

# Nutrient Deficiencies in Soils

**nitrogen and phosphorus found to be deficient in samples of soils representing many parts of the state**

**H. Jenny, J. Vlamis and W. E. Martin**

**Between 50% and 70%** of the soils in the major farming sections of California—from Siskiyou County in the north to Imperial County in the south—are deficient in available nitrogen.

Similarly, low levels of available phosphate appear to be widespread throughout the state in all but the recent alluvial soils.

The majority of the soils seem to be well supplied with available potash.

These conclusions were drawn from the findings obtained in a study of the fertility—the nutrient supply—of California soils, apart from other factors affecting growth of plants.

Some 450 samples of different soils representing five broad classifications were subjected to greenhouse tests in the study:

1. Recent alluvial soils which are formed on flood plains and in great fans on the floors of valleys. Some of the most productive soils in the state belong to this group.

2. Older alluvial soils, which have moderate accumulations of clay in the subsoil.

3. Claypan soils which have marked accumulations of clay in the subsoil.

4. Hardpan soils which are found on the terraces on the western slopes of the Sierra Nevada. The hardpan soils have developed on older plains and terraces and have cemented subsoils which impede root development.

5. Soils of hills and mountains which are found on a great variety of rocks and usually are shallow.

## Correlated Tests

Of the soils samples tested in the greenhouse, more than 100 were tested also by field experiments with wheat, barley, oats, alfalfa, ladino clover, table beets.

The pot tests were concerned with the surface soil to a depth of eight inches only because, as a rule, the subsoils tend to be lower in the nutrients tested.

The greenhouse tests represent an analysis of soil which uses a growing plant as an indicator of the excess or deficiency of available nutrients in the soil under test.

The relative yield of a pot test is a measure of the soil's ability to supply a given nutrient element under experimental standardized conditions.

The lower the relative yield of the indicator plant—in these studies Romaine lettuce was used—the greater is the chance of obtaining a response to an applied fertilizer in the field.

For each of the greenhouse tests, 20 six-inch flower pots were filled with 1,600 grams of dry soil. Four of the pots were

After a growth period of six to eight weeks the plants were harvested, dried at 70° C, and weighed.

A convenient method of expressing the dry weights of the lettuce plants as relative yields is obtained by formula. The weights of those plants which received the full treatment are divided into the weights

**Percentage of Soils Tested Having Low or High Levels of Available Phosphorus and Nitrogen**

| Available Phosphorus |     |      | Soils               | Available Nitrogen |      |                     |
|----------------------|-----|------|---------------------|--------------------|------|---------------------|
| No. of soils tested  | Low | High |                     | Low                | High | No. of soils tested |
| 137                  | 38% | 52%  | Recent alluvial     | 55%                | 16%  | 121                 |
| 91                   | 42  | 52   | Older alluvial      | 56                 | 14   | 81                  |
| 65                   | 71  | 23   | Claypan             | 71                 | 19   | 59                  |
| 27                   | 74  | 11   | Hardpan             | 48                 | 22   | 27                  |
| 110                  | 67  | 24   | Hills and mountains | 68                 | 17   | 96                  |

used as checks and no nutrients were added. To each of the other 16 pots 80 milligrams—the equivalent of 100 pounds an acre—of various nutrient combinations were added. Nitrogen was added as ammonium nitrate, phosphorus as mono-calcium phosphate, and potassium as potassium sulfate.

The full treatment of nutrients—two parts of nitrogen, three parts of phosphorus and one part of potassium—was added to the soil in four of the pots.

In groups of four the remaining 12 pots had partial treatments of added nutrients. The proportions of the nutrients used in the full treatment remained the same but four pots received no nitrogen, four had no phosphorus added and potassium was withheld from the last four.

All 20 pots were planted with one-month-old Romaine lettuce seedlings.

of plants with partial treatment and the result is multiplied by 100.

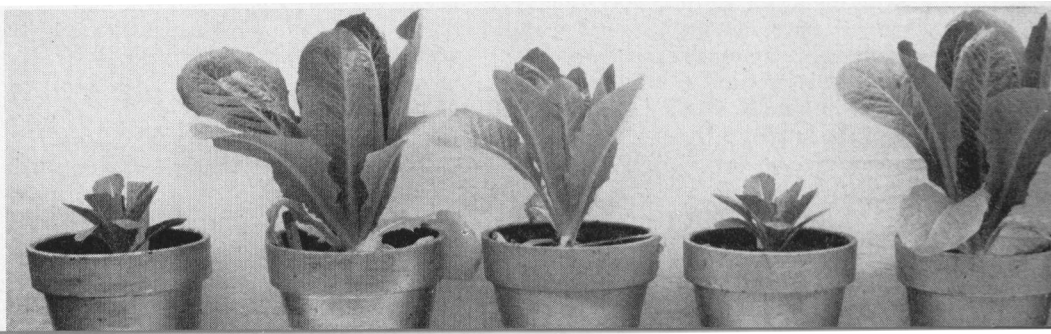
As an example: if the weights of the full treatment plants are 9.2 grams and the weights for partial treatment plants—no-phosphorus, for instance—are 4.0 grams, the relative yield would be 44%. Thus the no-phosphorus yield would be 44% of the full treatment yield.

With the coöperation of the Soil Conservation Service and the Agricultural Extension Service, the Division of Soils made more than 100 field-pot correlation tests for field and truck crops. Tree crops and vines were not included.

Between one-half and two-thirds of all the soils examined produced relative—no-nitrogen—yields of 30% or less which indicated they were sufficiently low in available nitrogen so a field response to

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**Comparative growth of Romaine lettuce as the indicator plant in greenhouse pot tests for relative yields. The plant on the left was the check plant which had no nutrients added and the relative yield was 11%; the second plant from the left received the full treatment of two parts of nitrogen, three parts of phosphorus and two parts of potassium, with a relative yield of 100%; the third plant had the partial treatment with the nitrogen withheld, relative yield was 48%; phosphorus was not given the fourth plant and the relative yield was 8%; the plant on the extreme right had no potassium added, the relative yield was 106%.**



## BUDS

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The part that light of varying intensity may play in retarding or hastening the ending of the rest is still not very clear. It may at winter intensities and duration be a retarding influence and become a stimulating influence at the higher intensities and longer duration of spring and summer.

The gardner and orchardist in regions of mild winters is thus confronted with a rather complicated situation involving temperature, light, variation of response of different kinds of plants, and possibly other factors, all of which affect spring growth. It appears clear from experience, however, that shade in winter is beneficial for plants with strong rest periods. It seems a reasonable deduction from the experimental results described above that plants subjected to fluctuating outdoor conditions may require a longer exposure to break the rest of buds than would be required under continuous low temperature.

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## PIPE

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fabrication and installation procedure that should largely eliminate such failure at no appreciable increase in cost.

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## SOILS

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applied fertilizer could be expected—provided other elements were not limiting.

No-nitrogen yields above 50% indicate high nitrogen supplies and little chance of field response to fertilizer.

Soils giving a no-phosphorus yield of 20% or less are so low in available phosphorus that they will, as a rule, produce a field response to applied fertilizer where other nutrient elements, specific soil conditions and water are not restrictive.

Phosphate responses in the field were especially noticeable during the cooler seasons of the year.

Soils producing no-phosphorus yields above 30% probably will not justify phosphate fertilization.

Low phosphate levels appear to be widespread in California, especially in

hardpan soils and in the soils in the hills and mountains.

In contrast, the recent alluvial soils are somewhat better supplied with available phosphorus and have the additional advantage of having great depth which provides a large nutrient reservoir.

Available phosphorus in soils with either pronounced acid reaction or with pronounced basic—alkaline—reaction tends to be in low supply. Soils which are neutral or with only slight acid or alkaline reactions are, on the average, better supplied with available phosphorus.

Of the 105 soils tested which had a pH—the measurable acidity and alkalinity—of below 5.9, which indicates strong acidity, 79% were low in available phosphorus.

Of the 20 soils tested which had a pH of above 8.3—markedly alkaline—80% were low in available phosphorus.

Of 116 soils slightly off neutral only 26% were found to be low in available phosphorus.

Nearly all of the soils investigated appear to be well supplied with potash for the requirements of the crops used in this study.

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