Diagnosing Potassium Deficiency and Maximizing Fruit Crop Productivity

By K.N. Tiwari

The potassium (K) requirement of fruit crops is particularly high. In contrast, however, the use of K fertilizers in Indian agriculture/horticulture is negligible. Appearance of K deficiency symptoms in fruit crops of India is becoming a common field problem. This article will serve as a diagnostic tool for K management in fruit crops.

India's wide range of agro-climatic zones provides a tremendous scope and potential for cultivation of a diverse group of fruit crops. Unfortunately, this potential has not yet been realized. There is a large gap between potential yields and actual yields harvested by farmers. For most fruit crops, yields realized are less than 50% of the easily achievable yield and 26% of the potential yield. India's current productivity of fruit crops is quite low (11.9 t/ha) as compared to the world average of over 25 t/ha. Of the various reasons responsible, inadequate and unbalanced nutrient use seems to be most important.

Mango: Old leaves show chlorosis and scorching of the tips of older leaves, spreading further towards margins.

A wide gap also exists between domestic demand and supply for fruits, and this gap can be bridged by increasing productivity – at least equal to the extent possible through area expansion. Current fruit production (2003) is estimated at 45 million metric tonnes (M t) (**Table 1**). India's fruit requirement for 2025 is estimated to be 120 M t. These production and productivity targets can be achieved only if modern intensive horticulture is practiced using most recent technologies, including integrated nutrient use.

The symptoms of K deficiency are often seen in fruit crops grown in India. Unfortunately, they go unattended because of lack of awareness to identify problems in the field. This article explains the diagnosis of K deficiency in fruit crops to ensure correct fertilization for high yield and top quality.

India's wide range of fruit crops collectively contribute to a large variation in nitrogen (N), phosphorus (P), and K removals (**Table 2**). Litchi will commonly remove the most N (194 kg N/ha), grapes remove the most P (48 kg P_2O_5/ha), and banana the most K (568 kg K_2O/ha). An average 11.9 t per ha fruit crop removes 91 kg N/ha, 23 kg P_2O_5 /ha, and 153 kg K_2O/ha—an $N:P_2O_5:K_2O$ ratio of

Table 1. Area, production, productivity (2002-03), and potentials for fruit crops, India.

Crop	Area, 000 ha	Production, 000 t	Productivity, t/ha		
			Actual	Potential	Percent diff.
Mango	1,623	12,733	7.8	20	39
Banana	475	13,304	28.0	60	47
Citrus	563	5,677	10.1	30	34
Apple	193	1,348	7.0	30	23
Guava	155	1,793	11.6	20	58
Pineapple	80	1,172	14.7	85	17
Sapota	84	913	10.9	80	14
Papaya	68	2,147	31.6	80	40
Grapes	52	1,248	24.0	40	60
Litchi	54	476	8.8	20	44
Others	441	4,391	11.9	46	26
All India	3,788	45,203	11.9	46	26

Table 2. Nutrient removal by India's major fruits crops

Crop	Removal, kg/t of produce		
	N	P_2O_5	K_2O
Mango	6.7	1.7	6.7
Banana	5.6	1.3	20.3
Citrus	9.0	2.0	11.7
Apple	3.3	1.5	6.0
Guava	6.0	2.5	7.5
Pineapple	1.8	0.5	6.3
Sapota	1.6	0.6	2.1
Papaya	2.8	0.8	2.3
Grape	8.0	2.0	9.0
Ber	4.0	1.8	6.3
Passion fruit	4.0	1.0	5.0
Litchi	22.0	3.5	29.0
Mean	6.2	1.8	9.4

100:29:152. Thus, the average uptake of K in contrast to N is 1.5 times larger.

Continued nutrient depletion has resulted in many soils being re-categorized as medium or lower in K fertility status where earlier they were classified as high or medium. Economic responses to applied K on soils having low and medium K fertility status are common. Sustained production in high K soils is also ensured with application rates designed to maintain soil fertility at an advantageous level.

Mango, banana, citrus, guava, papaya, grapes, and pineapple account for the major area and production of fruit crops grown in the tropics and subtropics. The majority of these fruits are marketable as fresh for domestic consumption and less than 1%...mainly mango, pineapple, and citrus...are marketable in other forms for export and domestic consumption. Fruit size, appearance, and color largely determine consumer acceptance. Factors such as fruit recovery, aroma, and taste play a secondary role in acceptability at market.

Citrus: Chlorosis and scorching of the tips of older leaves.

Despite the large production of fruits, fixed standards for quality parameters in most fruit crops are lacking. However, examples of increasing quality consciousness in fruit trade do exist. Maharashtra State Grape Growers Association has developed strict quality controls for grapes wherein quality and price are largely determined by shape, size of bunch (300 g), and total soluble solids (TSS) content of berries (22%). In Gujarat (Balsar District), a 10 kg box of Sapota containing 90 fruits is worth double the price compared to crops of lower weight. Farmers producing crops with bunch weights in the range of 15 to 17 kg receive double the price of bunches below 10 kg weight.

Many factors influence fruit quality and K nutrition is among the most important. Fruit size, appearance, colour, soluble solids, acidity, vitamin content, taste, as well as shelf-life are significantly influenced by adequate supply of K. These characteristics are affected by photosynthesis, translocation of photosynthates, regulation of stomata, activation of enzymes, and many other processes. Potassium's role in water regulation of the plants and tolerance to environmental stresses such as drought, excess water, wind, and high and low temperature is related to productivity of the trees and quality of the fruits. Widespread use of N fertilizers alone leave plants overly susceptibile to

With increasing severity of K deficiency, the following symptoms develop:

- Reduction in growth rate and vigour.
- Darkening of the leaves.
- Appearance of white, yellow, or orange chlorotic spots or stripes on older leaves, starting from the leaf tips and margins. In some species, irregularly distributed chlorotic spots begin appearing near the leaf tip. The base of the leaf usually remains dark green.
- Chlorotic areas become necrotic. The tissue dies and leaves dry up.
- The symptoms spread to younger leaves and risk of stress-induced death increases.
- Drought resistance declines.
- Roots are poorly developed and are often affected by rot.
- Disease incidence increases and crop quality is severely reduced.

Apple (left), Guava (right): Acute K deficiency; chlorosis and scorching of the margins of older leaves.

Banana: Chlorosis and scorching starting from the margins of older leaves.

the effects of diseases and pests – a scenario countered by optimum K nutrition. Other beneficial effects of K include high juice content, improved oil content of kernels, high vitamin C content, uniformity and acceleration of ripening of fruits, and resistance to bruising or physical breakdown during shipping and storage.

Potassium Deficiency Symptoms

Growing plants which contain inadequate K exhibit certain signs of such a deficiency. The first sign is a reduction in the growth rate of plants (which become stunted) and leaf color becomes darker than normal. Clearer deficiency symptoms start to appear as the plant grows to maturity. As K is highly mobile within the plant, the first symptoms appear on older leaves. The sequence in the development of deficiency symptoms is nearly identical with all plants, although particular species, cultivars, or clones may exhibit characteristic differences. In all cases, symptoms start from the distal part (tip) of the leaf. The base of the leaf usually remains dark green. Long before symptoms of K deficiency become visible, significant losses in both crop yield and crop quality have occurred. Apart from the above "typical" symptoms, other symptoms may occur as a result of imbalance of K with other nutrients, N and calcium (Ca) in particular. Symptoms similar to K deficiency can occur due to salt injury, fungal attack, faulty in-crop spray damage, etc. When diagnosing K deficiency in the field, the above conditions should be checked and eliminated as possible causes of confusion and incorrect diagnosis.

Orange: Chlorosis starting from the tips, spreading inside of older leaves.

Pineapple: Chlorosis and necrosis of tips; dead tissues and withering of older leaves in acute K deficiency.

Conclusion

The need and importance of K fertilization for harvesting high yields and superior quality produce is greater now than ever before. It can be put into practice by at least using the presently recommended K application rates along with other required nutrients as prescribed by soil test. At the same time, steps must be initiated to take a fresh look at the current approach and methodology for making K recommendations which are often proved inadequate for maximum economic yields. These should primarily address the need for using soil- and crop-specific limits of available soil K while making K recommendations and also provide recommendations for above average farmers who are not satisfied with moderate yield levels. BC

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Papaya: Chlorosis and necrosis of tips and margins; withering of old leaves in acute K deficiency.

Grape: Acute K deficiency; Chlorosis and scorching of the margins of older leaves.