Nutrients and Product Quality

By T.W. Bruulsema

The belief that organic nutrients promote food quality while mineral fertilizers promote quantity has been proven by research to be overly simplistic. Managing organic and inorganic nutrients clearly affects both quality and output of various cropping systems. Nutrient inputs should be chosen to efficiently provide balance for optimum results, specific to each soil and crop.

Crop quality factors such as protein, phytate (phytic acid), and trace mineral bioavailability can be manipulated by properly managing nitrogen (N) and phosphorus (P) fertilization. Nitrogen, P, and potassium (K) have been shown to increase sugar content in sweet corn, and increasing K levels boosted vitamin C levels in several vegetable crops.

Both organic and inorganic nutrient sources influence proteins, minerals, and vitamins in crop products, and affect their bioavailability. They also impact pests that reduce quality. With recent science on nutraceuticals, today's crop producers are becoming more effective in meeting human nutritional needs for promoting health and preventing disease.

Phytochemicals, Functional Foods, and Nutraceuticals

Functional foods are defined as foods that contain bio-active ingredients thought to enhance health and fitness. They are also called designer foods or pharma-foods. The active ingredients are phytochemicals, such as lycopene in tomatoes. These phytochemicals are not among the traditional nutrients (carbohydrates, proteins, fats, minerals, and vitamins) and are often called nutraceuticals, although that term is increasingly being used specifically for extracted concentrates.

Functional foods are associated with the prevention and treatment of at least four of the leading causes of death: cancer, diabetes, hypertension, and heart disease. A wide range of plants, including field crops like grains and soybeans, horticultural crops like broccoli and tomatoes, and specialty crops like ginseng and echinacea, contain nutraceutical ingredients.

Role of NPK in Phytochemical Synthesis

Only a few of the many phytochemicals with nutraceutical properties contain N, P, or K in their chemical structure. But since they are formed as a result of photosynthesis, they depend on the availability of essential nutrients. For example, research has shown that K has a positive influence on isoflavone levels in soybeans (**Table 1**) and lycopene in tomatoes.

USDA photo by Ken Hammond.

Safe, nutritious food can be produced with either inorganic or organic nutrients, or both in combination.

Diseases and Insects

Certain plant diseases can be suppressed by application of balanced nutrients. For example, P has been shown to reduce common root rot in barley and K has reduced rusts in cereals and stalk rot in corn. Potassium has also decreased leaf diseases in cotton and N and P have minimized wilt infection in potatoes and stain in soybeans. Recent research has shown that chloride (Cl^-) reduces the incidences of several diseases in small grains.

TABLE 1. Concentration of isoflavones in soybean seeds in response to applied K fertilizer (two sites, three years, 1998-2000).

K_2O application	Genistein	Daidzein	Glycitein	Total[1]
Spring banded	938	967	146	2,051
None	831	854	130	1,815
Increase due to K, %	13	13	12	13

[1]Total isoflavone concentration expressed as aglycone; sum of three components; parts per million (ppm).

A number of plant diseases have been reduced following manure application, including *Fusarium* diseases of tomato and lettuce, *Rhizoctonia solani* diseases of radish and rice, and *Sclerotinia sclerotiorum* disease of lettuce.

Management of nutrients to enhance resistance to disease and insects should recognize that:

- No nutrient controls all diseases.
- Nutrient balance is as important as any single nutrient level.
- Nutrients help more by stimulating growth than by increasing resistance.
- Damage or predisposition imposed by early deficiencies and imbalances may not be offset by later applications.
- Local environmental conditions may enhance or nullify the effect of a particular nutrient.

Organic Versus Conventional Production Systems

Comparison of food produced from organic farming systems and conventional systems is quite different from comparison of nutrients supplied by organic and inorganic sources. Producers in conventional production systems commonly apply a combination of organic and inorganic nutrient sources and so do organic producers. The differences have more to do with solubility and manufacture.

Organic production systems are characterized by standards that minimize or eliminate use of synthetic or manufactured inputs and encourage maximum use of natural resources. They rely on green manures, crop rotation, and animal manures. They may also include mineral nutrients in their naturally occurring state; for example, rock phosphate as a source of P and, in some cases, potassium sulfate (K_2SO_4) or sylvinite as a source of K. Nutrient input levels in organic farming systems also tend to be lower than in conventional systems because the philosophy is aimed at growing crops under more natural conditions, and deficiencies of N, P, and K are natural conditions.

Organic systems may also vary more widely in nutrient availability because of reliance on indigenous soil fertility which exhibits strong spatial variability. Comparing the relative effectiveness of organic versus conventional farming in producing high quality food is difficult. Few producers or researchers have extensive knowledge of both systems, so bias is a factor that cannot be entirely removed. Scientists have concluded, however, that organic foods are neither healthier nor safer than conventionally produced or genetically modified crops.

Summary

Managing nutrients, whether organic or inorganic, clearly can affect the quality of the output from crop production systems, be they organic or conventional. Both systems are capable of producing quality food. Nutrient inputs should be chosen to efficiently supply an appropriate balance of fertility to optimize yield and quality, specific to each soil and crop. BC

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