Policy Research Journal
ISSN (E): 3006-7030 ISSN (P) : 3006-7022 Volume 4, Issue 2, 2026

TREE AGE EFFECT ON FRUIT PHYSICAL, BIOCHEMICAL AND ANTIOXIDATIVE ATTREIBUTES OF "RED DELICIOUS" APPLE

Gull Marjan[1], Imran Ullah[*2], Yousaf Khan[3], Habibullah Kakar[4], Muhammad Akbar[5], Imran Ullah[6]

[1,*2,5]*Department of Horticulture, Muhammad Nawaz Shareef University of Agriculture Multan, Pakistan.*
[4]*Horticulturist Directorate of Agriculture Research Loralai, Govt of Balochistan.*[3]*Department of Agronomy, Muhammad Nawaz Shareef University of Agriculture Multan, Pakistan.*
[6]*Department of Soil and Environmental sciences, Muhammad Nawaz Shareef University of Agriculture Multan. Pakistan.*

[*2]Imran.ullah@mnsuam.edu.pk

DOI: https://doi.org/10.5281/zenodo.18604696

Keywords:
Red Delicious apple; Physical fruit attributes; Biochemical characteristics; Antioxidant activity; Phenolic content; Orchard management

Article History
Received: 05 December 2025
Accepted: 20 January 2026
Published: 11 February 2026

Corresponding Author: *
Imran Ullah

Abstract

Tree age is an important factor that affects the quality of different fruits including apples. This research plan was carried out to explore the impact of tree age on 'Red Delicious' apple fruit. Physiological mature apple fruits of different tree age groups (5-6 years, 10-11 years, and 16 -17years) plants were harvested from District Ziarat Balochistan. The harvested fruit of various age groups plants were evaluated for physical quality attributes (fruit color, firmness, weight, peel thickness, length, width, no of seeds), biochemical characteristics [TSS (Brix), TA (%), Vitamin C (mg/100g juice)], organoleptic and anti-oxidative parameter. In addition to the fruit study, the leaf samples of selected plants and soil samples also were investigated for physical and chemical attributes. The result showed that highest fruit peel thickness (1.28 mm), fruit length (7.33 cm), fruit width (5.97 cm), fruit volume (3.14 cm^3), and No. of seed (5.30) were recorded in fruit of 16-17 years plant. However, highest fruit weight (230 g) was found in 10-11 years of age apple plants. In biochemical characteristics, high vitamin C (38.78 mg/100g juice), and juice pH values (4.85) were found in 5-6 years apple plant. While maximum TA (0.26 %) and TSS/TA ratio (126.81) was recorded in the 10-11year age plant. However, the highest TSS value (27.05) Brix was recorded in the 16–17-year age plant. In anti-oxidative parameter, the highest TPC (4.29 u/mg protein), anthocyanin, CAT (254.25 u/mg protein) , and POD (52.42 u/mg protein) were recorded in 16–17-year age plant. However highest SOD values (95.12 u/mg protein) were recorded in 5-6 years age plant.

INTRODUCTION

The apple tree scientifically known as *Pyrus malus* L. This is the member of Rosaceae family. This fruit are more expensive in the world (Rehman *et al.*, 2018). According to Wani and Songara (2017) it flourishes between 1,500 and 2,600 meters above sea level. Hopf (1973) identified evidence of apple gathering at Neolithic (11,200

bP) and Bronze Age (c. 4,500 bP) sites throughout Europe. Evidence of apple production in Israel dates back to 1000 BC (Zohary and Hopf, 1994). The current investigation into the apple's ancestry necessitates a comprehensive review of the genus Malus, since very little is known on the probable location and timing of apple domestication beyond the

widespread cultivation of the fruit in the Old World throughout the Graeco-Roman period. Also, most wild species are interfertile and may be found all throughout the North American continent, Asia, and Europe (Simmonds, 1976). Apples, like many other varieties, are mostly found in a large area. Asia Minor, Central Asia, Pakistan, Himalayan India, and the Caucasus are all included in this region of Asia (Simmonds, 1976; Zhang *et al.*, 1993). Although there is some debate over where the domesticated apple tree originated, modern theory holds that Malus sieversii (Lindl.) Roem., a tree native to the central and eastern regions of China, played a pivotal role in its genesis (Juniper *et al.*, 1996). From almost inedible "crabs" to fruits that aren't too unlike from some current cultivars, M. sievert's fruit variety is vast. Various species of Chinese apple trees, such as M. sieboldii (Reg.) Rehd., If. prunifolia (Willd.) Borkh., and M. baccata(L.) Borkh., may have interbred in the eastern region with M. sievert. Combinations with trees such as Melaleuca orientalis, Melaleuca turkmenorum Juz., and (*Melaleuca Syfvestris* L.) Mill. may have occurred in the western region. Following the development of grafting techniques, a number of selected cultivars emerged, which had a major impact on horticulture in the Old World (Brown *et al.*, 2012). In the British Isles, when alien apple varieties first encountered favorable weather conditions, they mixed and changed, mostly among themselves, but also transformed and grew to such an extent that, by the end of the 1800s, nearly every town and village in central and southern England had its own apple variety. The total number of apple types likely exceeded 2,500 (Juniper *et al.*, 1996). In the early days of European settlers on the eastern coast of North America, they brought their own methods of growing plants, such as fruits and vegetables. Beginning in the late 1500s, they began planting European crops in the new colonies. Apples, for example, likely originated from apple seeds, but later on, they began planting specific types of apple trees in the tide water region and other areas.

Seed growing, as a method of establishing orchards, persisted in some regions of North America far into the nineteenth century. Consequently, the genetic diversity in North American orchards quickly surpassed that in European orchards (Simmonds, 1976). With an almost infinite potential for hybridization, North America became a vast experimental station, crudely screening seedling apple varieties (Juniper *et al.*, 1996). Because the seeds would have had a cooler stage of growth after the very cold winters in the American mainland, this could have been achieved by people who traveled and maintained gardens.Depending on the cultivar, age, and vigor of the tree, apple fruit buds may be found either terminally on fruiting spurs (short shoots) or laterally on long shoots; these bud types are intermingled (Buban and Faust 1982). According to Buban and Faust (1973), the floral primordial begins three to six weeks after bloom or when branch development stops. At the same time, embryos are developing in the seeds. There have been two perspectives on the study of fruit bud initiation and development: 2) the development of bud scales, leaves, and bracts; and 1) alterations in the apical meristem Changes in the morphology of the apical meristem follow changes in histology and cytochemistry (Faust ,1984). The previous section demonstrated that inflorescence is determinate; nonetheless, there is some disagreement over the word.An inflorescence without a centrifugal blooming sequence was described by Osterwalder (1910) as a compressed corymb. To include a corymbose raceme with a terminal bloom and a propensity for dichasial branching, Bijhouwer (1924) broadened this concept. According to Black (1916), the inflorescence typically consists of four to seven pedicelled blooms strung on a very small peduncle, sometimes known as a bourse or

fruiting spur. The cluster was described by Zielinski (1955) as a determinate inflorescence, a "false or spurious cyme" due to the following anthesis sequence: 1) king or terminal flower, 2) basal lateral flower, and 3) the other flowers in acropetal succession. Compared to early-flowering inflorescences, late-flowering in 4 of the cultivars had longer axes, fewer flowers, and bigger leaves (Rudloff and Feucht ,1957). These clusters of blossoms appear as the plant begins to bloom at the end of the growth season (Abbott, 19701). Apple blossoms are hermaphroditic and often include five sepals, five petals, a syncarpous gynoecium with five locules, and three whorls of stamens arranged in centripetal order (10, 5, and 5 stamens, according to Kraus and Ralston, 1916). A fleshy auxiliary fruit called a pome emerges from this kind of bloom. The five carpels have a drupe-like structure, with a stiff, membrane-covered endocarp and a soft exocarp and mesocarp (Zielinski ,1955). Starting with the male components, the article describes the reproductive organs of hermaphroditic apple blooms. According to Osterwalder (1910), each stamen has nine to twenty filaments and an anther that contains two microbes or pollen sacs. There is an epidermis on the anther wall, a fibrous (endothermic) layer with cells that have unevenly thick walls and two or three layers of tiny cells that help with dehiscence, and a tapetal layer that develops with the pollen grains and lines the locule.The 2-nucleate state is characterized by the shedding of pollen grains (Shoemaker ,1926). Cresti *et al.* (1983) classified the stigma as a moist kind. According to Braun and Stosser (1985), 2-3 days after bloom, the turgidity of stigmatic papillae is lost. Typically, five styles are joined at the base, although, according to Haskell (1956), there may be anywhere from four to six styles. The pollen tubes develop intercellularly via the solid core of the style, which is composed of transmission tissue (Anvari and Stosser 1981). According to Anvari and Stosser, every style's transmitting tissue is distinct and continuous, with a single locule. Interactions between the stigma, pollen, and the ovule, as well as between the transmitting tissue and the pollen tube, are regulated by two barriers. In the interactions between stigma style and pollen, Heslop-Harrison (1976) emphasized the importance of exine. The microspore and the tapetum both contribute to the exine's production.Lipides and proteins are metabolites that attach to the sculpted surface from the tapetum. A combination of these and the stigma's chemicals may prevent pollen from germinating when the two come into contact during pollination. For the most part, compatibility responses regulate how quickly pollen tubes expand in the transmission tissue (Haasbrook *et al.* 1967). Insects have a significant role in pollinating hermaphroditic apple blossoms (Free,1964). Entomologists have recently shown a connection between the structure of self-sterile 'Delicious' flowers and the behavior of bees in terms of pollination efficiency. For honey bees to be able to "side-work" (collect nectar) without touching the stigmas, flowers with erect stamen filaments and spaces between them are necessary (Robinson ,1979).

History of Apple

The FAO (2017) put Pakistan's apple fruit harvest at number ten among other key horticulture nutritive fruits, with a yield of 590,039 metric tons. Apple trees are grown in the mountainous regions of Baluchistan, KPK, and the northern parts of Pakistan. Baluchistan accounts for 64 percent of the country's apple harvest (GOP, 2006). While there are almost 10,000 identified apple varieties, only 20 are grown commercially in the United States and China, two of the world's largest apple producers (Janick *et al.*, 1996). Contrarily, in 2011, apple output hit a peak of 6.6 tons per hectare, with an area of 47.7 thousand hectares producing about 315.4 thousand tons (Ali et al., 2011). According to Javaid *et al.* (2011), Pakistan's apple orchards cover 1,13,000 hectares, yielding 4,41,600 metric tons of fruit each year. When it comes to apple production, Pakistan ranks 34th in terms of area and 24th in terms of orchard size. Toori *et al.* (2023) found that 25% of Pakistan's total apple output comes from the region of Balochistan, with Khyber Pakhtunkhwa coming in second. The mountainous regions of Punjab, Khyber

Pakhtunkhwa, and Baluchistan are ideal for growing apples in Pakistan (Rehman *et al*., 2018). Pakistan is known for its abundance of apple types, including golden, red, kala kulu, kaja, gacha, amri, mushadi, and kashmiri apples. Mustung, Kalat, Killa Abdullah, Killa Saifullah, Loralai, Pashin, Quetta, and Ziarat are some of the most important apple-growing areas in Baluchistan.

Ziarat is smack dab in the middle of one of these districts (Biswas and Sarkar, 2023). According to Mendenhall *et al*. (1979), Pakistan's fruit exports increased from 191,739 metric tons in 2012 to 218,203 metric tons in 2013, with a value of 143.4 million. According to Golias *et al*. (2008), apple fruits may vary in color, form, and possible physiological abnormalities according to cultivar, environmental conditions, and things that occur before and after harvest. The production, harvesting, packaging, handling, and marketing practices throughout the supply chain, as well as physiological diseases, have a direct impact on the quality, texture, and taste of apples, and hence on earnings. Because of their climacteric nature, apples are best enjoyed when picked at the peak of ripeness for maximum size, color, and taste. Many ripening-related changes take place in the month leading up to harvest, during harvest itself, and throughout the cold chain (Greene, 2010). The temperature during harvest and consumption is the most significant factor for apples; keeping them at the lowest safe temperature ensures great quality, high results, and a long shelf life (Kitinoja and Kader, 2002). There are a number of reasons why apples have piqued the interest of scientists. Apples are an attractive fruit for several reasons, including their low cost, adaptability, and high nutritional content, as well as the large array of bioactive components they contain. Few studies have examined whether other apple preparations (such as juice, pomace, cider, vinegar, etc.) offer the same health benefits as whole apples, even though eating apples has been linked to several good health outcomes. Though some say apples in their full form are healthier and more nutrient dense, others say apples in juice or another liquid form are more convenient (Benton and Young, 2019). Fruits are a great source of vitamin C, an effective antioxidant that may neutralize free radicals and aid in the cell and molecular protection against oxidative damage that can lead to several ailments. For both enzymatic and non-enzymatic processes, vitamin C may serve as an electron donor (Lykesfeldt *et al*., 2014). and a component of ferrous and 2-oxoglutarate dependent dioxygenases, which are enzymes that have a role in the hydrolysis of lysine and praline, two building blocks of collagen (Abdullah *et al*., 2022)It is involved in the biosynthesis of muscle carnitine and nor adrenaline, amidation of peptide hormones, histone demethylation, tyrosine metabolism, iron homeostasis via hypoxia-inducible factor hydroxylation, and other enzyme-catalyzed processes (Lykesfeldt, and Poulsen 2010).

Research Gap

Apple fruit quality is influenced by the age of the trees. But as far as we are aware, there are few if any papers in the literature discussing how different tree ages affect apple fruit quality. Moreover, no work has been reported in literature to explore the tree age effect of apple fruit in Baluchistan.

Hypothesis

It was hypothesized that various tree ages may effect Apple fruit quality attributes. Therefore, a study is planned to investigate tree age effect on apple fruit various quality attributes of cultivar red delicious grown under location of District Ziarat Baluchistan.

Objective

To investigate tree age effect on fruit physical, biochemical and antioxidative attributes of Red delicious apple.

Materials and Methods

Fruit harvesting

Ziarat is a district in North Balochistan, Pakistan situated at an altitude of about 2,400 meters with the GPS coordinates of (30.392609° N and 67.728362° E). The maximum temperatures range 20 -30 °C while the minimum temperatures hover around 10-15 °C with low humidity. It

receives an average of 457 millimeters (18 inches) of rainfall annually. For this study, apple fruit of different age groups (5-6, 10-11 and 16-17 years) grown in a commercial orchard located at (30.4663088° N and 67.5699081° E) Ziarat Balochistan were selected. Physiological mature fruits of selected plants were harvested, packed in boxes and immediately transported to postharvest Science and Technology Lab of MNS-UAM for assessment of various attributes such as analysis of physical, biochemical and antioxidative attributes. Each experimental treatment was consisting of 20 fruits, (5-fruit per replication, replicated four times). In addition to fruit sampling, the selected plants were sampled for leaf and soil.

Sampling of leaves and soil

Soil samples were collected from apple orchards at depths ranging from 6 to 12 inches. Through one orchard 12 apple plants of different ages were tagged. Leaf and Soil samples were collected. A composite soil sample was taken from two soil depths. In the meantime, leaves from the tagged plants were also collected. Twig leaves were taken at shoulder height from the selected plants in the orchard.

Soil Analysis

Electric conductivity of soil samples

The SI unit of EC is is Desi siemens per meter is (dS/m). The electrical conductivity (EC) of soil is a measure of its ability to conduct electricity. It is an important soil attribute that can indicate the salinity level of the soil. High EC values in soil can suggest the presence of excess salts, which can be harmful to plant growth.

Soil PH analysis

To determine the pH of the soil, a 10 g soil sample was collected and placed in a conical flask, and 150 ml of deionized water was added to make a 1:5 soil-water suspension.

After calibrating the pH meter using two buffers with pH values of 7.01 and 10.1, the pH of the sample was measured and recorded (Rayment and Higginson, 1992)

Soil texture

The hydrometer method, as outlined in the study by Estefan et al. (2013), was utilized to analyze soil texture. A soil sample weighing 40 g was air-dried and placed in a 500 ml beaker containing a 1% sodium hexametaphosphate solution. To this, 40 ml of the solution was added along with 150 ml of distilled water, and the mixture was left overnight in the beaker. The soil suspension was then stirred for 10 minutes using a mechanical stirrer and transferred to a 1L volumetric cylinder. A metal plunger was used to vigorously shake the suspension, and the initial reading was taken after 40 seconds.

Leaves Nutrients Analysis

Following the sulfuric acid digestion on a heated plate at 380 °C, macronutrients in leaves were analyzed. Following digestion, the Kjeldhals distillation equipment was used to analyse total nitrogen. To determine P and K in leaf samples, di-acid (HNO_3-$HClO_4$ = 2:1 ratio v/v) digestion was performed on a hot plate at 250 °C. P (ammonium vanadate-ammonium moly date yellow colour technique) and K were determined using a spectrophotometer (absorbance at 420 nm) and a flame photometer (PFP 7, Jenway except B, the wet digestion procedures were used to assess micronutrients in leaves using an atomic absorption spectrophotometer. Leaf samples were dry-ashed for 4 hours at 550 °C before B concentration levels were calculated with Azomethine.

Physical Parameters of Fruit

Fruit Volume

The volume of a fruit was measured in a 500ml beaker with water displacement method. The fruit is then put in the beaker, and the water level is checked after the fruit was dipped in the beaker.

Fruit weight (g)

The weight of fresh apple fruit was determined by selecting 5-fruit per replication and weighing them using a digital weighing balance (OHASU Corporation, USA) which gives the weight into grams and calculating the average fruit weight by

using the formula. By dividing the weight of the sample by the total number of fruits, the average weight was obtained.

$$\text{Fruit weight} = \frac{\text{Total fruit weight}}{\text{Total number of fruit}} \text{x } 100$$

Fruit diameter (mm)

The average diameter in millimetres was determined by measuring the diameter of five fruits each replication using a Vernier calliper (Mitutoyo 500-171-20, Japan).

Fruit length (mm)

We measured the diameter of certain fruits using a Vernier calliper (Mitutoyo 500-171-20, Japan) and averaged diameter in millimeters was than calculated.

Peel Weight (%)

Peel weight of 5 fruits were weighted by using electronic weight balance ((Mitutoyo 500-171-20, Japan) in grams and peel weight was calculated as per below mentioned formula:

$$\text{peel weight (\%)} = \frac{\text{peel weight}}{\text{Total weight of fruits}} \text{ x } 100$$

Peel thickness (mm)

Peel thickness of five fruit were measured in millimetres using a Vernier calliper (Mitutoyo 500-171-20, Japan). Next, we determined the mean diameter in millimetres.

Seed weight (mg)

We used a weight balance (OHASU Corporation, USA) to measure the weight of five fruits' seeds in grames, and then we took the average. We used the following formula to get the seed weight (%): $\text{Seed weight} = \frac{\text{Total Fruit weight}}{\text{Total No of fruit}} \text{x } 100$

Number of seeds

Seeds from 5 fruits from each replication were counted and the average was calculated.

Biochemical Parameters

Total soluble solids (TSS, Brix, %)

Fruits that have ripened were tested for total soluble solids (TSS) using a portable refractometer. The TSS was determined by extracting apple juice using a juicer equipment. In order to standardise the equipment and determine zero, distilled water was utilised. Using a dry and clean lens, a digital refractometer showed the result as brix after 2-3 drops of room temperature juice were added.

Titratable acidity (%)

The Titratable acidity was assessed by using procedure of Razzaq *et al*. (2013). A 100-mL flask held 10 mL of juice. As an indicator, the juice sample was then treated with 2–3 drops of phenolphthalein. Eventually, the test was titrated against 0.1 N NaOH until a pale pink tint was obtained. The TA content of juice was calculated using the following formula.

$$\text{Titratable acidity (\%)} = \frac{\text{0.1 N Vol. of NaOH used} \times \text{ 0.0064}}{\text{10 ml juice taken}} \times 100$$

Vitamin C (mg/100ml of juice)

Using Ruck's approach, the content of ascorbic acid, often known as vitamin C, was determined in 1961. To get the volume equivalent to the flask's capacity, a

100 mL volumetric flask was filled with 10 mL of juice and 0.4% oxalic acid. After passing the filtrate through a filter paper, 5 mL was added to a 20 mL beaker and the dye (2, 6-'dichlorophenolindophenol) was titrated until a vibrant pink colour was erreicht.

$$\text{Ascorbic acid (mg/100mL)} = \frac{1 \times \text{R1} \times \text{V}}{\text{R} \times \text{W} \times \text{V1}} \times 100$$

Where,

R = mL of dye used to titrate against 2.5 mL of reference solution (1.5 mL 0.4% oxalic acid + 1 mL standard ascorbic acid) (Standard reading) R1 = mL of dye used to titrate against V1 of aliquot (sample reading)

V = Volume of filtrate made by (0.4% oxalic acid)

V1 = mL of juice taken for titration

W = mL of juice taken

(In a 200 mL volumetric flask, we mixed 42 mg of NaHCO3 with 52 mg of 2,6 dichlorophenol indophenol to create a dye. The final volume, 200 mL, was achieved by adding distilled water to the initial volume.

Fruit Juice pH

A digital pH meter was used to determine the acidity level of the Apple juice (Starter 3100 OHASU Corporation, USA). The instrument's probe was dipped into 25 mL of juice in a beaker to get a reading. Consistent reading was recorded as the final pH value of the juice.

TSS: TA Ratio

The ratio of soluble solid content and titratable acidity was calculated by dividing the TSS (%) with respected value of TA (%) to get the TSS/TA ratio.

Statistical analysis

A one-factor factorial randomized complete block design (RCBD) with four replications was used to design the study. The experimental trial results were statistically evaluated using ANOVA. Mean comparison and correlation tests were performed using appropriate statistical software (Statistix® 8.1) to evaluate the relationship between fruit quality and harvest site.

Results and Discussion

Soil physical and chemical attributes

Soil Depth (inch)	E.C. dSm^{-1}	pH	Saturation %age	Texture
0-6	$2.54_{\pm 0.02}$	$8.9_{\pm 0.01}$	$42_{\pm 0.12}$	Loam
6-12	$3.53_{\pm 0.05}$	$8.5_{\pm 0.04}$	$42_{\pm 0.18}$	Loam

Soil attributes of selected apple orchard were presented in table 1 at two depths. The soil attributes at 0-6 inches indicated a soil EC of about 2.54 dSm^{-1}. while soil Ph is 8.9 and the texture are loam.

Soil attributes of selected apple orchard were presented in table (1) at two depths. The soil attributes at 6-12 inches indicated a soil EC of about 3.53 dSm^{-1}. while soil pH is 8.5 the texture is loam.

SOIL ATTRIBUTES OF SELECTED APPLE ORCHARD

Soil physical and chemical attributes of selected apple orchard

Leaves analysis

Nitrogen, Phosphorus, Potassium, Zinc, Copper, Iron, Manganese

The present data indicated that Nitrogen content of Apple leaves significantly affected by different plants age group. Results regarding age group indicated that maximum nitrogen content in 16-17 years age of tree group Apple leaves (1.51%) was recorded in Apple leaves. While less nitrogen was present in 5-6 years old tree (1.32%) and also less percentage in 10-11 years tree leaves (1.47%) as shown in (table 2.2).

Observation regarding Phosphorus of Apple leaves significantly affected different plants aged groups. In terms of age groups, the 16-17 years old age plant leaf had maximum concentration of phosphorous in leaf (1.51%). While according to plants aged 5-6 years old (1.32%) and (1.47%) in

10-11 years old plants respectively as shown in (table 2.2).The present data indicated that Potassium content in Apple fruit
leaves significantly affected by plants aged groups. Results indicated that higher potassium content (1.45 %) in 16-17 years of age was recorded in Apple fruit leave. While 5-6 years old age group leaves have (0.87%) potassium content and (1.20%) in 10-11 years old age group leaves as shown in (table 2.2).

The present data indicated that zinc content of apple leaves was significantly affected by different plants age group. Results regarding age group indicated that maximum zinc content (98.6%) was recorded in 5-6 years old apple tree leaves. While less zinc content (77.5%) was present in 10–11-year-old and (85.4%) in 16-17 years old tree leaves as shown in (table 2.2).

The present data indicated that cu content of Apple leaves significantly affected by different plants age group. Results indicated that maximum cu (24.3) content was recorded in 5-6 years old apple tree leaves. While less cu (77.5) was present in 10-11 and (12.1) in 16–17-year-old tree leaves.

Table 2.2: Selected apple plants leaves nutrients status

Age Group	Nitrogen %	Phosphorus %	potassium %	Zinc (ppm)	Copper (ppm)	Iron (ppm)	Boron (ppm)
5-6 Years	1.32	0.31	0.87	98.6	24.3	385	45.7
10-11 Years	1.47	0.34	1.20	77.5	18.7	427	66.4
16-17 Years	1.51	0.29	1.45	85.4	12.1	406	58.3

Fruit physical parameters

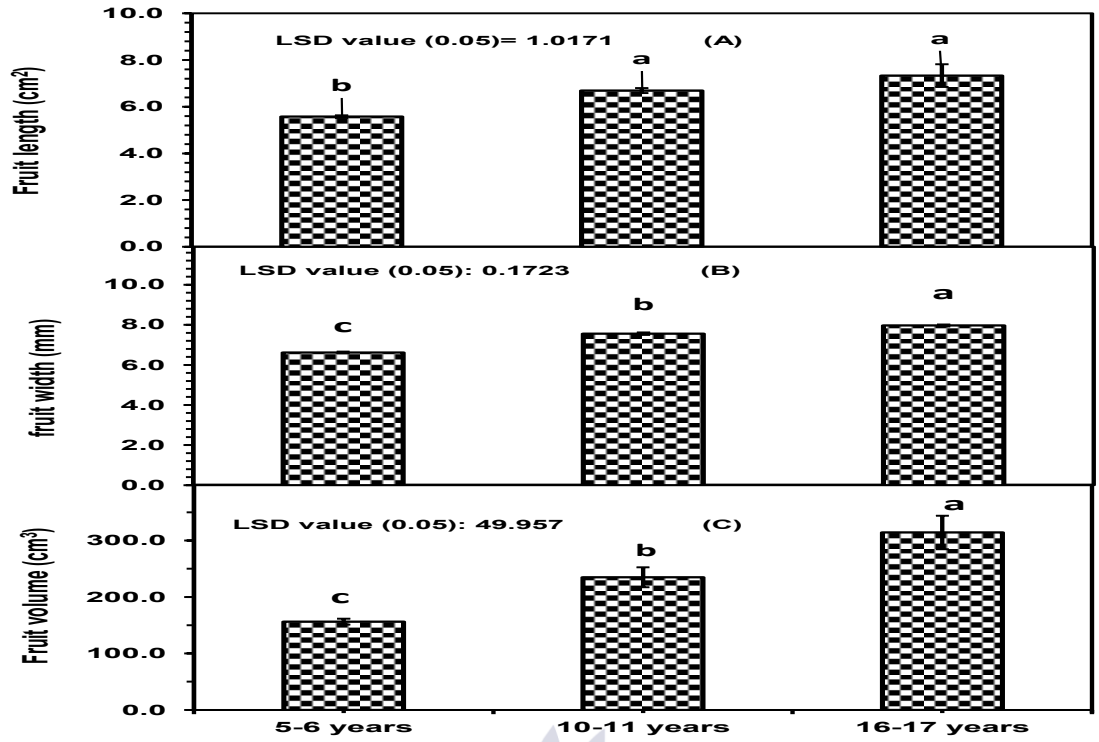
Fruit length, fruit width and fruit volume

The age group of apple trees has a significant impact on fruit length of apple ($p < 0.05$). When comparing apple trees of different ages, fruit from trees that were 16-17 years old had the longest average length (7.33 cm). (Fig. 2.1A).

Various age group of apple trees significantly ($p < 0.05$) affected the fruit width of apple fruit. Fruit of plant age group 16-17 years exhibited highest fruit width (7.97 mm) as compared to other age group plants. (Fig. 2.1B).

Similarly, fruit volume of apple fruit was significantly ($p < 0.05$) affected by apple tree age. Apple plants of age group 16-17-year-old exhibited significant highest fruit volume (314.25 cm^3) as compared to fruits of other age group plant (Fig. 2.1C).

Effect of tree age on fruit physical parameter fruit length (A), fruit width (B) and fruit volume (C) of 'Red Delicious' apple fruit. Means representing same letter are non-significant at $p \leq 0.05$.



A member of the Rosaceae family, the apple (Malus domestica L.) is a valuable perennial fruit crop that is native to many regions of Asia and Europe (Sandor,
2008). Other members of this subfamily include quince and pear. According to Moazzezi *et al.* (2012),
this fruit is typically cultivated in temperate zones across the globe. The apple, sometimes known as the "King of temperate fruit," thrives in climates that have mild summers, chilly winters, and never freezes in the spring. Apples are cultivated in hilly, temperate regions and need a chilling period of 1000 to 1600 hours. Grown between 1,500 to 2,600 metres above mean sea level, apple trees are among the most commercialised and extensively spread deciduous trees in the world (Skinner *et al.*, 2018; Wani and Songara, 2017). Apple blossoms are hermaphroditic, with a medium peduncle, twenty yellow stamens, five sepals, five pistils, and five pink-flecked white petals that make up the corolla. Pome fruits have two or five carpels that are covered by a fleshy covering. The calyx also has five sepals and pistils.

Apple blossoms (*Malus domestica)* are carried on fruiting spurs and, on longer branches, either faterally or terminally. There are several steps involved in the flowering process, which spans two seasons. The first season begins with flower induction, which fades with time, and continues through flower initiation, differentiation, and blooming in the second season. The process of flower induction marks the change from vegetative to reproductive growth in meristems. About fifty days after full bloom, the shoot apex begins to widen, a morphological hallmark of this period. According to Hanke (1981) and Foster *et al.* (2003), the morphological hallmark of the flower initiation stage is the doming of the shoot apex, which is accompanied by a sequence of histological alterations.Because of its numerous interconnected parts—including mature ovaries—the apple is technically a fake fruit. According to Hertog *et al.* (1993), the five ovaries of the flower are encased in a fleshy, edible tissue.

REFERENCE

Zhang, H.,L.P.Simmonds, J.I.L. Morison and D. Payne.1993. Estimation of transpiration from single trees: comparison of sap flow measurements with a combined equation. Agric. For. Meteorol. 87:155-169.

Zhang, W., J. Zhang and X. Hu. 1993. Distribution and diversity of Malus germplasm resources in Yunnan, China. Horti Sci 28:978–978.

Juniper, B.E., R. Watkins and S.A. Harris. 1996. The origin of the apple. Eucarpia Symposium on Fruit Breeding and Genetics .27–34.

Faust, M. (ed.). 1984. International workshop on controlling vigor in fruit trees. Acta Hort. 146. Intern. SOC. Hort. Sci., Netherlands.

Faust, M. 1973. Effect of growth regulators on firmness and red color of fruit. Acta Hort. 34:407-420.

Brown, S. 2012. Apple. In *Fruit Breeding*: 329–367. Springer US.

Shoemaker, J. S. 1926. Pollen development in the apple, with special reference to chromosome behavior. Bot. Gaz. 81:148-172.

Robinson, W. S. 1979. Effects of apple cultivar on foraging behavior and pollen transfer by honey bees. J. Am. SOC. Hort. Sci. 104:59and598.

FAO (Food and Agriculture Organization). FAO Statistical Databases. 2021. Available from:http://www.fao.org.

GOP, 2006. Agricultural Statistics of Pakistan, Ministry of Food, Agriculture, and Livestock. Food and Agriculture Div. Planning Unit, Islamabad.

Rehman, A., M.S. Khan, S.A. Zakaria, A.A. Malik and M. Shahid. 2018. To study the effect of willow extract on apple cuttings for different time duration. J. Bio Agri Healthcare 8:21–24.

Golias, J., P. Mylova and A. Nemcova. 2008. A comparison of apple cultivars regarding ethylene production and physico-chemical changes during cold storage. Hort. Sci 35:137–144.