Potassium Deficiency Symptoms in Vegetable Crops

By K.N. Tiwari and Gavin Sulewski

In recent years, the area under vegetables has increased in India, but there remains a large gap between potential yields and actual yields harvested by farmers. The appearance of potassium (K) deficiency symptoms in vegetable crops of India is becoming a common field problem. This article serves as a diagnostic tool for K management in vegetable crops.

India is endowed with favorable tropical, subtropical, and temperate climates, making it conducive for producing high quality, high value vegetables year round in various parts of the country. At present, 90 million tonnes (M t) of vegetables are produced from about 6 M hectares (ha)—less than 2% of the cropped land **(Table 1)**. For most vegetable crops, yields realized are less than 50% of the potential. By the year 2010, India will need to produce 160 M t of vegetables. Using an estimated land area of less than 8 M ha, this equates to a required increase in productivity of over 30%. This task calls for better crop husbandry, including the use of optimum rates of nitrogen (N), phosphorus (P), K, and other yield-limiting plant nutrients.

While the importance of balanced fertilizer use is widely recognized, its actual practice over much of the agricultural area in India continues to be neglected. Although India is the third largest user of fertilizers with the current annual consumption at around 18 M t, K fertilizers constitute only 9% of this; hence the necessity of emphasizing the role and importance of K in crop production. **Table 2** provides the basis for discussing the varied nutrient demands of vegetable crops. Considering an average 38 t/ha crop, vegetable production removes 148, 57, and 209 kg N, P_2O_5, and K_2O, respectively. Nutrient removal for the range of crops listed varies between 60 and 370 kg N/ha, 25 and 100 kg P_2O_5/ha, and 80 and 350 kg K_2O/ha. On average, plant uptake of K is 1.4 times more than N uptake.

Table 1. Area, production, productivity, and potential yields of vegetable crops in India (2000).

Crop	Area, 000 ha	Production, 000 t	Productivity, t/ha	
			Actual	Potential
Potato	1,341	25,000	19	40
Brinjal	500	8,117	16	60
Onion	493	4,900	10	35
Tomato	457	7,427	16	50
Okra	349	3,419	10	20
Peas	273	2,712	10	20
Cabbage	258	5,909	23	70
Cauliflower	248	4,718	19	50
Others	2,074	28,629	14	40
Total	**5,993**	**90,831**	**15**	**43**

Unbalanced fertilizer use (in this case application of only N or NP, but no K) leads to disproportional increase in K removal and reliance on the soil's K reserves. Without change in practice, each subsequent harvest exposes farm fields to the risks of low K supply. Out of the 361 districts surveyed several years ago for soil K fertility status, 47 districts were categorized as low (<120 kg K/ha), 192 were medium, and 22 districts were high (>280 kg K/ha). Such categories are still used for evaluating soil K status in the close

to 500 soil test laboratories operating in India. Since that survey, research data show that soils which initially tested high in K have become K-deficient due to heavy nutrient removal by harvested crop products and inadequate K application (Tiwari, 2001). Continued scant application of K fertilizers in the last two decades has left the number of districts in the low category virtually unchanged, whereas numbers in the high category have fallen considerably.

Potassium Deficiency Symptoms

It is importance to remember that long before symptoms of K deficiency become visible, severe losses in both crop yield and crop quality occur. **Figures 1 and 2** show how applied K can improve both yield and quality of vegetable crops. Application of 150 kg K_2O/ha gave an additional 5.9 and 6.2 t/ha of tomato and cauliflower, respectively (Rao, 1994). The increase in yield of carrot was 3.3 t/ha with 50 kg K_2O/ha.

The maximum increase in mean fruit weight was 27% with 100 kg K_2O/ha in cauliflower, 65% with 150 kg K_2O in tomato, and mean root weight increased by 29% with 50 kg K_2O in carrot.

Because K is highly mobile within the plant, deficiency symptoms are first observed on older leaves. The physiological sequence for developing K deficiency symptoms is almost the same with all plants, although particular species, cultivars, or clones may exhibit somewhat different characteristic symptoms.

Table 2. Nutrient removal by selected vegetable crops grown in India.

Crop	Yield, t/ha	Nutrient removal, kg/ha N	P_2O_5	K_2O
Asparagus	5	120	60	150
Potato	40	175	80	310
Brinjal	60	175	40	300
Onion	35	120	50	160
Tomato	50	140	65	190
Okra	20	60	25	90
Peas (dry grain)	2	125	35	80
Cabbage	70	370	85	480
Cauliflower	50	250	100	350
Carrot	30	125	55	200
Celery	30	200	80	300
Cucumber	40	70	50	120
Green Beans	15	130	40	160
Radish	20	120	60	120
Pumpkin	50	90	70	160
Spinach	25	120	45	200
Leek	35	120	45	280
Lettuce	30	90	35	160
Table beet	30	150	50	220
Cassava	40	150	70	350
Sweet Potato	40	190	75	340
Beans (dry grain)	2	155	50	120
Mean	**38**	**148**	**57**	**209**
Nutrient Ratio		**100**	**39**	**141**

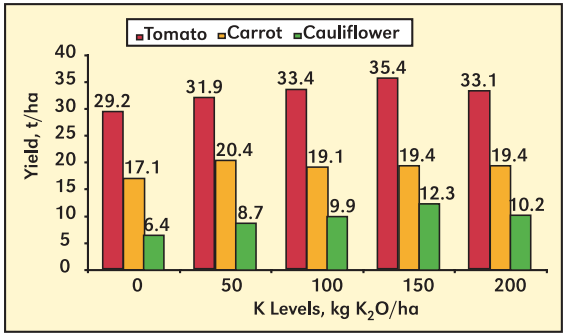

Figure 1. Effect of K application on yield of vegetables.

The first sign of K deficiency is a reduction in growth rate. Plants become stunted and usually leaf color becomes dark green. At a more advanced stage, specific deficiency symptoms appear. These include:

a. Decreased drought resistance.
b. Appearance of white, yellow, or orange chlorotic spots or stripes on older leaves, usually starting from the leaf tips and margins. In some species, irregularly distributed chlorotic spots appear, but in all cases symptoms start from the leaf tip. The base of the leaf usually remains dark green.
c. Chlorotic areas become necrotic, the tissue dies, and leaves dry up.
d. The symptoms spread to younger leaves and finally, under severe conditions, the entire plant may die.

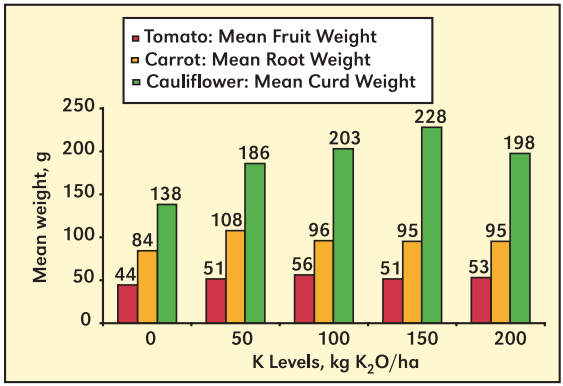

Figure 2. Effect of K application on quality of vegetables.

e. Roots of K-deficient plants are poorly developed and often affected by rot.
f. Disease incidence increases and crop quality is severely reduced, especially in the case of vegetables, fruit, tobacco, and fiber crops.

Apart from the above "typical" symptoms, other symptoms may occur as a result of imbalance of K with other nutrients, particularly N and calcium (Ca). Symptoms similar to K deficiency can also occur due to salt injury, fungus attack, and chemical spray damage. When diagnosing K deficiency in the field, these possible causes should be considered.

The following photos illustrate a few common K deficiency symptoms and effects in vegetable crops. For more photos and information, visit this website: **>www.ppi-ppic.org/ppiweb/gindia.nsf<.**

Amaranthus: Chlorosis and necrosis of leaf tips and withering of older leaves.

Okra: Chlorosis and necrosis of leaf tips and withering of older leaves.

Cowpea: Chlorosis and withering of margins of older leaves.

Conclusion

Symptoms of K deficiency are often seen in vegetable crops grown in India. They often go unattended because of lack of awareness by growers and extension workers. Negative soil K balances predominate—a situation that is not in the long-term interest of any farmer who plans to harvest progressively higher yields. New evidence shows that even traditionally recommended rates are insufficient to offset crop demand and effectively achieve high yields. **Including adequate K in a balanced fertilization program sustains profitable vegetable production.** BC

Dr. Tiwari (e-mail: kntiwari@ppi-ppic.org) is Director, PPI/PPIC-India Programme. Mr. Sulewski is Agronomist, PPI/PPIC International Program, Saskatoon, SK, Canada.

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