Potassium, Calcium, and Magnesium Balance and Reciprocal Relationship in Plants

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The three basic cations, potassium, calcium, and magnesium, compose the largest portion of the essential nutrient elements found in plant ash. There exists an interrelationship between these three cations in plants (4,10), and an understanding of this relationship is fundamental knowledge. Any practical or experimental design whose objective is to increase one of these cations in the plant must allow for the fact that the other cations will be decreased. The use of lime might increase the percentage content of calcium in the plant, but the content of magnesium and potassium may be lowered. The use of excessive amounts of potash will cause a very high content of potassium in the plant, but will lower the contents of calcium and magnesium. It is the purpose of this article to point out some of the factors which affect the cation content in plants.

Each of the basic cations perform certain well-known and specific physiological roles characteristic of the element. Any factor which interferes with these functions means a reduction in quality and quantity of plant growth. In spite of these specific essential functions attributed to only one element, there are many physiological functions performed in common by any of the three cations. Examples would include the buffering of cell sap, neutralization of organic acids, and regulation of salt concentration. The interchangeability of the basic cations in performing these chemical functions probably would have little or no effect on the yield and quality of the feed or food. In other words, there appears to exist in plants a fairly wide deviation from a theoretical balance for the performance of certain chemical functions. Any extreme deviation from a theoretical balance—a figure which only be roughly approximated—is not desirable, however, because many of the specific properties and functions of potassium, calcium, and magnesium are not interchangeable.

It is a well-known fact that there exists a mutual mechanical replacement of the basic elements in plants. This behavior is often referred to as "Ehrenberg's potash-lime law" (6) because he was one of the earliest men to report a reciprocal relationship between the contents of calcium and potassium in plants. Only recently have workers expressed in the literature the plant composition of cations on an equivalent basis. This method is preferred in a discussion of cations to that of using a percentage basis. Plant composition expressed in percentages tends to minimize the variation in magnesium. It also accentuates the variation in potassium since the equivalent weight of magnesium in comparison to hydrogen is 12, potassium 39,