Effect of Fertilizers on the Composition of Potatoes Grown in the Red River Valley of Minnesota

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The potato is an important cultivated crop in the Red River Valley of Minnesota. This crop requires relatively large amounts of plant food, and, consequently, for most soils, fertilizer applications are necessary for high yields. The results of field experiments indicate that there is a need for the use of phosphate and potash fertilizers for potatoes in the Red River Valley (15). During the course of the field trials studies were made to determine the influence of the fertilizers upon the composition and quality of the potatoes. Fertilizers improved the cooking quality of the potatoes, particularly on the lighter soils where nutrient deficiencies were more prevalent (8). The data reported in this article are concerned primarily with the effects of the fertilizers upon the composition of the potatoes.

Considerable work has been done on the influence of fertilizers upon the composition and quality of potatoes, and many conflicting results have been obtained (17). This is probably due in large part to the different conditions under which the fertilizers have been used. For any crop there is a certain optimum of soil and plant nutrient conditions which are most favorable to plant growth and deviations from this optimum may cause changes in plant composition. The effects of fertilizer elements on plant composition are interrelated since one fertilizer element may either enhance or have an antagonistic effect on the absorption of another. On soils which were deficient in potash in England (4, 6), both nitrogen and phosphate enhanced potassium deficiency symptoms in the potato tissue and phosphate deficiency symptoms were induced by nitrogen and nitrogen-potash treatments, but more strongly by the latter. It is, therefore, important that all nutrients are present in adequate amounts for the most satisfactory production of potatoes on a given soil.

METHODS

The potatoes used in this study were grown on three soil types—Fargo silty clay loam, Bearden silt loam, and Ulen fine sandy loam (13). Most of the Fargo and Bearden soils are high in crop productivity and are well adapted to the growth of potatoes. The sandy Ulen soils have a lower organic matter content than either the Fargo or Bearden soils and are much lower in water holding capacity. The supply of lime and magnesium in all of the soils is relatively high and some free lime is often present in the surface soil as well as in the subsoil.

Phosphate and potash fertilizers were used in the trials. The phosphate was applied, with a fertilizer attachment to the planter, at the acre rate of 100 pounds of 43% superphosphate. Different forms of potash were used at rates which were equivalent to 200 pounds of 60% muriate of potash and were broadcast immediately after the potatoes were planted. The phosphate and potash fertilizers were used at three rates, as well as at the single rates of applications. Standard varieties of potatoes were grown for the area, which included Irish Cobbler and Bliss Triumph.

The samples of both the tops and tubers used were composites of the plants grown on the various plots of a given treatment. The samples of potato tops, which consisted of the aerial portion of the plants, were taken in the latter part of August. Fifteen plants from a given treatment were selected at random and weighed in the field and a 2,000 gram portion of the sample of stems and leaves was then dried to constant weight in a forced-draft oven at about 120°C for use in obtaining the dry matter content and for use in making the ash analysis. Samples of potato tubers were selected at random from the harvest. Samples for the determination of dry matter were obtained by cutting longitudinal and transverse halves. Twenty tubers to give a fresh weight of 500 grams were boiled, dried at about 60°C in a forced-draft oven, dried to constant weight in an electric oven at 100°C.

In the chemical analysis of the plant materials determinations were made in duplicate or triplicate. Ash, total nitrogen, and chlorine were determined by official methods (1). Magnesium, phosphorus, potassium, and sulfur, after first ashed by the nitric-perchloric acid method or taken up with hot water, filtered, and made to a standard volume from which suitable aliquots were taken for the determinations. Calcium, phosphorus, and sulfur were determined by official methods (1). Magnesium was determined as magnesium ammonium phosphate with sulfuric acid and brom cresol green indicator. Phosphorus was measured by the sodium cobaltinitrite method.

Standard statistical methods were used in analyzing the results.

RESULTS AND DISCUSSION

DRY MATTER, NITROGEN AND MINERAL CONSTITUENTS

Potato tubers have been found to contain 78.0% water, 2.2% protein, or 0.352% nitrogen, 16.0% starch, 2.2% sugars, 0.4% crude mineral matter, and 0.2% fats, pectins, and other constituents (10, 17). When expressed on a dry basis the tubers contain about 10% protein, 72% starch, 2% sugars, and 4% mineral matter. The mineral or ash constituents of potatoes include potassium, calcium, magnesium, phosphorus, sulfur, silicon, chlorine, and other elements. For 40 varieties of potatoes Atwater and Bryant (2) found that the average ash contained the following percentages for the mineral constituents: potassium (K₂O) 59.2, phosphoric acid (P₂O₅) 4.7, and calcium (CaO) 0.7.