Biological Forum – An International Journal **14(4): 1232-1240(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Studies on different Stages of Maturity on Post Harvest quality of Mango (*Mangifera indica* L.) Cv. Chinnarasam and Navaneetham

S. Venkatesh[1]*, A. Kiran Kumar[2], A. Bhagwan[3] and S. Narender Reddy[4]

[1]Agriculture Officer, Administrative Office,
Sri Konda Laxman Telangana State Horticultural University, Mulugu (Telangana), India.
[2]Dean of Horticulture, Comptroller and Director of Extension, Administrative Office,
Sri Konda Laxman Telangana State Horticultural University, Mulugu (Telangana), India.
[3]Registrar, Administrative Office,
Sri Konda Laxman Telangana State Horticultural University, Mulugu (Telangana), India.
[4]Professor, Department of Plant Physiology, College of Agriculture, P.J.T.S.A.U, Hyderabad (Telangana), India.

(Corresponding author: S. Venkatesh)*
(Received 09 September 2022, Accepted 29 October, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The reduction in post-harvest losses, suitable harvesting stage of fruit (maturity) and optimum ripening conditions to have the best quality and longer shelf life has not been recognized in developing countries. This study was conducted to find the optimum stages of maturity and ripening conditions that ensure better quality for fresh consumption and long distance marketing. An experiment was carried out to investigate the studies on different stages of maturity (7-9°B TSS stage, and 9-11°B TSS stage) on ripening and post harvest quality of mango cv. Chinnarasam and Navaneetham. Fruits harvested at different stages of maturity (7-9°B TSS stage, and 9-11°B TSS stage) were assessed for physicochemical parameters such as physiological loss in weight (%), firmness(kg cm^{-2}), colour score for peel and juice, days taken to ripening, peel to pulp ratio, spoilage (%), and shelf life(days) and observations were recorded at an interval of 3 days at ambient temperature. Ethrel treated fruits showed early and uniform ripening thereby enhancing the quality. Mango fruits harvested at 9-11°B TSS stage recorded better physio-chemical parameters and organoleptic score with good flavor, texture and overall acceptability. From the experiment it was concluded that the mango fruits cv Chinnarasam and Navaneetham harvested at 9-11°B TSS stage were significant and superior in post-harvest quality.

Keywords: Post harvest quality, mango and shelf life.

INTRODUCTION

Mango (*Mangifera indica* L.) is considered as one of the choicest fruits of the world because of its attractive colour, delicious taste and excellent nutritional value. Immature harvesting is one of the major causes of postharvest losses in mango. The fruits harvested before the optimum stage of maturity reported significantly lower TSS, higher titrable acidity and poor sensory properties (Amarakoon *et al*., 1999), while the fruits harvested at ripe stage will have a shorter shelf life. Papaya cv. 'Golden' fruits harvested at optimum stage (16-25% of yellow skin) had superior scores for sensorial evaluation mainly for flavor and appearance (Bron and Jacomino 2006). Hence, right maturity at harvest is important for eating quality and shelf life of mango. As mango is a climacteric fruit, important biochemical changes occur during the process of ripening. Ethylene is a naturally occurring plant growth substance that has numerous effects on ripening and storage life of fruits (Barry and Giovannoni 2007). Non-uniformity and delayed ripening have been identified as the major constraints of natural ripening of mangoes (Amarakoon *et al*., 1999). Now a daysto meet the market demand mango traders use calcium carbide for ripening. As per Prevention of Food Adulteration Act (section 44AA), use of carbide is strictly banned as it contains impurities of arsenic and phosphorus hydride, which aretoxic to human health (Das *et al*., 2011). Hence, ethrel/ethylene gas has been found to be safest and ideal chemical for uniform ripening of fruits on commercial basis. Juicy varieties (sucking mangoes) of mango, with differing skin colour, stone size, sweetness and composition are available in the Indian market. Local juicy varieties include 'Peddarasam', 'Chinnarasam', 'Cherukurasam, 'Panchadarakalasa and these juicy varieties are popularly known as 'rasaalu'. 'Chinnarasam' is a major commercial pickle cultivar early stages and juicy variety in the later stages in Telangana State. The interest in fruit crops has increased due to increase in exports and income potential. Especially mangoes are in increasing commercial importance all over the world. Navaneetham fruits are sucking type characterized by juicy and soft flesh with attractive shape, with average fruit weight of 350 to 400 grams, is highly priced and popular juicy cultivar in the state. Most of its fresh

fruits are locally consumed, marketed in hotels and super markets; only very small scale is exported to north India. Fruits have demand all over India and have great export potential. Hence, post harvest management of mangoes is important in conservation and maintenance of quality of this fruit. The study is aimed at determining the post-harvest quality attributes of mango cultivars Chinnarasam and Navaneetham with the objectives to standardize the maturity stage of harvest for best quality of mango cultivars Chinnarasam and Navaneetham, on postharvest quality and shelf life.

MATERIALS AND METHODS

The present investigation was carried outduring 2015-16 at Fruit Research Station, Sangareddy, Medak, Telangana state. The experiment was planned under completely randomized block design (CRD) with factorial concept replicated thrice with twenty treatments. Mango (*Mangifera indica* L.) cv. Chinnarasam and Navaneetham fruits with uniform size were selected at harvest maturity stage of 7-9^{o}B TSS, 9-11^{o}B TSS and were treated with four different concentrations of ethrel *i.e*., 250, 500, 750, 1000 ppm and control (water), uniform fruits were selected and kept in air tight container. The fruits were kept for ripening for 24 hrs. Later the fruits removed from the container and kept under ambient conditions and samples were taken for analysis at an interval of 3 days and all the observations were recorded like TSS(^{0}B), color score for peel and juice, days taken to ripening, peel to pulp ratio, pulp to peel ratio, spoilage (%), shelf life (days), firmness (Kg cm^{-2}), PWL(%), total sugars(%), reducing sugars (%), Non reducing sugars (%),Vit C (mg/100g), acidity (%), Brix to Acid ratio(%), juice recovery, organoleptic score at three days interval by adopting respective traditional destructive methods.

RESULTS AND DISCUSSION

Mango cv. Chinnarasam and Navaneetham fruits showed early ripening with different concentrations of ethrel compared to control fruits. Ripening was faster in fruits harvested at second mature stage and then harvested at less mature stage. In the present investigation, mango fruits harvested at 9-11^{o}B TSS stage showed significantly higher weight loss compared to the fruits harvested at early stages of maturity. This is due to higher rates of respiration and transpiration with the advancement of ripening. The results of the experiment were briefly summarized below.

Physiological loss of weight (%): Among the fruits harvested at different maturity stages, an increasing trend in physiological weight loss with the advancement of maturity was noticed. The Mangoes harvested at 9-11^{0}B TSS indicated significantly high physiological weight loss of 5.84% on 6th day, and non-significant on 3rd, 9th and 12th day (Table 1). The current study demonstrates that higher weight loss in fruits harvested at the later stage of maturity (9-11°B TSS) could be due to higher rate of respiration and transpiration with the advancement of harvest maturity. Similar results were observed by Dick *et al*. (2009) in mango cultivar Kent; Lalel *et al*. (2002) in mango and Gupta and Jawandha (2010) in peach fruits cv. 'Earli Grande' (harvested at optimum stage of maturity).

Firmness (Kg cm^{2}): Among the fruits harvested at different maturity stages, decreasing trend in firmness with the advancement of maturity was noticed. The Mangoes at 9-11◦B indicated significantly lowest firmness of 1.30 kg cm^{-2} on 12th day followed by 3.13 kg cm^{-2} on 6th day, 5.01 kg cm^{-2} on 3rd day, and 13.19 kg cm^{-2} on '0' day, while the data on 9th day was non-significant (Table 2). Statistically, mangoes harvested at 7-9◦B TSS maturity stages are at par in respect of firmness loss. The current study demonstrates that higher loss in firmness of fruits harvested at the later stage of maturity (9-11°B TSS) could be due to changes in the amount of pectin materials cementing the cell walls and the hydrolysis of starch, hemicelluloses in the fruit. Further the firmness indicates the progression of ripening in climacteric fruits. A similar reduction in firmness of fruits with delay in harvest date has also been reported by Jha *et al*. (2013); Ornelas-Paz *et al*. (2018).

Peel colour score: The maturity stages differed significantly in respect of colour score. TSS 9-11◦B indicated significantly high colour score of 1.20% on 6th day, followed by TSS 7-9°B of 1.00% 6th day. On 9th day and 12th day the colour score was non significant (Table 3). The delay in yellow colour development in fruits harvested at early stage of maturity could be due to the enzymes related to ripening have not been fully synthesized or even inactivated. (Dang *et al.,* 2008); (Lalel *et al.,* 2002) in mango also pointed out that fruits at 100 per cent maturity exhibited colour change faster than fruits of lower maturity. Similar result was reported in mango (Varaprasad, 2013).

Pulp colour score: The maturity stages differed significantly in respect of pulp colour score. 7-9^{0} B indicated significantly high pulpcolour score of 2.30% on6thday and rest were non significant (Table 4).

Days taken to ripening (days): The maturity stages differed significantly with respect to days for ripening score. TSS 7-9◦B recorded 3.63days for ripening followed by TSS 9-11◦B 3.39 days respectively. The delay in ripening in fruits harvested at early stage of maturity could be due to the enzymes related to ripening have not been fully synthesized (Table 5). Dang *et al*. (2008); Lalel *et al*. (2002) in mango also pointed out that fruits at 100 per cent maturity exhibited ripening faster than fruits of lower maturity. Similar result was also reported by Varaprasad (2013) in Mango.

Peel to pulp ratio (%): Among the two cultivars maturity stages were non significant. The increase of pulp is an obvious sign of fruit ripening in mango cultivars (Table 6). During fruit ripening, chlorophyll concentration decreased substantially**,** while carotenoids concentration increased (Medlicott *et al.,* 1990). Among the two cultivars and maturity stages results were non significant.

Pulp to peel ratio (%): The maturity stages differed significantly with respect of pulp to peel score on 6th day as 1.77 at maturity stage 7-9°Brix, followed by 1.57 at maturity stage 9-11°Brix (Table 7). The delay in yellow colour development in fruits harvested at early

stage of maturity could be due to the enzymes related to ripening have not been fully synthesized or even inactivated. (Dang *et al*., 2008), (Lalel *et al*., 2002) in mango aalso pointed out that fruits at 100 per cent maturity exhibited colour change faster than fruits of lower maturity. Similar result was reported by Varaprasad (2013) in Mango.

Spoilage (%): Maturity stages differed significantly in respect of spoilage. The spoilage loss was significantly high in fruits harvested at 9-11°B TSS due to high susceptibility to fruit rots, on 9th day (17.13%), and 12th day (26.90%), followed by 7-9◦B maturity stage respectively (Table 8). This might have occurred due to increased respiration rate, enzyme activities and dissolution of cell wall which ultimately lead to early softening and over-ripening of fruits. This trend of increased spoilage with increased ripeness is similar to that reported by Gupta and Jawandha (2010) for peaches. Similar result was reported by Varaprasad (2013) in mango.

Shelf life (Days): Mango cultivars harvested at 7-9°B TSS recorded highest shelf life (8.53days) followed by 9-11◦B TSS (8.39 days). This might have occurred due to increased respiration rate, enzyme activities and dissolution of cell wall which ultimately led to early softening and over-ripening of fruits (Table 9).

TSS (^{o}BRIX): Mango fruits harvested at 9-11^{o}B TSS stage showed significantly higher TSS on '0' day (9.78), 3rd day (15.54), 6th day (17.34), 9th day (19.44) and on 12th day (20.23), followed by 7-9^{o}B TSS stage (Table 10). This could be due to the activation of hydrolytic enzymes which aid in conversion of starch, hemicelluloses and organic acids into various forms of sugars during the climacteric peak in the fruits followed by subsequent decline in sugars due to the metabolic break down as a result of respiratory process. The increase in TSS was the outcome of conversion of carbohydrates into simple sugars through a complex mechanism during the storage and the conversion rate was increased with the increase in temperature. This conversion is also considered to be one of the important indexes of ripening process in mango and other climacteric fruit (Doreyappy-Gowda and Huddar 2001; Kays, 1991; Kittur *et al*., 2001).

Titrable Acidity (%): It is evident from the data that as maturity progressed, acidity decreased progressively at ambient conditions. Mangocultivars at 7-9°B indicated highest acidity on '0' day (1.40%), 6th day (0.61%), 9th day (0.52%), and 12th day (0.44%). Followed by 9-11^{o}B TSS with acidity on '0' day (1.24%), 6th day (0.51%), 9th day (0.48%), and 12th day (0.39%) (Table 11). Organic acids are important for respiratory activity and as flavor constituents. During maturation and ripening, mango fruit experience a substantial loss of organic acids (Medlicott and Thompson 1985). This could be attributed to the conversion of acids into sugars (Pool *et al.*, 1972) and utilization of organic acids during respiration (Singh and Wahid Ali, 1996; Srivastava *et al.*, 1971). The decrease in acidity was attributed towards the conversion of citric acid into sugars and their further utilization in metabolic process of the fruit (Doreyappy-Gowda and Huddar 2001; Mizrach *et al*., 1997; Rathore *et al*., 2007; Srinivasa *et al*., 2002). These results correspond with the observations of Gill *et al*. (2015) who reported constant decrease in acidity of mango fruits during ripening.

Ascorbic acid (mg/100 g): It is evident from the data that as the maturity advanced, Mangoes showed a decreasing trend in respect of vitamin 'C'. Mangoes at 9-11°B maturity showed lowest vitamin 'C' as on '0' day (37.84 mg 100g^{-1}), 3rd day (33.45 mg 100g^{-1}), 6th day (29.12 mg 100g^{-1}), 9th day (25.46 mg 100g^{-1}), and 12th day (23.79 mg 100g^{-1}) (Table 12). Singh *et al*. (2012) in mango, Madhavi *et al*. (2005) in sapota also reported similar results, which were in confirmation with the present findings. Similar trend was also reported by Varaprasad (2013) in mango. This trend was due to conversion of acid into sugars and their further utilization in metabolic process of the fruit and that the chemical and biological process was increased with the increase in storage temperature (Doreyappy-Gowda and Huddar, 2001; Mizrach *et al*., 1997; Rathore *et al*., 2007; Srinivasa *et al.*, 2002).

Reducing sugars (%): As seen from the data, it is evident that mango fruits showed an increasing trend with the advancement of maturity in respect of reducing sugars. Mangoes harvested at 7-9°B TSS showed significantly low reducing sugars on '0' day 3.19%, 9th day 5.66%, whereas on 3rd day, 6th day and 12th day are non significant (Table 13). These results are in agreement with the report of Carrillo *et al.* (2000) elucidated that reducing sugar was increased during storage Similar increasing trend of reducing sugars during storage was also reported by Varaprasad (2013)in mango.

Non reducing sugars (%): Mangoes showed an increasing trend with the advancement of maturity in respect of non-reducing sugars. Mangoes harvested at 7-9°B TSS showed low reducing sugars on 3rd day (3.34%), 6th day (5.72%), 9th day (4.31%), and on 12th day (3.03%) (Table 14). Similar increasing trend of nonreducing sugars was recorded in mango this trend may be attributed to the increased activity of amylase.

Total sugars (%): Maturity stages significantly differ in respect of Total sugars. Mango fruits harvested at 9-11^{0}B TSS stage showed significantly higher total sugars on '0' day 5.57%, 3rd day 7.67%, 6th day 11.01%, 9th day 10.73%, and 12th day 9.27%, followed by 7-9°B TSS respectively (Table 15). This could be due to the activation of hydrolytic enzymes which aid in conversion of starch, hemicelluloses and organic acids into various forms of sugars during the climacteric peak in the fruits harvested at later stages of maturity. The subsequent decline in sugars was owed to the metabolic breakdown. Similar result is also reported by Varaprasad (2013) in mango. The plausible explanation for such trend is that the polysaccharides were converted into soluble sugar through hydrolytic conversion process, which was sensitive to temperature and/or to sunlight exposure for climacteric fruits during the ripening process (Campestre *et al*., 2002; Kays, 1991; Martinez *et al*., 1997).

Brix/Acid Ratio (%): Mangoes exhibited an increasing trend as the maturity advanced in respect of Brix/Acid Ratio. Mangoes harvested at 9-11°B showed significantly high Brix/Acid Ratio as on '0' day 7.99%,

3rd day 15.50%, 6th day 33.38%, 9th day 43.87%, and 12th day 59.55% (Table 16). The reason attributed to this increasing trend may be due to increase in formation sugars and break down of organic acids as the ripening advanced.

Juice recovery: Mango fruits harvested at 9-11°B TSS showed significantly higher TSS on 3rd day (37.58%), 9th day (52.63%), and 12th day (59.77%) (Table 17). This could be due to the activation of hydrolytic enzymes which aid in conversion of starch, hemicelluloses and organic acids into various forms of sugars during the climacteric peak in the fruits followed by subsequent decline in sugars due to the metabolic breakdown as a result of respiratory process.

Organoleptic score (%): Sensory scores for fruit appearance and colour, flavour and taste increased until ripe stage *i.e*., 6th day of storage with fruits harvested at 9-11°B TSS tend to decline till the end of storage. The extended shelf life and delay in the climacteric of fruits harvested at 9-11°B TSS stage might be the reason for obtaining highest scores during the later stages of storage (Table 18). Visual appearance or look of the fruit is important from the view point of acceptance by the consumer. The fruit appearance and colour improved during ripening. On the other hand, fruit texture gradually decreased with all the four stages of maturity during ripening. Brito and Narain (2002) also reported similar decrease in sapota fruit texture during maturation and ripening.

Table 1: Physiological loss in weight (%) of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stages at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 3	Chinnarasam	3.55	3.75	3.65	Cultivars(A)	0.14	0.04
	Navaneetham	4.06	3.67	3.87	Maturity stages(B)	N.S	0.04
	Mean	3.81	3.71		(A)×(B)	0.20	0.07
Day 6	Chinnarasam	5.26	5.71	5.48	Cultivars(A)	N.S	0.16
	Navaneetham	5.43	5.97	5.70	Maturity stages(B)	0.47	0.16
	Mean	5.34	5.84		(A)×(B)	0.67	0.23
Day 9	Chinnarasam	6.15	6.50	6.32	Cultivars(A)	N.S	0.31
	Navaneetham	7.37	6.50	6.93	Maturity stages(B)	N.S	0.31
	Mean	6.76	6.50		(A)×(B)	1.26	0.44
Day 12	Chinnarasam	9.45	10.22	9.83	Cultivars(A)	0.72	0.25
	Navaneetham	10.65	10.52	10.58	Maturity stages(B)	N.S	0.25
	Mean	10.05	10.37		(A)×(B)	1.02	0.35

Table 2: Firmness (kg cm^{-2}) of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stages at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 0	Chinnarasam	14.88	13.27	14.07	Cultivars(A)	N.S	0.14
	Navaneetham	14.44	13.12	13.78	Maturity stages(B)	0.40	0.14
	Mean	14.66	13.19		(A) × (B)	0.56	0.19
Day 3	Chinnarasam	5.38	4.53	4.96	Cultivars(A)	0.23	0.08
	Navaneetham	6.31	5.49	5.90	Maturity stages(B)	0.23	0.08
	Mean	5.85	5.01		(A) × (B)	0.33	0.11
Day 6	Chinnarasam	3.72	3.43	3.58	Cultivars(A)	0.18	0.06
	Navaneetham	2.98	2.82	2.90	Maturity stages(B)	0.18	0.06
	Mean	3.35	3.13		(A) × (B)	0.25	0.08
Day 9	Chinnarasam	2.22	2.22	2.22	Cultivars(A)	0.13	0.04
	Navaneetham	2.04	2.09	2.06	Maturity stages(B)	N.S	0.04
	Mean	2.13	2.15		(A) × (B)	0.19	0.06
Day 12	Chinnarasam	1.26	1.24	1.25	Cultivars(A)	N.S	0.02
	Navaneetham	1.18	1.36	1.27	Maturity stages(B)	0.07	0.02
	Mean	1.22	1.30		(A) × (B)	0.11	0.03

Table 3: Peal color score (%) of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stages at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 6	Chinnarasam	1.00	1.20	1.10	Cultivars(A)	N.S	0.05
	Navaneetham	1.00	1.20	1.10	Maturity stages(B)	0.16	0.05
	Mean	1.00	1.20		(A) × (B)	0.23	0.08
Day 9	Chinnarasam	1.00	1.20	1.10	Cultivars(A)	0.20	0.07
	Navaneetham	1.46	1.20	1.33	Maturity stages(B)	N.S	0.07
	Mean	1.23	1.20		(A) × (B)	0.28	0.10
Day 12	Chinnarasam	1.60	1.40	1.50	Cultivars(A)	N.S	0.09
	Navaneetham	1.53	1.40	1.47	Maturity stages(B)	N.S	0.09
	Mean	1.57	1.40		(A) × (B)	0.38	0.13

Table 4: Pulp color score (%) of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stages at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 3	Chinnarasam	1.66	1.80	1.73	Cultivars(A)	N.S	0.09
	Navaneetham	1.46	1.66	1.56	Maturity stages(B)	N.S	0.09
	Mean	1.56	1.73		(A)×(B)	0.38	0.13
Day 6	Chinnarasam	2.33	2.73	2.53	Cultivars(A)	N.S	0.10
	Navaneetham	2.26	2.46	2.36	Maturity stages(B)	0.29	0.10
	Mean	2.30	2.60		(A)×(B)	0.41	0.14
Day 9	Chinnarasam	3.13	3.20	3.16	Cultivars(A)	N.S	0.12
	Navaneetham	3.33	3.13	3.23	Maturity stages(B)	N.S	0.12
	Mean	3.23	3.16		(A)×(B)	0.49	0.17
Day 12	Chinnarasam	4.00	4.06	4.03	Cultivars(A)	N.S	0.12
	Navaneetham	4.26	4.06	4.16	Maturity stages(B)	N.S	0.12
	Mean	4.13	4.06		(A)×(B)	0.48	0.16

Table 5: Days taken to ripening of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stages at ambient temperature.

Treatments	7-9°B TSS	9-11^{0}B TSS	Mean	Factors	CD (5%)	SE (m) ±
Chinnarasam	3.93	3.53	3.73	Cultivars(A)	0.23	0.08
Navaneetham	3.33	3.26	3.29	Maturity stages(B)	N.S	0.08
Mean	3.63	3.39		(A)×(B)	0.33	0.11

Table 6: Peal to pulp ratio of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stages at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 0	Chinnarasam	0.35	0.42	0.39	Cultivars(A)	N.S	0.01
	Navaneetham	0.42	0.40	0.41	Maturity stages(B)	N.S	0.01
	Mean	0.39	0.41		(A)×(B)	0.04	0.01
Day 3	Chinnarasam	0.42	0.44	0.43	Cultivars(A)	N.S	0.01
	Navaneetham	0.40	0.41	0.41	Maturity stages(B)	N.S	0.01
	Mean	0.41	0.43		(A)×(B)	0.05	0.01
Day 6	Chinnarasam	0.44	0.49	0.47	Cultivars(A)	N.S	0.78
	Navaneetham	2.68	0.43	1.56	Maturity stages(B)	N.S	0.78
	Mean	1.56	0.46		(A)×(B)	3.18	1.11
Day 9	Chinnarasam	0.51	0.47	0.49	Cultivars(A)	N.S	0.01
	Navaneetham	0.55	0.52	0.54	Maturity stages(B)	N.S	0.01
	Mean	0.53	0.50		(A)×(B)	0.07	0.02
Day 12	Chinnarasam	0.54	0.55	0.55	Cultivars(A)	N.S	0.01
	Navaneetham	0.59	0.53	0.56	Maturity stages(B)	N.S	0.01
	Mean	0.57	0.54		(A)×(B)	0.07	0.02

Table 7: Pulp to peel ratio of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stages at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 0	Chinnarasam	2.31	2.26	2.29	Cultivars(A)	N.S	0.04
	Navaneetham	2.35	2.38	2.36	Maturity stages(B)	N.S	0.04
	Mean	2.33	2.32		(A)×(B)	0.17	0.06
Day 3	Chinnarasam	2.25	2.33	2.29	Cultivars(A)	N.S	0.03
	Navaneetham	2.31	2.31	2.31	Maturity stages(B)	N.S	0.03
	Mean	2.28	2.32		(A)×(B)	0.16	0.05
Day 6	Chinnarasam	1.79	1.72	1.76	Cultivars(A)	0.11	0.03
	Navaneetham	1.74	1.42	1.58	Maturity stages(B)	0.11	0.03
	Mean	1.77	1.57		(A)×(B)	0.15	0.05
Day 9	Chinnarasam	1.46	1.52	1.49	Cultivars(A)	N.S	0.04
	Navaneetham	1.49	1.32	1.40	Maturity stages(B)	N.S	0.04
	Mean	1.48	1.42		(A)×(B)	0.19	0.06
Day 12	Chinnarasam	1.43	1.50	1.47	Cultivars(A)	N.S	0.04
	Navaneetham	1.52	1.45	1.49	Maturity stages(B)	N.S	0.04
	Mean	1.48	1.48		(A)×(B)	0.17	0.06

Table 8: Spoilage (%) of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stages at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 6	Chinnarasam	12.46	12.4	12.43	Cultivars(A)	N.S	0.22
	Navaneetham	12.26	12.13	12.19	Maturity stages(B)	N.S	0.22
	Mean	12.36	12.26		(A)×(B)	0.91	0.31
Day 9	Chinnarasam	16.53	17.06	16.79	Cultivars(A)	0.61	0.21
	Navaneetham	19.13	17.20	18.16	Maturity stages(B)	0.61	0.21
	Mean	17.83	17.13		(A)×(B)	0.86	0.30
Day 12	Chinnarasam	26.46	26.60	26.53	Cultivars(A)	N.S	0.26
	Navaneetham	26.53	27.20	26.86	Maturity stages(B)	N.S	0.26
	Mean	26.49	26.90		(A)×(B)	1.05	0.36

Table 9: Shelf life (Days) of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stages at ambient temperature.

Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Chinnarasam	8.93	8.53	8.73	Cultivars(A)	0.28	0.10
Navaneetham	8.13	8.26	8.19	Maturity stages(B)	0.28	0.10
Mean	8.53	8.39		(A)×(B)	0.40	0.14

Table 10: TSS (^{o}B) of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stage at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 0	Chinnarasam	8.05	9.73	8.89	Cultivars(A)	0.09	0.03
	Navaneetham	8.14	9.83	8.99	Maturity stages(B)	0.09	0.03
	Mean	8.10	9.78		(A)×(B)	0.13	0.04
Day 3	Chinnarasam	13.87	14.83	14.35	Cultivars(A)	0.11	0.04
	Navaneetham	15.19	16.25	15.72	Maturity stages(B)	0.11	0.04
	Mean	14.53	15.54		(A)×(B)	0.16	0.05
Day 6	Chinnarasam	15.15	16.49	15.82	Cultivars(A)	0.09	0.03
	Navaneetham	17.19	18.19	17.69	Maturity stages(B)	0.09	0.03
	Mean	16.17	17.34		(A)×(B)	0.08	0.02
Day 9	Chinnarasam	17.34	18.44	17.89	Cultivars(A)	0.12	0.04
	Navaneetham	19.65	20.44	20.05	Maturity stages(B)	0.12	0.04
	Mean	18.50	19.44		(A)×(B)	0.08	0.02
Day 12	Chinnarasam	18.10	19.09	18.60	Cultivars(A)	0.15	0.05
	Navaneetham	20.56	21.37	20.97	Maturity stages(B)	0.15	0.05
	Mean	19.33	20.23		(A)×(B)	0.12	0.04

Table 11: Titrable acidity (%) of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stage at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 0	Chinnarasam	1.22	1.15	1.18	Cultivars(A)	0.06	0.02
	Navaneetham	1.58	1.33	1.45	Maturity stages(B)	0.06	0.02
	Mean	1.40	1.24		(A)×(B)	0.40	0.14
Day 3	Chinnarasam	0.80	0.84	0.82	Cultivars(A)	N.S	0.01
	Navaneetham	0.86	0.82	0.84	Maturity stages(B)	N.S	0.01
	Mean	0.83	0.83		(A)×(B)	0.05	0.01
Day 6	Chinnarasam	0.69	0.53	0.61	Cultivars(A)	0.02	0.00
	Navaneetham	0.52	0.49	0.51	Maturity stages(B)	0.02	0.00
	Mean	0.61	0.51		(A)×(B)	0.02	0.00
Day 9	Chinnarasam	0.55	0.54	0.55	Cultivars(A)	0.03	0.01
	Navaneetham	0.48	0.41	0.45	Maturity stages(B)	0.03	0.01
	Mean	0.52	0.48		(A)×(B)	0.04	0.01
Day 12	Chinnarasam	0.46	0.34	0.40	Cultivars(A)	0.02	0.00
	Navaneetham	0.41	0.44	0.43	Maturity stages(B)	0.02	0.00
	Mean	0.44	0.39		(A)×(B)	0.02	0.00

Table 12: Ascorbic acid (mg/100g) of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stage at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 0	Chinnarasam	37.98	37.51	37.75	Cultivars(A)	0.08	0.03
	Navaneetham	36.98	38.17	37.58	Maturity stages(B)	0.08	0.03
	Mean	37.48	37.84		(A)×(B)	0.12	0.04
Day 3	Chinnarasam	35.09	34.26	34.68	Cultivars(A)	0.11	0.03
	Navaneetham	32.72	32.63	32.68	Maturity stages(B)	0.11	0.03
	Mean	33.91	33.45		(A)×(B)	0.16	0.05
Day 6	Chinnarasam	30.93	30.36	30.65	Cultivars(A)	0.17	0.06
	Navaneetham	28.64	27.87	28.26	Maturity stages(B)	0.17	0.06
	Mean	29.79	29.12		(A)×(B)	0.08	0.25
Day 9	Chinnarasam	27.14	26.14	26.64	Cultivars(A)	0.93	0.32
	Navaneetham	26.14	24.77	25.46	Maturity stages(B)	0.93	0.32
	Mean	26.64	25.46		(A)×(B)	1.32	0.46
Day 12	Chinnarasam	25.29	24.23	24.76	Cultivars(A)	0.37	0.13
	Navaneetham	23.55	23.34	23.45	Maturity stages(B)	0.37	0.13
	Mean	24.42	23.79		(A)×(B)	0.53	0.18

Table 13: Reducing sugars (%) of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stage at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 0	Chinnarasam	3.13	3.15	3.14	Cultivars(A)	0.05	0.02
	Navaneetham	3.24	3.46	3.35	Maturity stages(B)	0.05	0.02
	Mean	3.19	3.31		(A)×(B)	0.08	0.02
Day 3	Chinnarasam	3.78	3.86	3.82	Cultivars(A)	N.S	0.02
	Navaneetham	3.84	3.74	3.79	Maturity stages(B)	N.S	0.02
	Mean	3.81	3.80		(A)×(B)	0.08	0.02
Day 6	Chinnarasam	4.74	4.48	4.61	Cultivars(A)	0.09	0.03
	Navaneetham	5.19	5.45	5.32	Maturity stages(B)	N.S	0.03
	Mean	4.97	4.97		(A)×(B)	0.12	0.04
Day 9	Chinnarasam	5.34	5.87	5.61	Cultivars(A)	0.05	0.02
	Navaneetham	5.97	6.26	6.12	Maturity stages(B)	0.05	0.02
	Mean	5.66	6.07		(A)×(B)	0.08	0.02
Day 12	Chinnarasam	5.99	6.05	6.02	Cultivars(A)	N.S	0.02
	Navaneetham	6.09	6.04	6.07	Maturity stages(B)	N.S	0.02
	Mean	6.04	6.04		(A)×(B)	0.11	0.03

Table 14: Non-reducing sugars (%) of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stage at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 0	Chinnarasam	2.06	2.32	2.20	Cultivars(A)	N.S	0.04
	Navaneetham	2.26	2.19	2.23	Maturity stages(B)	N.S	0.04
	Mean	2.16	2.26		(A)×(B)	0.16	0.05
Day 3	Chinnarasam	3.01	3.43	3.22	Cultivars(A)	0.11	0.04
	Navaneetham	3.67	4.30	3.99	Maturity stages(B)	0.11	0.04
	Mean	3.34	3.87		(A)×(B)	0.16	0.05
Day 6	Chinnarasam	5.71	6.35	6.03	Cultivars(A)	0.16	0.05
	Navaneetham	5.72	5.73	5.73	Maturity stages(B)	0.16	0.05
	Mean	5.72	6.04		(A)×(B)	0.23	0.08
Day 9	Chinnarasam	4.14	4.57	4.36	Cultivars(A)	0.10	0.03
	Navaneetham	4.47	4.74	4.61	Maturity stages(B)	0.10	0.03
	Mean	4.31	4.66		(A)×(B)	0.15	0.05
Day 12	Chinnarasam	2.90	3.24	3.07	Cultivars(A)	N.S	0.04
	Navaneetham	3.16	3.20	3.190.	Maturity stages(B)	0.12	0.04
	Mean	3.03	3.22		(A)×(B)	0.17	0.06

Table 15: Total sugars (%) of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stage at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 0	Chinnarasam	5.19	5.48	5.34	Cultivars(A)	0.13	0.04
	Navaneetham	5.51	5.66	5.59	Maturity stages(B)	0.13	0.04
	Mean	5.35	5.57		(A)×(B)	0.19	0.06
Day 3	Chinnarasam	6.80	7.30	7.05	Cultivars(A)	0.10	0.03
	Navaneetham	7.52	8.05	7.78	Maturity stages(B)	0.10	0.03
	Mean	7.16	7.67		(A)×(B)	0.14	0.05
Day 6	Chinnarasam	10.45	10.83	10.64	Cultivars(A)	0.15	0.05
	Navaneetham	10.91	11.18	11.05	Maturity stages(B)	0.15	0.05
	Mean	10.68	11.01		(A)×(B)	0.21	0.07
Day 9	Chinnarasam	9.48	10.45	9.97	Cultivars(A)	0.11	0.04
	Navaneetham	10.45	11.01	10.73	Maturity stages(B)	0.11	0.04
	Mean	9.97	10.73		(A)×(B)	0.16	0.05
Day 12	Chinnarasam	8.89	9.29	9.09	Cultivars(A)	0.13	0.04
	Navaneetham	9.25	9.25	9.25	Maturity stages(B)	0.13	0.04
	Mean	9.07	9.27		(A)×(B)	0.19	0.06

Table 16: Brix/acid ratio of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stages at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 0	Chinnarasam	6.60	8.50	7.55	Cultivars(A)	0.04	0.14
	Navaneetham	5.18	7.47	6.33	Maturity stages(B)	0.04	0.14
	Mean	5.89	7.99		(A)X(B)	0.56	0.19
Day 3	Chinnarasam	14.35	14.75	14.55	Cultivars(A)	0.69	0.24
	Navaneetham	15.30	16.25	15.77	Maturity stages(B)	N.S	0.24
	Mean	14.82	15.50		(A)X(B)	0.14	0.05
Day 6	Chinnarasam	19.31	23.83	21.57	Cultivars(A)	3.54	1.24
	Navaneetham	26.82	42.92	34.87	Maturity stages(B)	3.54	1.24
	Mean	23.06	33.38		(A)X(B)	0.21	0.07
Day 9	Chinnarasam	29.21	32.59	30.90	Cultivars(A)	2.74	0.96
	Navaneetham	40.49	55.16	47.82	Maturity stages(B)	2.74	0.96
	Mean	34.85	43.87		(A)X(B)	3.88	1.35
Day 12	Chinnarasam	42.90	52.80	47.85	Cultivars(A)	2.15	0.75
	Navaneetham	57.60	66.30	61.95	Maturity stages(B)	2.15	0.75
	Mean	50.25	59.55		(A)X(B)	3.05	1.06

Table 17: Juice recovery (%) of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stage at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 3	Chinnarasam	32.45	34.74	33.59	Cultivars(A)	2.62	0.91
	Navaneetham	37.44	40.42	38.93	Maturity stages(B)	2.62	0.91
	Mean	34.94	37.58		(A)×(B)	3.71	1.29
Day 6	Chinnarasam	42.36	45.43	43.89	Cultivars(A)	N.S	1.03
	Navaneetham	43.17	42.70	42.93	Maturity stages(B)	N.S	1.03
	Mean	42.76	44.06		(A)×(B)	4.17	1.45
Day 9	Chinnarasam	50.73	56.12	53.42	Cultivars(A)	3.30	1.15
	Navaneetham	42.57	49.15	45.86	Maturity stages(B)	3.30	1.15
	Mean	46.65	52.63		(A)×(B)	4.66	1.63
Day 12	Chinnarasam	57.55	60.79	59.17	Cultivars(A)	2.02	0.70
	Navaneetham	54.64	58.76	56.70	Maturity stages(B)	2.02	0.70
	Mean	56.09	59.77		(A)×(B)	2.86	1.00

Table 18: Organoleptic score (%) of Mango fruits Cv. Chinnarasam and Navaneetham as influenced by maturity stage at ambient temperature.

	Treatments	7-9°B TSS	9-11°B TSS	Mean	Factors	CD (5%)	SE (m) ±
Day 3	Chinnarasam	5.60	6.00	5.80	Cultivars(A)	N.S	0.14
	Navaneetham	5.86	6.13	6.00	Maturity stages(B)	0.29	0.14
	Mean	5.73	6.07		(A)×(B)	0.41	0.20
Day 6	Chinnarasam	6.86	6.86	6.86	Cultivars(A)	N.S	0.15
	Navaneetham	7.00	7.00	7.03	Maturity stages(B)	N.S	0.15
	Mean	6.93	6.93		(A)×(B)	0.44	0.22
Day 9	Chinnarasam	6.80	7.20	7.00	Cultivars(A)	N.S	0.13
	Navaneetham	7.13	7.33	7.23	Maturity stages(B)	N.S	0.13
	Mean	6.96	7.26		(A)×(B)	0.39	0.19
Day 12	Chinnarasam	7.06	7.20	7.00	Cultivars(A)	N.S	0.14
	Navaneetham	7.06	7.20	7.23	Maturity stages(B)	N.S	0.14
	Mean	7.06	7.20		(A)×(B)	0.42	0.21

CONCLUSION

The results of the experiment were briefly summarized and concluded below. In Chinnarasam and Navaneetham fruits harvested at maturity stage 9-11°B recorded significantly better-quality parameters when compared to maturity stage 7-9°B, However, the shelf life was less in maturity stage 9-11°B. Among the two maturity stages maturity stage 2 (TSS 9-11°) have more Physiological loss in weight when compared to maturity stage 1 (TSS 7-9°). Among the fruits harvested at different two maturity stages maturity stage 2 (TSS 9-11°) have less Fruit firmness when compared to maturity stage 1 (TSS 7-9^0). The spoilage loss was significantly high in fruits harvested at 9-11°B TSS stage of maturity due to high susceptibility to fruit rots. Mango fruits harvested at 7-9°B TSS recorded higher shelf life followed by 9-11°B TSS stage. Mango fruits harvested at 9-11^{o}B TSS stage showed significantly higher TSS than 7-9°B TSS. Mangoes at 7-9°B indicated highest acidity than 9-11^{o}B TSS. Mangoes at 9-11°B maturity showed lowest vitamin 'C' than 7-9°B maturity. Mangoes harvested at 7-9°B showed significantly low reducing sugars than harvested at 9-11°B maturity. Mango fruits harvested at 9-11°B TSS stage showed significantly higher total sugars compared to 7-9 ^{0}B TSS. Mangoes harvested at 9-11°B showed significantly high Brix/Acid Ratio as compared to7-9°B TSS.

FUTURE SCOPE

There is a need to standardize the maturity stage of harvest and ethylene concentration required for ripening to maintain quality and shelf life of all the juice varieties popular in Telangana State. To extend the

shelf life and reduce the post harvest loses in juice varieties, with impact on quality, there is a need to conduct experiments under cold storage conditions.

Acknowledgement. I would like to express my thankfulness towards my chairman and my advisory committee for sharing their valuable resources and giving me timely help. I would also like express my gratitude to COH- Rajendranagar, SKLTSHU, Mulugu, Telangana.

Conflict of Interest. None.

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How to cite this article: S. Venkatesh, A. Kiran Kumar, A. Bhagwan and S. Narender Reddy (2022). Studies on different Stages of Maturity on Post Harvest quality of Mango (*Mangifera indica* L.) Cv. Chinnarasam and Navaneetham. *Biological Forum – An International Journal, 14*(4): 1232-1240.