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Effect of post flowering foliar sprays of nutrients for accelerating harvesting of *kokum* (*Garcinia indica* Choisy)

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ABSTRACT

An investigation was undertaken to find out the effect of post flowering foliar nutrient sprays on harvesting, yield and fruit quality of *kokum*. The treatments consisted of various concentrations and combinations of urea (1.0%), potassium nitrate (3.0%), monopotassium phosphate (0.5%) and 19 N:19 P:19 K (1.0%). All foliar sprays improved yield and quality of *kokum* fruits. The treatment T_4 (3.0% KNO_3 at fruit set and 20 days after fruit set) was the best, which hastened harvesting by 34 days, improved the yield, resulted in maximum harvest before rains, improved acidity, TSS, reducing, non reducing and total sugars and also had the highest B: C ratio. All urea treatments delayed harvesting.

Key words: *Kokum*, foliar nutrients spray, harvesting, physico-chemical composition.

INTRODUCTION

Kokum (*Garcinia indica* Choisy) is one of the most important native tree spice of Konkan region. It is large sized, slender, dioecious, evergreen tree with drooping branches. Its fruit are used economically which are globose with a thin rind, 2.5 to 3.7 cm in diameter, green when young or dark purple or red when ripe, containing 5-8 seeds covered with white aril. The fruit has an agreeable flavour and a sweetish acid taste. Fruit is antihelmentic, antiacidic, cardiotonic and useful in piles, dysentery, tumours, pains and heart complaints. Kokum contains acids, *viz.* mallic acid, tartaric acid, 8-hydroxy citric acid and ascorbic acid. Among these acids it is a rich source of 8-hydroxy citric acid which is an unique acid, which lowers the blood lipids such as cholesterol and glycerides by triggering the fatty acid oxidation. The seed contains oil which remains solid at room temperature and has medicinal properties. Kokum fruit is used exclusively for preparation of value-added products such as *Amrit kokum* (*kokum* syrup), *amsul* (dried *kokum* rind), *agal* (brined *kokum* syrup). In spite of the unique medicinal and processing properties of *kokum* it is not commercially cultivated as that of mango and cashewnut in the region. *Kokum* fruits are ready for harvesting on the border of rainy season, *i.e.* during the month of April to June. As such 70 per cent fruits are caught in rains and become unuseful even for processing. According to a baseline survey this loss is estimated to be of Rs. 157 lakhs (Anon, 4). This huge natural loss is one of the major hurdle in expansion of this precious crop. An experiment was therefore undertaken to study the utility of foliar sprays of nutrients to reduce the harvesting period and improve the yield of *kokum*.

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MATERIALS AND METHODS

The trial was conducted at the farm of Department of Horticulture, College of Agriculture, Dapoli Dist., Ratnagiri for three consecutive years during 2008, 2009 and 2010. Thirty-year-old bearing *kokum* plants planted at a distance of 8 m × 5 m, under uniform recommended management practices were selected. The experiment was conducted in RBD with nine treatments of post flowering foliar sprays and three replications with a unit of two plants per treatment per replication. The treatment details were as follows; T_1 (1% urea) at and 20 days of fruit set), T_2 (1% urea at fruit set & 3% potassium nitrate after 20 days of fruit set), T_3 (1% urea at fruit set and 0.5% monopotassium phosphate after 20 days of fruit set, T_4 (3% potassium nitrate at & 20 days of fruit set, T_5 (3% potassium nitrate at fruit set and 0.5% monopotassium phosphate after 20 days of fruit set, T_6 (19N: 19P : 19K (1%) at & 20 days of fruit set), T_7 (19N : 19P : 19:K (1%) at fruit set & potassium nitrate (3%) after 20 days of fruit set), T_8 (19 N: 19P : 19K (1%) at fruit set & monopotassium phosphate (0.5%) after 20 days of fruit set) and T_9 (control - no foliar nutrient sprays).

The observations, *viz*., number of days required for harvesting, advancement / delay in harvesting, total yield, yield before rains and yield after rains were recorded. Ten fruits per treatment per replication were randomly selected for physico-chemical analysis,

viz., fruit weight, TSS, acidity, ascorbic acid, reducing sugar, non-reducing sugar and total sugars. The economics of pooled data of three years was worked out. The B:C ratio calculated by using following formula.

$$BCR = \sum_{t=0}^{T} \frac{R / (1+r)t}{C/ (1+r)t}$$

Where R = Returns from period, C = Cost of project, r = discount rate (11%) t = Period of project (3 years). The statistical analysis was done as per the method suggested by Panse and Sukhatme (14).

RESULTS AND DISCUSSION

The data on effect of foliar nutrient sprays on days required for harvesting and advancement/delay in harvesting are presented in Table 1. Both the parameters showed significant variation throughout the period of study. The days required for harvesting were minimum in treatment T_4 followed by T_5. Treatments T_1, T_2 and T_3 delayed harvesting were more than those in control. Treatment T_4 could hasten harvesting of *kokum* fruits by 34 days (pooled), which was followed by T_5 (21.83 days). The treatment T_1 delayed the maturity of kokum fruits by 4.83 days (pooled). The results indicated that potassium nitrate remarkably hastened harvesting, whereas urea delayed it. An increase in nitrogen supply delays senescence and stimulates growth (Horst Marschner, 8). Higher nitrogen is reported to delay fruit maturity in mango (Samra *et al*., 15). Potassium is metabolic activator, increasing the respiration and photosynthetic rate (Martin, 11). Potassium reported to advance maturity and ripening in fruit crops (Bose *et al*., 6). Kumar *et al*. (10) opined that the earlier maturity of mango could be due to increased hormonal activity due to potassium nitrate in mango

The highest total yield was recorded in treatment T_4 (64.8 kg/plant) during 2009, (83.3 kg/plant) in 2010 and in pooled analysis (74.2 kg/plant) (Table 2). All foliar nutrient treatments recorded higher yield than control during 2009, 2010 and in pooled analysis. The variation recorded in yield for various treatments during 2008, 2010 and in pooled was significant. T_4 and T_5 treatments were significantly superior over control. Nitrogen is supposed to give impetus to the formation of new cells and therefore associated with growth of mass (Nijjar, 13). Potassium is supposed to have a catalytic role and its supply augments carbon assimilation (Amar Singh, 1). Foliar sprays of potassium nitrate increased yield in mango (Anbu *et al*., 2). In T_5, phosphorus was also used which is an important constituent of nucleic acid and phospholipids and accumulated at higher percentage in fruits (Amar Singh, 1). The data in Table 2 indicated that the treatment T_4 contributed for the maximum yield harvested before rains in 2008 (67.3 kg/plant), 2009 (45.3 kg/plant), 2010 (61.8 kg/plant) and in pooled analysis (59.2 kg/plant) followed by T_5. Significant variation in yield was recorded among the treatments before rains. The yield harvested after rains (Table 2) was the highest in treatment T_1 for 2008 (35.8 kg/plant), 2009 (32.5 kg/plant), 2010 (42.3 kg/plant) and in pooled analysis (36.8 kg/plant) followed by T_2. The difference for the yield harvested after rains among various treatments was found significant during 2008, 2009, 2010 and pooled analysis.

Table 1. Effect of post flowering foliar nutrient sprays on days required for harvesting and advancement/delay of harvesting in *kokum*.

Treatment	Days required for harvesting (days)				Advancement/delay of harvesting (days)			
	2008	2009	2010	Pooled	2008	2009	2010	Pooled
T1 - Urea (1.0%)	139.50	138.00	113.83	130.44	9.17	3.67	1.67	4.83
T2 - Urea (1.0%) & KNO_3 (3.0%)	137.50	136.67	111.17	128.44	7.17	2.33	-1.00	2.83
T3 - Urea (1.0%) & MPP (0.5%)	140.67	138.17	111.83	130.22	10.33	3.83	-0.33	4.61
T4 - KNO_3 (3.0%)	94.33	92.83	87.67	91.61	-36.00	-41.50	-24.50	-34.00
T5 - KNO_3 (3.0%) & MPP (0.5%)	106.17	106.33	98.83	103.78	-24.17	-28.00	-13.33	-21.83
T6 -19:19:19 (1.0%)	111.83	116.33	101.00	109.72	-18.50	-18.00	-11.17	-15.89
T7 - 19:19:19 (1.0%) & KNO_3 (3.0%)	122.33	121.33	102.50	115.39	-8.00	-13.00	-9.67	-10.22
T8 - 19:19:19 (1.0%) & MPP (0.5%)	127.83	123.17	104.67	118.56	-2.50	-11.17	-7.50	-7.06
T9 - Control	130.33	134.33	112.17	125.61	0.00	0.00	0.00	0.00
CD at 5%	3.71	N.S	5.14	2.87	3.71	4.68	5.14	2.87

Table 2. Effect of post flowering foliar nutrient sprays on total yield, fruits harvested before and after rains (kg/tree), % fruits harvested before and after rains in *kokum*.

Treatment	Total yield				Harvested before rains				Harvested after rains				% fruits harvested before rains				% fruits harvested after rains			
	2008	2009	2010	Pooled	2008	2009	2010	Pooled	2008	2009	2010	Pooled	2008	2009	2010	Pooled	2008	2009	2010	Pooled
T1 - Urea (1.0%)	74.1	56.6	66.6	62.9	38.3	24.1	24.3	28.8	35.8	32.5	42.3	36.8	51.6	42.6	36.4	43.61	48.3	57.3	63.5	58.6
T2 - Urea (1.0%) & KNO_3 (3.0%)	75.8	62.0	67.8	66.2	44.0	30.1	31.1	35.1	31.8	31.8	36.6	33.4	58.0	48.6	45.9	50.87	41.9	51.3	54.0	50.4
T3 - Urea (1.0%) & MPP (0.5%)	86.0	49.8	72.1	63.3	54.5	25.0	41.5	40.3	31.5	24.8	30.6	29.0	63.3	50.1	57.5	57.01	36.6	49.8	42.5	45.8
T4 - KNO_3 (3.0%)	84.3	64.8	83.3	74.2	67.3	45.3	61.8	59.2	17.0	19.5	21.5	19.3	79.8	69.9	74.1	74.65	20.1	30.0	25.8	26.0
T5 - KNO_3 (3.0%) & MPP (0.5%)	86.6	60.0	77.5	70.2	65.0	38.6	55.1	50.4	21.6	21.3	22.3	21.7	75.0	64.4	71.1	70.20	25.0	35.5	28.8	30.9
T6 - 19:19:19 (1.0%)	71.6	55.5	74.5	64.5	49.1	30.0	45.6	41.6	22.5	25.5	28.8	25.6	68.6	54.0	61.3	61.31	31.	45.9	38.7	39.6
T7 - 19:19:19 (1.0%) & KNO_3 (3.0%)	64.1	55.6	61.1	58.9	43.5	32.6	36.8	37.6	20.6	23.0	24.3	22.6	67.7	58.6	60.2	62.22	32.2	41.3	39.8	38.4
T8 - 19:19:19 (1.0%) & MPP (0.5%)	60.6	61.6	66.8	63.2	36.8	35.5	35.6	36.0	23.8	26.1	31.1	27.0	60.7	57.5	53.3	57.21	39.2	42.4	46.6	42.7
T9 - Control	62.1	56.1	44.1	52.8	37.6	30.3	28.8	32.3	24.5	25.1	15.3	21.6	60.5	54.6	65.2	60.17	39.4	45.3	34.7	41.0
CD at 5%	17.5	N.S.	16.5	8.1	17.4	9.1	12.5	8.1	5.7	6.6	N.S	6.93								

The per cent yield harvested before rains (Table 2) was highest in treatment T_4 during 2008 (79.8%), 2009 (69.9%), 2010 (74.1%) and in pooled analysis (74.6%), which was followed by T_5. The lowest percentage of fruits before rains was found in T_1 throughout the experimental period. The reverse was true, as the per cent fruits harvested after rain in the total yield (Table 2) was highest in treatment T_1 during 2008 (48.31%), 2009 (57.35%), 2010 (63.51%) and in pooled analysis (58.63 %), whereas the per cent yield harvested after rains was minimum in treatment T_4. High nitrogen causes peaches to be late in ripening (Gustafson, 7). Potassium and phosphorous are reported to advance maturity and ripening in fruit crops (Arzumanov, 5).

The effect of post flowering foliar nutrient sprays on physico-chemical composition of *kokum* fruits found to be significant among all parameters except for fruit weight (Table 3). Importantly all foliar nutrient sprays improved the physico-chemical composition of *kokum* fruits over control. Among the various treatments T4 proved to be the best treatment, which registered the maximum acidity (4.22%), TSS (15.27°Brix), reducing sugar (5.41%), non reducing sugar (5.28%) and total sugars (8.89%). The nutrients nitrogen and potassium being essential constituents of several metabolically active compounds and are major structural constituent of cell which increase growth and development of all living tissue (Anon, 3). In foliar feeding, the nutrients are applied directly to the site of metabolism which could be attributed to enhanced carbohydrate metabolism (Miller and Turk, 12) and potassium acts as a catalyst that accelerates the rate of reactions (Jones, 9).The improvement in fruit quality by foliar sprays of potassium nitrate has been reported earlier by Vijayalakshmi and Srinivasan

Table 3. Effect of post flowering foliar nutrient sprays on physico-chemical composition of *kokum* fruits.

Treatment	Fruit weight (g)	Acidity (%)	TSS (°Brix)	Reducing sugar (%)	Non reducing sugar (%)	Total sugars (%) °Brix
T1 - Urea (1.0%)	27.27	3.94	13.94	4.73	4.95	7.86
T2 - Urea (1.0%) & KNO_3 (3.0%)	31.78	3.87	14.28	4.71	4.69	7.62
T3 - Urea (1.0%) & MPP (0.5%)	30.82	3.77	14.11	4.78	4.91	7.9
T4 - KNO_3 (3.0%)	28.62	4.22	15.27	5.41	5.28	8.89
T5 - KNO_3 (3.0%) & MPP (0.5%)	28.97	4.06	15.03	5.36	5.27	8.81
T6 - 19:19:19 (1.0%)	30.08	3.61	14.70	5.07	4.77	8.04
T7 - 19:19:19 (1.0%) & KNO_3 (3.0%)	28.63	3.96	14.60	4.92	4.70	7.8
T8 - 19:19:19 (1.0%) & MPP (0.5%)	27.71	4.02	14.18	4.82	4.81	7.84
T9 - Control	25.87	3.53	13.60	4.24	4.31	6.92
CD at 5%	N.S	0.19	0.14	0.24	0.27	0.28

Table 4. Economics of post flowering nutrient sprays on *kokum* (₹).

Treatment	Input cost (₹)	Total cost (₹)	Gross return (₹)	Net returns		B:C ratio
				Input cost (₹)	Total cost (₹)	
T1 - Urea (1.0%)	34,655	56,363	95,100	60,445	38,737	1.68
T2 - Urea (1.0%) & KNO_3 (3.0%)	43,097	68,743	1,08,460	65,363	39,717	1.57
T3 - Urea (1.0%) & MPP (0.5%)	36,077	62,773	1,18,740	82,663	55,967	1.89
T4 - KNO_3 (3.0%)	42,929	78,587	1,59,900	1,16,971	81,312	2.03
T5 - KNO_3 (3.0%) & MPP (0.5%)	44,520	76,780	1,39,520	95,000	62,740	1.81
T6 - 19:19:19 (1.0%)	36,564	63,871	1,19,820	83,256	55,949	1.87
T7 - 19:19:19 (1.0%) & KNO_3 (3.0%)	45,175	72,220	1,08,140	62,965	35,920	1.49
T8 - 19:19:19 (1.0%) & MPP (0.5%)	38,155	63,383	1,06,720	68,565	43,336	1.68
T9 - Control	33,118	56,033	93,560	60,442	37,526	1.66

(17) in mango and by macronutrients in grape (Singh *et al.*, 16).

The maximum net returns at input cost and at total cost were obtained in treatment T_4 (Rs. 1,16,971 and Rs. 81,312, respectively) (Table 4). The B:C ratio of T_4 (2.03) was the highest compared to control (1.66). Thus, it may be concluded that treatment T_4 comprising 3.0% KNO_3 at fruit set and 20 days after fruit set was most effective in advancing the harvesting by 34 days, improved the yield, maximum harvest before rains, improved acidity, TSS, reducing, non reducing and total sugars and also highest B:C ratio.

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