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Effect of ethrel on the ripening behaviour of mango (*Mangifera indica* L.) variety Dashehari

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Abstract
The present investigation entitled "Effect of ethrel on the ripening behaviour of mango (*Mangifera indica* L.) variety Dashehari" was executed in fruit science laboratory under Pt. K. L. S. College of Horticulture and Research Station, Rajnandgaon (C.G.) during the year 2021-2022. The Completely Randomized Design (CRD) was used for the experiment which included total 5 treatments *viz*., T0: Control (untreated), T1: @ 250ppm ethrel dip treatment, T2: @ 500ppm ethrel dip treatment, T3: @ 750ppm ethrel dip treatment, T4: @ 1000ppm ethrel dip treatment and replicated 4 times. The results revealed that treatment T4 (ethrel @ 1000ppm) was found best for physico-morphological and chemical parameters, while for the organoleptic evaluation treatment T3 (ethrel @ 750ppm) was found best.

Keywords: Mango, ripening, ethrel

Introduction
Mango (*Mangifera indica* L.) belongs to the Anacardiaceae family and it is the most significant tropical and sub-tropical fruits worldwide, especially in Asia. It has been originated from Indo-Burma, a region in South East Asia, in the foothills of the Himalayans (Mukherjee, 1951) [14]. Mango is the „King of fruits" because of its attractive colour, good taste, excellent flavor/aroma and nutritional content. It"s a delicacy for the table that gives millions of under-privileged people employment during summer (Doke, Dhemre and Kad, 2018) [6].
Dashehari fruits are small to medium sized fruits averaging 9 to 15cm in length and have an elongated, straight oval shape with blunt curved ends. The skin is semi thick, smooth, leathery and subtly waxy, ranging in color from light green to yellow, transforming into a golden yellow hue when ripe. Underneath the surface, the orange flesh is tender, succulent and almost entirely fibreless**,** encasing a moderately-sized stone. Dashehari mangoes are highly aromatic and bear a tropical, nect-like scent. The fruit"s flesh is very sweet and contains tropical, fruity and mildly tangy nuances. In India Dashehari mangoes are available in summer season. Ripening is a complex and irreversible physiological process by which fruit attains their desirable flavor, quality, colour, palatable nature and other textural properties. Ripening is associated with change in composition *i.e.* conversion of starch to sugar resulting into softening of tissue, colouring, sweetening and increase in its aroma compounds so that fruits become ready to eat. The rate of respiration and total amount of carotenoids in pulp are significantly increased by an increase in temperature. Ethylene production in fruit is also increased by increase ripening temperature up to 300C (Lalel, 2004) [11].
Now a day"s most climacteric fruits in India are ripened with industrial grade calcium carbide popularly known as, Masala" is used as in-discriminately for artificial ripening of mango. Calcium carbide usually contains traces of arsenic and phosphorus hydride which are extremely harmful for human health, and, thus, use of this chemical for ripening purpose is illegal in most countries (Hossain *et al.*, 2015) [9].
Artificial ripening of mango is relatively new concept in post harvest technology but it has great importance, particularly for mango export. Industrial ethylene-releasing substances such ethrel (2- Chloroethyl phosphonic acid, C7H6CIO3P) have been used successfully to ripen fruits like mango, banana, papaya and as well as for citrus de-greening in a regular manner.

Material and Methods

The present investigation was conducted in the year 2021-22 in the fruit science laboratory under Pt. K. L. S. College of Horticulture and Research Station Rajnandgaon (C.G.) during the year 2021- 2022. The experiment was laid out in Completely Randomized Design (CRD).

The fruits fully developed, uniform size, free from injuries and mature green but unripe mango were bought from Bharregaon farm, Rajnandgaon. Ethrel is available in liquid form and water soluble. To prepare 5 litres of stock solution, 10ml of ethrel was measured and dissolved under distilled water and made it up to 5 litres. Solution for various treatment *viz*., 250ppm, 500ppm, 750ppm and 1000ppm. Uniform size fruits were randomly selected for each treatment and fruits were dipped in the respective solution for 5 minutes and then dried for 30 minutes under fan. Fruits dipped in distilled water (5 minutes) were treated as control. Detailed observations were recorded at 4th, 8th and 12th days of storage.

Results and Discussion

Physico-morphological composition of fruits

1. **Physiological loss in weight (%):** The data regarding physiological loss in weight of mango is presented in Table 1 at 2nd, 4th, 6th, 8th, 10th and 12th days of ripening of mango fruits, significantly maximum physiological weight loss (3.36, 5.70, 9.45, 14.45, 15.73 and 18.86%) was recorded under the treatment T4 (1000ppm). However the minimum weight loss (1.23, 2.55, 3.46, 8.63, 11.73 and 13.95%) was recorded under treatment T0 (control). The increase in physiological loss in weight of ethrel treated fruits during ripening may be caused by an increase in physiological processes such as respiration, transpiration rate, which cause the fruits to ripen more quickly and uniformly than untreated ones. The similar results were also found by Kulkarni *et al*. (2004) [10] in mango Cv. Alphonso, Siddiqui and Dhua (2009) [20] in mango Cv. Himsagar, Singh *et al*. (2012) [21] in mango Cv. Amrapali, Mahajan *et al*. (2010) [12] in banana and Reyes and Paull (1995) [16] in guava.
2. **Pulp to peel ratio:** The data pertaining pulp to peel ratio of mango is presented in Table 2 at 4th, 8th and 12th day of ripening. The maximum pulp to peel ratio (2.78, 3.12 and 3.51) was noted under treatment T4 (ethrel 1000ppm), whereas minimum pulp to peel ratio (2.55, 2.66 and 2.86) was recorded under treatment T0 (control). The rise in pulp to peel ratio of mango may be the reason that the change in concentration of pulp and peel. Sugar synthesis is comparatively faster in pulp with respect to peel and thus change in osmotic pressure, the pulp is drained of water and the pulp to peel ratio increased according to (Shreshtha, 2010) [19]. These results were also found by Dalal *et al.* (1969) [3], Fernandes *et al*. (1979) [7], Tripathy *et al*. (1981) [24], and Sen *et al*. (1982) [18] in banana fruits.
3. **Shelf life (Days):** The data regarding shelf life of mango is presented Table 2. Significantly maximum shelf life of mango (12.65 days) was found under treatment T0 (control), while the minimum shelf life (6.24 days) was noticed under the treatment T4 (1000ppm). It might be because of faster rate of ripening in T4 as comparison to the other treatments. The maximum shelf life of 12 days was noted in T0 which is control where there was not treated with ethrel. In this treatment the slow rate of fruit ripening may have increased shelf life. The similar results were also found by Singh and Janes (2001) [22] and Baloch and Bibi (2012) [1] in mango, Gonge *et al.* (2014) [8], Sandeep *et al*. (2012) [17] in orange fruit.

Chemical composition of fruits

Total soluble solids (ºBrix): The data pertaining TSS of mango is presented in Table 3 at 4th, 8th and 12th of day of ripening. Significantly maximum TSS (18.34, 20.77 and 21.29ºB) was recorded under treatment T4 (ethrel 1000ppm), whereas minimum TSS (9.26, 12.46 and 15.63ºB) was noted under treatment T0 (control). Generally there was gradual rise in TSS (ºB) concentration may result from the conversion of carbohydrates into sugars, organic acids, and other soluble compounds are produced by metabolic process during ripening. The rapid losses of water from the fruits and the quicker conversion of starch into sugar may have caused the faster increase in TSS content. These findings are consistent with Das *et al*. (2011) [4] in the mango Cv. Alphonso, Chauhan *et al*. (2012) [2] in the orange fruit, Dhillon and Mahajan (2011) [5] in the pear fruit, Kulkarni *et al*. (2004) in the mango Cv. Neelum, Singh *et al*. (2012) in the mango Cv. Amrapali, and Mahajan *et al*. (2009) in bananas, Grand Naine.

Total sugars (%)

The data regarding total sugars of mango is presented in Table 4 at 4th, 8th and 12th of day of ripening. Significantly maximum total sugars (11.25, 16.84 and 18.79%) was recorded under treatment T4 (ethrel 1000ppm), whereas minimum total sugars (3.98, 7.52 and 13.25%) was noted under treatment T0 (control). The considerable rise in the amount of total sugars may be the results of the carbohydrates that accumulate through maturation in the form of starch breakdown into sugars as the fruit ripens. Similar findings were also reported by Singh *et al*. (2012) for mango Cv. Amrapali, Kulkarni *et al*. (2004) [10] for mango fruits Cv. Neelum, Tapre and Jain (2012) [23] for banana var. “Robusta”.

Reducing sugars (%)

The data regarding reducing sugars of mango is presented in Table 5 at 4th, 8th and 12th of day of ripening. Significantly maximum reducing sugars (4.56, 9.51 and 14.10%) was recorded under treatment T4 (ethrel 1000ppm), whereas minimum total sugars (1.23, 2.06 and 3.79%) was noted under treatment T0 (control). It might be caused by the hydrolysis of stored starch which releases sugars during fruit ripening. It was caused by the increased respiration rate and sugar content that resulted from the oxidation of carbohydrates. Dhillon and Mahajan (2011) [5] found similar results in pear fruits, Kulkarni *et al*. (2004) [10] in mango fruits Cv. Neelum, and Nair and Singh (2003) [15] in mango Cv. Kensington.

Organoleptic evaluation

The data pertaining organoleptic evaluation of mango is presented in Table 6. Significantly maximum mean score (8.02) was recorded under treatment T4 (ethrel 750ppm), whereas treatment T0 received the lowest mean score (6.49). The overall acceptability could be due to change in sugars content, increase in taste, flavour, colour and texture, among other things. Similar results were found by Kulkarni *et al*. (2004) [10] in mango Cv. Neelum, Nair and Singh (2003) [15] in mango Cv. Kensington, and Mahajan *et al*. (2010) [12] in banana Cv. Grand Nain

Table 1: Effect of ethrel on physiological loss in weight (%) of Dashehari mango

Notation	Treatment	Physiological loss in weight (%)					
		2nd day	4th day	6th day	8th day	10th day	12th day
T0	Control	1.23	2.55	3.46	8.63	11.73	13.95
T1	250ppm	2.29	5.17	7.44	12.51	14.87	16.82
T2	500ppm	2.45	5.38	8.52	13.18	14.94	17.95
T3	750ppm	2.47	5.49	9.18	14.32	15.65	18.69
T4	1000ppm	3.36	5.70	9.45	14.45	15.73	18.86
C.D. at 5%		0.122	0.265	0.365	0.495	0.856	0.911
S.E(m)		0.040	0.087	0.120	0.163	0.281	0.300
C.V. (%)		3.410	3.583	3.157	2.580	3.861	3.472

Table 2: Effect of ethrel on pulp to peel ratio and shelf life of Dashehari mango

Notation	Treatment	4th day	8th day	12th day	Shelf life (days)
T0	Control	2.55	2.66	2.86	12.65
T1	250ppm	2.60	2.73	2.99	10.81
T2	500ppm	2.68	2.88	3.24	8.71
T3	750ppm	2.71	3.02	3.38	7.52
T4	1000ppm	2.78	3.12	3.51	6.24
C.D. at 5%	NS	1.142	0.191	0.606	
S.E(m)	0.051	0.047	0.063	0.199	
C.V. (%)	3.842	3.248	3.921	4.338	

Table 3: Effect of ethrel on total soluble solids (ºBrix) of Dashehari mango

Notation	Treatment	TSS (ºBrix)		
		4th day	8th day	12th day
T0	Control	9.26	12.46	15.63
T1	250ppm	10.13	18.25	19.38
T2	500ppm	15.30	18.92	19.8
T3	750ppm	17.37	20.15	20.42
T4	1000ppm	18.34	20.77	21.29
C.D. at 5%		0.162	0.366	0.171
S.E(m)		0.053	0.120	0.056
C.V. (%)		0.757	1.328	0.582

Table 4: Effect of ethrel on total sugars (%) of Dashehari mango

Notation	Treatment	4th day	8th day	12th day
T0	Control	3.98	7.52	13.25
T1	250ppm	5.58	12.51	16.42
T2	500ppm	7.87	13.46	17.45
T3	750ppm	9.70	14.42	18.38
T4	1000ppm	11.25	16.84	18.79
C.D. at 5%		0.457	0.346	0.457
S.E(m)		0.150	0.114	0.150
C.V. (%)		3.916	1.759	1.783

Table 5: Effect of ethrel on reducing sugars (%) of Dashehari mango

Notation	Treatment	4th day	8th day	12th day
T0	Control	1.23	2.06	3.79
T1	250ppm	2.20	4.75	9.61
T2	500ppm	3.24	5.58	11.59
T3	750ppm	2.79	6.3	13.46
T4	1000ppm	4.56	9.51	14.10
C.D. at 5%		0.141	0.182	0.2
S.E(m)		0.046	0.060	0.066
C.V. (%)		3.299	2.126	1.302

Table 6: Effect of ethrel on organoleptic evaluation of Dashehari mango

Notation	Treatment	Organoleptic score				
		Colour	Flavour	Taste	Texture	Overall acceptability
T0	Control	6.52	6.61	6.35	6.48	6.49
T1	250ppm	7.11	7.14	7.32	7.23	7.20
T2	500ppm	7.46	7.52	7.63	7.47	7.52
T3	750ppm	8.24	8.11	8.11	7.62	8.02
T4	1000ppm	7.52	7.25	7.5	7.24	7.38
C.D. (5%)		0.506	0.48	0.45	0.443	0.253
S.E(m)		0.167	0.158	0.148	0.146	0.83
C.V. (%)		4.52	4.306	4.013	4.044	2.270

Conclusion

From above experiment entitled "Effect of Ethrel on the ripening behaviour of mango (*Mangifera indica* L.) Variety Dasheri." The following conclusion given below:

1. In the physical parameters treatment T4 showed the highest value of all the observations except weight of peel and shelf life that decreased with increase in ethrel concentrations.
2. In the chemical parameters treatment T4 showed the highest value.
3. The score for organoleptic test of mango fruit was highest in treatment T3 and least for treatment T0.

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