J Agric. Res., 2020, Vol. 58(3):183-187
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Agriculture Department
Government of Punjab

HORTICULTURE

PERFORMANCE OF DIFFERENT VARIETIES OF AVOCADO AT LOWER ALTITUDES OF MURREE HILLS

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Article received on: 28/11/2017
Accepted for publication: 08/09/2020

ABSTRACT

Avocado (*Persia americana*) is a fruit of immense economical importance besides it's medicinal benefits and various other usages. Considering its different high merit attributes different varieties of avocado of USA and Far East origin were planned to raise in Fruit Plant nursery Charapani Tret about 3500 feet above sea level. A trial on systematic evaluation of five varieties of this important fruit was tested at lower attitude of Murree hills (Hill Fruit Research Station, Murree), Pakistan during 2012-2015. The candidate varieties under evaluation were California Long, Ceylon Blue, Avocado selection 1, Avocado selection 2 and Avocado selection 3. Studies on physical parameters i.e. fruit size, pit size, pit to seed ratio and on prominent organoleptic characters were also the part of evaluation of quality characters. Sample size for the measurement of character of individual varieties was ten fruit. Studies on fruit size (l×b), size of pit, weight of the fruit and weight of seed remained significantly higher in avocado selection 1 than that of other varieties under evaluation. For internal quality attributes hedonic scale reading remained higher both for flavor and color in selection-1. As regards fruit texture, taste of the pulp and seed to core ratio remained maximum in avocado ceylon blue. Conclusively, selection-1 appeared to be a variety of economical significance for its large scale commercial cultivation particularly in the lower altitudes of Murree hill areas.

KEYWORDS: *Persea americana;* varieties; economic; hill; Muree; Pakistan.

INTRODUCTION

Avocado, botanically called as "*Persea americana"* of family laurceaeis a single seeded berry fruit. It is ever green and belongs to sub-tropical climatic region. It is believed to be originated in the state of Puebla, Mexico (Knight and Origin, 1980; Prabha *et al.,* 1980). The undomesticated/native variety is called as "criollo" which is small having dark black skin with large seed. Avocado alternatively called as alligator pear referred to a fruit which may be pear shaped, egg shaped or spherical. In the world, the commercially valuable fruit is mostly cultivated in Mediterranean or tropical climate. Fruit is climacteric;having olive green skin in most of the varieties and contains a large seed embedded firmly in the flesh. Avocado is chiefly propagated by grafting to ensure varietal purity besides. The inherent attributes of a certain variety/cv. particularly the yield and quality of the fruit.There are two types of avocado which grow well in sub-tropical and tropicalagro-climatology. The subtropical types can also be grown at lower altitudes with no or very little frost. Mature trees can tolerate low temperature up to -4°C for short period without undergoing anydamage. Prolonged frost results in fruit drop ultimately reducing the yield to cause economic losses. Young avocado plants should be protected from frost in early 3 years. During the months of May and July night temperature of 5-10°C suppress shoot growth and boost flowering (Anonymous, 2010). Flowering in avocado is affected by many factors such as juvenility, phenology, temperature, water stress and on vs. off year. In sub-tropical varieties flowering is induced by low temperature. Flowering is reduced at very high or low temperature (Buttrose and Alexander, 1978. As described by the Bergh (1974) flower opening and closing follows a regular pattern when the average night minimum and day maximum temperature is above 21°C. With decrease in average minimum temperature and day maximum temperature, flower opening is delayed. Irrigation schedule is second important consideration while growing Avocado. As compared to other fruit species, Avocado water stress do not increase flowering subjected to high or low temperature. After water stress flowering is delayed (Chaikiattiyos *et al.,* 1994).These conditions of climate exist only in few areas of world that's why avocado growing is limited to southern Spain, Israel, South Africa, Peru, northern Chile, Vietnam, Cuba, Australia, New Zealand, Mexico and Central America. A study was carried out on differentexotic varietiesof avocado viz. California longand Ceylon blue during 1999-2000 atHill Fruit Research Sub-Station, Charapani Tret (Nisar *et al.,* 2001). Out of three varieties under study

California long performed best with respect to fruit size and fruit weight and recommended for cultivation at Murree hills. Polate and Caliskan (2013) studied yield and fruit characteristics of seven varieties of apricot under sub-tropical climate of Mediterranean region in Turkey. Similar experiment was conducted by Abbas *et al.* (2016) on adaptability study of different varieties of apricot under soon valley. Seven varieties were tested against Organoleptic and physio-chemical parameters. Castel bright, Sarbagha and Badamivarieties were found to be suitable for growing on low mountainous areas *i.e.* 2500-3500 feet above sea level. Eight mango varieties grown under rain fed area of Jammu were investigated for growth, flowering and yield characteristics. Variety Dushehri exhibited better performance regarding higher fruit set and low fruit drop (Baksi *et al.,* 2012).

At present limited reference is available regarding commercial cultivation of avocado in Pakistan. So, current study was planned to carry out the adaptability studies of different varieties of avocado under Murree hills condition and to assess their quality characters for commercial cultivation. More over the plantation was standing at Hill Fruit Research Sub-Station, CharapaniTret which was chance seedlings of two exotic varieties i.e. California long and ceylon blue. It was need of the era to evaluate the chance seedlings to find out some strain of desirable characteristics suitable for commercial cultivation.

MATERIALS AND METHOD

Five different varieties of avocado were evaluated for their performance under the climatic conditions of Murree hills (Salient characteristics and pictures mentioned in Table. 1 and Fig. 1, respectively). The varieties are as follows:

California long,
Ceylon Blue,
Avocado selection 1
Avocado selection 2
Avocado selection. 3

Twelve year old plants of avocado were selected as experimental material. Plants were planted on terraces. Different physio-chemical analysis was performed on fruit maturity. Experiment was conducted at lower

Table No. 1 Color of fruit and maturity time

Variety	Flowering time	Flowering duration (days)	Fruit peel color	Maturity time
California long	1st March	18	Bluish	3rd week of September
Ceylon blue	10th March	20	Bluish	2nd week of August
Avocado selection. 1	15th March	18	Bluish green	1st week of October
Avocado selection. 2	10th March	22	Greenish	2nd week of September
Avocado selection. 3	15th March	17	Yellowish green	3rd week of August

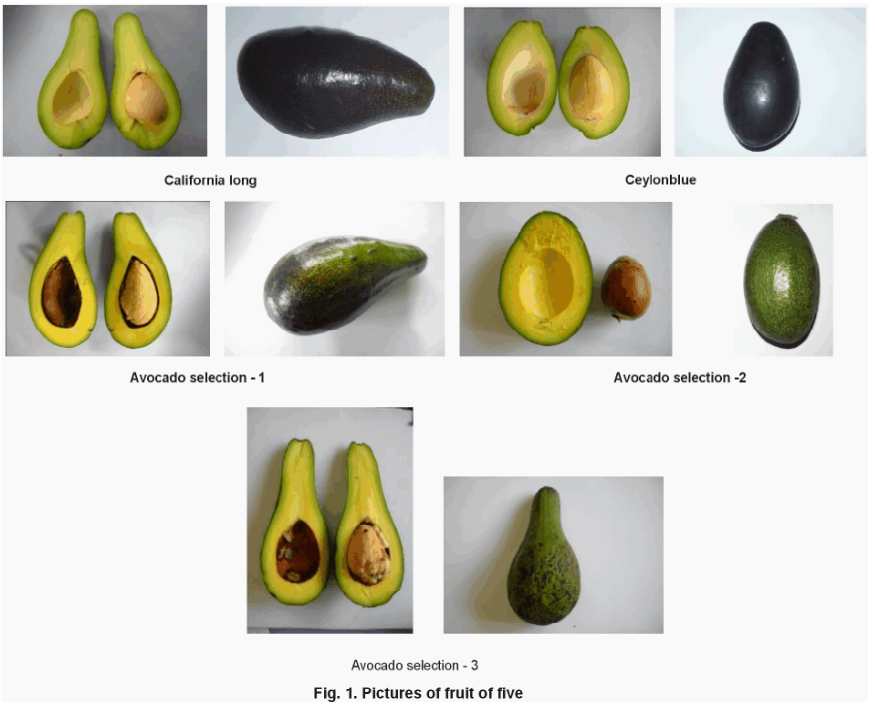

Fig. 1. Pictures of fruit of five

attitude of Murree hills during 2012-2015. Same cultural practices were performed for all varieties. Irrigation was done by harvesting water from springs and plants were fertilized with recommended NPK @ 1000-700-700g per plant. During December 60kg farm yard manure per plant was applied. Nitrogen was applied in 3 split doses; 1st before flowering, 2nd at pea stage and 3rd during the month August. At horticultural maturity fruit was harvested and brought to Hill Fruit Research Station Sunny Bank, Murree laboratory for analysis. 10 fruits from each replication were taken as sample and evaluated for Organoleptic (color, texture, taste and flavor) physical (fruit yield, maturity time, weight of fruit, fruit size) and biochemical attributes (total soluble solids). Hedonic scale was used for Organoleptic evaluation using arbitrary scale ranging from 1-9 (Peryam and Pilgrim, 1957) as: dislike extremely, dislike moderately, dislike very much, dislike slightly, neither like nor dislike (5), like slightly (6), like moderately (7), like very much (8) and like extremely (9). Most avocado varieties have green peel color but some varieties develop anthocyanin contents in peel which results in purplish or blashkish peel colour varietiesThesize of fruit was measured by digital Vernier caliper, weight was measured by Electronic scale, SF-400 and TSS was measured using Digital Refractometer Pal-1.

Experiment was laid out according to Randomized Complete Block Design (RCBD). Collected data was analyzed statistically by using the Fishers analysis of variance and treatments were compared by using the Least Significant Difference (LSD) test at 5% probability level (Steel *et al.,*1997).

RESULTS AND DISCUSSION

Fruit physical parameters

Fruit size: Data regarding fruit size of different varieties of avocado found statistically significant when analyzed at 5 % level of significance. Maximum fruit size (9195 mm) was observed in avocado selection 1which is at par with avocado selection 2 (9007 mm) and 3 (8279.8 mm). Minimum fruit size (4587.2 mm) was observed in ceylon blue. Genetically ceylon blue has smaller size. These results are in line with the results of Nisar *et al.* (2001), who studied performance of different exotic avocado varieties and found maximum fruit weight in California long.

Pit size: Analysis of variance at 5% level of significance revealed significant results for pit size for different varieties of avocado. Fruit harvested from avocado selection 1 had largest pit (2450 mm) while fruits of California long had smallest pit (1559 mm) (Fig. 3). Avocado selection 1 and 2 are found at par with respect to pit size (2384 mm and 2450 mm, respectively). Similarly california long (159 mm) and ceylon blue were found statistically at par. The results are in line with the findings of Nisar *et al.* (2001) who reported minimum pit size in california long.

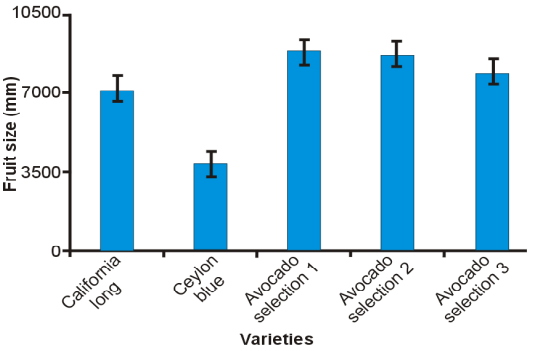

Fig. 2. Fruit size of five varieties of avocado under climatic conditions of Murree hills

Vertical bars represent ± SE of treatment means

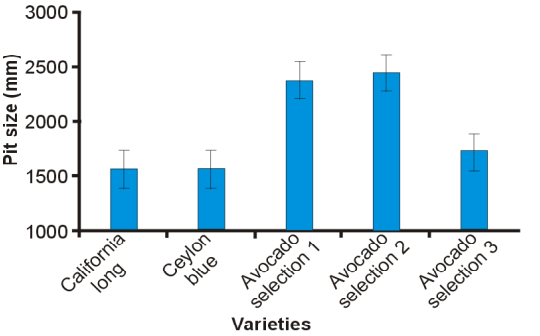

Fig. 3. Pit size of five varieties of avocado under climatic conditions of Murree hills

Vertical bars represent ± SE of treatment means

Fruit width and length: Fruit width and length of avocadoexhibited significant effect when analyzed statistically at 5% level of significance for their evaluation at Murree hills. Fruit harvested from avocado selection 2 exhibited maximum fruit width (121.17mm) and length (74.325 mm) while minimum fruit width (53.248mm) and length (86.13mm) was observed in California long (Table 2). Maximum fruit length and width was observed in the fruits harvested from california long (Nisar *et al.,* 2001).

Pit width and length: The results pertaining to pit width and length in various varieties of avocado grown under the climatic conditions of Murree hills indicated non-significant difference in treatment means. Maximum pit width and length were recorded from fruit harvested from trees of avocado selection 2. Fruit from avocado selection 3 had minimum pit width and California long exhibited minimum pit length (Table 2).

Seed to core ratio: Different varieties of avocado exhibited significant effects in terms of seed to core

Table 2. Physiochemical analysis of avocado varieties under climatic conditions of Murree Hills

Treatment	Fruit width	Fruit length	Pit width	Pit length	Seed: core
California long	53.25c	86.13d	36.52c	42.56c	20.345a
Ceylon blue	53.248c	112.00c	43.77b	43.77c	29.473a
Avocado selection. 1	65.28b	140.86b	38.53bc	61.93a	20.153b
Avocado selection. 2	74.395a	121.17a	59.26a	59.26a	22.412b
Avocado selection. 3	60.59b	136.40a	34.31c	50.32b	21.712b
Standard error	5.5672	8.0560	4.4826	4.6939	3.9301

ratio of fruit. Maximum seed to core ratio was obtained from fruits of ceylon blue while minimum in the fruit of California long. All the varieties were found at par with respect to seed to core ratio.

Fruit weight: The analysis of variance regarding the adaptability of different varieties of avocado in Murree hill area in terms of fruit weight presented in the Table 3 revealed that fruits harvested from avocado selection 1 had higher fruit weight as compared to the fruit of other varieties. Minimum fruit weight was recorded from the fruits of ceylon blue. Avocado selection 1 and 2 were found at par with respect to fruit weight.

Pit weight: Analysis of variance at 5 % level of significance revealed significant results for pit weight of different varieties of avocado grown under climatic conditions of Murree hills. Avocado selection 2 exhibited higher pit weight while minimum pit weight was recorded from the fruits of california long which was at par with Ceylon blue. While Avocado selection 1 and 2 were also statistically alike (Table 3).

Fruit yield: Fruit yield of 5 varieties of avocado exhibited significant results when analyzed statistically at 5 % level of significance. Maximum yield (79.5 kg) was obtained from trees of avocado selection 1 while minimum (53.1kg) in avocado selection 3 (Fig. 4). California long, ceylon blue and avocado selection 2 found to be at par with respect to fruit yield.

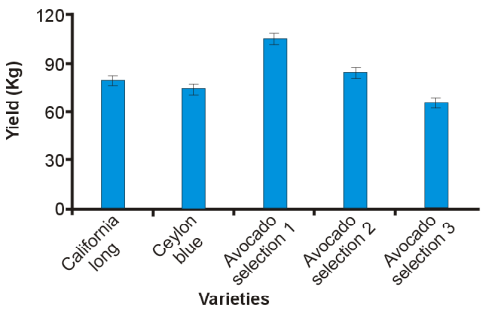

Fig. 4. Fruit yield of five varieties of avocado under Murree hills condition.

Vertical bars represent ± SE of treatment means

Organoleptic parameters

Organoleptic evaluation is a sensory tool to correlate the consumer's preference with physicochemical characteristics of fruits.

Flavor: Data regarding flavor (Table 3) of fruits of different varieties of avocado indicates that significant effect was found regarding their performance in Murree hills condition. Higher hedonic scale reading (8.50) for flavor was recorded (6.00) in avocado selection 1 as compared to Ceylon blue (6). While california long, avocado selection 2 and avocado selection 3 did not show significant difference among means.

Texture: Significant effect at 5 % level of significance (Table 3) was found regarding fruit texture of different varieties of avocado. Fruits harvested from Ceylon blue exhibited higher hedonic scale reading (8) while minimum hedonic scale reading (5) was recorded in avocado selection 3. california long and avocado selection 2 were found to be at par with respect texture.

Pulp color: Color of different varieties of avocado grown under climatic conditions of Murree hillsexhibitedsignificant difference when analyzed statistically at 5 % level of significance for their evaluation study. Higher hedonic scale reading (8.25) was observed in the fruits of avocado selection 1 while minimum (5) from the fruits of avocado selection 3, california long and ceylon blue was found at par with respect to pulp color.

Taste: The data concerning the taste of the fruit was analyzed statistically and found significant. Fruits harvested from Ceylon blue and avocado selection 1 exhibited higher hedonic scale reading (8.00) while lower found in avocado selection 3 (5.25). Maximum hedonic scale reading for fruit taste was observed in ceylon blue as compared to other varieties under study Nisar *et al.* (2001).

CONCLUSION

The studies on the quality characters of Avocado was an effort to showcase the worth of the area in producing very much demanding Avocado variety and subtending significance of this fruit for bringing it in the category of high value fruit crop. The studies are although preliminary in nature but it was ever first effort to persuade the fruit grower of the lower altitudes to include avocado in their horticultural activities as avocado is remunerating in monetary terms on account of its special fruit characters. The foremost

Table 3. Organoleptic analysis of avocado varieties under climatic conditions of Murree Hills

Treatment	Fruit weight	Pit weight	Flavor	Texture	Color	Taste
California long	177.0c	36.0b	7.50b	6.25b	7.00b	5.5bc
Ceylon blue	112.0c	33.0b	6.00d	8.00a	7.25b	8.00a
Avocado selection 1	260.75a	52.75a	8.50a	6.75a	8.25a	8.00a
Avocado selection 2	245.5a	54.75a	7.00bc	6.0bc	8.50a	6.75ab
Avocado selection 3	186.25b	40.00b	6.50cd	5.00c	5.00c	5.25c
Standard error	22.536	4.4826	1.1934	0.8783	1.0711	1.3193

among these is a rich source of cholesterol free fat from the plant origin. The above said single attributes of Avocado is of tremendous health benefits and its large scale cultivation of the dire need of the day

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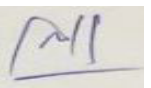
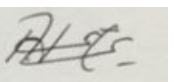
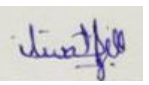
1.	Malik Mohsin Abbas	Conducted the experiment and collected data	
2.	Komal Aslam	Wrote up the manuscript	
3.	Muhammad Ishfaq	Supervised the research and reviewed the manuscript	
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