



**Full Length Article**

# Performance of Loquat (*Eriobotrya japonica*) Genotypes under Agro-Ecological Conditions of Khyber Pakhtunkhwa Province of Pakistan

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## ABSTRACT

Study was conducted to select the better genotypes of loquat (*Eriobotrya japonica* Lindl.) among those growing in Khyber Pakhtunkhwa (KPK), Pakistan. There is a great potential of loquat in the country, but it did not get the attention of the researchers in the past. Khyber Pakhtunkhwa province is rich in genotypes of loquat. At Takht Bhai (TB), an important loquat growing area of the province, 15 loquat genotypes were characterized and compared on the basis of various characteristics. Most of the genotypes had trees with semi upright habit, blunt acute leaf tips and obovoid shape of fruits. Majority of them had fruits with orange yellow skin, while colour of pulp in most of the genotypes was orange. Fruit weight ranged from 11.04 g in TB2 to 47.84 g in TB15. Lowest number of seeds per fruit was observed in TB6 (3.32), while highest in TB15 (5.13). Yield per plant was highest in TB7 (89.85 kg), whereas lowest in TB15 (25.85 kg). Preservation, propagation and commercial plantation of better genotypes identified through this study can play a significant role in improving loquat production as well as income of the farming community. These genotypes may also be utilized in future breeding programs of loquat. © 2011 Friends Science Publishers

**Key Words:** *Eriobotrya japonica*; Loquat; Fruit weight; Fruit yield; Seeds per fruit

## INTRODUCTION

Loquat (*Eriobotrya japonica* Lindl.) is an important fruit crop of two provinces of Pakistan viz. Punjab and Khyber Pakhtunkhwa province. About 98% of total loquat production comes from these two provinces (Hussain *et al.*, 2009a). Generally, in the world, loquat is found between the latitudes 20° and 35° north and south but can be grown up to the latitude 45° (Lin *et al.*, 1999; Polat & Caliskan, 2007). Pakistan is situated between latitudes 24° and 37° while at present most of the loquat growing areas in Pakistan (Kasur, Sargodha, Kalar Kahar, Choa Saiden Shah, Chhattar, Tret, Hasan Abdal, Wah, Haripur & Mardan) lie between latitudes 31° and 34° and there is room to expand its cultivation towards the north up to Malakand and Dir; and the south up to areas including Okara and Sahiwal, as it can grow in the areas, where citrus species are cultivated (Badenes *et al.*, 2000) and Pakistan is one of the largest citrus producing countries of the world (Mahmood & Sheikh, 2006). So there is a great potential of loquat cultivation in the country.

Its fruit develops during winter and ripens at early spring (Hussain *et al.*, 2009a). It gives good returns to the growers, as there is no other fresh fruit available in the

market during March/April to compete with it. A number of genotypes are scattered in different loquat-growing areas, but no study on these genotypes had been carried out in the past. Present paper is a part of the first ever detailed study on loquat in the country. Due to its propagation through seeds, many genotypes have been developed, while there is no standard or identified cultivar available to the growers for cultivation on commercial scale in the loquat growing pockets of Pakistan due to lack in research during past (Hussain *et al.*, 2009b). In general, the fruit weight observed in most of our orchards and markets range from 10 to 18 g. Moreover, it is full of seeds with very little flesh. Concept of only two cultivars exists in the farming community; the red flesh cultivar locally known as 'Ratta' and the white flesh cultivar known as 'Saita'. Actually these are not two cultivars but two loquat groups based on their flesh color, each group comprising of a number of genotypes with a variety of characteristics.

Better genotypes exist rarely in some orchards of the remote areas and most of the orchards are stuffed with the inferior genotypes having poor quality fruit. Khyber Pakhtunkhwa province is rich in genotypes of loquat with better characteristics but people are not aware about the

genetic diversity of loquat as well as presence of better genotypes. Takht Bhai (TB) is an important loquat growing area in the province, where maximum number of loquat genotypes can be found, as the loquat orchards in Mardan region are much larger and huge in size than those found in Punjab. Moreover, the growers are progressive and have maintained the better genotypes through vegetative propagation. Comparative study of these genotypes may be helpful in identifying the best of them for multiplication and plantation in other loquat growing areas. They can also be manipulated in the future breeding programmes for the development of new varieties with better yield and quality.

## MATERIALS AND METHODS

Fifteen loquat genotypes were permanently marked in a loquat orchard at Takht Bhai (district Mardan) located at 71° 55' 39" E longitude and 34° 16' 48" N latitude in Khyber Pakhtunkhwa province. Different codes (TB1 to TB15) were assigned to these genotypes as there is no named loquat cultivar in the country. Morpho-physical characteristics of all the genotypes were observed and comparison was made among them.

Morphological characteristics included in the study were plant growth habit, shape of leaf tip, shape of panicle, shape and colour of fruit and seed. Among physical parameters, fruit length, fruit width, width/length index, fruit weight, number of seeds per fruit, weight of single seed, total seed weight per fruit, flesh to seed ratio, number of fruits per bunch, fruit yield per plant, days taken from full bloom to maturity were taken in account. Furthermore, leaf length, leaf width, leaf area, number of flowers per panicle, panicle size and days from flowering to full bloom were also noted.

Study was conducted in Randomized Complete Block Design with three replications, each replication having one plant per genotype. Data were recorded for two consecutive years and statistical analysis was carried out using MSTATC package (MSTAT, 1999). Results of both the years did not differ significantly, so data was pooled and means were compared by Duncan's Multiple Range test at 5% level of significance (Gomez & Gomez, 1984).

## RESULTS

**General morphology:** Genotypes TB3 and TB11 had upright tree habit; TB8, TB12 and TB15 had spreading tree habit, while all other genotypes had semi upright tree habit. Shape of leaf tip was sharp acute in TB6, whereas blunt acute in all other genotypes. Shape of panicle was truncate conical in TB1, TB4 and TB10; it was cylindrical in TB3, TB6, TB7 and TB15, while conical in all other genotypes (Table I).

**Fruit and seed morphology:** Fruit skin colour was yellow in TB5 and TB11, orange in TB13, yellowish white in TB8 and TB15, while orange yellow in all other genotypes. Pulp

**Table I: General morphological characteristics of the loquat plants of different genotypes**

Genotype codes	Tree habit	Shape of leaf tip	Shape of panicle
TB1	Semi upright	Blunt acute	Truncate conical
TB2	Semi upright	Blunt acute	Conical
TB3	Upright	Blunt acute	Cylindrical
TB4	Semi upright	Blunt acute	Truncate conical
TB5	Semi upright	Blunt acute	Conical
TB6	Semi upright	Sharp acute	Cylindrical
TB7	Semi upright	Blunt acute	Cylindrical
TB8	Spreading	Blunt acute	Conical
TB9	Semi upright	Blunt acute	Conical
TB10	Semi upright	Blunt acute	Truncate conical
TB11	Upright	Blunt acute	Conical
TB12	Spreading	Blunt acute	Conical
TB13	Semi upright	Blunt acute	Conical
TB14	Semi upright	Blunt acute	Conical
TB15	Spreading	Blunt acute	Cylindrical

\*(TB: Takht Bhai)

colour was yellowish white in TB6, orange yellow in TB1, TB3, TB8, TB9 and TB15 while orange in all other genotypes.

Fruit shape was oblong in TB1 and TB10, round in TB3 and TB4 but obovoid in all other genotypes. Fruit shape at the basal end was acute in TB1 and TB2, round in TB4, TB5, TB8 and TB15, whereas obtuse in the remaining genotypes. Fruit shape at the apex was raised in TB1, TB2, TB9, TB10, TB11 and TB14, depressed in TB3 and TB7, while flat in all other genotypes. Seed colour was brown in TB1 and dark brown in TB2. All other genotypes had the seeds with light brown colour. Seed shape was round in TB4 and TB5, while elliptical in all the remaining genotypes (Table II).

**Fruit characteristics:** Fruit characteristics of the genotypes are given in Table III, which shows the significant difference among the genotypes. Fruit length was maximum (5.08 cm) in TB15 followed with non significant difference by TB5 (5.04). It was lowest in TB6 (2.88 cm). Fruit width was highest (4.15 cm) in TB15, which was followed with a significant difference by TB8 and TB13 (both having 3.72 cm width). Lowest fruit width was observed in TB2 (2.49 cm). Width length index was highest in TB3 (0.93) followed by TB6 (0.88) and lowest in TB5 (0.71). Fruit weight was maximum in TB15 (47.84 g) followed by TB8 (46.05 g) while lowest in TB2 (11.04 g). Highest flesh seed ratio by weight (3.05) was observed in TB8. It was followed by TB11, which had this ratio as 2.90. Lowest flesh seed ratio by weight (1.96) was recorded in TB2. Number of fruits per bunch was highest (13.50) in TB1 followed by TB9 (11.23) and minimum in TB14 (6.38). Highest yield per tree was recorded in TB7 (89.85 kg) followed by TB5 (69.47 kg) with a significant difference. TB15 had a yield of 25.85 kg per tree and remained at bottom showing significant difference.

**Seed characteristics:** Significant differences were noted among the genotypes with respect to all the seed characteristics studied (Table IV). Number of seeds per fruit

**Table II: Fruit and seed morphology of loquat genotypes**

Genotype codes	Skin color	Pulp color	Fruit shape	Fruit shape at the basal end	Fruit shape at the apex	Seed color	Seed shape
TB1	Orange yellow	Orange yellow	Oblong	Acute	Raised	Brown	Elliptic
TB2	Orange yellow	Orange	Obovoid	Acute	Raised	Dark brown	Elliptic
TB3	Orange yellow	Orange yellow	Round	Obtuse	Depressed	Light brown	Elliptic
TB4	Orange yellow	Orange	Round	Round	Flat	Light brown	Round
TB5	Yellow	Orange	Obovoid	Round	Flat	Light brown	Round
TB6	Orange yellow	Yellowish white	Obovoid	Obtuse	Flat	Light brown	Elliptic
TB7	Orange yellow	Orange	Obovoid	Obtuse	Depressed	Light brown	Elliptic
TB8	Yellowish white	Orange yellow	Obovoid	Round	Flat	Light brown	Elliptic
TB9	Orange yellow	Orange yellow	Obovoid	Obtuse	Raised	Light brown	Elliptic
TB10	Orange yellow	Orange	Oblong	Obtuse	Raised	Light brown	Elliptic
TB11	Yellow	Orange	Obovoid	Obtuse	Raised	Light brown	Elliptic
TB12	Orange yellow	Orange	Obovoid	Obtuse	Flat	Light brown	Elliptic
TB13	Orange	Orange	Obovoid	Obtuse	Flat	Light brown	Elliptic
TB14	Orange yellow	Orange	Obovoid	Obtuse	Raised	Light brown	Elliptic
TB15	Yellowish white	Orange yellow	Obovoid	Round	Flat	Light brown	Elliptic

\*(TB: Takht Bhai)

**Table III: Fruit characteristics of loquat genotypes**

Fruit characters	TB1	TB2	TB3	TB4	TB5	TB6	TB7	TB8	TB9	TB10	TB11	TB12	TB13	TB14	TB15	CV %
Fruit length (cm)	4.15c	3.01f	3.10f	3.67 e	5.04 a	2.88g	3.90d	4.42b	3.84d	4.20c	4.23c	3.93d	4.43b	3.87d	5.08a	2.18
Fruit width (cm)	3.17e	2.49h	2.88f	2.76 g	3.57 c	2.53h	3.33d	3.72b	2.93f	3.20e	3.33d	3.29d	3.72b	2.76g	4.15a	2.21
Width length index	0.77h	0.83ef	0.93a	0.75h	0.71 i	0.88b	0.85c	0.84d	0.76h	0.76h	0.79g	0.84de	0.84d	0.72i	0.82f	1.08
Fruit weight (g)	29.09e	11.04k	13.68j	16.57h	22.16g	13.86j	26.34f	46.05b	14.50j	26.02f	26.15f	36.52c	33.28d	15.91hi	47.84a	5.91
Flesh seed ratio	2.81bc	1.96h	2.31e	2.13fg	2.78bc	2.02gh	2.83bc	3.05a	2.49d	2.74c	2.90b	2.44d	2.21ef	2.14fg	2.87b	3.87
Fruits per bunch	13.50a	7.45gh	9.47d	7.98fg	7.15h	8.57ef	10.18c	8.43ef	11.23b	10.23c	8.75e	8.05fg	11.03b	6.38i	7.07h	5.56
Yield per tree (kg)	49.37e	39.49h	57.30c	44.88fg	69.47b	44.06g	89.85a	32.08j	52.41d	42.06gh	31.58j	35.07i	47.25ef	36.13i	25.85k	5.29

\*(TB: Takht Bhai); Means not sharing a letter differ significantly at  $P < 0.05$

was maximum (5.13) in TB15, followed by TB8 (4.88) with a significant difference. TB6 had the lowest number of seeds per fruit (3.32). Single seed weight was maximum (2.41 g) in TB15 followed by TB12 (2.40 g) both being at par with each other. TB3 had the lowest seed weight (0.98 g). Total seeds' weight per fruit was maximum in TB15 (12.37 g) followed by TB8 (11.37 g), while minimum in TB2 (3.73 g).

**Leaf characteristic:** All the genotypes exhibited the significant differences with reference to the leaf characteristics studied (Table V). Leaf length was maximum in TB8 (30.16 cm) followed by TB15 (29.98 cm) with a non-significant difference, while it was minimum in TB9 (18.28 cm). Maximum leaf width was recorded in TB15 (9.81 cm). TB5 and TB8 remained at par with it having leaf width of 9.57 cm and 9.75 cm, respectively. Lowest leaf width was observed in TB10 (5.89 cm). TB15 remained at top with reference to leaf area (215.43 cm<sup>2</sup>). TB8 had a leaf area of 214.97 cm<sup>2</sup> and remained at par with TB15. TB10 had the lowest leaf area (75.56 cm<sup>2</sup>).

**Inflorescence and days to maturity:** All the genotypes significantly differed in floral characteristics (Table VI). Number of flowers per panicle was highest in TB4 (172.82) followed by TB7 (164.07), while lowest in TB12 (75.15). Maximum panicle size (23.20 cm) was observed in TB1 which was followed by TB13 (22.80 cm) with non-significant difference. TB10 remained at par with TB13

with a panicle size of 22.51 cm. TB6 had the lowest size of panicle (17.99 cm). TB5 took the maximum time from flowering to full bloom (50.50 days). TB2 followed it with non significant difference by taking 49.17 days from flowering to full bloom. TB6, TB12 and TB15 also remained at par with TB5. The period from flowering to full bloom was shortest in TB9 (39.00 days). TB3 took the maximum time (136.2 days) from full bloom to maturity. TB2 and TB 8 remained at par with it taking 135.0 days and 134.8 days, respectively from full bloom to maturity. This period was shortest in TB13 (117.5 days).

## DISCUSSION

Three types of tree habit i.e., upright, spreading and semi upright has been observed in the genotypes under study. In literature, upright, semi upright and spreading tree habit has been reported in the loquat cultivars 'Cardona', 'Italiano 1' and 'Peluches' respectively (Llacer *et al.*, 2003).

Different fruit skin colors (yellow, orange, yellowish white, orange yellow) and pulp colours (yellowish white, orange yellow, orange) have been noted in this study. Orange yellow skin as well as pulp colour has also been reported in a number of loquat varieties including 'Cardona', 'Algerie' and 'Golden Nugget' (Llacer *et al.* 2003). 'Qingbian' in China has a yellowish white skin colour and white pulp colour (He *et al.*, 2007).

**Table IV: Seed characteristics of loquat genotypes**

Genotypes	Number of seeds per fruit	Single seed weight (g)	Total seeds' weight per fruit (g)
TB1	4.07h	1.88d	7.64d
TB2	3.38k	1.10h	3.73j
TB3	4.22g	0.98i	4.14
TB4	3.85i	1.37g	5.29g
TB5	3.39k	1.73e	5.85f
TB6	3.32k	1.38g	4.58h
TB7	3.63j	1.89d	6.87e
TB8	4.88b	2.33b	11.37b
TB9	4.13h	1.01i	4.15i
TB10	4.33f	1.60f	6.95e
TB11	4.77c	1.41g	6.70e
TB12	4.43e	2.40a	10.61c
TB13	4.67d	2.22c	10.36c
TB14	4.44e	1.14h	5.06g
TB15	5.13a	2.41a	12.37a
CV %	1.70	2.95	3.76

**Table V: Leaf characteristics of loquat genotypes**

Genotypes	Leaf length (cm)	Leaf width (cm)	Leaf area (cm <sup>2</sup> )
TB1	22.02d	8.78b	139.80d
TB2	20.08ef	6.98d	90.43g
TB3	22.48d	8.35c	124.35e
TB4	18.80gh	6.11ef	82.24h
TB5	28.16b	9.57a	166.14b
TB6	21.80d	8.09c	127.79e
TB7	20.47e	6.37e	90.89g
TB8	30.16a	9.75a	214.97a
TB9	18.28h	6.22ef	81.66h
TB10	19.35fg	5.89f	75.56h
TB11	21.77d	8.90b	138.17d
TB12	24.63c	7.22d	112.26f
TB13	22.46d	9.12b	152.52c
TB14	22.43d	7.18d	109.34f
TB15	29.98a	9.81a	215.43a
CV %	3.15	3.58	4.46

**Table VI: Floral characteristics of loquat genotypes**

Genotypes	Number of flowers per panicle	Panicle size (cm)	Days from flowering to full bloom	Days from full bloom to maturity
TB1	105.79 f	23.20 a	43.00 f	132.0 c
TB2	111.39 f	18.55 h	49.17 ab	135.0 ab
TB3	158.45 b	19.81 ef	39.67 g	136.2 a
TB4	172.82 a	19.87 e	42.17 f	123.5 e
TB5	144.18 c	19.31 g	50.50 a	125.8 d
TB6	95.15 g	17.99 i	48.67 abcd	123.7 e
TB7	164.07 b	18.50 h	48.17 bcd	119.2 fg
TB8	90.47 g	18.75 h	47.17 cde	134.8 ab
TB9	122.83 e	21.28 c	39.00 g	133.3 bc
TB10	105.91 f	22.51 b	41.50 f	132.5 c
TB11	136.57 d	19.38 fg	46.00 e	120.8 f
TB12	75.15 h	20.63 d	48.83 abc	123.7 e
TB13	134.00 d	22.80 ab	46.83 de	117.5 g
TB14	144.09 c	18.56 h	42.00 f	118.2 g
TB15	89.58 g	19.60 efg	48.83 abc	131.7 c
CV %	5.00	1.93	3.26	1.31

\*(TB: Takht Bhai); Means not sharing a letter differ significantly at  $P < 0.05$

Obovoid fruit shape has been observed in 'Magdal', 'Golden Nugget' and 'Tanaka' (Llacer *et al.*, 2003), while 'Donghuzao' (Zhao *et al.*, 2001), 'Ningbai', 'Qingzhong'

and 'Baili' (Feng *et al.*, 2007) were found to have round shaped fruit. 'Cardona', 'Alagrie' (Llacer *et al.*, 2003), 'Zhaozhong' and 'Baili' (Feng *et al.*, 2007) have oblong fruit shape.

TB8, TB11, TB15 and TB7 have excellent flesh seed ratios (3.05, 2.90, 2.87 & 2.83), respectively. 'Dr. Trabut', 'Gold Nugget', and 'Baffico' in Turkey have been found to have a flesh seed ratio of 3.79, 3.83 and 4.16, respectively (Durgac *et al.*, 2006).

In Spain, fruit weight of 'Italiano 1' (51.40 g) is not much different from that of TB15 and TB8, while it has only 3.70 seeds per fruit (Llacer *et al.*, 2003). Moreover, its seed content per fruit is just 6.50 g, which is almost half the seed content of TB15 and TB8. Lowest number of seeds per fruit found in TB6 (3.32) is still greater than that of 'Niuteibaisha' cultivar in China having 2.78 seeds per fruit (Feng *et al.*, 2007).

Genotypes with large leaf size are comparable with the Chinese cultivar, 'Guangyu' which has the leaves with 28.70 cm length and 10.00 cm width (Feng *et al.*, 2007). The genotypes with small leaves are comparable with 'Mojia No. 1' having 19.80 cm leaf length and 5.20 cm leaf width (He *et al.*, 2007).

In this study, number of flowers per panicle ranged from 75.15 in TB12 to 172.82 in TB4. In literature, different loquat cultivars have been reported to have different number of flowers per cluster, such as 72 in 'Zhaozhong', 92 in 'Qingzhong' (Feng, 2003), 130.40 in 'Ferdinando', 176.20 in 'Vainiglia' (Insero *et al.*, 2003), 189 in 'Golden Nugget', 227 in 'Buenet' and 273 in 'Saval 2' (Llacer *et al.*, 2003).

Out of the 15 genotypes at Takht Bhai, 8 have been observed to have fruit weight more than 25 g and three among them (TB8, TB12 & TB15) have fruit weight even more than 35 g. The highest fruit weight observed in TB15 (47.84 g) and TB8 (46.05 g) is slightly greater than that of 'Magdal' (45.50 g) and 'Cardona' (45.40 g) recorded in Spain (Llacer *et al.*, 2003). It is almost double the size of 'Wuerbaisha', a loquat cultivar in China, which had fruit weight of 24.80 g (Feng *et al.*, 2007). On the other hand, a number of cultivars in China and Spain have even higher fruit weight. 'Zhaozhong 6' (Zheng, 2001), 'Mojia No. 1' (He *et al.*, 2007), 'Donghuzao' (Zhao *et al.*, 2001) and 'Hongdenglong' (Jiang *et al.*, 2001) have fruit weight of 52.1 g, 53.2 g, 59.2 g and 63.1 g respectively. 'Tanaka' and 'Algerie', cultivars in Spain have fruit weight of 60.60 g and 65.00 g respectively, while fruit weight of 'Peluches' in Spain has been reported as 95.00 g (Llacer *et al.*, 2003), almost double the size of TB15 and TB8. Anyhow, no cultivar has yet been observed in Pakistan to have the fruits larger than those of TB15 and TB8. Fruit weight in these two genotypes is more than double the fruit weight observed in the genotypes in Chakwal district (Hussain *et al.*, 2009a).

Three genotypes TB3, TB5 and TB7 are the best with reference to yield per plant which is 57.30 kg, 69.47 kg and 89.85 kg, respectively. Yield of the first two genotypes is comparable with that of 'Champagne de Grasse' (70 kg per

plant) and 'M. Marie' (69 kg per plant) observed in Turkey (Karadeniz, 2003), while TB7 has a much higher yield as compared with that of 'Algerie' and 'Gold Nugget' (Hermoso & Farre, 2003), which have been reported to have a yield of 74 kg and 72 kg per plant respectively in Spain.

In conclusion, superior genotypes having greater fruit weight, higher yield and greater flesh seed ratio can be recommended for further propagation and plantation in the loquat growing areas of the country for getting better returns. They can also provide a base for planning the future breeding programs for this crop.

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