Fertility and salinity conditions in Tenerife rose culture

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INTRODUCTION. — The cultivation of the rose bush for cut flowers has increased extraordinarily in the last decades. It is estimated that at present the area given over to rose growing in Europe is some 2,500 Ha, of which almost 10% is in Spain. In the island of Tenerife the plantations take up 50% of the total area given over to roses in our country. It is possible to predict a very promising future for rose growing in the island in view of its profitability especially if it is remembered that heating is unnecessary here, whereas in European countries it is indispensable, and represents an important limiting factor due to the high cost of fuel. In addition it should be added that these countries tend to concentrate their production between April and October whereas in the Canaries cultivation is directed to achieving maximum production in winter.

Nevertheless the expansion of rose growing could be limited by certain environmental conditions, particularly the salinity of the soil.

The purpose of the present work is to make clear the possible effects of the chemical characteristics of the soil in the development of the rose bush for cut flowers.

We have noted in the literature that the various authors attribute little importance to the type of soil used in rose growing (VAN DAM and KOLMEYR, 1970; WHITE, 1969; TAYLOR, 1969; FUCHS, 1976; GRAIFENBERG, 1979). For this reason we have omitted, in our study, the granulometric analysis. Nevertheless the determinations of the moisture saturation percentages give us an idea of the type of texture, which in most cases is loam-clay, or loam-clay-sand. Moreover good drainage and the high organic material content give the soil optimum hydraulic and aeration properties which are of the greatest importance in rose growing.

The content of available nutrients may be a limiting factor in roses as has been shown by DASHEG and FEIGEN (1978) and VAN DAM
and Kolmeyer (1970). Nevertheless the nutrient richness of the original soil is not very important since the needs of the plant can be satisfied by fertilizers and dressings. The rose bush is also very demanding in organic matter, and on this point we recur to the statements of Sohan (1969) and Meilland (1955).

Perhaps the principal limiting factor in the cultivation of the rose bush for cut flowers is salinity to which this plant is very sensitive according to several researchers (McCall, 1961; Boodley, 1969; Bernstein, 1964; Richards, 1954; Baker, 1957; Graifenberg, 1979, etc.). For this reason we have given special attention, in our study, to this aspect of soil chemistry.

**Material and Methods.** - **Taking of samples.** — The taking of the samples under study was carried out during two consecutive years in the campaigns 1978-79 and 1979-80. The number of plantations sampled was 34, the total number of soils collected being 340.

The taking of soil samples was always carried out in homogeneous parcels in greenhouses with good yields, using an auger at a distance of 30 cm from the plant, and to a depth of 30 cm. Where the irrigation system used was drop by drop the sample was taken at half the radius of the moistened bulb formed, with the object of avoiding the zone in which salts accumulated.

In each plantation the number of samples taken varied with the area, the types of soils, and the varieties grown, the average being 5 samples per plantation per year. Each sample was composed of 10 subsamples.

In these soils pH, O.M., available P<sub>2</sub>O<sub>5</sub>, exchange cations, E.C. and cations and anions in the saturated extract were determined.

**Analytical Techniques.** — The pH was measured in a soil-water suspension in a ratio of 1:2.5. The electrical conductivity was measured in the saturation extract. The organic matter was determined by the dry combustion method using a Carminograph apparatus. For the extraction of available P<sub>2</sub>O<sub>5</sub> the Olsen procedure was followed.

The Na, K, Ca and Mg exchangeables were extracted with solutions of CH3COONa, 1N at pH = 7. In the extract Na and K were determined by flame photometry, and Ca and Mg by atomic absorption spectrophotometry.

**Results and Discussion.** — **pH.** — Table n. 1 sets out the average results of the chemical soil analyses of the 34 plantations under study arranged in ascending values of pH. Each value in the table represents the average of the determinations carried out in various soils grouped according to the following pH intervals: <5, 5.6-6, 6.7 and >7.
The soils studied show pH values varying from 4.0 to 8.1. Of the samples, 12% have a pH < 5; 34% are in the pH range 5 to 6; 37% in the 6 to 7 and 17% above 7. To summarize, most of the soils show weak or moderate acid reaction, soils of strong acid or moderate alkaline reaction being only slightly represented. We can, therefore, state that, in general, the pH of these soils are within the ranges considered optimum for this plant by different authors (GRAFENBERG, 1979; LOPEZ MELIDA, 1981).

The predominance of the acid pH is due primarily to the fact that the soils come from 'quarries' situated on the northern slope of the island. The original pH are modified throughout the period of cultivation by various factors: irrigation and additions of manure, dressing and fertilizers. To evaluate the relations between the pH and the other chemical properties of the soil we determined the binary regressions with the concentrations of O.M. and available P<sub>2</sub>O<sub>5</sub> and the exchange cations Ca, Mg and Na in the soils under study.

It can be seen (table n. 1) that the concentrations of the exchangeable cations rise with a rise in the pH, while those of O.M. and available P<sub>2</sub>O<sub>5</sub> decrease.

The statistical treatment of the analyses (table n. 2) gave highly significant positive correlation coefficients in the case of Na and Mg (r = 0.593 and r = 0.625, respectively) which make clear the close relation between the pH and the concentrations of exchangeable sodium and magnesium.

The effect of the organic matter of the soil on the pH is clearly seen when the binary correlation between both variables is calculated, a coefficient r = -0.432, significant at levels above 0.1%, being obtained. The corresponding regression equation is shown in table n. 3. This decrease of the pH when the soil O.M. levels increase can be attributed, mainly, to the structural improvements the
### Table 2. — Correlation coefficients and regression equations of the soil pH in relation to O.M., P.O₄, exchangeable Mg and Na, sum of cations and % K in the sum of cations.

<table>
<thead>
<tr>
<th></th>
<th>r</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>O.M.</td>
<td>-0.432***</td>
<td>y = 7.10 - 0.20x</td>
</tr>
<tr>
<td>P.O₄</td>
<td>-0.408***</td>
<td>y = 13.16 - 0.037x</td>
</tr>
<tr>
<td>Mg</td>
<td>0.621***</td>
<td>y = 4.84 + 0.16x</td>
</tr>
<tr>
<td>Na</td>
<td>0.593***</td>
<td>y = 4.77 + 0.08x</td>
</tr>
<tr>
<td>Σ cations</td>
<td>0.629***</td>
<td>y = -1.70 + 0.24x</td>
</tr>
<tr>
<td>% K</td>
<td>-0.423***</td>
<td>y = 13.59 - 0.51x</td>
</tr>
</tbody>
</table>

*** = significant at levels above 0.1%.

### Table 3. — Correlation coefficients and regression equations of the soil O.M. in relation to pH, P.O₄, exchangeable Mg and Na, sum of cations.

<table>
<thead>
<tr>
<th></th>
<th>r</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>-0.422***</td>
<td>y = 35.3 - 3x</td>
</tr>
<tr>
<td>P.O₄</td>
<td>0.673***</td>
<td>y = -1.19 + 0.012x</td>
</tr>
<tr>
<td>Mg</td>
<td>-0.524***</td>
<td>y = 12.91 - 0.93x</td>
</tr>
<tr>
<td>Na</td>
<td>0.355**</td>
<td>y = 2.71 - 0.14x</td>
</tr>
<tr>
<td>Σ cations</td>
<td>0.211*</td>
<td>y = 7.35 - 0.89x</td>
</tr>
</tbody>
</table>

*** = significant at levels above 0.1%; ** = significant at levels above 1%; * = significant at levels above 5%.

O.M. brings about in the soil which prevent the accumulation of the Na and Mg cations principally responsible for the increase of the pH, as we have seen.

Similar patterns to those described are noted by García and Díaz (1977) in soils given over to the cultivation of bananas in Tenerife.

**Organic Matter.** — The organic dressings used in rose cultivation in the island of Tenerife range from 20 to 40 kg. per m², the materials used being: peat, manure, various commercial composts, 'pincho' (pine leaves).

The percentages of organic matter found in the soils studied range from 1.74% to 10.25%, the average percentage being about 5%, a value somewhat below that recommended as optimum for the rose by Anstett (6%–8%) in France, but which is, nevertheless in agreement with those indicated by Herrera (1978) for rose growing in the Canaries (4%–7%). In these soils it is noticed that the levels of exchangeable sodium and magnesium decrease as the O.M. content of the soil increases. This is made clear by the negative correlation coefficients $r = -0.524$ and $r = -0.355$ obtained for
Mg and Na respectively. The corresponding regression equations can be seen in Table 3. Due to these relations of the organic matter with the exchange sodium and magnesium the negative correlation with the pH, previously commented on, is justified.

Available P₂O₅. — The concentrations of available P₂O₅ found in our study range from 300 ppm to 1300 ppm with an average value of 720 ppm considerably higher than those found in other regions, especially of it is remembered that the extraction procedure used (Olsen) extracts comparatively less phosphorus than the others. Thus, we see in the literature that the available P₂O₅ contents determined by various methods in rose soils range from 55 ppm to 1000 ppm.

Given that the rose bush’s needs of this nutrient are not very high we can consider 'a priori' that the available P₂O₅ content of these soils is, in general, more than sufficient, so that it is highly unlikely that phosphorus deficiency will appear in these conditions. The available P₂O₅ levels are conditioned, in part, by the fertilizer applied which accumulates mainly in fine-textured soils. The average value of available P₂O₅ is 652 ppm for soils with a saturation percentage <50%, 723 ppm for those between 50% and 60%, and 805 ppm for those above 60%.

The P₂O₅ and O.M. concentrations in these soils are closely related. This relation is already noted in Table 1 and confirmed by the statistical analysis, a positive correlation coefficient $r = 0.673$, significant at a level of 0.1%, being obtained. This correlation can be explained by the solubilizing effect of the organic matter on the soil phosphates, over and above the assimilable phosphorus contribution which the addition of M.O. makes.

The P₂O₅ content of these soils appears also to be affected by the pH as is shown by the statistical study in which a negative correlation coefficient $r = -0.401$, significant at levels above 0.1%, is obtained (see Table 2).

Exchange cations. — Exchangeable sodium is found in these soils in concentrations that range from 0.78 to 4.57 meq/100 gr., with an average value of 2.04. These raised exchangeable Na levels constitute, perhaps, one of the most outstanding negative characteristics of these soils as compared with those of other rose-producing
areas, where the exchangeable sodium concentrations are insignificant.

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The exchangeable magnesium is found in these soils in concentrations that range from 1.9 to 19.3 meq/100 gr., with an average value of 8.5 meq/100 gr., a considerably high level.

Since both cations, generally, come from the same source (the irrigation water) their concentrations in the exchange complex vary in parallel, which is seen, in a general way, in the table of average values (Table 1). This pattern is confirmed by the results of the statistical analysis with a positive correlation coefficient $r = 0.684$ significant at levels above 0.1%.

The exchangeable Ca concentrations in these soils range from 10.6 to 26.6 meq/100 gr. with an average value of 16.9. These values are high compared with those found in soils given over in the island to fruit crops such as bananas and avocados, which are relatively poor in calcium. The high calcium levels in the rose soils are due to the frequent dressings the bush receives, which results in an average value of 2.26 for the relation exchangeable Ca/Mg close to that indicated by various authors as optimum for soils of temperate regions, and much above that found in the banana soils of Tenerife where in many cases it is even below the unit (Garcia, 1977). It can be said that the calcium concentrations in the rose soils are generally sufficient to ensure an adequate calcium nutrition of the bush, so necessary to achieve a flower of good quality.

The absolute exchangeable K values in the soils studied is between 2.9 and 7.9 meq/100 gr. with an average of 5.1, representing in most of the soils more than 20% of the sum of the cations. This potassium richness is a common characteristic of island soils whether cultivated or not. In the former the potassium levels become very high because of intensive fertilizer use particularly in old plantations.

**Salinity.** — Table 4 shows the distribution of the soil samples according to the range of conductivity, and also the correspon-
Table 4. — Average ion concentration values in the saturation extract in ascending conductivity intervals.

<table>
<thead>
<tr>
<th>% of samples</th>
<th>E.C. (25°C) μhos/cm</th>
<th>K⁺ (meq/l)</th>
<th>Na⁺ (meq/l)</th>
<th>Ca⁺⁺ (meq/l)</th>
<th>Mg⁺⁺ (meq/l)</th>
<th>Cl⁻ (meq/l)</th>
<th>CO₃⁻⁻ (meq/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>&lt; 2000</td>
<td>3.68</td>
<td>6.55</td>
<td>4.97</td>
<td>4.93</td>
<td>3.73</td>
<td>2.70</td>
</tr>
<tr>
<td>50</td>
<td>2000-3000</td>
<td>7.52</td>
<td>8.48</td>
<td>9.58</td>
<td>9.48</td>
<td>3.05</td>
<td>2.27</td>
</tr>
<tr>
<td>23</td>
<td>3000-4000</td>
<td>9.54</td>
<td>9.81</td>
<td>17.64</td>
<td>15.03</td>
<td>6.26</td>
<td>3.00</td>
</tr>
<tr>
<td>11</td>
<td>&gt; 4000</td>
<td>11.64</td>
<td>10.49</td>
<td>19.09</td>
<td>19.38</td>
<td>6.53</td>
<td>3.48</td>
</tr>
</tbody>
</table>

The average concentrations of the cations, and of the anions Cl⁻ and CO₃⁻⁻.

A should be pointed out that 22% of the soils show conductivities between 2000 and 3000 μhos/cm (25°C) and 11% exceed 4000 μhos/cm the limit established by Schofield for saline soils. Nevertheless symptoms of toxicity by salts do not appear to be noticed in these plants, in spite of the fact that the rose bush is generally considered as sensitive or very sensitive to salinity. On this point Bernstein (1964) in his classification of plants in relation to salinity includes the rose bush in the second group, that is to say, among the plants whose yields are noticeably reduced when the E.C. of the saturation extract is between 2000 and 4000 μhos/cm. In these soils irrigated with water containing high concentrations of Na⁺, this cation, nevertheless, contributes in only a small degree to the total salinity, as can be seen in table n. 4.

The soluble Mg shows values between 2.60 and 34.70 meq/l. with an average value of 10.90 meq/l. which can be considered high. The increase which the levels of soluble magnesium undergo when the conductivity of the saturation extract rises is made clear in the same table. This behaviour is confirmed by the results of the statistical analysis which appear in table n. 5.

The effect of potassium fertilizer in the salinization of the soil becomes clear when the K concentration values in the saturation extract are examined. When the statistical analysis of these concentrations in relation to the E.C. is carried out a positive correlation coefficient r = 0.77, significant at levels above 0.1% is obtained. The corresponding regression line is shown in graph n. 1.

The soluble Ca is found in concentrations that range from 1.80 to 47.40 meq/l. with an average of 13.18 meq/l. in the previous
Table 5. — Correlation coefficients and regression equations of the saturation extract EC in relation to soluble cations.

<table>
<thead>
<tr>
<th>Ion</th>
<th>r</th>
<th>Regression Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na</td>
<td>0.431***</td>
<td>y = 1.56 + 0.14x</td>
</tr>
<tr>
<td>K</td>
<td>0.772***</td>
<td>y = 1.18 + 0.22x</td>
</tr>
<tr>
<td>Ca</td>
<td>0.840***</td>
<td>y = 1.56 + 0.098x</td>
</tr>
<tr>
<td>Mg</td>
<td>0.683***</td>
<td>y = 1.39 + 0.133x</td>
</tr>
<tr>
<td>Σ cations</td>
<td>0.932***</td>
<td>y = 0.53 + 0.037x</td>
</tr>
</tbody>
</table>

*** = significant at levels above 0.1%.

**Graph 1.** — Relation between the extract EC and soluble K.

In the table it will be noted that the soluble calcium values rise with an increase in the conductivity of the saturated extract.

In general, it can be said that the calcium represents the greatest proportion of the sum of the cations, contributing, therefore, to a greater degree to the conductivity of the saturation extract with which it is closely correlated. In fact, the correlation coefficient in this case is the highest of those found. The corresponding regression line is shown in graph n. 2.

As regards the anions, the Cl⁻ is found in concentrations that range from 1.40 to 16.20 meq/l. with an average value of 5.01 above that indicated, by various authors, as dangerous for the plant.
The CO$_3^{2-}$ concentrations in the saturation extract range from 0.14 to 5.67 with an average value of 2.53 meq/l. It should be pointed out that approximately 11% of the soil samples studied show CO$_3^{2-}$ levels in the saturation extract close to 4 meq/l, a value considered as limiting in the cultivation of roses in the Spanish Levant, whereas some foreign authors consider a value of 2 meq/l as limiting.

![Graph](image)

**Graph 2.** — Relation between the extract EC and soluble Ca.

**REFERENCES**


FERTILITY, SALINITY AND ROSE CULTURE


SUMMARY. — Cultivation of roses for cutting flowers is increasing its importance in the Canary Islands. This paper is the beginning of a series of studies on the fertility of the soils and mineral nutrition of roses in the island of Tenerife.

The following ranges represent the most common chemical characteristics: pH: 5.7; O.M.: 5.6%; P2O5: 300-1300 ppm. Exchangeable cations: Na: 0.3-4.3 meq/100 gr; Mg: 1.33-3.6 meq/100 gr; Ca: 10.62-26.60 meq/100 gr; K: 2.94-7.93 meq/100 gr.

High concentrations of soluble salts are also observed. The E.C. of the saturation extract is greater than 2 mmhos/cm (25°C) in most cases.

RÉSUMÉ. — Aux Iles Canaries l'importance de la culture des roses pour fleur coupée est en train d'augmenter. Nous commençons avec ce travail une série d'études sur la fertilité des sols et la nutrition minérale des roses à l'île de Tenerife.

Les caractéristiques les plus communes des sols présentent les « ranges » suivants: pH: 5.7; O.M.: 5.6%; P2O5: 300-1300 ppm; cations échangeables: Na: 0.78-4.37 meq/100 gr; Mg: 1.93-3.96 meq/100 gr; Ca: 10.62-26.60 meq/100 gr; K: 2.94-7.93 meq/100 gr.

On observe aussi des concentrations de sels assez élevées. La C.E. du extrait de saturation est au-dessus 2 mmhos/cm (25°C) dans la majorité des cas.


Die folgenden Ergebnisse vertreten die gewöhnlichen o. chemischen Eigenschaften: pH: 5.7; O.M.: 5.6%; P2O5: 300-1300 ppm; Austauschbares: Kationen: Na: 0.78-4.37 meq/100 gr; Mg: 1.93-3.96 meq/100 gr; Ca: 10.62-26.60 meq/100 gr; K: 2.94-7.93 meq/100 gr.

RESUMEN. — Los cultivos de rosas para flor cortada están incrementando su importancia en las Islas Canarias. Este trabajo es el comienzo de una serie de estudios sobre la fertilidad de los suelos y la nutrición mineral de las rosas en la isla de Tenerife.

Los siguientes rangos representan las características químicas más comunes de los suelos: pH: 5-7; M.O.: 5-6%; P₂O₅: 300-1300 ppm. Cationes cambiables: Na: 0.78-4.37 meq/100 gr; Mg: 1.93-19.36 meq/100 gr; Ca: 10.62-26.60 meq/100 gr; K: 2.94-7.93 meq/100 gr.

Se observan asimismo altas concentraciones de sales solubles. La C.E. del extracto de saturación es superior a 2 mnhos/cm (25°C) en la mayoría de los casos.

RIASSUNTO. — La coltura della rosa da fiore reciso ha incrementato la sua importanza nell’Isola Canarie. Questo rapporto è il primo di una serie di studi sulla fertilità dei suoli e sulla nutrizione minerale della rosa nell’isola di Tenerife.

I seguenti intervalli rappresentano le più comuni caratteristiche chimiche dei suoli: pH: 5-7; S.O.: 5-6% P₂O₅: 300-1300 ppm; cationi scambiabili: Na: 0.78-4.37 meq/100 gr; Mg: 1.93-19.36 meq/100 gr; Ca: 10.62-26.60 meq/100 gr; K: 2.94-7.93 meq/100 gr.

E’ stata trovata una concentrazione salina elevata. La C.E. dell’estratto acquoso del terreno è superiore a 2 mnhos/cm (25°C) nella generalità dei casi.

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