Effect of Different Sources of Potassium on Yield, Quality, and Leaf Mineral Content of Mango in West Bengal

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Foliar spray of K_2SO_4 proved more effective than KCl and KNO_3 in increasing the yield, quality, and shelf life of mango grown in the New Alluvial Zone of West Bengal. Irrespective of the K sources used, K application increased N, P, K, Zn, and Mn contents of mango leaf.

Potassium has an important role in influencing both yield and quality of many fruits (Dutta and Dhua, 2000). The application of adequate K along with N and P is well recognized for its contribution to fruit yield and quality responses (Muradov, 1975). Comparisons between K sources often suggest yield and quality (e.g. colour, texture, etc.) advantages associated with selection of K_2SO_4 over KCl (Su, 1969). Dutta (2004) observed that the application of K_2SO_4 (2% solution) improved fruit quality (i.e. total soluble solids, total sugar, ascorbic acid) of guava (*cv. Sardar*). The lack of available information for mango led to the establishment of this study, which examines the effect of different sources of K on yield, quality, and leaf mineral content of the crop.

This study was conducted at the Horticultural Research Station, Mondouri, and in the Post Harvest Technology Laboratory of Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India, for three successive years. The soil at this site was alluvial in nature and sandy loam in texture. Soil pH was 6.6 and it had 0.69% organic C, 0.39% available N, 94 kg P_2O_5/ha, and 280 kg K_2O/ha. The experiment was conducted in a randomised block design with seven treatments and three replications. Fixed doses of N (500 g) and P (250 g) were applied to mango [*cv. Amrapali*, (*Dashehari* × *Neelum*)] plants. This hybrid is precocious, distinctly dwarf, highly regular, late maturing, prolific in bearing, and is more suitable for high density orchards. Its pulp is deep orange red, and it has about 2.5 to 3.0 times more β-carotene than its parents. Because of its attractive flesh colour, this variety is well-suited to the international market.

Various K salts (i.e. K_2SO_4, KCl, and KNO_3) were sprayed four times on the leaves of the whole plant, at either 0.5 or 1.0% concentration, between September and December using 0.1% teepol as a surfactant. The fruits were harvested in the middle of June and brought to the laboratory for physical and chemical analysis using standard methods as outlined by Ranganna (2000). Leaf mineral primary and micronutrient content was also determined. The shelf life of fruit at ambient room temperature (36 to 39°C) and the physiological loss in weight (PLW) were also recorded.

Mango *cv. Amrapali* performs well in high density stands and has many fruit quality traits that are sought-after in international markets.

Yield and Fruit Characteristics

Foliar spray of the different K sources showed significant differences for yield or physical and chemical characteristics of the mango fruit. Potassium sulfate (1%) significantly increased fruit weight, fruit length, and yield (**Table 1**). Improvement in fruit yield and quality were more evident with higher levels of K, particularly with K_2SO_4, compared to their lower concentrations (**Table 1 and 2**). Singh et al. (1979) recorded a significant improvement in yield and quality of berry fruit by spraying 1.0% K_2SO_4. Cline and Bradt (1980) also observed a greater increase in berry yield with K_2SO_4 or KCl treatments than with KNO_3. Cohen (1976) observed that K application not only increased the fruit size, but also improved the rind

Table 1. Effect of different sources of potassium on physical characters of mango fruit.

Treatment	Yield, fruit/tree	Fruit weight, g	Fruit length, cm	Pulp, %
K_2SO_4 (0.5%)	173	167.7	9.11	68.1
K_2SO_4 (1.0%)	184	172.2	9.72	69.7
KCl (0.5%)	172	167.2	9.10	67.1
KCl (1.0%)	174	167.4	9.12	67.0
KNO_3 (0.5%)	169	159.0	8.92	64.1
KNO_3 (1.0%)	171	163.0	8.95	64.9
Control	163	158.6	8.12	60.1
SEm ±	0.6	0.2	0.01	0.4
CD (p = 0.05)	1.9	0.6	0.02	1.3

Common abbreviations and notes: K_2SO_4 = potassium sulphate; KCl = potassium chloride; KNO_3 = potassium nitrate; N = nitrogen; P = phosphorus; K = potassium; Zn = zinc; Mn = manganese; Fe = iron; C = carbon; ppm = parts per million; ATP = adenosine triphophate; NADPH = nicotinamide adenine dinueleotide.

Table 2. Biochemical changes on ripening of mango fruit as influenced by foliar spray of different potassium salts.

Treatment	Total soluble solids, °Brix	Total sugar, % fresh wt.	Acidity, % fresh wt.	Starch, % fresh wt.	Total phenol, % dry wt.	Ascorbic acid, mg/100 g/pulp	β-carotene, µg/100 g
K_2SO_4 (0.5%)	19.80	14.83	0.24	1.93	0.68	39.14	7,200
K_2SO_4 (1.0%)	20.40	15.11	0.23	1.81	0.66	38.11	7,412
KCl (0.5%)	17.40	13.12	0.27	1.94	0.71	39.00	7,100
KCl (1.0%)	17.80	13.72	0.24	1.84	0.67	38.72	7,215
KNO_3 (0.5%)	17.20	14.00	0.27	1.93	0.74	39.72	7,110
KNO_3 (1.0%)	17.80	14.14	0.26	1.92	0.69	38.14	7,310
Control	16.80	13.11	0.31	2.10	0.72	49.14	6,340
SEm ±	0.004	0.003	0.003	0.01	0.02	0.50	18
CD (p = 0.05)	0.012	0.009	0.010	0.03	0.06	1.52	55

thickness in citrus fruit. The increase in the number and size of fruits due to K application may be attributed to the improvement in vegetative growth of the plant as well as efficient transfer of photosynthates to the economic part of the plant. According to Nijjar (2000), K might have acted as activators for a number of complex enzyme systems and these enzymes catalyze metabolic reactions related to the carbohydrates, nucleic acid and nucleotides, amino acids, protein, and folic acid.

Table 3. Effect of different salts of potassium on mineral content of mango leaf.

Treatment	Nitrogen, % dry wt.	Phosphorus, % dry wt.	Potassium, % dry wt.	----- Micronutrients, ppm -----		
				Zn	Mn	Fe
K_2SO_4 (0.5%)	1.61	0.13	0.92	42.10	91.80	386.00
K_2SO_4 (1.0%)	1.69	0.19	1.11	40.22	92.11	397.00
KCl (0.5%)	1.49	0.14	0.89	39.11	91.30	371.00
KCl (1.0%)	1.50	0.15	0.91	41.72	91.70	361.00
KNO_3 (0.5%)	1.47	0.11	0.91	39.90	95.10	374.11
KNO_3 (1.0%)	1.51	0.19	0.94	41.82	97.11	363.11
Control	1.36	0.12	0.81	36.11	90.11	401.00
SEm ±	0.01	0.04	0.02	0.08	0.12	0.57
CD (p = 0.05)	0.04	0.13	0.07	0.21	0.36	1.73

Fruit Quality

The present study showed considerable improvement in fruit quality with K application. Application of K decreased starch and phenol content of fruit and increased the total soluble solids, total sugar, and β-carotene content of mango (**Table 2**). Starch, titratable acidity, and ascorbic acid content of fruits were lower in K-treated fruits than that of control. This may be attributed to faster rate of ripening with K application. Higher fruit quality, especially higher sugar content, can be explained by the role of K in carbohydrate synthesis, breakdown and translocation and synthesis of protein, and neutralization of physiologically important organic acids (Tisdale and Nelson, 1966). Potassium is responsible for energy production in the form of ATP and NADPH in chloroplast by maintaining balanced electric charges. Besides this, K is also involved in phloem loading and unloading of sucrose and amino acids and storage in the form of starch in developing fruits by activating the enzyme starch synthase (Mengel and Kirkby, 1987). The timing of this study's foliar K application also favours the conversion of starch into simple sugar during ripening by activating the sucrose synthase enzyme. Neutralization of organic acids due to high K level in tissues could have also resulted in a reduction in acidity (Tisdale and Nelson, 1966). Ramesh and Kumar (2007) observed similar results in banana. They obtained 28.9% TSS, 22.36% total sugar, and a 97.64 sugar-to-acid ratio with minimum (0.23%) acidity, due to application of 1.5% K_2SO_4.

Table 4. Effect of different sources of potassium on shelf life and physiological loss in weight (PLW) of ripe fruit.

Treatment	Shelf life in days	PLW, %
K_2SO_4 (0.5%)	6	11.72
K_2SO_4 (1.0%)	8	10.42
KCl (0.5%)	4	12.11
KCl (1.0%)	5	12.00
KNO_3 (0.5%)	4	12.41
KNO_3 (1.0%)	4	12.11
Control	3	13.11
SEm ±	0.6	0.48
CD (p = 0.05)	1.5	1.46

Leaf Mineral Content

Irrespective of different K sources, application of K increased the N, P, K, Zn, and Mn content in mango leaf while Fe content declined. Potassium applied as K_2SO_4 showed a higher improvement in N, P, K, Zn, and Mn content of the leaf (**Table 3**).

The PLW from harvested fruits, especially under tropical condition, causes severe economic losses. Mango trees receiving foliar spray as K_2SO_4 (1%) had a significant reduction in PLW. Fruits treated with K_2SO_4 (1%) recorded a maximum (8 days) shelf-life at ambient room temperature (**Table 4**). This

Table 5. Economics of different sources of potassium on Amrapali mango.

Treatment	Treatment cost†, INR/ha	Total cost, INR/ha	Total yield, kg/ha	Gross income††, INR/ha	Net income, INR/ha
K_2SO_4 (0.5%)	10,000	90,000	11,418	228,360	138,360
K_2SO_4 (1.0%)	20,000	100,000	12,659	253,180	153,180
KCl (0.5%)	9,100	89,100	11,490	229,800	140,700
KCl (1.0%)	18,200	98,200	11,624	232,480	134,280
KNO_3 (0.5%)	8,000	88,000	10,749	214,980	126,980
KNO_3 1.0%	16,000	96,000	11,150	223,000	127,000
Control	-	80,000	10,302	206,040	126,040
CD (p = 0.05)	12	10	10	144	123

† Cost of 500 g of KCl, KNO_3, and K_2SO_4 = INR 455, 400, and 500, respectively.
††Average Price of 1 kg mango = INR 20.

might be due to the fact that K_2SO_4 contains considerably more SO_4-S than other sources. However, Haifa (2009) obtained a most beneficial effect with the application of KNO_3. Extension of shelf life with the application of K_2SO_4 was also observed by Ramesh and Kumar (2007) in banana.

Summary

Foliar spray of different sources of K improved final fruit yield and net income (**Table 5**). The 1.0% K_2SO_4 treatment was most profitable and significantly more income was generated compared to the control. Yield, quality, and economic traits all suggest the advantages from applying 1.0 % K_2SO_4. Finally, it is recommended to integrate sulphate forms of foliar K into the nutrition of mango *cv. Amrapali* along with recommended doses of N and P.

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