Research Article

Ekin
Journal of Crop Breeding and Genetics

11(2):99-108, 2025

www.ekinjournal.com

Ekin International biannual peer-reviewed journal

DUS Characterization of Phalsa (*Grewia subinaequalis* DC.) Genotypes

Mukesh KUMAR[1*] Anuradha BISHNOI[1] Rajesh Kumar ARYA[2] Ram Karan GAUR[3]

[1] Chaudhary Charan Singh Haryana Agricultural University, Regional Research Station, Bawal (Haryana), India
[2] Department of Genetics and Plant Breeding, Chaudhary Charan Singh Haryana Agricultural University, Hisar, India
[3] Chaudhary Charan Singh Haryana Agricultural University, Krishi Vigyan Kendra, Rohtak (Haryana), India

[*] Corresponding author e-mail: sabharwalmk@hau.ac.in

Citation:
Kumar M., Bishnoi A., Arya RK., Gaur RK., 2025. DUS Characterization of Phalsa (*Grewia subinaequalis* DC.) Genotypes. Ekin J. 11(2):99-108.

Received: 08.06.2025 ***Accepted: 25.06.2025*** ***Published Online: 31.07.2025*** ***Printed: 31.07.2025***

ABSTRACT

Phalsa genotypes were characterized on the basis of DUS guidelines at experimental orchard, RRS Bawal. The genotypes were maintained under similar agronomic practices in randomized block design. The growth parameters were measured in the month of May and fruiting parameters were recorded at the maturity of fruits or at the time of picking. The qualitative data was observed by jury members by matching with the DUS characteristics. On overall basis the genotype was divided into three groups, tall, dwarf and tall plants with globose shaped fruits. The dwarf genotype starts bearing earlier than tall plants and tall plants with globose shaped fruits were late bearers. The yield of tall genotype was higher as compared to dwarf. However, shelf life of dwarf plants (roundish fruit), tall plants (roundish shape) and tall plants with globose shaped fruits was more as compared to fruits of tall plant. Fruits of tall genotypes were slightly infected with fruit fly in the last picking; however other two genotypes (dwarf plants and tall plant with globose shaped fruits) were resistant to fruit fly. None of the genotypes was infected with any disease. The fruit size and fruit weight of globose shaped fruits was more, however the seed size was also more. It is concluded from the four years study that the tall genotype having globose shaped fruits is a new and elite genotype with higher fruit weight, fruit yield and shelf life of fruits.

Keywords: Phalsa (*Grewia subinaequalis* DC.), DUS, genotypes, yield, shelf life, fruit fly

Introduction

Phalsa (*Grewia subinaequalis* DC.) is an important fruit crops of India and Southern Asia. It is hardy and drought tolerant crop, it can be grown on all kind of soils and climate except high altitude. India is said to be the home of phalsa because it is originated in India and South-East Asia. It yields delicious, sour to sweet, pleasant flavored edible quality fruits. Among 140 species of genus *Grewia*, only *subinaequalis* species produce commercially important fruits. It belongs to family Tiliaceae. Phalsa requires least inputs and has less attack of diseases and insect-pests. Under subtropical plants normally shed their leaves during the winter season; however, under tropical conditions, plants remain evergreen. The plant growth was observed optimum at 3°C to 45°C temperature and under light frost conditions. Fruit development, ripening and fruit color development requires a good amount of sunlight. It grows well on low fertile barren lands but well-drained loamy soil with a pH range from 6.1 to 6.5 is found the best for its growth, productivity and quality. The juice content in ripe fruits varied from 50-60, sugars 10-11 per cent and acids 2.0-2.5 per cent and a good source of vitamin A and C. Calories and fat are low in its fruit, while minerals and fibers are high. This is also a fair source of phosphorus 24.2 mg/100gm (Yadav, 1999) and iron 140.8 mg/100gm of fresh fruit weight (Khan et al., 2006). Ripened fruits are perishable so consumed fresh and may be processed in soft drinks *viz*; squash, juice, syrup, etc. Its fruits gave a cooling effect to stomach during summer. *Grewia* species are of high medicinal value due to presence of different metabolites like saponins, coumarins, anthraquinone (Sharma and Patni, 2013).

It is also associated with many health benefits, builds muscle, healthy bones, relieves stomachache, promotes healthy heart, prevents diabetes, lower down cancer risk (Steinmetz and Potter, 1991), cures anemia (Khemiss et al., 2006), heals wounds (Sharma and Patni, 2013), anti-inflammation, anti-microbial, treat respiratory problems and source of antioxidants (Kaur and Kapoor, 2005). The extract of bark (mucilaginous) is used to clarifying sugar and jaggery, and fibre for making rope. The wood of annual pruning are used for support sticks, basket making and fuel. Keeping in view the above benefits, the emphasis has been made to study the adaptability of different genotypes based on growth, yield and quality. The genotypes were evaluated to study the variation among different genotypes using the DUS guidelines. The suitable genotypes can be selected for the semi-arid conditions. This will also help the orchardist in the selection of an appropriate genotype of this neglected crop for large-scale cultivation or to include in breeding programme and to get higher yield of quality fruits. Therefore, this study has been planned to fulfill the gaps, increase adoption, awareness of this crop among farmers and fulfill the gap of productivity. This crop is most suitable for natural farming in hot arid climate because its litter fall increase organic carbon and fertility of the soil.

Materials and Methods

The experiment was conducted on 39 years old phalsa plants planted at 3 m x 3 m spacing in the experimental orchard, CCS Haryana Agricultural University, Regional Research Station, Bawal (Rewari), Haryana situated at an altitude of 266 m above mean sea level with coordinates of 28º 10′ N latitude and 76º 50′ E longitudes in South-West zone of Haryana. It comes under a typical semi-arid climatic zone with hot and dry summer during May and June (45°C and above) and extremely cold winter during December-January (0°C and below). The average rainfall is 456 mm, 80-85 per cent of total annual rainfall is received from the South West monsoon, i.e., from July to September, and a little shower of rainfall is received from December to February. On the basis of visual observations, a total of thirty-nine uniformly grown genotypes were selected randomly in three replications and maintained under uniform conditions of orchard management practices during the study period.

Thirty-five seedling plants of phalsa were selected to study the DUS characteristics. On the basis of plant height, plants were divided into two groups dwarf and tall while tall group was further divided into tall with round fruit and tall with (globose shaped fruit). The growth parameters of phalsa were recorded as per descriptor (Table 1) of NBPGR (Mahajan et al., 2002), and guidelines for DUS testing of PPV and FRA (Anonymous, 2016). Plant height was measured with the help of a graduated measuring pole from ground level to the tip of the highest shoot and the average height was expressed in a meter. Canopy spread was measured in both directions, *i.e.*, north to south and east to west, with the help of a graduated measuring tape. The average plant spread was calculated and expressed in a meter.

Internodal length, space between two nodes was recorded and average of middle internodes of five randomly selected shoots / plant was measured with the help of scale and mean value was worked out and expressed in centimeter. Tree habit was observed visually for depicting the shape of the tree at flowering and fruiting stage as upright, spreading and drooping as per tree shape given in the guidelines for DUS testing of PPV and FRA (Anonymous, 2016). Leaf shape was observed visually from mature leaves and marked as ovate (leaves which are egg-shaped, with the broader end of the leaf nearest the petiole), oblong (leaves almost resembling a rectangle with round corners) and elliptical (leaves are about twice as long as broad, the broadest part is in the middle and the two ends narrow equally). The margin of the leaves was observed visually from mature leaves as serrate, irregular and dentate. The pubescence on the dorsal side of mature leaves was observed with the help of convex lens at leaf maturity stage as sparse, medium and dense. The surface colour on the dorsal side of mature leaves was observed visually at maturity stage and marked as greenish white, light green, green etc. as per standard colour chart at the leaf maturity stage. Ten mature leaves were selected randomly from each direction of a plant. These leaves were used to measure leaf length and width with the help of measuring scale and mean value was calculated and expressed in centimeter. The type of inflorescence was observed visually during flowering as axillary cyme, leaf opposite cyme and axillary clusters based on group or cluster of flowers arranged on the stem. Numbers of flowers were counted manually from five randomly selected inflorescence from each direction of plant and mean value was worked out. Date of the start of flowering was observed at five per cent flower buds opening stage from tagged branches.

The date of the end of flowering was noted when 85-90 per cent flower buds opened on the tagged branches. The duration/ variation in the end of flowering in different plants was mentioned in a range. The petal colour was observed visually during flowering as yellow, dull yellow and others as per

standard colour chart. Uniformly ripened healthy fruits free from any injury or disease were harvested from each direction of tagged branches for the estimation of physio-chemical characteristics. The date of 50 per cent fruits maturity was noted when at least 50 per cent fruits attained maturity on the tagged branches. The variation in 50 per cent fruits maturity in different replications was mentioned in a range/period. The ripened fruits were picked and number of pickings were counted. Fruit length was recorded as average of 50 fruits per plant plucked randomly and their length from distal to proximal end and fruit breadth was measured with the help of digital vernier calipers and the average value was calculated and expressed in millimeter. These fruits were weighed on digital electronic balance and average fruit weight was calculated and expressed in gram. The shape of fruits was observed visually as round, globose and others based on curvature at the distal end of the fruit. Visual interpretation of fruit skin colour was carried out by considering the outer surface colour of the ripe fruits and marked as red, dark red, purple, deep purple and others as per standard colour chart. Fruit lobe was also observed visually as present or absent.

Ripened fruits collected from different directions of the plant were used to extract the juice and the quantity of juice extracted per 100 g fruit was expressed as low, medium and high. Ripened fruits were smashed to extract seeds and counted the number of seeds per fruit and average number of seeds per fruit was worked out. These seeds were used for 100 seed weight and average weight was expressed in gram. Seed edible quality was tested organoleptically by jury of 10 members. The weight of harvested fruits after each picking was recorded for final yield per plant and expressed as low (5 kg/plant), medium (7.5 kg/plant) and high (10 kg/ plant). Freshly harvested fruits were kept in perforated paper bags at room temperature to study shelf life. Loss in fruit weight was recorded at 6 hours interval and calculated as percent loss. Fruits were considered as spoiled when they start shriveling and become soft, and start oozing out liquid from stalk end of the fruit. When fruits decayed above 50 percent were considered as the end of shelf life. The ERMA made Hand Refractometer of 0 to 32 was used to determined TSS at 20°C. The refractometer was calibrated with distilled water after every sample and the unit value of TSS was expressed in degree Brix (°B).

Results and Discussion

On the basis of plant height, plants were divided into two groups tall and dwarf. The qualitative characters of different genotypes such as plant height ranged from 1.01 m to 2.91 m (Table 3a), tree spread 1.58 m - 3.69 m (Table 3b), internodal length 5.98 cm to 7.82 cm (Table 3c), leaf length 12.10 cm - 16.84 cm (Table 3d), leaf width 10.02 to 15.72 cm. The lowest tree spread was observed in dwarf plants. Genetic constitution/ variation in individual genotype or their acclimatization to varied agro-climatic conditions might be the reasons for variations in different characters (Singh et al., 2014). The observed differences in the growth of genotypes under different agro-climatic conditions might be due to their genetic makeup, prevailing climatic conditions and/or the interaction effect of genotype with the environment. The selection of cultivar must be based on the performance of genotype/ variety under particular condition because the same cultivars behave differently with a change in agro-climatic conditions. The variability in growth characters of plants might be due to specific characters of germplasm/ cultivar (Kumar et al., 2021). Similar type of variation was also observed in plant habit of Aonla under different agro-climatic conditions (Pathak et al., 2004; Singh et al., 2015; Kumar et al., 2016). The morphological variation in genotypes may be due to inherent genetic characteristics of genotypes (Kumar et al., 2024a)

Leaf shape was observed as cordate and leaf margin was serrate in all the genotypes. Pubescence on the dorsal side were observed as dense in double seeded trees, medium in tall and sparse in dwarf trees (Table 2). Leaf margin of all the genotypes was observed as serrated. The variability in phalsa leaf margin was observed similar by Haq et al., (2013). The similarity in the leaf margin of different genotypes might be due to the close relation in the genetic makeup of plant.

Leaf colour on dorsal side of the leaf was observed greenish white in dwarf trees, however, green in tall and double seeded trees. These types of variation in colour on the dorsal side of phalsa leaves were also found by Dhawan et al., (1993) and Mishra et al., (2018). Leaf size was observed (length and breadth) less in dwarf trees than tall and double seeded trees. The leaf size of the plant under humid conditions may be slightly more as compared to arid conditions. However, the variation in leaf size under similar conditions may be due to its genetic variability. These types of variation in leaf length and width of phalsa were also observed by Mishra et al., (2018) under the arid condition of CAZRI, Jodhpur.

Inflorescence type in all the genotypes was observed as auxiliary cluster, and the petals are dull yellow. This variation in inflorescence type and the number of inflorescences might be due to the genetic makeup of genotypes. However, such variations in a number of flowers per cyme in different ber cultivars were also observed by Gupta (2001) in Haryana.

Number of flower clusters per leaf were observed highest in dwarf trees, however, number of flowers per inflorescence were observed highest in tall and double seeded trees (Table 4-7). Start of flowering, end of flowering and fruit maturity were observed earliest in dwarf trees; however, these were observed late in tall double-seeded trees, and the number of fruit pickings was observed to be lowest. In case of dwarf and tall trees number of pickings varied from 6-8. This may be due to the requirement of environmental / physiological conditions of the particular genotype during this period. Such type of variation in fruit maturity was also found by Dhaliwal et al., (2012), Aulakh et al., (2013), Bakshi et al., (2015) in different Aonla cultivars.

Fruit length, fruit width and fruit weight were observed to be highest in double-seeded trees; however, these were observed to be observed lowest in dwarf trees (Table 4-7). Fruits of dwarf and tall trees were observed round in shape with bright purple colour whereas fruits of double seeded were lobbed with globose shaped and are dull purple in colour. Fruit lobe was present in all tall double seeded genotype, whereas it was absent in tall single seeded and dwarf genotypes. The variation in the present or absent of lob may be due to the number of seeds per fruit and it clear from the results that the fruits had two lobs were double seeded and without lob were single seeded or seeds are adjoining to each other. Moreover, extensive genetic variations in genotypes are significant for breeders to develop high-yielding varieties, premium quality fruits, and resistant or tolerant to various biotic/abiotic stresses (Kumar et al., 2024b).

Fruits from double seeded trees have highest TSS, however, fruits of dwarf and tall trees have less TSS (Table 4-7). Juice content was less in fruits from double seeded trees (Table 2). These variations in juice content of some genotypes might be due to more uptake of water, nutrients and also due to the translocation of photosynthates from source to sink. However, Muhammad et al., (2013) observed increase in juice yield in the tall type. Ray and Bala (2016) studied the shelf life and reported that the shelf life of phalsa varies between 24-48 h at ambient storage conditions. Mishra et al., (2018) observed 14 °B TSS in tall type phalsa genotype whereas 18-20 °B in dwarf type phalsa genotypes.

Seeds of double seeded were hard and comparatively large in size having more 100 seeds weight, whereas dwarf trees have smallest seeds (Table 4-7). Seeds of double seeded fruits were non-edible. Productivity and shelf life of the double seeded fruits was observed more as compared to other genotype. The lowest shelf life was observed in fruits of tall seedlings.

Infestation of fruit fly was observed in the last harvest of tall trees. The fruits from double seeded and dwarf trees were free from infestation of fruit fly. No disease incidence was observed in genotypes.

Off season flowering: The off-season flowering in phalsa might be due to global warming/variation in rainfall/ stress conditions or changes in tree physiology resulted in missing of particular phase after fruit harvest. The partial flowering occurs in plant it may exhaust plant and disturb the routine growth of plant. The fruit were not developed properly and drop subsequently. Similarly, these types of variation in off-season flowering and fruiting characteristics of phalsa were also found by Rai et al., (2002) in Aonla and Mishra et al., (2016) in different tropical and sub-tropical fruits.

Table 1. Descriptors of Phalsa.

Type of Planting Material	**Code**	**Tree Habit**	**Code**	**Leaf Shape**	**Code**
Seedling	1	Upright	3	Ovate	1
Cutting	2	Spreading	5	Oblong	2
Others	99	Drooping	7	Cordate	3
Leaf margin	**Code**	**Leaf pubescence on dorsal side**	**Code**	Elliptic	4
Serrate	1	Sparse	3	Oblong lanceolate	5
Irregular toothed	2	Medium	5	Other	99
Dentate	3	Dense	7	**Leaf surface colour on dorsal side**	**Code**
Inflorescence type	**Code**	**Patl colour**	**Code**	Greenish white	1
Axillary	1	Yellow	1	Light green	2
Leaf opposed cyme	2	Dull yellow	2	Green	3
Axillary cluster	3	Others	99	Other	99
Fruit skin colour	**Code**	**Fruit lobe**	**Code**	**Fruit shape**	**Code**
Red	1	Absent	0	Round	1
Dark Red	2	Present	1	Globose	2
Purple	3	**Productivity status**	**Code**	Others	99
Deep purple	4	Low (< 5 kg/ plant)	3	**Biotic stress susceptibility Categories**	**Rating**
Others	99	Medium (5 to 10 kg/ plant)	5	Very low or no visible sign of susceptibility	0-5%
Juiciness	**Code**	High (> 10kg/ plant)	7	Low	5-10%
Low	3	**Seed edible quality**	**Code**	Intermediate	10-20%
Medium	5	Non edible	0	High	20-40%
High	7	Edible	1	Very High	>40%

Table 2. Evaluation of phalsa genotypes as per DUS guidelines 2019-22

S. No.	**Characters**	**Type of Phalsa Genotypes**		
		Dwarf	**Tall**	**Double Seeded (tall)**
1	Type of planting material	1	1	1
2	Tree habit	7	5	5
3	Leaf shape	3	3	3
4	Leaf Margin	1	1	1
5	Leaf pubescence on dorsal side	3	5	7
6	Leaf surface colour on dorsal side	1	3	3
7	Inflorescence type	3	3	3
8	Petal colour*	2	2	2
9	Fruit shape	1	1	2
10	Fruit skin colour	4	4	3
11	Fruit lobe	0	0	1
12	Juiciness	7	7	5
13	Seed edible quality	1	1	0
14	Productivity status	5	7	7
15	Biotic stress susceptibility (insect pest)	1**	2**	1**

*Light pink at maturity

** The infestation of fruit fly was (*Bactrocera dorsalis*) was noticed as 3.0% in dwarf and 6.0% in tall during the month of June.

Table 3a. Plant height (m) of phalsa genotypes (2019-22).

Germplasm	Plant Height (m)			
	2019	2020	2021	2022
Dwarf	1.01±0.10	1.09±0.10	1.12±0.11	1.12±0.11
Tall	2.81±0.04	2.72±0.05	2.78±0.04	2.81±0.01
Double seeded (tall)	2.88±0.05	2.83±0.05	2.91±0.05	2.85±0.06
Range	1.01-2.88	1.09-2.83	1.12-2.91	1.12-2.85
CD (p=0.05)	0.22	0.18	0.18	0.21

Table 3b. Tree spread (m) of phalsa genotypes (2019-22).

Germplasm	Tree Spread (m)			
	2019	2020	2021	2022
Dwarf	1.62±0.04	1.58±0.05	1.58±0.05	1.58±0.05
Tall	2.52±0.35	3.07±0.05	2.87±0.19	2.95±0.12
Double seeded (tall)	3.54±0.17	3.67±0.19	3.65±0.19	3.69±0.19
Range	1.62-3.54	1.58-3.67	1.58-3.65	1.58-3.69
CD (p=0.05)	0.76	0.33	0.42	0.42

Table 3c. Internodal length (cm) of phalsa genotypes (2019-22).

Germplasm	Internode Length (cm)			
	2019	2020	2021	2022
Dwarf	6.14±0.08	6.04±0.09	6.02±0.11	5.98±0.18
Tall	6.10±0.07	7.53±0.24	7.50±0.25	7.54±0.34
Double seeded (tall)	7.76±0.20	7.64±0.20	7.70±0.19	7.82±0.17
Range	6.10-7.76	6.04-7.64	6.02-7.70	5.98-7.82
CD (p=0.05)	0.40	0.42	0.42	0.90

Table 3d. Leaf length (cm) of phalsa genotypes (2019-22).

Germplasm	Leaf Length (cm)			
	2019	2020	2021	2022
Dwarf	12.24±0.23	12.10±0.24	12.12±0.23	12.16±0.19
Tall	16.54±0.15	16.74±0.16	16.76±0.19	16.84±0.21
Double seeded (tall)	16.48±0.42	16.42±0.39	16.52±0.39	16.76±0.43
Range	12.24-16.54	12.10-16.74	12.12-16.76	12.16-16.84
CD (p=0.05)	0.93	0.44	0.51	0.48

Table 3e. Leaf width (cm) of phalsa genotypes (2019-22).

Germplasm	Leaf Width (cm)			
	2019	2020	2021	2022
Dwarf	10.02±0.09	10.06±0.11	10.16±0.09	10.02±0.16
Tall	15.64±0.19	15.60±0.18	15.70±0.18	15.70±0.21
Double seeded (tall)	15.42±0.13	15.50±0.15	15.72±0.17	15.68±0.21
Range	10.02-15.64	10.06-15.60	10.16-15.72	10.02-15.70
CD (p=0.05)	0.48	0.23	0.26	0.60

Table 4. Evaluation of phalsa genotypes for quality parameters as per DUS guidelines 2019.

S. No.	Characters	Type of Phalsa Genotypes		
		Dwarf	Tall	Double Seeded (tall)
1	Number of clusters per leaf axil	10-12	8-10	7-10
2	Number of flowers per inflorescence	2-5	3-4	3-4
3	Date of starting of flowering (at 5% buds opened)	22-26 March	25-31 March	1-6 April
4	Date of end of flowering (at 85 to 90% flowers bud opened)	25-30 April	1-8 May	15-22 May
5	Date of 50% fruit maturity (> 50% fruits attain maturity)	20-25 May	22-28 May	1-7 June
6	Number of fruit pickings	6-8	6-8	3-4
7	Fruit length (mm)	11.8-12.8	12.1-14.1	13.7-15.6
8	Fruit width (mm)	9.1-10.2	9.8-11.3	10.6-11.3
9	Fruit weight (g)	0.8-1.1	0.9-1.2	1.2-1.5
10	TSS (ºB)	18.1-19.2	18.9-20.8	21.4-22.8
11	Number of seeds per fruit	1-2	1-2	2
12	100 seed weight (g)	5.6-6.2	6.1-6.6	6.8-7.8
13	Shelf life	24 hr	24 hr	48 hr

Table 5. Evaluation of Phalsa genotypes for plant and fruit attributes as per DUS guidelines 2020.

S. No.	Characters	Type of Phalsa Genotypes		
		Dwarf	Tall	Double Seeded (tall)
1	Number of clusters per leaf axil	10-12	8-10	7-10
2	Number of flowers per inflorescence	2-5	3-4	3-4
3	Date of starting of flowering (at 5% buds opened)	22-27 March	25-2 April	1-7 April
4	Date of end of flowering (at 85 to 90% flowers bud opened)	25-2 April	1-9 May	14-22 May
5	Date of 50% fruit maturity (> 50% fruits attain maturity)	20-26 May	22-29 May	29 May-7 June
6	Number of fruit pickings	6-8	6-8	3-4
7	Fruit length (mm)	11.8-12.8	12.1-14.1	13.7-15.6
8	Fruit width (mm)	9.1-10.1	9.8-11.2	10.6-11.2
9	Fruit weight (g)	0.8-1.1	0.9-1.2	1.2-1.6
10	TSS (ºB)	18.2-19.2	18.8-20.8	21.2-22.8
11	Number of seeds per fruit	1-2	1-2	2
12	100 seed weight (g)	5.6-6.2	6.1-6.6	6.8-7.8
13	Shelf life	24 hr	24 hr	48 hr

Table 6. Evaluation of Phalsa genotypes for quality parameters as per DUS guidelines 2021.

S. No.	Characters	Type of Phalsa Genotypes		
		Dwarf	Tall	Double Seeded (tall)
1	Number of clusters per leaf axil	10-12	8-10	7-10
2	Number of flowers per inflorescence	2-5	3-4	3-4
3	Date of starting of flowering (at 5% buds opened)	23-29 March	26 March -3 April	2-9 April
4	Date of end of flowering (at 85 to 90% flowers bud opened)	26 April -3 May	1-8 May	15-23 May
5	Date of 50% fruit maturity (> 50% fruits attain maturity)	22-28 May	24-31 May	31 May-9 June
6	Number of fruit pickings	6-8	6-8	3-4
7	Fruit length (mm)	11.6-12.7	12.2-14.0	13.6-15.7
8	Fruit width (mm)	9.2-10.1	9.9-11.3	10.7-11.3
9	Fruit weight (g)	0.80-1.15	0.90-1.25	1.20-1.65
10	TSS (ºB)	18.1-19.3	18.7-20.9	21.3-22.9
11	Number of seeds per fruit	1-2	1-2	2
12	100 seed weight (g)	5.6-6.2	6.1-6.6	6.8-7.8
13	Shelf life	24 hr	24 hr	48 hr

Table 7. Evaluation of Phalsa genotypes for quality parameters as per DUS guidelines 2022.

S. No.	Characters	Type of Phalsa Genotypes		
		Dwarf	Tall	Double Seeded (tall)
1	Number of clusters per leaf axil	10-12	8-10	7-10
2	Number of flowers per inflorescence	2-5	3-4	3-4
3	Date of starting of flowering (at 5% buds opened)	22-31 March	24 March -5 April	4-12 April
4	Date of end of flowering (at 85 to 90% flowers bud opened)	25 April -5 May	2-10 May	17-25 May
5	Date of 50% fruit maturity (> 50% fruits attain maturity)	23-30 May	25-31 May	29 May-10 June
6	Number of fruit pickings	6-8	6-8	3-4
7	Fruit length (mm)	11.7-12.8	12.3-14.1	13.5-15.9
8	Fruit width (mm)	9.3-10.2	9.9-11.2	10.8-11.4
9	Fruit weight (g)	0.81-1.12	0.92-1.27	1.22-1.70
10	TSS (ºB)	18.2-19.4	18.6-20.9	21.1-22.9
11	Number of seeds per fruit	1-2	1-2	2
12	100 seed weight (g)	5.76-6.3	6.0-6.7	6.7-7.9
13	Shelf life	24 hr	24 hr	48 hr

References

Anonymous (2016). Guidelines of PPV&FRA for the conduct of test for distinctiveness, uniformity and stability on Indian gooseberry (*Emblica officinalis* Gaertn.). Plant Variety Journal of India, 10(2).

Aulakh PS, Kaur A, Singh J & Thakur A, (2013). Performance of Aonla (*Emblica officinalis* Gaertn.) cultivars in Punjab. Journal of Research Punjab Agricultural University, 50(3):110-113.

Bakshi P, Wali VK, Jasrotia A, Sharma A & Iqbal M, (2015). Evaluation of different Aonla (*Emblica officinalis*) cultivars under rainfed conditions of lower Shivalik foothills of Himalayas. Indian Journal of Agricultural Sciences, 85(8):1012-1016. https://doi.org/10.56093/ijas.v85i8.50817

Mor R, Kumar M, Kumar S, Kumari S and Jat ML, (2022). Decipheration of flowering and fruiting characters in phalsa (*Grewia subinaequalis*) germplasm under semi-arid conditions of Haryana. Current Horticulture, 10(2):62-65. https://doi.org/10.48165/

Dhawan K, Malhotra S, Dhawan SS, Singh D & Dhindsa KS, (1993). Nutrient composition and electrophoretic pattern of protein in two distinct types of Phalsa (*Grewia subinaequalis* DC). Plant Foods for Human Nutrition, 44(3):255-260. https://doi.org/10.1007/bf01088320

Gupta RB, (2001). Cyto-morphological studies in wild and cultivated species of ber [Master's thesis, CCS Haryana Agricultural University]. Hisar.

Haq MZ, Stankovic MS, Rizwan K & De Feo V, (2013). Phalsa (*Grewia asiatica* L.) food plant with multiple uses. Molecules, 18, 2663-2682. https://doi.org/10.3390/molecules18032663

Kaur C & Kapoor HC, (2005). Antioxidant activity of some fruits in Indian diet. In ISHS Acta Horticulturae. VII International Symposium on Temperate Zone Fruits in the Tropics and Subtropics, Part II (Vol. 696, pp. 563-565).

Khan AS, Hussain A & Khan F, (2006). Nutritional importance of micronutrients in some edible wild and unconventional fruits. Journal of Chemical Society of Pakistan*, (28)*:576-582.

Khemiss F, Ghoul-Mazgar, S, Moshtaghie AA & Saidane D, (2006). Study of the effect of aqueous extract of *Grewia tenax* fruit on iron absorption by everted gut sac. Journal of Ethnopharmacology, 103(1):90-98. https://doi.org/10.1016/j.jep.2005.07.017

Kumar M, Arya R, Kumar M, Gaur RK & Sharma S, (2021). Evaluation of Aonla varieties under semi-arid conditions of Haryana. EKIN Journal of Crop Breeding and Genetics, 7(2):139-144.

Kumar S, Sharma JR, Kumar M, Singh N & Kumar N, (2024). Evaluation of ber genotypes grown under semi-arid condition. Indian Journal of Horticulture, 81(4):359-365. https://doi.org/10.58993/ijh/2024.81.4.4

Kumar R, Khadda BS, Jadav JK, Rai AK, Khajuria S & Lata K, (2016). Evaluation of aonla (*Emblica officinalis*) varieties under hot semi-arid conditions of Western India. Current Horticulture, 4(2):39-43.

Kumar S, Sharma JR, Kumar M, Bishnoi M, Reetika & Gavri A, (2024a). Evaluation of ber (*Ziziphus mauritiana*) genotypes under semi-arid region of Haryana. Indian Journal of Agricultural Sciences, 94(8):881-889. DOI: 10.56093/ijas.v94i8.147830

Mahajan RK, Gangopadhyay KK, Kumar G, Dobhal VK, Srivastava U, Gupta PN & Pareek SK, (2002). Minimal descriptors agri-horticultural crops: Fruit crops. NBPGR, 3, 168-171.

Mishra DS, Tripathi A & Nimbolkar PK, (2016). Review on physiological disorders of tropical and subtropical fruits: Causes and management approach. International Journal of Agriculture Environment and Biotechnology, 9(6):925. 10.5958/2230-732X.2016.00120.0

Mishra D, Kumar R & Singh A, (2018). Phalsa (*Grewia subinaequalis* DC.). In S. N. Ghosh (Ed.), Breeding of Underutilized Fruit Crops (1st ed., pp. 405-410). Narendra Publishing House.

Muhammad Z, Milan SS, Komal R & Vincenzo DF, (2013). *Grewia asiatica* L., a food plant with multiple uses. Molecules*,* 18(3):2663-2682. doi: 10.3390/molecules18032663

Pathak RK, Singh S & Saroj PL, (2004). Aonla. In P. L. Saroj & O. P. Awasthi (Eds.), Advances in Arid Horticulture (Vol. 2, pp. 1-20). IBDC Publishers.

Rai M, Nath V, Singh HS, Dwivedi R & Gangopadhaya KK, (2002). Overcoming off season flowering in aonla. Indian Horticulture, 47(3):12-13.

Ray A & Bala K, (2016). Effects of storage conditions on sensory attributes of phalsa fruit (*Grewia asiatica*) of variety Sharbati. International Journal of Advanced Research in Science and Engineering, 5(8):720-725.

Sharma N & Patni V, (2013). *In vivo* and *in vitro* qualitative phytochemical screening of *Grewia* species. International Journal of Bio. Pharm Research, 4(9):634-639.

Singh AK, Singh S & Makwana P, (2015). Characterization of aonla (*Emblica officinalis*) varieties under zero irrigation semi-arid conditions. Indian Journal of Agricultural Sciences, 85(10):1365-1369. https://doi.org/10.56093/ijas.v85i10.52308

Singh RS, Bhargava R, Pal G & Sharma BD, (2014). Effect of spacing on growth and biomass production in bael (*Aegle marmelos* Correa) under hot arid conditions. Progressive Horticulture, 46(1):58-60.

Steinmetz K & Potter J, (1991). Vegetables, fruit and cancer epidemiology. Cancer Causes & Control, 2(5):325-357.

Yadav AK, (1999). Phalsa: A potential new small fruit for Georgia. In J. Janick (Ed.), Perspectives on New Crops and New Uses (pp. 348-352). ASHS.