Dear reader,

We are pleased to present the first edition of the PNA Newsletter!

The PNA Newsletter will appear on a regular base to update our subscribers about the latest potassium nitrate trials results and products characteristics, advantages and benefits, application methods and crop nutrition recommendations, and many more relevant issues.

In order to keep on receiving this newsletter in the future, you will have to subscribe to it by free of charge simple registration here.

Main topic in this edition

The importance of potassium nitrate as a chloride-free K source

Summary

A number of cash crops, such as vegetables, fruits, nuts and field crops, are known for their sensitivity to chloride. Chloride toxicity is expressed in the affected plants as leaf scorching. Excessive chloride in soil and irrigation water, when allowed to exist, will result in reduced crop yield and quality. When the chloride concentration in the soil solution increases, plants take up chloride on the account of essential anionic nutrients, especially nitrate.

Under those conditions of excessive chloride and salinity stress, potassium nitrate has proved to be the preferred N and K source, as it is virtually free of chloride, while its nitrate will counteract chloride's harmful effect. In a similar manner, the potassium in potassium nitrate counteracts the harmful effects of sodium.

1. Role of chloride in plant nutrition

Chloride (Cl) plays an essential role in plants as a counter-ion for the uptake and transport of cations, in enzyme activation and osmotic regulation. However, chloride application is rarely needed at rates over 10 kg/ha. Therefore, plant demand is easily satisfied through the uptake of chloride, naturally present in soils, applied as fertilizer impurities, via chloride-containing irrigation water or with chloride-containing rains in coastal areas. Therefore, generally, there is no need to include chloride in the plant nutritional programme. Furthermore, as will be explained later on, increased chloride levels will limit the uptake of nitrate by the plant.

2. Chloride sensitivity in crops

High levels of chloride in the soil solution will result in chloride (Cl) toxicity in the plant (Libro Azul, 2002) (Figure 1). In kiwi fruit, the severity of leaf necrosis following potassium chloride (KCl) application was attributed not to Cl toxicity but rather to N deficiency, enhanced by competition between Cl and NO_3 (nitrate) (Buwalda and Smith, 1991).

Figure 1. Chloride toxicity in litchi (left) and walnut (right) is shown as leaf scorching. Courtesy of SQM.

A number of crops are known for being sensitive to chloride:

- fruit crops (almond, apricot, avocado, banana, citrus, grapes, kiwi, litchi, mango, peach).
- berries (including strawberry).
- vegetables (lettuce, onions, sweet pepper).
- field crops (potato, tobacco).
- coffee.
- flowers.

3. Occurrence of elevated chloride levels in soil and irrigation water

Elevated chloride levels in soil and irrigation water can occur under the following conditions:

- Use of saline irrigation water (> 4 meq Cl/L = > 142 mg Cl/L).
- Influx of seawater into groundwater in coastal areas.
- Use of Cl-containing fertilizers (KCl, NH_4Cl, NPK 15-15-15).
- Poor soil drainage, due to:
    - lack of rainfall, especially in greenhouse soils in protected horticulture.
    - lack of leaching (Figure 2).

Figure 2. Salt accumulation in pepper growing under drip irrigation with saline water in Torréon, Mexico. Courtesy of SQM.

4. Antagonistic anionic interactions between NO_3^- and Cl^-

When the chloride concentration in the soil solution increases, plants take up chloride on the account of essential anionic nutrients, especially nitrate. The anionic interactions between NO_3^- and Cl^- have been interpreted as non-specific replacement effects and not as carrier competition processes (Mengel and Kirkby, 1987). This, of course, hinders plant growth. When chloride quantities go higher, toxic effects are caused, that may lead to loss of yields and may even cause plant death.

More information about the antagonism between NO_3^- and Cl^- uptake can be found on the PNA website: PRODUCT FEATURES & BENEFITS >> Cation and anion interactions >> Chloride versus nitrate

5. Negative effects of chloride on plant growth and quality

Elevated chloride levels may directly result in plant toxicity and reduce the quality of the harvested part of the plant. Examples of reduced quality are:

Potato:	Reduction in yield and dry matter content of potato tubers. Haeder (1976) showed in a comparison trial between a chloride-containing K-source (KCl) and a chloride-free K source (potassium sulphate, SOP) that with SOP more assimilates were stored in the tubers and less in the stems, compared to KCl. This resulted in greater tuber starch content with the chloride-free K-source.
Tobacco:	Reduced combustibility and "Wet dog" symptoms in tobacco (tobacco becomes dark and smelly after packing).
Sugar cane:	Reduced percentage of extractable sucrose.

6. Potassium nitrate will reduce salinity stress and counteract chloride's harmful effect

Excessive chloride is frequently associated with excessive sodium, the main two ions responsible for crop salinity stress. Salt accumulation at the soil surface will occur under dry conditions and insufficient irrigation that is unable to wash down the salts. Therefore, proper fertiliser selection will help to reduce the risk of soil salinity, thereby, preventing yield reduction, in particular when salts cannot be washed down by irrigation.

The electrical conductivity (EC) is a measure for salinity of soil solution or a water sample. EC value is influenced by the concentration and composition of dissolved salts. The higher the EC value the higher the salinity level and risk.

In Figure 3, the relative EC level of 1 gram potassium nitrate (PN), dissolved in a litre of water at 25°C, is set at 100% and serve as a reference, comparing it with combinations of alternative N and K sources, at equal N and K input levels. The combination of ammonium nitrate (AN) with potassium sulphate (SOP) or potash (KCl) results in increased salinity of 46% and 48% respectively, while the combination of ammonium sulphate (AS) with SOP or KCl raises the salinity by 92%.

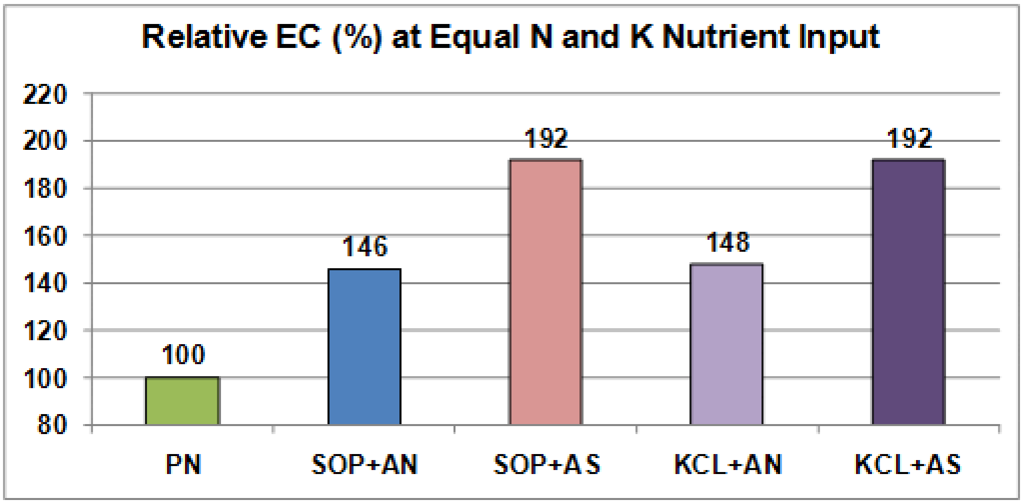

Figure 3. The combination of ammonium nitrate (AN) with SOP or KCl results in an elevated salinity by factors of 46% or 48% respectively, while the combination of ammonium sulphate (AS) with SOP or KCl raises the salinity by 92%, compared to potassium nitrate (PN) at equal N and K input levels.

Under high chloride growing conditions, the plant nutritional programme should predominantly consist of nitrate-nitrogen, such as potassium nitrate, calcium nitrate and magnesium nitrate as opposed to sources based on ammonium-nitrogen. Potassium nitrate is virtually free of detrimental chloride, and the nitrate in potassium nitrate counteracts the chloride's harmful effect. In a similar manner, the potassium in potassium nitrate counteracts the harmful effects of sodium.

7. Potassium nitrate is the preferred N and K source under chloride-affected, saline conditions

Figure 4 shows the result of different K fertilizer sources, applied at equal K-input levels, on the yield of potato in a demonstration trial, carried out by SQM. The greatest yield was obtained with potassium nitrate, followed by SOP and KCl.

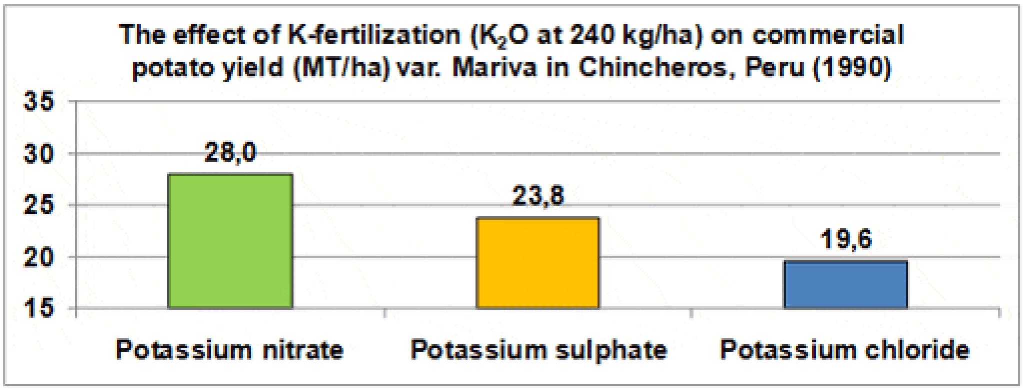

Figure 4. The effect of K-fertilization (K_2O at 240 kg/ha) on commercial potato yield (MT/ha)

HAIFA conducted a greenhouse-grown tomato trial, in which PN was compared with KCl in the fertigation programme. Both nutrition treatments were identical, except the type of potassic ingredient during the main growing season. The tomato crop was planted on October 16 with final harvest in the beginning of May the next year. The soil type was sandy loam. The base dressing consisted of 80 m^3 of cow manure per hectare. No mineral fertilizers were applied in the base dressing. All fertilizers were applied by 22 fertigation cycles with total N at 510 kg/ha, P_2O_5 at 280 kg /ha and K_2O at 790 kg /ha.

Figure 5 shows the differences between the cumulative yield weights of both treatments. The yield with PN was 13,8 MT/ha or 17,4% greater than with KCl, which resulted in a benefit to cost ratio of 15,2 to 1.

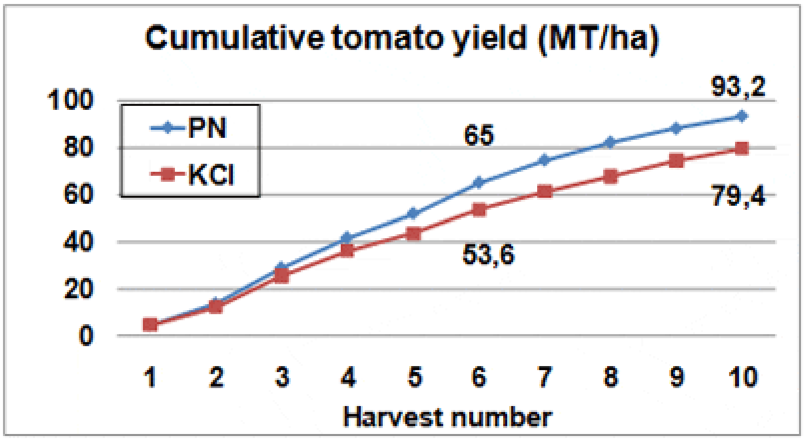

Figure 5. The effect of the K-source (PN vs. KCl) on tomato yield (MT/ha).

Literature cited

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