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Balancing Potassium, Sulfur, and Magnesium for Tomato and Chili Grown on Red Lateritic Soil

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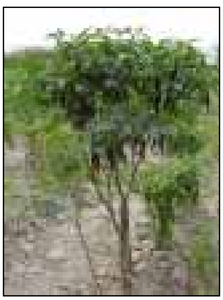
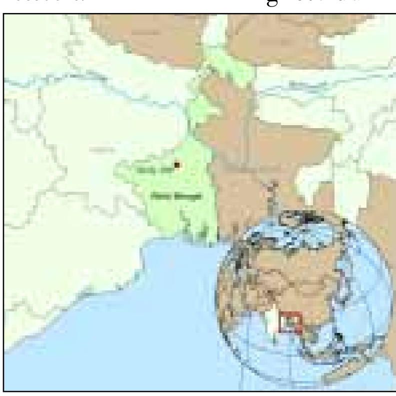
Potassium (K) improved yield and yield attributes in tomato and chili, as well as post-harvest quality...particularly at higher K rates. In both crops, use of potassium magnesium sulfate ($K_2SO_4 \cdot 2MgSO_4$) in conjunction with potassium chloride (KCl) proved superior to using KCl alone.



Soil-test based fertilization can support India's chili productivity.

West Bengal map showing the field study locations.



The importance of tomato as a vegetable crop is reflected in its large-scale cultivation in the world. Tomato is grown on about 4.5 million hectares (M ha) worldwide, the largest producer being China with 32 million metric tons (M t). India produces about 7.6 million M t of tomatoes from about 540,000 ha, an average productivity of 14 t/ha…or about half of the world average. High-yielding tomato production requires good nutrient management.

Phosphorus (P) is especially essential for early growth and root development, while nitrogen (N) and K are fundamental in ensuring normal growth and production of quality fruit.

Adequate K can enhance fruit quality by influencing sugar levels, as well as fruit ripening and storage characteristics. Soil K deficiency can lead to uneven, blotchy ripening, high levels of internal white tissue, yellow shoulder, decreased lycopene, and irregular shaped and hollow fruits. Tomato has a relatively high K requirement compared to N, with over 300 kg K_2O needed throughout the season. Demand for K is highest during fruit bulking. About 2.6 to 3.6 kg of K is required for each 1,000 kg of harvested tomato.

District-wise productivity varies considerably from 312 kg/ha to 1,576 kg/ha. Soil test-based nutrient applications are necessary to improve productivity.

Though considerable information has been accumulated on nutrient management in tomato and chili, attempts to maximize yield in nutrient-depleted red lateritic soils have been meager. The study reported here compared growth, yield, and yield attribute responses of tomato cv. S-120 and chili cv. Phule Jyoti to treatments relying solely on KCl vs. a combination of KCl + $K_2SO_4 \cdot 2MgSO_4$. The latter source is a naturally occurring mineral, recently included in the Fertilizer

Control Order of India. It contains 22% K_2O, 11% Mg, and 22% S in sulfate form.

The experiment was located on a farmer's field in the sub-humid lateritic belt of West Bengal. Selected soil characteristics include: pH, 6.6; organic matter, 0.7 %; cation exchange capacity (CEC), 10.4 meq/100cm^3; available N, P, and K were 97.2 kg/ha, 93.8 kg/ha, and 108.6 kg/ha, respectively. Rates of K allocated to tomato and chili are outlined in **Tables 1 to 4.** Potassium chloride was used in treatments T_1 to T_5, while T_6 used a combination of KCl + $K_2SO_4 \cdot 2MgSO_4$. In tomato, T_6 split the 190 kg K_2O/ha rate between 22 kg/ha as $K_2SO_4 \cdot 2MgSO_4$ and 168 kg/ha as KCl. In chili, T_6 split 150 kg K_2O/ha between 11 kg/ha as $K_2SO_4 \cdot 2MgSO_4$ and 139 kg/ha as KCl. A uniform rate of 150-80 kg N-P_2O_5/ha was applied to all plots. The full quantity of P was applied at transplanting, while N and K quantities were split between transplanting and 45 days after transplanting. Recommended cultural practices and plant protection measures were used throughout the experiment. Chemical analyses of harvested fruits were performed according to A.O.A.C. (1984).

Tomato – Plant height measurements taken at flowering failed to detect significant differences among treat-

Table 1. Effect of K treatment on growth and flowering of tomato.

Treatment, kg K_2O/ha	Plant height, cm	Basal girth, cm	Days till 50% flowering	Truss/plant	Fruit set/truss
T_1 - 110[1]	59.5	4.2	43.0	15.0	2.8
T_2 - 130[1]	58.3	4.0	45.0	16.6	2.8
T_3 - 150[1]	63.1	4.4	45.0	17.3	2.6
T_4 - 170[1]	67.6	4.4	42.3	18.6	1.7
T_5 - 190[1]	70.1	4.6	42.6	20.6	2.7
T_6 - 190[2]	77.9	4.8	40.0	24.0	3.5
C.D.*, p=0.05	5.5	0.3	2.5	2.1	NS

[1]Denotes K supplied as KCl. [2]Denotes K supplied as $K_2SO_4 \cdot 2MgSO_4$ + KCl.
*Critical Difference

Table 2. Effect of K treatment on yield and quality of tomato.

Treatment, kg K_2O/ha	Fruit weight, g	Yield, t/ha	TSS (° Brix) at 14 days,	Ascorbic acid at 14 days, mg/100g juice
T_1 - 110[1]	64.4	30.9	4.12	221.2
T_2 - 130[1]	78.4	32.8	5.72	273.7
T_3 - 150[1]	87.7	34.0	5.12	318.7
T_4 - 170[1]	88.8	35.5	4.72	356.2
T_5 - 190[1]	95.0	37.5	4.31	217.5
T_6 - 190[2]	102.8	44.1	5.31	277.3
C.D.*, p=0.05	2.6	5.8	0.014	12.7

[1]Denotes K supplied as KCl. [2]Denotes K supplied as $K_2SO_4 \cdot 2MgSO_4$ + KCl.
*Critical Difference

Table 3. Effect of K treatment on vegetative growth and fruit bearing behavior of chili.

Treatment, kg K_2O/ha	Plant height, cm	Branches /plant	Flowers /cluster	Clusters /plant	Fruits /cluster
T_1 - 70[1]	41.9	6.8	5.2	16.7	2.7
T_2 - 90[1]	46.4	6.5	5.2	17.3	2.7
T_3 - 110[1]	51.8	6.3	5.3	18.9	2.8
T_4 - 130[1]	57.3	6.5	5.7	21.3	3.2
T_5 - 150[1]	58.8	8.0	6.0	22.0	3.3
T_6 - 150[2]	65.1	8.7	6.8	23.1	3.8
C.D.*, p=0.05	2.25	0.76	0.46	1.79	0.44

[1]Denotes K supplied as KCl. [2]Denotes K supplied as $K_2SO_4 \cdot 2MgSO_4$ + KCl.
*Critical Difference

Table 4. Effect of K treatment on yield attributes and yield of chili.

Treatment, kg K_2O/ha	Fruit length, cm	Fruit weight, g	Seeds /fruit	Green fruit yield, t/ha
T_1 - 70[1]	4.2	1.2	28.3	3.8
T_2 - 90[1]	4.8	1.4	33.0	4.5
T_3 - 110[1]	4.7	1.5	36.6	5.4
T_4 - 130[1]	5.2	1.5	41.7	7.3
T_5 - 150[1]	5.3	1.6	47.9	9.8
T_6 - 150[2]	6.0	1.9	57.0	11.6
C.D.*, p=0.05	0.58	0.06	2.69	1.14

[1]Denotes K supplied as KCl. [2]Denotes K supplied as $K_2SO_4 \cdot 2MgSO_4$ + KCl.
*Critical Difference

ments. However, differences did appear prior to harvest and as a result crop height was highest under T_6 (**Table 1**). The basal girth of plants was also influenced by K fertilization and was equally greatest under T_6 or T_5. The effect of K rate or source on branch numbers per plant was not strongly apparent. Fewest days until 50% flowering was also achieved under T_6, as was the maximum number of flowers per truss, and the maximum number of trusses per plant. Differences in fruit set per truss were not significant.

Potassium has important quality benefits for tomato.

Tomato fruit weight and yield were highly dependent on K rate. However, the combined K source treatment (T_6) supported much higher fruit weight and yield compared to T_5, which provided the same rate of K as KCl alone (**Table 2**). Measurements of fruit weight during storage noted largest losses as a result of the T_5 treatment. Total soluble solids (TSS) in freshly harvested tomatoes varied to a small degree and fruits from T_6 had the highest initial measurements. Differences in TSS become more pronounced among treatments after 14 days of storage, but no clear trends could be related back to K rate or source. Higher K application rates appeared to stimulate acid accumulation in freshly harvested fruits. However, once fruits were stored, acid contents failed to follow any clear trend related to K fertilization. However, T_5 and T_6 did produce fruits with the lowest acid content after two weeks of storage. Ascorbic acid levels increased under storage. After 14 days, concentrations were found to increase steadily up to 170 kg K_2O/ha (T_4), then decrease sharply under the highest K application rate.

Chili – Potassium had a definite role in promoting vegetative growth of chili (**Table 3**). Plant height, branches per plant, flowers per cluster, rate. Yet, as was observed in tomato, an advantage for T_6 which provided 150 kg K_2O/ha split between $K_2SO_4 \cdot 2MgSO_4$ + KCl, was observed for nearly all these growth parameters. Percent fruit drop was not significantly affected by K application rate despite a trend suggesting otherwise. Individual chili fruit length, weight, and seeds contained within all increased with K rate, but once again T_6 produced the longest and heaviest fruits, with the highest number of seed per fruit (**Table 4**). Green fruit yield showed the same trend. Thus, compared to T_5, approximately 30% more green yield was obtained by substituting a portion of K in the form of $K_2SO_4 \cdot 2MgSO_4$. BC

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