Indian J. Hort. 72(1), March 2015: 38-42

Studies on the effect of foliar sprays of nutrients after fruit set on harvesting, yield and quality of *kokum* (*Garcinia indica* Choisy)

P.M. Haldankar* and A.V. Somavanshi
Department of Horticulture, College of Agriculture, Dr B.S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri 415 712, Maharashtra

ABSTRACT

An investigation was undertaken to study the effect of foliar application of nutrients after 30 days of fruit set on harvesting, yield and quality of *kokum* (*Garcinia indica* Choisy). The experiment was conducted during two consecutive years in a randomized block design with three replications and nine treatments consisting of various concentrations and combinations of urea (1.0%), potassium nitrate (3.0%), monopotassium phosphate (0.5%) and ready mixture 19 N: 19 P: 19 K (1.0%). All foliar nutrient sprays improved the physico-chemical properties of *kokum* fruit over control. The relative growth rate for length, circumference and fruit weight in all foliar nutrient sprays was greater than T_9 (control). Among all the treatments studied, T_5 was the best which pre-poned the harvesting by 39.5 days, maximised the yield before rains and contributed for desired chemical composition of fruits with respect to acidity, ascorbic acid, reducing, non-reducing and total sugars contents.

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

INTRODUCTION

Kokum (*Garcinia indica* Choisy) is one of the most valuable native tree spices in India. It is found mainly in the Konkan region of Maharashtra, Goa and North Karnataka in India. Kokum is a large sized evergreen tree, dioecious in nature. The fruits are of economic importance and the rind as well as seeds is also used. Fruit rind is anti-helmintic, antiacidic, cardiotonic and useful in piles, dysentery, tumors, pains and heart complaints. It is a rich source of 8-hydroxyl citric acid, a unique acid, which lowers the blood lipids such as cholesterol and glycerides by triggering the fatty acid oxidation. The rind of fruit is exclusively processed for preparation of unique value-added products such as *Amrit kokum* (*kokum* syrup), *Amsul* (dried *kokum* rind) and *Agal* (brined *kokum* syrup) etc. The seed contains oil, which remains solid at room temperature, is nutritive demulcent, astringent and emollient. In spite of the unique processing and medicinal properties, *kokum* is not commercially cultivated as other crops like mango, cashewnut etc. in the region. Late harvesting in May-June at the onset of rainy season is one of the main reasons of negligence by farmers for this precious crop. Most of the fruits are trapped in the rains and become unsuitable for processing resulting in loss estimated to the tune of 40 to 70%, which when valued in Indian currency is of Rs. 157 lakhs (Anon, 2). The major nutrients, nitrogen, phosphorous and potassium play an important role in the growth and development of fruit. An investigation was therefore undertaken to study the effect of post foliar application of major nutrients on harvesting, yield and quality of *kokum* fruits.

*Corresponding author's E-mail: parag5663@rediffmail.com

MATERIALS AND METHODS

The field experiment was conducted at the farm of Department of Horticulture, College of Agriculture, Dapoli, Ratnagiri, Maharashtra for consecutive two years. Thirty-year-old bearing *kokum* plants, planted at 8 m × 5 m, under uniform recommended management practices were selected. The soil was lateritic. The experiment was conducted in randomized block design with nine treatments of post flowering foliar sprays replicated thrice with a unit of two plants per treatment per replication. The treatment details are given in Table 1. Ten litre foliar

Table 1. Treatment details of post flowering foliar sprays on *kokum*.

Treatment	30 days after fruit set	50 days after fruit set
T_1	Urea (1.0%)	Urea (1.0%)
T_2	Urea (1.0%)	KNO_3 (3.0%)
T_3	Urea (1.0%)	MKP (0.5%)
T_4	KNO_3 (3.0%)	KNO_3 (3.0%)
T_5	KNO_3 (3.0%)	MKP (0.5%)
T_6	19 N:19 P:19 K (1.0%)	19 N:19 P:19 K (1.0%)
T_7	19 N:19 P:19 K (1.0%)	KNO_3 (3.0%)
T_8	19 N:19 P:19 K (1.0%)	MKP (0.5%)
T_9	Control (no spray)	Control (no spray)

sprays were applied to each experimental plant of respective treatment.

The observations, *viz*., number of days required for harvesting from fruit set, advancement/ delay in harvesting (days), fruits harvested before rains (kg/ plant), fruits harvested after rains (kg/ plant), unripe fruits remained after rains (kg/ plant), total yield (kg/ plant) were recorded. Ten fruits per treatment per replication were randomly selected for recording physico-chemical composition, *viz*., fruit weight (g), fruit length (cm), fruit circumference (cm), TSS (°Brix), acidity (%), ascorbic acid (mg/100 g), reducing sugar (%), non reducing sugar (%) and total sugars (%). The physico-chemical composition was recorded at 60 and 90 days after fruit set and at harvest. The statistical analysis was done as per the method suggested by Panse and Sukhatme (12). The relative growth rate of fruit weight, fruit length and fruit circumference was computed by formula suggested by Blackman (4).

Table 2. Effect of foliar nutrient sprays on number of days required for harvesting and advancement/delay in harvesting of *kokum* fruits.

Treatment	No. of days required for harvesting (days)	Advancement / delay in harvesting
T_1	136.50	2.5
T_2	136.91	2.91
T_3	136.00	2
T_4	107.50	-26.5
T_5	94.50	-39.5
T_6	109.41	-24.6
T_7	105.91	-28.1
T_8	119.66	-14.3
T_9 (control)	134.00	-
Mean	120.05	-
CD at 5%	3.51	-

RESULTS AND DISCUSSION

The period required for harvesting of *kokum* from fruit set without any treatment was 134 days in control (Table 2). The maximum reduction in days required for harvesting was found in T_5 (94.50 days). Apart from this treatment the days required for harvesting in treatment T_7, T_4, T_6 and T_8 were less than those of control. Treatment T_1, T_2 and T_3 recorded more number of days for harvesting than control. All foliar nutrient sprays could elevate the yield of *kokum* (Table 3). However the pattern of yield differed in various treatments. The maximum yield was obtained in treatment T_5 (84.17 kg) of which 68.67 kg fruits were harvested before rains and 12.33 kg fruits/ tree harvested immediately after rains, whereas 3.17 kg fruits remained unripe after rains. In control where any foliar nutrient spray was not used, the total yield was 52.08 kg/tree among which 26 kg fruits were harvested before rains, 21 kg fruits harvested immediately after rains and 5.08 kg fruits remained unripe even after rains. The maximum fruits harvested before rains was found in treatment T_5 (81.58%), whereas, in control it was 49.92%. The proportion of fruits harvested immediately after rains was highest in treatment T_1 (44.69%) and minimum T_5 (14.65%). The unripe fruits remained on tree after rains were more in treatments T_1, T_2 and T_3 as compared to other treatments.

The study indicated that higher doses of nitrogen in the initial stage of fruit growth delayed the harvesting,

Table 3. Effect of foliar nutrient sprays on fruit yield of *kokum* (kg/ plant).

Treatment	Total ripe fruits				Unripe fruits per plant remained after rains	% to total yield	Total yield of ripe and unripe fruits
	Harvested before rains	% to total yield	Harvested immediately after rains	% to total yield			
T_1	22.17	41.56	23.83	44.69	7.33	13.75	53.33
T_2	30.00	48.51	24.25	39.22	7.58	12.26	61.83
T_3	38.25	56.11	20.58	30.2	9.33	13.69	68.17
T_4	45.58	64.42	20.25	28.62	4.92	6.94	70.75
T_5	68.67	81.58	12.33	14.65	3.17	3.76	84.17
T_6	44.17	64.71	18.92	27.72	5.17	7.57	68.25
T_7	51.33	66.73	19.33	25.14	6.25	8.12	76.92
T_8	37.92	61.98	18.17	29.7	5.08	8.31	61.17
T_9 (control)	26.00	49.92	21.00	40.32	5.08	9.76	52.08
Mean	40.45	--	19.85	--	5.99	--	66.30
CD at 5%	12.01	--	4.41	--	0.95	--	13.20

whereas the lower doses of nitrogen along with higher doses of potassium and phosphorous preponed the harvesting. Nitrogen is supposed to give impetus to the formation of new cells and therefore growth in mass is associated with nitrogen (Miller and Turk, 10) but higher nitrogen causes peaches to be late in ripening, which were also of poor shipping quality (Gustafson, 8). Nitrogen delayed fruit maturity in mango (Samra *et al.*, 13). Potassium and phosphorus advance maturity and ripening in fruit crops (Bose *et al*., 3) and also increases the capacity to synthesize the starch (Singh, 14). This could be the reason of preponing the yield and improvement in quality of fruits from *kokum* trees sprayed with these nutrients. In *karonda*, the post-flowering foliar application of nutrients was found beneficial (Mukadam and Haldankar, 11).

The physical parameters of *kokum* fruits were improved by foliar nutrients (Table 4). Among the various treatments, T_3 contributed for maximum fruit weight (31.86 g), maximum fruit length (3.77 cm) and circumference (12.88 cm). The fruits obtained from T_9 (control) were the smallest with respect to length (3.45 cm), circumference (11.07 cm) and weight (24.74 g) at harvest. The relative growth rate of weight of fruits was greater in treatments T_1 to T_8 as compared to T_9 (control) at all stages of fruit growth upto harvesting (Fig. 1). It was at its peak from 60 to 90 days of fruit set irrespective of treatments, which was followed by that of 30 to 60 days after fruit set and 90 days after fruit

Table 4. Effect of foliar nutrient sprays on weight (g), length (cm) and circumference (cm) of *kokum* fruits.

Treatment	Weight (g)			Fruit length (cm)			Circumference (cm)		
	60 DAF	90 DAF	At harvest	60 DAF	90 DAF	At harvest	60 DAF	90 DAF	At harvest
T_1	22.97	30.84	26.92	2.74	3.31	3.58	10.14	10.87	11.56
T_2	24.22	31.82	30.13	2.84	3.35	3.65	10.34	11.44	11.93
T_3	25.15	32.74	31.86	2.91	3.56	3.77	11.25	12.11	12.88
T_4	23.92	29.87	28.44	2.99	3.52	3.74	10.68	11.87	12.60
T_5	23.76	30.31	29.02	3.14	3.52	3.73	10.79	11.89	12.74
T_6	23.98	29.92	29.04	3.06	3.48	3.68	10.73	11.92	12.62
T_7	23.68	31.44	27.96	3.05	3.39	3.58	10.74	11.86	12.01
T_8	23.62	30.17	27.07	3.05	3.32	3.62	10.31	11.51	11.76
T_9	22.36	26.89	24.74	2.60	3.16	3.45	9.21	10.71	11.07
Mean	23.74	30.45	28.36	2.93	3.40	3.64	10.46	11.57	12.13
CD at 5%	0.67	1.83	2.28	0.08	0.09	0.13	0.45	0.44	0.24

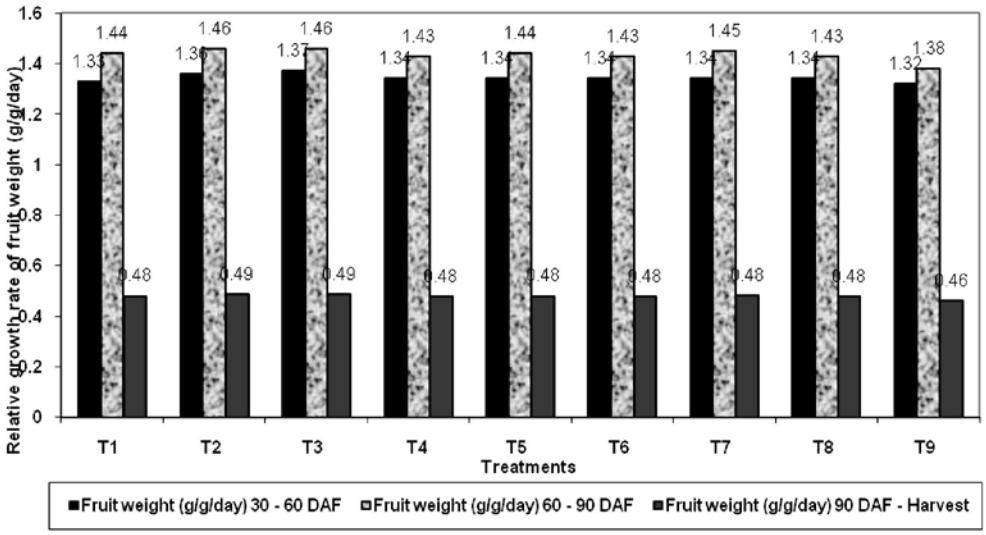

Fig. 1. Effect of foliar nutrient sprays after 30 days of fruit set on relative rate of weight (g/g/day) of *kokum* fruits (pooled data).

set to harvesting. Further, it was the maximum in T_3 at all stages as compared to other treatments. Linear increase was recorded for the relative growth rate of fruit length from 30 days of fruit set upto harvest of fruits irrespective of treatments (Fig. 2). It was at its peak from 90 days till harvest followed by period of 60 to 90 days after fruit set and 30 to 60 days after fruit set. It was higher at all stages of growth of *kokum* fruits in treatments T_1 to T_9 than T_9 (control). The relative growth rate recorded in T_3 was higher after 60 days of fruit set till harvest than other treatments. The pattern of relative growth rate for fruit circumference of *kokum* fruit was similar to that of fruit length (Fig. 3). The slowest growth rate of fruit circumference at all stages was found in T_9 as compared to other treatments. The TSS, acidity and ascorbic acid recorded in control at harvest was 13.40°B, 3.70% and 8.18 mg/100 g, respectively (Table 5). Among all the treatments T_4 (15.40°Brix) recorded the highest TSS at harvest, whereas treatment T_5 resulted in the highest acidity (4.17%) and ascorbic acid (9.85 mg/100 g) content in fruit at harvest. The reducing, non-reducing and total sugars obtained in treatment T_5 were maximum among all the treatments.

The major nutrients N, P, K help in increasing carbohydrate metabolism and increase in growth and development of living tissues (Miller and Turk, 10; Anon, 2). Increase in fruit weight due to foliar application of urea because of rapid multiplication and enlargement of cell and greater accumulation of sugar and water in expanded cells is reported in mango (Gupta and Bramhachari, 7). Singh and Bal (15) found improvement in fruit length in *ber* by foliar application

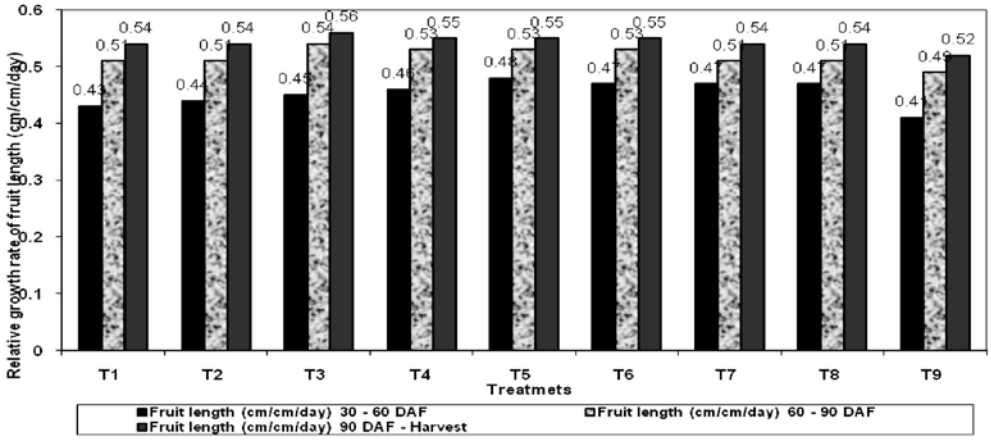

Fig. 2. Effect of foliar nutrient sprays after 30 days of fruit set on relative growth rate of fruit length (cm/cm/day) of *kokum* fruits (pooled data).

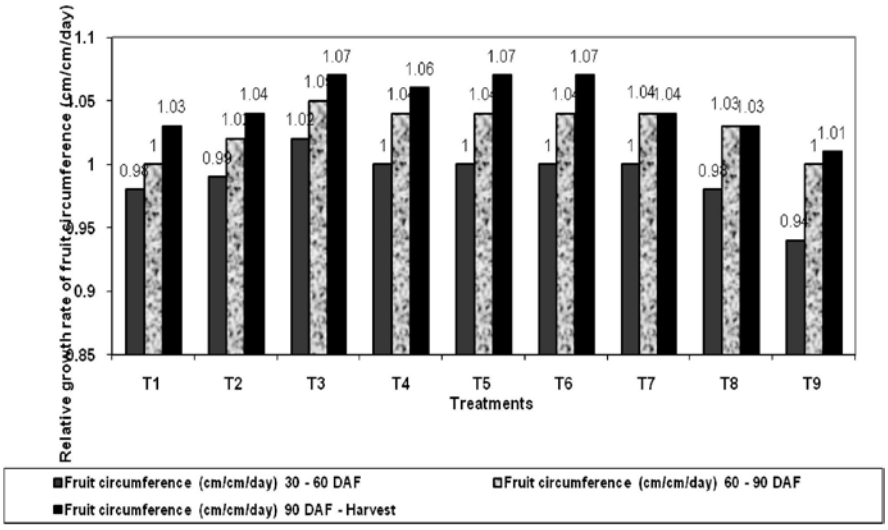

Fig. 3. Effect of post foliar nutrient sprays after 30 days of fruit set on relative growth rate of fruit circumference (cm/cm/day) of *kokum* fruits (pooled data).

Table 5. Effect of foliar nutrient sprays on chemical composition of *kokum* fruits.

Treatment	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg/100 g)	Reducing sugars (%)	Non reducing sugars (%)	Total sugars (%)
T_1	14.59	3.89	8.81	4.63	5.03	9.66
T_2	14.92	3.91	8.82	4.60	4.88	9.48
T_3	15.20	3.92	8.98	4.71	5.20	9.92
T_4	15.40	4.10	9.38	5.11	5.15	10.27
T_5	15.37	4.17	9.85	5.49	5.27	10.76
T_6	15.37	3.93	9.17	4.97	4.60	9.57
T_7	15.19	3.99	9.83	5.03	4.47	9.50
T_8	14.60	3.97	9.07	4.98	4.31	9.30
T_9 (control)	13.40	3.70	8.18	4.46	3.83	8.28
Mean	14.89	3.95	9.12	4.89	4.75	9.64
CD at 5%	0.29	0.10	0.58	0.20	0.33	0.30

of KNO_3. 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 Brahmachari *et al*. (5) in guava cv. Allahabad Safeda and in pear (Gill *et al*., 6).

REFERENCES

1. Anonymous, 2006. *Handbook of Agriculture*, Indian Council of Agricultural Research, New Delhi, pp. 410-12.
2. Anonymous, 2010. Base line survey report on a value chain for *kokum*, *karonda*, *jamun* and jackfruit submitted by Dr B.S. Konkan Krishi Vidyapeeth, Dapoli.
3. Bose, T.K., Mitra, S.K. and Sadhu, M.K. 1988. *Mineral Nutrition of Fruit Crops*, Naya Prokash Publication, Calcutta, 245 p.
4. Blackman, V.H. 1919. The compound interest low and plant growth. *Ann. Bot*. **33**: 353-60.
5. Brahmachari, V.S., Kumar, N. and Kumar, R. 1997. Effect of foliar feeding of calcium, potassium and growth substances on yield and quality of guava (*Psidium guajava* L.). *Haryana J. Hort. Sci.* **26**: 169-73.
6. Gill, P.P.S., Ganaie, M.Y., Dhillon, W.S. and Singh, Nav Prem. 2012. Effect of foliar sprays of potassium on fruit size and quality of Patharnakh pear. *Indian J. Hort.* **69**: 512-16.
7. Gupta, R.K. and Brahmachari, V.S. 2004. Effect of foliar application of urea, potassium nitrate & NAA on fruit retention, yield and quality of mango cv. Bombai. *Orissa J. Hort*. **32**: 7-9.
8. Gustafson, A.F. 2000. *Handbook of Fertilizers*, Agrobios (India), New Delhi, pp. 22-26.
9. Jones, V.S. 1979. *Fertilizers and Soil Fertility*, Reston Publishing Co., Reston, Virginia, pp. 190-91.
10. Miller, C.E. and Turk, L.M. 2004. Effect of nitrogen, phosphorus and potassium on plants and the quantities removed by the crops. **In**: *Fundamentals of Soil Science*, Biotech Books, New Delhi, pp. 291-300.
11. Mukadam, S.J. and Haldankar, P.M. 2013. Effect of paclobutrazol and post flowering foliar sprays of nutrients for accelerating harvesting of karonda. *J. Plant Studies*, **2**: 145-51.
12. Panse, V.G. and Sukhatme, P.V. 1997. *Statistical Methods for Agricultural Workers*, ICAR, New Delhi, pp. 97-156.
13. Samra, J.S., Thakur, R.S. and Chadha, K.L. 1977. Effect of foliar application of urea on yield and yield parameters of mango. *Indian J. Hort.* **3**: 26-29.
14. Singh, A. 2006. Environmental factors-Elements needed by plants. **In**: *Horticulture at Glance*, Kalyani Publications, pp. 9-12.
15. Singh, C. and Bal, J.S. 2006. Effect of nutrients and growth regulators on fruit drop, size and yield of ber (*Zizyphus mauritiana* Lamk.). *Int. J. Agric. Sci*. **2**: 358-60.

Received : February, 2014; Revised : October, 2014; Accepted : December, 2014