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RESEARCH PAPER

Post harvest treatments for enhancement of ripening in Kesar mango

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SUMMARY : An experiment was carried out to study the post harvest treatments on ripening of Kesar mango fruit during storage at Department of Horticulture, Junagadh Agricultural University, Junagadh during 2007 to 2009. Significant variation was observed due to post harvest treatments for majority of characters and enhanced ripening and gave early marketable fruits. Ethrel 1000 ppm gave highest marketable fruit and maximum percentage of ripened fruit. Lowest physiological loss of weight and percentage of spoiled fruit were recorded with carbendazim @ 1000 ppm. For qualitative parameters, ethrel 1000 ppm with carbendazim 500 ppm gave lowest acidity and maximum reducing sugar, whereas, ethrel 1000 ppm gave maximum reducing sugar. Similarly, highest percentage of total sugar was noted at ethrel 1000 ppm + carbendazim 500 ppm + neem extract 5 per cent during all days of storage. TSS was also found significant and highest TSS was registered with ethrel 1000 ppm + neem extract 10 per cent. In case of organoleptic test, ethrel 1000 ppm + carbendazim 500 ppm performed for better fruit and pulp color, whereas, ethrel 1000 ppm for highest rank in taste.

Key Words : Mango, Post harvest, Ethrel, Marketable, Spoiled, Organoleptic

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The mango (*Mangifera indica* L.) is a delicious fruit. Besides fine taste, its high palatability, sweet fragrance, attractive colour and nutritional value, it is called as king of fruits. It is grown in many states on large scale on 2.20 million hectares land and total production of 13.79 million tones with 6.30 MT / hectare productivity (Anonymous, 2008). Ripening is the problem of mango as due to climacteric nature of the fruit. Post harvest handling can play a major role to reduce post harvest losses. For good market price, it becomes essential that fruits must be ripened at proper time and transported to the market without spoilage. The fruits are ripened after harvesting. If harvesting is not done at exact maturity indices, the ripening of fruit is delayed or some time fruit is deteriorated without ripening. In market, many hazardous and unscientific methods are employed by the traders for ripening which is dangerous to human health. For good market price, it becomes essential that fruits must ripe uniformly and timely. Therefore, an experiment was conducted for post harvest treatment to enhance the ripening in mango cv. KESAR.

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EXPERIMENTAL METHODS

Green mature fruits with uniform size and shape having specific gravity between 1.0 and 1.04 were selected. The trial was conducted during three year from 2007-2009. The statistical design was Completely Randomized Design (C.R.D.) with three replications. The trial comprised of different eight treatments like control (T_1), ethrel 750 ppm (T_2), ethrel 1000 ppm (T_3), carbendazim 1000 ppm (T_4), ethrel 1000 ppm + carbendazim 500 ppm (T_5), ethrel 1000 ppm + neem extract 10 per cent (T_6), ethrel 1000 ppm + hot water treatment 52^0C $\pm$ for 5 minutes (T_7) and

ethrel 1000 ppm + carbendazim 500 ppm + neem extract 5 per cent (T_8). The fruits were dipped for 10 minute in different solutions as mentioned in the treatments. Neem leaf extract 5 and 10 per cent were prepared with crushing the green neem leaves. For hot water, fruits were dipped in water bath at 50 ± 2^0C for 10 minutes and then depped in respective chemical solution as per treatment. After treatment, the fruits were air dried for 30 minutes. Temperature was measured by using thermometer. Treated fruits were packed as such without wrapping, in corrugated fibre board (CFB) boxes and stored in the laboratory at room temperature. Boxes were of 30 x 30 x 30 cm size having 8 vents of 3 cm diameter of each one. Paper cutting were used as a cushioning material during storage. The fruits were selected from each lot at a time and used for analysis and organoleptic test. Analysis was done at 3 days interval and all the observations were recorded till the fruits were over ripe.

EXPERIMENTAL FINDINGS AND ANALYSIS

The percentage of marketable fruits was found significant during all days of storage except 3rd day (Table 1). Significantly maximum percentage of marketable fruits (97.16%) at 6th day was noted in ethrel 1000 ppm + neem extract 10 per cent (T_6), whereas, for 9th and 12th days, it was recorded in ethrel 1000 ppm (T_3) but was found at par with ethrel 750 ppm (T_2). The higher marketable fruits may be due to Ethrel which hastens ripening by increasing TSS, reducing acidity and the colour development was rich and texture was pleasing. The similar results were also obtained by Amrocho *et al.* (2000).

The percentage of loss in weight of fruit was increased with increase of storage period (Table 2). Significantly the lowest physiological loss of weight was recorded in carbendazim 1000 ppm (T_4) at 6th and 9th days, respectively and which was observed at par with ethrel 750 ppm (T_2) and ethrel 1000 ppm (T_3). The reduced weight loss might be due to antisenescent property of carbendazim and also binding the ethylene biosynthesis. The result is in conformity with those of Khader (1992) and Reddy and Haripriya (2002) in mango. The maximum weight loss was recorded in ethrel 1000 ppm + hot water treatment 52^0C ± for 5 minutes (T_7) followed by control. This has been due to activated enzymatic processes at higher temperature which enhanced the rate of various physiological and degradative processes. This result confirmed to the findings of Ashwini and Dhawan (1995).

Ripening increased with increase in storage period (Table

Table 1 : Effect of post harvest treatments on percentage of marketable fruit at 3rd, 6th, 9th and 12th days

Treats.	3rd day				6th day				9th day				12th day			
Years	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled
T_1	100.00	100.00	100.00	100.00	96.67	90.00	83.17	89.94	82.78	74.60	73.00	76.79	74.33	66.84	60.52	67.23
T_2	96.67	97.44	95.83	96.65	96.67	89.33	92.50	92.83	93.33	82.92	81.83	86.03	86.00	81.37	82.00	83.12
T_3	100.00	100.00	100.00	100.00	100.00	80.20	100.00	93.40	93.33	82.32	90.00	88.55	84.33	84.00	87.33	85.22
T_4	90.00	100.00	100.00	96.67	83.33	75.15	81.67	80.05	83.33	68.78	75.83	75.98	65.00	52.73	66.18	61.31
T_5	100.00	96.67	100.00	98.89	100.00	87.83	100.00	95.94	100.00	83.40	78.63	87.34	63.33	68.21	79.00	70.18
T_6	100.00	100.00	100.00	100.00	100.00	92.13	99.33	97.16	100.00	75.00	80.93	85.31	76.67	55.50	61.67	64.61
T_7	100.00	100.00	100.00	100.00	93.33	86.90	93.33	91.19	93.33	72.42	69.63	78.46	80.00	66.22	67.26	71.16
T_8	93.33	95.83	100.00	96.39	93.33	82.20	87.00	87.51	90.00	76.78	70.83	79.20	70.00	62.05	66.48	66.18
C.D. (P=0.05)	5.00	NS	NS	NS	7.90	3.74	5.62	5.83	6.15	5.96	3.58	10.04	2.89	2.30	1.79	13.55

NS=Non-significant

Table 2 : Effect of post harvest treatments on percentage of physiological loss of weight (%) at 3rd, 6th, 9th and 12th days

Treats.	3rd day				6th day				9th day				12th day			
Years	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled
T_1	4.11	4.97	5.27	4.78	6.31	8.85	11.32	8.83	10.53	12.37	13.75	12.22	17.07	15.61	19.94	17.54
T_2	2.50	3.89	4.86	3.75	5.04	6.86	6.56	6.15	8.23	8.22	8.26	8.24	11.05	12.88	15.76	13.23
T_3	2.95	6.22	4.00	4.39	9.04	7.47	6.79	7.77	13.33	10.52	10.76	11.54	13.71	19.71	12.12	15.18
T_4	3.56	3.77	4.94	4.09	4.52	3.87	5.02	4.47	7.23	7.43	5.35	6.67	12.94	12.69	12.79	12.81
T_5	4.95	3.22	4.44	4.20	8.08	4.61	6.18	6.29	12.58	7.57	10.65	10.27	12.63	12.64	10.33	11.87
T_6	3.16	4.49	5.56	4.40	6.72	9.12	8.97	8.27	16.41	9.41	14.40	13.41	16.99	16.33	21.34	18.22
T_7	2.62	6.84	5.07	4.84	6.01	7.95	10.58	8.18	8.68	8.28	10.64	9.20	21.78	27.46	24.96	24.73
T_8	3.05	4.11	5.34	4.17	7.06	10.70	10.06	9.27	9.43	11.28	13.88	11.53	17.34	18.24	19.56	18.38
C.D. (P=0.05)	0.29	0.29	0.61	NS	0.72	0.81	0.70	3.63	0.63	0.59	0.71	4.42	1.06	1.30	0.99	5.33

NS=Non-significant

Table 3 : Effect of post harvest treatments on percentage of ripened fruit (%) at 3rd, 6th, 9th and 12th days

Treats.	3rd day				6th day				9th day				12th day			
Years	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled
T_1	0.00	0.00	4.44	1.48	9.52	9.78	7.59	8.97	58.68	63.72	62.04	61.48	89.68	91.77	98.15	93.20
T_2	3.00	3.33	9.17	5.16	28.00	29.96	33.33	30.43	71.67	72.59	87.50	77.25	100.00	100.00	100.00	100.00
T_3	17.19	18.12	22.22	19.18	33.02	34.30	55.56	40.96	82.28	78.12	92.59	84.33	100.00	100.00	100.00	100.00
T_4	4.78	5.50	7.59	5.96	22.42	22.30	36.11	26.94	40.21	38.79	68.06	49.02	84.67	83.03	100.00	89.23
T_5	22.41	23.09	26.97	24.16	40.61	38.67	39.81	39.70	71.16	64.23	75.00	70.13	97.11	100.00	100.00	99.04
T_6	36.04	35.18	19.26	30.16	40.28	40.48	38.43	39.73	68.55	56.67	76.85	67.36	87.15	85.41	100.00	90.85
T_7	26.28	29.43	25.93	27.21	40.00	38.67	33.33	37.33	59.04	61.39	77.77	66.07	100.00	100.00	100.00	100.00
T_8	28.23	26.85	20.83	25.31	38.83	43.10	38.26	40.06	84.82	87.50	80.20	84.17	100.00	98.92	100.00	99.64
C.D. (P=0.05)	0.91	1.11	1.47	10.25	2.10	1.83	3.66	12.83	3.20	4.06	5.63	15.38	1.22	1.80	NS	9.02

NS=Non-significant

Table 4 : Effect of post harvest treatments on percentage of spoiled fruit (%) at 6th, 9th and 12th days

Treats.	6th day				9th day				12th day			
Years	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled
T_1	3.32	0.00	0.00	1.11	6.67	0.00	4.10	3.59	16.66	15.33	8.84	13.61
T_2	3.23	3.60	0.00	2.28	6.67	5.00	0.00	3.89	4.78	5.00	4.00	4.59
T_3	0.00	2.67	0.00	0.89	5.60	6.07	0.00	3.89	5.67	6.33	3.66	5.22
T_4	1.67	3.00	0.00	1.56	3.33	3.00	0.00	2.11	3.33	4.67	0.00	2.67
T_5	0.00	3.73	0.00	1.24	0.00	3.70	11.33	5.01	9.67	10.17	11.74	10.52
T_6	6.67	4.17	0.00	3.61	6.67	12.67	0.00	6.44	8.00	9.33	11.87	9.73
T_7	3.33	0.00	0.00	1.11	3.33	9.98	3.83	5.72	13.33	11.93	11.11	12.12
T_8	6.33	0.00	0.00	2.11	6.67	0.00	4.09	3.59	8.11	8.44	8.33	8.30
C.D. (P=0.05)	0.61	0.45	-	NS	0.74	0.670	0.394	NS	0.63	0.59	0.44	4.47

NS=Non-significant

Table 5 : Effect of post harvest treatments on percentage of acidity (%) at 3rd, 6th, 9th and 12th days

Treats.	3rd day				6th day				9th day				12th day			
Years	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled
T_1	0.85	0.86	0.88	0.86	0.80	0.86	0.76	0.81	0.56	0.65	0.64	0.62	0.49	0.46	0.48	0.48
T_2	0.91	0.92	0.81	0.88	0.82	0.85	0.84	0.83	0.50	0.61	0.61	0.57	0.40	0.43	0.42	0.41
T_3	0.87	0.82	0.76	0.82	0.83	0.72	0.72	0.76	0.52	0.54	0.54	0.53	0.41	0.38	0.39	0.39
T_4	0.80	0.79	0.85	0.81	0.73	0.78	0.79	0.77	0.57	0.60	0.59	0.59	0.43	0.44	0.43	0.43
T_5	0.75	0.76	0.73	0.75	0.69	0.73	0.66	0.69	0.49	0.55	0.50	0.51	0.39	0.41	0.38	0.39
T_6	0.90	0.93	0.85	0.89	0.80	0.85	0.83	0.83	0.58	0.56	0.60	0.58	0.44	0.46	0.46	0.45
T_7	0.83	0.85	0.86	0.85	0.77	0.85	0.84	0.82	0.58	0.57	0.58	0.58	0.56	0.47	0.43	0.49
T_8	0.89	0.88	0.83	0.86	0.83	0.88	0.81	0.84	0.56	0.57	0.56	0.56	0.48	0.48	0.49	0.48
C.D. (P=0.05)	0.02	0.03	0.02	0.08	0.03	0.03	0.02	0.08	0.02	0.02	0.02	0.06	0.02	0.02	0.01	0.06

NS=Non-significant

3). Ethrel 1000 ppm + neem extract 10 per cent (T_6) gave maximum ripened fruit (30.16%) at 3rd day of storage. Similarly highest ripened fruits (40.96, 84.33 and 100 %) were registered in ethrel 1000 ppm (T_3) at 6th, 9th and 12th days, respectively. However, it was found at par with ethrel 750 ppm (T_2). Similarly minimum percentage of ripened fruits was noted in control and carbendazim 1000 ppm. The result might be due to ethylene which changes colour of fruits is associated with the breakdown of chlorophyll, with stable carotenoid levels. Similar results were obtained by Mahajan and Dhatt (2003) in mango.

The per cent spoiled fruit was found non significant at 3rd, 6th and 9th days but it was found significant at 12th day (Table 4). Significantly lowest percentage of spoiled fruit (2.67 %) was recorded in carbendazim 1000 ppm (T_4) which was observed at par with treatment T_2 and T_3. While the highest percentage of spoiled fruit was (13.61) found in treatment T_1.

The reduction in spoilage fruit percentage by prolonging keeping quality. The antisenescent properties of carbendazim help in maintaining the fruits on fresh condition during storage.

For biochemical parameters, acidity was observed significant for all days (Table 5). Significantly lowest acidity and maximum reducing sugar (Table 6) were recorded in ethrel 1000 ppm + carbendazim 500 ppm (T_5) during all days of storage. Similarly for total sugar (Table 7), maximum (12.26, 12.74, 13.68 and 14.24%, respectively) were recorded in ethrel 1000 ppm + carbendazim 500 ppm + neem extract 5 per cent (T_8) for all days of storage, but noted at par with treatment T_3, T_5 and T_6 (Table 8). TSS was also observed significant for all days and significantly maximum TSS (17.94 and 20.63 B°, respectively) were noted in ethrel 1000 ppm + neem extract 10 per cent (T_6)

Table 6 : Effect of post harvest treatments on percentage of reducing sugar (%) at 3rd, 6th, 9th and 12th days

Treats.	3rd day				6th day				9th day				12th day			
Years	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled
T_1	2.02	2.13	2.48	2.21	2.09	2.15	2.14	2.13	3.06	2.91	2.95	2.97	3.46	3.53	4.06	3.69
T_2	1.98	2.17	2.10	2.08	2.09	2.20	2.19	2.16	3.11	2.72	2.89	2.91	3.43	3.50	4.00	3.64
T_3	2.02	2.28	2.23	2.18	2.10	2.35	2.44	2.30	3.39	3.33	3.57	3.43	4.43	4.23	4.37	4.34
T_4	2.03	2.11	1.97	2.04	2.11	2.36	2.26	2.24	3.59	2.96	3.03	3.19	3.67	3.07	4.04	3.59
T_5	2.03	2.47	2.37	2.29	2.06	2.48	2.61	2.38	3.29	3.08	3.21	3.20	4.28	4.43	4.50	4.40
T_6	2.04	2.07	1.90	2.00	2.11	2.13	2.13	2.12	3.46	2.82	2.81	3.03	3.96	3.91	3.87	3.91
T_7	2.04	2.20	2.17	2.14	2.12	2.34	2.24	2.23	3.53	2.81	2.88	3.07	3.80	3.96	4.26	4.01
T_8	2.05	1.97	2.00	2.01	2.08	2.50	2.37	2.31	3.21	3.12	3.03	3.12	4.07	4.13	4.15	4.12
C.D. (P=0.05)	NS	NS	NS	NS	NS	0.11	0.12	0.23	0.15	0.12	0.09	0.39	0.14	0.09	0.11	0.48

NS=Non-significant

Table 7 : Effect of post harvest treatments on percentage of total sugar (%) at 3rd, 6th, 9th and 12th days

Treats.	3rd day				6th day				9th day				12th day			
Years	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled
T_1	10.66	10.94	11.22	10.94	11.21	11.76	11.88	11.62	12.77	12.37	12.56	12.56	13.34	13.42	13.29	13.35
T_2	11.11	10.77	11.10	10.99	12.10	12.11	11.18	11.80	13.37	13.23	12.77	13.12	13.95	14.00	13.67	13.87
T_3	11.61	11.26	12.00	11.62	12.35	12.41	12.57	12.44	12.37	12.43	13.33	12.71	13.00	13.33	13.93	13.42
T_4	11.05	10.60	10.00	10.55	12.36	12.24	10.70	11.77	12.78	12.40	12.13	12.44	13.38	13.47	13.25	13.37
T_5	11.81	11.98	12.07	11.95	12.47	12.76	12.86	12.70	13.00	13.33	13.17	13.17	14.12	14.34	14.12	14.19
T_6	11.63	11.80	11.46	11.63	12.02	12.03	11.48	11.84	12.90	13.02	12.92	12.94	13.15	13.20	13.07	13.14
T_7	11.40	11.73	11.57	11.57	12.53	12.66	12.25	12.48	13.18	13.10	13.03	13.10	13.92	13.79	13.33	13.68
T_8	12.70	12.37	11.70	12.26	12.70	12.86	12.67	12.74	14.18	13.96	12.88	13.68	14.28	14.40	14.03	14.24
C.D. (P=0.05)	0.69	0.75	0.46	0.63	0.76	0.28	0.30	0.92	0.29	0.50	0.39	0.85	0.72	0.52	0.48	0.57

NS=Non-significant

Table 8 : Effect of post harvest treatments on percentage of TSS (B°) at 3rd, 6th, 9th and 12th days

Treats.	3rd day				6th day				9th day				12th day			
Years	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled	2007	2008	2009	Pooled
T_1	14.59	14.77	14.38	14.58	15.24	14.43	15.37	15.01	17.00	17.10	17.03	17.04	17.35	17.63	17.03	17.34
T_2	12.79	13.05	19.60	15.15	15.27	14.52	15.17	14.98	19.10	19.24	18.17	18.84	19.20	19.62	18.20	19.01
T_3	13.93	13.60	19.10	15.54	15.27	15.08	16.23	15.53	20.47	18.96	19.00	19.48	18.33	19.04	18.20	18.52
T_4	16.48	16.51	18.93	17.31	16.72	16.58	20.50	17.93	18.90	17.52	19.37	18.59	17.54	17.88	17.27	17.56
T_5	15.42	15.59	19.50	16.84	16.15	16.22	18.23	16.87	19.72	18.62	16.00	18.11	18.80	19.18	18.04	18.67
T_6	16.34	17.39	20.10	17.94	17.41	17.21	18.83	17.82	23.32	19.54	19.03	20.63	17.63	17.86	15.20	16.90
T_7	16.95	17.00	17.80	17.25	16.58	17.10	18.80	17.49	22.26	19.89	16.40	19.52	20.98	21.32	17.93	20.08
T_8	16.35	16.56	20.10	17.67	16.95	17.02	18.23	17.40	21.54	20.22	18.00	19.92	19.88	20.25	18.20	19.45
C.D. (P=0.05)	0.89	0.72	0.70	3.02	0.41	0.35	0.40	1.55	0.73	0.82	0.36	2.90	0.40	0.52	0.33	1.39

NS=Non-significant

Table 9 : Effect of post harvest treatments on fruit colour and pulp colour of mango fruit (Marks)

Treats.	Fruit colour (Marks)				Pulp colour (Marks)			
	2007	2008	2009	Pooled	2007	2008	2009	Pooled
T_1	7.36	7.13	5.67	6.72	7.22	6.82	7.00	7.01
T_2	7.44	6.87	6.27	6.86	6.39	6.40	6.39	6.39
T_3	6.52	6.60	6.91	6.68	6.39	6.38	6.50	6.42
T_4	7.00	6.55	6.29	6.61	6.96	7.03	6.87	6.95
T_5	7.53	7.80	7.53	7.62	7.28	7.28	7.46	7.34
T_6	7.08	6.51	6.25	6.61	7.08	7.08	6.67	6.94
T_7	7.52	7.03	7.17	7.24	7.08	7.06	6.52	6.89
T_8	6.55	6.79	6.33	6.56	6.75	6.75	6.83	6.78
C.D. (P=0.05)	0.51	0.21	0.14	0.86	0.24	0.15	0.18	0.38

Table 10 : Effect of post harvest treatments on aroma and taste of mango fruit (Marks)

Treats.	Aroma (Marks)				Taste (Marks)			
	2007	2008	2009	Pooled	2007	2008	2009	Pooled
T_1	6.28	7.00	5.93	6.40	6.55	6.53	6.50	6.53
T_2	6.39	5.93	6.32	6.21	7.00	6.86	7.28	7.04
T_3	6.58	6.33	7.03	6.65	6.86	6.93	7.47	7.09
T_4	6.86	6.32	5.66	6.28	6.94	6.87	6.50	6.77
T_5	6.44	7.27	6.93	6.88	5.92	7.07	6.63	6.54
T_6	5.69	6.33	6.60	6.21	6.64	6.22	6.04	6.30
T_7	7.42	6.58	6.93	6.98	6.64	7.18	6.95	6.92
T_8	6.50	6.54	6.50	6.51	5.89	6.41	6.58	6.29
C.D. (P=0.05)	0.55	0.40	0.26	NS	0.34	0.24	0.20	0.74

NS=Non-significant

during 3rd and 9th days of storage. In case of organolaptic characters, fruit colour, pulp colour and taste were found significant, whereas, aroma was found non significant. Significantly highest fruit and pulp color rank (7.62 and 7.34 marks, respectively) were registered in ethrel 1000 ppm + carbendazim 500 ppm (T_5). Similarly maximum rank of taste (7.09 mark) was noted in Ethrel 1000 ppm (T_3) (Table 9 and 10).

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