YIELD-DEPRESSION EFFECT OF FERTILIZERS AND ITS MEASUREMENT: III. AGROBIOLOGICAL ANALYSIS OF CERTAIN MULTIPLE-FACTOR FIELD TESTS SHOWING DEPRESSION BY NITROGEN

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The principal material for this paper was obtained from a nitrogen, phosphorus, and potassium experiment with potatoes on an acid Sassafras sandy loam located on the Eastern Shore of Virginia in 1943, as reported by R. L. Carolus. The fertilizer treatment (per acre) embraced all possible combinations of 60, 120, and 180 pounds of N; 80, 160, and 240 pounds of P₂O₅; 60, 120, and 180 pounds of K₂O; and 0 and 120 pounds of CaO in the form of gypsum. Each treatment was in triplicate, giving 18 series comprising a total of 54 treatments and 162 plots. The calcium in the form of gypsum was not observed to have any material effect on the yields.

Inspection of the data reported by Carolus shows that, in every series, amounts of nitrogen in excess of 60 pounds significantly reduced the yield of tubers. On the other hand, while the yield-lowering effect of increasing amounts of nitrogen pervades the whole work, it is evident that increased amounts of phosphorus and potash have acted to counteract the overall depressive effect of nitrogen; or, stated differently, we have before us the case where added nitrogen is out of nutritional balance with other growth factors concurrently present, and where the unbalance is at least partially corrected by increased additions of two other nutrients, namely, phosphorus and potash. Our object here is to make an agrobiologic analysis of this field test to the extent warranted or suggested by the published data.

Quantitative agrobiology is based primarily on Mitscherlich's law of the effect factors of the factors of plant growth, as expressed by the Mitscherlich-Baule normal yield equation \( y = A(1 - 10^{-0.01x}) \), which describes the action of any factor of plant growth, e.g., nitrogen, when this factor is acting positively to promote the growth of plants. It has also been shown that when this same factor is supplied to the crop on an otherwise normal soil in amounts that are out of due proportion with other plant nutrients, it acts negatively to depress plant growth. In that case the whole action of the growth factor is described by Mitscherlich's depression equation \( y = A(1 - 10^{-9.301x}) .10^{-kk^2} \), where the coefficient \( k \) measures the depressive effect.

In approaching this case it will be helpful to have in mind the general configuration of the Mitscherlich yield-depression diagram, which shows a family of curves calculated for different values of \( k \), as in Fig. 1. On this diagram (here abridged) it will be noted that each depression curve branches off from the normal curve and at first continues to rise with an outwardly convex profile to a certain...