COMPARATIVE STUDIES OF THE MINERAL NUTRITION IN CABBAGE AND LETTUCE PLANTS

By

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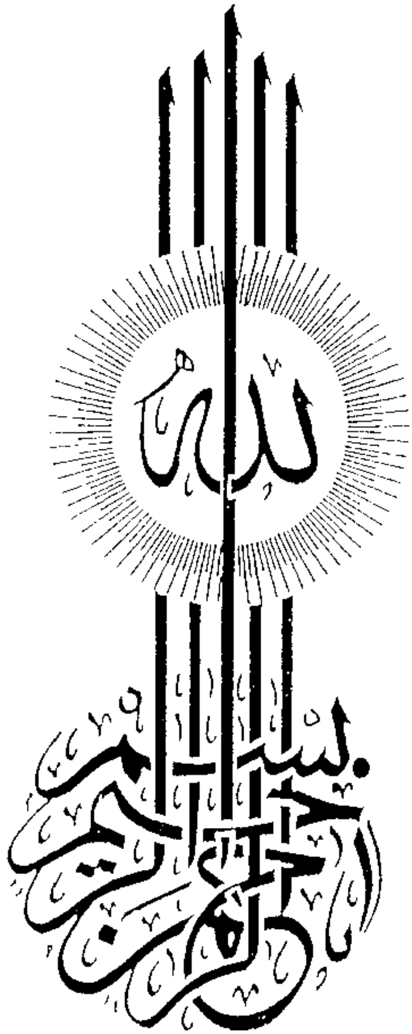
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CONTENTS

I - INTRODUCTION

The interaction of cations on the uptake process by plants has been extensively studied in recent years, studying some of the principle factors which determine the competition exists between ions. It has been widely reported that the absorption of K and Mg behaves competetively. Recently it has been indicated that such competition between K and Mg may not exist.

Low amounts of soil Mg as a result of leaching and cropping usually considered the prime reason for Mg deficiency in plants. But Mg uptake by plants also had been decreased by the presence of large amounts of other elements in the soil, mainly K and Ca. This had been observed even when an apparent adequate supply of available Mg was shown to be present by chemical analysis.

In fact, much of our knowledge concerning the interaction of nutrients in the uptake process has been obtained from solution cultures composed of two nutrient salts. In order to interpfet observations on the ion interrelationship it seems also of a considerable value to study the effect of particular element added on the simultaneous uptake of the other element which is present in the external media of the plant.

This thesis was undertaken to study the effect of nutrient-K and-Mg on their uptake in lettuce and cabbage plants.

II - REVIEW OF LITERATURE

Effect of K concentration on Mg uptake

The interrelationship between potassium and magnesium has been the subject of extensive studies by many workers.

Hovland and Caldwell (1963) stated that there are at least three general ways in which K may interfere with Mg in plants:

a) Addition of K to soil may decrease the ease of replacement of soil Mg and hence becomes less available for plant uptake,

b) Increased K in soils may provide more competition for Mg for exchange sites on plant root,

c) High amounts of K in some way prevent Mg from performing its function. Scharrer and Mengel (1958) found that decreasing Mg uptake with increasing K supply in water culture indicated a true physiological K/Mg antagonism, independent of the possible effect of the colloidal complex in soil and of the anion of the K salt applied. The results suggested that the physiological K/Mg antagonism is restricted to the green tissue, especially leaves. In another investigation, the same authors (1960) found that the additional supply of K given as foliar spray depressed Mg in leaves.

Johnson et al (1957) noted that the use of K fertilizers increased the incidence of Mg deficiency symptoms in celery. When correcting Mg deficiency symptoms they obtained effective control by spraying with 10 pounds of $MgSO_4$/acre at 10-day intervals. Also Boynton and Eickson (1954) observed that interveinal chlorosis and necrosis occurred in nursery beds because of Mg deficiency in soils of high K content. Leaf spray of urea, K phosphate, Mn, Zn and Fe sulphates applied at weekly intervals had no effect. Application of $MgSO_4.7H_2O$ gave a good stand. The addition of K_2HPO_4 resulted in leaf scorch and chlorosis. Therefore they concluded that application of K inhibited Mg absorption.

Working on grape, Beyers (1955) indicated that a high degree of chlorosis was consistently found in potash-treated plots as compared with no potash. Nitrogen and phosphate application had no consistent effect on chlorosis. This chlorosis was found to be caused by Mg deficiency induced by potash application. Analysis of leaves showed that K_2SO_4 increased K but decreased Mg.

Svanberg and Ekman (1952) noted that responses of potatoe in sandy clays to 10-20 kg/ha of soluble Mg increased with increasing Mg content of the soil. This was probably due to the concomitant high values of available K and indicated that determination of soil Mg alone is an insufficient index of the experiments in this nutrients.

Hunt et al (1964) found that when high dressings of KCl (0.75, 1.5, 2.25 cwt/acre) were applied in autumn and spring to perrenial rye grass, clover swards receiving $(NH_4)_2SO_4$ (30 or 60 lb N) and Kieserite (0,4 or 12 cwt), Mg content fell as the level of KCl increased. Autumn application resulted in a higher Mg content at the expense of the amount of K absorbed in spring herbage. The effects of the lowest levels of application of KCl were slight and become insignificant in later herbage samples. In (1963) Hemingway and Richie stated that annual application of 1-2 cwt/acre KCl to grassland (receiving 3 cwt Nitrochalk) significantly increased K in the herbage in all year but depressed Mg concentration after the second year.

Earlier in (1947) Boynton found that in acid soils the K status of the soil and K fertilization may influence Mg nutrition. Judged by their leaf content, apple trees deficient in Mg are high in K even when replaceable K is low in the soil. Liberal K fertilizing of trees on soils low in Mg induces Mg deficiency and increases its severity. K inhibits the absorption of Mg by roots and over a period of years it decreases the amount of replaceable Mg in the soil exchange mechanism. Also, in 1945 O'Donohue observed that with tobacco, potatoe and sugarbeet, Mg deficiency was induced by high K manuring, but visible signs in cereals were slight, Mg deficiency appeared to be fairly widely distributed. Soil samples from a field crop of tobacco exhibiting Mg deficiency had a very high available K status. In no instance where signs of Mg deficiency were present in plants was the soil deficient in exchangeable Mg, but exchangeable K was invariably high.

As regards Mg uptake,Prince et al (1947) stated that the most important factor influencing the uptake was the supply of available K. If there was an abundance of available K in the soil, Mg content of the plants was relatively low.

Working on cationic activities in clay suspension except in halloysite systems,Mclean (1950) found that the fraction active of Mg decreased rapidly with increasing K saturation, particularly in the montmorillinite system where Mg activity was too low to be measured when more than 5% of the exchange complex was occupied by K.

Mehlish and Reed (1958) observed lower Mg content of oats, turnip and soybean plants and also less Mg released by 1 m.e. HCl or NaOH per 100 gm of portsmouth fine sandy loam with increasing amounts of exchangeable K.

Ferrari and Sluijsmans (1955) found that not only did a high concentration of K ion in the soil depressed Mg uptake, but also a higher concentration of Mg within the plant was required to eliminate Mg deficiency symptoms when the internal concentration of K ions was at high level.

Davis and Mccall (1953)found that K fertilization increased the incidence of Mg deficiency in Utah 10B celery. The celery did not respond to a two-ton per acre application of $MgSO_4.7H_2O$, but 10 lb of the Mg salt per 150 gal. of water applied as spray at 10-day intervals, corrected the deficiency. K appeared to interfere with the absorption of Mg.

Hunter (1946) stated that when the ratio of K to Mg in the nutrient solution was high, absorption of Mg was most restricted and chlorosis was most severe. Induced chlorosis in tomatoes was associated with the use of K_2SO_4 as fertilizer, though the application of other K fertilizers also induced deficiency.

Lehmann (1969) stated that an increased concentration of K ion in the substratum retarded the accumulation of Mg. Berryman and Caldwell (1967) found that treatment with heavy dressings of K reduced percent of Mg. Alston (1966) stated that Mg percent and uptake were consistently decreased by applying K and increased by Mg. Perkins and Stelly (1958) also found that the application of K Cl decreased percentage of Mg in oats, crimson and clover crops. Seatz et al (1958) obtained results indicating that Mg content was highest with low K. Hoshimoto (1955) stated that the increase of K concentration in the culture decreased the concentration of Mg in the plant extracts.

Kpachenberger and Peterson (1955) stated that K fertilizers usually reduce Mg uptake by plants and may result in Mg deficiency. Schijen (1955) stated that Mg fertilizing should be based on K status as well as Mg status in the soil. Butijn (1950) found that narrow ratios of Mg/K caused Mg deficiency. Mg deficiency may be controlled by applying smaller dressings of K as well as by increasing dressings of Mg. Bear and Toth (1948) stated that on sandy and ... soils the customary liberal K dressings caused widespread Mg deficiency and plants responded markedly to dressings of $MgSO_4$. Word (1959) stated that treatments ranging from complete deficiency to luxury consumption levels resulted in decreasing amounts of Mg in all plant tissues. Cooper (1949) found that when increasing K fertilization, the percentage of Mg in wheat straw was decreased. Working with different plants, El-Kobbia (1960) found that the monovalent cation K seems to deminish the uptake of divalent cation Mg.

The reduction of Mg uptake caused by the increasing of K was also reported by many workers, Tysom (1930), York et al (1954), Schreiber (1950), Fudge (1947), Locas (1948), Boynton (1944), Mulder (1950,1952), Obenshain (1946),Leonard et al (1948), Leggett and Gilbert (1969), Jointer (1959), Omar and El Kobbia (1965 and 1966) and El-Kobbia and Omar (1965).

However, Forshey (1963) found that when comparatively low rates of K were applied with adequate Mg treatments, the depressing effect of K on Mg nutrition was not important.

Coic (1967) stated that there was little antagonism of K towards Mg. Ichikawa and Seo (1958) found that increasing K did not produce Mg deficiency symptoms. Antagonism between Mg and K occurred in 2% acetic acid extracts of leaf and stem and was less distinct in 70% alcohol extractions. By foliar application of K, Coin (1955) found that it had no significant effect on Mg, but a high level of K reduced Mg concentration in the tissue. The effect is ascribed to growth and translocation phenomena rather than to an antagonism operating at the intake phase. Lazaroff (1966) stated that Mg uptake was little affected by the concentration of K.