

Use of Soil Analysis in Osmocote Fertilizer Programs¹

O. A. Matkin

Soil and Plant Laboratory, Inc., Orange, California

Abstract. A method of determining the reserve fertilizer content of soil containing encapsulated slow-release fertilizer was tested. The procedure involved dual analysis by extraction before and after rupturing fertilizer capsules using a cereal grinder.

Dry soil bulk density measurement permitted calculation of theoretical fertilizer concentration. Comparison of calculated versus concentrations found were very close for potassium and nitrogen. Phosphorus found by analysis was lower than theoretical.

The unique feature of Osmocote² slow-release fertilizers as compared to other slow-release source materials is that all of the fertilizer potentially available is in a soluble form, though encapsulated and therefore not immediately available. Another unique feature which can sometimes lead to confusion or miscalculation is that the capsule itself does not disappear from the soil even though the fertilizer contained in it has been completely released.

The first feature suggests that a simple method of soil analysis might be employed to determine both the currently available nutrients, as is commonly done for soils, and also the potentially available nutrients. Thus the presence of the capsules could be evaluated for their true nutrient content. Such a system would enable the grower to evaluate the status at any given time and to determine whether additional slow-release fertilizer would be required to complete an existing crop or to grow a new one. Other slow-release fertilizers do not lend themselves to this special type of evaluation.

The basic purpose of soil analysis is to predict plant response. Unfortunately there is still a lack of uniformity of methods, though the procedure has been in use for a number of decades. Some of the methods currently in use would appear to have been selected more for the convenience of the analyst than for the ultimate purpose of predicting plant response. Modern technology permits remarkable precision in chemical analysis of solutions containing minerals. The problem seems to be one of obtaining an appropriate solution with which to carry out the analysis.

The typical approach in soil analysis is to mix the soil with a liquid and then to separate the liquid from the soil by filtration. A liquid solution is then

available for precise chemical analysis. The primary variables are liquid composition and extraction ratios. Extracting solutions range from distilled water to strong solutions of neutral salts, various acids, and in some cases, certain bases. Each extractant has a different effect on the solubility of soil minerals. Many soil scientists use different solutions to extract different elements.

It is evident that obtaining meaningful information from soil analysis is not dependent on accuracy of the analysis so much as it is in obtaining appropriate solutions with which to perform these analyses. To provide useful data, the extracted nutrients must relate to predictable plant response.

Preliminary investigations have shown that the normal extraction method of soils containing Osmocote resulted in little or no release of encapsulated nutrients and therefore illustrated the concentrations of available nutrients only. By passing the soil through a cereal grinder, it was possible to rupture the capsules and then the analysis revealed both current plus potentially available nutrients. Dual analysis can provide information on potentially available nutrients by simple subtraction. Since data are reported in parts per million parts dry soil, it is possible by calculation to determine the actual pounds of a given fertilizer formula that remain potentially available. However, to do this accurately, or to predict accurately the theoretical concentrations from a fresh addition of Osmocote fertilizer, it is necessary to have one other piece of information. This item is *dry bulk density*.

Since modern soil mixes cover a wide range of bulk densities and since fertilizer additions are commonly made in terms of pounds of fertilizer per cubic yard, the procedure used here included a determination of bulk density. This was easily done by pouring the prepared soil mix into a graduate cylinder with light tapping to permit a loose settled condition. The weight of a given volume of soil was recorded as pounds per cubic yard.

Using fine sand, loam soil, sphagnum peat moss and perlite, a series of mixes was prepared and tested for bulk density in order to obtain representation of a wide range. Final mixtures were selected to cover the desired range and Osmocote 14-14-14

was added at a rate of 10 lbs./cu. yd.

The methods utilized in work presented here employed a 10% sodium acetate solution as the extractant (2) for nitrate nitrogen, ammonium nitrogen, and potassium. The extraction ratio was 1:10, 1:20, or 1:40 (soil:solution), depending upon soil density. The purpose was to insure a substantial excess of sodium for cation exchange. Phosphate phosphorus was determined by extraction in similar ratio, using 0.5 molar sodium bicarbonate after the method of Olsen (3). This method has been widely accepted as reproducible and well correlated with plant response to phosphorus. In preliminary studies, it was found here that the bicarbonate method for phosphorus was far superior to sodium acetate extractable phosphorus in both quantitative and correlative evaluation.

Each of the test mixes was separated into two portions, one of which was ground through a cereal grinder in order to rupture the capsules. Bulk density was determined in the unground sample and both were extracted in the manner described above. Total available nitrogen was considered to be the sum of nitrate plus ammonium. Differences were calculated and compared to theoretical values of added fertilizer contained in the Osmocote capsule. Since the period of exposure was very limited, it was assumed that none of the encapsulated fertilizer had been released by osmotic action into the soil solution. The theoretical values for comparison were calculated, using the following formula:

$$\text{ppm nutrient} = \frac{R \times A \times 10^4}{BD}$$

R = rate of Osmocote addition in pound/cubic yard

A = percentage of nutrient in *elemental* form in Osmocote fertilizer

BD = dry bulk density of soil mix in pound/cubic yard

Since the fertilizer values for phosphorus and potassium are commonly listed as oxides, the formula of 14-14-14 Osmocote must be converted to its elemental form before using the above equation. Thus, the formula becomes 14-6.1-11.7.

Using the formula for theoretical concentrations as outlined above, curves were plotted to illustrate the theoretical concentrations versus soil bulk density and analytical data obtained for nitrogen, phosphorus, and potassium were plotted against respective theoretical curves. (Figures 1, 2, and 3).

The theoretical curves illustrate the rapid change in concentration which occurs with small change in density in the low density range. This, then, represents the area of maximum

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² Manufactured by Sierra Chemical Company, P. O. Box 275, Newark, California 94560.

potential error.

A comparison of data found versus theoretical revealed reasonably close correlation based on the single sample analysis, particularly in the case of potassium. Nitrogen values were next best, being slightly scattered and particularly out of line in only one case. Phosphorus values generally fell below the theoretical level. The low phosphorus results were not too unexpected since soil methods of determining available phosphorus are not completely correlated with fertilizer values assigned to the fertilizing products. Also, it is anticipated that a certain amount of fixation may occur when phosphates are added to soils.

The data obtained here were not of sufficient depth to illustrate whether the rate of release is uniform for all three major nutrients over a period of time. This would be a first prerequisite for the use of a single element as a key to the residual potential fertility of the mix containing Osmocote. Leaching trials (1) have indicated that the rate of release of the nitrogen and potassium in particular is fairly uniform and proportional to the quantities contained in the capsules. If this is to be accepted as a practical reality, it then becomes evident that a simple extraction for potassium by the dual analysis method would provide the most accurate assessment with the least analytical labor in determining the residual nutrient content of Osmocote-treated soil. Ideally, the analysis for all three major elements should be carried out.

A method of assessment of residual nutrient supply from encapsulated fertilizer as supplied in Osmocote granules has been suggested and value demonstrated. Although results were not stoichiometric compared with theoretical, they were amazingly close in assessment of nitrogen and potassium in particular. Replications were purposely omitted in order to assess the approach on the basis that might be employed in the field.

It is proposed that the quantity of residual nutrients contained with the capsule can be reasonably accurately determined by a dual analysis system and by calculating a theoretical value for the applied material based on soil density. Although some errors are evident, the method shows considerable promise and would seem to deserve further trial and evaluation.

Literature Cited

1. Cochrane, R. C. and O. A. Matkin. 1966. Nutrient Supply Characteristics of Slow Release Fertilizers. *The Plant Propagator*. 12 (4): 2-10.
2. Morgan, M. F. 1941. Chemical Soil Diagnosis by the Universal Soil Testing System. Conn. Agr. Exp. Sta. Bul. 450.
3. Olsen, S. R., C. V. Cole, F. S. Watanabe and L. A. Dean. 1954. Estimation of Available Phosphorus in Soils by Extraction with Sodium Bicarbonate. USDA Circ. 939.

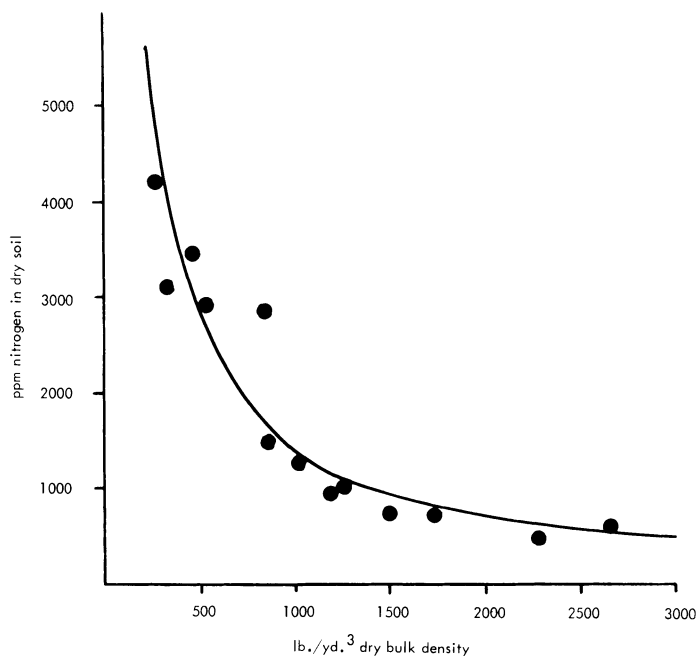


Fig. 1. Values found compared to theoretical.

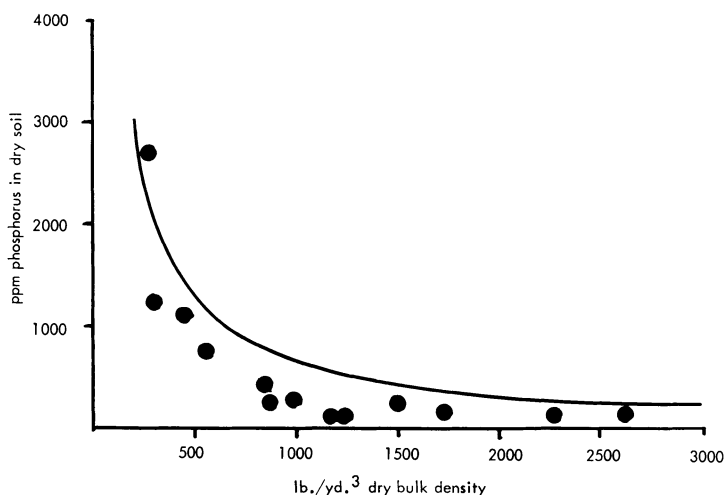


Fig. 2. Values found compared to theoretical.

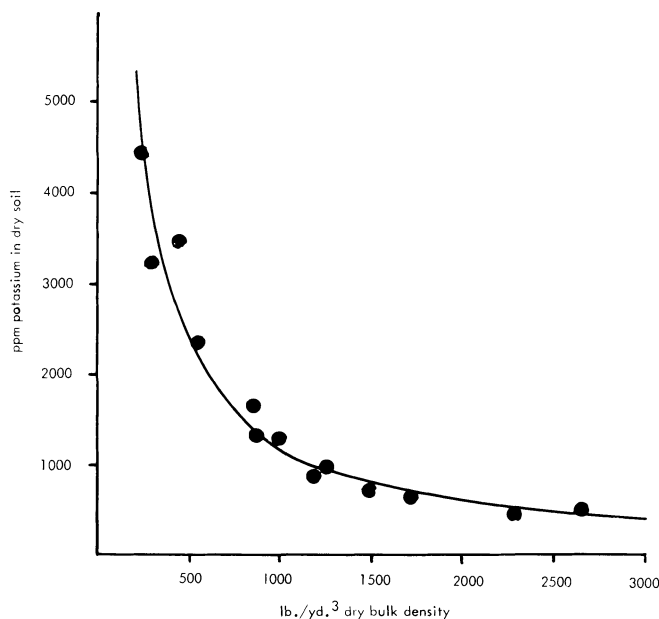


Fig. 3. Values found compared to theoretical.