PLANT NUTRITION

At least 15 elements are of importance in crop production. Carbon, hydrogen and oxygen are obtained from air and water. The others are obtained from the soil and are thus potential fertilizer nutrients. Six of these are required in relatively large quantities, and are referred to as macro-nutrients. These are nitrogen (N), phosphorus (P), potassium (K), calcium(Ca), magnesium (Mg) and sulphur (S). The other elements are used in much smaller quantities and are termed micro-nutrients or trace elements. These micro-nutrients are boron (B), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo) and zinc (Zn).

Good plant development and yields depend on an adequate supply of all these elements throughout growth. A deficiency of any one of them will affect yields detrimentally.

Deficiencies of more than one element at a time are quite common. As visual symptoms of deficiencies tend to mask one another, it can be difficult to diagnose the actual problem. Specific plant symptoms which develop as a result of deficiency of a particular element may also differ markedly among different vegetable crops, and this makes identification difficult unless a grower is experienced in this aspect.

However, there are often considerable similarities in the deficiency symptoms exhibited by the different vegetable crops. The descriptions of the more common deficiency symptoms, given below, may assist in making the correct diagnosis and could allow timely action to be taken.

MACRO-NUTRIENTS

Nitrogen

Nitrogen (N) plays an important role in the formation of protein and is an integral part of the chlorophyll molecule.

An adequate supply of N is associated with vigorous vegetative growth and a deep green colour. An over-supply of N may cause excessive, succulent growth with large, soft, thick and floppy leaves, and large, soft, poor-quality fruits, or roots and tubers with poor keeping quality. Such plants often wilt easily, tend to lodge and are more susceptible to disease and insect attack. Excess N (imbalance in the plant) can cause thin cell walls, allowing fungi to penetrate more rapidly, whereas balanced nutrition can increase vigour of the plant. The growing period of the crop and its harvest may also be prolonged with excess N. Nitrogen is the element most likely to be deficient in vegetable production. Deficiencies show up as follows ; with the most obvious symptom being a yellowing of the older leaves first:

1. Plants show slowed growth, with the stems thin, spindly and hard, and fewer lateral shoots.
2. Leaves fade to yellowish green, even yellow ,and may turn brown and die in severe cases; lower leaves first affected; leaves are smaller and thinner than normal. Some purpling may develop under low temperature conditions.
3. Roots are not initially affected, but later become stunted and discoloured.
4. Most commonly experienced in sandy soils subject to excessive leaching, and on cold, wet soils.

Phosphorus (P)

Most KwaZulu-Natal soils are naturally deficient in P. They are mostly also acid. This soil acidity can rapidly fix applied P into relatively unavailable forms.

Phosphorus is an essential constituent of many vital compounds and is present in most enzymes. An adequate supply of P tends to counter the deleterious effects of an excess of N, in that it hastens maturity, improves fruit quality, favours root growth and may increase disease resistance.

An excess of P is not likely to directly reduce yields if a balanced fertilization programme is used, but in many areas of KwaZulu-Natal, severe zinc deficiencies may be induced by high P applications.

P deficiency is difficult to diagnose and severe yield depressions may often occur without showing leaf deficiency symptoms:

Plant maturity and fruit setting are delayed, stems are thin and woody, with shorter than normal growth.
Leaves tend to be smaller and darker green; undersides have a reddish-purple colouration, especially on leaf veins, at first on older leaves.
Fibrous root development is restricted.
Typically occurs in acid soils; also occurs with prolonged cold conditions, especially if soil is wet.

Potassium (K)
The functions of potassium in the plant are not fully understood. It does play an important role in the water economy of plants and reduces the tendency to wilt. It also hardens supporting tissues and thereby reduces lodging. K may reduce susceptibility to disease and it improves the quality of fruits and other storage organs like swollen roots and tubers. A balanced N to K ratio is particularly important in plant nutrition, as K tends to reduce the adverse effects of excessive N.

Most plants can take up large quantities of K without severe adverse effects. However, an excess of K may upset nutrient balance and thus induce deficiencies of other elements such as magnesium.

Potassium is very mobile within the plant, and deficiency symptoms consequently appear first in older tissue, as K is translocated to the newer tissue where it is most needed. Deficiency of K is often shown as a marginal leaf scorch, which is progressive and irreversible, and may result in leaf death. General deficiency symptoms are:

Stems slender, become woody.
Basal leaves first affected, greyish yellow or brown colour especially at margins, which develop scorched appearance; specks develop along veins of leaf with chlorotic areas in leaf.
Roots are poorly developed, discoloured.
Typically occurs on excessively leached, sandy soils.

Calcium (Ca)
The functions of calcium within the plant are not clear. It is, however, considered necessary for the formation of cell walls, and is thought to be associated with certain enzyme systems.

As most soils contain sufficient Ca to satisfy plant requirements, and because of liming and the use of other fertilizers containing Ca as a secondary constituent, actual deficiencies of Ca are rare. Excess calcium does not appear to affect plant growth directly, but may affect the uptake of certain elements from the soil.

The presence of adequate calcium in the soil has a suppressive effect on some seedling

diseases, but may aggravate potato common scab incidence. Calcium in plant tissues can reduce bacterial soft rot. Calcium is not very mobile in plants and under certain conditions, such as drought, deficiency symptoms may occur, even though there is an adequate supply of Ca in the soil. Due to this poor mobility, symptoms are usually seen in new growth or tips of leaves or fruit. The following symptoms are associated with Ca deficiency:

Stems are thick and woody, terminal buds may die.
Older leaves have normal colour but new leaves may be yellowed.
New growth is not turgid.
Root tips die, restricting root development.
Vegetables have specific symptoms: blossom end rot in tomato and brinjal fruit, tipburn in lettuce and cauliflower leaves, blackheart in celery, cavity spot in carrot and brown heart in endive.
Ca deficiency is expected on acid, leached soils, or soils with high potassium levels, or plants with high nitrogen levels, compared with calcium.

Excess levels of aluminium (in acid soils)cause poorly-developed root systems, with many adventitious roots near the soil surface.

Magnesium (Mg)
Magnesium is a constituent of chlorophyll. It assists in the production of carbohydrates, proteins and fats, and is specific to many enzyme systems. There are few reports of Mg excess.

Deficiencies of Mg are common in KwaZulu-Natal with its leached, acid soils. There is usually a loss of healthy green colour between the veins of the older leaves, later spreading to younger leaves. This inter-veinal chlorosis may turn brown, leaves become brittle and older leaves may drop. Such deficiencies are most common on acid, leached or sandy soils which have received high potassium dressings.

Sulphur (S)
Sulphur is an essential constituent of many proteins and enzymes. Plants require about as much sulphur as phosphorus. Sulphur has little residual action in the soil as it is rapidly leached. Reports of S excess are thus rare, except possibly near certain industrial complexes where sulphur pollution occurs.

In the past, incidental applications of S in other fertilizer materials ensured an adequate supply for crop requirements. The current trend towards the use of high analysis fertilizers, which contain only very small quantities of S, will probably result in more cases of S deficiency being experienced. Deficiency symptoms are as follows:

Stems are elongated, spindly and woody.
Lower leaves are thick and firm, developing chlorosis which may be confused with nitrogen deficiency.
Roots system is extensively developed, but spindly roots.
Sulphur deficiency could develop in sandy soils if no sulphur-containing fertilizers are applied.

MICRO-NUTRIENTS (trace elements)

Boron (B)
Crop requirements for B vary quite markedly, with deficiency symptoms probably most common on cabbage, cauliflower and beetroot. General deficiency symptoms are:

New bud leaves and petioles are light in colour and may be distorted. There may be rosetting at shoot terminals, due to multiple bud development.
Stems are shortened and internodes short; with extreme deficiency buds die. Cauliflower may show hollow stem, celery develops cracked stem.
Root growth is retarded; discoloured corky areas form in root crops, e.g.internal browning in turnip and brown heart of beetroot.
Deficiency may occur in any soil, but it is more common on light sandy soils, or soils which have recently been heavily limed. Some crops have a higher boron requirement than others.

Excessive boron may cause yellowing and necrosis of the margins of primary leaves.

Molybdenum (Mo)
Molybdenum is required in minute quantities for assimilating nitrates, as well as for fixing atmospheric N in the root nodules of legumes. Excess Mo in plants can be harmful to animals that eat them as it can cause sterility, amongst other things.
Deficiencies of Mo are quite common in several vegetable crops in KwaZulu-Natal. This is partially due to a reduced uptake of Mo on acid soils; adequate liming will sometimes solve the problem. Cauliflower is sometimes used as an indicator plant to show Mo deficiency because of its great susceptibility. Cabbage and cucurbits are also fairly easily affected. General symptoms are:

Older leaves have inter-venal chlorosis, new leaves may be green but become mottled in developing. Leaves are distorted at edges, later are narrow and very distorted, e.g. whiptail in cauliflower. Heads of cauliflower have small, open curds.
Occurs on acid soils.

Zinc (Zn)
This is a very important trace element in KwaZulu-Natal, with deficiency symptoms being widespread in many areas. Vegetable crops commonly affected include green beans, green mealies and sweet-corn. The deficiency symptoms are often found in scattered patches in a land, with apparently healthy plants growing close to others showing acute deficiencies. Symptoms include:

Inter-veinal chlorosis in new leaves and later the whole leaf becomes chlorotic. In some cases there may be necrosis of leaf tissue. New leaves are small.
Occurs in cold wet soils or with excess phosphate fertilization or liming to pH values above 5.5 in Kcl.

Manganese (Mn)
Manganese becomes more soluble in acid soils and is thus more likely to cause toxicity than deficiencies. Toxicity may also be induced by water-logging.

Deficiencies are generally found in naturally alkaline or calcareous areas, which tend to occur in drier climates, or else where soils have been overlimed and have a pH value in KCl of over 5.5. Inter-veinal chlorosis starts in new leaves, with older leaves affected later. Veins remain green. Chlorotic areas may fade to light brown and then die. Beetroot leaves become redder and onion leaves show narrow chlorotic striping.

Toxic levels of manganese in acid soils can be corrected by liming. Symptoms of Mn toxicity vary among vegetable crops. There is slow growth and necrotic spots on young plants. Small black spots develop on stems and on the underside of mature leaves. Veinal chlorosis may be seen on leaves and their inter-veinal areas may have some yellowing.

Iron (Fe)
Iron deficiency symptoms are similar to those of Mn. There is also inter-veinal chlorosis - a distinct light yellow - which may develop to a more uniform yellow, almost white, in the leaf. It also commences in the young leaves. Usually there is no necrosis (die-back).

Iron deficiency is also not common in KwaZulu-Natal as it tends to occur in calcareous, alkaline or overlimed soils.

Copper (Cu)
Deficiencies throughout the entire country are rare. It could be expected in soils which are very high in organic matter. Plant growth is retarded, and leaves may appear elongated. Leaves are softer than normal and may show a light chlorosis.

Sodium (Na) and Chlorine (Cl)
These two elements are not a consideration in plant nutrition, except for their role as constituents in salt toxicity in plants. Where saline water is used for irrigation, salts accumulate in the root zone. Salt uptake may result in elevated tissue levels of Na and Cl. Tipburn and stunting symptoms of salt toxicity are actually the manifestation of induced physiological drought in vascular tissues.