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Studies on the pattern of changes in physical characters of developing ber (*Zizyphus mauritiana* Lamk.) fruits

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Abstract
The present investigation entitled "Studies on changes during growth and development of ber (*Zizyphus mauritiana* Lamk.) fruit cv. (Narendra Ber Selection-1)" was carried out during the year 2016-2017. The studies comprised experiments namely. Studies on the pattern of changes in physical characters of developing ber fruit. The study revealed that fruit length increased from days of fruit setting (0.49) cm to (4.51) cm at 168 days after fruit setting. Breadth of the ber fruit increased continuously from fruit set (0.38) cm to (4.66) cm at maturity. An increase in weight was observed during entire period of growth and development but marginal increase (37.24) g was at harvesting stage of fruit growth. The volume of fruits increased continuously during entire phase of growth (0.71) to 37.46 (cm^3). The pulp weight is increased gradually from 91th days to maturity and the seed was traceable only from 91th days after fruit set and weight of seed was increase gradually till 168th days. Specific gravity, which first increased at mid of November then decreased when fruits proceeded toward at harvesting stage.

Keywords: Physical characters, growth and development, harvesting, maturity, volume

Introduction
Ber (*Zizyphus mauritiana* Lamk**.**) is an ancient fruit tree of India and China. In fact it was one of the prominent fruits on which sages in ancient India lived during Vedic ages. There is a reference to ber in "Yajurved", written not later than 1000 B.C. Ber (*Ziziphus mauritiana* Lamk.) is also known as Chinese date, Chinee/Chinkee apple, jujube, Indian plum, Regi pandu, Indian jujube and masau, belongs to the family Rhamnaceae and genus *Zizyphus.* It is a tetraploid (2n=48) in nature. It is grown in countries like Iran, Syria, Australia, USA, France and certain parts of Italy, Spain and Africa. Precisely it is seen to be growing under tropical and sub-tropical as well as Mediterranean regions of the world. The center of origin for this fruit crop is Central Asia. This includes north-west India, Afghanistan, regions of Tajikistan, Uzbekistan and China. It is found growing wild, semi-wild and in cultivated form in almost all parts of India. (De Candolle, 1886) [2].The medicinal values of various parts of the tree and fruits of *Ziziphus spp*. are many and yet not fully exploited (Sin ko, 1976) [8]. The maturity plays an important role in quality and shelf life of ber fruit. It grows even on the marginal soil and various kinds of waste land situation such as sodic saline soil, ravines, arid, semi-arid region including plated area of Bundelkhand and South India. Regarding its distribution it grows most widely in Punjab plains, U.P., Haryana, Rajasthan, M.P., Bihar, Maharashtra, Assam, A.P., Tamil Nadu and West Bengal. In U.P. ber orchards are found around Varanasi, Aligarh, Saharanpur, Faizabad, Agra and Raibareilly districts. However, scattered planting is common in plains. It is hardy and flourishes well under little care in wide range of soils and climatic conditions. It grows even on the marginal soil and various kinds of waste land situation such as sodic saline soil, ravines, arid, semi-arid region including plated area of Bundelkhand and South India. Regarding its distribution it grows most widely in Punjab plains, U.P., Haryana, Rajasthan, M.P., Bihar, Maharashtra, Assam, A.P., Tamil Nadu and West Bengal. In U.P. ber orchards are found around Varanasi, Aligarh, Saharanpur, Faizabad, Agra and Raibareilly districts. However, scattered planting is common in plains. It is hardy and flourishes well under little care in wide range of soils and climatic conditions. It grows even on the marginal soil and various kinds of waste land situation such as sodic saline soil, ravines, arid, semi-arid region including plated area of Bundelkhand and South India. Regarding its distribution it grows most widely in Punjab plains, U.P., Haryana, Rajasthan, M.P., Bihar, Maharashtra, Assam, A.P., Tamil Nadu and West Bengal. In U.P. ber orchards are found around Varanasi, Aligarh, Saharanpur, Faizabad, Agra and Raibareilly districts. However, scattered planting is common in plains. It is hardy and flourishes well under little care in wide range of soils and climatic conditions.

The studies on changes during growth and development are essential requirement to determine the maturity, harvesting time and method. The present investigations were therefore, aimed to generate basic information on the namely studies on the pattern of changes in physical characters of developing ber.

Material and Methods

The present investigation was carried out at Main Experiment Station of the Department of Horticulture, Narendra Deva University of Agriculture & Technology, Narendra Nagar, Kumarganj, Faizabad 224229 (U.P.) India during the years 2016-17. The experiment was conducted on 24 years old uniform vigorous ber trees (Nrendra Ber Selection-1) which received uniform cultural operation throughout the experimental period. The details of the materials used, the trial was laid out in a randomized block design having six treatments with four replications.

Fruit length of four randomly selected fruits from each treatment was measured in seven days interval with a vernier calliper. The measurement of the length was made in the polar axis of the fruit, i.e., between apex and stem, the average was computated and expressed in centimeters. Fruit diameter of four randomly selected fruits from each treatment was measured at seven days interval with a vernier calliper at the point of maximum breadth in the direction perpendicular to the axis, the average was computated and expressed in centimeters. Weight of fruits of ber under study was recorded by electronic balances and average weight in (g.) is expressed as weight of fruit. The volume of fruit was measured as the volume of water displaced in a measuring cylinder by immersing four randomly selected fruits from each treatment and the average was expressed fruit volume as cubic centimeters (cc). The specific gravity of four randomly selected fruits was computed by dividing the fresh weight of the fruits by volume of fruits and expressed in (g/cc). Separation of the pulp from the seed was carefully done by hand. With the help knife and seeds were washed and put on tissue paper for two minutes. The pulp portion of the fruit was computed by the following formula:

$$\text{Pulp portion} = \frac{\text{Weight of fruit(g.) - Weight of seed (g.)}}{\text{Weight of fruit(g.)}}$$

Results and Discussion

Changes in physical attributes during growth and development of ber cv. NBS-1

Interval (Days)		Fruits length (cm)	Fruits breadth (cm)	Fruits weight (g)	Fruits Volume (cm^3)	Specific gravity	Pulp weight (g)	Seed weight (g)
21	October	0.49	0.38	0.75	0.71	1.07	-	-
28		0.52	0.46	0.81	0.75	1.09	-	-
35		0.86	0.57	0.91	0.83	1.11	-	-
42		1.12	0.69	1.05	0.85	1.36	-	-
49	November	1.49	1.09	1.29	0.89	1.44	-	-
56		2.03	1.35	2.44	1.76	1.51	-	-
63		2.68	1.80	5.01	4.35	1.19	-	-
70		2.91	2.68	6.21	5.48	1.14	-	-
77	December	2.94	2.88	7.67	7.17	1.13	-	-
84		2.99	2.91	8.28	7.78	1.11	7.54	0.74
91		3.11	2.96	8.58	8.05	1.07	7.59	0.99
98		3.23	2.99	8.81	8.59	1.06	7.62	1.19
105	January	3.29	3.02	9.05	8.73	1.05	7.71	1.34
112		3.31	3.03	11.36	10.94	1.05	9.81	1.55
119		3.39	3.19	11.69	11.17	1.04	9.84	1.85
126		3.42	3.27	17.75	17.36	1.02	15.73	2.02
133	February	3.51	3.31	18.89	18.39	1.01	16.62	2.27
140		3.59	3.39	20.68	19.88	0.99	18.31	2.37
147		3.75	3.60	25.65	25.98	0.98	23.20	2.45
154		3.93	3.93	25.82	26.11	0.98	23.26	2.56
161	March	3.98	4.17	31.21	31.82	0.98	28.22	2.99
168		4.51	4.66	37.24	37.46	0.97	34.17	3.07
SEm±		0.35	0.33	1.39	1.29	0.12	1.13	0.26
CD at 5%		0.99	0.95	4.12	3.80	0.34	3.31	0.74

The observation on the following attributes was started to record since 09.10.2016 when fruit become measurable.

The length of fruits recorded at various stages from fruit setting to harvesting showed increasing pattern in fruit length however length increased rapidely during initial phase of growth. The length of fruit was found to be significantly increased from days of fruit setting to 168 days of fruit setting. An increase in fruit length might be due to accumulation of foods and water into fruits and more cell division and cell elongation that was harvesting time of the fruits. The observations are in close proximity to the findings of Pandey *et al.*, (1990) [6] who reported that the length of the ber cv. Banarasi Karaka fruit increased continuously from fruit set till maturity at all stages of growth and development.

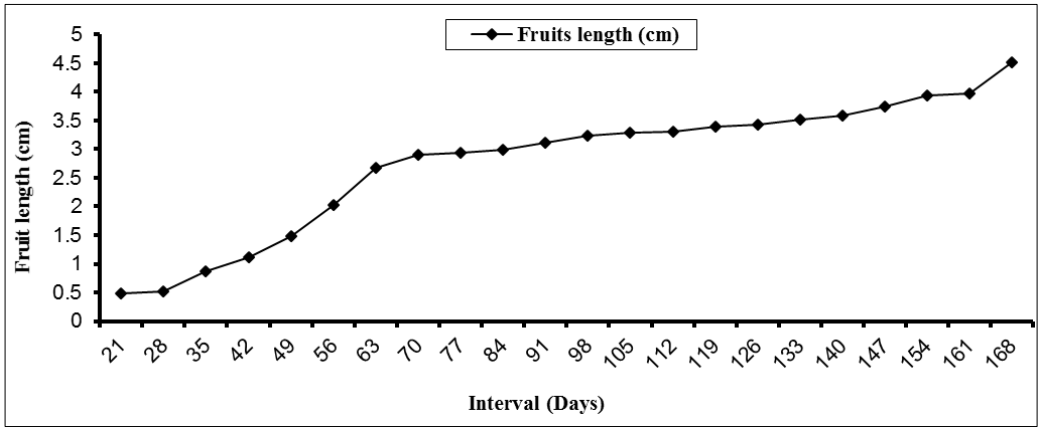

Fig 1: Changes in fruit length during growth and development of ber fruit

The breadth of fruits showed increasing trend during studies period which might be due to division and elongation of cell and food water accumulation in to the fruits. The increase was rapid of early stage of growth than latter stage. That breadth of the ber fruit increased continuously from fruit set till maturity at all stages of growth and development.

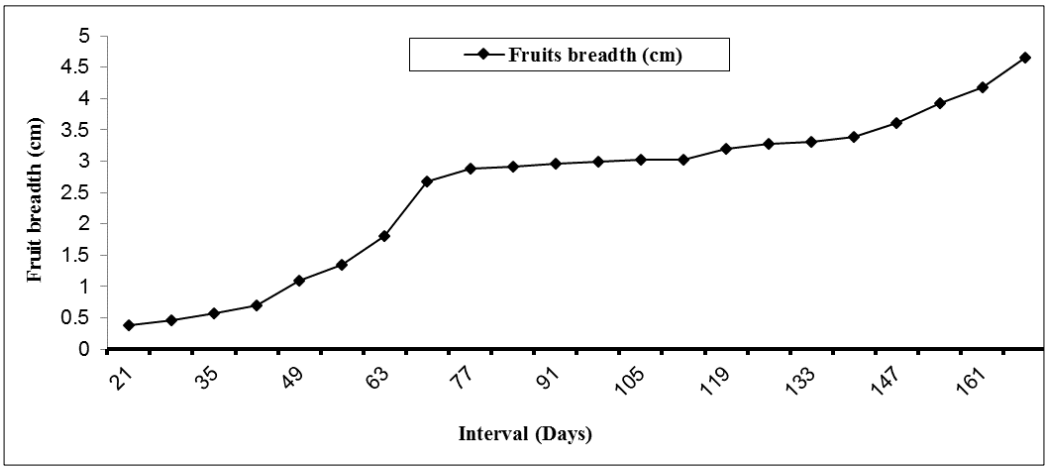

Fig 2: Changes in fruit breadth during growth and development of ber fruit

An increase in weight was observed during entire period of growth and development but marginal increase was at latter stage of fruit growth. The increase in weight indicates the accumulation of metabolites and cell elongation in fruits during the period at rapid rate. The similar trend in weight of ber fruits is reported by Bhatia and Gupta (1984) [3] in cvs. Gola, Kaithali and Umran.

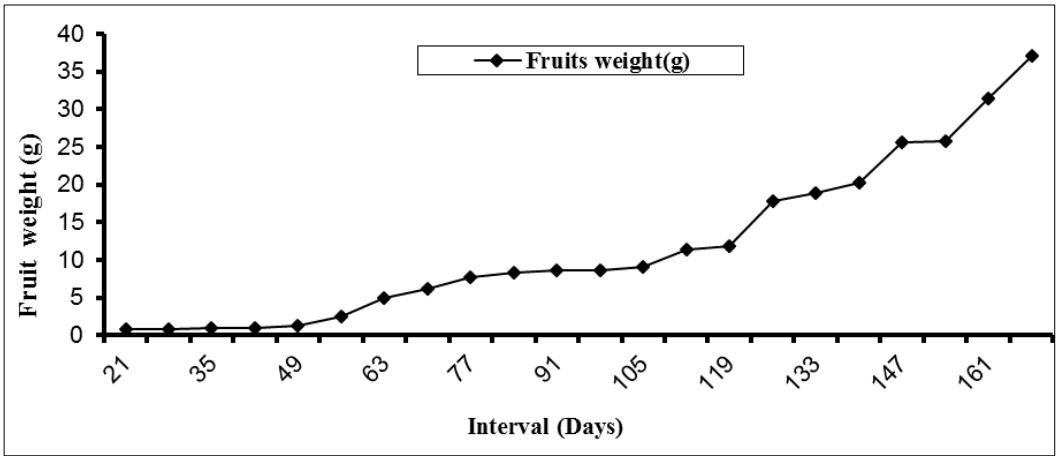

Fig 3: Changes in fruit weight during growth and development of ber fruit

The volume of fruits increased continuously during entire phase of growth and increase was rapid at latter stage of fruit growth. Volume increase indicates the accumulation of metabolites and cell elongation in fruit during the period at rapid rate. The continuous increased in volume of fruit have also been reported by Raut *et al.*, (2004) [7] and Paralkar *et al.*, (1987) [5] in Kalipatti fruits.

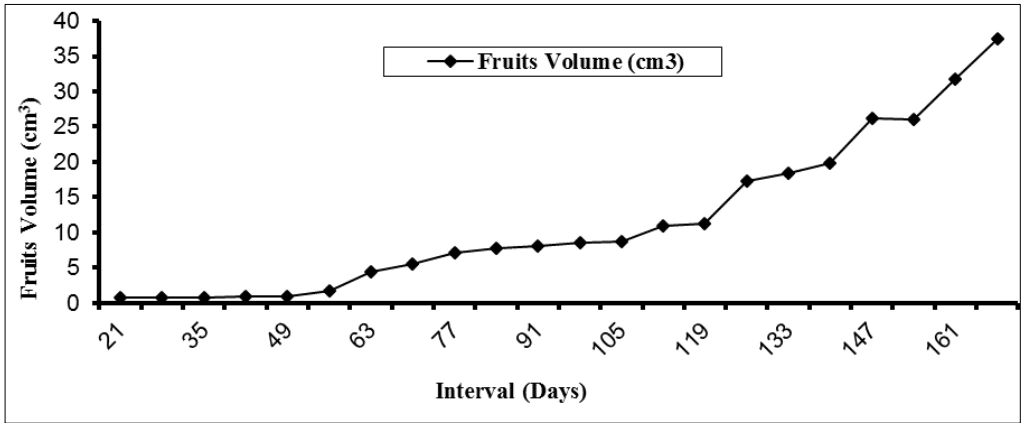

Fig 4: Changes in fruit volume during growth and development of ber fruit

The specific gravity of ber fruit increased continuously during growth and development. Maximum specific gravity of ber fruit was recorded at 56 days of fruit setting thereafter it was decrease till 0.97 at 168 days. The increasing in specific gravity might be due to accumulation of more metabolites resulting higher weight at faster rate than increase in the volume. The continuous change in specific gravity of fruit has also been noted by (Pandey *et al.,* 1990) [6] They reported that specific gravity of the ber obtained at fruit setting stage was 1.06 (g/cc) but decreased continuously after 105 days after fruit set.

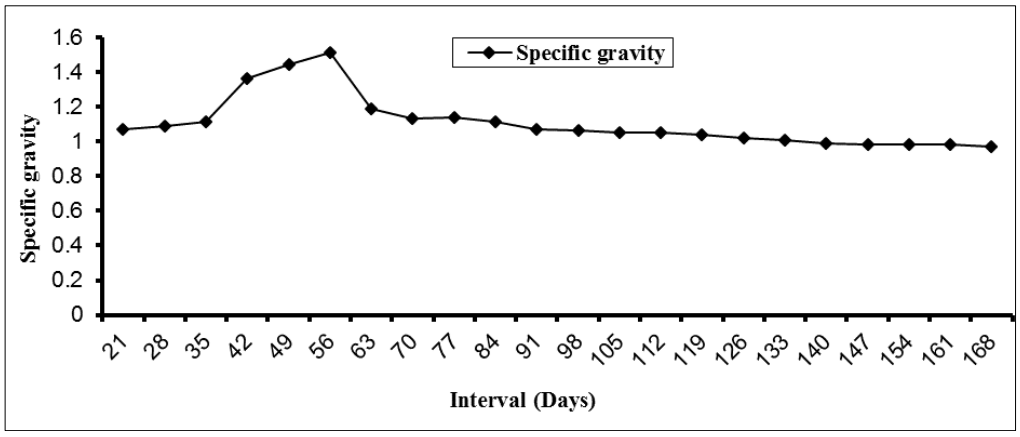

Fig 5: Changes in specific gravity during growth and development of ber fruit

The pulp weight is increased gradually from 91 days to maturity. It is evident from the results given in Table that the pulp weight recorded from 91th day after set increased gradually towards harvest. The increase in pulp weight was corresponding with increase in fruit weight. The results were in line with the findings of (Ingle *et al.,* 1982) [4], who observed a gradual increase in pulp weight throughout the development of sapota fruit till harvest maturity.

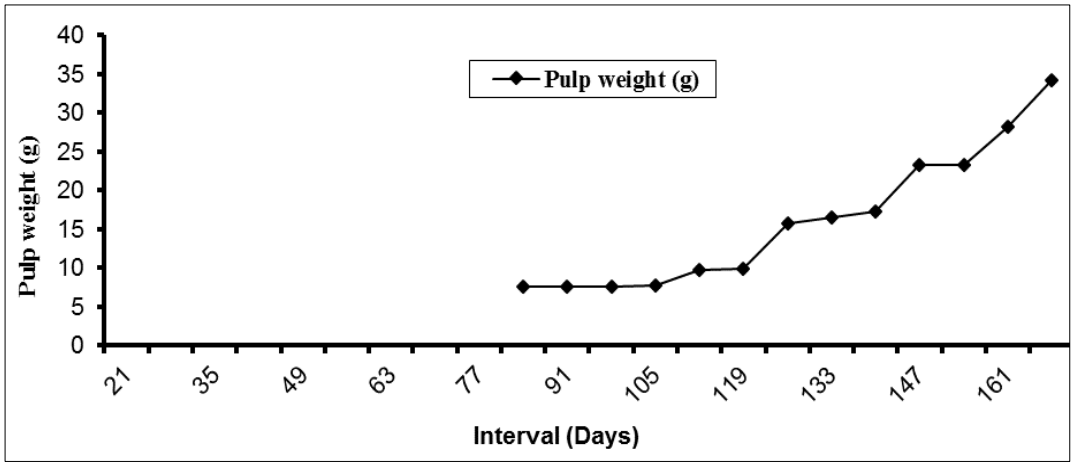

Fig 6: Changes in pulp weight during growth and development of ber fruit

As observed from the data, the seed was traceable only from 91th days after set and weight of seed was increase gradually till 168 days. This is consitant with the result obtained by Gupta *et al.,* (1984) [3] two ber cultivars viz. Jogia and Kaithli.

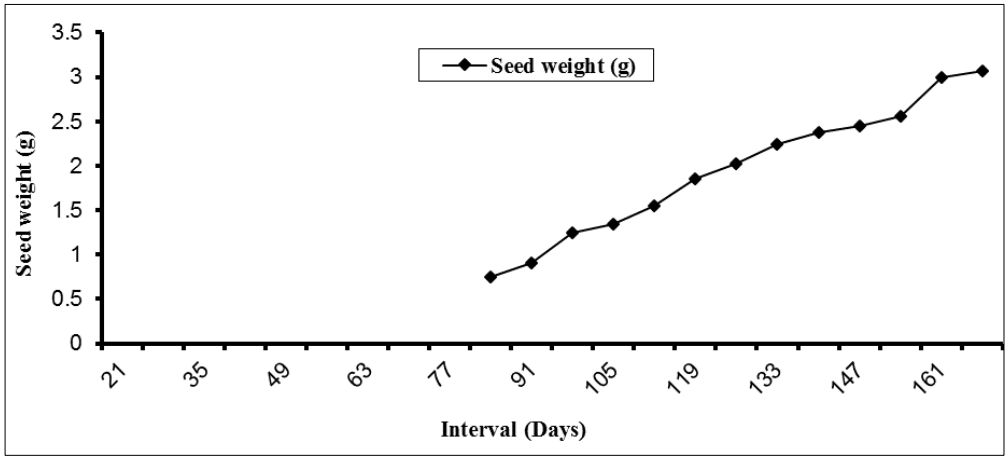

Fig 7: Changes in seed weight during growth and development of ber fruit

Conclusion

The study revealed significant differences of different stages fruit characters studied. Fruit length, breadth, weight, pulp weight, volume and seed weight increased from fruit set till maturity at all stages of growth and development accept specific gravity, specific gravity first increases at mid of November then decreased at harvesting stage.

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