International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(1): 71-76
www.biochemjournal.com
Received: 01-09-2023
Accepted: 05-10-2023

RV Savaliya
Research Scholar, Department of Fruit Science, ASPEE College of Horticulture, Gujarat, India

DK Sharma
Research Scientist, Agriculture Experimental Station, Paria, Gujarat, India

AH Baraiya
Ph.D. Research Scholar, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture, Gujarat, India

PK Dodiya
M.Sc. Research Scholar, Department of Vegetable Science, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India

NV Parakhiya
Research Scholar, Department of Fruit Science, ASPEE College of Horticulture, Gujarat, India

Corresponding Author:
AH Baraiya
Ph.D. Research Scholar, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture, Gujarat, India

Determination of suitable maturity index of mango (*Mangifera indica* L.) fruits var. Sonpari

RV Savaliya, DK Sharma, AH Baraiya, PK Dodiya and NV Parakhiya

DOI: https://doi.org/10.33545/26174693.2024.v8.i1Sb.287

Abstract
Present experiment was laid out with objective to study to determine the suitable maturity stage for harvesting and its effect on post-harvest shelf life of mango fruits var. Sonpari. Treatments comprised harvesting fruits at different maturity weeks *viz*., 14th week, 15th week, 16th week, 17th week, 18th week and 19th week after flowering. Fruits harvested at 18th week after flowering was found highest in terms with Weight of fruits, Fruit length, Fruit diameter, Specific gravity, Fruit volume, Fruit Firmness and Pulp: Stone ratio at the time of harvesting and ripening respectively. Organoleptic Evaluation with overall acceptability and Shelf life at ambient condition were also found maximum in fruits harvested at 18th week after flowering. While, Days required for ripening and Physiological loss in weight at 3rd day, 6th day, 9th day, 12th day and 15th day were recorded minimum from this treatment. Moreover, maximum results in TSS (10.75, 22.04 °Brix), Ascorbic Acid (20.04, 12.54 mg/100 g), Reducing sugars (8.62, 13.82%), Non-reducing sugars (1.58, 1.68%) and total sugars (10.19, 15.50%) with minimum titrable acidity was found (2.18, 0.18%) at the time of harvesting and ripening respectively from this treatment.

Keywords: Maturity index, mango, post-harvest shelf life, physical quality parameters, chemical quality parameters

1. Introduction
Mango (*Mangifera indica* L.) belongs to the family anacardiaceae to which cashew nut, pistachio nut, Indian hog plum and chironji also belongs, considered to be choicest of all indigenous fruits and internationally known as ambassador of India. Physical, morphological and environmental factors indicate highest concentration of species of *Mangifera* in Malayan Peninsula followed by eastern peninsula, Thailand and Indo-china. In India, mango occupies an area of 2.26 Mha area and 21.82 Mt production and productivity is 8.7 MT/ha. Gujarat is one of the major mangoes growing states which has bought 1.63 lakh ha area with 1.21 Mt production with productivity of 8.11 MT/ha (Anon., 2018) [2].

There are many health benefits of mango fruits and it can be used at all stages of development. Ripe mango can play important role in balancing human diet by providing about 64-86 calories of energy, 156 mg potassium, 2 mg sodium per 100 grams of pulp. The unripe mango reported 90 percent moisture, 0.7 percent protein, 0.1 percent fat, 8.8 percent carbohydrate, 0.01 percent calcium, 0.02 percent phosphorous, 1.1 percent fiber, 10.0-12.0 °Brix TSS, 8.7-12.93 percent sugar, 0.12-0.38 percent acidity, 1.20-7.83 percent total phenol and 6.8-38.8 mg/100 gm ascorbic acid (Raghupathi and Bhargava, 1994) [23].

Sonpari which is also known as Gujarat Mango Hybrid-1 (GMH-1), was released in the year 2000 from Agriculture Experiment Station, Paria. The mango hybrid was developed by taking Alphanso as a female parent and Baneshan as male parent. It is vigorous, heavy yielder, regular in bearing, suitable for planting at normal spacing, high density, ultra high density planting. Fruit flesh is firm and fiberless and resembles to that of Alphanso and very good for table purpose. It's fruits are free from spongy tissue disorder which is very common in Alphonso variety.

At present, Indian mangoes are exported to neighboring markets. The quality attributes such as size, shape, colour, flavour should be maintained in newly evolved varieties so that India can increase its presence in the international market (Thulasiram *et al*., 2016) [20]. Harvested immature fruits often subjected to shriveling and mechanical damage which turns into inferior flavour and quality and it cause high post-harvest losses.

Whereas, at the same time, over ripe fruits are likely to become soft with insipid flavour soon after harvest. Hence, the fruits usually picked mature but unripe so that they can withstand the post-harvest handling system when shipped to long distance.

Therefore, evaluation of promising mango (*Mangifera indica* L.) fruits var. 'Sonpari' for a given set of ecology to determine the suitable week of harvest from flowering to maturity for increasing the shelf-life and minimizing the post harvest losses.

2. Materials and Methods

The experiment was carried out during January 2020 to June 2020 in Block-E 1 having mango var. Sonpari orchard with 3m × 3m planting distance at Regional Horticultural Research Station (RHRS), ASPEE College of Horticulture and Forestry Navsari Agricultural University, Navsari. The experiment was laid out in completely randomized design (CRD) with three repetitions and six treatments of different maturity weeks *viz*., T_1: 14th week, T_2: 15th week, T_3: 16th week, T_4: 17th week, T_5: 18th week and T6: 19th week after flowering. The trees under experimentation were 9 years old of var. Sonpari. Twenty randomly flowering panicles were tagged at the time of full bloom stage in all directions and retained as per treatment. The fruits of Sonpari were harvested manually as per the treatment in experiment.

3. Results and Discussion

3.1 Physical quality parameters

3.1.1 Weight of Fruit

The data on different physical quality parameters are presented in Table 1, 2 and 3. The data revealed that maximum fruit weight *viz*. 300.45 g and 212.45 g were recorded under treatment T_5 (harvesting at 18th week after flowering) and ripening of fruit, respectively. Treatment T_5 was found at par with treatments T_4 and T_6 at the time of harvesting while, at the time of ripening treatment T_5 was at par with treatment T_6. Minimum fruit weight *i.e.*, 220.31 g and 150.41 g at the time of harvesting and ripening of fruit, respectively was noted under treatment T_1 (14th week after flowering). The fruit weight of mango shows increasing trend from initial stage of harvest to maturity followed by a declining at fruit ripening. The results of the study revealed that the increase in fruit weight was observed between 14th week – 18th week after flowering and later it was decreasing. The higher fruit weight was observed in T_5 (18th week after flowering). Moreover, Carbohydrate metabolism plays an important role for fruit development particularly changes with the starch content in mango fruits (Lakshimnarayana *et al.*, 1970 and Pandey *et al.*, 1974) [12, 16]. The rise in fruit weight is associated with increase in amylase activity and with simultaneous increase of amylase activity, fruit weight was also increased (Fuchs *et al.*, 1980) [6].

3.1.2 Fruit Length and Fruit Diameter

The highest fruit length (12.26 cm, 11.74 cm) and fruit diameter (8.51 cm, 8.06 cm) was observed under treatment T_5 (18th week after flowering) at the time of harvesting and ripening of fruit, respectively. In the aspects of fruit length, treatment T_5 was at par with treatments and T_4 and T_6 at the time of harvesting while, at the time of ripening, non-significant results were observed. In regards of fruit diameter, treatment T_5 was at par with treatment T_6 at the time of harvesting and ripening. While, the lowest fruit length (10.04 cm, 9.89 cm) and fruit diameter (6.38 cm, 5.84 cm) at the time of harvesting and ripening of fruit, respectively recorded under treatment T_1 (14th week after flowering). This might be due to the hormonal activity of seed which plays a vital role in development of the fruit during maturity stages. While lowest fruit length and diameter was recorded in initial week of harvest 14th week after flowering (T_1). An increase in fruit length and diameter from marble stage to ripe stage was reported by Pandey *et al.*, (1974) [16], Verma *et al.*, (1986) [22] and Kudachikar *et al.*, (2003) [11] in mango fruits which supports the present findings.

3.1.3 Specific Gravity

The maximal specific gravity *i.e.*, 1.64 and 1.07 at the time of harvesting and ripening, respectively were noted in 28 fruits of treatment T_5 (18th week after flowering) and was at par with treatments T_4 and T_6 at the time of harvesting while, at the time of ripening, treatment T_5 was found at par with treatment T_6. Although, the minimal specific gravity at the time of harvesting (1.37) and ripening (0.71) was registered under treatment T_1 (14th week after flowering). The higher specific gravity was observed in fruits harvested during 18th week after flowering. Rajput *et al.*, (1999) [24] found that specific gravity of mango fruits decreased gradually during early stages but it was found to increase thereafter continuously till fruits attained maturity. The specific gravity of developing fruits in the mango cultivars Alphonso and Raspuri, increased with fruit development and reached the value near to 1.0 at harvest maturity. This was due to proportionate increase in fruit weight and fruit volume (Kudachikar *et al.*, 2003) [11].

Table 1: Physical quality parameters

Treatments	Weight of fruit (g)		Fruit length (cm)		Fruit diameter (cm)		Specific gravity		Fruit Volume (ml)	
	At the time of harvesting	At the time of ripening	At the time of harvesting	At the time of ripening	At the time of harvesting	At the time of ripening	At the time of harvesting	At the time of ripening	At the time of harvesting	At the time of ripening
T_1: 14th week after flowering	220.33	150.43	10.03	9.90	6.37	5.87	1.37	0.71	160.73	211.20
T_2: 15th week after flowering	238.57	165.13	10.60	10.30	6.90	6.33	1.43	0.80	167.40	208.20
T_3: 16th week after flowering	258.00	179.73	11.07	10.73	7.37	6.90	1.50	0.88	172.63	204.33
T_4: 17th week after flowering	271.50	188.67	11.47	11.07	7.67	7.20	1.53	0.93	177.37	201.40
T_5: 18th week after flowering	300.47	212.47	12.27	11.73	8.50	8.10	1.64	1.07	182.87	198.57
T_6: 19th week after flowering	292.07	208.47	12.13	11.57	8.47	7.97	1.60	1.04	182.13	200.80
S.Em.±	11.54	4.47	0.38	0.43	0.22	0.23	0.04	0.02	7.45	7.23
CD @ 5%	35.57	13.77	1.19	NS	0.67	0.70	0.13	0.06	NS	NS
CV%	7.59	4.20	5.92	6.85	5.00	5.58	4.86	3.64	7.42	6.13

Table 2: Physical quality parameters

Treatments	Fruit Firmness (kg/cm^2)		Pulp: Stone ratio		Days Require for Ripening	Shelf life (days)	Physiological Loss in Weight (%)				
	At the time of harvesting	At the time of ripening	At the time of harvesting	At the time of ripening			3rd day	6th day	9th day	12th day	15th day
T_1: 14th week after flowering	15.63	7.47	3.47	3.13	Fruits were not ripened properly	Fruits were not ripened properly	19.67	26.43	27.87	0.00	0.00
T_2: 15th week after flowering	15.37	7.13	3.73	3.43			19.17	26.23	27.83	0.00	0.00
T_3: 16th week after flowering	13.37	5.80	4.00	3.73	6.63	12.67	18.03	23.90	23.83	22.68	0.00
T_4: 17th week after flowering	12.33	5.07	4.10	3.97	6.17	13.00	17.33	22.53	22.50	22.39	0.00
T_5: 18th week after flowering	10.83	3.97	4.53	4.43	4.60	16.00	15.23	19.07	17.63	21.34	31.41
T_6: 19th week after flowering	9.43	2.93	4.47	4.37	5.40	15.33	16.30	20.83	20.10	21.84	32.66
S.Em.±	0.43	0.17	0.10	0.10	Not subjected to statistical analysis		0.67	0.94	0.70	Not subjected to statistical analysis	
CD @ 5%	1.32	0.54	0.29	0.31			2.07	2.90	2.16		
CV%	5.78	5.60	4.07	4.51			6.59	7.03	5.21		

Table 3: Physical quality parameters

Treatments	External skin (Peel) colour (RHS colour chart)		Flesh (Pulp) colour (RHS colour chart)	
	At the time of harvesting	At the time of ripening	At the time of harvesting	At the time of ripening
T_1: 14th week after flowering	141B Deep yellowish green	144B Strong yellow green	1D Pale green yellow	4C Light greenish yellow
T_2: 15th week after flowering	141C Strong yellow green	2B Brilliant greenish yellow	2D Pale green group	13B Brilliant yellow
T_3: 16th week after flowering	143B Yellow green	10A Brilliant yellow	4D Brilliant greenish yellow	15B Vivid yellow
T_4: 17th week after flowering	144C Strong yellow green	17B Vivid yellow	6D Light greenish yellow	23A Vivid orange yellow
T_5: 18th week after flowering	150B Brilliant yellow green	16A Vivid yellow	8C Brilliant greenish yellow	25A Strong orange
T_6: 19th week after flowering	154B Brilliant yellow green	17B Strong orange yellow	9C Brilliant yellow	23A Vivid orange yellow

Table 4: Chemical Quality parameters

Treatments	TSS (°Brix)		Titrable Acidity (%)		Ascorbic Acid (mg/100 g)		Reducing Sugars (%)		Non-Reducing Sugars (%)		Total Sugars (%)	
	At the time of harvesting	At the time of ripening	At the time of harvesting	At the time of ripening	At the time of harvesting	At the time of ripening	At the time of harvesting	At the time of ripening	At the time of harvesting	At the time of ripening	At the time of harvesting	At the time of ripening
T_1: 14th week after flowering	8.40	16.20	4.33	1.60	19.33	10.60	5.70	9.57	0.97	1.37	6.67	10.90
T_2: 15th week after flowering	8.93	17.50	4.20	1.53	19.53	11.07	6.40	10.57	1.10	1.47	7.53	11.97
T_3: 16th week after flowering	9.47	18.93	3.53	1.07	19.70	11.53	7.07	11.53	1.23	1.53	8.30	13.00
T_4: 17th week after flowering	9.83	19.77	3.17	0.80	19.80	11.83	7.57	12.23	1.37	1.57	8.90	13.80
T_5: 18th week after flowering	10.77	22.03	2.17	0.20	20.07	12.53	8.60	13.83	1.60	1.68	10.20	15.50
T_6: 19th week after flowering	10.60	21.70	2.67	0.53	20.00	12.47	8.37	13.70	1.57	1.67	9.93	15.37
S.Em.±	0.25	0.28	0.09	0.05	0.52	0.45	0.22	0.48	0.05	0.05	0.23	0.50
CD @ 5%	0.77	0.85	0.28	0.15	NS	NS	0.69	1.48	0.15	0.16	0.69	1.56
CV%	4.46	2.48	4.67	8.54	4.59	6.61	5.70	9.57	6.51	5.91	4.48	6.51

3.1.4 Fruit volume

Fruit volume at the time of harvesting and ripening was not influenced by different harvesting time of mango var. Sonpari. Although, the highest fruit volume (182.88 ml) at the time of harvesting was observed under treatment T_5 (18th week after flowering) while, at the time of ripening treatment T_1 (14th week after flowering) had the maximum fruit volume (211.20 ml). Whereas, the lowest fruit volume (160.73 ml) at the time of harvesting was noted under treatment T_1 (14th week after flowering) while, at the time of ripening treatment T_5 (18th week after flowering) had the minimum fruit volume (198.55 ml). The variation in fruit

volume was also observed by Gowda and Ramanjaneya, (1994) [8] and Abirami *et al.,* (2004) [1]. The volume of fruit is directly proportional to size of fruits and it is a purely varietal character which influenced by environments and locations.

3.1.5 Fruit firmness

The apex fruit firmness was recorded under treatment T_1 (14^{th} week after flowering) at the time of harvesting (15.62 kg/cm^2) and at the time of ripening (7.46 kg/cm^2). In the aspects of fruit firmness at the time of harvesting and ripening, treatment T_1 was at par with treatment T_2. Although, the minimal fruit firmness (9.41 kg/cm^2, 2.91 kg/cm^2) at the time of harvesting and ripening, respectively was found under treatment T_6 (19^{th} week after flowering). The firmness of fruits decreases with the increase in storage period of fruit. The lower firmness of Sonpari fruits was recorded in the treatment T_6 (19^{th} week after flowering) of raw mango fruits and higher firmness was retained in the initial week of harvest T_1 (14^{th} week after flowering). The firmness of the fruit is associate with the stage of maturity. In initial stage of fruit development, the firmness of fruit remains almost constant and after attaining maturity decreased gradually.

3.1.6 Pulp: Stone ratio

The highest Pulp: Stone ratio at the time of harvesting (4.56) and ripening (4.43) was noted under treatment T_5 (18^{th} week after flowering). Treatment T_5 was found at par with treatment T_6 at the time of harvesting and ripening. While, the lowest Pulp: Stone ratio was recorded under treatment T_1 (14^{th} week after flowering) at the time of harvesting (3.48) and ripening (3.12). The data revealed that Pulp: Stone ratio increased from initial week of harvest to last week of harvest and showed slight decline at final harvest. Pulp: Stone ratio was observed maximum at T_5 (18^{th} week after flowering). After the ripening of mangoes, starch being hydrolyzed (Mattoo and Modi, 1969) [13], changes occurred in amylase activities at the same time. Recovery of pulp is also associated with no edible portion and the size of fruit. Stone percentage was declined at ripe stage and showed maximum 34 increase in growth rate during this period is directly associated with maximum activity of auxin and gibberellins like substance in the stone. An increase in pulp and stone ratio from subsequent weeks of harvest observed in mango fruits were also reported by Pandey *et al.,* (1974) [16] and Padhiar *et al.,* (2011) [15] in mango.

3.1.7 Days required for ripening

Minimum days required for ripening of fruits (4.62) was observed in fruits harvested during 18^{th} week after flowering while fruits are harvested during 14^{th} and 15^{th} weeks could not attain the stage of ripening. The similar results have been reported by Kudachikar *et al.,* (2003) [11] and stated that physico-chemical changes during early stage of ripening were slow but increased rapidly during middle but again slowed down during the later stage of harvest of mango fruits.

3.1.8 Shelf life

The maximum shelf life at ambient condition (16.00 days) in mango var. Sonpari was observed in fruits harvested during 18^{th} week after flowering (T_5). Initial periods of harvesting showed less shelf life and fruit get shriveled, and did not ripen properly. Whereas the fruits harvested later showed early ripening and can be stored for the suitable period of time. These results are in close proximity with earlier findings of Emmanuel *et al.,* (2009) [5] and Tridjjaja and Mahendra (2000) [21] in mango fruits.

3.1.9 Physiological loss in weight

Minimum physiological loss was recorded in fruits under 18^{th} week after flowering (T_5) at 3^{rd} day (15.23), 6^{th} day (19.05), 9^{th} day (17.65), 12^{th} day (21.34) and 15^{th} day (31.41). Data of 12^{th} day and 15^{th} day were not subjected to statistical analysis as no harvesting was possible at 14^{th} and 15^{th} week after flowering. The weight loss by the time of total ripening with early harvested fruits could be logical effect of a long time of storage period due to physiological immaturity of fruits. So, as far as storage is concern, the treatment T_5 (18^{th} week after flowering) performed well in Sonpari. Similar trend was observed in research findings of Emmanuel *et al.,* (2009) [5] in mango, Shattir and Abu-Goukh (2010) [19] in papaya and Gupta and Jawandha (2010) [9] in peach.

3.1.10 Peel colour

Data of peel colour of mango var. Sonpari at harvest showed 141B-deep yellowish blue which changes to 154B-brilliant yellow green upto later harvesting. At the time of ripening at initial stage colour of peel is 144B-strong yellow green which changes to 17B-strong orange yellow upto later harvesting. The yellow colour is usually developed much later than fruits reach full maturity and thus cannot be used as an index for early picking. The peel colour at harvest was represented by various shades of yellow green which was changed into yellow orange on ripening (Sharma and Rana, 2007 and Sharma 2010) in mango. Jha *et al.,* (2005) reported that change in fruit colour could be used as reliable index of maturity in mango.

3.1.11 Pulp colour

On the ripening, the pulp colour invariably changed to different shades of orange for different weeks of harvest at various maturity stages. Colour of the raw fruit pulp matched with the 1D-pale green yellow in initial weeks of harvest and its intensity of colour increased with maturity 9C-brilliant yellow by the last harvesting date. On the ripening, during the initial weeks, the pulp colour of ripened fruit was 4C-light greenish yellow for initial weeks while higher intensity of orange colour was observed in T_5 (18^{th} week after flowering) *i.e.,* 25-A strong orange. Pulp colour is a destructive index but more consistent and reliable than changes in peel colour and is used more often. The changes in colour were uniform when the fruit reaches the maturity and commonly it is used as maturity index of several mango 33 growing regions. *Lakshminarayan et al.,* (1970) [12], Sharma and Rana (2007) [18] and Sharma (2010) [17] reported that mango fruit flesh changes its colour from white to cream and then light yellow/light orange shades as the fruit approaches maturity.

3.2 Chemical quality parameters

3.2.1 TSS

The data on chemical quality parameters are presented in Table 4. The highest TSS (10.75 ºBrix and 22.04 ºBrix) was recorded under treatment T_5 (18^{th} week after flowering) at the time of harvesting and ripening, respectively. Treatment T_5 was at par with treatment T_6 at the time of harvesting and ripening. Whereas, the lowest TSS (8.38 ºBrix and 16.20 ºBrix) was observed under treatment T_1 (14^{th} week after flowering) at the time of harvesting and ripening,

respectively. The gradual increase in TSS of fruits was observed with increase in harvested at different maturity stages was found. Increasing in the subsequent weeks of harvest showed upward trend of total soluble solids. Gangwar and Tripathi (1973) [7] also reported similar trends in this constituent during harvesting and ripening of mango fruits.

3.2.2 Titrable acidity
The lowest titrable acidity *i.e.,* 2.18% and 0.18% at the time of harvesting and ripening, respectively was observed under treatment T_5 (18th week after flowering). While, the highest titrable acidity (4.32%, 1.28%) was observed under treatment T_1 (14th week after flowering) at the time of harvesting and ripening, respectively. It is evident from the data presented in results that there is a decreasing trend of acidity was observed from the initial weeks of harvest to the later weeks of harvest Banik and Sen (2003) [3] reported that acidity of fruit was increased during the early stages of development but significantly declined at the harvest maturity. The decrease in 40 acidity of late harvested fruits might be due to conversion of acids into sugars and then utilization as respiratory substrate during ripening and later on titrable acidity continuously decreased after the ripening of fruits.

3.2.3 Ascorbic acid
Ascorbic acid content of mango var. Sonpari at the time of harvesting and ripening was not influenced by different harvesting time. Although, maximum ascorbic acid content (20.04 mg/100 g and 12.54 mg/100 g) at the time of harvesting and ripening, respectively was observed under treatment T_5 (18th week after flowering) while, minimum ascorbic acid content (19.36 mg/100 g and 10.62 mg/100 g) at the time of harvesting and ripening, respectively was observed under treatment T_1 (14th week after flowering). Though the effect was non-significant but increase in ascorbic acid content was observed with the increase in weeks of harvesting in both raw and ripen fruits. The increase in ascorbic acid is probably dur to catalytic influence of growth substances on the biosynthesis of ascorbic acid from sugar. Such variation in ascorbic acid could be attributed to the nature and extent of genetic variability present in the experimental material These results are findings of Modesto *et al.,* (2016) [14] in mango fruits.

3.2.4 Reducing sugars
The higher value of reducing sugars (8.62% and 13.82%) was noted in fruits of treatment T_5 (18th week after flowering) at the time of harvesting and ripening, respectively. Treatment T_5 was found at par with the treatment T_6 at the time of harvesting and ripening. Whereas, the lower values of reducing sugars (5.68%, and 9.54%) at the time of harvesting and ripening, respectively was recorded under treatment T_1 (14th week after flowering). Slow ripening process in early harvested fruits showed the slow hydrolysis of starch into sugars which liberating reducing sugar slowly, ultimately lower content of reducing sugar was recorded. On the other hand, harvesting at later stage showed more hydrolysis of starch at faster rate which increased content of reducing sugar. This might be due to biochemical content of fruits change in sugar resulting into increase in the sugar content of the fruits. After the fruit ripening, starch content decreased up to some extent resulting into increase in the reducing sugars of fruits (Fuchs *et al.,* 1980) [6]. These results are close proximity with the earlier findings of Datta and Mukherjee (1980) [4] in guava.

3.2.5 Non-reducing
The maximum value of non-reducing sugars (1.58% and 1.68%) was noted under treatment T_5 (18th week after flowering) at the time of harvesting and ripening, respectively. Treatment T_5 was found at par with treatment T_6 at the time of harvesting while, at the time of ripening treatment T_5 was found at par with treatment T_4 and T_6. Whereas, the minimum values of reducing sugars (0.96% and 1.36%) at the time of harvesting and ripening, respectively was recorded under treatment T_1 (14th week after flowering). During the ripening process, there was an increase in starch content of fruits and increase in the non-reducing sugar of fruits. Similar trend has been reported by Pandey *et al.,* (1974) [16] in mango.

3.2.6 Total sugars
The apex value of total sugars (10.19% and 15.50%) at the time of harvesting and ripening, respectively, was observed under treatment T_5 (18th week after flowering) which was at par with the treatment T_6. While, the minimum value of total sugars (6.64% and 10.90%) was noted under treatment T_1 (14th week after flowering). An increased concentration of sugars from early stage of development to ripe stage of fruit development might be due to conversion of starch into sugars during biochemical changes under ripening process led to the greater sucrose content resulted in increase of the sweetness of fruits. An increase in total sugars from early stage of development to later stage was reported by Pandey *et al.,* (1974) [16] in mango.

4. Conclusion
By considering the findings of present experiment, it can be concluded that harvesting of mango var. Sonpari during 18th week after flowering (T_5) has given good results in aspects of physical quality parameters *viz*., fruit weight, fruit length, fruit diameter, specific gravity, pulp: stone ratio and organoleptic evaluation along with chemical quality parameters *viz*. TSS, titrable acidity, ascorbic acid, reducing sugars, non-reducing sugars and total sugars. Hence, harvesting at 18th week after flowering can be considered as best harvesting index for mango var. Sonpari.

5. References
1. Abirami K, Nachegowda V, Reddy YTN. Physico-chemical attributes of certain poly-embryonic varieties of mango. South Indian Horticulture. 2004;52(1/6):291-296.
2. Anonymous. Indian Horticulture Database. Gurgaon, Haryana: National Horticulture Board; c2018.
3. Banik BC, Sen SK. Physico-chemical changes during growth and development of fruits of mango cultivars Fazli and Langra. Indian Agriculture. 2003;47(1/2):51-55.
4. Datta MN, Mukherjee SK. Studies on the changes during growth and development of guava (*Psidium guajava* L.) fruits. Indian Journal of Horticulture. 1980;37(3):211-219.
5. Emmanuel D, Adopo AN, Camara B, Emmanuel M. Influence of maturity stage of mango at harvest on its ripening quality. Fruits. 2009;64:13-18.
6. Fuchs V, Edna P, Zauberman G. Changes in amylase activity, starch and sugar contents in mango fruit pulp. Scientia Horticulturae. 1980;13:155-160.

7. Gangwar BM, Tripathi RS. A study on physico-chemical changes during growth, maturity and ripening in mango. Punjab Horticulture Journal. 1973;13(4):230-236.
8. Gowda DIN, Ramanjaneya KH. Studies on physio-chemical characteristics of some commercial cultivars of mango. Indian Food Industry. 1994;48(2):45-49.
9. Gupta N, Jawandha SK. Influence of maturity stage on fruit quality during storage of Early Grand peaches. National Science Biology. 2010;2(3):96-99.
10. Jha SN, Chopra S, Kingsly ARP. Determination of sweetness of intact mango using visual spectral analysis. Biosystems Engineering. 2005;91(2):157-161.
11. Kudachikar VB, Kulkarni SG, Aradhya SM, Prasad BA, Ramana KVR. Physico-chemical changes in mango (*Mangifera indica* L.) varieties Alphonso and Rajapuri during fruit development and maturation. Journal of Food Science and Technology. 2003;40(3):285-289.
12. Lakshminarayana S, Subhadra NV, Subramanyam H. Some aspects of developmental physiology of the mango fruit. Horticultural Science. 1970;45(2):133-142.
13. Mattoo AK, Modi VV. Ethylene and ripening of mangoes. Plant Physiology. 1969;44(2):308.
14. Modesto JH, Leonel S, Segantini DM, Souza JMA, Ferraz RA. Qualitative attributes of some mango cultivars fruits. Australian Journal of Crop Science. 2016;10(4):565-570.
15. Padhiar BV, Saravaiya SN, Tandel KA, Ahir MP, Bhalerao PP, Bhalerao RR, *et al*. Performance of fruits of nine mango cultivars under south Gujarat condition in relation to physical characters. Asian Journal of Horticulture. 2011;6(2):393-397.
16. Pandey RM, Rao MM, Singh RN. Biochemical changes in developing mango fruit (*Mangifera indica* L.) cv. Dashehari. Progress in Horticulture. 1974;5:47-59.
17. Sharma SK. Studies on harvest maturity of Mallika and Amrapali mango cultivars grown under the submontane region of Himachal Pradesh. Indian Journal of Horticulture. 2010;67(4):450-455.
18. Sharma SK, Rana V. Studies on harvest maturity of Dashehari and Langra cultivars of mango grown under the submontane region of Himachal Pradesh, India. Asian Journal of Horticulture. 2007;2(2):37-42.
19. Shattir AET, Abu-Goukh ABA. Physico-chemical changes during growth and development of papaya fruit and physical changes. Agricultural Biology Journal of North America. 2010;1(5):866-870.
20. Thulasiram R, Alagumani T, Duraisamy MR. Preferences of quality attributes for mango export: A conjoint analysis approach. Indian Research Journal of Agricultural Economics and Statistics. 2016;7(1):42-47.
21. Tridjaja NO, Mahendra MS. Maturity indices and harvesting practice of Arumanis mango related to the target market. Journal of Agricultural Technology. 2000;1(3):17-22.
22. Verma RA, Tripathi MP, Shrivastava RK. Studies on development of carotenoids during ripening of mangoes cv. Dashehari. Progress in Horticulture. 1986;18(1-2):39-44.
23. Bhargava BS, Raghupathi HB. Zinc status of soils and petioles of vineyards of Peninsular India. Agropedology. 1994;4:113-120.
24. Grady WM, Myeroff LL, Swinler SE, Rajput A, Thiagalingam S, Lutterbaugh JD, *et al*. Mutational inactivation of transforming growth factor β receptor type II in microsatellite stable colon cancers. Cancer research. 1999 Jan 15;59(2):320-324.