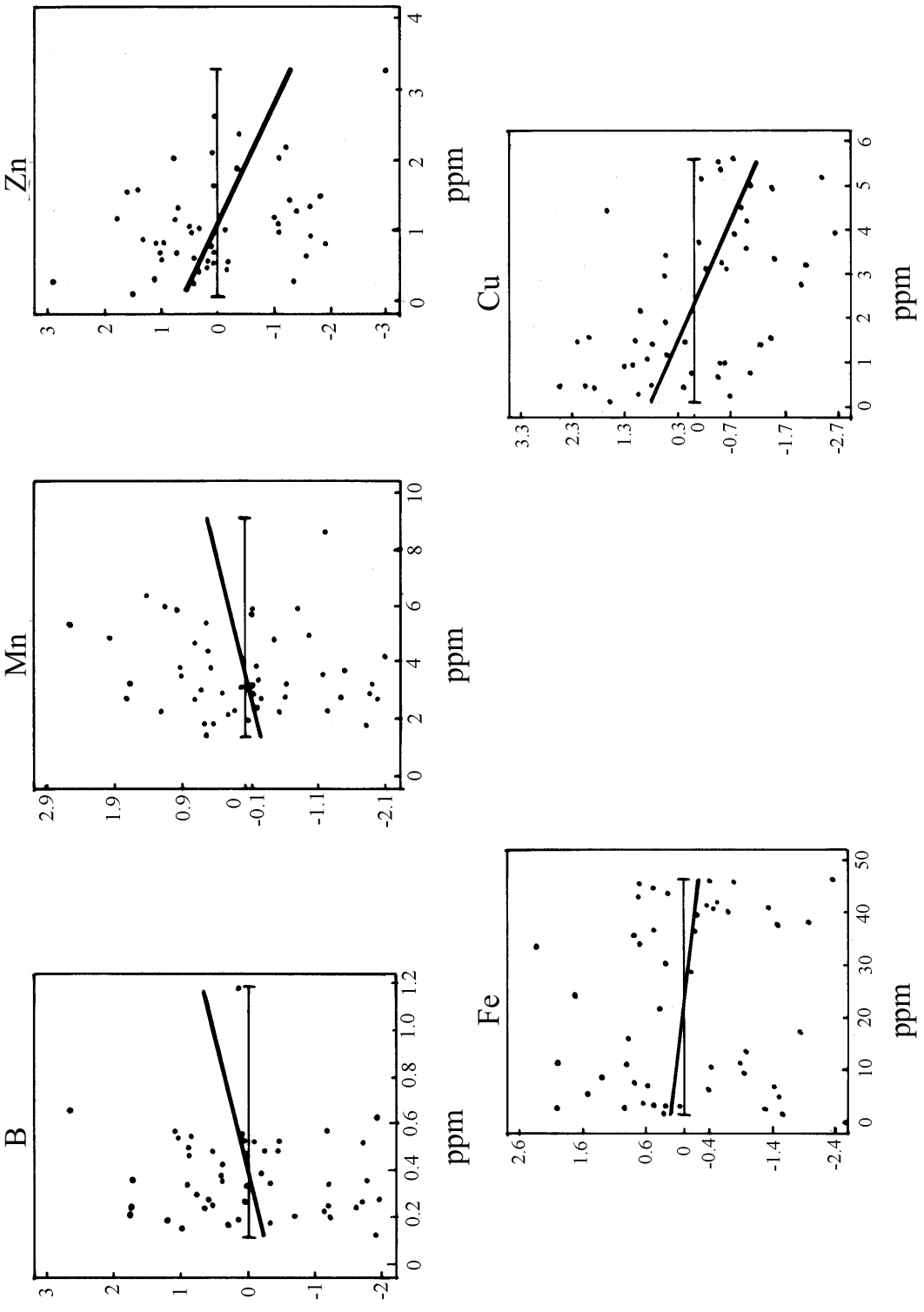

Figure 4.Component effect of soil B, Mn, Zn, Fe and Cu content on maize yields (sd=2.54 t/ha).

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